THE COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

PENNDOT

ROADSIDE VEGETATION MANAGEMENT
RESEARCH REPORT
SEVENTEENTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY

RESEARCH PROJECT # 85-08
REPORT # PA 03-4620 + 85-08

PENNSTATE

1855

REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
July 03, 2003

3. REPORT TYPE AND DATES COVERED
Seventeenth Annual Report (3/23/02 to 3/18/03)

4. TITLE AND SUBTITLE
Roadside Vegetation Management Research Report - Seventeenth Year Report

5. FUNDING NUMBERS
359704 WO#2

6. AUTHOR(S)
Art Gover
Jon M. Johnson
Larry J. Kuhns

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Pennsylvania State University
College of Agricultural Sciences
University Park, PA 16802

8. PERFORMING ORGANIZATION REPORT NUMBER
PA-4620-03-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
The Pennsylvania Department of Transportation
Commonwealth Keystone Building, P.O. Box 2857
Bureau of Maintenance and Operations, 6th Floor
Harrisburg, PA 17105-2857

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Research Project - 4620
Project Manager - Joe Demko - Bureau of Maintenance and Operations, Office of Roadside Development

12A. DISTRIBUTION/AVAILABILITY STATEMENT

12B. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The seventeenth year report on a cooperative research project between the Pennsylvania Department of Transportation, Bureau of Maintenance and Operations; and the Pennsylvania State University, College of Agricultural Sciences; including:
Brush control research evaluating basal bark and cut surface applications on ailanthus and black locust.
Evaluation of glyphosate formulations.
Control of Japanese stiltgrass.
Using Plateau herbicide as a plant growth regulator.
Evaluation of sulfometuron formulations, diuron, and prometon/diuron premixes for bareground weed control.
Review of 2002 Roadside Vegetation Management Conference Field Day.

14. SUBJECT TERMS
Keywords: basal bark, cut surface, glyphosate formulations, ailanthus management, Japanese stiltgrass control, plant growth regulator, bareground weed control, native species, slope stabilization, hydroseeding, Japanese knotweed management, reed canarygrass control.

15. NUMBER OF PAGES
60 pages

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
None	None	None	

ACKNOWLEDGMENTS

This research represents a cooperative effort between The College of Agricultural Sciences of The Pennsylvania State University and The Pennsylvania Department of Transportation. Personnel contributing to the production of this report include the following Penn State faculty and staff:

Arthur E. Gover	Research Support Associate
Jon M. Johnson	Research Support Associate
Larry J. Kuhns	Professor of Ornamental Horticulture

We would like to begin by thanking the PENNDOT District Roadside Specialists who have been instrumental in the success of this project's efforts. Thanks must also be extended to Robert Peda, Director of the Bureau of Maintenance and Operations, for his continued support. We would also like to thank the Central Office staff - Joe Demko and Barbara Schell-Magaro - who have contributed to and supported the research project. We were assisted in many phases of this work by student employee Jonathan Henry. Invaluable technical assistance was provided by Doug Banker and Tracey Harpster.

We are indebted to Tom Yocum, Stu Kehler, and others in District 9-0 who offered their expertise and assistance in preparation for the 2002 field day. We would also like to extend our thanks to Don Sharp and Al Schrand of Finn Corporation; Ron Ciolfi, Tom Master, Wayne Carberry, Art Perdue, and Derek and Steve Waskiewicz of Wolbert and Master; Glen Ballinger of Profile Products; and Doug Caldwell of River Valley Organics for providing their time, products, equipment, and expertise at the 2002 field day.

We would like to gratefully acknowledge the assistance of the representatives of the various manufacturers providing products for the vegetation management industry, who have lent their time, expertise, and material support on many occasions. The following manufacturers assisted this research project during the 2002 season with material support:

Aventis Environmental Sciences USA LP
Arborchem Products, Inc.
BASF Specialty Products
DowAgroSciences LLC
E.I. DuPont de Nemours & Co.
Exacto Chemical Company
Makhteshim-Agan of North America
Monsanto
Novartis Crop Protection, Inc.
Syngenta Professional Products

This project was funded by The Pennsylvania Department of Transportation, Bureau of Maintenance and Operations.

TABLE OF CONTENTS

INTRODUCTION

In October, 1985, personnel at The Pennsylvania State University began a cooperative research project with the Pennsylvania Department of Transportation to investigate several aspects of roadside vegetation management. An annual report has been submitted each year which describes the research activities and presents the data. The previous reports are listed below:

Report # PA86-018 + 85-08 - Roadside Vegetation Management Research Report

Report # PA87-021 + 85-08 - Roadside Vegetation Management Research Report
- Second Year Report

Report # PA89-005 + 85-08 - Roadside Vegetation Management Research Report
- Third Year Report

Report # PA90-4620 + 85-08 - Roadside Vegetation Management Research Report
- Fourth Year Report

Report # PA91-4620 + 85-08 - Roadside Vegetation Management Research Report
- Fifth Year Report

Report # PA92-4620 + 85-08 - Roadside Vegetation Management Research Report
Sixth Year Report

Report # PA93-4620 + 85-08 - Roadside Vegetation Management Research Report
Seventh Year Report

Report # PA94-4620 + 85-08 - Roadside Vegetation Management Research Report
Eighth Year Report

Report # PA95-4620 + 85-08 - Roadside Vegetation Management Research Report
Ninth Year Report

Report # PA96-4620 + 85-08 - Roadside Vegetation Management Research Report
Tenth Year Report

Report # PA97-4620 + 85-08 - Roadside Vegetation Management Research Report
Eleventh Year Report

Report # PA98-4620 + 85-08 - Roadside Vegetation Management Research Report
Twelfth Year Report

