WEED REMOVAL TIMING WITH ROUNDUP READY CORN

D. Wilson, M. VanGessel, Q. Johnson, A. Cooper[1]

ABSTRACT

The advent of herbicide resistant crops has greatly reduced the amount of time and labor necessary to conduct weed removal experiments. Weed removal with herbicides differs from hand weeding in that weed death occurs over a period of time during which the weeds continue to compete with the crop. Experiments were conducted to examine weed removal timing with Roundup Ultra (glyphosate) in Roundup Ready corn in 1998 and 1999 at Georgetown and Middletown, DE. Treatments included weedy and weed-free checks, a preemergence (PRE) herbicide (Bullet or Harness Extra) plus postemergence (POST) glyphosate, single applications of glyphosate applied at the 2, 4, 6, 8, or 10 collar corn growth stages, glyphosate at the 4 collar stage followed by a second application at the 10 collar stage, glyphosate at the 6 collar stage followed by glyphosate at the 10 collar stage, and glyphosate at the 2 collar stage followed applications at the 6 and 10 collar stages.

Grain yields were analyzed at the 5% level and means were grouped by calculating a least significant difference. At Georgetown in 1998 the PRE followed by POST glyphosate and the POST glyphosate applications at the 2, 4, or 8 collar stages had the highest yield. At Georgetown in 1999 the highest yielding treatments were sequential glyphosate applications at 2, 6, and 10 collar stages and the PRE plus POST treatment. At Middletown only the glyphosate application at the 10 collar stage and the weedy check were not in the top group which had a range of 15 bu/A.

While the results vary among the locations and years it appears that a single glyphosate application at the 2 collar stage is too early and allows excessive late season weed competition while the glyphosate application at the 10 collar stage is too late and allows too much early competition. Only the PRE herbicide plus POST glyphosate treatment and the sequential glyphosate treatments are consistently in the top yield groups. If a farmer wants to use a total POST program the first glyphosate application should be made at the 4-6 collar stage with careful monitoring to determine if a second glyphosate application at the 10 collar stage is necessary. Achieving consistent weed control with glyphosate in corn will be much more of a challenge than it is in soybeans, as corn may require a longer weed-free period.

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TIMING OF GLYPHOSATE APPLICATION FOR PERENNIAL WEED CONTROL IN SOYBEANS

A. Cooper, M. VanGessel, and C. Whaley[1]

ABSTRACT

Optimum weed control and yield can be achieved with one application of glyphosate applied to glyphosate-resistant soybean (*Glycine max*) during the third to fourth week after planting. However, this research has been conducted with annual weed species. The optimum time to treat perennial weeds has not been determined. Most perennials are most sensitive during late-vegetative or early-reproductive stages. Waiting until these later stages can impact herbicide coverage, reducing weed control, as well as reducing yield due to early-season weed competition.

Studies were conducted in 1998 and 1999 to determine Canada thistle (*Cirsium arvense*) or horsenettle (*Solanum carolinense*) control when glyphosate was applied at 3, 4, 5, or 6 weeks after planting (WAP). Glyphosate-resistant soybeans were planted in 38 cm rows. Glyphosate rate was 1.0 lbs ai/A. Furthermore, at 5 WAP glyphosate applied at 0.75 and 1.5 lbs ai/A. Finally, sequential glyphosate applications at 1 lb ai/A were applied at 4 and 6 WAP.

In 1998, Canada thistle control was best with an application at 6 WAP or the sequential application of 4 and 6 WAP. A definite trend for later applications improving control was observed.

Horsenettle control in 1998 and 1999 was similar for applications at 4, 5 or 6 WAP. The 0.75 lb ai/A rate provided similar level of control as the higher rates.

Effective perennial weed control requires an aggressive long-term approach. These plots will be followed until the following spring to determine if an in-crop glyphosate application can be an effective long-term tool for Canada thistle or horsenettle control.

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EFFECT OF HERBICIDE RATES AND IRRIGATION TIMING ON WEED CONTROL IN IRRIGATED CORN

Sujatha Sankula[1] and Mark J. VanGessel

ABSTRACT

Preemergence herbicide treatments require rainfall to move/incorporate the herbicide into the soil where it is available for uptake by germinating weed seedlings. Information is limited on the timing of incorporation and appropriate rates of premix products. A simulated rainfall study was conducted in 1999 as randomized complete block with factorial arrangement of three irrigation timings and three use rates of a premix of metolachlor + atrazine. Herbicide application was made after planting followed by irrigation either immediately, 7 DAT, or 14 DAT. Herbicides were applied at 2.0, 2.5, or 3.2 kg ai/ha that represent use rates for coarse, medium, or fine textured soils, respectively. Plots that are to receive irrigation at a particular timing were irrigated with 3 cm of water while the rest of the plots remained covered with a clear plastic of 4.2 m x 7.5 m. Evaluations on weed control and weed counts were taken from an area of 1.5 m x 6 m from the center of each plot 4 WAT, 8 WAT, and prior to physiological maturity. Visual weed control evaluation was affected both by irrigation timing and herbicide rates while, weed counts were influenced only by irrigation timing. Weed control was greater by 5 to 15% when irrigation followed immediately after herbicide application compared to the rest of the timings. No differences were found in weed control when plots were irrigated 7 or 14 days after herbicide application. Similar results were noted with weed counts. The mid and high rates of herbicides provided higher level of weed control compared to low rate.

A parallel study was conducted at three locations to evaluate the use rates of a premix of metolachlor + atrazine with and without simazine in irrigated corn production. Design was a randomized complete block with factorial arrangement of treatments. Treatments included metolachlor + atrazine at 2.3, 2.8, 3.2, and 3.7 total kg ai/ha alone or with simazine at 1.1 kg ai/ha. Comparison treatments were established with 2.8 kg/ha of metolachlor + atrazine in combination with 1.4 kg/ha of simazine plus a weedy check. Except for 2.3 kg/ha metolachlor + atrazine applied alone, no differences were noted in pre-harvest weed control and weed counts among herbicide treatments at all locations. No differences were detected in final yield between treatments. This study emphasizes that additional residual herbicide is not needed to increase weed control if metolachlor + atrazine is used at 2.8 kg/ha on coarse textured soils.

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EFFECT OF RATE, FORMULATION AND APPLICATION METHOD ON EFFICACY AND PHYTOTOXICITY OF GRANULAR HEXAZINONE IN WILD BLUEBERRY FIELDS

D. E. Yarborough and T. M. Hess[1]

ABSTRACT

Granular hexazinone has been used in wild blueberry fields since 1993, either as a liquid impregnated on fertilizer or as a 10% granule. Concerns about lack of efficacy and blueberry injury when applied with a Vicon-type spreader prompted a request to evaluate a 5% granule to provide for better distribution and crop safety. Granular hexazinone was applied as Pronone MG® on 6/16/99 with either an air assist spreader or Vicon® spreader at 1 or 2 lb ai/a in a 5% or 10% formulation to 1.5 acre blocks on a commercial blueberry field on Township 18 MD, Maine. Ten, 1 meter square transect per treatment block were evaluated for two untreated blocks and for each application equipment, formulation and rate (2x2x2= 8 treatment blocks) on 8/6/99 for weed cover and phytotoxicity to blueberry plants. The effect of equipment was highly significant with the air-assist application having a greater weed cover and less phytotoxicity and the Vicon spreader with less weed cover and a higher phytoxicity rating. With both the air-assist spreader and the Vicon spreader, weed cover was reduced for the treated vs the untreated and was lower for the 2 lb vs the 1 lb rate but formulation percentage had no effect on weed cover. Phytotoxicity was significantly higher on the 10% vs the 5% formulation, when applied with the Vicon spreader, but rate or formulation had no significant effect on phytotoxicity when applied with an air assist spreader. So the 5% granule would provide better crop safety when used at the higher rate in the Vicon spreader but had no significant effect on weed cover. No effect on weed cover or phytotoxicity for the 5% vs 10% formulation was seen when applied with the air-assist spreader.

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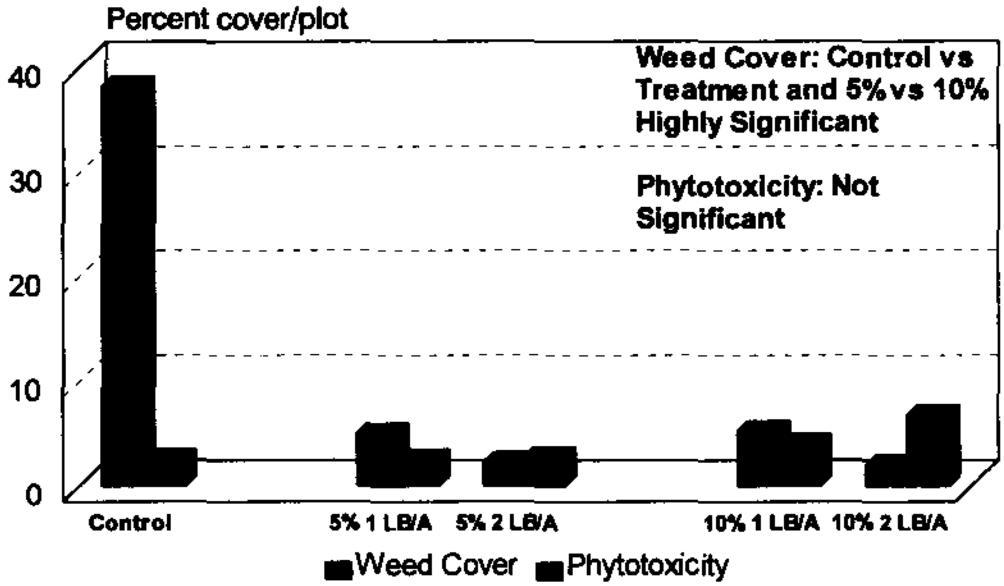
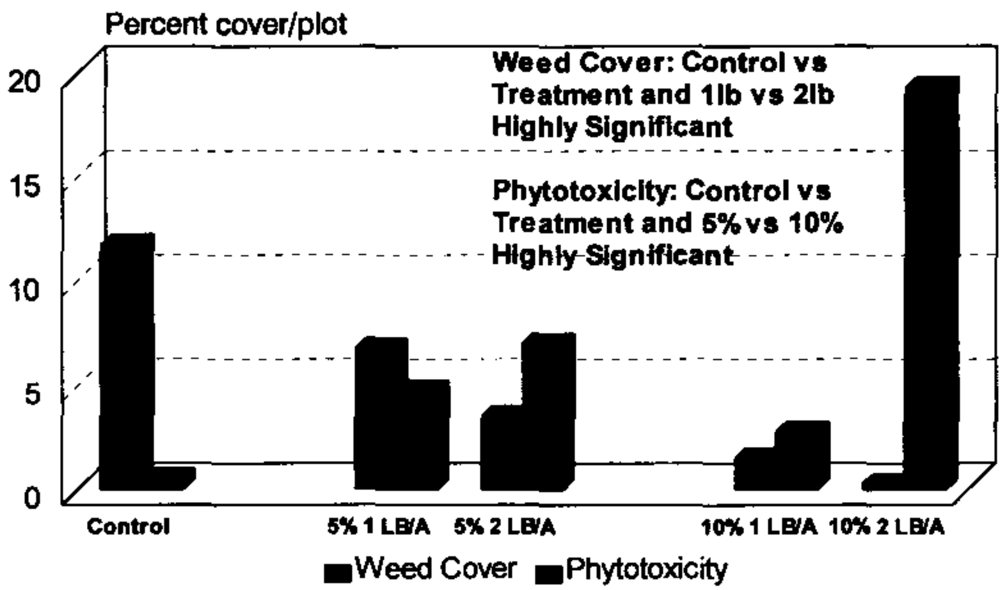
Effect of Pronone Applied with Air Assist Spreader on Weed Cover and Blueberry Injury



Effect of Pronone Applied with Vicon Spreader on Weed Cover and Blueberry Injury



COMPARISON OF SULFOSATE AND GLYPHOSATE FOR WEED CONTROL IN WILD BLUEBERRIES

D. E. Yarborough and T. M. Hess[1]

ABSTRACT

Use rates of hexazinone, the primary weed control material available for wild blueberries (*Vaccinium angustifolium*), have been reduced because of problems with leaching, and subsequent detection in groundwater. Lower rates have resulted in less effective weed control and in a change in weed species present. Postemergence control of weeds growing above and among the blueberry crop canopy is needed. A study was conducted at Blueberry Hill Farm, Jonesboro, ME and Guptills Wild Blueberry Farm, Wesley, ME from June to September, 1999 to compare the effectiveness of sulfosate and glyphosate with or without ammonium sulfate (AMS) applied by a Sideswipe® hockey stick type wiper in 10% or 20% solutions to dogbane (*Apocynum androsaemifolium*), bracken fern (*Pteridium aquilinum*) and mixed hardwoods (*Acer, Alnus, Betula sp.*) on 7-8-99. A directed spray of 1% or 2% v/v sulfosate and glyphosate, with or without AMS, was applied to 1 meter square bunchberry plots (*Cornus canadensis*) and individual plant clumps of bunch grass (*Andropogon scoparius*) with a CO_2 powered backpack sprayer on 7-1-99 and 6-30-99, respectively. Phytotoxicity was evaluated at 7, 14, 21, and 42 days after treatment (DAT) and treatments were replicated 4 times. Dogbane, bracken fern and bunch grass were controlled equally well with either material regardless of AMS addition. Complete control of bunch grass was obtained at 7 DAT and dogbane at 21 DAT. Addition of AMS had no effect on the control of bunch grass, bracken fern, dogbane or bunchberry but improved consistency of control for hardwoods. Bunchberry was suppressed by glyphosate or sulfosate up to 21 DAT, but then regrowth began to occur. This experiment indicates that sulfosate or glyphosate are equally effective in controlling bunch grass, bracken fern, dogbane and hardwoods but not bunchberry. The addition of AMS was only beneficial with the woody species treated.

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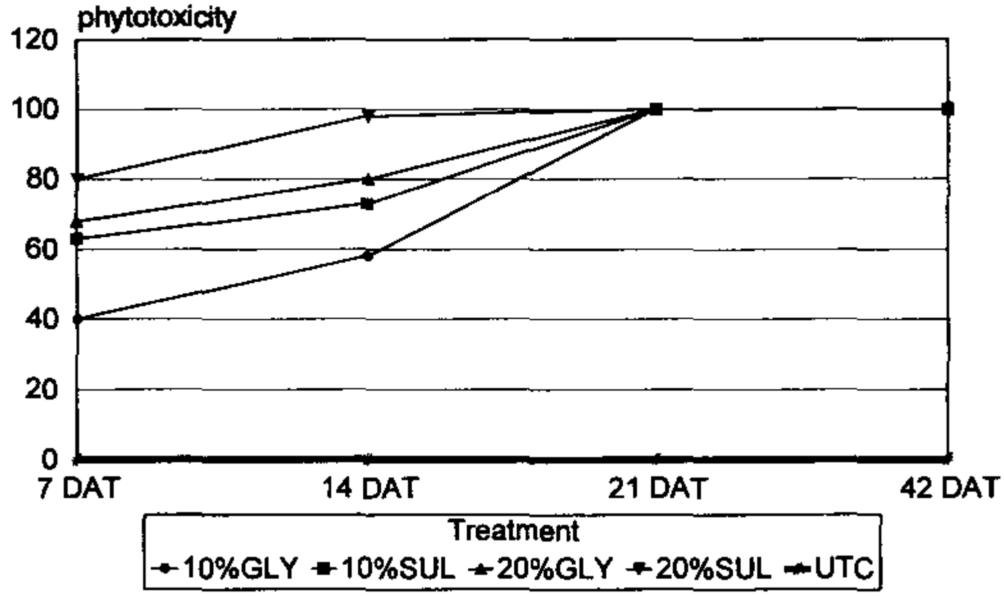
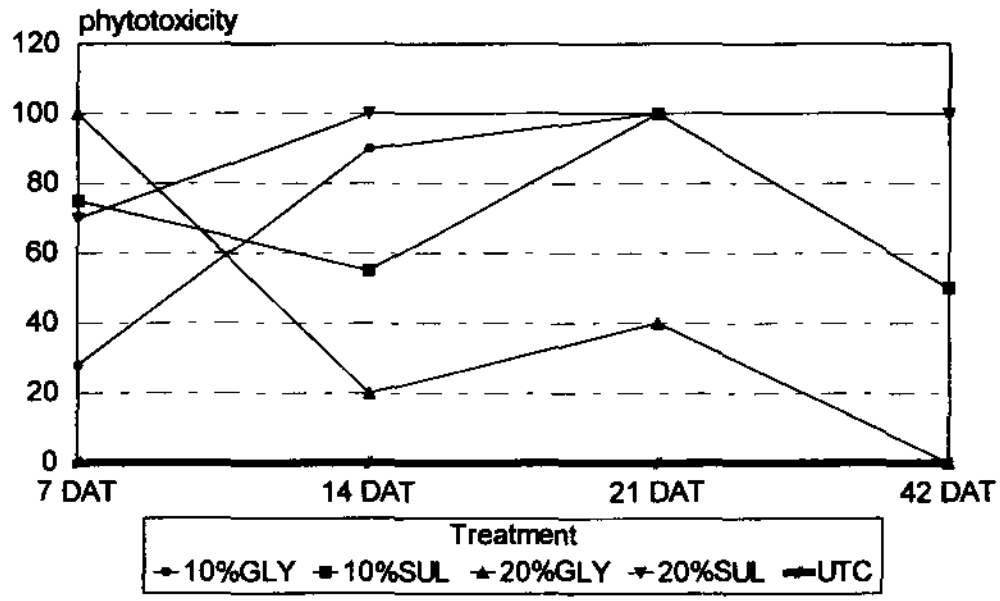
Comparison of Sulfosate and Glyphosate with AMS for Hardwood Control



Comparison of Sulfosate and Glyphosate without AMS for Hardwood Control



Material=significant at 7 DAT and highly significant at 14 and 21 DAT, Rate=highly significant at 7 DAT, and 21 DAT

POLLEN TRANSPORT FROM GENETICALLY MODIFIED CORN

J.M. Jemison, Jr.[1] and M. Vayda[2]

ABSTRACT

Concern over the transport of genetically engineered (GE) corn pollen in the U.S. is growing. Organic producers particularly organic dairy and sweet corn growers fear the loss of their organic certification if GE proteins are found in their corn. Although corn pollen grains are among the largest and heaviest of wind pollinated plants, transport is possible. Critics of GE frequently refer to the "gene cloud" of mutant corn pollen travelling distances of many miles to cross pollinate and contaminate non-GE corn. In the summer of 1999, we planted four research plots to corn between May 15 and May 17. An 83-day Roundup-Ready (RR) corn (DeKalb 335 RR) hybrid was used for two of these studies, and one of these studies was vandalized in August after the corn had shed pollen. These studies were located side by side. In the other two studies, (a phosphorus fertility trial and another weed control study), we planted another 83-day hybrid, Agway 144. Because of the close planting dates and the same maturities, this provided us with the opportunity to evaluate the potential cross pollination of GE corn pollen with standard corn silage hybrids.

The two studies with RR corn located side by side were approximately 37,190 ft^2 in total area and were located between the two other corn trials. The phosphorus study was approximately 12,000 ft^2 and was located 175 feet east of the RR study. The prevailing winds come from the southwest, and this study should represent a worst-case scenario for cross pollination. The other weed control study was located 1150 feet southwest of the RR study. The size of that plot was 11,520 ft^2. This represents the lowest chance of getting cross pollination. To evaluate cross-pollination and the effect of position in the field, we divided each study into three areas: closest to the field, a middle section and a section farthest away from the GE pollen source. Four replicate samples were collected from each study. We collected corn from the RR study as well. A figure showing the layout is presented below.

Corn was harvested from each study on September 17 to provide seed to germinate in the greenhouse. We collected 100 ears from each location within each study area. Corn ears were dried in a greenhouse until dry enough to germinate. Seeds were sown in 4.5 ft^2 greenhouse flats with potting soil at half inch spacing or approximately 170 seeds/flat. We are currently at this stage in the research. Plant emergence will be recorded for each flat. At the 2 leaf stage, plants will be sprayed by hand with a 0.5% solution of Roundup Ultra. Plants that survive will be scored, and the process will be repeated as many times as possible to increase the sample size as high as possible.

At this time, we have no results to present. Results will be available at the meeting.

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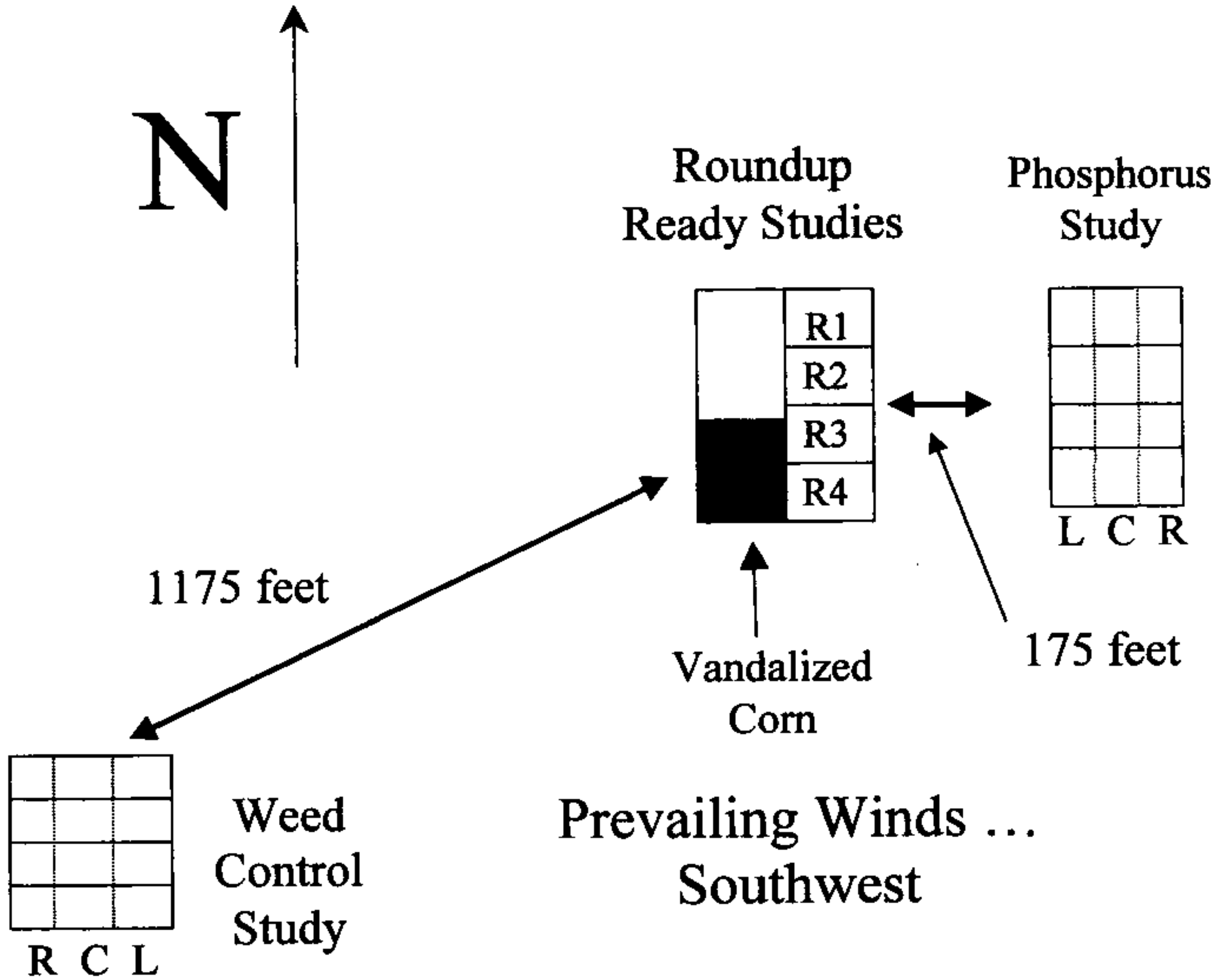
N
Roundup
Ready Studies
R1
R2
R3
R4
Phosphorus
Study
L C R
1175 feet
Vandalized
Corn
175 feet
Weed
Control
Study
R C L
Prevailing Winds ...
Southwest

SUMMARY OF THE 1999 NORTHEAST WEED SCIENCE SOCIETY COLLEGIATE WEED CONTEST

K. W. Bradley, E. S. Hagood, J. Derr, S. R. King, I. Morozov, and C. Kenley [1]

ABSTRACT

The 16th annual Northeast Weed Science Society collegiate weed contest was held on July 20, 1999 in Blacksburg, Virginia, on the campus of Virginia Polytechnic Institute and State University and the nearby Smithfield Plantation. A total of 57 students from 10 universities competed in the contest, which was an 8-hour event that began at 8:00 a.m. and lasted until 5:00 p.m. Schools competing in the contest included Cornell University, North Carolina State University, Penn State University, State University of New York – Cobleskill, University of Delaware, University of Guelph, University of Kentucky, University of Maryland, University of Nova Scotia Agricultural College, and Virginia Polytechnic Institute and State University. There were a total of 9 graduate and 9 undergraduate teams along with 2 graduate individuals and 1 undergraduate individual competing in the contest.

Contestants tested their skills in weed identification, herbicide symptomology, sprayer calibration, and solving grower problems throughout the course of the day. Students were required to identify 20 weeds by common name and 5 weeds by scientific name in the weed identification event, and 10 unknown herbicides in the herbicide symptomology event. Three of the grower problems in this year's contest were associated with turfgrass, one problem involved pumpkin production, and the remaining three problems were associated with corn production.

North Carolina State University (Shawn Askew, George Scott, Andrew McRae coached by John Wilcut), finished first in the graduate contest, while Virginia Polytechnic Institute and State University (Rob Richardson, Peter Sforza, Andy Bailey, Greg Armel, coached by Dan Poston) finished second. Penn State University (Wade Esbenshade, Steve Josimovich, coached by Dwight Lingenfelter) finished third place in the contest. The first place graduate individual in the contest was Rob Richardson from Virginia Polytechnic Institute and State University. Second place in the graduate individuals went to Shawn Askew from North Carolina State University, while third place went to Art Graves from Virginia Polytechnic Institute and State University. George Scott and Andrew McRae, both from North Carolina State University, tied for fourth place.

The winner of the undergraduate contest was Nova Scotia Agricultural College (Kerry Cluney, Gordon Murray, Peter Burgess, Stephen Crozier, coached by Glen Sampson), followed by State University of New York – Cobleskill (Steven DuBois, Andrew Miller, coached by Doug Goodale) in second place and North Carolina State University (Kevin Clemmer, John Lowery, Keith Burnell, coached by John Wilcut) in third place. The first place undergraduate individual was Keith Burnell of North Carolina State University, while Gordon Murray of Nova Scotia Agricultural College came in second and Andrew Miller of State University of New York – Cobleskill came in third.

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VIRGINIA TECH'S ONLINE WEED IDENTIFICATION AND PEST MANAGEMENT GUIDE

K. W. Bradley, P. Sforza, and E. S. Hagood [1]

ABSTRACT

The Virginia Tech Weed Identification Guide and the Pest Management Guide for Field Crops have been available on the internet since 1996 at the web sites http://www.ppws.vt.edu/weedindex.htm and http://www.ppws.vt.edu/~pmg/intro.htm. Collectively, these guides serve as an important resource for many growers and agrochemical dealers throughout Virginia and the eastern United States. More recently, the weed identification guide has developed into a valuable educational resource in undergraduate weed science courses taught at Virginia Tech and at other universities across the nation.

The weed identification guide currently has 180 separate weed species available for viewing, however additional weed images are being added daily. Each web page provides an average of 3 to 4 images of each weed. These images illustrate specific features of each weed that are important for identification, such as flowers, fruit, and leaf shape. Many of the weed pages have a botanical description accompanying each image and additional descriptions will be included in the future. The weed identification guide is primarily intended to assist in the identification of common weeds and weed seedlings that normally occur in most pastures and field crops of the eastern United States. However, several aquatic weeds and weeds commonly associated with turfgrass are also included in the guide.

The online pest management guide contains current weed control recommendations for alfalfa, corn, cotton, pastures, small grains, sorghum, soybeans, peanuts, and tobacco. The recommendations included in the guide are based on research conducted by several extension weed specialists at Virginia Tech and throughout the northeastern United States. Recommendations are given for some of the more common and troublesome weeds associated with each crop, along with specific use-rates for each herbicide listed. The web pages also contain a guide to prepackaged herbicide mixtures, a guide to single active ingredient herbicides, and rainfree periods for most postemergence herbicides. The internet guide is updated regularly and is a direct reflection of the information published in the annual Virginia Cooperative Extension Pest Management Guide for Field Crops.

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WEED SCIENCE FOR THIRD GRADERS – "WEEDS AND HOW NOT TO BE ONE"

Nancy Gift[1]

ABSTRACT

Weed science, and agriculture in general, used to be a topic which children learned on their parents' farms or gardens. Today, however, few children have so close a connection to their food sources, and most know little, besides what they might hear in the popular press or see in the grocery store, about agricultural production. At the 1999 W.S.S.A. conference in San Diego, W. Slijk presented a program for high school students learning about invasive weeds on urban interfaces, suggesting that far more could be done to educate youth about weed science. In spring of 1999, a Cornell University Public Service Center-sponsored short course titled "Weeds and How Not to Be One" was taught to third-graders in Mr. Paul Tatar's class at South Hill Elementary School in Ithaca, NY. The Graduate Student School Outreach Program, which sponsored the course, is designed to give graduate students a chance to present topics from their fields of interest to elementary, middle, and high school students from local schools. This program serves both to enhance the curriculum for the local students, and to give graduate students the opportunity to learn teaching techniques and skills from experienced, professional classroom teachers. Teachers also benefit from this collaboration by enhancing their knowledge of current directions in various fields of study and exposure to new activities and university resources.

Students participated in eight lessons, each between 30 minutes and one hour in length, on weed science and plant biology. In the first lesson, students were given weed and crop seeds, and the difference between a weed and a crop was discussed. In the second lesson, students were taken out to the schoolyard, and introduced to weed identification with several edible and medicinal weeds, including dandelion, spring rocket, wild onion, curly dock, and the odiferous, invasive weed garlic mustard. On another day, students participated in weed control of corn by pulling and cultivating (using hand-held garden tools) weeds in flats of corn interseeded with foxtail and lambsquarters, and observed the difficulty in controlling weeds in corn interseeded with a cover crop (alfalfa). Other hands-on lessons included: rainfall erosion on flats with and without ground cover, a walk to a nearby wildflower preserve to observe invasive weeds and local wildflowers, pollinating and dissecting flowers, and observing phototropism in classroom plants. More advanced topics such as photosynthesis and plant cell anatomy were introduced with handouts. On the final day, the children's regular teacher brought in a well-seasoned salad of dandelion greens, and the students were, as they requested, given their flats of weeded corn to take home.

Student responses and enthusiasm for the topic varied widely, but one constant was that students all seemed eager to volunteer for participation in hands-on activities. The material presented was far beyond their normal curriculum, and though they may not remember the details, the hope is that these details, when presented again later, will seem more familiar and interesting to them. And, as their teacher noted to them, "You now know more about plants than many of your parents."

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WEED CONTROL AND YIELD OF CUT FLOWERS TREATED WITH TWO HERBICIDES

E. Jay Holcomb, Tracey Harpster, Larry Kuhns, and Robert Berghage[1]

ABSTRACT

This experiment was designed to compare the productivity of four species of cut flowers treated with either napropamide or dithiopyr to weeded control plots, and to determine the effectiveness of the herbicides in controlling weeds. Weed control with napropamide and dithiopyr was similar for the cut flowers tested. Applications of both napropamide and dithiopyr had a slight depressing effect on plant quality. However, at harvest only celosia had shorter stems and reduced fresh weight due to napropamide and dithiopyr application.

INTRODUCTION

Pest infestations are one of the most frequent causes of reduced yield of cut flowers, and weeds are one of the pests that must be controlled. If weeds are left uncontrolled, yield of many cut flowers are dramatically reduced. However, manually controlling the weeds can be very expensive in terms of time and labor and desirable plants are often damaged by mechanical and hand removal of weeds.

The pre-emergent herbicide that some cut flower growers use is napropamide. In previous research we determined that napropamide gave good early season weed control but marginal late season weed control and that one species of cut flower, celosia, was injured by it early in the season. A new herbicide, dithiopyr, has recently been labeled for ornamentals. This set of studies was established to compare the productivity of four species of cut flowers treated with either napropamide or dithiopyr to weeded control plots, and to determine the effectiveness of the herbicides in controlling weeds.

METHODS AND MATERIALS

Seeds of cockscomb (*Celosia cristata* L.), Cramers Yardstick (*Artemesia annua L.*), and China aster (*Callistephus chinensis* (L.) Nees) were germinated in the greenhouse in mid March and were planted to the field on June 8, 1999. Two millets, Tapestry (*Echinochloa crus-galli* (L.) Beauvois) and Spray (*Setaria italica* (L.) Beauvois), were sown directly in the field on June 8. In the field the plants were grown in raised beds that 6 feet long and 30 inches wide with drip tape running down the center of the bed. There were two rows of plants on each bed and the plants were spaced about 1 foot apart in the row. On June 11 treatments in Table 1 were applied to the celosia, artemesia and China aster. The treatments were applied to both millets on June 29.

All beds were hand weeded before herbicide applications. The first herbicide application was made on June 11 between 8:00 and 10:00 am. Conditions at the time of the application were clear and sunny, 67° F with 0 to 3 mph winds. The June 29 applications were applied from 4:00

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and 5:00 pm and the conditions were overcast, 72°F and 5 to 8 mph winds. Dithiopyr and napropamide were applied over-the-top with a CO_2 test plot sprayer at 30 psi through an 8004E nozzle at 22 gallons per acre. There were three replications of each treatment with 12 plants per species in each rep. All plots were overhead irrigated within 24 hours after herbicide applications. During the season the control plot was weeded so the plants were not affected by competition from weeds.

At 4 and 8 weeks after treatment (WAT) the weed control and plant quality were evaluated. In September all plants were harvested and the flowers were weighed and stem length was measured.

RESULTS AND DISCUSSION

At 4 WAT, except for celosia, neither plant quality nor weed control were affected by herbicide applications. For celosia, both napropamide and dithiopyr treated plots had less weed cover than the weeded control (Table 1). Weed species present in the plots included common lambsquarters (*Chenopodium album* L.), common ragweed (*Ambrosia artemisiifolia* L.), common purslane(*Portulaca oleracea* L.), green foxtail (*Setaria viridis* (L.) Beauv.), redroot pigweed (*Amaranthus retroflexus* L.), shepherd's-purse (*Capsella bursa-pastoris* (L.) Medicus), smooth pigweeed (*Amaranthus hybridus* L.), tumble pigweed (*Amaranthus albus* L.) and yellow foxtail (*Setaria glauca* (L.) Beauv.). At 8 WAT the napropamide and dithiopyr treatments in the aster, celosia, and artemisia continued to have weed cover ratings equivalent to the weeded control. In the millet plots, the herbicides provided poor weed control. There were no differences in weed control between the herbicide treatments in any of the plots.

At 4 WAT there were statistical differences in plant quality (Table 2) of the aster, celosia, and millet. However, the differences were inconsistent and economically insignificant. All plants recovered by 8 WAT, and only the millet treated with napropamide at 3 lbs ai/A had quality ratings lower than the weeded controls.

At harvest, neither herbicide had any effect on shoot length or weight of artemesia, aster, or millet flowers (Tables 3 & 4). For celosia, napropamide at 3 lbs ai/A and dithiopyr at 0.5 lbs ai/A significantly depressed shoot length. Compared to the weeded control, celosia weight was depressed by both rates of napropamide. The length and weight of spray millet was not affected by either herbicide, but the tapestry millet was less than half the weight of the spray millet.

In summary, napropamide and dithiopyr provided similar levels of weed control in this test. Both reduced plant quality of three of the species initially, but had little effect on the plants at the end of the season. At harvest only celosia had shorter stems and reduced fresh weight due to napropamide and dithiopyr application.

Table 1. Effect of napropamide and dithiopyr on weed control in artemesia, aster, celosia, and millet plantings. Weed control values represent the percent of the soil covered by weeds. All values are averaged over three reps for each crop. 1/

		Artemesia		Aster		Celosia		Millet
	lbs./A	7/12	8/12	7/12	8/12	7/12	8/12	8/12
Weeded Control	-	7.3	1.3	7.3	6.7	2.7 a	5.3	0.0 b
Napropamide	3	1.3	4.3	1.3	5.3	1.3 b	13.7	60.0 a
Napropamide	6	1.7	2.0	2.0	2.0	0.7 b	0.6	50.0 a
Dithiopyr	0.3	0.3	2.0	0.7	2.3	1.0 b	8.0	56.7 a
Dithiopyr	0.5	1.7	3.0	0.7	1.3	1.3 b	3.0	48.3 a
Significance		NS	NS	NS	NS	***	NS	*

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

Table 2. Effect of napropamide and dithiopyr on artemesia, aster, celosia, and millet plant quality. Plant quality represents the vigor and freedom from damage of the crop; 1 = dead and 10 = excellent condition. All values are averaged over three reps for each crop. 1/

		Artemesia		Aster		Celosia		Millet
	lbs./A	7/12	8/12	7/12	8/12	7/12	8/12	8/12
Weeded Control	-	7.8	9.4	10.0 a	9.7	9.6 a	9.8	10.0 a
Napropamide	3	7.4	9.5	9.1 c	9.7	8.7 c	9.9	7.9 b
Napropamide	6	7.5	9.8	9.9 a	9.6	8.3 cd	9.8	9.4 a
Dithiopyr	0.3	8.1	9.7	9.7 b	9.4	9.2 b	9.8	9.3 a
Dithiopyr	0.5	7.5	9.3	10.0 a	9.7	8.1 d	9.6	9.4 a
Significance		NS	NS	***	NS	***	NS	***

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

Table 3. Effect of napropamide and dithiopyr on artemesia, aster, celosia, and millet flower stem lengths (centimeters) harvested over a three week period. All values are averaged over three reps for each crop. 1/

		Artemesia	Aster	Celosia	Millet	
	lbs./A				Spray	Tapestry
Weeded Control	-	68.9	35.4	58.4 a	97.1	81.6
Napropamide	3	68.6	33.4	49.9 b	95.8	71.0
Napropamide	6	69.0	35.8	53.1 ab	92.9	72.3
Dithiopyr	0.3	61.8	34.8	53.6 ab	94.9	74.8
Dithiopyr	0.5	67.8	34.4	50.4 b	93.7	74.8
Significance		NS	NS	*	NS	NS

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

Table 4. Effect of napropamide and dithiopyr on fresh weights (grams) of artemesia, aster, celosia, and millet, harvested on September 9, 1999. All values are averaged over three reps for each crop. 1/

		Artemesia	Aster	Celosia	Millet	
	lbs./A				Spray	Tapestry
Weeded Control	-	237	52.3	604 a	43.7	18.4
Napropamide	3	250	59.6	454 b	40.5	12.9
Napropamide	6	243	58.6	443 c	40.2	18.8
Dithiopyr	0.3	230	48.6	557 ab	38.0	15.4
Dithiopyr	0.5	283	58.1	520 ab	36.3	13.8

Significance	NS	NS	*	NS	NS

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

The Effect of Total Postemergence Herbicide Timings on Corn Yield

D. B. Vitolo, C. Pearson, M. G. Schnappinger, and R. Schmenk

ABSTRACT

Replicated field trials were conducted in Livingston, New York, in 1996, 1997, and 1998 to evaluate the effect of pre- and postemergence herbicide programs on weed control and corn grain yield. Bicep II Magnum brand herbicide applied preemergence was compared to three timings of a total postemergence herbicide program using either Exceed + Accent + Banvel brand herbicides (1996) or Roundup Ultra brand herbicide (1997-1998), and to Bicep II Magnum brand herbicide followed by a postemergence program. Postemergence timings corresponded to average weed heights of 2 to 4, 6 to 8, and 10 to 12 inches. In all years, the preemergence treatments resulted in > 90% control of all weeds, and the postemergence applications killed all emerged weeds. The weed spectrum in the test area included giant foxtail (*Setaria faberi* Herrm.), common ragweed (*Ambrosia artemisiifolia* L.), common lambsquarters (*Chenopodium album* L.), velvetleaf (*Abutilon theophrasti* Medik.), and wild radish (*Raphinus raphanistrum* L.).

In both 1996 and 1997, yield loss was correlated with delaying postemergence applications, with the drier year (1997) resulting in higher percentage losses than 1996. Only the 2- to 4- inch postemergence timing resulted in yields similar to the preemergence treatment.

In 1998, a wet spring was followed by dry summer. The 2-to 4-inch application timing was too early, and new weeds germinated to compete with the crop. The 10-to 12- inch application timing was too late, with the larger weeds reducing yield. Only the 6- to 8- inch postemergence timing resulted in yields similar to the preemergence treatment.

In all 3 years, the application window for total postemergence treatments was narrow, ranging from 10 to 21 days. Given the challenge that herbicide applicators have in covering their acres, and the unpredictability of each season (weather, wet fields, and proper timing), a preemergence herbicide application followed by a postemergence herbicide, when needed, provides corn growers with an excellent strategy for flexible and effective weed control.

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WEED CONTROL AND MINERALIZATION OF NITROGEN AND PHOSPHORUS FROM COMPOSTED POULTRY MULCH IN A WEST VIRGINIA PEACH ORCHARD

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ABSTRACT

Large amounts of poultry manure and bedding (litter) are generated and applied to farm land in the eastern U.S. Improper management of manure and nutrient runoff can cause eutrophication and other undesirable changes in aquatic communities. Poultry waste can be converted to a stable organic fertilizer by composting. Composted poultry litter has been incorporated into soil prior to planting annual crops but soil incorporation may not be practical beneath fruit trees. Synthetic fertilizers are usually applied to the soil surface each spring to provide N for the season's crop. This experiment was designed to determine the effect of surface application of poultry litter on peach tree growth and yield. The objectives were to determine the effect of two rates of composted poultry litter applied to a peach orchard on (1) N and P concentrations in soil and peach leaves, (2) peach yield, and (3) weed abundance.

Peach trees (*Prunus persica* L. 'Sunhigh') were planted in March 1988 with a 5 by 5 m spacing. A 3-m-wide vegetation-free strip was maintained beneath the trees. One experimental unit consisted of a plot beneath one tree. In May 1998 all plots received 1 kg diuron/ha plus 1 kg terbacil/ha and the following 4 treatments were applied: commercial fertilizer (15 g N / m^2 as 0.15 kg 10/10/10 N/P/K / m^2), low rate poultry litter (15 g N / m^2 as 2.9 kg composted litter / m^2), high rate poultry litter (62 g N / m^2 as 11.6 kg composted litter / m^2), and no treatment control. Soil and peach leaf N and P and weed abundance were measured during 1998 and 1999. The experiment was a randomized complete block design with 5 single tree experimental units for a total of 20 experimental units.

Weeds were completely controlled during 1998 with the early-season herbicide application and no differences occurred between treatments. During 1999 when no herbicide was applied, the high rate poultry litter reduced the % ground area covered by weeds to 2, 9, 10, 23, and 27% in May through September, respectively compared with 30, 40, 53, 81, and 86% in May through September, respectively for the commercial fertilizer-treated plots. Weed weight in September 1999 in plots treated with high rate poultry litter was 330 g / m^2. Weed weight in plots treated with commercial fertilizer was 622 g / m^2. Plots treated with low rate of poultry litter and control had high weed abundance, similar to plots treated with commercial fertilizer. Although fewer weeds grew through the high rate of poultry litter, weeds were large and would require management in addition to poultry litter mulch.

Soil N was highest in plots treated with commercial fertilizer (16.4 µg $N\text{-}NH_4$ and 18.6 µg $N\text{-}NO_3$ per g soil, 6 weeks after treatment) and did not differ among the remaining treatments (in the high rate of poultry litter - 3.2 µg $N\text{-}NH_4$ and 0.7 µg $N\text{-}NO_3$ per g soil, 6 weeks after treatment). Water soluble P in the soil did not differ among treatments at 6 weeks after treatment (approximately 12 µg P per g soil for all treatments). At 47 weeks after treatment plots with the high rate of poultry litter had 30 µg P per g soil compared with 14 µg P per g soil in plots treated

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with commercial fertilizer. In general, Mehlich 1 acid-soluble P did not differ among the litter- and fertilizer-treated plots (averaging 45 µg P per g soil). However, it was lowest in control plots (averaging 21 µg P per g soil).