Report # PA99-4620 + 85-08 - Roadside Vegetation Management Research Report
Thirteenth Year Report

Report # PA00-4620 + 85-08 - Roadside Vegetation Management Research Report
Fourteenth Year Report

Report # PA01-4620 + 85-08 - Roadside Vegetation Management Research Report
Fifteenth Year Report

Report # PA02-4620 + 85-08 - Roadside Vegetation Management Research Report
Sixteenth Year Report

Use of Statistics in This Report

Many of the individual reports in this document make use of statistics, particularly techniques involved in the analysis of variance. The use of these techniques allows for the establishment of a criteria for significance, or, when the differences between numbers are most likely due to the different treatments, rather than due to chance. We have relied almost exclusively on the commonly used probability level of 0.05. When a treatment effect is significant at the 0.05 level, this indicates that there is only a five percent chance that the differences are due to chance alone. At the bottom of the results tables where analysis of variance has been employed, there is a value for least significant difference (LSD). When analysis of variance indicates that the probability that that variation in the data is due to chance is equal or less than 0.05, Fisher's LSD means separation test is used. When the difference between two treatment means is equal or greater than the LSD value, these two values are significantly different. When the probability that the variation in the data is due to chance is greater than 0.05, the L.S.D value is reported as 'n.s.', indicating non-significant.

This report includes information from studies relating to roadside brush control, herbaceous weed control, roadside vegetation management demonstrations, and total vegetation control under guiderails. Herbicides are referred to as product names for ease of reading. The herbicides used are listed on the following page by product name, active ingredients, formulation, and manufacturer.

Product name, active ingredients, formulation, and manufacturer information for products referred to in this report.

Trade Name	Active Ingredients	Formulation	Manufacturer
Arborchem Basal Oil	diluent	- - -	Arborchem Products, Inc.
Arsenal	imazapyr	2 S	BASF Specialty Products
Assure II	quizalofop-P	0.88 EC	E.I. DuPont de Nemours & Co.
Derringer	glufosinate-ammonium	1 S	Aventis Environ. Sci. USA LP
Direx	diuron	4 L	Griffin LLC
Embark	mefluidide	2 S	PBI Gordon Corporation
Endurance	prodiamine	65 WG	Novartis Crop Protection, Inc.
Envoy	clethodim	0.94 EC	Valent Professional Products
Event	imazethapyr + imazapyr	1.46 L	PBI Gordon Corporation
Escort	metsulfuron methyl	60 DF	E.I. DuPont de Nemours & Co.
Fusilade II	fluazifop-P	2 EC	Syngenta Professional Products
Garlon 4	triclopyr	4 EC	DowAgroSciences LLC
Glyflo	glyphosate	4 S	Top-Pro
Glyphosate	glyphosate	4 S	E.I. DuPont de Nemours & Co.
Glypro	glyphosate	5.4 S	DowAgroSciences LLC
Goal	oxyfluorfen	1.6 E	DowAgroSciences LLC
Hi-Dep	2,4-D	3.8 S	PBI Gordon Corporation
Karmex	diuron	80 DF	E.I. DuPont de Nemours & Co.
Krenite S	fosamine ammonium	4 S	E.I. DuPont de Nemours & Co.
Krovar I	bromacil + diuron	80 DF	E.I. DuPont de Nemours & Co.
MANA-202	diuron	7 F	Makhteshim-Agan of N. Amer.
MANA-203	diuron	90 DF	Makhteshim-Agan of N. Amer.
Metgard	metsulfuron	60 DF	Makhteshim-Agan of N. Amer.
Milestone VM	azafeniden	80 DG	E.I. DuPont de Nemours & Co.
Oust	sulfometuron methyl	75 DF, 75 XP	E.I. DuPont de Nemours & Co.
Pendulum	pendimethalin	3.3 EC	BASF Specialty Products
Plateau	imazapic	2 S	BASF Specialty Products
Poast	sethoxydim	1.5 EC	BASF Specialty Products
Pramitol/Diuron	prometon + diuron	4L (2+2)	Control Solutions, Inc.
Prism	clethodim	0.94 EC	Valent U.S.A. Corporation
QwikWet 357	adjuvant	- - -	Exacto Chemical Company
Rodeo	glyphosate	5.4 S	Monsanto
Roundup	glyphosate	4 S	Monsanto
Roundup PRO	glyphosate	4 S	Monsanto
Roundup Pro Dry	glyphosate	71.4 DG	Monsanto
Sahara	diuron + imazapyr	DG	BASF Specialty Products
Spike	tebuthiuron	80 DF	DowAgroSciences LLC
Stalker	imazapyr	2 EC	BASF Specialty Products
Surflan	oryzalin	4 AS	DowAgroSciences LLC
Telar	chlorsulfuron	75 DF	E.I. DuPont de Nemours & Co.
Thinvert RTU	invert emulsion	- - -	Waldrum Specialties, Inc.
Tordon K	picloram	2 S	DowAgroSciences LLC
Touchdown Pro	glyphosate	3 S	Syngenta Professional Products
Vanquish	dicamba-glycolamine	4 S	Syngenta Professional Products
Velpar DF	hexazinone	75 DF	E.I. DuPont de Nemours & Co.
Velpar L	hexazinone	2 S	E.I. DuPont de Nemours & Co.

EFFECT OF BASAL BARK APPLICATION TIMING ON SUPPRESSION OF AILANTHUS RESPROUTS

Herbicide trade and common chemical names: Garlon 4 (*triclopyr*).
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*)

ABSTRACT

This trial investigated the effect of timing of basal bark applications on the amount of resprouting. The phenological timings chosen were bud swell, full leaf expansion, post seed development, and dormancy. The corresponding application dates were April 20, July 12, September 13, and November 20, 2001, respectively. By August 2002, all treated stems were controlled and only first and second year resprouts were counted. Basal area ranged from 6.7 to 14.3 in.^{2} for the treated plots. This represents from 4.1 to 17.6 percent of what originally was present. Resprout height varied from 10.6 to 18.1 in. for the treatments. There were no statistical differences found between any of the treatment dates for any of the data collected.