Although four times more N was applied with the high rate poultry litter than with commercial fertilizer, mineralization was low, indicating that poultry litter could be used as a weed suppressant without adversely affecting nitrogen release to the environment. In fact, large quantities of composted poultry litter may not provide sufficient nitrogen for fruit tree production and greater mineralization may be necessary. However, P mineralization may be problematic and requires further investigation. Finally, in this experiment only the higher rate of composted poultry litter provided partial weed control in a peach orchard.

EVALUATION OF METOLACHLOR AND PEBULATE IN PLASTICULTURE TOMATO

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ABSTRACT

Tomato *(Lycopersicum esculentum mill.)* production is significant in southern and mid-Atlantic regions of the U.S. There are approximately 4200 acres of tomato grown on the Eastern Shore of Virginia. The expected cancellation of methyl bromide registration is encouraging growers to search for alternative means of weed control for tomato grown under plastic. A suitable replacement for methyl bromide would be of obvious benefit. Nutsedge species (*Cyperus spp.)* are a major problem in tomato production primarily due to the highly competitive nature of these weeds and their frequent penetration of plastic bed covers. Two herbicides that suppress growth of nutsedge species are metolachlor and pebulate. Metolachlor suppresses yellow nutsedge (*Cyperus esculentus L.)* while pebulate can suppress yellow and purple nutsedge (*Cyperus rotundus L.)* but tomato tolerance to these herbicides applied under plastic is not known.

Field experiments were initiated in 1999 to evaluate tolerance of tomato to s-metolachlor and pebulate. Study design was a randomized complete block with three replications. Following herbicide application, beds were covered with black plastic and 'Agro Set' tomato were transplanted 12 in. apart into the beds. Treatments included s-metolachlor (0.75, 1.0, and 1.5lb ai/A), pebulate (3.0, 4.5, and 6.0 lb ai/A), and a nontreated check. All other production practices were standard according to Virginia Extension recommendations. Crop injury was visually estimated at 2, 3, and 9 wk after treatment (WAT). Six plants from each one-row plot were hand-harvested three times to achieve optimum yield, quality, and grade. Tomato fruit were graded and weighed at each harvest date. Fruit from each plot were separated into culls (malformed tomato or tomato with less than a 2.25 in-diameter), medium (<2.75 in), large (<3.5 in), and jumbo (>3.5 in) sizes.

There were no significant treatment effects for injury found between herbicide-treated tomato at each injury evaluation. Injury from herbicide treatments was from 11 to19% at 2 WAT, 7 to 17% at 3 WAT, and 5 to 11% at 9 WAT. Injury was numerically, although not significantly, highest from s-metolachlor at 1.5 lb/A (19, 17 and 11% at 2, 3, and 9 WAT, respectively) and lowest from s-metolachlor at 0.75 lb/A (13, 11, and 5% at 2, 3, and 9 WAT, respectively). Injury from pebulate at any rate was 12 to 13% at 2 WAT, 7 to 11% at 3 WAT, and 5 to 9% at 9 WAT. Herbicide treatments generally had little or no effect on tomato grade and total yield when compared to nontreated tomato. Large fruit from each treatment made up the highest percentage of yield at each of the three harvest periods. These data illustrate the potential for s-metolachlor and pebulate use in tomato grown under plastic. Future research will investigate the use of s-metolachlor and pebulate under plastic at these same rates alone and with soil fumigation with 1,3-dichloropropene plus chloropicrin.

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HERBICIDE APPLICATIONS VERSUS HANDWEEDING HERBACEOUS PERENNIAL PLUGS: POTENTIAL FOR CROP DAMAGE AND CROP LOSS

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ABSTRACT

Handweeding and one-time herbicide applications were evaluated for their relative effectiveness in reducing weed populations indigenous to herbaceous perennial plant production. Commercially available herbaceous plugs, weed infested during propagation and prior to receipt, were transplanted into finishing 4 inch pots and weed and crop growth evaluated. Crop plants were grouped into categories by leaf size and the effectiveness of weed control measures was evaluated during the season. Handweeding small and mid-sized crops resulted in greater crop damage and loss than herbicide applications despite the relative ineffectiveness of post-emergent applications of broad spectrum herbicides. Handweeding large-sized crops resulted in greater crop densities and greater weed control than post-emergent applications but handweeding efforts had to be repeated to maintain that effectiveness. Handweeding followed by pre-emergent applications offers the best compromise between potential crop loss and weediness.

INTRODUCTION

The production of herbaceous perennial ornamental plants for both wholesale and retail sales in the Northeast typically begins with the importation of dormant or near-dormant plugs from large mid-western propagators. Plug sizes may vary from an average minimum 3/4 inch to an average maximum 2.25 inch diameter and plugs may be bare-root, in soil or sphagnum or produced in variously sized trays. For most retail sales, dormant plugs are received in late winter/early spring and transplanted to the final pot sizes and "grown-on" in cool greenhouses, unheated hoop houses, under shade clothes, on landscape fabric, or directly on sales benches.

In recent years, numerous complaints have been made concerning the receipted condition of these plugs; with especial emphasis placed on their "weediness". In various circumstances, weed growth resumed in advance of crop growth; concommitant with crop growth or followed but later overshadowed crop growth. The greatest severity of complaint concerned those weeds that outgrew the crop to the extent that the crop could not be distinguished from the weeds or was lost completely.

MATERIALS AND METHODS

A brief survey was taken to determine which species of herbaceous perennials plugs were most likely to harbor weeds and if the expected size of the crop influenced, in any way, the severity of weed interactions. The weed species most commonly encountered were determined and the proportion of the crop lost when weed control measures were not taken was estimated. Weed control efforts were initiated on two crops each of three different size categories; control efforts included handweeding and one-time herbicide applications.

Handweeding was evaluated at plug planting by counting and identifying weed populations as nursery employees removed them; the size of the remaining plug was estimated. Pots were placed in a special holding area that maintained the normal nursery regime (irrigation, fertilization) and weeds counts were made 1, 2, 4 and 8 weeks after planting (wap).

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Crop leaf and weed leaf size were estimated on a scale of 1-10 were 1 was very fine grass like foliage and 10 was very large tropical like foliage. The success or failure of handweeding as a function of crop to weed leaf size ratios was evaluated by estimating weed numbers, crop size and crop loss.

Herbicides were applied to pots on the day of transplanting as directed sprays to the surrounding soil with minimal crop interception. Three herbicides were evaluated for efficacy 4, 8 and 16 weeks after treatment (wat): Gallery (isoxaben [N-[3-(1-ethyl-1-methylpropyl)- 5-isoxazolyl] -2,6-dimeth-oxybenzamide]), Dacthal (DCPA[dimethyl 2,3,5,6-tetrachloro-1,4- benzenedicarboxylate]) and Roundup (glyphosate [N-(phosphonomethyl)glycine] were applied at label rates with a four gallon Solo backpack pump sprayer delivering 1.5 gal/1000 ft^2 at 30psi.

RESULTS AND DISCUSSION

The introductory survey revealed that nearly all receipted plugs harbored various weeds; both small and large in stature (Table 1). The principal weeds removed at transplanting were bittercress, oxalis, clover, chickweed, mouse-ear chickweed and dandelion. Plantain, annual and Kentucky bluegrass and crabgrass appeared far less frequently in the plugs but were dispersed from other sources during the course of the season. Handweeding at the time of transplant effectively removed most but not all of these weeds. Considerable crop damage and crop loss accompanied weed removal at transplant; employees reported that they could not distinguish weed from crop or were unable to remove one from the other without tearing. Crops were given a strength estimation based on their rate of growth from the plug. Crop regrowth strength did not appear to influence crop loss due to handweeding; rapidly growing 'strong' crops such as Achillea and Veronica suffered losses of 25 and 75%, respectively; while slower growing crops such as Lavendula or Nepeta were identically damaged. Nearly all the weeds encountered here were able to resume growth before the crop; many of them were able to continue growth after crop growth slowed or reverted to flowering. However the rapidity of crop growth during the first two to four weeks after transplant effectively limited growth of many of these weeds. Only a few weeds exhibited growth concomitantly with the crop. Crop size was markedly suppressed by handweeding damage and/or weed growth; 2.5 inch plugs were often reduced to less than 1 inch; 1 inch circular plugs were often less than 1/2 inch diameter. Crop loss ranged from none in very aggressive crops (or crops that had broken dormancy prior to receipt i.e. Baptisia, Geranium, Hemerocallis, Hosta) to 75% in slower growing or small stature crops i.e. Nepeta, Thymus, Veronica.

In an attempt to explain why handweeding proved both difficult and damaging; crop and weed plants were given an estimation of leaf size for those leaves evident at or within 2 weeks of transplanting, Table 2. Tiny leaved crops such as Tunica or Thymus were often indistinguishable from tiny leaved weeds such as carpetweed or starwort and share the same leaf size estimate. A similar pattern held true from small leaved plants such as Veronica and mouse-ear chickweed,; moderate sized plants such as Oenothera and dandelion and large leaved plants such as Hosta and plantain. Developing a ratio of crop leaf size to weed leaf size (c/w) demonstrated the similarities between crop and weed and assisted growers in training employees in handweeding, Table 3. The crop size at maturity reflected the ability of the crop to outgrowth both handweeding damage and weeds and had little bearing on the c/w ratio. Crop losses were greatest where the c/w ratio was small; crops with the same leaf size were routinely misidentified whether large or small. For example removing bittercress from Erodium or chickweed from Veronica resulted in 80% or greater crop loss; identical damage occurred removing plantain from Rudebeckia or Hosta Successful handweeding with minimal damage occurred only when c/w was great and the difference between leaf sizes exceeded 4. The success of training employees was greatest when leaf size differences were large; using this size difference minimized the time wasted on teaching weed and crop identification. However, it required knowledgeable or experienced personnel, usually owners, consultants or scouts to successfully handweed plugs with identically sized leaves.

Handweeding at the time of transplant resulted in the greatest crop loss, Table 4. Delaying handweeding for 1 week was not particularly advantageous; while crop regrowth occurred, it did not outpace weed growth and identification remained difficult. Delaying handweeding for 2-4 weeks greatly improved crop survival in large leaved crops; significant losses also occurred at 8 weeks with small leaved crops. Weed growth obscured crops at 8 wat and crop size declined; often to unacceptable levels.

Herbicide use minimized crop damage but weed control was generally unacceptable. Where most of the weed originated in the plug itself and resumed growth prior to or concomitant with the crop; herbicides applied to surrounding soil proved ineffective. Control 4 wat for both Gallery and Dacthal ranged from excellent in large leaved aggressive plants such as Hosta and ornamental grasses to poor in small leaved crops such as Veronica or Iberis. Control at 8 weeks was superior to that observed 4 wat; rapid expansion growth of the crop appears responsible for crowding or overshadowing weeds. With the onset of branching and/or flowering and the decay of herbicides, weed growth resumed and percent control declined. Using Roundup to selectively kill growing weeds in dormant plugs proved damaging. Apparent dormancy was misleading, sufficient crop regrowth had occurred and crop damage was substantial. Weed suppression was insufficient at 4 wat and declined to very low levels thereafter. At 16 wat, no weed control was seen in Roundup treated pots. Handweeding 4 weeks after Roundup application proved promising; much of the crop survived phytotoxicity to resume growth and weed identification was markedly improved.

CONCLUSIONS

Handweeding perennial plugs upon receipt and at transplant resulted in substantial crop losses, due principally to misidentification and small size. Categorizing weed and crop by leaf size improved employee training and reduced crop loss due to handweeding errors only when knowledgeable personnel could complete the removal of like-sized weeds. Handweeding and its damages highlighted the frailty of herbaceous perennial plugs and the frequency with which weeds occur in imported plant materials. The rapidity of weed growth and the damage that ensued could not be offset by handweeding; rather those damages were exacerbated and crop loss was excessive. Applications of two pre- and one postemegrent herbicides did not adequately control weeds actively growing in plugs at the time of transplant. Postmergent Roundup proved damaging; preemergent applications were helpful but did not result in a weed-free crop. Far greater crop cleanliness is necessary at the point of propagation to ensure that distant exportation does not result in nursery-wide weed contamination. While the responsibility for crop cleanliness rests with the whole sale producer; there remain few options for local nurseries; to date; those options are both time-consuming and prone to damage. An exploration of other herbicides with greater efficacies; incorporation of granular herbicides in soilless mixes; drench or dip methods for ensuring weed to herbicide contact; the development of Roundup-ready plant material and other suggestions deserve serious consideration as methods to reduce the damage currently plaguing the herbaceous perennial industry.

Table 1: A partial survey of receipted herbaceous perennial transplant plugs; their weeds and severity of weed growth.

Crop and Weed Strength and Regrowth Potential

Crop Identification	Crop Strength[1]	Weed Identification[2]	Weed Severity	Weed Growth[3] Prior	Concom	Post	Crop Estimates Size cm²	Loss%
Achillea	8	Bittercress Oxalis Chickweed Dandelion Plantain	8	Y	Y	Y	8	25
Aquilegia	3	Oxalis Chickweed Dandelion Clover Plantain	9	Y	Y	Y	6	65
Aster	5	Bittercress Chickweed Dandelion Plantain	4	Y	N	Y	10	5
Baptisia	5	Oxalis Poa Chickweed Dandelion Clover Plantain	1	Y	N	N	16	0
Campanula	3	Bittercress Oxalis Poa Chickweed Clover	8	Y	Y	Y	4	40
Coreopsis	5	Bittercress Oxalis Poa Chickweed Plantain	5	Y	N	N	8	10
Delphinium	1	Bittercress Dandelion Clover Plantain	8	Y	Y	Y	10	25
Digitalis	3	Oxalis Poa Chickweed Dandelion	6	Y	N	N	10	30
Echinacea	1	Bittercress Oxalis Poa Dandelion Clover Plantain	8	Y	N	Y	12	45
Filipendula	1	Bittercress Oxalis Poa Chickweed Dandelion Clover	2	Y	N	N	14	20
Geranium	4	Poa Chickweed Dandelion Clover Plantain	6	Y	N	N	16	0
Grasses	1	Oxalis Poa Chickweed Dandelion Clover	9	Y	N	Y	16	10
Hemerocallis	5	Bittercress Oxalis Poa Dandelion Clover Plantain	7	Y	Y	Y	16	0
Hosta	4	Poa Chickweed Dandelion Clover Plantain Clover	8	Y	Y	Y	16	0
Iris	9	Poa Chickweed Dandelion Clover Plantain Clover	6	Y	Y	Y	20	0
Lavendula	4	Bittercress Oxalis Poa Chickweed Dandelion Clover	8	Y	Y	Y	2	65
Lupinus	8	Bittercress Poa Dandelion Clover Plantain	4	Y	N	N	8	15
Monarda	8	Poa Chickweed Dandelion Clover Plantain	5	Y	N	N	6	10
Nepeta	2	Bittercress Oxalis Poa Chickweed Dandelion Clover	6	Y	Y	Y	2	75
Phlox	4	Bittercress Oxalis Poa Dandelion Clover Plantain Clover	6	Y	N	Y	8	65
Creep Phlox	6	Bittercress Oxalis Poa Dandelion Clover Plantain Clover	4	Y	Y	Y	4	35
Rudebeckia	4	Poa Chickweed Dandelion Clover Plantain Clover	3	Y	N	N	6	25
Salvia	5	Bittercress Oxalis Poa Chickweed Dandelion Clover	6	Y	Y	Y	4	55
Thymus	6	Bittercress Oxalis Poa Chickweed Dandelion Clover	7	Y	Y	Y	2	65
Veronica	7	Bittercress Oxalis Poa Chickweed Dandelion Clover	9	Y	Y	Y	4	75

[1] Crop strength estimated at time of transplant; estimates based on rate of regrowth in first month from propagation plug; it has no bearing or relevance to later plant growth habits: i.e. ornamental grasses are notoriously slow to resume growth yet exhibit rapid growth and attain great size later in the season.

[2]Point of origin or source nursery has tremendous influence on original weeds.

[3]Yes(Y) or No(N) as descriptors of regrowth of weeds prior to, concommitant with or following crop regrowth from plugs.

Table 2: Estimates of herbaceous perennial crop and weed leaf size at time of transplant

Example: Herbaceous Perennial	Leaf Size	Example: Weed Species
Tunica Dianthus Sagina Thymus	1	Mollugo, Starwort
Erodium Arabis Dianthus Teuchrium	2	Oxalis, Bittercress
Salvia Veronica Scabiosa Rue Iberis	3	Chickweed, Mouse-ear chickweed
Geum Amsonia Polemonium Potentilla	4	Annual, Kentucky Bluegrass
Stokesia Veronica Platycodon Knautia	5	Vetch, Crabgrass
Baptisia Lupinus Lychnis Oenothera Trollius	6	Dandelion, Clover
Echinacea Eupatorium Pulmonaria Symphytum	7	Hawksweed, Goldenrod
Digitalis Filipendula Rudebeckia Primula	8	Broadleaf Plantain
Hemerocallis Iris Bergenia Grasses	9	Populus, Prunus
Hosta Darmera Petasites Rodergesia	10	Petasites

Table 3: Handweeding success or failure as a function of crop to weed leaf size ratios.

C/W Ratio	Example Crop	Weed	Crop Size in^2	Crop Loss(#/10)	Success/Failure
1 / 1	Tunica	Mollugo	4	9	F
1 / 3	Thymus	Chickweed	6	6	F
1 / 6	Dianthus	Dandlion	12	1	S
2 / 2	Erodium	Bittercress	4	10	F
2 / 4	Arabis	Ann Bluegrass	4	10	F
2 / 6	Dianthus	Clover	16	2	S
2 / 8	Teuchrium	Plantain	8	10	S
3 / 2	Iberis	Bittercress	8	8	F
3 / 3	Veronica	Chickweed	14	8	F
3 / 8	Iberis	Plantain	8	3	S
4 / 4	Amsonia	Ann Bluegrass	8	8	F
4 / 6	Sedum	Dandelion	10	4	S
4 / 8	Polemonium	Plantain	14	2	S
6 / 2	Lupinus	Bittercress	16	0	S
6 / 4	Oenothera	Clover	14	4	S
6 / 6	Trollius	Dandelion	10	8	F
6 / 8	Baptisia	Plantain	8	7	F
8 / 1	Digitalis	Mollugo	16	0	S
8 / 2	Bergenia	Bittercress	16	0	S
8 / 4	Filipendula	Ann Bluegrass	16	0	S
8 / 6	Primula	Hawksweed	14	5	F
8 / 8	Rudebeckia	Plantain	12	10	F
10 / 2	Hosta	Sedum	16	0	S
10 / 3	Rodgersia	Chickweed	16	0	S
10 / 6	Darmera	Dandelion	16	0	S
10 / 8	Hosta	Plantain	16	6	F

Table 4: Effect of handweeding and handweeding interval on crop size and crop loss.

		Crop Size (inches)[1] Timing of handweeding (weeks after transplanting)					Crop Loss Total per 24	Success/Failure
Crop	Crop Strength	0	1	2	4	8		
Erodium	2	2	2	4	4	4	19	F
Dianthus	2	2	6	4	4	4	14	F
Veronica	3	2	8	6	6	4	13	F
Iberis	3	2	4	4	4	4	16	F
Stokesia	5	2	5	9	8	5	6	S
Echinacea	7	2	4	9	10	10	4	S
Filipendula	8	4	4	9	16	16	3	S
Grasses	9	2	8	16	24	24	2	S
Hosta	10	2	4	12	16	16	4	S
Symphytum	7	4	4	8	0	0	24	F

[1] Maximum space available was 16 sq in.

Table5: Effect of three herbicides on weed growth in herbaceous perennials pots of differing crop strengths.

		Herbicides % Weed Control 4, 8, 16 (wat) weeks after treatment								
		Gallery			Dacthal			Roundup[1]		
Crop	Strength	4	8[2]	16[3]	4	8	16	4	8	16
Erodium	2	88	90	48	90	95	53	65	25	0
Dianthus	2	65	55	43	65	50	40	60	15	0
Veronica	3	60	65	50	70	65	53	63	28	0
Iberis	3	63	70	50	65	60	50	48	33	0
Stokesia	5	75	75	75	70	63	60	63	25	0
Echinacea	7	60	75	70	58	70	70	60	33	0
Rudebeckia	8	65	75	65	63	75	65	60	33	0
Grasses	9	95	90	75	95	100	75	60	45	0
Hosta	10	100	90	75	95	100	75	60	45	0

[1] Substantial damage occurred as crop was no longer fully dormant at time of application; crop regrowth did occur but weeds eventually overshadowed all crop growth.
[2] Crop growth was rapid in period of 4-8 wat and often outgreww weed competion
[3] Once pots filled and crop flowered or resumed leaf replacement growth, weeds again encroached to limit crop size.

DOUBLE CROP CORN WEED CONTROL IN VIRGINIA

S. R. King, E.S. Hagood, and C.C. Kenley[1]

ABSTRACT

Double crop production of corn (*Zea mays*) for grain following the harvest of a small grain is not currently practiced in Virginia. Historical precipitation and evapotransportation data indicate that delayed corn planting could result in a higher probability of moisture during critical periods of crop development. Double crop corn may also reduce economic risk as two crops would be harvested in the same year. Field experiments were conducted in three Virginia locations in 1998 and 1999 to determine the herbicide inputs required for double crop corn production relative to those required in full season no-till corn production. Experiments were conducted in a split-plot, randomized complete block design with cropping system as the main plot and herbicide treatment as the subplot. Herbicide treatments included combinations of nonselective herbicides for no-till establishment and/or preemergence residual herbicides and/or selective postemergence herbicides in both production systems. Glyphosate tolerant corn was planted in all experiments and postemergence glyphosate treatments were also evaluated. In each experiment, dependent variables included weed control by species evaluated throughout the season, as well as weed biomass and corn yield evaluated at the end of the growing season. Generally, nonselective herbicides were not required in the double crop system where atrazine was applied as a preemergence treatment, or where selective postemergence treatments were applied. Where a significant proportion of the infestation was comprised of perennial species, however, atrazine treatments were not sufficient in the double crop system. Postemergence glyphosate treatments provided excellent broad spectrum weed control in this situation. In heavy annual grass infestations, postemergence glyphosate treatments provided superior weed control to preemergence treatments alone, and equivalent weed control to treatments in which both preemergence and postemergence herbicides were applied. Corn yield response to weed control and cropping system variables varied significantly between the 1998 and 1999 growing seasons. Where adequate late season rainfall was received, economic return from small grain and corn crops in the double crop system was higher than the return in the full-season system, particularly in infestations where the double-crop system allowed significant reduction in herbicide input.

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ABSORPTION, TRANSLOCATION AND METABOLISM OF ISOXAFLUTOLE IN YELLOW FOXTAIL (*Setaria lutescens*).

S. Kushwaha* and P. C. Bhowmik[1]

ABSTRACT

Our preliminary studies have shown yellow foxtail [*Setaria lutescens* (Weigel) Hubb.] to be less sensitive to isoxaflutole [5-cyclopropyl-4-(2-methylsulphonyl-4-trifluromethylbenzoyl) isoxazole]. Experiments were conducted to study the extent of absorption, translocation of foliar applied, and metabolism of root applied isoxaflutole in yellow foxtail. Ring labeled ^{14}C isoxaflutole was applied to three-leaf seedlings in half strength Hoagland solution. Plants were harvested 3, 6, 12, 24, 48, 72, 96 and 120 hours after treatment. Plants were sectioned in treated leaf, leaves above treated leaf, leaves below treated leaf and roots. The amount of ^{14}C isoxaflutole in various plant parts was determined by digesting the plant samples in biological oxidizer. By the end of 48 h, foliar absorption reached to the maximum of 67.4% of total applied radioactivity. Treated leaf, leaves above treated leaf, leaves below treated leaf and roots had 45.0, 6.4, 15.6 and 0.5% radioactivity respectively. For metabolism study of root applied isoxaflutole, plants were harvested at 72 and 168 h. Plant extract was subjected to thin layer chromatography. The total radioactivity was identified as isoxaflutole, diketonitrile metabolite, unknown metabolite A and benzoic acid, and the distribution was 4.6, 64.5, 7.3 and 17.9% at 72 h, and 4.1, 55.8, 9.5 and 24.2% at 168 h, respectively.

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ANNUAL WEED AND GRASS CONTROL IN CORN WITH ZA-1296

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ABSTRACT

ZA-1296 is a new triketone herbicide for preemergence (PRE) or postemergence (POST) weed control in field corn (*Zea mays* L.). Herbicides in this chemical class have controlled numerous annual broadleaf and grass weeds without injury to corn. Field studies were conducted in 1999 at the Eastern Shore Agricultural Research and Extension Center near Painter, VA to evaluate corn and weed response to PRE and POST ZA-1296 in conventional and no-till systems. In no-till studies, ZA-1296 was applied PRE at 0.07, 0.14, 0.21, and 0.28 lb ai/A in combination with sulfosate (1.0 lb ai/A) and POST at 0.031, 0.063, 0.094, 0.125, and 0.166 lb/A following PRE sulfosate (1.0 lb/A). POST treatments in all studies were applied with 1.0% v/v crop oil concentrate and 2.5% urea ammonium nitrate fertilizer.

In no-till studies, ZA-1296 applied PRE at 0.14 lb/A or POST at 0.063 lb/A provided ≥90% control of smooth pigweed (*Amaranthus hybridus* L.) 7 wk after planting (WAP). In contrast, morningglory (*Ipomoea* spp.) control was ≤49% and ≤73% with PRE and POST applications, respectively. Cutleaf eveningprimrose (*Oenothera laciniata* Hill) plants were present at planting; therefore, PRE applications were actually POST relative to cutleaf eveningprimrose. Cutleaf eveningprimrose control was 99% from 0.21 lb/A ZA-1296 mixed with sulfosate compared to 39% with sulfosate alone. Horseweed [*Conyza canadensis* (L.) Cronq.] control in a separate no-till study with 0.14 to 0.28 lb/A ZA-1296 alone was 61 to 78% 3.5 to 4.5 WAT but control decreased over time.

Smooth pigweed, common ragweed (*Ambrosia artemisiifolia* L.), and common lambsquarters (*Chenopodium album* L.) control with ZA-1296 (0.14 or 0.28 lb/A) applied PRE in conventional tillage systems was 48 to 69% 3 WAT and control was generally higher when ZA-1296 was mixed with atrazine (0.5 lb ai/A) or acetochlor (1.6 lb ai/A). Annual grass control, predominantly giant foxtail (*Setaria faberi* Herrm.), with ZA-1296 PRE was unsatisfactory (<5%) 3 WAP; however, control with ZA-1296 (0.14 or 0.28 lb/A) plus acetochlor (1.6 lb/A) was 99% and comparable to control with acetochlor (1.5 lb/A) plus atrazine (1.0 lb/A). Yields were generally greater from corn treated with ZA-1296 plus acetochlor than with ZA-1296 alone and reflected differences in grass control.

In follow-up greenhouse studies, poor control of giant foxtail by ZA-1296 was confirmed. Control of giant foxtail 2 WAT with POST ZA-1296 applied at 0.094 and 0.188 lb/A was 12 and 17%, respectively. In contrast, yellow foxtail [*Setaria glauca* (L.) Beauv.] and large crabgrass [*Digitaria sanguinalis* (L.) Scop.] control with the same rates was 64 to 71 and 82 to 86%, respectively.

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RESPONSE OF DICLOFOP-RESISTANT ITALIAN RYEGRASS (*Lolium multiflorum*) TO SELECTED PREEMERGENCE HERBICIDES.

I.V. Morozov, E.S. Hagood, and P.L. Hipkins.[1]

ABSTRACT

Italian ryegrass has become a competitive weed in small grains in the northwestern and southeastern United States. In 1993, resistance to diclofop was confirmed in one Virginia biotype from south central Virginia. Following the 1997-98 growing season, Italian ryegrass seed was collected from 32 locations in Virginia where diclofop applications failed to provide acceptable control. Three rates of diclofop were applied postemergence to ryegrass plants from these locations, and resulted in confirmation of herbicide resistance in ten biotypes, and various degrees of susceptibility in other biotypes. Greenhouse and field studies were conducted to evaluate various rates of several preemergence herbicides for diclofop-resistant Italian ryegrass control. Field studies were conducted in Amelia County, Virginia. Varying rates of preemergence herbicides including two acetochlor formulations, BAY MKH 6561, BAY MKH 6562, chlorsulfuron, chlorsulfuron + metsulfuron methyl, a tank mixture of chlorsulfuron + metsulfuron methyl + FOE 5043 + metribuzin, diclofop-methyl, FOE 5043 + metribuzin, metribuzin, metolachlor, and pendimethalin were applied to plots arranged in a randomized complete block design with four replications. Significant differences in diclofop-resistant ryegrass response to preemergence herbicide treatments were observed. Acetochlor, FOE 5043 + metribuzin, metolachlor, metribuzin, and a tank mixture of chlorsulfuron + metsulfuron methyl + FOE 5043 + metribuzin provided the highest degree of Italian ryegrass control. The remaining herbicides evaluated exhibited poor control of diclofop-resistant ryegrass. The safety of preemergence treatments was evalutated on wheat and barley. Greenhouse tests showed that preemergence treatment with metribuzin caused the highest degree of injury to both wheat and barley. Significant injury to barley was observed with preemergence treatments of BAY MKH 6561 and BAY MKH 6562. The higher rate of metolachlor caused only an intermediate degree of injury. The remaing herbicides were found to be safe on both barley and wheat.

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MANAGING QUACKGRASS INFESTATIONS AS COVER CROPS IN HERBICIDE-RESISTANT CORN

N. Gift, R.R. Hahn, and J. Mt. Pleasant[1]

ABSTRACT

Quackgrass (*Elytrigia repens* (L.) Nevski) is an invasive weed – not normally considered to be a desirable cover crop. However, its high nutritional value makes this weed more tolerable in alfalfa (*Medicago sativa* L.) than in corn (*Zea mays* L.). Growers typically attempt to eradicate quackgrass from corn fields, but manage this weed less aggressively in alfalfa, where it contributes to hay quality and yield. The objective of this study was to evaluate herbicides for use in herbicide-resistant corn which could: 1) suppress quackgrass to minimize its effect on corn silage yield, 2) leave adequate quackgrass residue to control erosion (act as a good cover crop), and 3) leave quackgrass as a grass companion crop for alfalfa. Results of the first objective are reported here.

This study was established at two sites, both with heavy existing quackgrass infestations. In Dryden, NY, corn hybrids 'DK493GR' (glufosinate-resistant) and 'DK493RR' (glyphosate resistant) were planted on May 20, 1999 in a split plot arrangement, with corn hybrid as the main plot, and herbicide as the subplot. Late post-emergence treatments were applied to both hybrids on June 30, 1999. Treatments included an untreated check (both hybrids), glufosinate (0.37 and 0.44 lb ai/A) (GR only), glyphosate (1.0 lb ai/A) (RR only), primisulfuron (0.57 oz ai/A) (RR only), and nicosulfuron (0.50 oz ai/A) (both hybrids). In Valatie, NY, 'DK493SR' was also included, as well as the additional treatments of sethoxydim (0.19 and 0.28 lb ai/A) (SR only). Untreated check and nicosulfuron treatments were also applied to SR corn. Corn in Valatie was planted on May 28,1999, and herbicides were applied on June 24, 1999.

Response variables include quackgrass ratings, corn ratings (including yellowing and leaf rolling, due to drought conditions), corn silage yields, and ground cover measurements. Yields were low due to drought conditions across New York. Glyphosate treatments resulted in the highest yields at both locations (14.9 tons/A in Dryden; 14.8 tons/A in Valatie). Yields of glufosinate treatments did not differ from glyphosate treatments in Dryden, but were lower than glyphosate treatments in Valatie. Primisulfuron and nicosulfuron treatments' yields were not different from those of glyphosate treatments at Valatie, but were lower than glyphosate treatments in Dryden. Sethoxydim (Valatie only) yields were equivalent to the weedy check. Weedy check treatments had the lowest yields in Dryden (9.5 tons/A), and were statisically equivalent to the worst treatments in Valatie (12.0 tons/A). In-season quackgrass injury ratings for both locations indicate that yields were highly correlated with the degree of quackgrass suppression. In extremely dry seasons such as 1999, the potential for maintaining a healthy quackgrass cover, without reducing corn yields, seems low. Fall evaluations of quackgrass cover will reveal whether the suppressed quackgrass in the high-yielding treatments will provide adequate ground cover.

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EFFECT OF HERBICIDE RATE, SEQUENTIAL HERBICIDE TREATMENT, AND MOWING ON MUGWORT CONTROL

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ABSTRACT

Three field trials were conducted during 1998 and repeated in 1999 to evaluate mugwort (*Artemesia vulgaris* L.) control with several herbicides and herbicide/mowing regimes. A logarithmic sprayer was utilized in the first field trial to determine herbicide rates that provide acceptable mugwort control. Sequential herbicide treatments were applied to mugwort at 7-week intervals in the second field trial to evaluate mugwort control following one, two, and three herbicide applications. In the third field trial, the effect of sequential mowing was investigated by applying herbicides to mugwort regrowth following either one or two mowings. The herbicides evaluated in all three field trials included 2,4-D amine, 2, 4-D ester, dicamba, triclopyr, clopyralid, picloram, metsulfuron, glyphosate, and glufosinate. Pelargonic acid was also evaluated as an addition to 2,4-D amine, glyphosate, and glufosinate in the logarithmic sprayer trial. In the logarithmic sprayer trial, all herbicides except for metsulfuron were evaluated at the rates of 8, 4, 2, 1, 0.5, and 0.25 lb ai per acre. Metsulfuron was evaluated at an analogous rate range with the highest rate being 0.56 lb ai per acre. In the sequential herbicide and sequential mowing trials, 2,4-D amine, 2,4-D ester, and glyphosate were applied at 4.0 lb ai per acre, triclopyr and dicamba at 2.0 lb ai per acre, glufosinate at 1.5 lb ai per acre, picloram at 1.0 lb ai per acre, clopyralid at 0.25 lb ai per acre, and metsulfuron at 0.0112 lb ai per acre.

In the logarithmic sprayer trial, 100% control of mugwort was achieved with all rates of picloram during both years. In 1998, all rates of clopyralid provided greater than 95% control of mugwort. In 1999, however, slightly lower levels of control were observed at the 0.25, 0.5, 1.0 and 2.0 lb clopyralid rates. The next highest level of mugwort control was achieved with the 8, 4, and 2 lb glyphosate rates, which provided greater than 90% control in both years. Dicamba also provided greater then 90% mugwort control at the 8 lb rate during both years. All remaining herbicides generally provided unacceptable control of mugwort.

Sequential herbicide treatment trials conducted during both years revealed that only one application of picloram was required to provide 100% mugwort control. Additionally, two or three treatments of clopyralid or glyphosate did not significantly enhance mugwort control compared to one application of these herbicides. In 1998, a second application of 2,4-D amine, 2,4-D ester, dicamba, or triclopyr significantly improved mugwort control, however a third application of any of these herbicides was not warranted. Mugwort control was also significantly improved with each additional application of glufosinate in 1998.

In the sequential mowing trial, two mowings did not significantly enhance mugwort control in the clopyralid, dicamba, metsulfuron, picloram, or triclopyr treatments in either year. In 1998, a second mugwort mowing significantly improved mugwort control in plots treated with 2, 4-D amine, 2, 4-D ester, glyphosate, and glufosinate. In 1999, however, the second mowing only enhanced mugwort control in plots treated with 2, 4-D ester and glufosinate.

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USING HERBICIDE RESISTANT HYBRIDS TO MANAGE BURCUCUMBER (*SICYOS ANGULATUS*) IN CORN.

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ABSTRACT

Burcucumber (*Sicyos angulatus* L.) is an annual climbing vine that is capable of germinating throughout a growing season, producing multiple flushes of seedlings from early May to August in Pennsylvania. Due to burcucumber's prolonged germination, it has been a difficult weed to control with conventional herbicide programs. The introduction of herbicide resistant hybrids may provide more effective control options for burcucumber.

Experiments examining burcucumber management in glufosinate resistant and imidazolinone resistant corn (*Zea mays* L.) varieties were conducted in both 1997 and 1998 in southeastern Pennsylvania. A glufosinate resistant corn variety was planted in 15 and 30 inch rows and POST treatments of glufosinate and glufosinate + atrazine were applied three and four weeks after planting. In another study, an imidazolinone resistant corn variety was planted in 30 inch rows and fifteen PRE and POST herbicide programs were evaluated. Herbicide treatments included isoxaflutole, prosulfuron, simazine, imazethapyr + imazapyr, imazamox, chlorimuron + thifensulfuron, nicosulfuron + rimsulfuron + atrazine, prosulfuron + primisulfuron, and combinations with atrazine. In both studies, weed density, control, and biomass, as well as crop yield were recorded. In the glufosinate tolerant corn study, weekly counts of new burcucumber emergence were also noted.

Burcucumber germinated throughout the growing season, with the greatest amount of emergence occurring in early June and gradually decreasing to minimal emergence numbers by the middle of July. In general, the PRE herbicide programs were less consistent in controlling burcucumber when compared to the POST programs. Several post emergence programs, such as imazethapyr + imazapyr and imazamox, were also ineffective in managing burcucumber. Chlorimuron + thifensulfuron, nicosulfuron + rimsulfuron + atrazine, and prosulfuron + primisulfuron provided greater than 80% and 90% control of burcucumber in 1997 and 1998, respectively. Glufosinate provided effective early burcucumber control regardless of application timing or row spacing, however, it did allow new burcucumber emergence due to lack of residual control. The addition of atrazine to any herbicide program increased control in most situations. Row spacing had little effect on burcucumber emergence or control and appears to have little impact on burcucumber management in corn.

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EFFECT OF REDUCED HERBICIDE RATES AND CULTIVATION FOR WEED CONTROL IN NO-TILL CORN

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ABSTRACT

An experiment was repeated for three growing seasons at the Agronomy Research Farm near Rock Springs, PA. The experiment was part of the NE-92 Regional Project and a similar study was conducted at Cornell University. The objective was to examine the effect of reduced herbicide rates and row cultivation for weed control in no-till corn for grain or silage. The corn for grain was no-till planted into shredded corn stalks, while the corn for silage was no-till planted into a rye (*Secale cereale* L.) cover crop. Approximately 5 days prior to corn planting, 1.0 lb ai/A glyphosate was broadcast applied to kill emerged vegetation including the rye cover crop. The rye cover crop at corn planting was 12 to 18 inches tall ranging from 1380 to 2470 lb/A dry matter, depending on the year. Five weed control treatments included a broadcast application of atrazine, metolachlor, and pendimethalin at 1.36 + 1.64 + 0.75 lb ai/A, respectively (1X), the 1X treatment followed by cultivation (1X+C), the 1X treatment applied at one-half the rate followed by cultivation (0.5X+C), the 1X treatment applied in a 15 in band followed by cultivation (B+C), and an untreated plot. Row cultivation was accomplished using a Sukup no-till cultivator. A single cultivation was performed about 5 weeks after corn planting in 1996, while two cultivation's approximately one week apart (5 and 6 weeks after planting) were conducted in 1997 and 1998. The experiment was replicated four times and the treatments were repeated in the same field location each year for three years. Weed control treatments were evaluated through visual estimates of percent control, weed density, and weed biomass. Corn silage or grain yield measurements were collected each fall.

The dominant weeds in the study included common lambsquarters (*Chenopodium album* L.), giant foxtail (*Setaria faberi* Herrm.), smooth pigweed (*Amaranthus hybridus* L.), velvetleaf (*Abutilon theophrasti* Medic), common ragweed (*Ambrosia artemisiifolia* L.), and yellow nutsedge (*Cyperus esculentus* L.). Common lambsquarters was the most severe species present. In 1996 and 1997, control of common lambsquarters was better in corn grain/corn residue than in corn silage/rye residue. Control of the other weeds was similar across corn and rye residue. The 1X+C treatment provided 90% or greater weed control all three years, while the other treatments generally provided greater than 80% control. In 1998, control was less in untreated corn residue compared to untreated rye residue. In addition, control was better in the 1X corn residue treatment compared to the 1X rye residue plot. It appeared that rye residue provided some weed control benefit in 1998 in the absence of herbicide, but may have reduced herbicide performance in the absence of cultivation. In addition, corn vigor was reduced in 1998 in the rye residue treatments compared to the corn residue treatments. With one exception, grain and silage yields were reduced in only the untreated plot, compared to the other weed control treatments. In 1997, silage yield was higher in two of three cultivation treatments than in the 1X treatment. These data suggest that reduced herbicide rates with cultivation can effectively manage weeds in conservation tillage systems. However, crop residue can also impact weed severity and herbicide performance.

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NICOSULFURON/RIMSULFURON COMBINATIONS FOR POSTEMERGENCE WEED CONTROL IN FIELD CORN

R. R. Hahn and P. J. Stachowski[1]

ABSTRACT

Field experiments were conducted at several locations in 1999 to compare early postemergence (EPOST) applications of nicosulfuron/rimsulfuron combinations with glyphosate in glyphosate-resistant corn (*Zea mays* L.) and with preemergence (PRE) programs in conventional corn. At three locations, EPOST applications of 12.6 oz ai/A of nicosulfuron/rimsulfuron plus atrazine (Basis Gold) alone, and in combination with 2 oz ai/A of dicamba, and of 0.38 oz ai/A of nicosulfuron/rimsulfuron (DPX-79406) plus 2.05 oz ai/A of clopyralid/flumetsulam (Hornet) were compared with EPOST applications of 1 lb ai/A of glyphosate. These EPOST nicosulfuron/rimsulfuron treatments were compared with a PRE application of 2.89 lb ai/A of *s*-metolachlor/atrazine (Bicep II Magnum) followed by a MPOST application of 4 oz/A of dicamba or a PRE standard of 2.25 lb ai/A of s-metolachlor/atrazine (Bicep Lite II Magnum) plus 1.5 lb ai/A of pendimethalin in experiments with conventional hybrids.

In two experiments, EPOST applications of nicosulfuron/rimsulfuron plus atrazine and of nicosulfuron/rimsulfuron plus clopyralid/flumetsulam controlled an average of 90 and 99% of the velvetleaf (*Abutilon theophrasti* Medicus) respectively compared with 95% velvetleaf control with the EPOST glyphosate application. Green foxtail (*Setaria viridis* (L.) Beauv.) control averaged 76% with the nicosulfuron/rimsulfuron combinations while glyphosate controlled 99% in one experiment. There were no differences in corn yields among these treatments at either location. Control of triazine-resistant (TR) common lambsquarters (*Chenopodium album* L.) was 63% with EPOST application of nicosulfuron/rimsulfuron plus atrazine alone and 100% when applied with dicamba. The EPOST nicosulfuron/rimsulfuron plus chlorpyralid/flumetsulam treatment controlled 70% of the TR lambsquarters while glyphosate provided 100% control. With a conventional hybrid, PRE application of *s*-metolachlor/atrazine plus pendimethalin controlled 89% of a TR lambsquarters population producing a yield of 74 bu/A. MPOST application of nicosulfuron/rimsulfuron plus atrazine alone and with dicamba controlled 40 and 75% of the TR lambsquarters and yielded 15 and 76 bu/A respectively. Yield from the untreated check was 2 bu/A. Finally EPOST application of nicosulfuron/rimsulfuron plus atrazine alone or of nicosulfuron/rimsulfuron plus clopyralid/flumetsulam controlled an average of 97% of the triazine-susceptible lambsquarters and of the yellow foxtail (*Setaria glauca* (L.) Beauv.) and yielded an average of 103 bu/A of grain corn with a conventional hybrid. The PRE standard followed by a MPOST dicamba application also provided 97% lambquarters control but only 63% foxtail control and yielded 64 bu/A. Yield from the untreated check was 23 bu/A.

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Perennial and Annual Weed Control In Glyphosate Tolerant Crops

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ABSTRACT

Multiple-year studies were initiated in 1998 with the objectives of evaluating weed control and weed shifts following POST applications of glyphosate in glyphosate-tolerant crops. Studies were conducted at Keedysville, MD on Hagerstown silt loam soils with 2.1 to 2.4% OM and pH of 6.5 to 6.9. In one study, POST applications of 0.75, 1.0, and 1.5 lbs ai/A glyphosate were made to soybeans in the V-2, V-4, and V-8 stage of growth. Control of giant foxtail (*Setaria faberi* Herrm.) And common lambsquarters (*Chenopodium album* L.) was better following V-4 and V-8 application (93 to 100%) than with V-2 applications of glyphosate (53 to 60%). This was due to late emergence of these annual weeds. Hemp dogbane (*Apocynum cannabinum* L.) control following POST applications of 0.75 lbs/A was greater with V-2 applications (98%) compared to later applications (60 to 73%). Hemp dogbane control was similar at all application stages with 1.0 and 1.5 lbs/A glyphosate (83 to 97%). Hemp dogbane had initiated reproductive growth by the later application stages which apparently made hemp dogbane less susceptible to 0.75 lbs/A glyphosate. Pokeweed (*Phytolacca americana* L.) control was excellent (97 to 100%) for all rates and stages of application of glyphosate. Soybean yield was lower with V-8 glyphosate applications than earlier applications suggesting that early weed competition reduced yield. A separate study was designed to examine long-term weed control in glyphosate-tolerant corn and soybean rotations. Glyphosate applied at 1.0 lbs/A to 5-inch corn and V-4 soybeans provided 90% or greater control of hemp dogbane, giant foxtail, and common lambsquarters 8 weeks after treatment. Similar control was obtained in year 2 regardless of the crop rotation. In both corn and soybeans three weeds were observed that were not controlled by glyphosate applications. These weeds were honeyvine milkweed [*Ampelamus albidus* (Nutt.) Britt.], smooth groundcherry (*Physalis subglabrata* Mackenz. & Bush).

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GLYPHOSATE ALONE AND PRECEDED BY PREEMERGENCE HERBICIDES IN GLYPHOSATE-TOLERANT CORN

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ABSTRACT

Annual grass and broadleaf weed control in corn has traditionally been achieved with preemergence (PRE) combinations of triazine and chloroacetamide herbicides. Follow-up postemergence (POST) herbicide applications are occasionally required to achieve season-long control, however the use of herbicide-tolerant corn (*Zea mays* L.) may reduce or eliminate the need for PRE herbicides.

Field experiments were conducted in 1998 and 1999 at the Eastern Shore Agricultural Research and Extension Center near Painter, VA to evaluate weed and crop response to POST glyphosate applied at various timings and to evaluate the potential benefit of PRE herbicides in Roundup Ready® corn. In 1998, POST glyphosate (1.0 lb ai/A) was applied at 2, 3, 4, 5 and 3 plus 5 wk after planting (WAP). Glyphosate was applied alone and preceded by s-metolachlor (0.78 lb ai/A) plus atrazine (1.0 lb ai/A). In 1999, POST glyphosate applications were made approximately 2, 3, 7, or 3 plus 7 WAP. As a comparison, s-metolachlor plus atrazine was included in the study.

In 1998, corn injury from glyphosate was minimal (≤ 10%) with and without s-metolachlor plus atrazine PRE. Late-season (9 WAP) weed control and corn yields were generally greatest when POST glyphosate applications were made 4, 5, or 3 plus 5 WAP compared to 2 or 3 WAP. Corn yield and weed control were generally similar with PRE s-metolachlor plus atrazine and POST glyphosate at 4, 5, or 3 plus 5 WAP. POST glyphosate applications following PRE s-metolachlor plus atrazine did not improve broadleaf weed control 9WAP or corn yield compared to PRE s-metolachlor plus atrazine alone. However, POST glyphosate applications made 3, 4, 5, or 3 plus 5 WAP following PRE s-metolachlor plus atrazine improved annual grass control compared to s-metolachlor plus atrazine alone.

Efficacy of PRE s-metolachlor plus atrazine in 1999 was reduced by very dry growing conditions. Annual grass and broadleaf weed control 9 WAP with POST glyphosate applications (62 to 97%) was significantly greater than with PRE metolachlor plus atrazine (37 to 47%). These obvious differences in weed control should have been reflected in corn yields but yields were similar with all treatments and extremely variable. Variability in yields was likely due to bird damage early in the growing season, drought stress, and poor corn standability.

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EFFECT OF CORN WEED MANAGEMENT PROGRAMS ON HORSENETTLE CONTROL

C. Whaley, M. J. VanGessel, and Q. Johnson[1]

ABSTRACT

Horsenettle (Solanum carolinense L.) infestations have been increasing in the mid-Atlantic region due to increased no-tillage production and lack of effective control measures in many crops. Horsenettle is a perennial species that emerges late in the spring and is very sensitive to frost. Thus, fall glyphosate applications are often applied too late to be effective. Field studies were conducted from 1997 to 1999 at three locations in Delaware. The benefits of a fall glyphosate application followed by in-crop herbicide programs on horsenettle shoot populations were evaluated in a no-tillage soybean (Glycine max L.) -corn (Zea mays L.) rotational system. The studies were a two-factor factorial, arranged as a randomized complete block design with four replications. The first factor was a fall herbicide application. Fall treatments were glyphosate at 2.2 kg ai/ha, applied at least two weeks prior to frost, or no fall treatment. The second factor was an in-crop herbicide application at 3 weeks after planting. In-crop treatments included glyphosate, prosulfuron + primisulfuron + dicamba + nonionic surfactant, halosulfuron + dicamba + nonionic surfactant, dicamba + atrazine, nicosulfuron + rimsulfuron + atrazine + dicamba + crop oil concentrate, nicosulfuron + dicamba + crop oil concentrate. Percent control and shoot populations were recorded at planting, and at 11 weeks after the in-crop treatment (WAT).

In the 1997-98 study, fall glyphosate applications did not improve horsenettle control compared to no fall treatment when percent control was recorded 11 WAT. The in-crop treatments of prosulfuron + primisulfuron + dicamba + nonionic surfactant and nicosulfuron + dicamba + crop oil concentrate provided over 80% control. However, at the two locations in the 1998-99 studies, the fall glyphosate application increased the efficacy of most in-crop herbicide applications by reducing the number, vigor, and biomass of horsenettle shoots. At 11 WAT, in-crop applications of glyphosate or prosulfuron + primisulfuron + dicamba + nonionic surfactant with no fall glyphosate applications, resulted in similar horsenettle control (>75%) to fall glyphosate applications followed by the remaining herbicide treatments.

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ROUNDUP VS. LIBERTY: WHAT HAVE WE LEARNED?

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ABSTRACT

Experiments were conducted at Penn State University starting in 1995 with glyphosate and glufosinate resistant crops. Soybean and corn studies examined these herbicides alone, in combination with other herbicides, postemergence following soil-applied herbicides, and in sequential postemergence applications. Soybean trials were conducted in seven to 15 inch rows and in 30-inch row spacings. All corn trials were conducted with 30 inch spaced rows. Glyphosate was applied at 0.75 to 1.0 lb ai/A. Glufosinate was applied at 0.27 to 0.36 lb ai/A. Post applications were applied between 3 and 6 weeks after planting. All studies were planted in reduced tillage systems that generally included spring chisel plowing and disking once or twice. Most experiments were consisted of 10 by 25 foot plots replicated three times.

Common weeds throughout these studies included common lambsquarters (*Chenopodium album* L.), giant foxtail (*Setaria faberi* Herrm.), smooth pigweed (*Amaranthus hybridus* L.), velvetleaf (*Abutilon theophrasti* Medic), common ragweed (*Ambrosia artemisiifolia* L.), and yellow nutsedge (*Cyperus esculentus* L.). In addition, eastern black nightshade (*Solanum ptycanthum* Dun.) and burcucumber (*Sicyos angulatus* L.) were present in a few experiments. For Roundup Ready soybeans, row spacing did not greatly influence glyphosate performance. Glyphosate alone consistently controlled most weeds in soybean. Tank-mixtures or sequential treatments were generally not needed unless weed infestations were severe or under conditions that prevented soybean canopy closure. In Roundup Ready corn, single glyphosate treatments did not consistently control all weeds. Sequential treatments provided the most consistent control whether it was a soil applied product followed by glyphosate post or two applications of glyphosate. Tank mixtures with glyphosate were slightly better than glyphosate alone, but not as consistent as sequential treatments. Liberty Link corn results were similar to Roundup Ready corn results. Glufosinate alone was rarely effective for complete weed control. Sequential treatments that followed a soil applied treatment provided the most consistent control with glufosinate. Tank mixtures and split post applications were better than glufosinate alone, but not as effective as a sequential soil applied treatment followed by glufosinate post.

These results demonstrate that glyphosate performance in Roundup Ready corn is different from Roundup Ready soybean, where single applications of glyphosate have been very consistent and effective. Corn more often requires two separate applications. Glufosinate performance in Liberty Link corn is similar to glyphosate performance in Roundup Ready corn, but probably even less likely to succeed in a single application approach. Sequential treatments that include a soil residual herbicide application followed by a post application of glufosinate have been most successful in Liberty Link corn.

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EFFECTIVENESS OF GLYPHOSATE AND SEVERAL OTHER HERBICIDES FOR MANAGING WEEDS IN ROUNDUP READY CORN

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ABSTRACT

With the recent introduction of Roundup Ready corn (*Zea mays* L.) hybrids, some speculation has been placed on herbicide mixtures with glyphosate and application timing to obtain effective weed control. The following research was designed to evaluate glyphosate alone at different application timings as well as to compare glyphosate mixed with other herbicides to traditional herbicide programs.

In 1999, field studies were conducted at Lawrence, Crawford, Juniata, York, Lebanon, and Wayne counties Pennsylvania. Roundup Ready corn was planted during May and the following herbicide treatments were evaluated: (1) s-metolachlor+atrazine plus pendimethalin, PRE (2.2 lb and 1.24 lb ai/A respectively); (2) acetochlor+atrazine, PRE (2.8 lb ai/A) followed by glyphosate, POST, (1 lb ai/A); (3) glyphosate, EPOST, (1 lb/A); (4) glyphosate, POST, (1 lb/A); (5) glyphosate, LPOST, (1 lb/A); (6) glyphosate plus atrazine, EPOST, (1 lb plus 1 lb ai/A); and (7) glyphosate, EPOST (1 lb/A) followed by glyphosate, LPOST, (0.75 lb/A). Although weed species and severity differed across locations, giant foxtail (*Setaria faberi* Herrm.), common lambsquarters (*Chenopodium album* L.), velvetleaf (*Albutilon theophrasti* Medic.), smooth pigweed (*Amaranthus hybridus* L.), common ragweed (*Ambrosia artemisiifolia* L.), Pennsylvania smartweed (*Polygonum pensylvanicum* L.), and yellow nutsedge (*Cyperus esculentus* L.), were most often present. The York County site was dominated by Johnsongrass (*Sorghum halepense* (L.) Pers.). A randomized complete block design with three replications was used for all studies. Herbicides were applied with a CO_2-backpack sprayer that delivered 20 gpa. Above-ground weed biomass and corn grain yield were collected at the end of season. Samples were oven dried and corn yield was converted to bu/A at 15.5% moisture.

Location by treatment interactions were absent for four of six counties, so weed biomass data were combined over Lawrence, Wayne, Lebanon, and Juniata counties. At these locations, all herbicide treatments effectively controlled the weeds, while weed biomass in the untreated plot averaged 2219 lb/A. At Crawford County, the LPOST application of glyphosae was ineffective probably due to the larger weeds and poor spray coverage. At York County, s-metolachlor+ atrazine plus pendimethalin was the only treatment not different from the control; this was primarily due to the presence of Johnsongrass that was not controlled by the PRE treatment.

Corn yield ranged from an average low of 40 bu/A in Wayne County to a high of 160 bu/A in Lawrence. Corn yield data was combined across locations because of the lack of location by treatment interactions. Across locations corn yield in the untreated plots averaged 47 bu/A while the herbicide treatments ranged from 86 to 97 bu/A.

In summary, application timing for glyphosate was generally not as critical in 1999 as it may be in other years due to dry weather and a lack of subsequent weed emergence. Only with a LPOST application, where herbicide deposition may have been impacted because of larger corn, were differences in timing observed.

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WEED CONTROL PROGRAMS WITH GLUFOSINATE- AND GLYPHOSATE-RESISTANT FIELD CORN

P.J. Stachowski and R.R. Hahn[1]

ABSTRACT

Field experiments were established in 1999 to evaluate the effect of application timing of glufosinate and glyphosate treatments on weed control and corn (*Zea mays* L.) yields and to evaluate the effect of residual herbicides with glyphosate. A preemergence (PRE) standard of *s*-metolachlor/atrazine plus pendimethalin was applied in all experiments. Applications of 1.34 lb ai/A of glufosinate/atrazine (Liberty ATZ) were made early, mid- and late postemergence (EPOST, MPOST, and LPOST) at one location. Glyphosate applications of 1 lb ai/A were made EPOST, MPOST, and LPOST at three locations. In addition, EPOST applications of glyphosate were made in combinations with residual herbicides.

All glufosinate/atrazine applications provided excellent (94%+) velvetleaf (*Abutilon theophrasti* Medicus) and green foxtail (*Setaria viridis* (L.) Beauv.) control except the MPOST application which controlled 65% of the velvetleaf. Control of velvetleaf and green foxtail was only 9 and 33% respectively with the PRE standard due to limited rainfall for herbicide activation. With limited rainfall throughout the season, silage corn yields with the EPOST, MPOST, and LPOST glufosinate/atrazine applications were only 10.1, 8.1 and 6.9 T/A respectively. The PRE standard yielded 6.3 T/A and the untreated check 3.3 T/A. Although application timing in an adjacent glyphosate-resistant corn experiment planted the same day affected velvetleaf control, it did not affect green foxtail control or grain corn yields. In a second experiment planted 10 days later, velvetleaf control was 96, 80, and 47% for the EPOST, MPOST, and LPOST glyphosate applications respectively. Green foxtail control was 94, 98, and 30% and corn yields were 108, 98, and 44 bu/A respectively. By comparison, the PRE standard controlled 60 and 89% of the velvetleaf and foxtail respectively and yielded 91 bu/A. The yield from the untreated check was 20 bu/A. An experiment with heavy velvetleaf and redroot pigweed (*Amaranthus retroflexus* L.) pressure was conducted with glyphosate-resistant corn. Velvetleaf and pigweed control were 60 and 90% respectively with the PRE standard. The three POST glyphosate applications controlled an average of 97 and 96% of the velvetleaf and pigweed respectively. The average yield for the three glyphosate treatments was 181 bu/A compared with 173 and 107 bu/A for the PRE standard and untreated check respectively. Finally, in an experiment with triazine-resistant common lambsquarters (*Chenopodium album* L.) and fall panicum (*Panicum dichotomiflorum* Michx.) control averaged 97 and 98% respectively for the three POST glyphosate treatments compared with 89 and 97% respectively for the PRE standard. There were no significant differences in corn yield among these treatments. The addition of residual herbicides to EPOST glyphosate treatments had little impact on weed control ratings or grain corn yields in these experiments.

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INFLUENCE OF TIMING ON WEED MANAGEMENT IN GLYPHOSATE-RESISTANT CORN

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ABSTRACT

A 1999 field trial conducted in Lebanon, CT evaluated the influence of the time of glyphosate (Roundup Ultra) application on the competitive effects of weed populations on corn (Zea mays L.) yield. Agway 637RR, a 107 day glyphosate-resistant corn variety, was planted on May 13, 1999. Preemergence treatments (PRE) were applied on May, 18th. Early postemergence treatments (EP) were applied on June 10th, when the corn had 4-to-5 leaves, and 8-to-14 inches in height. Mid postemergence treatments (MP) were applied on June 16th, when the corn had 5-to-6 leaves, and 16-to-21 inches in height. Late postemergence treatments were applied on June 24th, when the corn had 8-to-9 leaves, and 30-to-34 inches in height. Treatments included glyphosate alone at 0.5, 0.75, and 1.0 lb ai/A, all applied at the EP, MP, and LP timings. Other treatments included glyphosate at 1.0 lb ai/A EP in combination with EP applications of either atrazine at 0.75 lb ai/A, or acetochlor + atrazine (Harness Xtra 5.6L) at 1.75 lb ai/A, glyphosate EP followed by glyphosate LP, both at 1.0 ai/A, and acetochlor + atrazine (Harness Xtra 5.6L) at 2.1 lb ai/A PRE followed by glyphosate at 1.0 lb ai/A (MP). Comparative treatments included s-metolachlor + atrazine (Bicep II Magnum 5.5L) at 2.9 lb ai/A + pendimethalin (Prowl 3.3EC) applied PRE, rimsulfuron + atrazine + nicosulfuron (Basis Gold 90DF) at 0.79 lb ai/A applied EP, and s-metolachlor (Dual II Magnum 7.64EC) at 1.27 lb ai/A applied PRE followed by prosulfuron+ primisulfuron (Exceed 57WG) at 0.036 lb ai/A applied EP. The study was a randomized complete block design with three replications. Herbicides were applied with a CO_2 backpack sprayer delivering 20 gpa at 32 psi. Weed control was assessed by visual ratings on July 3rd, and September 28th. The dominant weed species were velvetleaf [Abutilon theophrasti Medik], giant foxtail [Setaria faberi Herrm.], and wild cucumber [Echinocystis lobata (Michx.). Common lambsquarters [Chenopodium album L.], redroot pigweed (Amaranthus retroflexus L.),and large crabgrass [Digitaria sanguinalis (L.) Scop.] were also present in the study area.

All herbicide treatments resulted in excellent control of all weed species by the time of harvest with the exception of s-metolachlor + atrazine + pendimethalin applied PRE that had a severe infestation of wild cucumber. Both that treatment and the untreated check would have not been harvestable with standard harvesting equipment. Corn silage and grain yields were similar among the EP treatments of glyphosate alone at all three rates and the other PRE and EP treatments combinations. Both the overall corn silage and grain yields were reduced by the extended period of weed competition when glyphosate treatments applied alone were delayed. Average silage yields were 30.3, 26.1, and 22.5 T/A, with the EP, MP, and LP treatments of glyphosate, respectively. Average grain yields were 215, 189, and 167 bu/A, with the EP, MP, and LP treatments of glyphosate, respectively. This study indicates that when glyphosate treatments are applied alone, applications should be made prior to the fifth leaf stage of corn in order to avoid potential yield loss from the extended period of weed competition. When preemergence treatments are applied, this allows more flexibility in the timing of the postemergence applications to obtain maximum corn yields.

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EARLY POSTEMERGENCE TIMING OF PREMIXES AND GLYPHOSATE: A NICE MATCH FOR ROUNDUP READY CORN

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ABSTRACT

Growers need effective weed control programs that limit the number of trips across the field. Recent revisions to herbicide labels allow premixed soil-applied herbicides to be applied to emerged corn (*Zea mays*). This offers the potential to achieve early postemergence control followed by residual control.

Labeled rates of the various premixed herbicides were applied to corn at the spike to V-1 stage. These herbicide premixes included atrazine in combination with s-metolachlor, alachlor, acetachlor, SAN-582, and FOE-5043 plus metribuzin, as well as Basis Gold. Atrazine was also tank-mixed with pendimethalin and Basis. Fall panicum (*Panicum dichotomiflorum*) control at layby was not acceptable for most treatments. Treatments with Basis plus atrazine or Basis Gold did provide 90% control of fall panicum. Poor control with other treatments was due to both poor initial control and lack of effective residual control for the weed species present.

A second experiment examined most of the same premixed herbicides tankmixed with glyphosate, at 1 lb ai/A, and applied to 2 to 5-collar Roundup Ready corn. Excellent early-season weed control was achieved with all treatments due to addition of glyphosate. No reduction in glyphosate control was observed with any of the tank-mixtures. Full-season control depended on species present at the various sites. In particular, morningglory (*Ipomoea* sp.) control was reduced with treatments containing less than 1.0 lb ai/A of atrazine.

Delaying application of residual herbicides results in effective weed control until the crop is at a more advanced stage compared to applications made at planting. The use of Roundup Ready corn and addition of glyphosate as a tank-mixture improves postemergence control. Finally, control of the initial flush of weeds is not dependent on rainfall or irrigation to move the soil-applied herbicide into the soil.

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IMPACT OF GLYPHOSATE TIMING AND CORN ROW SPACING FOR COMMON LAMBSQUARTERS CONTROL IN ROUNDUP READY CORN.

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ABSTRACT

Two separate studies were conducted in 1998 and repeated in 1999 that investigated the effect of glyphosate application rate and timing and row spacing on the control of common lambsquarters (*Chenopodium album* L.) in Roundup Ready corn. Two sites were chosen in Centre County, PA and the two studies repeated at these sites. All plots were planted on the same day and treated preemergence with a broadcast application of fluthiamide (FOE-5043) at 0.6 lb ai/A for annual grass control. In the rate and timing experiment, glyphosate was applied at 0.5, 0.75, and 1.0 lb ai /A at four application times ranging from 3 to 7 weeks after planting (WAP) (POST 1-4). In the row spacing experiment, glyphosate was applied at 0.5 and 1.0 lb/A to corn planted in 15 and 30 inch spaced rows at two application times ranging from 3 to 6 WAP (EPOST & LPOST). Common lambsquarters percent control, density and biomass were measured. A total of four experiments were conducted each year for two seasons. Each treatment was replicated four times in each experiment.

In the rate and timing experiment application timing was significant for common lambsquarters control at both locations and for both years. In two of these locations, control of common lambsquarters was greater as application was delayed, especially in 1998. At one location, common lambsquarters control was reduced in the POST 4 application because of larger weeds and interference of the spray pattern by larger corn. Application rate was significant in only one of the four locations, where common lambsquarters control increased with increasing rate. In general glyphosate provided good to excellent common lambsquarters control regardless of rate and timing. In the row spacing study, glyphosate generally provided good to excellent common lambsquarters control regardless of rate, timing or row spacing. In one location, control was reduced in the 0.5 lb/A LPOST narrow row corn treatment. This was probably due to poor spray coverage caused by interference of corn planted in 15 inch rows.

These two studies show that glyphosate provides good control of common lambsquarters in Roundup Ready corn. Application timing can influence control, while corn row spacing was not an important consideration in these experiments.

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SAFENING OF SULFOSATE WITH BENTAZON IN ROUNDUP READY SOYBEANS

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ABSTRACT

Sulfosate or glyphosate were applied to soybeans at 1.0, 2.0, 3.0, or 4.0 lb ai/A one month after planting, when the crop was at the two to four trifoliate leaf stage of growth. Each rate of sulfosate was also applied as a tank-mix with bentazon at 0.0313, 0.0625, 0.125, or 0.25 lb ai/A. Soybean leaves that intercepted the spray were injured by all the rates of sulfosate evaluated. The injury appeared within one to two weeks after treatment as tiny necrotic spots or flecks on the treated leaves that resulted in a speckled appearance. The injury increased in severity as the sulfosate rate increased, but even at the highest sulfosate rate evaluated, the injury did not appear to be severe enough to influence yield. Glyphosate did not affect the soybean leaves that were sprayed at any rate applied. New soybean growth appeared chlorotic for within two weeks after treatment, when treated with either sulfosate or glyphosate at rates of 2.0 lb ai/A or higher. The intensity of the chlorosis increased as the rate of each herbicide increased. The degree of chlorosis in the new growth was similar or slightly greater when glyphosate was applied, compared to when sulfosate was applied at the same rate. Recovery of the new growth was evident within three weeks, and the chlorosis was completely gone four weeks after treatment. The addition of bentazon eliminated the speckling injury observed on the treated leaves when sulfosate was applied at 1.0 or 2.0 lb ai/A. The injury to the treated leaves was greatly reduced, but not eliminated when higher rates of sulfosate were applied with bentazon. Bentazon did not reduce weed control or the chlorosis observed in the new growth after treatment with sulfosate.

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PREEMERGENCE HERBICIDES INFLUENCE WEED MANAGEMENT IN GLYPHOSATE-TOLERANT SOYBEANS

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ABSTRACT

In numerous competition studies, weed removal at 4 to 6 wk after planting (WAP) resulted in soybean [Glycine max (L.) Merr.] yields comparable to yields produced by soybean maintained weed-free season long. Glyphosate controls many annual broadleaf weeds and grasses postemergence (POST), but complete kill of weeds and subsequent reductions in weed competition often requires 14 to 21 d. Preemergence (PRE) herbicides reduce early weed competition and may complement POST glyphosate applications in Roundup Ready® soybean. Field studies were conducted in 1998 and 1999 in Painter, VA, to evaluate the potential benefits of preemergence (PRE) metolachlor or metolachlor plus flumetsulam applications to POST glyphosate applications. Glyphosate (1.0 lb ai/A) applications were made 3, 4, 5, and 6 WAP in 1998 and 1999. Glyphosate applications followed PRE herbicide treatments or no herbicide PRE both years. In 1998, PRE herbicide treatments were 1.0 lb ai/A s-metolachlor and 1.7 lb/A s-metolachlor plus 0.054 lb ai/A flumetsulam. In 1999, PRE treatments were 1.0 lb/A s-metolachlor plus 0.032 lb/A flumetsulam and 1.4 lb/A s-metolachlor plus 0.044 lb/A flumetsulam.

Compared to glyphosate alone in 1998, PRE herbicides allowed glyphosate applications to be made later without reducing soybean seed yields significantly. Soybean seed yields were 50 and 47 bu/A with POST glyphosate applied alone 3 and 4 WAP, respectively. Delaying glyphosate applications until 5 or 6 WAP reduced soybean yields to 35 and 32 bu/A, respectively. Soybean seed yield with PRE s-metolachlor plus flumetsulam was 42 bu/A and POST glyphosate applications did not increase yields significantly. Also, soybean yields from any treatment containing s-metolachlor plus flumetsulam were similar to yields with POST glyphosate applied alone at 3 or 4 WAP. Soybean seed yield with s-metolachlor was 30 bu/A and increased to 54, 44, and 46 bu/A as a result of POST glyphosate applications made 3, 4, and 5 WAP, respectively. With PRE s-metolachlor, delaying POST glyphosate applications until 6 WAP reduced soybean yield to 21 bu/A. Yield increases with POST glyphosate applications 3, 4, and 5 WAP were attributed primarily to improved broadleaf weed control. With or without PRE treatments in 1999, weed control with POST glyphosate applications was generally lowest when applications were made 6 WAP. Common ragweed (*Ambrosia artemisiifolia* L.) and annual morningglory (*Ipomoea* spp.) control 10 WAP with s-metolachlor plus flumetsulam was approximately 30 and 60 percent, respectively; POST glyphosate applications made 3, 4, 5, or 6 WAP improved the control of both weeds.

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EFFECTS OF MANGANESE AND BORON ON GLYPHOSATE AND SULFOSATE ACTIVITY IN GLYPHOSATE-TOLERANT SOYBEAN

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ABSTRACT

Foliar applications of manganese (Mn) to soybean *(Glycine max (L.) Merr.)* are a common practice in coastal plain soils where deficiencies of this nutrient frequently occur. These foliar applications are typically made just prior to or at the bloom stage of soybean growth. Many soybean producers apply foliar nutrients and herbicides simultaneously for convenience. However, some nutrients such as Mn affect herbicide performance when mixed with herbicides. Recent speculation that foliar applications of boron (B) could enhance soybean yield has prompted interest in mixing B with postemergence herbicides.

Field experiments were conducted at the Eastern Shore Agricultural Research and Extension Center near Painter, VA in 1998 and 1999 to determine if additions of two formulations of Mn and one of B would affect weed control by glyphosate and sulfosate. Glyphosate and sulfosate rates were 0.5 and 1.0 lb ai/A in both yr and herbicides were also included at 1.25 lb/A with Mn in 1999. Lignin and chelate formulations of Mn at 4% v/v of the total spray mix were included both yr with each rate of glyphosate and sulfosate. All treatments with Mn were applied approximately 30 d after planting. In additional treatments, the effects of B at 0.25 lb/A with or without 4.25 lb/A ammonium sulfate (NH_4SO_4) were investigated. Herbicides plus B combinations were applied at soybean bloom or sequentially at 3 wk after planting followed by application at bloom.

Soybean injury from herbicide treatments was generally 0 to 3% from glyphosate treatments and 2 to 6% from sulfosate treatments regardless of Mn or B additions. Both Mn formulations reduced control of common lambsquarters *(Chenopodium album L.)*, common ragweed (*Ambrosia artemisiifolia L.)*, three morningglory species (*Ipomoea spp.)*, and large crabgrass (*Digitaria sanguinalis L.)* by 0.5 lb/A glyphosate or sulfosate 28 to 53%. Similar reductions in control of common lambsquarters, common ragweed, and large crabgrass occurred when Mn lignin or Mn chelate were added to glyphosate and sulfosate at 1.0 and 1.25 lb/A. Additions of B or B plus ammonium sulfate to glyphosate and sulfosate did not reduce weed control in 1999. In addition to other data, pHs of herbicide solutions were measured. Glyphosate and sulfosate decreased pHs of water used as herbicide carrier from 7.8 to 5.1 and 4.9, respectively. Addition of Mn lignin had little effect on raising the pH of standard herbicide solutions while additions of Mn chelate and B (with or without ammonium sulfate) increased pH to 6.7 and 7.3, respectively, in solutions with glyphosate and sulfosate.

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COMPARISON OF WEED CONTROL SYSTEMS WITH HERBICIDE RESISTANT CORN

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ABSTRACT

Crop Protection companies are now promoting weed control systems that are built around herbicide resistant corn (*Zea mays* L.) hybrids. Since these technologies are relatively new, little is known about how these systems compare in terms of efficacy, yield, and relative cost.

In 1999 a field experiment was established at the University of Delaware's Research and Education Center to evaluate weed control systems that are being promoted by DuPont, Monsanto, AgrEvo, and Cyanamid. For each company a preemergence (PRE) followed by mid-postemergence (MPOST) system (PRE fb POST) and a total early-postemergence (EPOST) system were evaluated. Additionally, for Monsanto and AgrEvo total MPOST systems were included. The DuPont systems utilized a conventional corn hybrid (Pioneer 3394, 110crm); Monsanto systems utilized a glyphosate-resistant corn hybrid (Dekalb DK589RR, 108crm); AgrEvo systems utilized a glufosinate-resistant corn hybrid (Pioneer 34A55LL, 110crm); and Cyanamid systems utilized an imidazolinone-resistant corn hybrid (Pioneer 3395IR, 110crm). Control of common lambsquarters (*Chenopodium Album* L.), common ragweed (*Ambrosia artemisiifolia* L.), large crabgrass (*Digitaria sanguinalis* (L.) Scop.), and ivyleaf morningglory (*Ipomoea hederacea* (L.) Jacq) were evaluated visually. Corn yields and relative system costs were also compared.

All of the systems provided excellent common lambsquarters control (>93%). All of the systems provided excellent common ragweed control (>91%) except Cyanamid systems at both PRE fb POST (86%) and EPOST (76%). All of the systems provided very good to excellent control of large crabgrass (>87%) except the DuPont system at EPOST (75%) and AgrEvo systems at both EPOST (79%) and MPOST (65%). Many of the systems provided very good control of ivyleaf morningglory (>84%). However, the DuPont, Monsanto, and AgrEvo EPOST systems provided 72%, 80%, and 79% ivyleaf morningglory control, respectively.

Yield reductions attributed to reduced weed control were observed in the Cyanamid PRE fb POST system, EPOST systems from DuPont, AgrEvo, and Cyanamid, and the AgrEvo MPOST system. Lower yields in all of the Monsanto systems were attributed to corn hybrid. This hybrid's maturity appeared to be shorter in this test than relative maturity ratings would suggest, and it was more prone to lodging. Calculated net returns were lower with the Cyanamid PRE fb POST system, the DuPont and Cyanamid EPOST systems, and the AgrEvo MPOST system.

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COMPARING IMAZAPYR, IMAZETHAPYR, PENDIMETHALIN AND HALOSULFURON-METHYL FOR CONTROLLING WEEDS IN IMI CORN

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ABSTRACT

Genetically manipulated corn acres planted annually are continuing to rise. In turn, this expands the growers' weed control options both in available herbicides and the time of applications. The purpose of this study was to compare a traditional treatment of pendimethalin and halosulfuron-methyl to imazethapyr alone and premixed with imazapyr (Lightning). The null hypothesis indicated no significant difference in weed control or yield between the selected herbicides.

The study was established as a randomized complete block design with 4 replications. Mycogen 2285 was planted the second week in May into a 58 degree F soil and a planting of 34,000 seed per acre. A commercial field sprayer fitted with 8004 nozzles adjusted to 38 psi was used to apply all treatments two days after planting except for the halosulfuron-methyl which was applied 10 days post emergence using the same sprayer. The selected herbicides were applied at the labeled rates including imazethapyr at 1.44 oz/A, premixed imazethapyr plus imazapyr at 1.28 oz/A, and pendimethalin at 3.6 pts./A and halosulfuron-methyl at 1.3 oz/A.

The results of the study showed no significant difference in weed control or silage yield between the treatments hence the null hypothesis was accepted. Based on the results of the study, a grower might well select from the three treatments based on the cost of the products and/or the aesthetic appearance of the field. Imazethapyr or imazethapyr plus imazapyr provided comparatively less expensive yet observably better weed control than the traditional pendimethalin followed by halosulfuron-methyl applied early post.

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Table 1

Mean Percent Weed Control Values at the Time of Harvesting Mycogen 2285 Treated with Labeled Rates and Times of Application for Selected Herbicides*			
	Pendimethalin + Halosulfuron-Methyl	Imazethapyr + Imazapyr	Imazethapyr
Velvetleaf	85	90	80
Yellow Foxtail	90	95	85
Yellow Nutsedge	95	90	80

*LSD 12.25 @ 5%

Table 2

Mean Mycogen 2285 Silage Yields and Harvest Values Resulting from the Labeled Application Time and Rates of Selected Prevalued Herbicides			
	Pendimethalin +	Imazethapyr + Imazapyr	Imazethapyr
Silage Yield (T/A)**	14.00	12.75	13.00
Silage Value ($20/Ton)	280	255	260
Herbicide Cost ($/A)	26	15	13

**LSD 3.45 @ 5%

ROUNDUP-READY CORN: THE MAINE EXPERIENCE

J.M. Jemison, Jr.[1]

ABSTRACT

Genetic Engineering (GE) has been hailed as the answer for a cleaner environment, a continuous and abundant food supply, and a means to respond quickly to specific needed changes in crop varieties. It has also been condemned as an unpredictable science, the beginning of the end of agricultural genetic diversity, a potential creator of superweeds, and an ecological menace that will destroy natural systems on which human life depends.

Concern over genetically engineered (GE) food is growing in both Europe and in the United States. Groups of highly vocal, militant activists are trying to capture the attention of the American public who had apparently accepted GE as a generally positive direction for U.S. agriculture. This highly political and strongly polarized issue has piqued the interest of the news media with Newsweek recently publishing an article on "Frankenfoods" and wire services carrying information about attacks on research plots across the country. The internet has changed the speed with which information travels and potential accuracy of information. The need for the University to be able to provide credible information to this highly complicated issue continues to grow.

This summer, a research study was vandalized at the University of Maine. The action raised a number of important issues: 1) how do we avoid loss of valuable information while maintaining public access to research; 2) how extensive will the future destruction be; 3) how to increase public input and understanding of our applied research programs; and 4) how to prepare educators to be versed on all aspects of the GE issue and in risk communication in order to be credible sources of information.

In the presentation, I will discuss my views regarding each of these points. Public access to research is critical to agricultural advancement. We must determine ways to allow public access without compromising our ability to collect needed data. In our study, the vandals only destroyed the crops. The violence and destruction in other events has intensified; but, how far will this go? Concern over public funds being used to further industry, and credibility of information generated is under indictment. For example, in our local editorials, I was accused of being a "shill for Monsanto" because I was given a free bag of seed corn for the study. I received no additional funding from Monsanto to do this work, yet that was the most frequently asked question of me by the media. Lastly, we must completely understand all aspects of the materials we are using. It doesn't matter that we may have no formal training in molecular biology, GE critics expect us to know everything about the modified crops we are growing including which marker genes are in specific plants, distance pollen can travel, and many other details. We need to be trained in risk communication in order to be seen as credible sources of information.

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SMALL GRAIN WEED CONTROL - NEW WEEDS, NEW PRODUCTS AND NEW PROBLEMS

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ABSTRACT

The package-mix thifensulfuron-methyl + tribenuron-methyl (Harmony Extra - DuPont) has the lion's share of the post small grain herbicide market in the mid-Atlantic region of the U. S. This package-mix controls most of the broadleaf weeds growers typically find in their fields. With continued usage of this package-mix, we are starting to see a shift in weed problems. Grassy weeds such as annual bluegrass (Poa annua L.), annual ryegrass (Lolium multiflorum Lam.), brome grass species (Bromus spp.) and bulbous oatgrass (Arrhenatherum elatius var. bulbosus Willd.) are becoming more invasive in many small grain fields. Diclofop-methyl (Hoelon - AgrEvo) has been tested for its activity on these grass species. While it has activity on annual ryegrass, it will not control the other grasses. With continued usage of diclofop-methyl, diclofop-methyl resistant annual ryegrass is now prevalent in the region. From 1996 through 1999, a variety of preemergence and postemergence herbicides were evaluated for their biological activity on these different weedy grass species. Also, soybeans [Glycine max (L.) Merr.] were planted behind the herbicide applications, typifying a double-crop soybean rotation, in order to examine any potential carryover effects from the herbicides tested.

Postemergence herbicides tested included the following: imazamethabenz-methyl (Assert - American Cyanamid), tralkoxydim (Achieve - Zeneca), clodinafop-propargyl (Discover - Novartis), and sulfosulfuron (Maverick - Monsanto). Imazamethabenz-methyl had activity on some of the grass species, but wheat (Triticum aestivum L.) tolerance was unacceptable. Sulfosulfuron had the best activity of all the products tested, with good control of annual bluegrass, annual ryegrass and bulbous oatgrass. Wheat tolerance was acceptable with sulfosulfuron. Carryover to double-crop soybeans was observed with sulfosulfuron. The carryover effects were negated with a planting of STS soybeans.

Preemergence applications of s-metolachlor (Dual II Magnum - Novartis) and FOE-5043 + metribuzin (Axiom - Mobay), as well as preemergence and postemergence applications of chlorsulfuron (Glean - DuPont) and chlorsulfuron + metsulfuron-methyl (Finesse - DuPont) were made to annual ryegrass. Depending upon rate, good annual ryegrass control was achieved with preemergence applications of all four herbicides. Poor ryegrass control was achieved with postemergence applications of chlorsulfuron and chlorsulfuron + metsulfuron-methyl. Carryover to double-crop soybeans was noted with chlorsulfuron and chlorsulfuron + metsulfuron-methyl. The carryover effects were negated with a planting of STS soybeans.

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TIMING OF GLYPHOSATE, SULFOSATE AND IMAZETHAPYR APPLICATION FOR IVYLEAF MORNINGGLORY CONTROL

A.O. Ayeni and B.A. Majek[1]

ABSTRACT

Ivyleaf morningglory (*Ipomoea hederacea*) is a common weed of glyphosate-tolerant soybean (GTS) not readily controlled with POST applications of glyphosate. Studies were conducted at Rutgers Agricultural Research and Extension Center under greenhouse conditions (75 to 90°F day, 60 to 70°F night, 16 h light) to compare the effectiveness on ivyleaf morningglory of glyphosate (0.75 lb/A), sulfosate (1.1 lb/A), imazethapyr (0.056 lb/A), glyphosate + imazethapyr (0.75 + 0.056 lb/A), and sulfosate + imazethapyr (1.1 + 0.056 lb/A) applied at 15, 20, 25, and 30 d after planting (DAP). Ammonium sulfate (1% w/v) was added to glyphosate and glyphosate + imazethapyr solutions, and a non-ionic surfactant (2%) to sulfosate and sulfosate + imazethapyr solutions. Untreated ivyleaf morningglory/GTS mixture and sole GTS were included as checks. Ivyleaf morningglory (seed source: Valley Seed Service, Fresno, CA) and GTS (Roundup Ready Soybean, Lot 9134 from UAP Seed, Greeley, CO) were raised together in 2-gal plastic pots filled with regular mix (2:1 v/v peat moss:vermicullite mix plus lime, fertilizers and micronutrients). Three stands of ivyleaf morningglory and two of GTS were maintained per pot. A calibrated greenhouse sprayer, fitted with 8002VS-nozzle tip and operated at 30 psi and 68 gpa, was used for herbicide application. Experiments were set up in four randomized complete blocks and herbicides were evaluated based on ivyleaf morningglory control and soybean injury.

Glyphosate alone applied 15 to 25 DAP reduced ivyleaf morningglory biomass 90 to 93%, 8 WAP. Application at 30 DAP reduced biomass 71%. Limited regrowth (= new growth) occurred after initial injury at all stages of herbicide application. Sulfosate alone caused biomass reduction that ranged from 35 to76%. The herbicide was ineffective due to rapid recovery of ivyleaf morningglory from initial phytotoxicity. Imazethapyr caused 97, 80, 76, and 41% reduction in biomass when applied at 15, 20, 25 and 30 DAP, respectively; and prevented regrowth in ivyleaf morningglory for the duration of the experiment. Glyphosate + imazethapyr and sulfosate + imazethapyr caused 84 to 99% biomass reduction in ivyleaf morningglory when applied 15 to 25 DAP. The effectiveness of both mixtures declined to 73 and 52%, respectively, when applied 30 DAP. The mixtures also prevented regrowth as observed with imazethapyr treatments.

Glyphosate and sulfosate were safe on GTS, but imazethapyr and its mixture with glyphosate or sulfosate were phytotoxic (50 to 95% injury rating) at all stages of application. Recovery of GTS from herbicide injury was fast when application was at 15 DAP, but relatively slow with subsequent applications. The highest soybean total dry weight was obtained with glyphosate alone applied 15 and 20 DAP followed by glyphosate + imazethapyr at 15 DAP and imazethapyr alone at 20 DAP. Other treatments resulted in low dry weight due to herbicide injury or ivyleaf morningglory interference or a combination of both factors.

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MODE OF ACTION, ABSORPTION, TRANSLOCATION AND METABOLISM OF MESOTRIONE IN WEEDS AND CORN

B. A. Lackey[1], R. A. Wichert[2], D. W. Bartlett[3], and J. K. Townson[3]

ABSTRACT

Mesotrione (ZA1296) is an experimental triketone (2-benzoylcyclohexane-1,3-diones) herbicide being developed for preemergence and postemergence weed control in corn. The molecular target for ZA1296 is the enzyme p-hydroxyphenylpyruvate dioxygenase (HPPD). This enzyme is involved in the pathway that converts the amino acid tyrosine to plastiquinone. ZA1296 is structurally similar to the substrate p-hydroxyphenylpyruvate and acts by competitive inhibition which results in the blockage of carotenoid synthesis. Radiolabelled mesotrione was used to study foliar uptake and translocation in corn and weeds at intervals ranging from 1 hour to 7 days after application. Foliar uptake of mesotrione is rapid, with 30 to 90% of applied radioactivity absorbed within 6 hours of application, depending on species. Progression of uptake with time varied with species, but by one day after treatment uptake into common lambsquarters (Chenopodium album L.) was greater than in giant foxtail (Setaria faberi Herrm.) and ivyleaf morningglory [Ipomoea hederacea (L.) Jacq.]. Uptake of radiolabel by corn was less than uptake by the weeds evaluated. Phosphor image analysis of radiochemical at 1 and 7 days after treatment showed both xylem and phloem movement. Recovery of parent mesotrione, as a percentage of the total extractable radioactivity that moved out of the treated leaf, ranged from 10 to 42% in weeds and none was recovered in corn. Differential sensitivity of corn and weeds are explained by differences in uptake and metabolism.

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[1]ZENECA Ag Products, Macedon, NY; [2]ZENECA Ag Products, Richmond, CA; and [3]ZENECA Ag Products, Jealott's Hill, UK.

MESOTRIONE USE IN CORN WEED CONTROL SYSTEMS

J. C. Jacobi and B. A. Lackey[1]

ABSTRACT

Mesotrione, also known as ZA1296, is a new broadleaf weed herbicide being developed for field corn. Mesotrione has activity on velvetleaf (Abutilon theophrasti Medicus), common cocklebur (Xanthium strumarium L.), pigweeds and waterhemps (Amaranthus spp.), common lambsquarters (Chenopodium album L.), common ragweed (Ambrosia artemisiifolia L.), giant ragweed (Ambrosia trifida L.), jimsonweed (Datura stramonium L.), nightshade (Solanum spp.), common sunflower (Helianthus annuus L.), smartweeds (Polygonum spp.), and several other broadleaf weeds. Weed control systems where mesotrione could be used include (a) one-shot, preemergence applications with an acetanilide (such as acetochlor, metolachlor, or dimethenamid), (b) preplant burndown applications with non-selective herbicides, (c) postemergence tankmixes of mesotrione with nicosulfuron, glyphosate, glufosinate and other postemergence grass herbicides, and (d) a preemergence grass herbicide followed by mesotrione applied postemergence. Postemergence applications of mesotrione should include crop oil concentrate alone or with UAN fertilizer. A premix of mesotrione and acetochlor is under development. Corn exhibits excellent tolerance to mesotrione applications.

[1]ZENECA Ag Products, Dover, DE and Macedon, NY, respectively.