INTRODUCTION

Ailanthus is a troublesome, root-suckering tree species common to Pennsylvania's roadsides. There has been a concerted effort by this Project to find effective methods of controlling this species through past studies and demonstrations. Mechanically or chemically treating ailanthus usually results in a dramatic flush of root sprouts.

This trial was conducted to compare the effect of basal bark application timing on reducing the resprouts from roots of ailanthus. The phenological timings chosen were bud swell, full leaf expansion, post seed development, and dormancy. The corresponding application dates were April 20, July 12, September 13, and November 20, 2001, respectively.

MATERIALS AND METHODS

This trial was located on I-81 along the southbound off ramp to SR 114 near Mechanicsburg, PA. The study area was a south facing cut slope with a large, established stand of ailanthus. The herbicide mixture used in the study included 25% Garlon 4 and 75% Arborchem Basal Oil[1/] v/v, plus a dye indicator. The treatments were applied to completely cover the lower 12 in. of each stem. The average volume applied per treatment ranged from 22.3 to 32.4 gal/ac. Application equipment included backpack sprayers equipped with a Spraying Systems #5500 Adjustable ConeJet nozzle with a Y-2 tip. The area was arranged in a randomized complete block design with three replications. Plot size was 40 by 40 ft. with 20 by 20 ft. subplots located in the center of each. All data was collected within each subplot. Initial stem counts and tree diameters were taken at the time of treatment. The initial data for the untreated plots was recorded on October 18, 2001. Tree diameters were measured at approximately 6 in. above the soil surface. Resprout information was collected between August 1 and 5, 2002 for all treatments.

[1/] A 1:3 mixture of Garlon 4 (4 lb triclopyr acid/gal, as the butoxyethyl ester, Dow AgroSciences, Indianapolis, IN) and Arborchem Basal Oil (Arborchem Products, Mechanicsburg, PA).

RESULTS AND DISCUSSION

Prior to treatment the plots averaged from 117 to 188 stems/subplot. Basal area ranged from 98 to 210 in^2. By August 2002, the average number of sprouts within each subplot had increased from the original count. Basal area decreased for all treated plots regardless of timing. All treated stems were controlled and only first and second year resprouts were counted. Basal area ranged from 6.7 to 14.3 in^2 for the treated plots. This represents from 4.1 to 17.6 percent of the basal area originally present. The resprout basal area for the untreated check is reported as percent increase due to sprouting and does not include the basal area of the living, original stems. Resprout height varied from 10.6 to 18.1 in. for the treatments. There were no statistical differences found between any of the treatment dates for any of the data collected. The untreated check was not included in the statistical analysis.

CONCLUSIONS

Previous work had suggested that there was a correlation between basal bark application timing and the amount of resprouting on ailanthus. The results of this test did not reproduce these previous observations. Basal bark applications made to ailanthus serve to reduce the basal area by controlling the large treated stems. Some degree of resprouting can be expected regardless of the time of year the application is made. Primary control measures made on ailanthus require a follow-up to ensure proper management of this species.

MANAGEMENT IMPLICATIONS

Basal bark treatments are an effective tool for controlling large ailanthus trees that pose no threat of falling onto the roadway or create some other foreseen hazard. This application is regarded as one option, as a first step, to managing an ailanthus stand. There will always be a need for foliar follow-up treatments. This application, when applied correctly to the root collar, will prevent vigorous sprouts from developing off the trunk of the tree. Root sprouts do not grow as rapidly as sprouts that develop from the base of the tree. Therefore, root sprouts that arise from a basal application are much easier to target with a foliar follow-up treatment due to their reduced size.

Table 1: Basal bark applications of Garlon 4 at 25% in Arborchem Basal Oil were made to ailanthus on either April 20, July 12, September 13, or November 20, 2001. Resprout information was recorded between August 1 and 5, 2002. Data on original stem number and basal area, plus the resprout stem number, basal area, and average resprout height within a 400 ft^2 sub-plot for each treatment are presented. The number in parentheses next to resprout stem number indicates the percent increase in stem number from the original. The number in parentheses following the resprout basal area represents the percent of resprout basal area compared to the original basal area present for that treatment. Each value is the mean of three replications.

Application	Original		Resprout		
Timing	Stem No.	Basal Area	Stem No.	Basal Area	Height
		(in^2)		(in^2)	(in)
untreated[a]	117	165	235 (167%)	4.0 (3.2%)	7.5
Apr 20	157	178	197 (137%)	11.5 (8.0%)	18.1
Jul 12	160	210	270 (226%)	9.8 (5.6%)	10.6
Sep 13	188	156	295 (217%)	6.7 (4.1%)	11.4
Nov 20	157	98	487 (324%)	14.3 (17.6%)	10.6
LSD (p=0.05)	n.s.	n.s.	n.s. (n.s.)	n.s. (n.s.)	n.s.

[a]The untreated check was not included in the statistical analysis.