INFLUENCE OF CROWNVETCH WITH AND WITHOUT SECONDARY COVER CROPS ON ANNUAL WEED CONTROL AT REDUCED HERBICIDE RATES IN CORN

N. L. Hartwig[1]

ABSTRACT

In previous research, crownvetch (Coronilla varia) when used as a perennial living mulch and suppressed sufficiently to prevent competition with a companion corn (Zea mays L.) crop, did not contribute anything to annual weed control. In this experiment, oats (Avena sativa L.) and a mixture of Canadian pea and triticale (X Triticosecale Wittmack) were drilled as 2° cover crops at 2.5 bu/A and 100 lb/A resepectively into established crownvetch on April 3 to see if there was an improvement in weed control over that provided by crownvetch alone when treated with lower rates of herbicides that are at least somewhat selective for both crownvetch and the 2° cover crops.

To identify weed suppressive potentials of the different covers as well as the potential for reducing herbicide inputs, the following weed control treatments were randomly assigned to 12 plots within each cover crop block. Weeds were controlled with 1/4 X, 1/2X, and 1X application rates (levels) of the following early post emergence broadcast applied herbicide treatments. The corn was planted on April 30, one month before herbicide applications were made. On May 27, corn was in the spike stage and crownvetch was 3-4"; oats 6-8" and pea + triticale 6-8".

1. May 27, '97 - rimsulfuron + thifensulfuron methyl (Basis®) plus atrazine + metolachlor (Bicep II®)[1] @ 0.0125 + 1.335 + 1.6 #ai/A*
2. May 27, '97 - rimsulfuron + thifensulfuron methyl (Basis®) plus isoxaflutole (Balance®) + metolachlor (Dual II®)[1] @ 0.0125 + 0.07 + 1.95 #ai/A*
3. May 28, '97 - rimsulfuron + thifensulfuron methyl (Basis®) plus atrazine + imazethapyr (Contour®) + metolachlor (Dual II®)[1] @ 0.0125 + 0.5 + 0.0625 + 1.95 #ai/A*
4. May 28, '97 - rimsulfuron + thifensulfuron methyl (Basis®) plus imazethapyr (Pursuit®) plus metolachlor (Dual II®)[1] @ 0.0125 + 0.0625 + 1.95* (* = 1X rates)

[1] Chaser® (NIS @ 0.25% v/v + UAN @ 1.5% v/v) included with all the above treatments.

The soil was a Hagerstown Silt Loam (Typic Hapludult) with a pH of 6.8. All treatments were applied with a tractor mounted small plot sprayer with XR80015 flat fan nozzles at 28 psi in 10, 20 and 40 gal/A of water. 'Pioneer 3395 IR' (109 day) corn was planted in 15 by 25 ft. plots with a six row no-till planter in 30 in. rows on April 30, 1997 with 100 lb/A of 10-30-10 fertilizer in the row. Imidazolinone resistant corn was planted since imazethapyr (Pursuit) was a component of of treatments 3 and 4. Urea @ 160 lb N/A was applied broadcast at corn planting time.

There was an excellent stand of oats, Canadian pea and triticale in the crownvetch by late May. Annual grass was virtually 100% controlled by the herbicides at all rates but broadleaf weed control; triazine resistant pigweed (Amaranthus hybridus) and lambsquarters (Chenopodium album) was generally significantly less at lower herbicide rates without a cover crop for the first two herbicide mixtures(Table 1). Weed control was generally significantly improved (>93%) even at the lowest herbicide rates with crownvetch and slightly better yet with 2° cover crops. Although average corn height, population and yield were all significantly reduced, especially at lower herbicide rates, it was not only due to increased crownvetch growth but rather competition from a combination of crownvtetch and the secondary cover crops (oats, triticale) and uncontrolled annual broadleaf weeds.

At this point, it would appear that annual weed control is possible with competition from a partially controlled cover crop but at the expense of growth and yield of corn, especially in a year of inadequate rainfall.

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Table 1. Control of 3 cover crops and impact on annual weed control and corn injury, height, population and yield with 4 herbicide mixtures at 3 rates when averaged over 4 replications.

			<-------7/12/97-------				------->	<-------8/22/97-------		------->	<---8/5/1997--->		
			Corn	CV	2° CC	AnGR	A.BLV	CV	2° CC	A.BLV	<-------	Corn	------->
Cover	Herbicide	Herb.	Inj.	Cont.	Cont.	Cont.	Cont.	<-----Dry	Wt.	Yield----->	Ht.	Pop.	Yield
Crop	Treatment	Level	%	%	%	%	%	lb/A	lb/A	lb/A	cm	plants/A	bu/A
None	Basis + Bicep II a	1/4X	7.5	99.3	.	99.5	81.8	.	.	1239	146	18150	81
None	Basis + Bicep II a	1/2X	8.3	100.0	.	99.5	88.3	.	.	786	148	15972	84
None	Basis + Bicep II a	1X	3.8	99.3	.	99.8	99.3	.	.	159	155	18223	90
None	Basis + Balance + Dual II a	1/4X	4.5	100.0	.	99.3	93.8	.	.	1692	151	18077	82
None	Basis + Balance + Dual II a	1/2X	5.8	100.0	.	100.0	98.3	.	.	522	155	18803	109
None	Basis + Balance + Dual II a	1X	5.0	99.5	.	100.0	99.8	.	.	110	156	19893	113
None	Basis + Contour + Dual II a	1/4X	7.8	99.8	.	100.0	99.3	.	.	279	148	17715	89
None	Basis + Contour + Dual II a	1/2X	6.3	99.7	.	100.0	99.8	.	.	70	158	18368	98
None	Basis + Contour + Dual II a	1X	2.0	99.3	.	100.0	100.0	.	.	0	157	20256	116
None	Basis + Pursuit + Dual II a	1/4X	8.3	99.0	.	100.0	97.8	.	.	567	138	17642	79
None	Basis + Pursuit + Dual II a	1/2X	5.3	99.0	.	100.0	99.3	.	.	692	156	17569	96
None	Basis + Pursuit + Dual II a	1X	2.3	99.8	.	100.0	100.0	.	.	52	157	20328	108
None (Average)b			5.5 c	99.5 a	.	99.8 a	96.4 b	.	.	514 a	152 a	18415 a	95 a
Crownvetch (CV)	Basis + Bicep II a	1/4X	13.8	87.5	.	100.0	95.5	1129	.	562	114	16698	48
Crownvetch (CV)	Basis + Bicep II a	1/2X	4.8	92.5	.	100.0	97.3	663	.	851	122	18441	51
Crownvetch (CV)	Basis + Bicep II a	1X	4.5	83.8	.	100.0	100.0	972	.	25	148	18223	93
Crownvetch (CV)	Basis + Balance + Dual II a	1/4X	12.5	96.0	.	99.3	95.8	517	.	1219	132	16335	70
Crownvetch (CV)	Basis + Balance + Dual II a	1/2X	4.0	95.5	.	100.0	99.0	608	.	259	143	18295	82
Crownvetch (CV)	Basis + Balance + Dual II a	1X	9.5	95.8	.	100.0	99.8	756	.	140	139	17279	82
Crownvetch (CV)	Basis + Contour + Dual II a	1/4X	17.5	87.8	.	100.0	100.0	1630	.	30	100	18198	42
Crownvetch (CV)	Basis + Contour + Dual II a	1/2X	11.3	87.3	.	100.0	99.3	1585	.	95	111	17932	48
Crownvetch (CV)	Basis + Contour + Dual II a	1X	3.8	90.3	.	100.0	100.0	1251	.	2	137	18803	80
Crownvetch (CV)	Basis + Pursuit + Dual II a	1/4X	6.5	93.3	.	100.0	96.8	841	.	498	123	17134	48
Crownvetch (CV)	Basis + Pursuit + Dual II a	1/2X	5.3	93.3	.	100.0	99.5	1013	.	199	137	17569	70
Crownvetch (CV)	Basis + Pursuit + Dual II a	1X	5.5	95.8	.	100.0	100.0	901	.	105	143	19892	85
Crownvetch (CV) (Average)			8.2 bc	91.5 c	.	99.9 a	98.6 a	994 a	.	332 bc	129 b	17895 a	67 b
CV+Oats	Basis + Bicep II a	1/4X	86.8	93.0	5.0	100.0	99.5	304	3440	393	74	12996	13
CV+Oats	Basis + Bicep II a	1/2X	47.5	91.0	67.5	75.0	99.8	360	1527	70	99	17061	39
CV+Oats	Basis + Bicep II a	1X	6.3	91.0	99.0	100.0	99.8	820	145	90	134	18223	76
CV+Oats	Basis + Balance + Dual II a	1/4X	68.5	97.5	23.8	99.8	98.0	122	2749	418	89	15101	22
CV+Oats	Basis + Balance + Dual II a	1/2X	76.0	96.3	13.8	100.0	100.0	66	3231	189	78	18586	17
CV+Oats	Basis + Balance + Dual II a	1X	55.0	97.8	40.0	100.0	100.0	51	3135	25	100	18513	38
CV+Oats	Basis + Contour + Dual II a	1/4X	98.8	94.8	4.5	100.0	100.0	547	3504	50	59	12052	3
CV+Oats	Basis + Contour + Dual II a	1/2X	86.3	94.3	35.0	100.0	100.0	689	2122	323	71	15028	13
CV+Oats	Basis + Contour + Dual II a	1X	11.3	92.5	78.0	100.0	100.0	669	1243	55	111	19650	47
CV+Oats	Basis + Pursuit + Dual II a	1/4X	87.5	95.8	16.3	99.8	99.0	446	1769	478	73	15827	13
CV+Oats	Basis + Pursuit + Dual II a	1/2X	67.5	96.3	45.0	100.0	100.0	451	1383	65	82	18731	23
CV+Oats	Basis + Pursuit + Dual II a	1X	9.5	95.5	93.8	100.0	100.0	415	290	95	122	19457	67
CV+Oats (Average)			58.4 a	94.6 b	42.7 c	97.9 a	99.7 a	412 c	2062 a	187 c	91 d	16710 b	31 c
CV+Pea+Triticale	Basis + Bicep II a	1/4X	16.8	90.8	83.0	97.5	93.3	223	309	1085	108	17279	41
CV+Pea+Triticale	Basis + Bicep II a	1/2X	12.0	93.0	96.5	100.0	99.3	922	114	926	130	17860	65
CV+Pea+Triticale	Basis + Bicep II a	1X	3.3	95.3	100.0	100.0	99.5	319	0	100	146	19675	93
CV+Pea+Triticale	Basis + Balance + Dual II a	1/4X	7.5	96.8	94.3	100.0	98.3	274	159	1174	129	17497	63
CV+Pea+Triticale	Basis + Balance + Dual II a	1/2X	4.0	95.8	97.0	100.0	99.3	268	159	687	139	17134	82
CV+Pea+Triticale	Basis + Balance + Dual II a	1X	1.5	97.5	98.8	100.0	100.0	274	56	90	152	18295	93
CV+Pea+Triticale	Basis + Contour + Dual II a	1/4X	31.3	84.0	85.8	100.0	100.0	370	1030	174	78	17860	19
CV+Pea+Triticale	Basis + Contour + Dual II a	1/2X	11.3	91.0	92.8	100.0	100.0	491	1217	309	111	17860	48
CV+Pea+Triticale	Basis + Contour + Dual II a	1X	9.0	77.0	97.5	100.0	100.0	922	412	274	123	20110	74
CV+Pea+Triticale	Basis + Pursuit + Dual II a	1/4X	22.5	91.8	94.5	100.0	99.5	628	168	891	98	18658	45
CV+Pea+Triticale	Basis + Pursuit + Dual II a	1/2X	12.0	91.0	98.5	100.0	99.5	689	28	269	122	18223	56
CV+Pea+Triticale	Basis + Pursuit + Dual II a	1X	3.3	94.0	99.8	100.0	100.0	498	4	129	139	19384	85
CV+Pea+Triticale (Average)			11.2 b	91.5 c	94.8 b	99.8 a	99.0 a	490 bc	305 b	509 a	123 c	18320 a	64 b
	Treatment Signific.level (P)		0.0001	0.0002	0.0001	0.5060	0.0530	0.0005	0.0001	0.0001	0.0001	0.0001	0.0001
	LSD (0.05)		15.8	9.2	17.4	9.1	7.6	701.0	861.0	577.5	21.4	2928.0	25.4

a Includes Chaser (NIS @ 0.25% v/v + UAN @ 1.5% v/v)

b Cover crop means followed by the same letter are not significantly different according to Duncan's multiple range test. (P=0.05)

TRUMPETCREEPER, HONEYVINE MILKWEED, AND HEMP DOGBANE CONTROL WITH POSTEMERGENCE CORN HERBICIDES

K. W. Bradley, P. Davis, S. R. King, and E. S. Hagood [1]

ABSTRACT

Three field experiments were conducted during 1999 in Virginia in separate locations with severe infestations of trumpetcreeper (*Campsis radicans* (L.) Seem *ex* Bureau), honeyvine milkweed (*Ampelamus albidus* (Nutt.) Britt.), and hemp dogbane (*Apocynum cannabinum* L.). Trumpetcreeper and honeyvine milkweed experiments were established in existing no-tillage corn fields while the hemp dogbane experiment was established in a fallow area previously planted in wheat (*Triticum aestivum* L.). The sulfonylurea herbicides halosulfuron, primisulfuron, and prosulfuron plus primisulfuron (Exceed®) were evaluated in all three experiments, either alone or in combination with dicamba at 0.25 or 0.375 lb ai per acre. Nicosulfuron was also included in the hemp dogbane experiment, either alone at 0.031 lb ai per acre or in combination with 0.5 lb 2,4-D, or 0.25 or 0.375 lb dicamba per acre. Glyphosate was evaluated in all experiments at 1, 2, and 4 lbs ai per acre as a potential perennial weed control tool in glyphosate-tolerant (Roundup Ready™) corn. The experimental herbicide ZA1296 was also evaluated as a postemergence treatment in all three experiments. ZA1296 was applied either alone at 0.94 lb ai per acre or in combination with 0.25 or 0.375 lb dicamba per acre, 0.5 lb 2,4-D per acre, 0.0178 lb primisulfuron per acre, 0.012 lb rimsulfuron per acre, or 0.012 lb rimsulfuron plus 0.5 lb 2,4-D per acre.

ZA1296 in combination with either 2,4-D, dicamba, or rimsulfuron plus 2,4-D provided greater than 70% control of trumpetcreeper at 3 months after treatment (MAT). Similar levels of trumpetcreeper control were achieved with the 4.0 lb glyphosate rate, while slightly lower levels of control were observed when dicamba was added to the halosulfuron or prosulfuron plus primisulfuron treatments. Halosulfuron, primisulfuron, and prosulfuron plus primisulfuron provided essentially no trumpetcreeper control without the addition of dicamba.

At 3MAT, ZA1296 in combination with rimsulfuron and 2,4-D provided 75% control of honeyvine milkweed. When applied in combination with dicamba, halosulfuron, primisulfuron, and ZA1296 provided levels of honeyvine milkweed control ranging from 53 to 68%. Honeyvine milkweed control was less than 50% when halosulfuron, primisulfuron and prosulfuron plus primisulfuron were applied alone, and also with all rates of glyphosate applied.

When applied in combination with dicamba, ZA1296 provided 89 to 94% control of hemp dogbane at 3MAT. Slightly lower levels of control were achieved with nicosulfuron in combination with either 2,4-D or dicamba. When applied alone, both nicosulfuron and ZA1296 provided essentially no hemp dogbane control. The combination of halosulfuron, primisulfuron, or prosulfuron plus primisulfuron with either rate of dicamba provided 76 to 88% control of hemp dogbane. However, the level of control achieved by the addition of these sulfonylureas was usually not statistically different from the control afforded by either rate of dicamba alone.

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WEED CONTROL OPTIONS FOR POSTEMERGENCE CONTROL OF TRIAZINE-RESISTANT WEEDS IN CORN

H. Menbere* and R. L. Ritter

ABSTRACT

Triazine-resistant common lambsquarters (Chenopodium album L.) and smooth pigweed (Amaranthus hybridus L.) continue to plague farmers throughout the mid-Atlantic region of the U. S. It is estimated that these two plants can now be located in every county in Maryland. Their spread is due to several factors; use of preemergence herbicide programs that do not control these pests, lack of control of weed escapes, spreading of manure contaminated with weed seed, and custom combining that allows for seed dispersal in contaminated equipment.

Preemergence control of these two weeds is limited to a number of products. Pendimehtalin (Prowl - American Cyanamid) can provide fair to good control early in the season, but results have been inconsistent in Maryland. Acetochlor (Harness - Monsanto, Surpass/TopNotch - Zeneca) may also provide some early season control. Flumetsulam (Python - Dow AgroSciences), flumetsulam combinations (Bicep TR - Novartis, Broadstrike/Dual - Novartis) and rimsulfuron + thifensulfuron-methyl (Basis - DuPont) have provided best preemergence control, but under cool, wet conditions, corn (Zea mays L.) injury may occur

Under most growing conditions in Maryland, a timely application of a postemergence corn herbicide is usually justified, not only for control of triazine-resistant weeds but for perennial broadleaf weed control as well. Dicamba (Banvel, Clarity - BASF), dicamba + atrazine (Marksman - BASF), or combinations of dicamba with either primisulfuron-methyl (Beacon) or primisulfuron-methyl + prosulfuron (Exceed) can provide good postemergence control of triazine-resistant weeds and provide good suppression of perennial broadleaf weeds as well.

Recently, a number of new postemergence herbicides, herbicide package-mixes and herbicide tank-mixes have been studied for their utility in the control of triazine-resistant weeds. Products under study that will be discussed include the following: diflufenzopyr + sodium salt of dicamba (Distinct - BASF), primisulfuron-methyl + sodium salt of dicamba (NorthStar - Novartis), nicosulfuron + sodium salt of dicamba (Celebrity Plus - BASF), and combinations of pyridate (Tough - Novartis) or carfentrazone (Aim - FMC) with other tank-mix partners.

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FLUFENACET PLUS METRIBUZIN PLUS ATRAZINE - A NEW ROADSPECTRUM HERBICIDE FOR CORN.

R.H.Ackerman, F.H.Chow, R.D. Rudolph and J.R. Bloomberg[1]

ABSTRACT

Flufenacet plus metribuzin plus atrazine is a new 75% dry flowable herbicide premix developed by Bayer Corporation for soil-applied control of both grassy and broadleaf weeds in field corn grown for grain or silage. The trade name of this premix product is Axiom™ AT. Each unit of Axiom AT contains 19.6 percent flufenacet, 4.9 percent metribuzin and 50.5 percent atrazine. Axiom AT mixes well in either water or sprayable grade liquid fertilizer carriers. Axiom AT can be used on most soil types where corn is grown and can be applied either preplant surface, preplant incorporated or preemergence in conventional, reduced-tillage or no-till corn. Recommended use rates range from 1.125 to 2.625 lb. a.i./a. depending on crop management system, timing, soil texture grouping and soil organic matter content. Axiom AT may be applied alone or in-tank mixture with additional registered herbicides and adjuvants or followed with sequential herbicide applications to enhance burndown or control of difficult weed species.

Use rates in Bayer and northeastern university trials ranged from 1.13 to 2.25 lb. a.i./a. as per proposed label recommendations for preemergence application. Axiom AT provided particularly good control of velvetleaf (*Abutilon theophrasti*) and giant foxtail (*Setaria faberi*) when compared to standard premix herbicides. The addition of isoxaflutole @ 0.035 lb. a.i./a. to Axiom AT improved control of velvetleaf and triazine-resistant common lambsquarters (*Chenopodium album*). Corn tolerance to Axiom AT was excellent.

[1] Bayer Corporation, Sherrill, NY, State College, PA, Atlanta, GA and Kansas City, MO respectively.

SPREAD OF THE MUSK THISTLE BIOLOGICAL CONTROL PATHOGEN *Puccinia carduorum* FROM VIRGINIA TO CALIFORNIA.

D. G. Luster, Y. T. Berthier, W. L. Bruckart, and M. A. Hack[1]

ABSTRACT

The rust pathogen *Puccinia carduorum*, originally collected in Turkey in 1978, was studied in Virginia in a series of field experiments from 1987-90 for the control of musk thistle (*Carduus thoermeri*). Since these studies, rust samples have been collected and examined from musk thistle populations in several states across the U.S. Urediniospore ornamentation and analysis of ribosomal Internal Transcribed Spacer 2 (ITS2) DNA sequences were used to confirm the identity of the rust samples as *P. carduorum*. Unique DNA sequences in the ITS2 region of *P. carduorum* permit us to discriminate the musk thistle pathogen from a morphologically indistinguishable strain of *P. carduorum* that is indigenous to California, and only pathogenic on the closely related slenderflower thistle (*C. tenuiflorus*). Teliospores of *P. carduorum* collected from musk thistle from California since 1998 were found to contain the same ITS2 sequence as that from the foreign isolate originally studied in Virginia. These data strongly suggest that the pathogen has dispersed across the entire U.S. since the Virginia field studies.

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CONTROLLING ASTERACEAE WEEDS WITH REPEAT APPLICATIONS OF PSEUDOMONAS SYRINGAE PV TAGETIS AND SILWET L-77.

J. C. Porter, T. A. Bewick, F. L. Caruso, and D. Henderson[1]

ABSTRACT

Single applications of bacterial suspensions of Pseudomonas syringae pv tagetis (Pst) (10E9 cfu/ml) plus Silwet L-77 (0.5% v/v) to the Asteraceae weeds narrowleaf goldenrod (Euthamia tenuiifolia), dandelion (Taraxacum officinale), and devil's beggarticks (Bidens frondosa) at the 4 to 6 leaf stage have resulted in limited reductions in biomass production by the plants for the first 2 to 3 weeks following treatment. By the fourth week after treatment, plants recover from the disease and resume normal growth. In greenhouse studies, repeat applications of bacterial suspensions of Pst (10E9 cfu/ml) plus Silwet L-77 (0.5% v/v), were applied one, two, and one and two weeks after the initial applications to the same weeds, 5 ml/plant, 4 replications per treatment. Shoots were harvested five weeks after the initial applications were made and their dry weight determined. All repeat applications significantly increased the amount of control achieved (up to 100% control of dandelion, 95% control of narrowleaf goldenrod, and 57% control of devil's beggarticks). There were no significant differences among them.

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A SEED GERMINATION PROTOCOL
FOR MILE-A-MINUTE (POLYGONUM PERFOLIATUM L.) [1]

Wu, Y.[2], W. L. Bruckart [3], R. A. Creager [3], and M. R. Gale [2]

ABSTRACT

Mile-a-minute seeds were collected near Boaz, West Virginia, in October 1998. Seeds were air-dried at room temperature for 18 days. They were then placed in airtight containers and stored at three temperatures: room temperature, 4-5°C in a refrigerator, or at -2 to -3°C in a freezer. After five months of storage (March 1999) samples of one-hundred mature, intact seeds from each storage temperature were removed monthly and planted in a 17x17x6 cm flat of Bacto Professional Planting Mix (65.75% horticultural sphagnum peat, 34.25% perlite, pH 5.5-6.5). The planting mix was then moistened and unsealed flats were placed in a refrigerator at 4-5°C to stratify the seeds. When seedlings emerged in any flat, all three flats in that sample period were removed from the refrigerator and placed at room temperature. These flats were observed for two weeks at room temperature and germination rates were recorded. Each flat then was returned to the refrigerator for additional stratification. In a separate study, one hundred seeds were planted and stratified immediately after the 18-day air-dry period. Seedling emergence was not observed in the refrigerator, but good emergence (86%, Figure 1) resulted after moving to room temperature in March 1999.

Seeds stored at room temperature before stratification had germination rates from 34% to 86%, and length of stratification varied from 4 to 19 weeks. Germination rate decreased from March to September, as did the period for stratification (Figure 1). Seeds stored under refrigeration had germination rates of 10% (flat # 2-2) after 13 weeks (in June, 1999) of stratification, and 4% after 16 weeks (in July, 1999) of stratification, respectively, which were the only two months seedlings appeared. Seeds stored in the freezer had germination rates of 1% after 13 weeks (in June, 1999) of stratification and 16% after 16 weeks (in July, 1999) of stratification, respectively, also the only two months seedlings appeared. New seedlings appeared in flat #2-2 in October 1999 after an additional 28 weeks of stratification. It's germination rate increased by 60% to total 70% overall.

Germination of Mile-a-minute seeds stored at room temperature before stratification was faster and more reliable than for seeds stored at cooler temperatures according to this protocol. Mile-a-minute seeds may germinate in the fall under controlled condition, based on experience with flat #2-2. Plans are to continue this study with seeds collected in 1998 and to initiate a new test with seeds harvested in 1999.

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[1] The USDA Forest Service, Forest Health Technology Enterprise Team, Morgantown, WV 26505, funds this research.
[2] Research Scientist and Associate Professor, School of Forestry and Wood Products, Michigan Tech. Univ., Houghton, MI 49931. The corresponding author is currently located at USDA Forest Service, Forest Health Technology Enterprise Team, Morgantown, WV 26505
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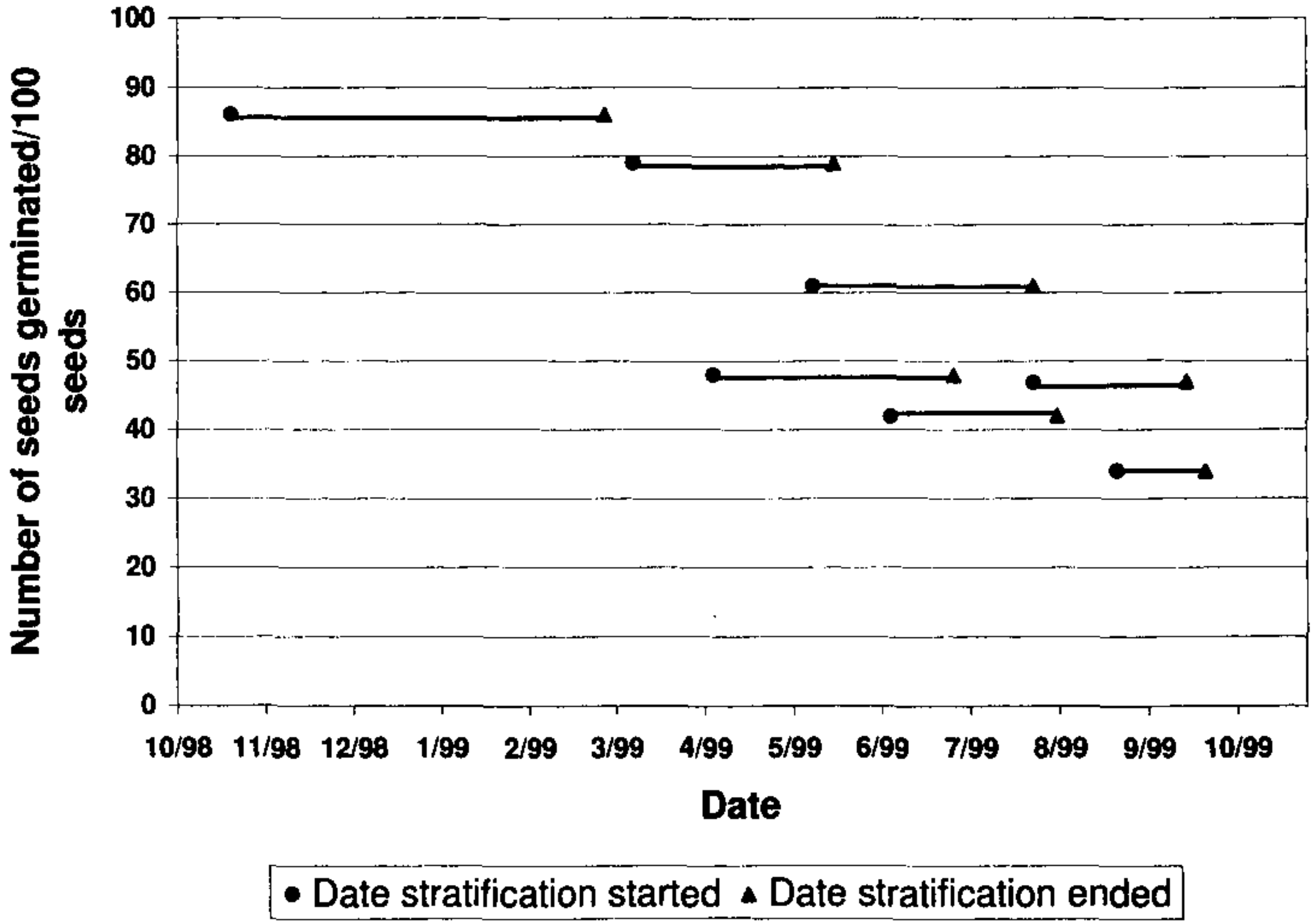
Figure 1. Germination Rate of Room-Temperature-Stored Mile-a-minute Seeds



FIELD TRIAL RESULTS WITH SMOLDER: A BIOHERBICIDE FOR DODDER CONTROL

T. A. Bewick, J. C. Porter and R. C. Ostrowski[1]

ABSTRACT

Field studies were conducted in 1998 and 1999 to determine the optimum rates of application for a preemergence (PRE) and a post-emergence (POST) formulation of Smolder bioherbicide. The active ingredient of the bioherbicide is the fungus *Alternaria destruens*. Studies were conducted in cranberry in MA and carrot in WI. In 1998, PRE results were inconclusive. In 1999, however, results in both locations indicated that a formulation produced by Sylvan, Inc., applied at 60 lb. of product per acre, was effective in controlling dodder. In WI carrot trials, this rate of product completely controlled dodder for the entire season. In both years and in both locations, dodder infestation was reduced at least 90% by POST application of 10^{10} viable condia per acre. In 1998, yield of carrot was significantly increased by this application. Based on these results, and results of previous non-target plant studies and toxicity testing, an Experimental Use Permit will be sought for the 2000 growing season.

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BIOLOGICALLY BASED WEED CONTROL STRATEGIES FOR *Poa annua* MANAGEMENT USING *Xanthomonas campestris* pv. *poannua*

S. Mitra and T. E. Vrabel[1]

ABSTRACT

Annual bluegrass (*Poa annua* L.) is a widespread serious weed species of golf turf. Its competitive nature when managed at close mowing heights on golf course greens and fairways allows annual bluegrass to outcompete desired species such as creeping bentgrass (*Agrostis palustris* Huds.) and take over as the dominant species. The susceptibility of annual bluegrass to environmental stresses and diseases as well as its undesirable characteristic of prolific seed head production in early summer make it a major turf management problem for the golf course superintendent.

Eco Soil Systems, Inc. initiated in 1998 an EUP to evaluate for commercializing a strain of *Xanthomonas campestris* pv. *poannua* that is formulated as a liquid containing live active bacteria in high concentrations. This product has the flexibility of being marketed as a packaged material delivered directly to the end user or, in the near future, increased at the application site in conjunction with the BioJect™ on site fermentation system. This report is a summary of the findings from the applications made in 1999. The objective of the application program is to cause significant levels of infection in annual bluegrass plants which would weaken them and make them more susceptible to mortality caused by cold stress over the winter, and by heat and drought stress in the early summer. Applications in 1999 began when mid day air temperatures reached 18 degrees C.

Infection rates were similar to those seen in 1998 with leaf tissue analysis of *Poa annua* plants sampled from treated golf courses shows an 80% or better infection success rate. Initial infection symptoms are seen as an etiolation of seed stalks and stems that is followed by subsequent chlorosis and epinasty of affected plants. Infection and symptoms occurred in both the annual (*P. annua* ssp. *annua*) and perennial (*P. annua* ssp. *reptans*) annual bluegrass subspecies. Annual bluegrass infection and mortality levels were greater when applications were made at temperatures between 24 and 31 degrees C and turf was maintained at lower irrigation levels following treatment. Applications of growth regulators such as paclobutrazol prior to Xanthomonas application weakened the *Poa annua* and increased effectiveness. Desirable species such as creeping bentgrass (*Agrostis palustris* Huds.) and velvet bentgrass (*Agrostis canina* L.) are not affected by *Xanthomonas campestris* pv. *Poannua* regardless of growth stage.

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[1]Eco Soil Systems, Inc., 10740 Thornmint Road, San Diego, CA 92127

Xanthomonas campestris pv. *poannua* EFFICACY ON THE ANNUAL BIOTYPE OF *Poa annua*.

J. C. Cook, J. C. Neal, and F. H. Yelverton[1]

ABSTRACT

Field evaluations were conducted to determine the efficacy of the bacterial pathogen, *Xanthomonas campestris* pv. *poannua* (Xcp), on the annual biotype of annual bluegrass (*Poa annua* ssp. *annua*). Xcp innoculum (strain MB245) was produced by EcoSoil Inc. Target inoculation concentrations of 10^7 and 10^8 cfu's per ml were applied weekly or biweekly for six weeks. Applications were made at 200 gallons per acre with an air-pressurized sprayer. Visual evaluations for annual bluegrass control were recorded weekly. Additionally, percent seedhead suppression was recorded at the time of peak seedhead production, and percent cover of annual bluegrass was recorded on the last rating date of May 25, 1999. There were no significant differences between weekly and biweekly inoculations. Inoculation concentrations of 10^7 cfu's per ml did not control annual bluegrass. Four weeks after initial inoculation, plots with 10^8 cfu's per ml began to exhibit disease symptoms. Weed control increased over time to 68% by May 25, 1999. Inoculation concentrations of 10^8 cfu's per ml provided 88% seedhead suppression on May 17, 1999. Percent cover of annual bluegrass on May 25, 1999 was reduced by 51.6% as compared to the untreated. No further data were collected because of the decline of the untreated annual bluegrass due to high temperatures and drought.

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NON-NATIVE VASCULAR FLORA OF BISCAYNE NATIONAL PARK, FLORIDA

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ABSTRACT

The non-native vascular flora of Biscayne National Park, Florida consists of 80 species within 35 families. The Poaceae (16 species) contains the largest number of non-native species. Other families containing a high number or percent of non-native plants, are the Agavaceae, Arecaceae, Crassulaceae, Fabaceae and Sapotaceae. Schinus terebinthefolius, Casuarina equisetifolia and Casuarina glauca pose a threat to the native species in the park.

INTRODUCTION

Biscayne National Park, (BNP) comprises 73,000 hectares. It is located between 25° 28'N Latitude, 80° 20'W Longitude, south of Miami, Florida. The park's northern boundary is near the southern end of Key Biscayne, while the southern boundary is near the northern end of Key Largo. Most of the land, 69,557 ha is submerged. Mangrove shoreline 1,935 ha and islands 1,720 ha make up the balance of the land that comprise Biscayne National Park. The largest islands, listed in decreasing order of size are Elliott Key 668 ha, Old Rhodes Key 259 ha, Sands Key 169 ha, Totten Key 154 ha, Little Totten Key 80 ha and Swan Key 48 ha.

Congress approved the creation of Biscayne National Monument in 1968. President Johnson signed the bill on October 18, 1968, which authorized the National Park Service to purchase and develop the park over a five-year period at the cost of twenty five million dollars.

The object of this study is to determine the non-native vascular flora of Biscayne National Park. A secondary objective is to identify the non-native plants that pose a threat to the native vegetation.

CLIMATE

The climate of Biscayne National Park is subtropical marine characterized by dry mild winters and long warm summers. Mean annual temperature is 24.4°C. January is the

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coolest month with a mean temperature of 20.2°C, while August is the warmest month averaging 28.4°C. Annual rainfall, generally a product of connective sea breezes, is 1169mm. Occasional tropical storms and hurricanes may produce heavy amounts of precipitation. Most of the rain falls during the summer. Frosts rarely occur at the Park[1].

GEOLOGY AND SOILS

Biscayne Bay is a shallow-water estuary along the southeast coast of Florida ranging in depth from approximately one to three meters. An elongated ridge of Key Largo Limestone forms a border on the eastern boundary of the park. The soils on the Keys at Biscayne National Park are very shallow and are generally classified as Entisols. The underlying rock is porous Miami Oolite (Oolite limestone) of Pleistocene origin[2].

METHODS

Collecting trips were made to the park in January, February, July and December 1997 and February and June 1998. Objectives for each trip included the collection of voucher specimens and accumulation of information on abundance for each species. More than 500 specimens form the basis for this study. Taxonomically problematic specimens were sent to various experts for annotation.

Voucher specimens have been deposited at the herbarium at Everglades National Park, Homestead, Florida; partial duplicate sets have been deposited in the herbaria of Brooklyn Botanic Gardens (BKL), University of Michigan (MICH), Missouri Botanical Gardens(MO), New York State Museum (NYS), University of South Florida (USF), Jim Montgomery's private herbarium (JM) and Fairchild Tropical Gardens (FTG). Accession numbers will be assigned by scientists at Everglades National Park, Homestead and will be available upon request from the National Park Service. Nomenclature generally follows Wunderlin[4].

RESULTS AND DISCUSSION

Eighty species, including cultivated plants, 21.1% of the flora, are not native to the region. These 80 species of naturalized exotics and cultivated species that have not escaped from cultivation are found within 35 families. The family with the greatest number of non-native species, 16, is the Poaceae. Other families containing a high number or high percent of non-native plants are the Agavaceae, Arecaceae, Crassulaceae, Fabaceae, and Sapotaceae.

The vascular flora of Biscayne National Park consists of 380 species within 261 genera and 92 families. The major families include the Poaceae (47 species), Asteraceae (40 species) and Fabaceae (37 species). Other large families are the Rubiaceae (13 species) and Malvaceae (10 species). Twenty three percent of the species comprising the total flora are contained in the Poaceae and Asteraceae. The largest genera are Tillandsia (7 species) and Chamaesyce (6 species). A summary of the Park's Flora is given in Table 1.

Non-native species are a minor component of the natural vegetation and occur principally in ruderal sites, lawns and along the edges of trails and roads. Several non-native plants, Schinus terebinthifolius, Casuarina equisetifolia and Casuarina glauca pose a threat to the native species in the park[3].

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Table 1 STATISTICAL SUMMARY OF THE VASCULAR FLORA OF
BISCAYNE NATIONAL PARK, FLORIDA

	Ferns and Fern allies	Conifers	Dicots	Monocots	Total
Families	**5**	**1**	**70**	**16**	**92**
Genera	**8**	**1**	**195**	**57**	**278**
Species	**9**	**1**	**276**	**94**	**380**
Native Species	**8**	**1**	**226**	**63**	**298**
Non-Native Species	**1**	**0**	**50**	**31**	**82**

EVALUATION OF AZAFENIDIN FOR PREEMERGENCE WEED CONTROL UNDER GUIDERAILS

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

ABSTRACT

A study was established to evaluate azafenidin alone and in combination with other herbicides for preemergence weed control under highway guiderails. The study was located along SR 33, near Nazareth, PA. Treatments were applied to 5 by 25 ft plots using a CO_2-powered backpack sprayer equipped with a single Spraying Systems OC-12 spray tip, delivering 40 GPA at 34 psi, on May 6, 1999. Treatments were arranged in a randomized complete block design with three replications. Treatments included an untreated check; 3.2, 4.8, 6.4, and 8 oz/ac azafenidin alone or in combination with either 2.25 oz/ac sulfometuron methyl or 102 oz/ac diuron; 2.25 oz/ac sulfometuron methyl or 102 oz/ac diuron alone and in combination; and a commercial premix of 12.4 oz/ac imazapyr plus 100 oz/ac diuron [2/]. All treatments except the untreated check included 24 oz ae/ac glyphosate[3/] to control existing vegetation. Green cover ratings and cover by crownvetch (*Coronilla varia* L.) were taken on May 13, 7 days after treatment (DAT); June 10, 35 DAT; July 7, 62 DAT; August 5, 91 DAT; September 2, 119 DAT; and October 14, 161 DAT. Predominant weed species were crownvetch, Canada thistle (*Cirsium arvense* L.), prostrate spurge (*Euphorbia humistrata* Engelm), spotted knapweed (*Centaurea maculosa* Lam.), goldenrod (*Solidago* spp.), dandelion (*Taraxacum officinale* Weber), common burdock (*Arctium minus* (Hill) Bernh), dropseed (*Sporobolus vaginiflorus* Torr.), kochia (*Kochia scoparia* (L.) Schrad.), and chicory (*Chicorium intybus* L.).

The baseline rating 7 DAT accounted for vegetation present at treatment, and showed there were no significant differences among the treatments at the initiation of the study, with average green cover ratings between 30 and 55 percent. At the other rating dates, from 35 DAT to 161 DAT, all treatments had significantly less weed cover than the untreated check. By 161 DAT, 4.8 oz/ac azafenidin, 2.25 oz/ac sulfometuron methyl, and azafenidin at either 3.2 or 4.8 plus diuron at 102 oz/ac had a significantly higher percentage of weeds than the best treatments.

Although there were no statistical differences among most of the treatments after the 7 DAT rating, by 161 DAT there were trends. At all rates of application, azafenidin alone provided control comparable to azafenidin plus diuron. Adding sulfometuron methyl to all rates of azafenidin provided less weed cover than azafenidin alone. Those treatments containing azafenidin plus sulfometuron methyl had 4 percent or less green cover by weeds even 161 DAT. Similar studies performed in 1997 and 1998 also suggest that azafenidin plus sulfometuron methyl provides excellent long term weed control. Azafenidin would serve as a suitable replacement for diuron in the standard 2.25 oz/ac sulfometuron methyl plus 102 oz/ac diuron mix used in this experiment.

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

[2/] Sahara, 7.78% imazapyr plus 62.22% diuron, American Cyanamid Company, Parsippany, NJ.

[3/] Roundup Pro, isopropylamine salt of glyphosate, 3 lb ae/gallon, Monsanto Company, St. Louis, MO.

TABLE 1: Green cover ratings of weed species located under a guiderail near Nazareth, PA. Treatments were applied May 6, 1999. Green cover ratings were taken 7, 35, 62, 91, 119, and 161 DAT. Each value is the mean of three replications.

Treatment[1/]	Application Rate	Green Cover of Weed Species					
		7 DAT	35 DAT	62 DAT	91 DAT	119 DAT	161 DAT
	(oz/ac)	(---%					---)
Untreated Check	---	42	50	35	28	60	65
azafenidin	3.2	33	4	3	3	6	19
azafenidin	4.8	55	4	6	6	9	21
azafenidin	6.4	33	5	3	4	6	12
azafenidin	8.0	32	3	3	3	4	10
sulfometuron methyl	2.25	32	1	2	7	16	21
azafenidin sulfometuron methyl	3.2 2.25	30	1	1	1	1	3
azafenidin sulfometuron methyl	4.8 2.25	38	1	1	1	1	2
azafenidin sulfometuron methyl	6.4 2.25	37	2	1	1	2	3
azafenidin sulfometuron methyl	8.0 2.25	42	2	1	1	1	4
sulfometuron methyl diuron	2.25 102	33	1	1	1	1	2
diuron	102	50	7	6	4	10	19
azafenidin diuron	3.2 102	37	6	6	7	12	25
azafenidin diuron	4.8 102	40	4	7	7	13	38
azafenidin diuron	6.4 102	40	1	1	1	6	17
azafenidin diuron	8.0 102	40	2	2	1	6	14
imazapyr diuron	12.4 100	37	2	1	1	1	3
Significance Level (p)		0.4382	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)		n.s.	6	6	7	14	19

[1/] All treatments except the untreated check contained glyphosate (Monsanto Company) @ 24 oz ae/ac.

AUTOMATING MONITORING OF ROADSIDE WEEDS

N.P. Cain[1], K. McKague[2], L. Kingston[3], and S. Struger[3]

ABSTRACT

An integrated system was evaluated for monitoring of roadside weed locations and related features, incorporating global positioning systems (GPS) for locating the sites in the field and geographic information systems (GIS) for storing, managing, manipulating and displaying the data. Weed areas, desirable vegetation, water features, culverts and sensitive adjacent land use were recorded. Methods of recording various roadside features as polygon, linear or point data were explored. Two systems of collecting the information were compared - a polygon, field-based collection system and a linear, vehicle-based collection system. Data collected can be used for planning of roadside vegetation management operations, contract management, quality control, and for communication of vegetation features to staff involved in planning, design and construction.

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BACKPACK-BASED BRUSH MANAGEMENT ON A LIMITED ACCESS RIGHT-OF-WAY

J.M. Johnson, A.E. Gover and Larry J. Kuhns[1/]

ABSTRACT

Within a limited access right-of-way, at least three vegetation management zones should be designated. These management zones include a non-selective zone addressing the shoulders and guiderails; a safety clear zone extending at least 30 feet from the road edge that is kept free of all woody vegetation; and a selective zone extending to 80 feet from road edge, where tall growing woody species, as well as any other undesirable species would be suppressed. With this zone concept in mind the Penn State Roadside Research Project, a cooperative project between The Pennsylvania State University and The Pennsylvania Department of Transportation, set out to establish a large scale demonstration of selective brush control techniques. In particular, to demonstrate the effectiveness of backpack-based applications on managing vegetation in the selective zone. A 14 mile stretch of I-78 in Northampton County was chosen for the demonstration. This section of I-78 was first opened to traffic in November, 1987. The initial applications were made in October, 1993. At that time, the most common brush species were staghorn sumac (*Rhus typhina* L.) and black locust (*Robinia pseudoacacia* L.). Other species included: boxelder maple (*Acer negundo* L.), shrub-type willows (*Salix* spp.), black birch (*Betula lenta* L.), yellow-poplar (*Liliodendron tulipifera* L.), sycamore (*Platanus occidentalis* L.), Ailanthus (*Ailanthus altissima* Mill.), and Paulownia (*Paulownia tomentosa* Thunb.).

Table 1 lists the vegetation efforts that were undertaken by the research project, as well as time, materials and comments. The Penn State/PennDOT Roadside Vegetation Management project has spent nearly 300 hours actually treating brush in this corridor, in addition to other projects and follow-up evaluations. Vegetation management in the selective zone is crucial to maintaining a safe corridor, but is often neglected. The hazards associated with tall growing trees falling onto the roadway and limited sight distance are the primary concerns associated with vegetation in this zone.

There are several considerations worth mentioning for vegetation management in the selective zone. Clearing as far from the roadway as practical during construction is essential. Areas along I-78 that are native terrain, where no cut or fill activity was done, were often cleared to only 50 feet from the roadway. These areas are populated by large trees that were probably tall enough to fall on the roadway when it was built. Again, a distance of eighty feet from the roadway should be managed for the elimination of tall growing trees where the right-of-way width allows.

A brush management program should be initiated as soon as possible after construction of a limited-access roadway. Six years after the opening of I-78, there was already large, well established brush present. The sooner a brush management program begins, the smaller the brush, the more selective the applications can be and the less damage will be done to desirable vegetation.

The Krenite-based applications relied on in this demonstration were specific to brush. To address the herbaceous species such as Canada thistle (*Cirsium arvense* L.) or Japanese knotweed (*Polygonum cuspidatum* Sieb. & Zucc.) at the same time as brush, a mix based around glyphosate or broadleaf chemistry should be employed. Where colony-forming herbaceous vegetation is treated, reseeding desirable species is necessary.

For contracting purposes, a contract crew should be able to switch between backpacks and truck based hoses based on the vegetation. These methods of application provide flexibility, greater selectivity and are relatively inexpensive. Based on rough area estimates using the most expensive visit (7/98), the cost of managing brush in this corridor works out to about $6.50/acre per operation. This cost was arrived at using the following estimates:

14 miles long, two 80 ft shoulders, a 50 ft median = 356 acres; $24/hour x 77 hours = $1848; herbicide cost = $436.

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Table 1: Summary of brush management efforts by the Penn State research project along I-78 in Northampton County. For comparative purposes, the distance covered if the entire corridor was treated would be considered 42 miles.

Application	Date	Distance Covered (miles)	Material Use	Hours	Comments
Backpack Foliar	10/7/93 10/8/93	17	9.8 gallons, KreniteS[1/]/Arsenal[2/] 5.0/0.5 % v/v	14	Too late - leaf drop on some species. Also put out small scale Spike and Velpar plots on black locust.
Basal Bark	4/7/94 4/8/94	16	17.6 gallons, Garlon 4[3/] / basal oil, 15/85 % v/v	37.5	Some behind-the-wall work. Much sumac resprouted
Backpack Foliar	8/29/94 8/30/94	38	67 gallons, Krenite S/Arsenal, 5.0/0.5 % v/v	77	Except for short stretch of grass median, covered entire corridor.
Basal Bark	3/28/96	0.5	8 gallons, Garlon 4/ basal oil, 20/80 % v/v	10	Targeted black locust, Paulownia, ailanthus, willow
Cut Surface	3/28/96	0.5	0.25 gallon, Garlon 4/ basal oil, 20/80 % v/v	10	Much black locust, some willow cut and treated.
Backpack Foliar	7/29/98 7/30/98	39	122 gallons Krenite S/Arsenal, 5.0/0.5 % v/v	77	Very dry. Brief downpour on 7/29. A lot of work done to move back the edge
Backpack Foliar Thinvert Carrier	7/29/98	3	5.5 gallons total, Krenite S/Arsenal, or Garlon 3A[4/] /Arsenal	4	Each mix was 10/0.5 % v/v, respectively, applied at 3 to 5 gallons per acre.
Backpack Foliar	6/16/99 6/17/99	34	44 gallons, Krenite S/Arsenal 5.0/0.5 % v/v	54	Still dry. Much multiflora rose and locust. Rained out 6/17
Cut Surface	6/16/99 6/17/99	12	0.5 gallon, Pathway RTU[5/]	14	Black locust, sycamore, boxelder, poplar, willow

[1/] Krenite S, 4 lb fosamine ammonium/gal, E.I. DuPont de Nemours, Wilmington, DE.
[2/] Arsenal, 2 lb imazapyr/gal, American Cyanamid Company, Parsippany, NJ.
[3/] Garlon 4, 4 lb triclopyr ester ae/gal, DowElanco, Indianapolis, IN.
[4/] Garlon 3A, 3 lb triethylamine salt of triclopyr ae/gal, DowElanco, Indianapolis, IN.
[5/] Pathway RTU, 3% ae picloram plus, 11.2% ae 2,4-dichlorophenoxyacetic acid, DowElanco, Indianapolis, IN.

COMPARISON OF REHABILITATION SEQUENCES FOR JAPANESE AND SAKHALIN KNOTWEED INFESTATIONS

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

ABSTRACT

Four operation sequences to convert roadside sites infested with Japanese knotweed (*Polygonum cuspidatum* Sieb. & Zucc.) and Sakhalin knotweed (*Polygonum sachalinense* F.Schmidt ex Maxim.) to a grass mixture were compared. The four sequences were developed by varying the order of a primary herbicide treatment, grass seeding, and a follow-up herbicide treatment. Sixteen months after initiation of the trial, three sequences featuring primary treatment in the spring of the first year provided at least 60 percent grass cover, and less than 10 percent Sakhalin knotweed cover at a southeastern PA site. The fourth sequence, featuring a late summer primary treatment, provided equal knotweed suppression, but only 18 percent grass cover. A second trial on Japanese knotweed in a highway interchange complex in southwestern PA was largely unsuccessful to poor knotweed control.

INTRODUCTION

Japanese and Sakhalin knotweeds are stout, erect, herbaceous perennials that commonly grow to heights of 2 to 3 m. They spread vigorously by vegetative means, and are capable of producing dense monocultures covering several hectares. Both species occur on desolate, disturbed sites, and Japanese knotweed has been documented to tolerate extremes in low pH and infertility (McKee, et. al, 1982). In a roadside setting, particularly in narrow right-of-ways, both species can pose a serious problem due to loss of sight distance, damage to asphalt pavements from emerging shoots, and environmental degradation due to reduction in biodiversity. As part of an ongoing project funded by the Pennsylvania Department of Transportation, four rehabilitation sequences to convert knotweed-infested roadsides to a grass mixture were compared at two sites, one in Doylestown, PA (near Philadelphia), and one in Etna, PA (near Pittsburgh).

MATERIALS AND METHODS

Each of the four rehabilitation sequences consisted of three operations; 1) a primary herbicide treatment to kill the above-ground growth of knotweed and provide an opportunity for a seeding to be established, 2) the seeding of a 55/35/10 mixture of hard fescue (*Festuca brevipila* Tracey), red fescue (*Festuca rubra* ssp. *rubra* L.), and annual ryegrass (*Lolium multiflorum* L.), seeded at 112 kg/ha, and 3) a follow-up herbicide application to provide control of the inevitable knotweed resprouts and further reduce the vigor of the underground organs. An integral element of any invasive species rehabilitation project is continued (perpetual) maintenance after the desired replacement species has been established.

Table 1 lists the code names and generalized timetable of the sequences, as well as the treatment dates for both sites. The Doylestown site was located in a stand of Sakhalin knotweed on a fill slope originally seeded to crownvetch along SR 611. Individual experimental plot were 6 by 9 m, and were arranged in a randomized complete block with four replications. At study initiation on April 6, 1998, knotweed emergence was just beginning, with shoots extending up to 0.2 m. Knotweed residue from previous seasons provided nearly complete cover. On April 30, when the first herbicide treatments were made, the knotweed shoots ranged in height from 0.2 to 1.0 m. On August 31, previously untreated knotweed averaged 2.5 m in height.

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Table 1: Sequence codes and generalized timing for the primary treatment, follow-up treatment, and grass mixture seeding for the four rehabilitation sequences compared. Listed below the generalized times are the actual operation dates for the Doylestown and Etna sites. In the sequence codes, 'P' indicates primary herbicide treatment, 'F' follow-up herbicide treatment, and 'S' seeding, and '=' indicates the two operations can occur during the same site visit.

Sequence	Primary Treatment	Follow-up Treatment	Grass Seeding
S/P/F	knotweed leaf-out	late summer	early spring
Doylestown	*4/30/98*	*8/31/98*	*4/6/98*
Etna	*5/14/98*	*9/1/98*	*4/15/98*
P=S/F	knotweed leaf-out	late summer	knotweed leaf-out
Doylestown	*4/30/98*	*8/31/98*	*4/30/98*
Etna	*5/14/98*	*9/1/98*	*5/14/98*
P/F/S	knotweed leaf-out	late summer	late summer
Doylestown	*4/30/98*	*8/31/98*	*9/14/98*
Etna	*5/14/98*	*9/1/98*	*9/1/598*
P/S/F2	late summer	late summer/fall	spring year 2
Doylestown	*8/31/98*	*6/10/99*	*9/14/98*
Etna	*9/1/98*	*6/24/99*	*9/15/98*

The Etna site was located in the interchange complex of SR 8 and SR 28, on the north bank of the Allegheny River. Each of the three replications were located in a separate stands of Japanese knotweed. Average plot size was 95 m^2. Two of the knotweed patches were undisturbed, while the third was located at the convergence of two on-ramps and was routinely mowed two to three times per year. The P/S/F2 sequence plots were cut to a height of about 0.3 m on May 14 in all three replications, to simulate the mowing that untreated knotweed would otherwise receive where sight distance would be compromised. At study initiation on April 15, 1998, knotweed was already 1 to 1.3 m in height in the undisturbed areas. The canopy was still somewhat open as Japanese knotweed shoots appear to elongate more before leaf expansion, compared to Sakhalin knotweed. When the primary herbicide treatments were made to the S/P/F, P=S/F, and P/F/S sequences on May 14, 1998, the knotweed ranged from 2.0 to 2.5 m in the undisturbed areas, and 0.8 to 2.0 m in the on-ramp area. Previously untreated knotweed was 1.5 to 2.0 m on September 1, 1998.

Herbicide treatments were applied with lever-actuated backpack sprayers, equipped with a single Spraying Systems #5500 Adjustable ConeJet with an X-6 tip, with a targeted carrier volume of 187 L/ha. Both primary and follow-up treatments were a mixture of dicamba (3,6-dichloro-2-methoxybenzoic acid) plus clopyralid (3,6-dichloro-2-pyridinecarboxylic acid) at 2.2 plus 0.21 kg/ha, respectively. All applications included an organosilicone-based surfactant at 0.1 percent v/v. Seed was pre-weighed for each plot, and distributed by hand.

RESULTS AND DISCUSSION

There was considerable contrast in the outcome between the two sites. At Doylestown, all four sequences provided 93 to 97 percent reduction of Sakhalin knotweed by August 5, 1999, 16 months after initiation of the trial. The S/P/F, P=S/F, and P/F/S sequences were rated between 60 and 70 cover by the seeded grasses, while the P/S/F2 sequence was rated at only 18 percent cover. This was due in part to the later establishment date and the dry fall of 1998, and also because there was more knotweed residue in the P/S/F2 plots. In addition to residue already present at the initiation of the study, these plots had the residue from an another season of growth, compared to the sequences initially sprayed in the spring. This residue was abundant enough to appear to inhibit establishment of the seed mix, rather than serving as a protective mulch.

The Japanese knotweed at the Etna site was not satisfactorily controlled, particularly in the undisturbed areas, and the grass mixture never had an opportunity to establish. Knotweed in the undisturbed stands was reduced in height by about 20 percent compared to the height at treatment on 5/14/98, but had greater than 90 percent cover. In the on-ramp area, which was somewhat open to begin with, cover from the grass mixture was 90 to 95 percent for the S/P/F, P=S/F, and P/F/S sequences on June 24, 1999, 14 months after study initiation. Knotweed cover averaged 25 percent for these three sequences, and retreatment was definitely needed.

A contributing factor to the reduced success at the Etna site may be that the knotweed was much larger than the knotweed at the Doylestown site when the spring herbicide treatments were applied, making uniform coverage with a low volume application difficult. Another factor may be that Japanese knotweed is more tolerant to dicamba and clopyralid than Sakhalin knotweed. When the results of this study are considered collectively with previous disappointing results with dicamba plus clopyralid on Japanese knotweed in field day-type demonstrations in northeastern and southeastern PA, it becomes apparent that the approach of regarding the two knotweed species as basically identical in terms of management may be seriously flawed.

SUMMARY

When evaluated in August, 1999, rehabilitation sequences initiated in April, 1998 in a stand of Sakhalin knotweed had resulted in better establishment of the seeded fine fescue mixture than the sequence initiated at the end of August, 1998. This difference is probably temporary, as knotweed reduction was excellent in all four sequences, and the grass in the later-initiated sequence should come to be as well established as the spring-initiated sequences during the 2000 growing season. When an effective herbicide combination is utilized, vegetation managers have considerable flexibility in their approach to rehabilitating knotweed infested sites. As long as managers acknowledge the tenacity and persistence of invasive species such as knotweed, use an adapted seed mix, and seed at the right time, they can successfully rehabilitate sites using a variety of sequences.

ACKNOWLEDGMENTS

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IR-4 ORNAMENTAL RESEARCH PROGRESS FOR 1999[1]

J. Ray Frank[2]

ABSTRACT

The IR-4 Ornamental Research Program was initiated in 1963 to develop data for use in the national label pesticide registration for specialty or minor use food crops. In 1977, the IR-4 Program began developing research data for use in the national registration of pesticides for the green industry.

In 1999, over 600 ornamental research trials were conducted including 202 on herbicides and 48 on plant growth regulators. These trials were conducted in 13 states by 14 researchers on the following herbicides:

Bentazon	Imazethapyr	Oxyfluorfen + Pendimethalin
Clethodim	Metolachlor	Pendimethalin
Clopyralid	Napropamide	Prodiamine
Diclobenil	Oryzalin	Thiazopyr
Dithiopyr	Oxadiazon	Trifluralin
Fluazifop-P-butyl	Oxyfluorfen + Oryzalin	

Plant growth regulators include:

Chlormequat chloride	Paclobutrazol
Ethephon	Uniconazole P

During 1999, 274 new registrations were obtained as the result of the IR-4 Program. Since the Ornamental Program was initiated, over 6,800 registrations have been obtained with over 1,600 of them for herbicides and 75 for plant growth regulators.

These registrations include those for nursery, floral crop, forestry and turf production. Registrations have also been developed for use in the commercial landscape, interior plantscapes and tissue culture.

[1] New Jersey Agriculture Experiment Station, Publication No. A27200-05-99 supported by State, U.S. Hatch Act and other U.S. Department of Agricultural funds.

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WETLAND NURSERIES AND WATER GARDEN TRADE SPREAD A FEDERAL NOXIOUS AQUATIC WEED, *Salvinia molesta*

S. H. Kay and S. T. Hoyle[1]

ABSTRACT

Giant salvinia (*Salvinia molesta* D. S. Mitchell), a federal noxious weed, was found in TX in a schoolyard pond in Houston in May 1998 and in a farm pond in July. In September, it was collected in LA from the Bayou Teche and found in the backwaters of Toledo Bend Reservoir. In October, a technician with NC State University discovered it in a water garden exhibit at the NC State Fair. By December, it had been detected in the lower reaches of the Sabine and Trinity Rivers in TX and had been found in several small ponds, nurseries, garden centers, and personal water gardens in NC. Giant salvinia was identified in a pond in Auburn, AL, in January 1999, and in a canal in Naples, FL, in February. In April, it was seen in a pond and adjacent ditch in MS and in Enchanted Lake, HI. In June, the USDA-ARS released imported weevils, *Cyrtobagous salviniae*, for giant salvinia control at three locations in eastern TX. By July and August, new infestations had been reported in TX, AZ, and CA, and the Auburn, AL, pond infestation was no longer contained. CA reported giant salvinia for sale in 37 towns in 12 counties in July and that a few plants were found in a ponded area of the San Diego River. Garden centers in all of these states as well as OR, WA, VA, PA, and OK have been selling this weed as an ornamental. Several wetland nurseries have advertised this plant in their catalogs and via their websites, and there have been instances where individuals advertised the plants on line either for sale or trade.

The escape and naturalization of giant salvinia in the South and Southwest, its widespread sale by nurseries and garden centers, and its easy availability through catalogs and on-line sources present a serious dilemma for water resources management in the southern United States. The presence of naturalized populations in northern TX indicates that giant salvinia has the potential to spread to areas which had been presumed much too cold for its survival during the winter. Examination of the weed's current distribution and the plant hardiness zones and its successful overwintering in water gardens in NC suggests that it also could become established in some areas of coastal New England and the Pacific coast.

Regulation of sales of federal noxious weeds, including giant salvinia and others, primarily has been left up to the departments of agriculture in each state, once the plants have become established within the borders of the United States. Inconsistency of state and federal regulatory statutes and enforcement, combined with the unfamiliarity of regulatory

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personnel with many of the illegal plants has provided an environment highly conducive to the spread of noxious aquatic and wetland weeds. Efforts by a few states and by several federal agencies to combat the spread of giant salvinia and other Federal noxious aquatic weeds must be embraced and enforced uniformly by all states and federal agencies to be effective.

WATER GARDEN / WEED GARDEN?

S. T. Hoyle and S. H. Kay [1]

ABSTRACT

The popularity of water gardening has increased dramatically in North Carolina and throughout the country during the past few years. Sales of equipment and plants for water gardens have nearly doubled annually over the past five years, and industry projections suggest that this rate of increase will continue for another five years.

The demand for water and wetland plants has spawned the growth of aquatic plant nurseries. In some cases, plants contain undesirable, highly invasive species such as hydrilla (*Hydrilla verticillata* L.f. Royle) as contaminants. A number of undesirable species such as giant salvinia (*Salvinia molesta* D. S. Mitchell) have been cultivated, sold, and distributed widely, either mistakenly or intentionally, under the wrong scientific and common names. The increasing availability of plants from mail order and on-line catalogs has only aggravated this situation. The great majority of these plants never become problems. However, a few have proven to be highly invasive including waterhyacinth [*Eichhornia crassipes* (Martius) Solms-Laubach] and purple loosestrife (*Lythrum salicaria* L.) and have caused significant environmental damage through habitat destruction. In 1999, waterhyacinths were found in several locations in North Carolina. Each of these "new" infestations have been traced back to intentional introductions from water gardens. Preventing the introduction and spread of noxious aquatic weeds can save millions of dollars of public and private money annually for weed control activities.

Just because a plant is interesting or has a pretty flower does not constitute justification for releasing it into the environment. Invasive species including giant salvinia and hydrilla, both Federal Noxious Weeds, are not native to the United States and have entered either as contaminants among other plants or as intentional introductions. Is this what YOU want in your ponds and lakes? Moreover, how much are you willing to spend to get rid of those plants, which become weedy? Careful consideration of the nature of the plants you intend to put into a water garden, aquascape, or wetland can reduce the likelihood of inadvertently creating a weed management problem. Even plants native to one part of the country may be invasive in another part of the country. A wise approach is to select vegetation native to the region where it is to be planted and, whenever available, to use only those species which usually are not invasive.

The best assurance of having attractive, trouble-free water gardens, aquascapes, and wetland plantings is careful plant selection. Educate yourself about the nature of aquatic and wetland plants, and know what you want before you purchase. Beware of salesmen who seem too eager to sell you large numbers of expensive, pretty plants and who assure you that they are not invasive and will never become troublesome. Even when purchasing native plants from local sources, be sure your plants are free of unwanted contaminants. Visit the nursery, and look carefully at the plants they have for sale to determine that there are no unwanted plants mixed with them. Also, be sure that your source of plants is a state-certified nursery or dealership. If you find that you have too many plants, dispose of them properly - NEVER dump them into the ditch, pond, lake or river where they may become someone's problem.

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TOLERANCE OF ORNAMENTAL GROUNDCOVER SPECIES TO POSTEMERGENCE APPLICATIONS OF CLOPYRALID

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ABSTRACT

In 1999, two studies were conducted at the Long Island Horticultural Research and Education Center (LIHREC), Riverhead NY and the Penn State University Horticulture Farm (PSUHF) at Rock Springs, PA to determine the tolerance of various ornamental groundcovers to the herbicide clopyralid (Lontrel). Treatments consisted of three rates of clopyralid (0.25, 0.5 and 1.0 lb./ac.) and an untreated control. Treatments were applied twice 30 days apart during the growing season. English ivy (*Hedera helix*), pachysandra (*Pachysandra terminalis)* and vinca (*Vinca minor*) were tested at both sites. A decrease in dry weights was observed for ivy at all treatment rates at both sites. Dry weight decreased for vinca only at the LIHREC site at the highest rate of clopyralid. For pachysandra, no effect on dry weight was observed.

Eight additional species were tested at the LIHREC site including bugleweed (*Ajuga reptans* 'Burgundy Glow'), daylily (*Hemerocallis* 'Burning Daylight'), gazania (*Gazania rigens* 'Daybreak Mix'), hosta fortunei (*Hosta fortunei* 'Aureo-marginata'), hosta siebold (*H. siebold* 'Elegans'), rosemary (*Rosmarinus officinalis* 'Prostratus'), sedum (*Sedum spurium* 'Dragon's Blood Tricolor'), and veronica (*Veronica peduncularis* 'Georgia Blue'). Dry weights did not significantly decrease for treated samples of rosemary, veronica, ajuga, and daylily. Dry weights decreased for gazania, hosta fortunei, and sedum at all rates and for hosta siebold at the two higher rates.

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CLOPYRALID EFFECTS ON FIELD-GROWN WOODY ORNAMENTALS

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

ABSTRACT

Five deciduous ornamental shrubs were examined for their tolerances to clopyralid, sprayed over the top of plants on April 8, 1999. The shrubs (and the condition of their buds on April 8) were the following: redosier dogwood [*Cornus sericea* 'Red Twig'] (buds tight); dwarf burning bush [*Euonymus alatus* 'Compacta'] (buds ¼ to ½ inch long); forsythia [*Forsythia x intermedia* 'Lynwood Gold'] (buds ¼ to ½ inch long); panicle hydrangea [*Hydrangea paniculata* 'PeeGee'] (buds tight); and weigela [*Weigela florida* 'Java Red'] (buds tight). The shrubs were planted in 1998 in a sandy loam soil, were sheared 1 to 2 weeks prior to clopyralid application, and were all less than 6 inches tall at the time of treatment. Clopyralid was applied in a volume of 30 gal/A at rates of 0.125, 0.25, or 0.5 lb/A a.i. The primary weed was horseweed [Conyza canadensis (L.) Cronq.], the rosettes of which had a diameter of 1 to 2 inches.

All rates of clopyralid completely controlled horseweed. Plant injury (0 = no injury; 10 = dead) was evaluated on June 4 and July 14, and plant vigor ratings were taken on August 31 (0 = dead; 10 = excellent vigor). Weigela and dwarf burning bush were highly sensitive to clopyralid, which, at all application rates, caused substantial injury (ratings of 3.0 or higher) to these two shrubs. Clopyralid at 0.5 lb/A nearly killed most of the weigela plants. Plants less severely injured displayed leaf curling or cupping. Panicle hydrangea was intermediate in susceptibility to clopyralid. Injury ratings for hydrangea ranged from 1.5 to 5.0 depending on clopyralid rate, but plants treated with 0.125 or 0.25 lb/A rates recovered to have vigor ratings of 8.5 or higher by the end of August. Redosier dogwood and forsythia were the most tolerant shrubs to clopyralid. Injury ratings did not exceed 2.0 for these plants treated with clopyralid at 0.125 or 0.25 lb/A, and plant vigor ratings were at least 8.25 for all treatments.

Because clopyralid was highly active on seedling horseweed at even the 0.125 lb/A rate, it would be of interest to evaluate tolerances of dormant shrubs at even lower clopyralid dosages.

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MUGWORT CONTROL WITH CLOPYRALID AND HERBICIDE MIXTURES

A.O. Ayeni and B.A. Majek[1]

ABSTRACT

Mugwort (*Artemisia vulgaris*) is a major perennial weed of field nursery in New Jersey with limited chemical control options under grower's conditions. Two rates (X and 1.5X) each of clopyralid (Stinger) (9 & 14 oz/A), clopyralid + 2, 4-D (Weedar 64) (9 + 16 & 14 + 16 oz/A), clopyralid + 2,4-D + dicamba (Millennium) (44 & 65 oz/A), clopyralid + dicamba + MCPA (Trupower) (44 & 65 oz/A), and dicamba + MCPA + triclopyr (Coolpower) (52 & 78 oz/A) were applied for mugwort control at 4, 6, and 8 weeks after planting (WAP). An untreated control was added for comparison. Herbicides were applied with a calibrated greenhouse sprayer fitted with 8002VS-nozzle tip and operated at 30 psi and 68 gpa. Mugwort was raised under greenhouse conditions (75 to 90°F day, 60 to 70°F night, 14 to16 h light) from 3- to 4-inch rhizome fragments planted in 2-gal plastic pots filled with regular mix (2:1 v/v peat moss:vermicullite mix plus lime, fertilizer, and micronutrients). The experiment was set up in four randomized complete blocks. Mugwort control was assessed based on foliage dry weight (live portions only) four to eight weeks after herbicide application as well as dry weight of regrowth five weeks after top removal.

All herbicide treatments applied 4 WAP controlled mugwort 100% within four weeks after treatment. With herbicide application 6 WAP, Trupower and Millennium controlled mugwort more than 95% within six weeks after treatment while Coolpower, Stinger or Stinger + 2,4-D caused 90 to 95% control. When applied 8 WAP, Millennium, Trupower or Coolpower caused only 60 to 67% control four weeks after treatment and Stinger or Stinger + 2,4-D killed less than 50% mugwort foliage. When observed for five weeks after top removal, there was no regrowth from all herbicide treatments applied at 4 or 6 WAP except Coolpower applied 6 WAP at 52 oz/A which produced regrowth with dry weight 2.1% of untreated control. When mugwort was treated 8 WAP, Millennium caused the least regrowth of approx. 0.5% dry weight of untreated control followed by Stinger + 2,4-D (2.2%), Trupower (3.8%), Stinger (4.1%) and Coolpower (48.5%). It was concluded that all the herbicides tested are effective for the control of 4- to 6-week old mugwort at the rates evaluated, but for 8-week old mugwort stands, Millennium is the most effective, followed by Stinger + 2,4-D, Trupower, and Stinger in that order. Coolpower, a non-clopyralid containing herbicide mixture, is ineffective at 52 to 78 oz/A for the control of 8-week old mugwort stands.

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HERBICIDE EVALUATIONS IN CHRISTMAS TREE PLANTINGS OF FIR (*ABIES* spp.)

J. F. Ahrens and T. L. Mervosh[1]

ABSTRACT

The need for herbicide alternatives for Christmas trees led us to evaluate several herbicides during 1998 and 1999, with emphasis on fir tolerance before and during active growth in the spring. Accordingly, repeated experiments were conducted at The Connecticut Agricultural Experiment Station in Windsor, CT and with cooperating growers in Somers, CT and Woodbury, VT. Soil types were sandy loams or silt loams. Herbicide sprays were applied with a CO_2-pressurized backpack sprayer in 20 gal/A over the top of or on the lower two-thirds of the trees. Herbicides evaluated in one or more experiments included atrazine 90DF plus simazine 90DF, hexazinone 75DF, thiazopyr 2L, azafeniden 80DF and the sulfonylurea herbicides thifensulfuron-methyl 25DF, chlorimuron-ethyl 25DG, sulfometuron-methyl 75DG, prosulfuron 57WDG, and MON 37503 75WDG. Rates are listed in oz a.i./A or lb a.i./A.

Hexazinone at 0.5, 1.0, or 1.5 lb/A and sulfometuron-methyl at 0.375 and 0.75 oz/A applied 2 weeks before planting fraser fir (*Abies fraseri*) caused no injury. However, hexazinone at 1.0 and 1.5 lb/A applied to established fraser fir before bud break caused slight to moderate necrosis. Sulfometuron-methyl at 0.1875 to 0.375 oz/A did not injure dormant fraser fir and caused only slight, tolerable chlorosis on fraser fir during active growth. Thifensulfuron-methyl at 0.25 or 0.5 oz/A plus 0.25% X-77, and chlorimuron-ethyl at 0.125 or 0.25 oz/A plus 0.25% X-77 caused no injury to dormant fraser fir and slight, tolerable chlorosis in June on actively growing fraser fir. Prosulfuron at 0.1425 or 0.285 oz/A plus 0.25% X-77 applied during active growth of fraser fir in early and mid June in VT caused moderate to severe chlorosis on sprayed foliage. However, sprays of prosulfuron in CT at 0.285 or 0.57 oz/A without surfactant resulted in only slight chlorosis on fraser fir before or after bud break.

MON 37503 at 0.5 or 1.0 oz/A applied before bud break did not injure newly planted Canaan fir (*Abies balsamea var. phanerolepsis*) in CT nor established fraser fir in VT. Thiazopyr at 0.5, 1.0, or 2.0 lb/A before bud break did not affect established Canaan fir in VT but injured newly planted Canaan fir in CT. Thiazopyr applied just before or at bud break at 0.5 or 1.0 lb/A did not injure balsam fir (*Abies balsamea*) or fraser fir in CT following two applications in two years. Azafeniden applied at 0.5 lb/A during active growth caused more injury to fraser fir than did 1.5 lb/A applied before bud break. During active growth, injury to fraser fir from azafeniden at 0.5 lb/A was similar to injury from atrazine (2 lb/A) plus simazine (2 lb/A). Neither treatment injured fraser fir before bud break. New growth of balsam fir also was sensitive to azafeniden, whereas newly planted or established Canaan fir tolerated up to 1.5 lb/A before bud break. At 0.5 lb/A, azafeniden gave excellent preemergence and postemergence control of large crabgrass (*Digitaria sanguinalis*). Herbicides with postemergence activity clearly were safer to conifers when applied to dormant foliage than when applied to new needle growth.

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POTENTIAL WEEDINESS OF SEVERAL NEW HERBACEOUS PERENNIAL CROPS

Annamarie Pennucci[1]

ABSTRACT

A brief review of new herbaceous perennial crops indicates that several have already demonstrated the potential for intra- and inter-nursery spread. A list of potential nursery crops that may act as invasive weeds follows. An analysis of morphological factors that predispose these crops to act as weeds and a description of potential factors to consider prior to crop release is suggested.

INTRODUCTION

During the past two seasons, several New Hampshire nurseries and farm stands reported the unexpected spread of novel crop plants into pots and containers of both woody and herbaceous plant materials. Such unwelcome movement within the nursery compromised plant identity, plant health and the economic requirement for weed free status. Consequently, questions arose concerning the necessity of crop cleanliness, recognition and hand removal of one of the crop plants, using herbicides to prevent further ingress, and separation or containment to prevent further spread of seemingly desirable species.

Several of these plants are newly developed or selected for the herbaceous perennial trade and while some are closely related to or cultivars of existing crop or weed species, others are new genera whose potentials as crop or weed remains unknown.

MATERIALS AND METHODS

Two nurseries located in southern New Hampshire first reported the appearance of unusual plants in purchased containers as early as 1997. Both nurseries obtained plant materials from several of the same mid-western plug propagators and from the same two in-state perennial plant whole-salers. Both nurseries were surveyed monthly in 1998 and 1999 for unusual weeds and those weeds were identified according to both standard references and new crop catalogues.

Movement of these novel crops/weeds (cw) within the nursery was measured in linear feet from the original source plants to other plants held in stock areas, in feet and in acres from stock to sales tables and in total acres across the nursery. Morphological traits that might account for movement were determined and the number of pots within each crop species infested with cw was counted monthly. Herbaceous perennial crop plants were categorized by the amount of soil visible at maturity and the relative strength of the crop and the number of crop plant units invaded in each category was determined.

Industry standard herbicides were used at label rate in each of these nurseries. Typically, Dacthal (DCPA [dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate]) was applied as the crop resumed spring growth at preemergence and 10 weeks later as a postemergent drench; Preen (pendimethalin [N-(1-ethylpropyl) -3,4-dimethyl-2,6-dinitrobenzeneamine] applied preemergent and 8 weeks later as a postemergent drench; Gallery (isoxaben [N-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl] -2,6-dimeth- oxybenzamide] applied preemergent and Scotts OH-2 (pendimethalin + oxyfluorfen [2-chloro-1-(3-ethoxy-4- nitrophenoxy)-4-(trifluoromethyl)benzene] applied pre/post as crop growth resumed. Herbicidal efficacy on cw was determined 6 and 16 weeks after final treatment.

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RESULTS AND DISCUSSION

Several newly released herbaceous perennials offered in the wholesale trade in 1998 and 1999 demonstrated the potential for significant inter-nursery spread and reclassification as weeds. Plant movement occurred in several different ways: from container to container, from container to surround ing soil, from container to gaps in protective landscape fabric and from containers to soil under or on sales benches. The reproductive morphologies were often different in each potentially weedy species; their identity, methods and seasons of dispersal are given in Table 1.

It is interesting to note that neither nursery actually bought any of the first nine plants listed in Table 1; they arrived into each nursery as weeds in other purchased plant material in 1998.

For comparative purposes, Appendix 1 provides a compilation of herbaceous perennials whose aggressive and/or invasive habits have been documented and referenced in trade publications.

The distance each of these nine most-invasive plants was able to move in the course of one season varied with the plant in question and ranged from several feet to several acres, Table 2. For the purposes of this paper, data relative to spread, aggressiveness and host tolerance will be limited to those nine previously identified as novel and potentially explosive.

Several cw were able to infest more than one pot of nearly every other plant species in the nursery, others infested fewer containers in a wide array species while others only infested herbaceous perennials. Several cw set and dispersed seed sufficiently early to infest annual plants located on the opposite side of the nursery, many of the cw were able to infest established containerized or balled and burlapped trees and shrubs, Table 3.

The herbaceous perennial crop plants were grouped into categories according to the relative amount of soil visible at crop maturity, August 1999. An estimated strength value was assigned to each category as a method of inferring crop resistance to these new weeds or weed strength against crops that are occasionally weedy themselves, Table 4. Category 1 plants had 75% or more soil visible and were considered weakly resistant to weed invasion while category 5 plants filled the pots, had less than 5% soil visible and were considered strongly resistant to weed infestation.

The ability of novel weedy plants to infest crops by categories varied with the weed and the category; many of these new cw were able to infest pots despite lack of visible soil, Table 5.

Herbicide use suppressed the development of cw principally by delaying the infestation of host plants until later in the season. Each of the herbicides commonly used by these nurseries effectively prevented cw in both sale and stock plants for 8-12 weeks depending on the compound. Little carryover past their expected duration occurred and rapid movement of cw followed the decline of herbicidal activity, Table 6.

CONCLUSIONS:

Of the many new cultivars and species available to the nursery trade in recent years, nine plants exhibit tendencies that would classify them as weeds and potentially classify them as invasive weeds. Often, these plants demonstrated more than one reproductive morphology; these usually occurred simultaneously during the same and/or several season(s). These plants exhibited rapid spread across the nursery and were capable of infesting plants in hundreds of square feet to several acres. These novel weeds appeared in a wide variety of herbaceous perennials, containerized, B&B trees and shrubs, annual flats and jumbo annual pots. The most invasive of these plants infested plants in pots whose soil availabilities ranged from little or none to nearly all of the pot area and none of these cw appeared inhibited by or restricted from pots containing any particular species. The mechanisms of crop stress and occasional crop loss incited by cw are undetermined; several possibilities include: physical crowding, induction of nutrient deficiencies, induction of water stress, contaminating pathologies or entomologies or alleleopathy.

Table 1: Identification, morphological characteristics and season of dispersal of novel crop plants exhibiting invasiveness, the first 10 of which are ranked by importance in 1999.

Crop plants with apparent weed tendencies			
Identification: Genus, species	Common name	Morphology of dispersal	Season of dispersal
Ixeris dentata	var stolonifera	rhizomes, stolons, seeds	all season, dormant[2]
Viola koreana	Korean violet 'Stylettas'	seeds, stolons, plantlets	all season, dormant
Viola labradorica	Labrador violet	seeds, stolons	late summer, autumn
Oxalis acetostella	Wood oxalis	seeds	spring, summer, autumn
Trifolium tricolor	Tricolor clover	seeds, stolons	summer, autumn
Sedum reflexum	Reflexed sedum	leaves, plantlets	all season, dormant
Hieracium pilosella	Downy hawksweed	stolons	summer, autumn
Lysimachia ciliata	Downey loosestrife	rhizomes	summer, autumn
L. ciliata atropurpurea	Purple downey loosestrife	rhizomes	summer, autumn
Rumex sangineus	Bloody dock	seeds	summer, autumn, spring
Ajuga reptans	'Metallic crispa', others	stolons	all season
Aster novae-belgii	'Professor Kippenberg'	rhizomes	spring, summer, autumn
Aster novae-belgii	'Melba'	rhizomes	spring, summer, autumn
Convallaria majalis rosea	Pink lily of the valley	rhizomes, pips	all season
Coreopsis rosea	Pink Tickseed	rhizomes, seeds	spring, summer, autumn
Darmera peltata	Umbrella plant	rhizomes, seeds	spring, summer
Dennstaedtia puntiloba	Hay secented fern	rhizomes	all season
Deschampsia cespitosa	'Gold veil' tussockgrass	stolons. seeds	summer
Epimedium rubrum	Barrenwort	rhizomes, seeds	summer, autumn
Eymus arenarius glaucus	Lyme grass	rhizomes, seeds	all season
Euphorbia dulcis	'Chameleon' spurge	rhizomes, seeds	summer, autumn
Gypsophila ceratastoides	Mouseear baby breath	seeds, stolons	summer
Hippocrepsis comosa	Horseshoe Vetch	rhizomes, seeds, rooted stems	summer, autumn
Lamiastrum galeobdolon	'Hermans Pride'	stolons	summer, autumn
Lamium maculatum	'Pink Pewter' Dead nettle	stolons, seeds	summer, autumn
Liriope spicata	Lily turf	rhizomes	summer
Lysimachia numm. aurea	Golden moneywort	stolons, plantlets	summer, autumn
Macleaya microcarpa	'Kelways' coral plume	rhizomes, seeds	all season
Monarda didyma	'Claire Grace'	rhizomes	all season
Oenothera rosea	Pink sundrops	seeds	all season
Pachysandra terminals	'Green sheen, silver edge'	rhizomes	summer, autumn
Panicum virgatum	'Heavy metal' switch grass	rhizomes, seeds	summer, autumn
Petasites japonicus	Butterbur	rhizomes,seeds	summer, autumn
Phalaris arundinacea	'Feesey's' Ribbon Grass	rhizomes	all season

Physostegia viginiana	variegata	rhizomes	all season
Polygonatum multiflorum	variegatum var sol seal	rhizomes	all season
Sanguinaria canadensis	Bloodroot	rhizomes	all season
Sanguisorba obtusa	Japanese burnet	seeds	summer
Sedum acre	Golden sedum	leaves, stems, plantlets	summer, autumn
Sedum minus	Tiny sedum	leaves, plantlets	all season
Sedum reptans, stolonifera	Creeping sedum	leaves, stems, plantlets	all season, dormant
Silphium perfoliatum	Cup plant, rosinweed	rhizomes, seeds	summer, autumn
Solidago rugosa	'Fireworks'	rhizomes, seeds	all season
Stylophorum diphyllum	Celandine poppy	rhizomes, seeds	spring, summer, autumn
Symphytum grandiflorum	Comfrey	rhizomes, seeds	spring,sutumn
Tiarella cordifolia	'Running Tapestry'	stolons	all season
Tiarella cordifolia	'Slick Rock'	stolons	all season
Veronica pectinata	Comb speedwell	stolons	spring, autumn
Veronica spicata	'Waterperry'	stolons	spring, sutumn
Vinca minor	variegated 'Ralph Shugert'	stolons	all season

[1] Capable of infesting host plants when host plants are fully dormant; weed may or may not exhibit season of dormancy

Table 2: The occurrence within and relative distance crop weeds traveled during a single season:[3]

Species:	Numbers of infested plants found at a given distance (feet, acres): Less than 50 ft	50-100ft	100-200ft	1-2acre	2-5acre
Ixeris dentata	556	478	306	88	56
Viola koreana	343	201	106	51	42
Viola labradorica	247	198	142	29	12
Oxalis acetostella	301	228	216	60	31
Trifolium tricolor	108	56	43	28	3
Sedum reflexum	228	217	209	187	96
Hieraceum pilosella	18	9	6	0	0
Lysimachia ciliata p.	46	18	4	0	0
Rumex sanginea	208	156	98	12	0

[3] The numbers of plants infested in a linear measure, independent of host plant species or genera.

Table 3: The numbers of crop weeds encountered in stock plants grouped by plant association.

Crop weed:	Numbers of cw found per category of crop plant: Herb. per.	Woody trees	Woody shrubs	Annuals(flats)[4]	Annuals (2" pot)
Ixeris dentata	1,504	233	163	43	1,040
Viola koreana	743	176	192	12	1,018
Viola labradorica	628	143	190	0	1,021
Oxalis acetostella	736	191	208	63	1,109

Trifolium tricolor	232	26	62	0	18
Sedum reflexum	933	209	178	13	1,036
Hieraceum pilosella	33	4	16	0	0
Lysimachia ciliata p.	68	14	19	0	0
Rumex sanginea	474	106	109	0	6
Total plants available:	25,000	2,500	2,500	25,000	20,000

[4] Majority of annual flats had sold prior to weed movement or seed disperal

Table 4: Categorizing host plant strength as a function of pot coverage and soil visibility

Category:	Criteria:	Strength	Examples:
Category 1:	75-95%	1	Hemerocallis, Iris, Lupinus, Hosta, Lilium, Delphinium, Eupatorium
Category 2:	50-75%	2	Campanula, Geranium, Euphorbia, Stokesia, Columbine, Helenium, Malva
Category 3:	25-50%	3	Veronica, Salvia, Erica, Calluna, Heuchera, Calmagrostis, Festuca
Category 4:	5-25%	4	Asters, Ground covers, Sedum, Symphytum, Pennisetum, Galium
Category 5a:	-5%	5a	Monarda, Physostegia, Solidago, Phalaris, Lysamachia, Vinca, Aguja
Category 5b:	-5%	5b	Epimedium, Tiarella, Waldensteina, Lamium, Solomon Seal, Chrysagonum

Table 5: Invasive potential of CW as a function of host plant category:

	Numbers of plants per strength category infested with crop weeds					
Crop Weeds:	1:	2:	3:	4:	5a:	5b:
Ixeris dentata	86	72	48	50	56	32
Viola koreana	72	56	52	56	39	38
Viola labradorica	82	85	60	56	52	48
Oxalis acetostella	53	62	49	53	61	49
Trifolium tricolor	28	16	9	11	6	3
Sedum reflexum	90	78	63	66	69	58
Hieraceum pilosella	16	6	3	0	0	0
Lysimachia ciliata p.	28	4	0	0	0	0
Rumex sanginea	66	48	49	39	25	18
Total plants available:	3,500	3,500	3,000	3,000	2,500	2,000

Table 6: The number of cw found in herbicide treated crop plants 6 and 16 weeks after treatment(wat):

	Number of cw plants counted per herbicide treatment made to mixed perennials									
	Gallery		Dacthal		Preen		Scotts OH2		Rout	
Crop Weed:	6wat	16wat	6wat	16wat	6wat	16wat	6wat	16wat	6wat	16wat
Ixeris dentata	2	98	4	96	3	100	3	86	0	58
Viola koreana	4	86	12	92	5	98	3	81	2	62
Viola labradorica	16	92	31	100	6	97	4	82	3	68
Oxalis acetostella	21	100	3	100	11	100	5	100	4	100

Trifolium tricolor	0	18	0	26	0	21	0	11	0	14
Sedum reflexum	28	122	11	100	23	100	3	100	8	92
Hieraceum pilosella	0	0	0	4	0	6	0	12	0	9
Lysimachia ciliata p.	0	2	0	5	0	8	0	9	0	8
Rumex sanginea	0	76	0	62	0	58	0	49	0	48
Total plants available:	100	100	100	100	100	100	100	100	100	100

Appendix 1: Identification, morphological characteristics and season of dispersal of familiar herbaceous perennials exhibiting weediness and industry-recognized invasiveness.