EFFECT OF CUT SURFACE APPLICATION TIMING ON SUPPRESSION OF AILANTHUS RESPROUTS

<u>Herbicide trade and common chemical names</u>: Garlon 4 (*triclopyr*).
<u>Plant common and scientific names:</u> tree-of-heaven or ailanthus (*Ailanthus altissima*)

ABSTRACT

This trial investigated the effect of application timing on resprouting following cut surface applications of Garlon 4 on ailanthus. Four timings were chosen including bud swell, full leaf expansion, post seed development, and dormancy. The corresponding treatment dates were April 24, July 5, August 30, and November 15, 2001. Each timing included cutting alone and cut plus stump treatment with 25% Garlon 4 in Arborchem Basal Oil. Herbicide treatments were made to the stumps immediately following cutting. Ratings were taken August 15 through September 14, 2002, one year after treatment (YAT). Significant root suckering occurred with all treatments regardless of herbicide treatment or timing. Average root sucker height was the only significant interaction. The April 24 timing resulted in taller root suckers for the herbicide treated plots than the July 5 and November 15 timings with heights of 24, 12, and 15 inches, respectively. Two possible explanations for this difference are the April 24 timing had more time to develop larger root suckers, plus there would have been a greater buildup of carbohydrates in the roots to fuel the growth of root suckers compared to the other timings. Only a few treated stumps resprouted. This happened in the August timing only and may be the result of overlooked stumps that were untreated. Sprouting did occur on the stumps of untreated plots.

INTRODUCTION

Ailanthus is a troublesome tree species that needs to be controlled for a variety of reasons including the height of growth (reaching 60 ft.), weak-wood, root suckering ability, rapid growth, adaptation to poor quality sites, allelopathic abilities which limits the growth of neighboring plants, and lack of insect or disease pests. Controlling ailanthus has been a focus of this project's research efforts in recent years. Several trials and demonstrations have indicated that ailanthus root suckering may be reduced by applications made during the growing season. The movement of carbohydrates toward the roots during this time would suggest that perhaps herbicides would more readily be translocated to the roots if applied from full leaf out until leaf drop. This study investigates the effect of application timing on reducing ailanthus root suckering following cut surface applications.

MATERIALS AND METHODS

The study was established along the shoulder of the SR 114 off-ramp of I-81 South near Mechanicsburg, PA. Treatments were applied on April 24, July 5, August 30, and November 15, 2001. The four timings correlate to phenological events occurring throughout the year. The timings included bud swell, full leaf expansion, post seed development, and dormancy. Each timing included both an herbicide treated and untreated plot. The herbicide mix used in the trial was Garlon 4 at 25% diluted in Arborchem Basal Oil, plus a dye indicator[1]. The herbicide

---

[1] A 1:3 mixture of Garlon 4 (4 lb triclopyr acid/gal, as the butoxyethyl ester, Dow AgroSciences, Indianapolis, IN) and Arborchem Basal Oil (Arborchem Products, Mechanicsburg, PA), plus a dye indicator.

mixture was applied immediately following cutting to the cut surface and sides of the stump to the soil line using a squirt bottle. This mix was used for all four timings involved in this trial.

Plots were 40 by 40 feet arranged in a randomized complete block design, RCBD, with three replications. Subplots measuring 20 by 20 ft were located in the center of each plot. All measurements were taken within the subplots to allow the surrounding areas to act as a buffer from adjacent treatments. Due to a preexisting decline in the ailanthus stand that went unnoticed at the onset of the study, five additional plots were created to replace those not suitable for evaluation.

Information for each plot was collected in the days preceeding the treatment and included both a stem count and tree diameter measurement. Original stem caliper measurements were taken 6 inches above soil line. This data was used to calculate original stem numbers and original basal area. Root sucker and stump sprout information was collected from August 15 through September 14, 2002 and included the diameters (measured at 3 inches above soil line or at point of attachment on stump), height, and number of each. Throughout this text there is reference made to both root suckers and stump sprouts. Root suckers are sprouts originating from the soil and primarily arise from roots, but may include some seedlings. Stump sprouts are sprouts originating from the stump. The number and caliper of stumps that had at least one resprout was also recorded. These were considered to be surviving stumps. Information collected was used to determine percent cut stem mortality, stump sprouts per stem, average stump sprout height, average root sucker height, and total sprout basal area. Percent cut stem mortality represents the reduction in the number of original stems cut compared to the number of stumps that had resprouted one year after treatment (YAT). Stump sprouts per stem is the average number of sprouts arising from surviving stumps for each treatment. Average root sucker and stump sprout height is the average height of each corresponding type of sprout. Total sprout basal area includes the area of both root suckers and stump sprouts recorded one YAT.

RESULTS AND DISCUSSION

The site for this trial was a mature stand of tree-of-heaven. The entire embankment averaging 150 wide and stretching 0.25 mile was heavily infested by this species. One tree was observed to be 24 years old while several others were of similar age. Trees in the study area showed symptoms of obvious decline even in untreated plots throughout the 2001 season. The reasons for this are unclear. The study was initiated in April of 2001 prior to leaf-out. It was not obvious, at this point, that many trees were dead or dying throughout the trial area, especially in one half. With the trial largely underway by the time the symptoms became evident, it was decided to continue despite the potential problems this factor presented.

The cause of stand decline remains uncertain. No herbicide treatments were recorded for this area in recent years. The pattern of injury was not symptomatic of herbicides either. There were various insect populations feeding on the root suckers and stump sprouts throughout the 2001 and 2002 growing season, but nothing that would cause the stand to decline significantly. Verticillium wilt (*Verticillium albo-atrum* and *V. dahliae*) has been shown to affect tree-of-heaven[2]. Symptoms that appeared to indicate verticillium wilt were noted within the stand, but laboratory results could not substantiate this claim. The shaley soil typical of the site, along with drought conditions in previous seasons, could have had a negative impact on the stand as well. This is unlikely since ailanthus is so tolerant of adverse site conditions. While it was not obvious

[2] Stipes J.R. and M.A. Hansen. May 2000. Verticillium Wilt of Shade Trees. Virginia Cooperative Extension. Publication Number 450-619.

what caused the initial decline, it was felt that with the substitution of five plots in an adjacent area that a fair evaluation of the treatment effects could be documented. Sprout mortality was probably greater within the boundaries of the original study area than under normal conditions due to the environmental impacts noted above.