Crop plants with commonly recognized weed tendencies

Identification: Genus, species	Common name	Morphology of dispersal	Season of dispersal
Aegopodium podagraria	Goutweed	rhizomes	all season
Ajuga reptans	Bugleweed, many cvs	stolons, seeds	all season
Artemisia sps.	Silver king, queen	rhizomes, seeds	summer, autumn
Cerastium tomentosum	Snow in summer	stolons, stems	summer
Cephalaria gigantea	Giant scabious	seeds, rhizomes	summer, autumn
Convallaria majalis	Lily of the valley	rhizomes, pips	all season
Epimedium versicolor	Sulphur bishops hat	rhizomes	summer, autumn
Euphorbia epithymoides	Cushion spurge	seeds	summer, autumn
Euphorbia myrsintes	Myrtle leaved spurge	rhizomes, seeds	summer, autumn
Euphorbia cyparassis	Poor mans evergreen	rhizomes, seeds	summer, autumn
Geranium endressii	Wargrave pink	rhizomes, seeds	summer, autumn
Geranium macrorrhizum	Spessart	rhizomes, seeds	spring, summer, autumn
Hedera helix	Baltic ivy	rooted stems	summer, autumn
Hemerocallis flava	Lemon lily	stolons, daughter plants	summer, autumn
Hemerocallis fulva	Roadside orange daylily	stolons, daughter plants	all season
Lamiastrum galeobdolon	Golden archangel	stolons, rooted stems	summer, autumn
Lysamachia clethroides	Gooseneck loosestrife	rhizomes, seeds	all season
Macleaya cordata	Plume poppy	rhizomes, seeds	spring, summer, autumn
Monarda didyma	Cambridge Scarlet	rhizomes	all season
Oenothera fruticosa	Evening Primrose	rhizomes, seeds	summer, autumn
Pachysandra terminalis	Japanese Spurge	rhizomes, rooted stems	spring, summer, autumn
Phlox subulata	Moss pink	rhizomes, seeds	spring, summer, autumn
Physostegia virginiana	Obedient plant	rhizomes, seeds	all season
Sanguisorba canadensis	Canadian burnet	seeds	summer
Solidago sps.	Goldenrod	rhizomes, seeds	spring, summer, autumn
Tiarella cordafolia	Foamflower	stolons, rooted stems	summer, autumn
Vinca minor	Myrtle	stolons	all season

NUTRIENT REMOVAL BY WEEDS IN CONTAINER NURSERY CROPS

G.M. Penny and J.C. Neal[1]

ABSTRACT

A field study was conducted to determine the nutrient removal from a container substrate by five common nursery weed species: chamberbitter (*Phyllanthus urinaria*), longstalked phyllanthus (*Phyllanthus tennulus*), eclipta (*Eclipta prostrata*), fireweed (*Errechtities hieracifolia*) and garden spurge (*Euphorbia hirta*). One-gallon pots were filled with a bark:sand substrate (6:1 v:v), amended with 2.2 lb N (in the form of Scotts High N 24-4-8) and 6 lb dolomitic limestone per cubic yard, and uniformly sown with weed seed of each species. Plants were then grown under normal container production conditions for 10 weeks after which plants were destructively harvested, and fresh and dry weights recorded. Eclipta and fireweed had the greatest biomass production. Percent nitrogen on a dry weight basis for chamberbitter, longstalked phyllanthus, eclipta, fireweed, and garden spurge were 2.35%, 1.91%, 1.75%, 1.95% and 1.86% respectively. There were no significant differences in nitrogen and potassium uptake between species with the exception of garden spurge for which nitrogen and potassium uptake was significantly less. Species differed in uptake of phosphorous, as follows eclipta > fireweed = chamberbitter > longstalked phyllanthus > garden spurge. The nitrogen uptake by weed species in this experiment resulted in dollar losses (i.e. losses of applied fertilizer) of $0.85-$1.74 per 1000 pots. In an unreplicated sample of weeds from a commercial nursery it was found that spotted spurge (*Euphorbia maculata*) had a nitrogen uptake of 1.16 lb per 1000 pots, which equates to a dollar loss of approximately $4.09.

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EVALUATIONS OF PENNMULCH, WULPAK AND GEODISK FOR WEED CONTROL IN CONTAINERS

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ABSTRACT

Three studies were conducted to evaluate "mulches" for weed control in container ornamentals. Wulpak^R, pelletized sweepings from the shearing floors of sheep operations, was used as a mulch or as a compressed disk which was shaped to fit the top of the container. PennMulch^R is a pelletized newspaper product, with 1% nitrogen added, that is spread over the top of the medium. Both the Wulpak and PennMulch pellets absorb water and swell to approximately twice their volume. Geodisk^R, is a geotextile disk with a coating of Spinout^R, manufactured to fit different sized containers. In each test, the potting substrate was pine bark + sand (~ 7:1 v/v) amended with fertilizer and lime; weed seed were sown before application of mulches, disks or herbicides.

In the study at Castle Hayne, NC, PennMulch and Geodisk were compared to standard preemergence herbicides. The test was conducted in a randomized complete block design with 4 replications and three pots per species per plot. The PennMulch was applied as a one-half inch deep mulch on top of the medium. The test was initiated on 3/31/99. Approximately 10 weeks after initial treatment, all the weeds were removed and on 6/23/99 the chemical treatments were reapplied. The weed species used in this study were spotted spurge (*Euphorbia maculata*), eclipta (*Eclipta alba),* crabgrass (*Digitaria sanguinalis*), longstalk phyllanthus (*Phyllanthus tennelus*), doveweed (*Murdannia nudiflora*) and hairy bittercress (*Cardamine hirsuta*).

Two tests were conducted at the Horticulture Field Laboratory (HFL) in Raleigh. One test, to compare Geodisk and Wulpak disk, was in a randomized complete block design with 3 treatments and 5, single-pot per species replications. The second test was a comparison of Pennmulch and Wulpak pellets each applied at two depths, 0.25 and 0.5 inch. The test was conduced in a randomized complete block design with 6 treatments and 4 replications, with 3 pots per species per plot. The weed species used in both tests were spotted spurge, longstalk phyllanthus crabgrass, horseweed (*Conyza canadensis*) and common groundsel (*Senecio vulgaris*). Both studies were initiated on 7/13/99.

In the Castle Hayne study, PennMulch and Geodisk controlled bittercress as well as Scotts OH2 (oxyfluorfen + pendimethalin), the chemical check. In early ratings, crabgrass control was good and phyllanthus control was moderate with the mulch and disk treatments but poor in later ratings. At 10 weeks after treatment (WAT), spurge control was excellent by all three methods. Eclipta and doveweed were better controlled by the mulches than by OH2.

In the disk study at HFL, Raleigh, both Geodisk and Wulpak disks controlled horseweed and groundsel. Control of spurge was excellent with the Geodisk and fair with the Wulpak disk. Phyllanthus was not controlled by either disk. At 8WAT control had generally lessened but the pattern of control did not. In the depth of mulch study, groundsel and horseweed were controlled in all mulch treatments, but in the 0.25 inch Pennmulch plots groundsel control dropped to 75% by 12 WAT. Spurge and phyllanthus were controlled by all treatments except PennMulch at 0.25 inch. Only Wulpak at 0.5 inch controlled crabgrass.

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CONTROL OF *POA ANNUA* FROM MULTIPLE SEASONAL APPLICATIONS OF ETHOFUMESATE IN 1998 AND 1999

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

ABSTRACT

Two of the studies were conducted during 1998 using multiple applications of ethofumesate throughout the season for the control of *Poa annua*. One study was conducted at the State College Elks Country Club, Boalsburg, PA on a mature stand of *Poa annua* and perennial ryegrass (#13 fairway). The other study in 1998 was conducted at the Valentine Turfgrass Research Center, University Park, Pa on a mature stand of *Poa annua* and creeping bentgrass (simulated fairway). In 1999, a similar study was conducted on a mixed stand of creeping bentgrass ('Penncross') and *Poa annua* at the Valentine Turfgrass Research Center, Penn State University, University Park, Pa. The study at the Elks Country Club was a randomized complete block design with 3 replications. Treatments (ethofumesate 1.5EC at 0.25, 0.5, 0.75, 1.0 lbs ai/A) were applied on June 8, 1998 and were reapplied every 21 days until September 18, 1998 using a three-foot hand held CO_2 powered boom sprayer with two 6504 flat fan nozzles calibrated to deliver 40 GPA at 30 psi. In addition, a separate area was treated using ethofumesate 1.5EC at a rate of 0.75 lb ai/A on Sept 30, Oct 27 and Nov 19, 1998 using the afore mentioned equipment and application methods. This area was treated to provide a comparison for control resulting from a more conventional timing of application. The second study in 1998 conducted at the Valentine Center was a randomized complete block design with 3 replications. Treatments (ethofumesate 1.5EC at 0.25, 0.5, 0.75, 1.0 lbs ai/A) were applied on April 23, 1998 and were reapplied every 21 days until September 18, 1998 using a three-foot hand held CO_2 powered boom sprayer with two 6504 flat fan nozzles calibrated to deliver 40 GPA at 30 psi. Again a reference area was treated using ethofumesate 1.5EC at a rate of 0.75 lb ai/A on Sept 30, Oct 27 and Nov 19, 1998 using the afore mentioned equipment and application methods. The 1999 study at the Valentine Center was a randomized complete block design with three replications. All of the treatments (ethofumesate 1.5EC at 0.75, 1.0, 1.5 lbs ai/A) were applied on April 15, and May 12, 1999 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi. Sequential applications of all treatments except Turf Enhancer were made on June 9, and 30, July 21, Aug 11, Sept 1 and Oct 1, 1999 using the afor mentioned application technique. Results form the Elks Country Club study showed that the lowest rate of ethofumesate tended to increase the amount of *Poa annua* from June 6, 1998 until May 5, 1999. The 0.75 lb ai/A rate appeared to have no effect, while the high rate (1.0 lb ai/A) tended to cause a slight decrease in the amount of *Poa annua* The fall application of 0.75 lb ai/A applied three times (September, October, and November) resulted in a substantial reduction in *Poa annua* when compared to the lower rate, sequential seasonal applications. In the 1998 study at the Valentine Center, control of *Poa annua* was evaluated approximately one year after treatments were initiated. In all cases, including the control, the amount of *Poa annua* in the plots increased. Ethofumesate applied at 1.0 lb ai/A and ethofumesate at 0.25 lb ai/A in combination with Primo at 0.25 lb ai/A resulted in a significant increase in the amount of *Poa annua* compared to untreated turf. As in the study at the Elks

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Country Club, the fall applications (three times at 0.75 lb ai/A) used as a reference reduced *Poa annua* by 92%. Results from the 1999 study at the Valentine Center showed that increasing the rate of ethofumesate to 1.5 lb ai/A for each application did not improve control. Ethofumesate applied eight times at 0.75 lbs ai/A resulted in a 64% reduction in *Poa annua* from May 5 to the Aug 31 rating date. Additions of urea and Sprint tended to reduce (antagonize) control at all rates.

ANNUAL BLUEGRASS (*Poa annua*) CONTROL WITH ETHOFUMESATE

S.E. Hart and D.W. Lycan[1]

ABSTRACT

Field Experiments were conducted in 1999 at the Rutgers University Experimental Horticultural Farm II in New Brunswick NJ and the Little Mill Country Club in Marlton NJ to evaluate spring and summer applications of ethofumesate for control of annual bluegrass in bentgrass fairways maintained at a mowing height of 9 mm. At Horticultural Farm II the turf was colonial bentgrass (*Agrostis tenuis)* variety 'SR 7100' infested with approximately 40% *P. annua* while the turf at Little Mill was a mixture of unknown varieties of creeping bentgrass (Agrostis palustris) and perennial ryegrass (*Lolium perenne)* infested with approximately 60% *P. annua.* Ethofumesate applications were initiated on April 5 and applied 8 times at approximately 3-week intervals throughout the spring and summer. Ethofumesate was applied four times at 1.7, 1.1 or 0.8 kg ai/h followed by four applications at 0.8, 0.6 or 0.4 kg/h, respectively. All ethofumesate applications were applied with 4.8 kg/h of urea and 9.1 kg/h iron chelate. One application of paclobutrazol at 0.6 kg/h applied late April was also evaluated for control of *P. annua.* All herbicide applications were applied with a CO_2 backpack sprayer delivering 740 L/ha.

Ethofumesate applied twice at 1.7, 1.1, or 0.8 kg/h provided 59, 62-82 and 80-83% *P. annua* seedhead suppression as compared to untreated plots on May 20th. Prior to the onset of high summer temperatures, three applications of ethofumesate at 1.7, 1.1, or 0.8 kg/h reduced *P. annua* populations at Horticultural farm II from 38 to 22, 16 and 20%, respectively. However, injury to bentgrass was 25, 15, and 5%, respectively. Paclobutrazol reduced *P. annua* populations to 26% with no bentgrass injury. At Little Mill three applications of ethofumesate at 1.7, 1.1, or 0.8 kg/h reduced *P. annua* populations from 62 to 16, 23 and 32%, respectively. However, injury to bentgrass was 55, 53, and 33%, respectively. Paclobutrazol reduced *P. annua* populations to 34% with no bentgrass injury. Throughout the summer *P. annua* populations declined in the untreated plots due to summer heat stress but appreciable increases in *P. annua* control were not detected with additional applications of ethofumesate while bentgrass turf quality continued to be lower as compared with untreated or paclobutrazol treated bentgrass. In September, following all eight applications of ethofumesate, *P. annua* populations were only significantly lower then untreated plots at Little Mill when ethofumesate was applied at the highest application rates.

The results of these studies suggest that spring applications of ethofumesate may potentially provide seedhead suppression and substantial population reductions of *P. annua.* However, summer application of ethofumesate could not further reduce *P. annua* populations and continued to cause unacceptable injury to bentgrass. The vigor reduction of bentgrass may have allowed *P. annua* to more easily reinfest the ethofumesate treated plots in late summer.

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ETHOFUMESATE RESISTANT CREEPING BENTGRASS?

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

ABSTRACT

In November of 1993, a patch of creeping bentgrass growing in a golf course fairway that had been subject to a total of twelve applications of ethofumesate at 0.5 lbs ai/A from 1989 to 1993 was sampled for identification and plant increase purposes. Twelve three-quarter inch plugs were removed from the patch and were transferred to a greenhouse and potted in four-inch pots. A positive identification for creeping bentgrass was made and the plugs were grown in the pots until September of 1994. At that time, a portion of the bentgrass in each pot was transferred to a flat and allowed to increase as was the turf that remained in the pot. Another portion from each pot was planted in the field to assess seed production potential. By March of 1995, the pots had filled in and a phytotoxicity study was conducted using rates of ethofumesate that ranged from 1.5 to 12.5 lbs ai/A from a single application. No phytotoxicity was observed. In April of 1996, the bentgrass in the flats was harvested by cutting stolons (with three to four nodes) with a shears and placing them in water. After all the flats were harvested, the stolons were transferred to the Valentine Research Center where an eight hundred square foot area was stolonized using the harvested material. Later in 1996, the first seed was harvested from plants space planted in 1994. This seed was used to establish twelve (one for each original flat) plots in an area adjacent to the sprigged plot. In October of 1996, a phytotoxicity experiment was conducted on the sprigged plots. Ethofumesate was applied in October and twice in November at rates ranging from 1 to 4 lbs ai/A for each application. Phytotoxicity was rated in the spring of 1997 and none was found. Also in 1997, more plot area was established using stolons for one area and a blend of the seed from all twelve sources (each pot) for the other area. Research on this area, which contains plots of five other creeping bentgrasses (all commercially available) and locally produced annual bluegrass is under the direction of Dr. David Huff, Penn State's turfgrass breeder. Experiments are currently under way to further document the degree of apparent resistance that the selected creeping bentgrass possesses. In addition, research will be conducted soon to ascertain whether the observed resistance/tolerance has a genetic basis that could be transferable.

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LATERAL DEVELOPMENT OF PLANT GROWTH REGULATOR TREATED 'TIFWAY' BERMUDAGRASS

M.J. Fagerness and F.H. Yelverton[1]

ABSTRACT

The ability of plant growth regulators (PGRs), such as trinexapac-ethyl (TE) and paclobutrazol (PB), to suppress shoot biomass production and enhance shoot density in 'Tifway' bermudagrass [*Cynodon dactylon* (L.) Pers. x *Cynodon transvaalensis* (Burtt-Davy)] has been documented. However, determination of how PGRs affect lateral development of this species remains a necessity for complete understanding of how they affect growth and development. Research was conducted in a greenhouse over two years to investigate how various application patterns of either TE or PB affect both basic growth and lateral development patterns in established 'Tifway' bermudagrass. 10-cm sod cores were established in 23-cm pots and were maintained at a 1.9 cm cutting height. All pots were subirrigated and were fertilized at 49 kg N/ha/month. Trinexapac-ethyl and PB were applied once, twice, or three times during the experiment at 0.11 and 0.56 kg a.i./ha, respectively. Both TE and PB inhibited shoot biomass production. Paclobutrazol, especially applied two or three times, had the greatest effect on this measured parameter. Post inhibition growth enhancement (PIGE) was evidenced for both PGRs and was most pronounced when sequential applications were minimized. Shoot density was enhanced by either PGR. However, the duration of such enhancements by TE was dependent upon sequential applications while this dependency did not exist for PB. Stolon length was unaffected by TE in either year of the experiment. PB significantly reduced stolon length in both years; this suppressive effect was dependent upon sequential applications in 1998 but not in 1999. PB was the only PGR that affected stolon numbers emerging from the sod core. However, this effect, characterized by reductions in stolon number, was dependent upon sequential applications of PB. Three applications of PB resulted in a two-fold increase in overall sod core areas in 1998 while maximum such increases with TE were 30-40%. The three-application regime with PB did not produce the same effects in 1999. However, core area was maximized in 1999 in pots treated with one or two applications of PB. The stronger suppressive effect of PB on 'Tifway' bermudagrass growth did not relate to decreased core area in this experiment. It is believed that strong suppression of stolon length with PB results in more rapid incorporation of these tissues into the perceived canopy. The absence of TE effects on stolon length affected the overall outward development of TE treated cores. However, enhancements of measurable shoot density may have accounted for slight increases in TE treated cores. Results suggest that PGRs may help facilitate 'Tifway' bermudagrass establishment. However, the suppressive and persistent effects of PB may necessitate higher sprig planting densities to maximize the utility of this PGR.

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TRINEXAPAC-ETHYL EFFECTS ON THATCH DEVELOPMENT AND MOWING QUALITY OF 'TIFWAY' BERMUDAGRASS

M.J. Fagerness and F.H. Yelverton[1]

ABSTRACT

Recent observations of reduced mowing injury in trinexapac-ethyl (TE) treated 'Tifway' bermudagrass [*Cynodon dactylon* (L.) Pers. x *Cynodon transvaalensis* (Burtt-Davy)] produced the hypothesis that, in addition to canopy height reduction, TE may affect the development of thatch in this species. Research was conducted at two locations in North Carolina in summer 1999 to investigate how various seasonal application patterns of TE affected thatch layer development in established 'Tifway' bermudagrass over the course of the growing season. TE was applied once, twice, or three times during the growing season at 0.11 kg a.i./ha. Physical development of the thatch layer was quantified through measurements of thatch depth and thatch biomass while mowing quality was assessed using subjective visual quality measurements and quantification of both shoot density and the percentage of verdure which was green tissue. Additional assessment of mowing quality was achieved through acquisition and comparative analysis of digital images. All measurements were conducted at biweekly intervals, beginning at the time TE was initially applied. While thatch development parameters did vary with location, results showed that neither thatch depth not thatch biomass were appreciably affected by TE at either location, especially later in the growing season when chronic effects of TE might be most evident. However, patterns of visual quality and shoot density did favor areas treated with TE, illustrating that a) assessment of turfgrass quality is influenced by shoot density and b) reduced canopy heights in TE treated areas, coupled with increased shoot density, may serve to buffer 'Tifway' bermudagrass from mowing injury. Additionally, measurements of the percentage of verdure composed of green shoot material favored TE treated areas, especially earlier in the growing season. This pattern diminished towards the end of the growing season, as did patterns of TE enhanced shoot density and visual quality. The absence of dramatic differences among plots inhibited the utility of digital image analysis for quantifying mowing quality but identified trends showed TE treated turf to be of higher mowing quality. Overall, results suggested that TE effects on canopy development in 'Tifway' bermudagrass can have a significant impact on mowing quality while development of the thatch layer was unaffected by TE and seemed of limited importance to mowing quality.

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RE-ROOTING OF FOUR VARIETIES OF CREEPING BENTGRASS AFTER APPLICATIONS OF BENSULIDE AND DITHIOPYR

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

INTRODUCTION

This study was conducted at Penn State University, University Park, Pa in the greenhouse at the Agricultural Sciences and Industries Building to evaluate the re-rooting of 'Penncross', 'Seaside', 'Penneagle' and 'Pennlinks' creeping bentgrasses. Applications of bensulide and dithiopyr were applied to the bentgrasses for two growing seasons. Samples were taken the spring following the two years of applications for the assessment of re-rooting.

METHODS AND MATERIALS

This experiment was a completely random design with nine replications. On Feb. 27, 1999, two-inch diameter plugs were collected from the plots in the field that received the herbicide applications. The soil was removed to a depth of 0.5 inch. The plugs were then planted in a sand medium in four-inch pots in a greenhouse.

Bensulide and dithiopyr were applied during two of the three previous growing seasons. All treatments were applied on May 3, 1996 and, with exception of dithiopyr again on May 30, and Aug 26, in 1996. In 1998, all treatments were applied on April 16 and with exception of dithiopyr again on May 20, and Aug 19. All applications were applied using a three-foot hand held CO_2 powered boom sprayer with two 6504 flat fan nozzles calibrated to deliver 80 GPA at 30 psi. After each application the test site received approximately 0.5 inch of water.

RESULTS AND DISCUSSION

Color (phytotoxicity) was rated on five consecutive days in March after the plugs were placed in the greenhouse (Table 1). No differences were found in color regardless of treatment during the five day 'green-up' phase of the experiment. On March 18, topgrowth was harvested and fresh weights of clippings was recorded (Table 2). No significant differences or trends were found among the treatments. On March 23, roots were harvested, dried, and weighed as a means of assessing re-rooting. No significant differences in re-rooting were found for Penncross, Seaside or Pennlinks varieties. However, Penneagle that had been treated in 1996 and 1998 at the high rate (40, 30, and 30 pts/A) had significantly reduced re-rooting compared to untreated Penneagle. Dithiopyr was not found to cause any significant decrease in re-rooting on any of the varieties when applied at the label rate (0.5 lbs ai/A) with a spring (April) application.

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Table 1. Phytotoxicity ratings taken in 1999 on a scale of 1-10 where 1 = brown, 7 = acceptable and 10 = dark green.

Treatment	Form	Rate (pt/a)	Timing	3-2	3-3	3-4	3-5	3-6
			Penncross creeping bentgrass					
BENSULIDE	4L	20	April	8.6a[1]	9.1a	9.3a	9.2a	9.2a
BENSULIDE	4L	15	May					
BENSULIDE	4L	15	Aug					
BENSULIDE	4L	40	April	8.4a	9.1a	9.2a	9.1ab	9.1a
BENSULIDE	4L	30	May					
BENSULIDE	4L	30	Aug					
DITHIOPYR	1EC	0.5 lb ai/A	April	8.5a	9.1a	8.9ab	8.9ab	8.9a
CHECK				8.4a	8.9a	9.1a	9.0ab	8.9a
			Seaside creeping bentgrass					
BENSULIDE	4L	20	April	8.5a	9.0a	9.1a	9.0ab	9.0a
BENSULIDE	4L	15	May					
BENSULIDE	4L	15	Aug					
BENSULIDE	4L	40	April	8.6a	9.0a	9.2a	8.9ab	8.9a
BENSULIDE	4L	30	May					
BENSULIDE	4L	30	Aug					
DITHIOPYR	1EC	0.5 lb ai/A	April	8.2a	8.8a	9.1a	8.9ab	8.8a
CHECK				8.5a	9.1a	9.1a	8.9ab	9.0a
			Penneagle creeping bentgrass					
BENSULIDE	4L	20	April	8.5a	8.8a	9.0a	8.8ab	8.9a
BENSULIDE	4L	15	May					
BENSULIDE	4L	15	Aug					
BENSULIDE	4L	40	April	8.5a	9.0a	9.1a	8.9ab	9.0a
BENSULIDE	4L	30	May					
BENSULIDE	4L	30	Aug					
DITHIOPYR	1EC	0.5 lb ai/A	April	8.6a	8.9a	9.2a	8.8ab	9.1a
CHECK				8.4a	8.7a	8.9ab	8.8ab	9.0a
			Pennlinks creeping bentgrass					
BENSULIDE	4L	20	April	8.6a	9.1a	9.2a	9.0ab	9.1a
BENSULIDE	4L	15	May					
BENSULIDE	4L	15	Aug					
BENSULIDE	4L	40	April	8.6a	9.0a	9.1a	9.0ab	9.0a
BENSULIDE	4L	30	May					
BENSULIDE	4L	30	Aug					
DITHIOPYR	1EC	0.5 lb ai/A	April	8.5a	8.8a	9.1a	8.7b	9.0a
CHECK				8.7a	9.0a	9.2a	9.1ab	9.0a

1 – Means followed by the same letter do not significantly differ (P = 0.05, Duncan's New MRT).

Table 2. Top growth weights (fresh) and root weights (dry) in grams.

Treatment	Form	Rate (pt/a)	Timing	Top growth 3-18	Root 3-23
			Penncross creeping bentgrass		
BENSULIDE	4L	20	April	2.94a[1]	0.21ab
BENSULIDE	4L	15	May		
BENSULIDE	4L	15	Aug		
BENSULIDE	4L	40	April	2.64a	0.17ab
BENSULIDE	4L	30	May		
BENSULIDE	4L	30	Aug		
DITHIOPYR	1EC	0.5 lb ai/A	April	2.32a	0.15ab
CHECK				2.65a	0.23ab
			Seaside creeping bentgrass		
BENSULIDE	4L	20	April	2.59a	0.19ab
BENSULIDE	4L	15	May		
BENSULIDE	4L	15	Aug		
BENSULIDE	4L	40	April	2.58a	0.19ab
BENSULIDE	4L	30	May		
BENSULIDE	4L	30	Aug		
DITHIOPYR	1EC	0.5 lb ai/A	April	2.59a	0.21ab
CHECK				2.36a	0.17ab
			Penneagle creeping bentgrass		
BENSULIDE	4L	20	April	2.55a	0.23ab
BENSULIDE	4L	15	May		
BENSULIDE	4L	15	Aug		
BENSULIDE	4L	40	April	2.55a	0.14b
BENSULIDE	4L	30	May		
BENSULIDE	4L	30	Aug		
DITHIOPYR	1EC	0.5 lb ai/A	April	2.72a	0.25ab
CHECK				2.45a	0.25a
			Pennlinks creeping bentgrass		
BENSULIDE	4L	20	April	2.58a	0.17ab
BENSULIDE	4L	15	May		
BENSULIDE	4L	15	Aug		
BENSULIDE	4L	40	April	2.67a	0.19ab
BENSULIDE	4L	30	May		
BENSULIDE	4L	30	Aug		
DITHIOPYR	1EC	0.5 lb ai/A	April	2.55a	0.21ab
CHECK				2.47a	0.24ab

1 – Means followed by the same letter do not significantly differ (P = 0.05, Duncan's New MRT).

BROADLEAF WEED CONTROL IN 1999

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

ABSTRACT

This study was conducted on a mature stand of perennial ryegrass at the Landscape Management Research Center, Penn State University, University Park, Pa. The objective of the study was to determine the efficacy of broadleaf weed herbicides when applied in early and late summer for control of dandelion, common plantain, and white clover.

This study was a randomized complete block design with three replications. All of the treatments were applied on June 7 and August 31, 1999 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi. Control of the weeds was rated on August 9 and Oct 6, 1999. The treatments were: L-0337, L-0338, Dive, Drive and Momentum, NB20332, NB30401, NB30402, NB30403, NB20334, NB30405, Trimec Classic, Confront, Momentum, Weed-B-Gone, Acclaim Extra and Confront, Preclaim and Confront.

Applications of the commercial standards Momentum, Trimec Classic, Confront, and Weed-B-Gone resulted in very good to excellent control of white clover and common plantain however, all of the standards had relatively poor control of dandelion when rated on Aug 9. Observation of the dandelions 4 to 6-weeks after application revealed apparent good control. However, by the eight-week rating date, many of the dandelions had resprouted from the taproot. All of the treatments had some level of control of common plantain and white clover, but all had limited control of dandelion. Of the series, NB20334 appeared to have best range of control across the three weed species but still not acceptable on dandelion. The addition of Acclaim Extra to Confront did not appear to antagonize efficacy as Acclaim or Preclaim. Drive provided excellent control of white clover by itself. Combining Drive with Momentum (L0338) improved common plantain control slightly. Tank mixing Drive and Momentum resulted in improved dandelion control compared to Momentum alone, but the control of white clover was decreased. All treatments were reapplied on Aug 31 and a second rating for control was made on Oct 6. All treatments provided acceptable dandelion control except NB30405, and the combination of Preclaim and Confront. All treatments provided acceptable plantain control except L-0337 (Drive G) Drive. Only NB30405 failed to provide acceptable control of white clover.

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CONTROL OF DALLISGRASS IN COOL SEASON TURF

C. E. Jentes[1], R. D. Bullock[2], D. W. Williams[3], J.B. Breuninger[4], and R.B. Cooper[5]

ABSTRACT

Experiments were conducted in Missouri, Kentucky and Tennessee in 1998 and 1999 to test the efficacy of triclopyr in controlling dallisgrass (Paspalum dilatatum). This research was based on 1997 observations by Bullock in Tennessee. Tests conducted in 1998 were initiated to confirm the activity and identify the best formulation and application method. Natural infestations of dallisgrass in cool season turfgrasses were sprayed using a CO_2 backpack sprayer. Results from 1998 confirmed the effectiveness of triclopyr (Turflon Ester) in controlling dallisgrass with greater than 80% control 10 weeks after treatment (WAT). In 1999, application timing and tankmix partners weretested. Results in 1999 showed that repeat applications of Turflon Ester two weeks apart beginning in June after dallisgrass approached full greenup provided 100% control of dallisgrass 6 WAT. Turflon Ester at the rate of 1.0 lb. ai/A provided the most consistent control over the testing period, and sequential applications produced nearly 100% control in the first season of use. No injury was observed on tall fescue however transient injury was observed when Kentucky bluegrass was treated in the summer with high rates of triclopyr.

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RESPONSE OF KENTUCKY BLUEGRASS AND PERENNIAL RYEGRASS TO THE APPLICATIONS OF ETHEPHON UNDER REDUCED LIGHT CONDITIONS

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INTRODUCTION

Little is known about the effects that ethephon might have on the turf quality of perennial ryegrass and Kentucky bluegrass grown under different levels of shade. Six studies were conducted on a mature stand of perennial ryegrass (three studies) and Kentucky bluegrass (three studies) at the Landscape Management Research Center, Penn State University, University Park, Pa. The objective of the studies was to determine whether ethephon treated turf would have improved quality under varying levels of shade.

METHODS AND MATERIALS

Each study was a randomized complete block design with three replications. All of the treatments (ethephon at 3,5, and 10 oz/M) were applied on June 21, 1999 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi.

Each study area was covered with a shade cloth (kept twenty inches above the turf canopy with a wooden rack) to simulate shade. Shade was imposed at three levels (30, 55 and 73 percent light filtering). The racks with shade cloth were removed each week to record data and mow and then returned.

All test sites were maintained at two and one half inches with a rotary mower with clippings removed. The test site was irrigated as needed for the duration of the study. Color ratings were taken approximately every seven days for six weeks. Fresh weights (g) were harvested using a twenty inch rotary mower making one pass per plot on Aug 3.

RESULTS AND DISCUSSION

On July 20, (approximately one month after treatment) the color ratings for Kentucky bluegrass tended to produce a trend whereby a slight increase in color was observed as the rate of ethephon increased from 3 to 10 oz/M across all three levels of shade (Table1). On July 27, Kentucky bluegrass treated with ethephon at the lowest level of shade (30%) had a slightly better color than untreated turf. This trend was not found on the final rating date (Aug 3).\

Kentucky bluegrass shaded at the 55% level tended to have improved color on July 27 compared to untreated turf. By the final rating date (Aug 3) all ethephon treated Kentucky bluegrass was rated below the acceptable level of 7. Only untreated turf was rated as acceptable.

On July 20, Kentucky bluegrass treated with ethephon at the 10 oz/M rate and exposed to 73% shade was rated above the level of acceptably (7). At 73% shade, all treated and untreated

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Kentucky bluegrass was rated to have unacceptable color on the final two rating dates (July 27 and Aug 3).

At the 30% shade level ethephon treated perennial ryegrass color was rated lower than untreated turf but not below the level of acceptability of 7. By July 27 only the perennial ryegrass treated with ethephon at 3 oz/M was rated lower that untreated turf. On the final rating date (Aug 3) all perennial ryegrass (treated and untreated) was rated 8.5 for color.

When perennial ryegrass was subjected to a 55% shade and rated for color only the 5 and 10 oz/M rate of ethephon on July 13 were below that of untreated turf.

On July 13 all ethephon treated perennial ryegrass under 73% shade had color ratings below untreated turf but not below a level of acceptability. On July 27 perennial ryegrass treated at the 3 and 10 oz/M rates of ethephon had poorer color than the untreated perennial ryegrass. By the final rating date (Aug 3) all perennial ryegrass treated with ethephon was rated to have poorer color than untreated turf. Regardless of treatment, the color ratings of the perennial ryegrass was never rated below the acceptable level.

After harvesting fresh weights of perennial ryegrass grown at 55% shade on Aug 3 the untreated turf produced 137.7 grams of clippings which was significantly more than the perennial ryegrass treated at any rate of ethephon (Tables 2 and 3).

More shade/ethephon research should be conducted in the future. Although, some interesting results were found in these studies, the shade canopies should be put in place just after turf green up in the spring and treatments be withheld until the turfgrass is acclimated to the shade environment. The study should then be conducted for the entire growing season.

Table 1. Color ratings of Kentucky bluegrass and perennial ryegrass with varying degrees of shade and rates of ethephon.

Treatment	Form	Rate (oz/M)	Color 6-29	7-6	7-13	7-20	7-27	8-3
Kentucky bluegrass 30 % shade								
CHECK			8.8[1]	8.8	8.5	8.8	7.7	8.5
ETHEPHON	2SL	3	8.8	8.8	8.6	8.9	8.0	8.5
ETHEPHON	2SL	5	8.8	8.8	8.7	8.9	8.2	8.5
ETHEPHON	2SL	10	8.8	8.8	8.8	9.0	8.3	8.5
Kentucky bluegrass 55 % shade								
CHECK			8.8	8.7	8.5	8.8	7.5	7.1
ETHEPHON	2SL	3	8.8	8.7	8.7	8.8	7.9	6.8
ETHEPHON	2SL	5	8.8	8.7	8.8	8.9	8.0	6.7
ETHEPHON	2SL	10	8.8	8.7	8.8	9.0	7.7	6.5
Kentucky bluegrass 73 % shade								
CHECK			8.8	8.7	8.3	6.2	4.8	4.0
ETHEPHON	2SL	3	8.8	8.7	8.3	6.3	5.3	4.4
ETHEPHON	2SL	5	8.8	8.7	8.8	6.8	4.3	4.0
ETHEPHON	2SL	10	8.8	8.7	8.8	7.2	4.0	3.5
Perennial ryegrass 30 % shade								
CHECK			8.8	8.8	8.3	8.5	8.0	8.5
ETHEPHON	2SL	3	8.8	8.8	8.2	8.5	7.9	8.5
ETHEPHON	2SL	5	8.8	8.8	8.2	8.5	8.0	8.5
ETHEPHON	2SL	10	8.8	8.8	8.0	8.5	8.0	8.5
Perennial ryegrass 55 % shade								
CHECK			8.8	8.8	8.7	8.5	8.0	8.5
ETHEPHON	2SL	3	8.8	8.8	8.7	8.5	8.0	8.5
ETHEPHON	2SL	5	8.8	8.8	8.5	8.5	8.0	8.5
ETHEPHON	2SL	10	8.8	8.8	8.6	8.5	8.0	8.5
Perennial ryegrass 73 % shade								
CHECK			8.8	8.8	8.7	8.5	7.8	8.0
ETHEPHON	2SL	3	8.8	8.8	8.6	8.5	7.6	7.5
ETHEPHON	2SL	5	8.8	8.8	8.6	8.5	7.8	7.8
ETHEPHON	2SL	10	8.8	8.8	8.5	8.5	7.5	7.8

1 - Where 0 = brown, 7 = acceptable and 10 = dark green

Table 2. Fresh weight (grams) harvested on Aug 3 from Kentucky bluegrass grown under varying degrees of shade and treated with three rates of ethephon.

Treatment	Form	Rate Oz/M	(——Degree of Shade——) 30	55	73
CHECK			119.0a[1]	195.7a	175.0a
ETHEPHON	2SL	3	142.7a	201.3a	191.0a
ETHEPHON	2SL	5	132.3a	225.7a	178.0a
ETHEPHON	2SL	10	157.3a	232.7a	186.7a

1 - Means followed by same letter in the same column do not significantly differ (P=0.05, Duncan's New MRT).

Table 3. Fresh weight (grams) harvested on Aug 3 from perennial ryegrass grown under varying degrees of shade and treated with three rates of ethephon

Treatment	Form	Rate Oz/M	(——Degree of Shade——) 30	55	73
CHECK			82.3a[1]	137.7a	155.7a
ETHEPHON	2SL	3	89.7a	119.7b	147.7a
ETHEPHON	2SL	5	82.7a	119.7b	150.0a
ETHEPHON	2SL	10	84.0a	121.7b	159.0a

1 - Means followed by same letter in the same column do not significantly differ (P=0.05, Duncan's New MRT).

CREEPING BENTGRASS SEEDLING TOLERANCE TO HERBICIDES AND PACLOBUTRAZOL

J.E. Kaminski and P.H. Dernoeden[1]

ABSTRACT

The tolerance of creeping bentgrass (*Agrostis palustris* Huds.) seedlings to most available herbicides has not been studied in the transition zone climate of the mid-Atlantic region. This type of research is needed due to the increase use of creeping bentgrass as a fairway turf in the region. The primary objectives of this investigation were to determine: 1) bentgrass tolerance to these chemicals when applied at various stages of seedling development; 2) establishment rate; and 3) germination and establishment of new seedlings following treatment of the test site with glyphosate and re-seeding the following spring. The study was initiated on a mature stand of 'Penncross' creeping bentgrass grown on a modified sandy mix with a pH of 6.2. The study area was treated with glyphosate on 14 September 1998. The site was then verticut and seeded with 'Crenshaw' creeping bentgrass at 1.0 lb. seed/1000ft^2 on 21 Sept. 1998. Turf was mowed to a height of 0.60 inches. Treatments were applied two (i.e., 12 October), four (i.e., 28 October), and seven weeks (i.e., 17 November) after seedlings had emerged. Sprayable herbicides were applied in 50gpa with a CO_2 pressurized sprayer equipped with an 8004E nozzle. Siduron 3.1G was applied with a shaker bottle. Plots were evaluated for seedling injury, percent bentgrass coverage, percent bareground, and overall quality between 28 October 1998 and 8 April 1999. To evaluate the potential soil residual of the compounds, the test site was treated with glyphosate on 23 April 1999, and monitored for seedling emergence and establishment (i.e., 20 May to 17 June 1999). The site was verticut and again seeded with Crenshaw on 6 May 1999. Plots measured 5 by 5 ft and were arranged in a randomized complete block design with four replications. Data were subjected to analysis of variance and significantly different means were separated by the least significant difference test (p=0.05).

Test results indicated that caution should be used when applying certain herbicides or paclobutrazol prior to and following the seeding of bentgrass. Data showed that ethofumesate (0.75 lb a.i./A) and paclobutrazol (0.125 lb a.i./A) were too injurious to apply two weeks after seedling emergence. Some reduction in bentgrass cover also occurred when bensulide (7.5 lb a.i./A) and siduron (6.0 lb a.i./A) were applied to seedlings two weeks after emergence. Plots treated with the aforementioned herbicides, however, exhibited acceptable cover before spring. Chlorsulfuron (0.125 lb a.i./A) was extremely phytotoxic to bentgrass seedlings when applied at two or four weeks after emergence. Bensulide (7.5 lb a.i./A), siduron (6.0 lb a.i./A), ethofumesate (0.75 lb a.i./A), and paclobutrazol (0.125 lb a.i./A) were generally safe when applied four weeks after bentgrass emergence. Applying ethofumesate (0.75 lb a.i./A), prodiamine (0.32 lb a.i./A), or ethofumesate + prodiamine (0.75 + 0.32 lb a.i./A) seven weeks after seedling emergence was not injurious. The study site was treated with glyphosate on 23 April 1999 and overseeded 6 May 1999. The soil residual of prodiamine applied on 17 November 1998 caused a significant and commercially unacceptable level of seedling death. No other treatments applied in October or November, 1998 (i.e., ethofumesate alone) caused unacceptable seedling emergence in plots overseeded in May 1999.

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MANAGING FENOXAPROP RESISTANT CRABGRASS IN GOLF COURSE TURF

D.R. Spak[1]

ABSTRACT

Herbicide resistance management has recently become an important consideration in managing turfgrass weeds, particularly annual grassy weeds. The reliance on a limited number of herbicides representing only a few herbicide classes has lead to the development of isolated cases of resistance in weeds such as crabgrass (*Digitaria ischaemum*), goosegrass (*Eleusine indica*), and annual bluegrass (*Poa annua* L.).

Fenoxaprop was first registered in 1985 for postemergence control of smooth crabgrass in cool season turfgrasses. In 1996, the first documented case of crabgrass resistance to fenoxaprop occurred on a golf course tee where fenoxaprop had been used exclusively for more than 12 years. Because no other effective postemergent option was available in creeping bentgrass (*Agrostis palustris*), no other crabgrass or goosegrass herbicides were used during this time. There is a need to develop herbicide resistance management strategies (cultural and chemical) for preventing the development of resistance in summer annual grasses namely crabgrass and goosegrass. In addition, there is also the need to develop strategies to prevent the spread of resistant grasses once resistance has developed.

In 1999, a study was initiated on a golf course tee where fenoxaprop resistance was suspected due to the gradual loss in crabgrass control. The objective was to evaluate various herbicide programs for the controlling both crabgrass and goosegrass. Herbicide treatment programs included the use of tank-mixing preemergence and/or postemergence herbicides with different modes of action. The companion herbicides included bensulide, dithiopyr, and the newly registered herbicide quinclorac, each applied alone or in combination with fenoxaprop early (pre to spike) or mid-postemergence (1-2 tiller).

Results of this study will be discussed and perspectives on managing and preventing resistance to fenoxaprop and other herbicides will be presented.

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POSTEMERGENCE SMOOTH CRABGRASS CONTROL EVALUATIONS IN MARYLAND, 1998 - 1999

P. H. Dernoeden and J.M. Krouse[1]

ABSTRACT

Three studies were conducted to evaluate herbicides for postemergence smooth crabgrass (*Digitaria ischaemum* [Schreb.] Muhl.) control in mature stands of perennial ryegrass (*Lolium perenne*). The objectives of the three studies were as follows: I) to assess Acclaim Extra (fenoxaprop) and Daconate 6 (MSMA) tank-mixes as a possible resistance management strategy for crabgrass; II) to compare the crabgrass control effectiveness of Acclaim Extra and Drive (quinclorac) to PreClaim (fenoxaprop + pendimethalin) applied in early and mid-postemergence application timings; and III) to compare multiple, low rate, application timings of Acclaim, Acclaim Extra, and Prograss (ethofumesate) for crabgrass control efficacy. Drive was tank-mixed with methylated seed oil (1% v/v) in all studies. Herbicides were applied in 50 gpa with a CO_2 pressurized (35 psi) backpack sprayer equipped with an 8004E Tee Jet nozzle. All sites were irrigated 24 hrs prior to each herbicide application and thereafter to prevent wilting of the turf. Plots were 5 by 5 ft and were arranged in a randomized complete block with four replicates. Percent of plot area covered with crabgrass was assessed in mid-to-late August using a visual 0 to 100% linear scale where 0 = no crabgrass and 100 = entire plot area covered with crabgrass. Data were subjected to analyses of variance and significantly different means were separated by the least significant different t-test ($P = 0.05$).

In study I, there were two application regimes: 1) sequential applications at 1 - 2 leaf (L) + tillering (T) stages, and 2) a single application at tillering. Data showed that only plots treated sequentially with Acclaim Extra alone (0.04 lb ai/A = lb/A); 1-2L + T) provided excellent control (<4% crabgrass cover). Good control (<10% crabgrass cover) was provided by the sequential, Acclaim Extra + Daconate 6 (0.04 + 0.5 lb/A) treatment. The high rate of Daconate 6 (1.0 lb/A) tank mixed with Acclaim Extra (0.04 or 0.09 lb/A) appeared to have antagonized Acclaim Extra in both regimes (31 - 85% crabgrass cover). Extremely poor control was provided by Daconate 6 alone (1.0 lb/A) and Drive (0.75 lb/A) (85 and 21% crabgrass cover, respectively).

In study II, there were three application timings: 1) early post (1 - 4L); mid-post (1 - 2T); and late-postemergence (≥3T). Drive (0.75 lb/A) provide poor control in the early and late post timings (44 - 66% crabgrass cover), but gave fair control when applied in the mid-post timing (15% crabgrass cover). PreClaim (1.54 and 2.06 lb/A) applied in the early postemergence timing provided unacceptable control (11 - 13 crabgrass cover), but PreClaim (2.06 lb/A) applied in the mid-post timing gave excellent (2% crabgrass cover) control. Acclaim Extra (0.09 or 0.12 lb/A) and Puma (fenoxaprop, 0.09 lb/A) also gave commercially acceptable control (1 - 5% crabgrass cover) when applied in either the mid-or-late postemergence timings.

In study III, Acclaim Extra 0.57EW (0.016 and 0.020 lb/A), Acclaim 1EC (0.031 lb/A) and Prograss (0.75 lb/A) were applied on either a 14 or 21-day interval beginning when crabgrass was in the 1 - 2 L stage. Except for Prograss (15% crabgrass cover), all treatments provided outstanding crabgrass control (0 - 3%). There was no difference in the level of control provided by Acclaim or Acclaim Extra applied on either the 14 or 21-day spray interval schedule.

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ADVANCED FORMULATION TECHNOLOGY FOR IMPROVING PREEMERGENCE HERBICIDAL ACTIVITY

D. L. Loughner, J.J. Jaeger, J. F. Walter and J. Natoli[1]

ABSTRACT

Polymer encapsulated (PE) formulations of dithiopyr (DIMENSION Turf Herbicide) where evaluated by university scientists and contract research facilities across the United States during the 1999 field season. A total of eleven preemergence crabgrass studies were conducted. The studies compared the residual effectiveness of two PE formulations with the commercial 1 lb/gal emulsifiable concentrate (EC) and fertilizer granule (FG) formulations.

Results indicate that the PE formulations performance was equal to, or, in many, cases, better than the EC and comparable to the FG. These results indicate that a highly effective, non-solvent based sprayable formulation of DIMENSION, can be produced.

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PREEMERGENCE SMOOTH CRABGRASS AND BROADLEAF WEED CONTROL IN MARYLAND, 1998-1999

J. G. Davis, P. H. Dernoeden, and J. M. Krouse[1]

ABSTRACT

Three studies were conducted to evaluate herbicides for preemergence smooth crabgrass (*Digitaria ischaemum* [Schreb.] Muhl.), yellow woodsorrel (*Oxalis stricta* L.), and spotted spurge (*Euphorbia maculata* L.) control in perennial ryegrass (*Lolium perenne* L.). Sprayable herbicides were applied in 50 gpa with a CO_2 pressurized (35 psi) backpack sprayer equipped with an 8004E nozzle. Granulars were applied using a shaker bottle. All sites were irrigated 24 hrs prior to and after each herbicide application and thereafter to prevent wilting of the turf. Plots measured 5 by 5 ft. and were arranged in a randomized complete block with four replicates. Percent of plot area covered with crabgrass, woodsorrel, and spurge was assessed using a visual 0 to 100% linear scale where 0 = no weeds and 100 = entire plot area covered with weeds. Treatments with crabgrass cover ratings exceeding 5% were considered to be commercially unacceptable. Data were subjected to analyses of variance and significantly different means were separated by the least significant difference test (p = 0.05).

In study I, crabgrass pressure was severe, and all treatments reduced smooth crabgrass cover significantly. Except for Dimension (dithiopyr) 1EC and 0.1G applied at 0.25 lb ai/A, all other dithiopyr treatments (i.e., 40WP and SC-102098 2.3 and 2.5 SC), applied at 0.25 and 0.38 lb ai/A, and Barricade (prodiamine) 65DG (0.65 lb ai/A) provided acceptable crabgrass control. There were no significant woodsorrel or spurge cover differences among the treatments.

In study II, crabgrass pressure was severe, and all treatments reduced crabgrass cover significantly (Table 1.). Only Dimension 0.1G (0.38 lb ai/A) provided complete control, but Team Pro (benefin + trifluralin) (1.5 +1.5 lb ai/A) and TADS 13173 2G (oxadiazon) (4.0 lb ai/A) provided equivalent levels of acceptable crabgrass control. Good control was provided by pendimethalin 0.86G (1.5 + 1.5 lb ai/A) and TADS 13172 2G (4.0 lb ai/A). All other treatments provided unacceptable crabgrass control. There were few woodsorrel and spurge plants in the control plots due to competition from the earlier germinating crabgrass. Therefore, data were analyzed without using the data from the untreated control. Team Pro (1.5 + 1.5 and 2.0 lb ai/A), and pendimethalin 0.86G (1.5 + 1.5 and 2.0 lb ai/A) provided excellent preemergence woodsorrel control. Plots receiving Dimension 0.1G (0.38 lb ai/A) were free of woodsorrel. Except for TADS 13172 2G (2.0 lb ai/A), none of the oxadiazon treatments reduced woodsorrel cover when compared to Team Pro (1.5 + 1.5 and 2.0 lb ai/A), pendimethalin 0.86G (1.5 + 1.5 and 2.0 lb ai/A), and Dimension 1EC (0.25 +0.25 lb ai/A). None of the treatments reduced spurge cover significantly.

Crabgrass pressure in study III was moderate. Drive (quinclorac) treatments provided little or no preemergence crabgrass or woodsorrel control (Table 2.). Only Pendulum 3.3EC (pendimethalin) (1.5 + 1.5 lb ai/A) and Pendulum 2G (1.5 + 1.5 and 3.0 lb ai/A) provided acceptable crabgrass and woodsorrel control.

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Table 1. Preemergence smooth crabgrass control, spurge, and woodsorrel control, 1999

	Rate	% cover crabgrass	spurge	woodsorrel
Treatment*	lb ai/acre	16 Aug	20 Aug	20 Aug
Team Pro 0.86G	1.5+ 1.5	2 ab**	0.5 a	0.5 ab
Team Pro 0.86G	2.0	11 c	3.0 a	0.3 ab
Pendimethalin 0.86G	1.5+ 1.5	8 bcd	0.5 a	0.5 ab
Pendimethalin 0.86G	2.0	11 cd	2.5 a	1.1 abc
Dimension 0.1G	0.38	0 a	1.8 a	0.0 a
Barricade 0.22G	0.5	11 cd	1.5 a	1.5 bcd
TADS 13172 2G	2.0	23 e	2.7 a	1.3 abc
TADS 13172 2G	3.0	13 d	0.8 a	3.5 e
TADS 13172 2G	4.0	9 cd	2.0 a	2.5 cde
TADS 13173 2G	2.0	15 d	1.3 a	2.8 de
TADS 13173 2G	3.0	10 cd	1.1 a	2.3 cde
TADS 13173 2G	4.0	6 abc	0.8 a	2.8 de
Ronstar 2G	2.0	15 d	0.8 a	2.1 cde
Ronstar 2G	4.0	9 cd	2.3 a	2.3 cde
Untreated	--	76 f	--	--

* Treatments were applied on 13 April and sequentials were applied 27 May 1999.

** Means in a column followed by the same letter are not significantly different at p=0.05 level according to the least significant difference t test.

Table 2. Drive and Pendulum granular vs. spray formulations for smooth crabgrass and woodsorrel control, 1998.

	Rate	% crabgrass cover	No. woodsorrel plants/25 ft^2
Treatment*	lb ai/acre	3 Sept	17 Aug
Drive 75 DF + MSO**	0.50	20.5 ab***	15.3 a
Drive 75 DF + MSO	0.75	15.0 abc	7.3 bcd
Drive 0.57G	0.50	12.8 bcd	13.3 ab
Drive 0.57G	0.75	16.5 abc	12.0 ab
Pendulum 3.3EC	3.0	8.8 cde	1.0 de
Pendulum 3.3EC	1.5 + 1.5	2.3 de	0.8 de
Pendulum 2G	3.0	0.3 e	0.3 e
Pendulum 2G	1.5 + 1.5	0.0 e	0.3 e
Dimension 1EC	0.25 + 0.25	1.0 e	0.8 de
Untreated	--	24.0 a	11.5 abc

* Treatments were applied on 10 April, and sequentials were applied 28 May 1998.

** Drive 75DF was tank-mixed with methylated seed oil (1% v/v).

***Means in a column followed by the same letter are not significantly different at p=0.05 level according to the least significant difference t test.

SMOOTH CRABGRASS CONTROL IN 1999

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

ABSTRACT

Four studies were conducted on a mature stand of perennial ryegrass at the Landscape Management Research Center, Penn State University, University Park, PA. One of the studies was an evaluation of products for preemergence control of smooth crabgrass, one study was an evaluation for pre-post control , and two studies were conducted for post control of crabgrass in the two to three tiller stage. In the preemergence study, a randomized complete block design was used with three replications. All of the treatments were applied on April 28, 1999 using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two, flat fan, 6504 nozzles at 40 psi. Granular treatments were applied with a shaker jar. After application the entire test site received approximately 0.5 inch of water. Crabgrass germination was first noted in the test site on May 12, 1999. Non treated checks were rated to have a minimum of 80 percent crabgrass infestation in all replications. The pre-post study, was a randomized complete block design with three replications. All of the treatments were applied on June 18, 1999 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi. Granular treatments were applied with a shaker jar. The post emergence studies were randomized complete block designs with three replications. All of the treatments were applied on July 19, 1999 using a three foot CO_2 powered boom sprayer calibrated to deliver 40 gpa using two, flat fan, 6504 nozzles at 40 psi. In the preemergence study, most of the herbicides used provided commercially acceptable control (at least 85%). Those providing the best control (at least 95%) were the following; prodiamine 65WDG at 0.5 and 0.65 lbs ai/A, dithiopyr 1EC at 0.38, dithiopyr 40WP at 0.25 and 0.38 lbs ai/A, dithiopyr FG AND445 0.164G at 0.38 lbs ai/A, and XF99007 2.32SC at 0.25 and 0.38 lbs ai/A. Those providing from 90 to 95% control included; prodiamine 65WDG at 0.38 lbs ai/A, AND672-99 at 3.6 lbs product/M, XF99006 2.32SC at 0.25 and 0.38 lbs ai/A, pendimethalin 60WG at 1.5 lbs ai/A, Team Pro, 0.86G at 2 lbs ai/A, and dithiopyr FG AND445 0.164G. Those materials that did not provide acceptable control were; 011399B, 011399C, 012799E, 012799F, prodiamine at 0.25 lbs ai/A, AND669-99 at 3.6 lbs product/M, AND670-99 at 3.6 lbs product/M, dithiopyr (Crabex) 0.14G at 0.125 lbs ai/A, pendimethalin (Scotts) 0.86G at 1.5 lbs ai/A, oxadiazon 2G at 2.0 lbs ai/A, and Team 0.87G at 2.0 lbs ai/A. In the pre-post study, acceptable postemergence control of smooth crabgrass was attained by applications of the following herbicides; Drive 75DF at 0.75 lbs ai/A with 1%v/v MSO, Drive 75DF at 0.75 lbs ai/A plus 0.375 lbs ai/A of Dimension and MSO at 1% v/v, Drive 75DF at 0.75 lbs ai/A plus 1.5 lbs ai/A of pendimethlin and MSO at 1%v/v, and Acclaim Extra 0.57EW at 0.09 lbs ai/A plus Dimension 40WP at 0.5 lbs ai/A. All treatments containing granular Drive, Preclaim 3.09EC at 2.06 lbs ai/A, Dimension 40WP at 0.5 and 0.25 lbs ai/A and Puma 1EC at 0.12 lbs ai/A did not provide a commercially acceptable level of control. In the post emergence study, acceptable postemergence control of smooth crabgrass was attained by the application of Acclaim Extra 0.57EW at 0.12 lbs ai/A, Puma 1EC at 0.12 lbs ai/A, Acclaim Extra

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0.57EW at 0.12 lbs ai/A plus Confront 3SL at 0.375 lbs ai/A, and Preclaim 3.09EC at 2.06 lbs ai/A plus Confront 3SL at 0.375 lbs ai/A. All other treatments did not provide commercially acceptable control. In the other post emergence study, acceptable postemergence control (85%) of smooth crabgrass was attained by the application of Drive 75DF at 0.75 lbs ai/A plus MacroSorb Foliar at 2 oz/M with MSO at 1%v/v and Acclaim Extra 0.57EW at 0.12 lbs ai/A plus MacroSorb Foliar at 2 oz/M. All other treatments did not provide commercially acceptable control. Control was enhanced for Drive 75DF at 0.75 lbs ai/A, Drive 75DF at 0.5 lbs ai/A, Acclaim Extra 0.57EW at 0.12 and 0.09 lbs ai/A by the addition of MacroSorb Foliar. Adding MacroSorb Foliar to the Dimension 1EC formulation did not enhance control at 0.5lbs ai/A.

LONGEVITY OF PREEMERGENCE CRABGRASS HERBICIDES

Jeffrey F. Derr[1]

ABSTRACT

Studies were conducted to determine the length of residual control for commonly-used turf preemergence herbicides. In the first study, flats were buried in a field location and filled with native soil. The pH was 5.3 with 1.5% organic matter. Six flats were used per plot. Herbicides applied as sprays and their application rates were: prodiamine, 0.75 lb ai/A; pendimethalin, 3.0 lb/A; dithiopyr, 0.5 lb/A; bensulide, 10.0 lb/A; siduron, 10.0 lb/A; and oryzalin, 3.0 lb/A. The following herbicides were applied in granular form at 3.0 lb/A: benefin, benefin plus trifluralin and oxadiazon. Plots were treated on April 3, 1998. A rain totaling 1.75" fell 1 day after treatment. Flats were removed at 0, 1, 2, 3, 4, and 5 months after treatment (MAT) and seeded with large crabgrass [*Digitaria sanguinalis* (L.) Scop.] and yellow foxtail [*Setaria glauca* (L.) Beauv.]. Flats were maintained in the greenhouse. Shoot fresh weight was recorded approximately 1 month after seeding.

At 0 MAT, all treatments controlled both weed species greater than 95%. At 1 MAT, all chemicals except benefin plus trifluralin reduced large crabgrass shoot weight by over 95%. All treatments except bensulide, benefin, and benefin plus trifluralin reduced yellow foxtail shoot weight by over 90%. At 2 MAT, only prodiamine, pendimethalin, and oxadiazon reduced shoot weight of both species by over 90%. By 3 MAT, only prodiamine provided over 90% reduction in large crabgrass shoot weight, while oxadiazon reduced shoot weight by 89%. At 3 MAT, numerical reduction in large crabgrass shoot weight was in the order, from greatest to least: prodiamine, oxadiazon, oryzalin, pendimethalin, bensulide, dithiopyr, siduron, benefin, and benefin plus trifluralin. Only prodiamine and oxadiazon reduced yellow foxtail shoot weight over 90% at 3 MAT. BY 4 MAT, no treatment reduced large crabgrass shoot weight by 90% or more. Prodiamine reduced large crabgrass shoot weight by approximately 80% while all other treatments gave less than a 50% reduction. Oxadiazon reduced yellow foxtail shoot weight by approximately 85% at 4 MAT. All other treatments provided less than 70% reduction. At 5 MAT, all treated flats had a similar large crabgrass shoot weight as the untreated flats. At 5 MAT, prodiamine and oxadiazon reduced yellow foxtail shoot fresh weight by approximately 55 and 75%, respectively. Shoot weights in the other treatments were similar to that in untreated flats.

A second study was conducted in an established turf site. At 3 MAT, prodiamine, pendimethalin, dithiopyr, bensulide, benefin plus trifluralin, oxadiazon, and benefin all provided over 80% control of a mixture of large and smooth crabgrass. At 5 MAT, prodiamine, benefin plus trifluralin, and oxadiazon controlled large and smooth crabgrass 70% or greater. Pendimethalin, dithiopyr, bensulide, and benefin controlled large and smooth crabgrass less than 60% at 5 MAT. Herbicide longevity is dependent upon the herbicide used and weed species.

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EFFICACY OF DITHIOPYR FORMULATIONS FOR PREEMERGENCE ANNUAL GRASS CONTROL

R. B. Taylorson 1

ABSTRACT

The study was conducted during 1999 at the University of Rhode Island turf research farm on a 7-year old stand of Kentucky bluegrass (Poa pratensis) and creeping red fescue (Festuca rubra) mowed at 1.75 inches. The formulations of dithiopyr were applied to plots six feet wide by eight feet long with a two foot untreated strip between adjacent plots. There were four replicates in a randomozed complete block design. All treatments were applied on April 21,1999 with either a backpack sprayer at 48 GPA or a Gandy drop spreader. Ratings of smooth crabgrass (Digitaria ischaemum) control were taken at approximately four-week intervals over a 20 week period useing a 0-10 scale with 0 being no control and 10 perfect control. Ratings of 7 or below would be unsatisfactory control. The plots were also rated for turf injury but none was observed from any treatment.

Rates of application were 0.18 and 0.25 lb ai/A for all formulations. The formulations examined included the 1EC, 0.072 and 0.164% granulars, a 40% WP, and a 2.32 and 2.52 lb/gal SL. After 20 weeks, unacceptable control ratings were given by both rates of the EC, and the low rates of the granular and WP. The most effective treatments (in ascending order) were the WP at 0.25 lb/A, the 2.32 SL at 0.25 lb/A and the 2.52 SL at both the 0.18 and 0.25 lb/A rates. Ratings for the latter were 8.6 and 9.2 respectively.

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WEED CONTROL IN PUMPKINS WITH PREEMERGENCE HERBICIDES OR A KILLED RYE MULCH

Todd L. Mervosh[1]

ABSTRACT

Two experiments were conducted in 1999 in Windsor, CT to evaluate weed control strategies for pumpkins (*Cucurbita pepo* L.). The design for both experiments was a randomized complete block with four replicates. In one experiment, preemergence herbicide treatments were evaluated for weed control and for effects on vigor and yield of eight pumpkin varieties ('Howden', 'Oz', 'Mystic', 'Jackpot', 'Wizard', 'Spookie', 'Magic Lantern', and 'Baby Pam'). The experiment was conducted in tilled soil (sandy loam, ~2% organic matter, pH 6.1). On June 23, four seeds of each variety were planted (one hill per variety) in 10 ft by 20 ft plots. Treatments, applied on June 24, were the following: untreated check, weed-free (hoed) check, ethalfluralin (1.125 lb/A a.i.), clomazone ME [microencapsulated] (0.5 lb/A a.i.), ethalfluralin + clomazone ME (1.125 + 0.5 lb/A a.i.), and metolachlor (0.95 lb/A a.i.). Herbicides were applied in a spray volume of 25 gal/A to a dry soil surface with a CO_2-pressurized backpack sprayer. The field was irrigated on June 25 and as needed during the summer. Plant vigor and weed control were evaluated on July 15, after which plants were thinned to two per hill. The only plants that displayed reduced vigor were some 'Jackpot' and 'Wizard' plants in plots treated with metolachlor. Each herbicide treatment provided at least 98% control of large crabgrass (*Digitaria sanguinalis*) and stinkgrass (*Eragrostis cilianensis*), and 95% or greater control of redroot pigweed (*Amaranthus retroflexus*) and common purslane (*Portulaca oleracea*). Neither ethalfluralin nor metolachlor controlled velvetleaf (*Abutilon theophrasti*), and clomazone ME had no activity on carpetweed (*Mollugo verticillata*). The combination of ethalfluralin plus clomazone ME prevented at least 98% of all weeds present. Varietal differences occurred in the effects of weed competition or herbicide treatment on pumpkin yields. Relative to the weed-free check, total yield (lbs) of pumpkins harvested on September 9 was 38% lower in untreated check plots, but was not significantly affected by any of the herbicide treatments.

In another experiment, an early spring-seeded rye (*Secale cereale* L.) crop was used to create a mulch for pumpkins seeded in a sandy loam soil. On June 11, the rye in selected 10-ft by 70-ft plots was sprayed with glyphosate (1 lb/A a.i.). The remaining plots were tilled on June 22. On June 23, seeds of 'Howden' and 'Pankow's Field' pumpkins were planted in alternate hills spaced 10 ft apart in each plot. Four seeds were planted 1 1/2 inches deep in each hill. Of the tilled plots, half were sprayed on June 24 with ethalfluralin + clomazone ME (1.125 + 0.5 lb/A a.i.). The field was irrigated on June 25 and as needed during the summer. Because of considerable damage to pumpkin seedlings from feeding by mice, several hills had to be replanted. Damage was most severe in the killed rye plots, in which several mouse burrows were present. Dense populations of common purslane and annual grasses grew in the tilled check plots, but weeds were prevented almost completely in the herbicide-treated tilled plots. The killed rye mulch suppressed weed emergence for a few weeks, but moderately high weed densities developed by late July. At harvest on September 14, yields (lbs) of the two pumpkin varieties were nearly identical. Compared to the tilled check yield (100%), yields from the killed rye mulch plots (173%) and the herbicide-treated tilled plots (344%) were considerably greater.

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EFFECTS OF DROUGHT ON THE INTERFERENCE OF REDROOT PIGWEED, LARGE CRABGRASS AND SMALLFLOWER GALINSOGA IN PEPPER

R. Fu[1] and R. A. Ashley[2]

ABSTRACT

This is the second year of a two-year replicated study to determine the influence of emergence time and density of redroot pigweed *Armaranthus retroflexus* L., large crabgrass *Digitaria sanguinalis* (L) Scop. and smallflower galinsoga *Galinsoga ciliata* L. on the yield loss of bell pepper *Capsicum annuum* L. The early growing season of 1999 was particularly dry. The monthly precipitation was 5.44, 7 .40 and 3.27 inches in May, June and July in 1998, while in 1999, the monthly precipitation was only 3.97 and 0.13 inches in May and June, 5.44 inches in July. Although there was more rain in July than last year, the evaporation and transpiration was large due to the high temperature (The degree days was 818.5 Fahrenheit in July of 1999, and 726.5 in July of 1998 with base temperature to be 47 degree Fahrenheit). The establishment of the plants was seriously retarded by the unfavorable weather. Compared to last year, the peppers were transplanted to the field 11 days earlier, but the harvest was started 9 days later. The overall yields of all treatments decreased dramatically with weed-free yield decreased as much as 50%.

The experiments were conducted on the research station of Department of Plant Science, University of Connecticut at Mansfield, CT in 1999. Weed densities of 0, 1, 2, 4, 8, 16, 32 plants m^{-1} were established within 15cm on either side of the crop row for each weed species. The effects of two emergence times – weed seedlings emerged right after transplanting of pepper and weed seedlings emerged two weeks after transplanting were studied.

Generally, the weeds showed more competitive ability under the dry weather. For crabgrass, low densities like 1 or 2 seedlings m^{-1} caused 37.3% and 41.8% yield loss for early emergence time this year, and the percentage losses were 25.0% and 26.2% respectively last year. The maximum yield loss decreased from the 97.7% of last year to 93.1% under the highest weed density of the first emergence time, and increased from 61.4% to 74.1% for the highest weed density for the late emergence time.

Redroot pigweed turned out to be most competitive species this year. One pigweed m^{-1} emerged right after transplanting could cause more than 40% of yield loss while this number was 7.3% last year. The highest density of early emerged pigweed caused a yield loss up to 98% and the maximum yield loss was only 66% last year. The impact of late emerged pigweed on yield loss was just very slightly less severe.

Low densities of smallflower galinsoga had less effect on yield loss in percentage than last year when the seedlings emerged right after transplanting. One or two galinsoga m^{-1} caused about 25% yield loss last year and this year the yield loss was about 13%. The converse was true for the later emerging weeds. Last year the late emerged weeds had no significant effect on the pepper yield, and this year the yield loss showed a steady increase when the weed densities get higher with the highest yield loss to be 47.5%.

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IS THERE FOLIAR ABSORPTION OF PENDIMETHALIN AND S-METOLACHLOR IN CABBAGE

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ABSTRACT

New York State is the largest producer of cabbage for cole slaw in the United States. A large portion of cabbage production cost is weed control. Herbicide use is the major method used by farmers to control weeds in cabbage. However, nutsedge and velvetleaf are becoming problems in cabbage fields. Nutsedge can be controlled with s-metolachlor, available to growers under a Third Party Special Local Need registration, and is usually applied post transplant. Velvetleaf is not controlled by currently registered herbicides. The objective of this research was to explore the possibility of applying pendimethalin POST with s-metolachlor for velvetleaf control in transplanted cabbage. The experiment was conducted in the greenhouse with day/night temperatures of 25/21 °C. Sunlight was supplemented with metal halide lamps (300 $\mu E\ m^{-2}\ S^{-1}$ PPFD) giving a 14-h photoperiod. Cabbage was transplanted (4-5 lvs) into 16.5 cm diameter plastic pots containing a 1:1 (v/v) mixture of vermiculite and peat. Herbicides were applied with an air-driven, single nozzle greenhouse track sprayer that delivered 290 L/ha at 240 kPa. S-metolachlor (0.94, 1.88 lb ai/A), and pendimethalin (0.75, 1.5 lb ai/A) were applied 1-3 days after transplanting to single plants. Treatments were applied to soil only (S), leaves only (L) and soil + leaves (S+L). Following herbicide application, the pots were divided into two identical groups and were either bottom or top watered. Herbicide injury (% of the untreated control) was evaluated 7, 14, 21 days after treatment (DAT) using a 0 to 100 scale (0% = no injury, 100% = total plant death). Plants were harvested 21 DAT, dried, and weights were recorded. The experimental design was a split-split plot with three replications, and the experiment was repeated twice. Results showed that there was no significant difference between watering methods. No foliar injury was observed with either herbicide when cabbage plants were covered during application (S). When the leaves were exposed (L, L+S) to s-metolachlor, transitory chlorosis occurred. In the case of pendimethalin, leaf exposure (L, L+S) caused severe necrosis on treated leaves and malformation of newly emerging ones. Cabbage plants were stunted by all treatments, but those where foliage was covered (S) were less so than when foliage was exposed to the herbicides (L, L+S). Dry weights were not significantly reduced by any treatment where foliage was covered (S). Dry weights were reduced when leaves were exposed to pendimethalin, but not when exposed to s-metolachlor. This experiment demonstrated that both s-metolachlor and pendimethalin applied POST caused foliar injury and stunting in cabbage. However, s-metolachlor injury was generally transitory while pendimethalin injury caused long-term foliar malformation and growth reduction.

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WEED MANAGEMENT WITH HALOSULFURON IN SUMMER SQUASH

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ABSTRACT

Summer squash (*Cucurbita pepo* L.) is an economically important vegetable crop in Virginia. With this interest in squash production there is need for additional weed control alternatives. Currently there are no postemergence herbicides registered for control of broadleaf weeds and yellow nutsedge (*Cyperus esculentus* L.) in squash. Both yellow nutsedge and morningglory (*Ipomoea* spp.) are problems in squash production due to their competitiveness and invasive nature. Halosulfuron controls yellow nutsedge and suppresses annual morningglories. Halosulfuron may offer improved weed control in summer squash; however, the effect of halosulfuron on squash has not been studied extensively.

In 1999, field experiments were conducted at the Eastern Shore Agricultural Research and Extension Center near Painter, VA to investigate weed control and squash response to halosulfuron. Plots were 25 feet long and arranged in a randomized complete block design with 3 replications. 'Monet' and 'Tigress' were selected as representative yellow and zucchini squash cultivars, respectively. Ethalfluralin (0.56 lb ai/A) and clomazone (0.156 lb ai/A) were applied PRE to all plots except untreated controls. Halosulfuron was applied PRE and POST at 0.004, 0.008, 0.016, and 0.024 lb ai/A. Non ionic surfactant (0.25%) was included with all POST treatments.

POST treatments were generally more injurious than PRE treatments. 'Monet' squash was injured 10 to 25% by PRE treatments 2 wk after planting (WAP), but only minimal injury was observed 4 WAP (0 to 3%). In contrast, injury from POST treatments was 16-35% 2 wk after treatment (WAT). Injury to 'Tigress' zucchini from PRE treatments 2 and 4 WAP was 12 to 17% and 1 to 4%, respectively. 'Tigress' was most sensitive to injury from POST treatments with 25 to 47% injury 2 WAT. POST treatments delayed maturity of 'Monet' and 'Tigress'. Although yields were initially lower in squash treated POST, squash yields from fourth and later harvests were equal to or significantly higher from squash treated POST than from squash treated PRE.

Morningglory control by PRE treatments averaged from 41 to 74% in both squash cultivars. Control from POST halosulfuron was significantly higher and ranged from 66 to 80%. Annual morningglories were initially suppressed by POST applications but recovered and interfered with later harvests. Yellow nutsedge control in the greenhouse 1 WAT with 0.004 lb/A halosulfuron was >80%.

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EFFECTIVENESS OF DIFLUFENZOPYR PLUS DICAMBA FOR WEED CONTROL IN SWEET CORN

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ABSTRACT

Two field trials were conducted in 1999 to evaluate postemergence applications of BAS662 (diflufenzopyr + dicamba) in combination with several labeled pre and postemergence herbicides as a weed control option in sweet corn (*Zea mays saccharata* L. var. Lancelot). The first trial evaluated sweet corn tolerance to several rates (0.148, 0.196, 0.294, 0.391 kg ai/ha) of BAS662 applied early postemergence (EP). All treatments were preceded by preemergence applications of dimethenamid + atrazine at 2.8 kg ai/ha. The four BAS662 treatments were applied with a non-ionic surfactant at 0.25% v/v alone and in combination with a 28% nitrogen solution. A hand weeded check was included. Tolerance to BAS662 was evaluated by analysis of plot weights, average length of a random sample of ten ears, and tip fill of the same ten ears.

Tip fill was not affected by any herbicide treatment. There were significant differences among treatments in plot weight ($P<0.07$) and ear length ($P<0.05$). Ear length was reduced by all rates of BAS662 except at the 0.148 kg ai/ha rate compared to the hand weeded check. Plot weights were lower compared to the hand weeded check with the 0.294 and 0.391 kg ai/ha rates of BAS662 that included the nitrogen solution and the 0.391 kg ai/ha rate applied alone.

The second trial was a weed control experiment that included BAS662 applied EP with combinations of several labeled herbicides. All EP treatments were preceded by preemergence applications of dimethenamid at 0.84 kg ai/ha. EP treatments included BAS662 at 0.098, 0.148, and 0.196 kg ai/ha applied alone, and BAS662 at 0.098 kg ai/ha in combination with bentazon at 0.56 and 0.84 kg ai/ha, bentazon + atrazine at 0.87 and 1.16 kg ai/ha , and atrazine at 0.56 kg ai/ha. Other treatments included dimethenamid alone, atrazine + *S*-metolachlor at 3.23 kg ai/ha and an untreated check. Weed control was evaluated by visual control ratings taken seven weeks after planting. Weed dry weights were taken from quadrat samples nine weeks after planting. Yield was measured by plot weight of marketable ears.

Ratings evaluated control of three weed species: large crabgrass (*Digitaria sanguinalis* (L.) Scop.), redroot pigweed (*Amaranthus retroflexus* L.) and common lambsquarters (*Chenopodium album* L.). All treatments including BAS662 gave good to excellent control of all three species. Dimethenamid alone gave fair control of pigweed and no control of common lambsquarters. Atrazine + *S*-metolachlor provided fair control of crabgrass and very good control of pigweed and lambsquarters. Analysis of weed dry weights determined that broadleaf weed control was excellent in all treatments accept dimethenamid alone. Grass control was variable among treatments but overall control in the dimethenamid + BAS662 treatments were comparable to the atrazine + *S*-metolachlor treatment. All treatments significantly improved sweet corn yields compared to the untreated check. There were no differences among any of the BAS662 treatments or the atrazine + *S*-metolachlor standard. Only the dimethenamid treatment applied alone resulted in significantly reduced yields compared to other treatments.

BAS662 could be an answer to broadleaf weed control in sweet corn where triazine resistance may be present. More testing on different soil types and stage of corn growth will be needed to determine the safest application rates.

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WEED CONTROL IN SWEET CORN WITH CARFENTRAZONE

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ABSTRACT

Sweet corn (*Zea mays*) growers could benefit from the availability of a POST herbicide that improves overall weed control, but not limit crop rotation. The development of PPO-inhibitors in field corn (Zea mays) may provide some new options for sweet corn as well. There is interest in labeling carfentrazone for use in sweet corn. Studies were conducted to evaluate the potential for carfentrazone use in sweet corn.

Carfentrazone was compared with other PPO-inhibitors, CGA-248757 and flumiclorac. Field studies were conducted in 1998 and 1999 at the University of Delaware's Research and Education Center. In 1998, carfentrazone, CGA-248757, and flumiclorac were applied alone and in combination with 2,4-D. In 1999, carfentrazone, CGA-248757, and flumiclorac were also applied in combination with atrazine. 'Bonus' was the sweet corn variety in 1998. To evaluate crop tolerance, in 1999 four sweet corn varieties were used. 'Bonus' and 'Sterling' are both processing varieties and 'Cotton Candy' and 'Alpine' are both fresh market varieties. Each variety was planted in separate rows of four row plots. Treatments were applied at V-5 corn stage in 1998 and V-3 stage in 1999.

Injury was more noticeable when carfentrazone, CGA-248757, and flumiclorac were tank-mixed with 2,4-D or carfentrazone was applied with atrazine, compared to these herbicides applied alone. Weed control was improved when either of the PPO-inhibitors was tank-mixed with 2,4-D or atrazine compared to these herbicides alone. Cotton Candy was more tolerant to the PPP-inhibitors than the other varieties.

While carfentrazone or other PPO-inhibitors tested are not broad spectrum enough, they may have merits to supplement soil-applied herbicides. These herbicides will need to be used as a planned approach since their effectiveness on weeds 7.5 to 10 cm tall is greatly reduced, with a few exceptions. Furthermore, the early application timing will improve weed control of those species with marginal tolerance to these herbicides.

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SWEET CORN TOLERANCE TO NICOSULFURON AND CARFENTRAZONE

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ABSTRACT

Postemergence herbicides provide IPM options for sweet corn (*Zea mays saccharata* L.). Nicosulfuron and carfentrazone were evaluated with non-ionic surfactant as postemergence treatments on several sweet corn varieties. In the mid-Atlantic area, other crops are planted after sweet corn harvest; therefore, postemergence herbicides for sweet corn should not affect successive crops. Nicosulfuron and carfentrazone appear to have that characteristic.

Sweet corn was planted in 36 inch row widths on May 4 and June 11, 1999, in a Norfolk loamy sand (0.6% OM) and sprinkler irrigated as needed. Preemergence herbicides, *S*-metolachlor (0.78 lb ai/A) and atrazine (1.0 lb ai/A) were applied to the May 4 planting, whereas, only *S*-metolachlor (0.63 lb ai/A) was applied to the June 11 planting. Postemergence treatments were applied at the fifth leaf collar stage-of-growth (approx. 29 days after planting) and the June 11 planting received an additional five day delayed post treatment at the sixth leaf collar growth stage. The spray volumes on the May 4 and June 11 plantings were 31 and 17 gal/A, respectively. Non-ionic surfactant was added to all treatments at 0.25% V/V.

Nicosulfuron at 0.031 and 0.062 lb ai/A, postemergence on the sweet corn varieties, 'Bonus/Attribute' (yellow, Se) and 'GSS 9299' (yellow, Sh2) did not reduce yields with or without husks. 'Sterling' (white, Su) yield with or without husks was unaffected by nicosulfuron at 0.062 lb ai/A. Nicosulfuron , 0.125 lb ai/A postemergence to 'Bonus/Attribute', 'Sterling' and 'GSS 9299' did not reduce sweet corn yields in the husk; however, only the yield of 'Sterling' and 'GSS 9299' without husks was slightly depressed, which indicated a slightly smaller cut-off corn yield. The June 11 planting of 'Bonus/Attribute' was treated with nicosulfuron, 0.078 lb ai/A and the yield with husk was not reduced; whereas, yield without the husk was reduced. The yield of varieties, 'Fantasia' (white, Se), 'Dynamo' (yellow, Su) and 'Esquire' (yellow, Su) were not reduced by nicosulfuron at 0.031 lb ai/A; however, rates of 0.062 and 0.125 lb ai/A caused yield reductions. 'Early Cogent'(white, Su) shoepeg-type sweet corn yields were not affected by nicosulfuron, 0.062 and 0.125 lb ai/A. Sweet corn injury symptoms were primarily chlorosis; however, tolerant varieties had much less chlorosis than susceptible varieties. Tolerant varieties may have 20 to 30% growth reduction at the high rates without a yield reduction; whereas, susceptible varieties had yield losses. Carfentrazone, 0.008 and 0.016 lb ai/A , did not reduce growth or yields of 'Sterling' or 'Bonus/Attribute' sweet corn. The carfentrazone injury symptom was a band of chlorosis across emerging leaves at the time of application. Nicosulfuron injury was associated with distorted straightness of kernel rows; whereas, carfentrazone did not affect kernel orientation. Application of nicosulfuron, 0.125 lb ai/A at the sixth collar stage did not significantly increase injury compared to application at the fifth collar stage of sweet corn growth. Commercial control of morningglory (*Ipomoea* spp.) was provided by both nicosulfuron and carfentrazone. Yellow nutsedge (*Cyperus esculentus* L.) was suppressed by nicosulfuron.

Nicosulfuron may be applied postemergence only to sweet corn varieties which have demonstrated tolerance; whereas, carfentrazone, postemergence, appears to have less potential to injure sweet corn varieties.

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COMPARISON OF USING LEAF AREA AND WEED DENSITY AS PREDICTORS IN MODELING INTERFERENCE

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ABSTRACT

Weed density model and leaf area model are two of the many empirical models developed to quantify the crop yield respone to weed interference. The former uses the weed density as the predictor and is widely used in the present weed management systems. The latter uses the leaf area index (LAI) as the predictor and has the potential to provide better fit of data and more accurate predictive ability. The performance of the two models were evaluated to see which model give a better fit of data and seek information useful for a better weed management system.

The experiments were conducted on the research station of Department of Plant Science, University of Connecticut at Mansfield, CT in 1999. The model crop is bell pepper Capsicum annuum L. and the weeds include two species: redroot pigweed Armaranthus retroflexus L., and large crabgrass Digitaria sanguinalis (L) Scop.. Seedlings emerged right after transplanting of peppers were the target weeds of this study. Weed densities of 0, 1, 2, 4, 8, 16, 32 plants m^{-1} were established for each species within 15cm on either side of the crop row. Additional plots were established to measure leaf area of pepper and weeds. The leaf area was measured at approximately 3, 4 and 5 weeks after transplanting (WAT) pepper into field. The models were compared by the residual mean squares (RMS). The smaller the residual mean square, the better the data were described by the model.

Both models gave a good fit of the crabgrass data. The RMS of the weed density model is 6.18. For leaf area model, the RMSs were 4.54, 4.54 and 3.76 when the predictor was the LAI calculated from the leaf area measured on 3, 4, 5 WAT. Hence the model using LAI of 5 WAT gave the best fit of data. However, by the time of 5 WAT, the seedlings of crabgrass had already been relatively large. The leaf area at 3 or 4 WAT still could be a good predictor since the RMS's are only slightly larger. Besides, both models have two important parameters: weed-free yield and maximum yield loss to be estimated. The estimated weed-free yield agreed with the actual weed-free yield under all cases, but the maximum yield loss were all a little overestimated with the weed-density model having the closest estimate to be 101.1%. The actual maximum yield loss was 93.1%.

The LAI measured on 3 WAT showed to be best predicator of pigweed yield loss. The model estimate of maximum yield loss was 99.6% and very close to the actual maximum loss of 98.7%. The RMS was 0.32, the smallest one among all models. The RMSs of the other two leaf area models were 0.35 and 0.34. The weed-density model had the largest RMS of 0.54. The maximum yield loss was all a little overestimated under the other situations. All models gave a good estimate of weed-free yield.

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IR-4 MNINOR CROP PESTICIDE REGISTRATION UPDATE

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ABSTRACT

The IR-4 project is a publicly funded effort to support the registration of pesticide and biological pest control agents on minor food crops. In contrast to the past few years, the year 2000 promises to be active one for the review of herbicide petitions by the EPA.

Herbicides that are expected to be registered are: clethodim for strawberry, celery, root vegetables (includes carrot and radish), cucurbit vegetables, cranberry, clover and rhubarb; clomazone for cucurbit vegetables (includes cucumber, squash and melon); clopyralid for head and stem *Brassica* sp.; glyphosate for use as a desiccant on dry pea; metolachlor on carrot (muck soil), asparagus, Swiss chard, grass for seed, pepper (bell and non-bell), rhubarb, tomato and spinach; paraquat for endive, persimmon, artichoke and dry pea; pendimethalin on carrot, fruiting vegetables (includes tomato and pepper), citrus, mint (grown in the PNW) and tree nuts; pyridate on mint; sethoxydim for pistachio and safflower.

Additionally, a petition for the use of glyphosate on numerous commodities as a pre-emergence application or postemergence directed or shielded application has been submitted to EPA. IR-4 is hopeful that even greter number of herbicides will be registered in the year 2001.

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RESULTS OF NEW YORK VINEYARD TRIALS USING AZAFENIDIN

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ABSTRACT

Preemergence herbicide options in grape (Vitis sp.) are relatively limited and few new herbicides have been registered for vineyard use in recent years. Azafenidin was evaluated for its potential use in four experiments conducted in Lake Erie region vineyards in 1998 and 1999. In each year, one experiment was conducted in a vineyard that had received no preemergence herbicide application in the previous year and which contained very high giant foxtail (Setaria faberi Herrm.) pressure, while a second experiment was conducted in a vineyard with a history of more typical weed management programs. In all experiments azafenidin was evaluated at several rates and as single or split applications. For the first application 1 lb. ai/A glyphosate was added in both years. For the second application the same rate of glyphosate was applied in 1998 and 0.63 lb. ai/A paraquat was applied in 1999.

No phytotoxic effects to grapevines were observed from any treatment.

1998 Experiment 1 - Among single applications, only the highest tested rate of azafenidin (24 oz. ai/A) provided adequate giant foxtail control. Comparable foxtail control was achieved with split applications of azafenidin as low as 4 oz. ai/A.

1998 Experiment 2 - Annual grasses (a mix of giant and yellow foxtail, large crabgrass, fall panicum, and barnyardgrass) and pennsylvania smartweed (Polygonum pensylvanicum L.) were adequately controlled at all tested rates of azafenidin, although control was somewhat less at the lowest tested single application rate (4 oz. ai/A).

1999 Experiment 1 - Split applications of azafenidin as low as 4 oz. ai/A provided control of giant foxtail similar to the 24 oz. ai/A single application (Table 1). Three treatments received a glyphosate-only application for the first application followed by azafenidin at 4, 6, or 8 oz. ai/A; the two higher rates provided control of foxtail similar to the 24 oz. single application and the split applications. Split applications resulted in lower end-of-season ground cover of perennials and biennials (burdock, dandelion, goldenrod, and wild carrot) than single applications.

1999 Experiment 2 - All tested rates of azafenidin provided good control of large crabgrass (Digitaria sanguinalis (L.) Scop.), and pigweed species (Amaranthus sp.).

These results suggest azafenidin will be a useful addition to the arsenal of preemergence herbicides for vineyards. Especially in vineyards with very high pressure from summer annuals such as giant foxtail, a split application approach appears most promising.