Although there was an obvious reduction in height and basal area among both treated and untreated plots, herbicides did not significantly impact the amount of suckering from the roots. Resprout numbers far exceeded the original stem counts for all treatments. With the elimination of the originally treated stems, the overall height of the canopy was obviously reduced. By fall 2002 the basal area still had not approached the initial basal area measurements recorded for each treatment. Original basal area ranged from 85 to 239 in^2 while basal area measurements of all resprouts, 1 YAT, ranged from 5 to 64 in^2. Almost all herbicide treatments, regardless of timing, completely prevented sprouting from the stumps. The only exception was the August 3rd timing in which an average of 2 stumps per plot survived. This may have been the result of a few inadvertantly untreated stumps.

A statistical analysis of the interaction of herbicide by timing, using original stem numbers and original basal area as covariates, revealed only average root sucker height as significant. Since original stem numbers and original basal area were not significant when used as covariates their significance levels are not reported. A closer examination of the average root sucker height revealed a significant timing effect within the treated plots. The root sucker height was greater for the April 24 timing in the herbicide treated plots than the July 5 and November 15 timings with heights of 24, 12, and 15 inches, respectively. Two possible explanations for this difference are the April 24 timing had more time to develop larger root suckers, plus there would have been a greater buildup of carbohydrates in the roots to fuel the growth of root suckers compared to later timings. Three other interactions were close to being significant including percent cut stem mortality, number of stump sprouts per stem and average stump sprout height with significance levels of 0.0518, 0.0552, and 0.0673, respectively.

There were also significant differences between stumps treated with herbicides and those that were not. Herbicide treated plots had significantly fewer stump sprouts, increased cut stem mortality, lower average stump sprout height, and less total sprout basal area than plots where no herbicide was applied.

CONCLUSIONS

This trial clearly demonstrated that treating the stumps, regardless of timing, will eliminate stump sprouts. Herbicides should be applied to the stumps to keep vigorous stump sprouts from returning. The height of stump sprouts ranged from 2 inches to 14 ft. in this study with the greatest average stump sprout height being 60 inches for the untreated April 24 timing. Root suckers are somewhat less vigorous and ranged from 1 in. to 12 ft. with the greatest average height being only 34 inches for the untreated July 5 timing. Although timing was significant for average root sucker height in the treated plots the difference was not substantial enough to suggest this timing over the others.

This study does not substantiate the claim that applications made during the growing season will reduce root suckering. It does demonstrate the importance of treating stumps and planning ahead for followup foliar applications to an ailanthus stand. Cutting ailanthus and treating the stumps resulted in few, if any, stump sprouts and root suckers averaging 24 inches or less by one YAT. Although there will be a few root suckers that attain greater heights, the majority will be short enough to reasonably treat with foliar applications the year after cutting.

MANAGEMENT IMPLICATIONS

Cut surface treatments should be applied immediately following a clearing operation. Timing seems to be less critical with this application method on ailanthus since translocation to the roots has been minimal, at best. Herbicide treatments applied to the surface and sides of the stump will prevent vigorous stump sprouts from developing. Followup foliar herbicide treatments should be made after one full growing season. This will ensure that the canopy is still at a height that can be treated with relative ease. Annual visits to address further root suckers should also be incorporated into the management plan. Each subsequent year should result in fewer root suckers. If a suitable groundcover does not become established then one should be seeded to the site. A groundcover comprised of grasses adapted to the site conditions would be best. A well established grass stand is competitive and allows for the continued use of selective herbicides to control ailanthus root suckers without damaging the grass groundcover.

Table 1: Summary of original stem and stump sprout numbers. 'Stump sprout number' is the total number of stump sprouts 1 YAT. 'Percent cut stem mortality' is the number of stumps that did not resprout divided by the number of original stems multiplied by 100. The 'stump sprout per stem' indicates the average number of stump sprouts per surviving stump. 'Average stump sprout height' is the average height of those sprouts originating from the stump. Original stem numbers were used as a covariate to derive other data and were not significant. Therefore, no significance levels were determined for original stem number. A '---' indicates that a significance level was not determined because the interaction was not significant. Each value is the mean of three replications.

Application Timing		Original Stem	Stump Sprout	Cut Stem Mortality	Stump Sprout per Stem	Avg. Stump Sprout Ht.
		(no.)	(no.)	(%)	(no.)	(in)
Untreated						
Apr 24	(n=3)	72	88	35	2.1	60
Jul 5	(n=3)	40	107	31	4.3	49
Aug 30	(n=3)	67	86	63	3.5	33
Nov 15	(n=3)	57	81	37	2.2	30
LSD (p=0.05)			---	n.s.	n.s.	n.s
Treated						
Apr 24	(n=3)	38	0	100	0	0
Jul 5	(n=3)	36	0	100	0	0
Aug 30	(n=3)	33	3	96	1.2	26
Nov 15	(n=3)	63	0	100	0	0
LSD (p=0.05)			---	n.s.	n.s.	n.s.
Interaction (Herbicide x Time)						
Significance Level (p)			0.7947	0.0518	0.0552	0.0673
Untreated	(n=12)	59	90	41	3	43
Treated	(n=12)	43	1	99	0.3	7
Herbicide						
Significance Level (p)			0.0001	0.0001	0.0001	0.0001
Apr 24	(n=6)	55	44	67	1.1	30
Jul 5	(n=6)	38	54	65	2.1	25
Aug 30	(n=6)	50	44	80	2.3	30
Nov 15	(n=6)	60	40	68	1.1	15
Time						
Significance Level (p)			0.8263	0.1784	0.0113	0.4068
LSD (p=0.05)			n.s.	n.s.	0.9	n.s.

Table 2: Summary of the root sucker number, total sprout number, average root sucker height, plus the original and total sprout basal area. The 'root sucker number' is the number of root suckers which may include some seedlings. 'Total sprout number' is the number of root suckers and stump sprouts 1 YAT. The 'average root sucker height' is the average height of all root suckers 1 YAT. Both original and total sprout basal area include the area of all stems within the subplot at the time of treatment and 1 YAT, respectively. Original basal area was used as a covariate to derive other data and was not significant. Therefore, no significance levels were determined for 'original basal area'. A '---' indicates that a significance level was not determined because the interaction was not significant. 'Average root sucker height' had a significant interaction, therefore LSD values were calculated. Each value is the mean of three replications.

Application Timing		Root Suckers	Total Sprouts	Average Root Sucker Ht.	Original Basal Area	Total Sprout Basal Area
		(#)	(#)	(in)	(in^2)	(in^2)
Untreated						
Apr 24	(n=3)	250	338	26	199	64
Jul 5	(n=3)	201	308	34	239	39
Aug 30	(n=3)	348	434	16	146	23
Nov 15	(n=3)	186	267	10	223	16
LSD (p=0.05)		---	---	n.s.		---
Treated						
Apr 24	(n=3)	274	274	24	161	22
Jul 5	(n=3)	157	157	12	85	5
Aug 30	(n=3)	170	173	20	176	15
Nov 15	(n=3)	235	235	15	142	13
LSD (p=0.05)		---	---	8		---
Interaction (Herbicide x Time)						
Significance Level (p)		0.7465	0.7758	0.0193		0.2617
Untreated	(n=12)	246	337	21	202	35
Treated	(n=12)	209	210	18	141	14
Herbicide						
Significance Level (p)		0.6453	0.1581	0.2282		0.0177
Apr 24	(n=6)	262	306	25	180	43
Jul 5	(n=6)	179	232	23	162	22
Aug 30	(n=6)	259	303	18	161	19
Nov 15	(n=6)	211	251	13	183	14
Time						
Significance Level (p)		0.8572	0.8993	0.0420		0.1090

EVALUATION OF HERBICIDES FOR CONTROL OF AILANTHUS USING CUT SURFACE APPLICATIONS

Herbicide trade and common chemical names: Escort (*metsulfuron*), Garlon 4 (*triclopyr*), GlyPro (*glyposate*), Krenite S (*fosamine*), Stalker (*imazapyr*), Tordon K (*picloram*),
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*).

ABSTRACT

This study investigates the effectiveness of several herbicides, alone and in combination, at reducing ailanthus resprouts. The application method used was cut surface. Large, healthy stands of ailanthus were cut in August of 2001 and treatments applied to the surface and sides of each stump immediately following the cutting operation. From September 5 to October 27, 2002 data was collected for each treatment to determine which herbicides were most effective at reducing resprouting both from the stump and roots. All treatments controlled resprouting equally. Stem mortality, that is, the percentage of stumps that did not resprout following treatment, was high for all treatments. The untreated plots had an average stem mortality of 52 percent, while stem mortality ranged from 84 to 96 percent in the treated plots. Apparently, simply cutting the stems resulted in some stem decline, but herbicide treatment resulted in significantly higher mortality. Stump sprouts are much more aggressive than those arising from roots. Any attempts to minimize stump sprouts will help in the long-term management efforts to control an ailanthus stand.

The number of root suckers that resulted were not significantly different among treatments, including the untreated check. An overall decline in basal area was observed for all treatments. Original basal area ranged from 234 to 546 in^2, while basal area in the treated plots one year after treatment (YAT) ranged from 17 to 36 in^2. The untreated check had a total sprout basal area of 74 in^2 which was significantly higher than the treated plots. This is largely due to the increased number and size of stump sprouts occurring in the untreated plots. The total height of the stump sprouts is also evidence of the vigorous nature of sprouts arising from the stump. The untreated check had a significantly higher cumulative height of stump sprouts than any of the treatments. Left untreated the stump sprouts flourished and added significantly to the volume of ailanthus returning to the site.

All treatments performed equally well and significantly reduced the number of sprouting stumps compared to the untreated control. The failure to control root suckers with any of the treatments suggests that the herbicides are not being effectively translocated to the root system. The application timing was thought to be the best possible time for movement of these herbicides to the roots. Perhaps the disruption to the vascular tissue during the cutting operation limits movement of these herbicides.

INTRODUCTION

Ailanthus is a problematic tree species that has become well established on many of Pennsylvania's roadsides. It is a root-suckering species that forms large colonies where it exists. It is fast growing, weak-wooded, and capable of growing to heights of 60 feet. Ailanthus also spreads readily by both the abundant seed it produces and the distribution of root fragments. This tree species has no significant insect or disease pests in the U.S. and has the ability to grow in poor quality sites. Because it flourishes in full sun and thrives in poor growing conditions the roadside provides an ideal environment for the establishment and spread of this species.

The cutting and removal of ailanthus is often necessary to eliminate large trees that present a hazard to the roadway. Cutting should be followed with an herbicide application to the stump to prevent sprouting from the stump. Throughout this text there is reference made to both stump sprouts and root suckers. Stump sprouts are defined as sprouts originating from the stump, while root suckers originate from the soil. Root suckers are primarily sprouts arising from roots, but may include some seedlings. Stump sprouts are much more aggressive than seedlings or suckers arising from the roots. In this trial one year old stump sprouts ranged in height from 1 in. to 10 ft. with an average height of 2.4 ft., while root suckers ranged from 0.4 in. to 8 ft. and averaged 1.4 ft. in height. Ideally, an herbicide applied to the cut surface would not only control stump sprouts, but also translocate to the root system and prevent suckering from the roots.