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Table 1. Percent ground cover of SETFA, POLPY, and perennials for Experiment 1 in 1999.
All April 29 applications include glyphosate, all June applications include paraquat.
D=diuron,S=simazine,N=norflurazon.

APR. 29 TREATMENT	JUNE 9 TREAT.	SETFA 7-Jun	SETFA 29-Jun	SETFA 20-Jul	SETFA 24-Aug	POLPY 24-Aug	perennials 24-Aug
4 oz. azafenidin	(none)	1	12	31	56	3	12
6 oz. azafenidin	(none)	1	4	20	49	3	14
8 oz. azafenidin	(none)	0	2	10	22	1	22
10 oz. azafenidin	(none)	0	2	6	17	2	21
12 oz. azafenidin	(none)	0	2	9	18	1	21
24 oz. azafenidin	(none)	0	1	2	2	0	15
(glyphosate only)	4 oz. azafenidin	55	3	15	33	4	3
(glyphosate only)	6 oz. azafenidin	38	0	1	4	1	4
(glyphosate only)	8 oz. azafenidin	53	1	2	3	1	6
4 oz. azafenidin	4 oz. azafenidin	1	0	1	4	0	3
6 oz. azafenidin	4 oz. azafenidin	1	0	2	5	0	6
8 oz. azafenidin	4 oz. azafenidin	0	0	1	3	0	5
4.8 lb. D + 3.6 lb. S	(none)	1	1	4	10	1	7
4 lb. N + 3.6 lb. S	(none)	1	3	8	16	2	16
(glyphosate only)	(none)	53	69	80	90	4	3
none	(none)	40	36	45	61	8	24
	p<0.05	0.0001	0.0001	0.0001	0.0001	0.0001	0.0019

HERBICIDE TOLERANCE IN CRANBERRIES

A.O. Ayeni, B.A. Majek, J. Hammerstedt and J.L Coia[1]

ABSTRACT

More herbicide options are needed to manage the dynamics of weed flora in cranberry bogs in New Jersey. Several herbicides were compared with others previously identified to have some potentials in cranberries. The study was conducted at Rutgers Agricultural Research and Extension Center under greenhouse conditions (75 to 85°F day, 55 to 65°F night, 16 h light) to determine herbicide safety on cranberries and subsequently identify those to take to the field for further evaluation. The herbicides compared were nicosulfuron, (0.062 lb/A), chlorimuron (0.02 lb/A), rimsulfuron (0.032 lb/A), triflusulfuron (0.067 lb/A), triasulfuron (0.026 & 0.052 lb/A), tribenuron (0.004, 0.01, & 0.02 lb/A), MON 37503 (0.016, 0.032, & 0.064 lb/A), asulam (2 & 4 lb/A), metolachlor (2 & 4 lb/A), carfentrazone (0.008 & 0.016 lb/A), quinclorac (0.5 lb/A), clomazone (0.25 & 0.50 lb/A), ZA 1296 (0.19 & 0.38 lb/A), and V-3153 (0.02 & 0.04 lb/A). The cranberry plants treated were raised in the greenhouse from 3- to 4-inch stem cuttings planted in 4-inch pots filled with Berryland sand soil that was collected from a herbicide-free site at the Blueberry/Cranberry Research Center, Chatsworth, NJ. Plants were 12 weeks old at the time of treatment. A calibrated greenhouse sprayer, fitted with 8002VS-nozzle tip and operated at 30 psi and 68 gpa, was used for herbicide application. The experiment was set up in four randomized complete blocks and repeated. Herbicidal action was observed for eight weeks and plants were harvested to determine dry matter for the treated stock and regrowth (= new growth) after herbicide application.

At two weeks after treatment, cranberry plants showed varying degrees of injury ranging from "non-phytotoxic" to "highly phytotoxic". Nicosulfuron, triasulfuron, quinclorac, and ZA 1296 were non-phytotoxic (injury ≤1 on 0 to10 scale); clomazone was slightly phytotoxic (injury 2 to 3); chlorimuron, rimsulfuron, triflusulfuron, tribenuron, and MON 37503 were quite phytotoxic (injury 4 to 5); while carfentrazone, metolachlor, and V-3153 were highly phytotoxic (injury ≥6). Asulam was highly phytotoxic (injury 7 to 8) but symptoms were not fully expressed until 5 to 6 weeks after treatment. Symptomatic expressions showed that asulam, carfentrazone, MON 37503, and V-3153 were strong apical dominance inhibitors (strong-ADI's); chlorimuron, metolachlor, and tribenuron were mild-ADI's and the remaining herbicides were non-ADI's. Regrowth potential, measured by regrowth dry weight as percent dry weight of treated stock, was highest (60 to 83%) in plants treated with ZA 1296, quinclorac, nicosulfuron, and clomazone in that order. Asulam caused the least regrowth (20%) eight weeks after treatment. Based on cranberry safety, it was concluded that ZA 1296, quinclorac, nicosulfuron, and clomazone are potential candidate herbicides for further evaluation.

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Trade Name	Common Name	Family
Accent	Nicosulfuron	Sulfonylurea
Classic	Chlorimuron	Sulfonylurea
Matrix	Rimsulfuron	Sulfonylurea
Upbeet	Triflusulfuron	Sulfonylurea
Amber	Triasulfuron	Sulfonylurea
Express	Tribenuron	Sulfonylurea
Asulox	Asulam	Phenylcarbamate
Dual Magnum	Metolachlor	Chloroacetamide
Aim	Carfentrazone	Aryl triazinone
Impact	Quinclorac	Quinoline carboxylic acid
Command	Clomazone	Isoxalidinone
ZA 1296	Mesotrione (proposed)	Triketone
Mon 37503		Sulfonylurea
V-3153		

Classification based on action on apical dominance

Strong Apical Dominance Inhibitor (S-ADI)	Mild Apical Dominance Inhibitor (M-ADI)	Non Apical Dominance Inhibitor (N-ADI)
Asulam	Chlorimuron	Command
Carfentrazone	S-Metolachlor	Quinclorac
Mon-37503	Tribenuron	Nicosulfuron
V-3153		Rimsulfuron
		Triasulfuron
		Triflusulfuron
		ZA-1296

Classification based on level of safety on cranberries

Non-phytotoxic (≤1, 2WAT)*	Mildly phytotoxic (2-3, 2WAT)	Quite phytotoxic (4-5, 2WAT)	Highly phytotoxic (≥6, 2WAT)
Nicosulfuron	Clomazone	Rimsulfuron	Carfentrazone
Quinclorac		Triflusulfuron	V-3153
ZA 1296		Tribenuron	Asulam**
Triasulfuron		Mon 37503	S-Metolachlor
		Chlorimuron	

*Phytotoxicity rating on a scale of 0 – 10, two weeks after herbicide treatment

** Asulam phytotoxicity symptom is delayed and may not be visible until several weeks (up to 6 weeks) after treatment.

RESPONSE OF THREE CRANBERRY CULTIVARS TO THREE SULFONYLUREA HERBICIDES

T. A. Bewick and J.C. Porter[1]

ABSTRACT

The cranberry cultivars Early Black, Howes and Stevens were tested for tolerance to rimsulfuron, nicosulfuron and prosulfuron. All herbicides were applied at 0, 35 and 70 g ai/ha in 246 L/ha of carrier. Applications were made after fruit had set. Each cultivar was growing in separate areas. There were four replications of each herbicide and rate arranged in a Completely Random Design. Plots were 1 m^2. Visual observations were made throughout the growing season for symptoms of crop injury. At harvest, all fruit were collected with hand-held scoops. Fruit were sorted, counted and fresh weight determined. Analysis of variance was used to determine treatment effects and interactions. Based on fruit fresh weight, rimsulfuron and nicosulfuron did not injure any of the cultivars. Prosulfuron reduced fruit weight in all cultivars. In 'Early Black' and 'Howes', only the high rate of prosulfuron caused weight reduction. In 'Stevens' both 35 and 70 g/ha caused reduction in fruit weight when compared to the untreated controls.

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EFFECTS OF SEVERAL POTENTIALLY USEFUL HERBICIDES IN CRANBERRIES

B. A. Majek and A. O. Ayeni[1]

ABSTRACT

Extensive greenhouse screening identified several new herbicides with potentially low phytotoxicity when applied to established cranberries. These herbicides were evaluated in cranberry bogs at Rutgers Blueberry/Cranberry Research and Extension Center in 1998 and 1999. Dormant herbicide treatments were applied on April 28, 1998, and on May 5, 1999. Postemergence treatments were applied on June 16, in 1998, and on June 10, 1999 when the cranberries were in bloom and growing rapidly. Treatments applied to dormant cranberries included pronamide at 3.0 lb ai/a, isoxaflutole at 0.14 lb ai/a, clomazone at 0.5 lb ai/a, asulam at 4.0 lb ai/a, quinclorac at 0.5 lb ai/a, rimsulfuron at 0.03 lb ai/a, and thiflusulfuron at 0.06 lb ai/a. June treatments, to actively growing cranberries in bloom, included asulam at up to 4.0 lb ai/a, chlorimuron at 0.02 lb ai/a, nicosulfuron at 0.06 lb ai/a, quinclorac at 0.5 lb ai/a, rimsulfuron at 0.03 lb ai/a, tribenuron-methyl at 0.004 to 0.02 lb ai/a, and thiflusulfuron at 0.06 lb ai/a. Isoxaflutole caused very slight marginal whitening of new foliage for a few weeks after application. Although less than ten percent of the new foliage was affected by isoxaflutole, and recovery was rapid, the herbicide was dropped after 1998 due to groundwater contamination concerns. Asulam caused the cranberries to exhibit a slight to moderate subtle change in the color of the foliage that appeared in the new growth and lasted for one to three months after application. The foliage treated with asulam appeared tanner in color than untreated cranberries. The color difference was clearly noticeable next to untreated cranberries, but would be more difficult to recognize if the entire bog were treated. No other symptoms were observed, and the cranberries recovered by late summer. Chlorimuron caused cranberry foliage to exhibit slight temporary chlorosis, which appeared about a week after the June application. Recovery was rapid and complete. All the herbicides screened on cranberries were also evaluated for the control of three serious weeds in cranberries, roundleaf greenbriar (Smilax rotundifolia L.), prickly dewberry (Rubus flagellaris L.), and yellow loosestrife (Lysimachia terrestris (L.) BSP.). Two herbicides, quinclorac and asulam, were effective for the control yellow loosestrife, when applied in July. None of the herbicides effectively controlled prickly dewberry or roundleaf greenbriar.

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MULTIFLORA ROSE (*Rosa multiflora*) CONTROL USING FERTILIZER IMPREGNATED METSULFURON-METHYL

D. Richmond, E. Smolder, M. B. Bennett, D. Davis, C. Hickman, J. Hileman, E. Rayburn, and R. Chandran[1]

ABSTRACT

Multiflora rose (*Rosa multiflora* L.), an introduced species, is a widespread weed problem in West Virginia. Past studies showed that fertilizer impregnated metsulfuron was effective in controlling this weed. In 1999, six field studies were conducted in different counties to determine the effectiveness of metsulfuron impregnated in a 19-19-19 fertilizer. Metsulfuron (45 or 90 mg) dissolved in 100 ml water, each of which impregnated in 50 g fertilizer, provided >90% control of the weed at four locations at 12 weeks after treatment (WAT). Average visual injury from the lower rate was 92% and that from the higher rate was 97% at 12 WAT. At four locations, there were no differences in injury ratings at 12 WAT from herbicide rates. At 8 WAT, <70% multiflora rose injury was observed at all locations.

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Mark VanGessel, Editor
University of Delaware,
Georgetown

Presidential Address

Delivered January 4, 1999 at the

53rd Annual Meeting of the

Northeastern Weed Science Society

Boston Marriott Cambridge Hotel
Cambridge, MA

David B. Vitolo
Novartis Crop Protection, Inc.
Hudson, New York

WHY ARE GRADUATE STUDENTS LIKE DOGS?

Good Morning, and Happy New Year.

Welcome to the fifty-third Annual Meeting of the Northeastern Weed Science Society.

Thank you for coming, and particular thanks to all of you who have volunteered your time and efforts throughout the year to keep this society functioning this year.

Before I begin I want to take care of some housekeeping:

* I have had two bosses in the thirteen years I've worked for Ciba, and now Novartis, and I want to thank them both, Charlie Pearson and Stan Pruss, for their tolerance these past few years (although this is probably the first time tolerance and Stan Pruss have been used in the same sentence).
* I thank my family for twenty years of Christmas, New Years, and NEWSS.
* And I thank Diane Keil, my co-worker at our research station, for all her hard work and assistance.
* Finally, I want to let Brad Rauch (my summer intern) know that this tie is not a signal about anything.

I'm going to keep this simple and short. I know that all presidents say that, but trust me... That said, I'll never get this chance again. So I 'm going to try to fit in several subjects into this talk.

First, What it takes to make this society function: I've been impressed these past few years with how much effort it takes from so many people to keep this group going. This particular position, President, has been a lot of fun (and you can come face-to-face with your strengths, and weaknesses, in front of 200 people) I'd recommend getting involved with society activities to anyone. Please give your name in to Andy Senesac. If you have, but haven't been asked, try again. There is plenty to do. Remember: the key word here is volunteer. They don't get paid. And even though the job is reward enough, it brings me to my next topic:

How we recognize individual efforts: Awards - it's nice to get them. Just ask our award winners. Individual members should be recognized for their efforts, be it for service to the society, or professional excellence. We have had excellent nominees for our awards this year, and I recognize the achievements of the award recipients, (although I have a feeling Schnappinger will be insufferable in the coming year). However, we should have gotten 100's of nominees for these awards. I know that form looks intimidating. You see it and think: "I'm going to have to justify my choice, and that's going to take a lot of work." But it doesn't work that way. Just send a name in to the Awards Chair next fall (by the way that's me), and let the committee do all the work. Here's my challenge to you all: Next year: each one of you will nominate someone for a NEWSS award.

Care and feeding of graduate and undergraduate students: I think quite often about my old Boss, Dick Ilnicki. He's a remarkable guy, and I'm forever grateful for all he did for me, and everything he introduced me to.

Now Professor Ilnicki had a reputation for having a bit of a temper, and several Professors in the Department came to me when I first started, letting me know that I could count on them to look out for me if things got too rough. But they never got rough at all, even after my first day when I drove over the backpack sprayer. So he really was a great guy to work for, even if one of his favorite jokes was:

"Why are Grad Students Like Dogs? Answer: "Because the second you praise them they piss on the floor."

Dick Ilnicki had a lot of grad students, but not too many went on to have their own. I can think of Dick begetting Henry, begetting Robin (in a professional sense, of course)- and keeping the clan going, but there are a lot of their students who went on to very successful careers outside of universities. And it's a probably a good thing, too. Because if all of his students had as many as he did, we'd be up to here in unemployed weed scientists.

So those of us who didn't go into Universities, we're kind of like Aunts and Uncles without kids. Some times it's a tragedy that they didn't have children and sometimes it's a blessing for us all (You know whom I'm talking about). But they play an important roll in our upbringing.

And one of the things that made working with Dick so exciting, was the way he encouraged us to interact with those "Aunts and Uncles". People like Schnappinger and Steve Dennis and Janice Scalza. These individuals took time out of their busy lives to let us know what they did for living. So here's my last challenge: professors- make your students get out and see what non-university weed scientists are up to. Tap into Jerry Baron at IR-4, or Neal Anderson at EPA, or a consultant or chemical company research rep. We have a tremendous diversity in our membership. And all of you Aunts and Uncles- Make time for these students, formally or informally. And Students- Take advantage of all these different people. We will all be better off.

So I have The Three Challenges (Sounds Like a bad Chinese menu selection, "My wife will have General Tso's Chicken, and I'll have the Three Challenges") for all of us:

Volunteer, recognize someone, and take a student to lunch.

I said it would be simple.

WINTER SQUASH CULTIVARS DIFFER IN RESPONSE TO WEED COMPETITION

Elizabeth T. Maynard[1]

ABSTRACT

Eight winter squash cultivars (Cucurbita maxima Duch. 'Buttercup Burgess' and 'Autumn Cup', C. moschata Duch. ex Poir. 'Butternut Supreme' and 'Butter Boy', and C. pepo L. 'Table Queen', 'Table Ace', 'Taybelle', and 'Mesa Queen'), were compared for their response to interference from a natural weed population. Cultivars were main plots in rows 50 ft long by 8 ft wide, and weed treatments (weedy [W] or non-weedy [NW]) were 25-ft subplots. There were four replications in a randomized complete block design. In mid-June 1998, 25 3- to 4-week old squash seedlings were transplanted in each 50-ft row. NW plots were treated with ethalfluralin (1.13 lb ai ac^{-1}) before planting and were hand-hoed once. Data were analyzed using ANOVA followed by single df contrasts to test for effects of species, growth habit, and cultivar, and their interactions with weed treatment.

Pigweeds (Amaranthus spp.) dominated the weed population, followed by common lambsquarters (Chenopodium album L.). Weed dry weight sampled in mid-August averaged 809 ± 46 g m^{-2} in W plots and 184 ± 46 g m^{-2} in NW plots.

Marketable yield was greatest for butternut types and least for the most viny acorn type, 'Table Queen' (Table 1). Marketable yield in W plots ranged from 7% to 20% of yield in NW plots but that percentage did not differ among cultivars.

Yield components differed among cultivars (Table 1). Acorn types had the smallest fruit and the most fruit per plant, while butternut types had the largest fruit. W plots produced smaller fruits, and fewer fruits per plant than NW plots. Weed effects on yield components were similar across cultivars in most instances. The exception to this was the effect of weeds on number of fruit per plant: for this component of yield, weeds affected 'Autumn Cup' less than 'Buttercup Burgess'.

Cultivars differed in number of main stem nodes (NODE#): acorn types had more nodes than others (Table 1). The effect of weeds on NODE# differed among cultivars. 'Table Ace' and 'Taybelle' produced fewer nodes in W plots. Weeds did not affect NODE# for other cultivars. The percentage of main-stem nodes which were female (%FEM) varied among cultivars, with 'Butternut Supreme' having the lowest and 'Buttercup Burgess' the highest. 'Butternut Supreme', 'Table Ace', and 'Taybelle' had lower %FEM in W plots, but %FEM of other cultivars was not affected by weeds. The percentage of main stem female nodes which produced fruit varied among cultivars, but was not influenced by weeds.

These data suggest that winter squash cultivars vary in how they respond to weeds. The effect of weeds on number of fruit per plant, vine growth, and flower sex depended on cultivar. Additional work is necessary to confirm these findings.

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Table 1. Effect of weeds on marketable yield, yield components, node number, flower sex, and fruit set of eight winter squash cultivars.[a]

Cultivar	Marketable Yield			Average Fruit Weight			Number of Marketable Fruit per Plant			Number of Main Stem Nodes		Percentage of Female Nodes on Main Stem		Percentage of Female Nodes with Fruit on Main Stem	
	NW	W	W	NW	W	W	NW	W	W	NW	W	NW	W	NW	W
			% of			% of			% of						
	---lb/plot---		NW	------lb------		NW	---no/plant---		NW	---no/plant---		------%------		------%------	
Autumn Cup	50.3	8.5	19	2.62	1.40	54	1.93	0.58	33	–[b]	–	–	–	–	–
Buttercup Burgress	55.4	5.6	12	2.53	1.83	72	2.25	0.30	14	48.0	42.0	30	26	22	10
Butter Boy	68.3	5.6	7	2.71	1.78	66	2.53	0.30	10	28.5	27.8	20	21	17	18
Butternut Supreme	82.8	9.6	12	3.34	1.91	55	2.56	0.50	21	41.8	32.0	18	10	18	24
Mesa Queen	51.8	9.0	16	1.83	1.04	60	2.98	0.83	28	50.3	38.5	19	18	39	21
Table Ace	61.3	7.8	12	1.65	1.13	68	3.68	0.65	17	62.5	31.5	21	14	27	28
Table Queen	39.5	5.8	13	1.19	0.90	73	3.28	0.63	18	65.3	61.5	20	18	20	12
Taybelle	61.9	12.7	20	1.93	1.29	67	3.20	0.95	29	61.0	37.5	23	16	25	25
Analysis of Variance[c]															
Cultivar (C)	**		ns	****		ns	**		†[d]	****		**		*	
MSError a	106.70		55.99	0.0820		179.2	0.2486			97.94		32.83		94.38	
Weeds (W)	****			****			****			****		**		ns	
C X W	*			*			*			†		ns		ns	
MSError b	97.34			0.0796			0.1882			100.33		20.06		181.82	

[a]Weeds were controlled with ethalfluralin at 1.13 lb ai/ac applied before planting and one hand-weeding (NW), or left uncontrolled from planting through harvest (W). Yield based on 10 plants from 20 ft by 8 ft area. Node and flower data taken from one plant per plot, 4 to 5 and 11 to 12 weeks after transplanting.

[b]Node data for Autumn Cup unavailable due to compact growth habit.

[c]ns, †, *, **, ***, **** indicate non-significance and $P \leq .1, .05, .01, .001, .0001$, respectively for main effects of cultivar (n=8), weeds (n=32), and interaction (n=4).

[d]Analysis based on arcsine-squareroot-transformed proportions to stabilize variances and normalize residuals. Untransformed means presented.

INCORPORATING QUINCLORAC IN AUTUMN TURFGRASS RENOVATION EFFORTS

Annamarie Pennucci [1]

ABSTRACT

Quinclorac (Q) (Drive, BASF) is a unique chemistry that offers both pre and postemergent herbicidal control of crabgrass and a partial list of broadleaf weeds. Q provides six to eight weeks of optimal preemergent control of crabgrass but can be very effective when applied through seedhead exertion and seed drop. The influence of late and ultra-late applications on turfgrass renovation efforts is unknown and experiments were undertaken to determine the effect of Q treatment date on subsequent seed germination, establishment and seedling vigor. Attempts were made to determine the optimum date of seeding following Q application and to determine the minimal interval necessary to avoid turfgrass seedling stand loss.

Quinclorac at 1.0 lb ai/1000ft^2 was applied to three replicate large 12x12' plots containing 25% or more crabgrass on each of four postemergent timings: late post (4 tillers) ultra late (6-7 tillers), at seedhead exertion and post crabgrass anthesis (early and midmonth in both July and August). One cultivar each of fine, hard and sheep fescue were drop seeded into 2 foot wide strips within Q plots on each of three seeding dates: Sept 5, Sept 15, Oct 5. An early frost seeding of one fine and one hard fescue was made on Nov 5 into the remaining strips of each Q plot. Seed germination and seedling vigor were visually estimated 1, 2, 4 and 8 weeks after seeding (was).

None of the three grasses seeded Sept 5 germinated in this test. This represents seeding 6w after late, 5w after ultra late, 4w after exertion and 3 w after post-anthesis Q treatments. Evaluations made 1,2,4 or 8 was revealed no observable germination. Less than 10% germination was noted in late post (8wat) Sept 15 date. Less than 25% of fine or hard fescues germinated when seeded 10wat or Oct 5 date. Germination events appeared slow and seedling vigor was poor. Frost seeding made Nov 5 were the only successful renovation seedings in this test. Nearly 50% germination was observed in late and ultra late seedings (14 and 13 wat respectively).

Quinclorac cannot be used at its optimum crabgrass control dates if turfgrass renovation efforts are to follow. Where ultra late crabgrass control is desired, subsequent seeding efforts are best accomplished as frost or dormant seedings or delayed until the following spring. While frost seeding increases the likelihood of renovation success, these late seedlings often exhibit "frost-delay' and the resulting turfgrass quality may not be as high as expected or desired.

Table 1: The effect of Quinclorac on turfgrass seed germination.

% Germination (Visually estimated)

	Sept 5									Sept 15									Oct 5									Nov 5			
	2 was			4was			8was			2was			4was			8was			2was			4was			8was			2was		4was	
Q treat	F	H	S	F	H	S	F	H	S	F	H	S	F	H	S	F	H	S	F	H	S	F	H	S	F	H	S	F	H	F	H
Late post	0	0	0	0	0	0	0	0	0	0	0	0	10	5	0	10	5	0	5	5	0	15	10	0	25	20	10	25	20	40	45
Ultra late	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	25	15	10	20	20	40	45
Exertion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	15	15	20
Post anthesis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	15	15	15
Control	65	55	50	85	80	65	95	95	90	45	40	30	75	60	50	85	85	70	45	45	40	75	80	70	90	91	80	35	35	55	30

[1]Northeast Turf and Ornamental Research, Raymond, N.H. 03077

INFLUENCE OF WEED GROWTH AND HERBICIDES ON DISEASE DEVELOPMENT AND RHIZOME INJURY TO GERMAN IRIS

Annamarie Pennucci[1]

ABSTRACT

Field-grown German iris (*Iris germanica* L.) are subject to immense weed, insect and disease pressures. Two of those problems, iris borer and Didymellina leaf blight are indigenous to the Northeast while weed pressures vary according to locale. In prior routine herbicide efficacy testing, it was noted that crop health in control plots was often significantly less than that of treated plots despite a lack of phytotoxicity or injury directly attributable to herbicide application. Several studies were undertaken to determine the significance of borer and leaf blight as casual agent (s) of that crop loss and to evaluate the role weeds and their control may play in field grown propagation and production of this immensely popular garden perennial.

INTRODUCTION

An extremely valuable and historically popular herbaceous perennial, the German Iris exhibits a period of rapid spring growth followed by a two-three week period of flowering in late May and early June. The German iris is a cool season perennial showing extensive regrowth and corm branching in autumn and winter months and may not exhibit complete dormancy in the Northeast. German iris is commonly bred and propagated in large dryland nurseries in the Pacific northwest or in dry upland regions of the lower mid-west; principally to avoid the corm rots and insect pests so readily encountered elsewhere. Branched corms are sold to wholesale and large retail facilities in the Northeast and are field- or pot-grown to maturity in one to three years. Rhizome replication and development occur during quiescent summer months and commercial division and replanting is recommended during August. Root growth and flower initiation follow in September and October. As such, German iris has a short intense period of spring bloom and sale; followed by a long summer of relative inattention.

At maturity, leaf height of German iris may exceed 2.5 feet with flower panicles held higher still. With the exception of tall broadleaf annual and perennial weeds, few grass or short weeds seem to affect iris growth and development. Field-grown iris have gained in popularity as means to maximize crop return while minimizing crop investment but are subject to a wide variety of both grass and broadleaf weeds. Current commercial "wisdom" favors production with a minimum of weed control efforts followed by handweeding at the time of transplant. Herbicides may be used to "clean-up" the crop early the following May but summer weed encroachment is rarely addressed. The resulting fields are often infested with annual grasses such as crabgrass, annual bluegrass and annual sedge, perennial grasses such as red fescue and hairgrass and perennial rosette weeds such as dandelion, plantain, ox-eye daisy, etc. In a two year survey, iris grown in such weedy conditions were seldom of salable quality as field grown stock and frequently exhibited insect feeding damage and leaf blight.

Two major pests of German iris, the iris borer and iris leaf blight can both alone and together decimate German iris crops and may account for near total crop loss in years of protracted wet spring weather (spring of 1998). Both appear to be favored by the presence of weeds and excess mulch and both are subject to intense management immediately prior to and during bloom.

[1] Northeast Turf and Ornamental Research, Raymond, N.H. 03077

Control efforts aim to eradicate both pests prior to the onset of summer; additional applications of insect or disease control materials are rarely made until late summer division when one clean-up application is attempted as part of the propagation efforts.

This study was undertaken to determine if grassy and broad-leaf weeds in field grown German iris provided an environment conducive to continued disease and insect pressure. This study sought to determine if the use of weed control practices; both mechanical and chemical, could minimize the extent and severity of infestation.

MATERIALS AND METHODS

Three and two year old iris plants of mixed commercially available cultivars were used for evaluation. Iris were established in September 1997 as three plants per plot with three replicate plots for a total of nine plants per treatment. Weed control treatments were initiated in the spring of 1998 and included check plots with no treatment; hand weeding accomplished once in mid-June; hand weeding accomplished once monthly for five months; Dacthal applied at label rate on May 1 and Dacthal + Roundup at label rates applied June 1. Separate insect and disease control measures were used: Cygon or Curalan, repectively, was applied at label rates on May 1 and June 1, and a surfactant incorporated to ensure coverage.

Weed canopy densities were visually estimated on a scale of 1-10 where 1 was no weed cover and 10 was crop loss and complete weed cover. Estimates were made monthly in May, June, July and August. Leaf blight lesions were counted on each of the two most recently expanded leaves and counts were made twice monthly. Actual surface area was estimated as lesion length x width and was made once in June but will not be reported here. Iris borer damage was counted as the number of leaves exhibiting feeding sites visible per plant (three to ten leaves) in May and again in June. End of season corm counts were made in August and reflect crop and corm loss as a result of borer activity. The number of possible commercial sized divisions per plant was determined in August as a measure of plant health.

RESULTS AND DISCUSSION

Annual grass weeds and a wide array of various prostrate broad leaf weeds occurred in all non-herbicide treated plots. Crabgrass, foxtail, barnyard grass, starwort, carpetweed, ox-eye daisy, evening primrose etc. developed in late May and/or in late June in plots treated with Dacthal or Dacthal + Round-up. Insect damage was first observed in late April; continued insect feeding, egg laying and larval migration into corms occurred throughout May, June and July. Initial pinpoint leaf lesions of Didymellina leaf blight were visible May 15th and continued to increase in both size and in number throughout the summer months.

Without weed control treatments, weed canopies overtook crop canopies and significantly retarded crop growth and development. Flower and leaf number, flower size and plant height were all reduced by high numbers of weeds (Table 1). All leaves in all control plants supported 5 or more leaf lesions and all plants exhibited 3 or more insect feeding sites. By August, 82 % of the control corms were infested with borers and the control crop was considered a total loss.

One single hand weeding event did not significantly reduce disease or insect pressure and results paralleled that of control plants.

Frequent hand weeding reduced weed canopies to low levels on an intermittent basis. Weed regrowth occurred sporadically. Disease and insect damage still resulted in losses of 50% or greater. Flower number and size and leaf number were equivalent to those plants whose weed canopies were chemically removed. Nearly all leaves supported three or more leaf lesions and 2 or more insect feeding sites. 40% of all corms were damaged beyond survival and few lateral corm buds could be harvested for commercial division.

Plots treated with herbicides had significantly fewer insect feeding sites in May, June and July. Routine herbicide retreatment further reduced insect feeding damage to less than 25% of the expanded leaves. By August only 12% of the corms were irreparably damaged by iris borer.

Plants in herbicide treated plots had fewer disease lesions but the overall surface area was not significantly different from that of untreated plants. Weed canopy or cleanliness significantly influenced losses associated with iris borer but did not appear to affect iris susceptibility to Didymellina leaf blight (Graph 1).

Insect and disease control applications were ineffective in suppressing damage when applied to control, hand weeded or weed infested plots (Table 2). Over-the-top or broadcast applications did not appear to deposit sufficient material on foliage nearly hidden in the weed canopy. Broadcast applications did not improve insect and disease control and losses paralleled those of non-treated plants. Insect and disease control applications were initially effective when applied to plants in Dacthal- treated plots. As the summer progressed, however, weed breakthrough compromised targeted insect and disease applications and the actual amount of spray deposited on iris leaves rather than weeds remains questionable.

Fungicides and insecticides provided excellent control when applied to plots previously treated with the pre/post herbicide combination. Sufficient crop contact and translocation occurred to insure adequate control and 88% or more of the crop survived. Plants averaged 6 or more divisible corms in August.

CONCLUSIONS

German Iris cannot be successfully produced without the combined inputs of weed, insect and disease control materials. Increasingly dense weed canopies will suppress crop growth, flower number and flower size. Increasingly dense weed canopies will interfere with spray deposition and limit pesticide efficacies.

Minimizing weed canopies will minimize iris borer leaf feeding and increase both corm survival and the number of potential divisions from those corms. Effective pre-season weed control will increase the success of insecticide applications and minimize the environment conducive to iris borer egg laying, feeding and development. Minimizing weed canopies had no appreciable effect of the occurrence of leaf blight but excessive weed canopies suppressed fungicide efficiency and therefore increased the severity of infection. The potential increase in relative humidity resulting from weed encroachment was not measured in this study but may account, in part, for the increases in disease severity in those plots with poor weed control.

Despite a short crop sale season; continued attention to pest control will insure both crop survival and replication for later sales. A weed free environment will also ensure that far fewer iris borer eggs and larva and leaf blight lesions survive to act as propagules in current or subsequent crop years. Additionally, a weed free field environment will also minimize the transfer of weed seed into pots and minimizethe amount of handweeding and /or herbicide applicatioms required during the spring of the crop sale year.

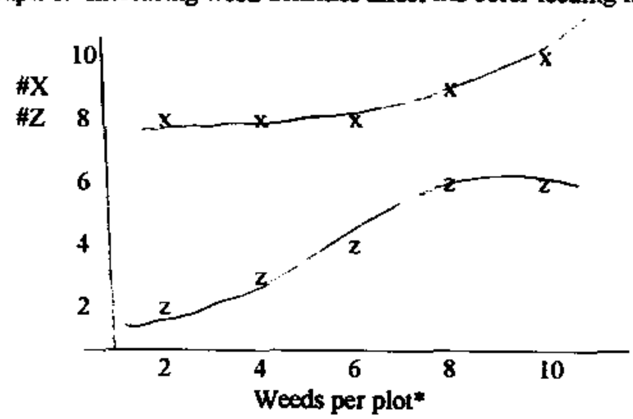
Table 1: Weed canopy, insect and disease infestation in German Iris as affected by weed control

Treatment:	Weed Canopy June 1	Weed Canopy July 1	Insect Feeding #/L May 1	Insect Feeding #/L June 1	Disease lesions #/L May 1	Disease lesions #/L June 1	Corm Survival August 1
Control	8.0	9.5	5.5	7.5	7.0	9.0	15%
Hand weed 1x	6.5	5.5	5.0	6.0	5.5	6.0	20%
Hand weed 5x	4.5	3.5	2.0	5.0	3.0	5.0	40%
Dacthal	<0.5	2.5	2.0	4.0	2.5	4.0	70%
Dacthal + Roundup	<0.5	1.0	1.0	2.0	2.0	3.0	88%
LSD 0.5	2.2	1.0	1.0	1.5	1.5	1.0	12%

Table 2: Effect of weed control on subsequent insect and disease control efforts in German Iris

Treatment:	Insect feeding #/L - insecticide	Insect feeding #/L + insecticide	Disease lesions #/L - fungicide	Disease lesions #/L + fungicide	# Corm Division Per plant	
Control	9.0	7.0	36.6	30.2	0.0	1.0
Hand weed 1x	8.0	7.0	30.5	26.5	0.0	1.0
Hand weed 5x	6.0	5.0	28.5	24.5	1.0	2.0
Dacthal	2.0	0.0	26.5	12.2	2.0	3.0
Dacthal + Roundup	1.0	0.0	28.2	10.2	2.0	6.5
LSD 0.05	2.5	1.6	10.2	4.2	0.5	0.5

Graph 1: Increasing weed densities affect iris borer feeding intensity but not disease development



leaf lesions per 2 fully developed leaves (x)
insect feeding sites per plant (z)

* Visual estimates (1-10) of increasing weed densities from hand weeded and control plots arrayed together.

BRUSH CONTROL WITH DORMANT SEASON HERBICIDE APPLICATIONS IN JANUARY AND APRIL

A. E. Gover, J. M. Johnson and L. J. Kuhns[1/]

ABSTRACT

Dormant season brush control treatments provide vegetation managers a longer operational season, and more contractual flexibility. Currently, the only operationally viable dormant technique is basal bark application, which is useful for low to moderate density brush with stem diameters up to 15 cm. Where the brush is small, and high density, such as resprout clusters, basal bark becomes very laborious. A dormant application that could be quickly applied to small, dense brush would facilitate follow-up herbicide applications to mechanical operations. As part of an ongoing research project funded by the PA Department of Transportation, six aqueous herbicide combinations were evaluated for control of brush resprouts provided by January or April applications. Treatments included glyphosate[2/] at 90 g/L alone or combined with imazapyr[3/] at 1.2 g/L, with either of two experimental adjuvants, MON 59120 or MON 59175, each at 10 percent v/v; and glyphosate at 36 g/L plus imazapyr at 1.2 g/L, or imazapyr alone at 1.2 g/L, each with MON 59120 at 10 percent v/v. The January applications included propylene glycol at 10 percent v/v. The January applications were made to first year resprouts on an electric distribution right-of-way (ROW), near Freedom, PA, on January 16, 1998. The targets ranged from 0.3 to 1.5 m in height. Sprout cluster density averaged 4100/ha, and average application volume was 90 L/ha. Applications were made with a CO_2-powered, hand-held sprayer equipped with a single Spraying Systems #5500 Adjustable ConeJet with an X-6 tip. Plots were 23 by 6 m, arranged in a randomized complete block with two replications. Predominant species were black cherry (*Prunus serotina* Ehrh.), sassafras (*Sassafras albidum* (Nutt.) Nees), and red oak (*Quercus rubra* L.), with lesser amounts of black locust (*Robinia pseudoacacia* L.). The April trial was established on an electric transmission ROW near Aliquippa, PA, on April 21, 1998. The brush was two-season resprouts, ranging from 1 to 3 m in height, with phenology ranging from bud swell to 10 percent leaf-out (flowering in sassafras). Applications were made with a CO_2-powered, hand-held sprayer equipped with a single Spraying Systems 1504 flat fan tip, providing an average application volume was 150 L/ha. Plots were 10 by 10 m, arranged in a randomized complete block with two replications. Predominant species were staghorn sumac (*Rhus typhina* L.) and sassafras, with lesser amounts of black cherry, black locust , and red oak. Visual assessments of treatment effect were taken for each trial on August 6, 1998. On the January site, each sprout cluster was rated on a 1 to 4 scale, where '1'=no effect, '2'=injury, but recovery likely, '3'=injury, mortality likely, and '4'=dead. Percent mortality was calculated by dividing the number of stems rated '3' and '4' by the number of total stems. On the April site, non-suckering species such as black cherry and red oak were rated individually using the 1 to 4 scale, while sumac and sassafras were rated for the entire plot on the 1 to 4 scale.

Collective results from the January site, and black cherry results from the April site are listed in Table 1. None of the January treatments were effective, with percent mortality ranging from 20 to 41 percent. The April applications were very effective on black cherry, ranging from 83 to 100 percent mortality. The ratings on the suckering species were not enlightening, as sumac and sassafras were given a '2' in each plot. Treated sumac and sassafras stems were effectively controlled, but root suckering was vigorous. The addition of imazapyr to glyphosate at 90 g/L appeared to reduce the number of resprouts, but not individual vigor. The operational effect on suckering species was a one year delay, as the sumac and sassafras resprouts were generally as tall as the treated stems.

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[2/] Accord Herbicide, isopropylamine salt of glyphosate, 360 g ae/L, Monsanto, St. Louis, MO.

[3/] Arsenal, isopropylamine salt of imazapyr, 240 g ae/L, American Cyanamid Co., Wayne, NJ.

Table 1: Percent mortality of resprout clusters treated January 16 and April 21, 1998. January results are for all species on site, primarily black cherry, sassafras, red oak, and black locust, and are the mean of two replications. April results are black cherry only. The number of targets is indicated in parentheses.

Treatment	Spray Solution Concentration	January Trial	April Trial
		--percent mortality (# plants)--	
glyphosate[1] MON 59120[2]	90 g/L 10 % v/v	35	83 (6)
glyphosate MON 59175[2]	90 g/L 10 % v/v	20	90 (20)
glyphosate imazapyr[3] MON 59120	90 g/L 1.2 g/L 10 % v/v	29	100 (19)
glyphosate imazapyr MON 59175	90 g/L 1.2 g/L 10 % v/v	22	83 (41)
glyphosate imazapyr MON 59120	36 g/L 1.2 g/L 10 % v/v	41	97 (18)
imazapyr MON 59120	1.2 g/L 10 % v/v	34	94 (18)
LSD (p=0.05)		n.s.	

[1] Accord Herbicide, isopropylamine salt of glyphosate, 360 g ae/L, Monsanto, St. Louis, MO.
[2] experimental adjuvant, Monsanto, St. Louis, MO.
[3] Arsenal, dimethylamine salt of imazapyr, 240 g ae/L, American Cyanamid Co., Wayne, NJ.

EFFECTS OF PRE-PLANT HERBICIDES ON THE ESTABLISHMENT OF FINE FESCUES DURING ROADSIDE RENOVATION

A. E. Gover, J. M. Johnson and L. J. Kuhns[1/]

ABSTRACT

Canada thistle (*Cirsium arvense* (L.) Scop.) is a common weed in roadside plantings of crownvetch (*Coronilla varia* L.) in Pennsylvania. Where infestations are severe, conversion to a grass mixture is a recommended option. As part of an ongoing research project funded by the PA Department of Transportation, a series of trials were established to evaluate several herbicides as tank mix partners for glyphosate to enhance the activity of the initial herbicide treatment against the Canada thistle-crownvetch complex without inhibiting grass establishment. Two trials were established to investigate the effect of herbicides applied at different intervals before seeding on the establishment of a fine fescue mixture. A trial seeded August 19, 1997, compared glyphosate at 3.4 kg/ha; clopyralid at 0.21 and 0.42 kg/ha; picloram at 0.56 and 1.1 kg/ha; chlorsulfuron at 0.021 and 0.042 kg/ha; metsulfuron methyl at 0.021 and 0.042 kg/ha; and imazapyr at 0.14 and 0.28 kg/ha. These treatments were applied 72, 36, 25, and 7 days before seeding (DBS). The experiment was seeded to a 55/35/10 percent mixture of hard fescue (*Festuca brevipila* Tracey), red fescue (*Festuca rubra* ssp. *rubra* L.) and annual ryegrass (*Lolium multiflorum* Lam.), respectively, seeded at 112 kg/ha. A second trial was seeded June 19, 1998, comparing glyphosate at 3.4 kg/ha alone and in combination with the same treatments as the 1997 trial, except for the deletion of the high rate of imazapyr, and the addition of triclopyr at 1.1 kg/ha and dicamba at 1.1 kg/ha. These treatments were applied 56, 28, 14, and 7 DBS. This trial was seeded to a 60/40 mix of hard fescue and creeping red fescue, respectively, at 112 kg/ha. The experimental design for both trials was a randomized complete block with a split-plot treatment arrangement, with application time as the whole plot. Both trials were conducted on an Opequon-Hagerstown complex (Lithic hapludalf) in a glyphosate-killed stand of Kentucky bluegrass (*Poa pratensis* L.). Prior to study initiation, the killed sod was shredded with a Lely Roterra to an approximate depth of 5 cm to expose the mineral soil. The seeding was done with a tractor-mounted slice seeder, dropping seed over slits approximately 1.2 cm deep on 7.6 cm centers. Both trials were irrigated as needed to keep the seedbed moist.

For first season ratings of grass establishment, there was a significant interaction between application timing and herbicide treatment for both trials. There was no significant effect due to herbicide treatment for the earliest application dates in either trial. Establishment differences became evident in the treatments applied 36 DBS in the 1997 trial, and 28 DBS in the 1998 trial. In the 1997 trial, for percent total cover ratings taken 64 days after seeding, the 36 DBS glyphosate treated plots had 77 percent cover, while chlorsulfuron at 0.026 and 0.052, and imazapyr at 0.28 kg/ha had significantly less cover at 55, 33, and 30 percent respectively. As the interval between treatment and seeding decreased to 7 days, imazapyr at 0.14 and metsulfuron methyl at 0.021 and 0.042 kg/ha also significantly reduced ground cover compared to glyphosate alone.

In 1998, for ratings of percent fine fescue cover taken 125 days after seeding, glyphosate plus picloram at 3.4 plus 0.56 kg/ha treatments had 93 and 94 percent fine fescue cover, for the 28 and 7 DBS treatments, respectively. Chlorsulfuron at 0.052, metsulfuron methyl at 0.042, and imazapyr at 0.14 kg/ha, applied 28 DBS, were rated significantly lower at 42, 48, and 55 percent, respectively. At 7 DBS, these three treatments provided 10, 42, and 30 percent cover respectively. Percent fine fescue cover ratings in the 1997 trial, taken in October, 1998, ranged from 94 to 97 percent, indicating that full stands can develop despite inhibition during early establishment. However, considering that clopyralid, picloram, dicamba, or triclopyr did not inhibit establishment under any of the observed conditions, there is little justification to potentially reduce establishment during renovation by including chlorsulfuron, metsulfuron methyl, or imazapyr in the pre-plant application.

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