Based on results of previous trials and demonstrations, we feel that applications made later in the growing season will be most effective. This is a hypothesis we are testing in separate trials. Movement of carbohydrates to the root system occurs during the growing season once the canopy has developed enough to be self-supporting. This time of year would present phloem mobile herbicides the greatest opportunity to move into the roots. Treatments were applied in August because it fell within this proposed optimal timing.

Several herbicides were chosen for this trial including Garlon 4, Stalker, Tordon K, Glypro, Krenite S, and Escort. Garlon 4 and Stalker are both oil and water soluble. The remaining herbicides are water soluble. Tordon K will solubilize in oils that contain high amounts of emulsifiers. All these products, except Escort, are labeled for cut stump application. Garlon 4 alone at rates of 20 to 25% in oil is commonly used for this treatment method. Stalker or Tordon K can be added in lesser amounts to enhance the control of more difficult root-suckering species. Glypro at 50% solution or undiluted has been suggested to minimize resprouting of ailanthus in industrial applications. Therefore, both the undiluted Glypro and 50% Glypro plus Stalker were evaluated. Krenite S is also applied at 50% solution or undiluted. In this trial it was used at 50% Krenite S plus Stalker. Escort has shown excellent control of ailanthus in foliar trials and was included in this trial based on this previous work.

The appropriate rate of Escort for this application is unknown. For this trial it was diluted at a rate of 2.35 oz Escort per gallon of Arborchem Basal Oil. The Escort dosage was based on a target rate of 20 oz Escort/ac and previous volume estimates used for cut stump applications on neighboring ailanthus stands of 8.5 gal/ac. This Escort rate far exceeds the maximum annual use rate of 4 oz/ac Escort found on the label. This rate was established for experimental purposes only. If this dosage was ineffective, further investigation would be unnecessary.

MATERIALS AND METHODS

This trial was established on a cut slope along SR 81S, near Harrisburg, PA, on the following dates: August 8, 10, 14, and 15, 2001. Treatments included 20% v/v Garlon 4 alone or in combination with 2% Stalker or 5% Tordon K, all in Arborchem Basal Oil; 100% GlyPro; 50% GlyPro plus 2% Stalker in water; 50% Krenite S plus 2% Stalker in water; and 2.35 oz/gal Escort in Arbochem Basal Oil. Trees were cut down and then cut into pieces so they laid flat using chain saws. Immediately following cutting the cut surface and sides of each stump were treated using a squirt bottle with one of the treatments listed above. The study was arranged in a randomized complete block design with three replications. The first and second replications were contiguous while the third replication was located approximately one-quarter mile away.

Plot size was 20 ft. wide by 60-80 ft. deep. The caliper of all cut stems were measured and recorded just prior to or during cutting. Measurements were taken approximately six inches above the soil line. The number of stems cut was also recorded. This information was used to determine the original stem number and basal area. One year after treatment (YAT) all stump sprouts and root suckers within each plot were harvested and measured. The data was collected from September 5 to October 27, 2002. Root suckers were pulled out or cut at the soil line. The caliper, height, and number of root suckers was recorded. Caliper measurements of root suckers were taken at 3 inches above the soil line. Surviving stumps, those having at least one sprout, were also counted and their diameter measured. The number, caliper, and height of each stump sprout was also recorded. Stump sprouts were measured at the point of attachment to the stump.

The data collected was used to calculate both original and total sprout basal area. Total sprout basal area figures incorporate both stump sprouts and root suckers. Stem mortality is the percentage of stumps that did not develop a single stump sprout by 1 YAT. The total height of stump sprouts and root suckers is the cumulative total height of each type of sprout within the plot.

RESULTS AND DISCUSSION

Originally, the average number of trees within a plot ranged from 32 to 125 while basal area varied from 234 to 546 in^2. None of the original measurements were significantly different. The data collected 1 YAT showed no statistical differences among treatments, but the untreated check was significantly different than the treatments for several of the variables measured. The total number of root suckers averaged from 289 to 566 for the treatments and were not significantly different. Total sprout basal area, which includes stump sprouts and root suckers, was significantly higher for the untreated plots. Total sprout basal area averaged 74 in^2 in the untreated areas, but only 17 to 36 in^2 in the treated areas. The average number of stumps that resprouted was also significantly higher for untreated plots, with an average of 51 stumps resprouting versus 2 to 10 stumps resprouting within treated plots. A better indicator is the stem mortality which is the number of originally treated stumps that did not resprout. Treated areas had significantly higher stem mortality. Treated plots ranged from 84 to 96 percent mortality while untreated plots had an average stem mortality of only 52 percent. The total height of root suckers 1 YAT was not significantly different. Total root sucker height ranged from 4311 to 9580 in. The total height of stump sprouts in the untreated check was significantly higher than in the treated plots. The stump sprouts in the untreated check had a cumulative height of 5712 in. and the herbicide treated plots ranged from 52 to 778 in.

CONCLUSIONS

This study demonstrates that treating the stumps is critical to preventing the reestablishment of ailanthus from stump sprouts. While applying herbicides to the freshly cut stump did not effectively reduce root suckers, it did minimize sprouting from the stump. This, in turn, lessens the overall basal area and sprout height that returns the following season. By reducing the number of large stump sprouts there should be less energy produced to reinforce the root system. Also, with the canopy height reduced, it is much easier to apply followup foliar applications to areas that have been cut and stump treated.

MANAGEMENT IMPLICATIONS

Cut surface treatments should be applied immediately following a clearing operation. Timing and herbicide selection seems to be less critical with this application method since translocation to the roots has been minimal, at best. Herbicide treatments applied to the surface and sides of the stump will prevent vigorous stump sprouts from developing. Followup foliar herbicide treatments should be made after one full growing season. This will ensure that the canopy is still at a height that can be treated with relative ease. Annual visits to address further root suckers should also be incorporated into the management plan. Each subsequent year should result in fewer root suckers. If a suitable groundcover does not become established then one should be seeded to the site. A groundcover comprised of grasses adapted to the site conditions would be best. A well established grass stand is competitive and allows for the continued use of selective herbicides to control ailanthus root suckers without damaging the grass groundcover.

Table 1: Summary of original stem number, total sprout number, original basal area, and total sprout basal area. Original stem number and original basal area data were recorded near the treatment dates of August 8, 10, 14, and 15, 2001. The total root suckers is the number of sprouts emerging from the soil only, while total sprout basal area incorporates both stump sprouts and root suckers. These values were determined from data collected one year after treatment (YAT) from September 5 to October 27, 2002. All values are the mean of three replications.

Treatment	Application Rate	Original Stem No.	Total Root Suckers	Original Basal Area	Total Sprout Basal Area
	(% v/v)	(#)	(#)	(in^2)	(in^2)
Untreated	---	110	307	271	74
Garlon 4	20	90	385	361	32
Arborchem Basal Oil	80				
Garlon 4	20	125	402	546	26
Stalker	2				
Arborchem Basal Oil	78				
Garlon 4	20	102	289	288	22
Tordon K	5				
Arborchem Basal Oil	75				
GlyPro	100	92	566	352	32
GlyPro	50	32	434	251	36
Stalker	2				
Water	48				
Krenite S	50	84	380	344	19
Stalker	2				
Water	48				
Escort	2.35 oz/gal[1/]	91	355	234	17
Arborchem Basal Oil	95				
LSD (p=0.05)		n.s.	n.s.	n.s.	29

[1/] The rate of Escort used in this trial was determined based on a target of 20 oz Escort/ac. Similar areas were treated with cut surface applications at volumes of approximately 8.5 gal/ac of total solution. Based on these estimates 1.24 oz Escort was mixed in 100 mL of water and added to 1900mL of Arborchem Basal Oil.

Table 2: Summary of number of sprouting stumps, percent stem mortality, total height of stump sprouts, and total height of root suckers. Treatments were applied August 8, 10, 14, and 15, 2001. Sprout information was collected one year after treatment (YAT) from September 5 to October 27, 2002. The number of sprouting stumps represents any stump that has, at least, one sprout originating from it. Percent stem mortality is the percentage of stumps that had no sprouts by 1 YAT compared to the original stem count. The total height of stump sprouts is the cumulative height of all sprouts originating from the stump while total height of root suckers is the cumulative height of sprouts originating from the soil. All values are the mean of three replications.

Treatment	Application Rate	Stumps that Sprouted	Stem Mortality	Total Height Stump Sprouts	Total Height Root Suckers
	(% v/v)	(#)	(%)	(in.)	(in.)
Untreated	---	51	52	5712	5588
Garlon 4	20	4	94	299	7620
Arborchem Basal Oil	80				
Garlon 4	20	5	96	152	5904
Stalker	2				
Arborchem Basal Oil	78				
Garlon 4	20	2	96	147	4311
Tordon K	5				
Arborchem Basal Oil	75				
GlyPro	100	8	90	778	9580
GlyPro	50	4	84	559	7425
Stalker	2				
Water	48				
Krenite S	50	10	91	519	4353
Stalker	2				
Water	48				
Escort	2.35 oz/gal[1]	2	96	52	5122
Arborchem Basal Oil	95				
LSD (p=0.05)		24	15	2333	n.s.

[1] The rate of Escort used in this trial was determined based on a target of 20 oz Escort/ac. Similar areas were treated with cut surface applications at volumes of approximately 8.5 gal/ac of total solution. Based on these estimates 1.24 oz Escort was mixed in 100 mL of water and added to 1900mL of Arborchem Basal Oil.

THE EFFECT OF APPLICATION TIMING OF CUT SURFACE TREATMENTS ON RESPROUTING OF BLACK LOCUST

Herbicide Trade and common chemical names: Garlon 4 (*triclopyr*)
Plant common and scientific names: black locust (*Robinia pseudoacacia*), tree-of-heaven (*Ailanthus altissima*)

ABSTRACT

Stems of black locust were cut and stump treated with 25% Garlon 4 in Basal Oil on May 26, 2000 (flowering), August 21, 2000 (full canopy), October 26, 2000 (leaf drop), and April 9, 2001 (dormant). Application date did not have a significant effect on the number or basal area of resprouts on July 1, 2002. All resprouts were suckers from roots rather than stump sprouts.

INTRODUCTION

Black locust is a suckering, nitrogen-fixing tree species, native to North America that is well adapted to the disturbed soils created by road construction. Efforts to remove black locust from roadsides usually fail in the long term due the suckering response of black locust after cutting. The fast-growing suckers grow at a higher density than the original stand, and the thorny appendages at the base of each leaf are much stouter on sucker growth. The resulting thicket becomes worse than the original stand within a few seasons.

Based on past work with black locust and ongoing work with another suckering species, tree-of-heaven, we wanted to compare the effect of conducting cut surface work at different times of year on the amount of resprouting that will occur. Based on results of basal bark experiments[2] and a fall-applied basal bark and cut surface demonstration conducted for the 2000 Field Day, we feel that applications made during the growing season are more effective than those made when the trees are dormant, because during the growing season the plant is translocating carbohydrates to the root system. Theoretically, systemic herbicides should follow this flow and injure the root system, and therefore reduce suckering.

MATERIALS AND METHODS

A black locust population in the infield of the interchange of SR 22/764/220 near Duncansville, PA, was divided into plots, and cut and stump-treated on the following dates: May 26, 2000, August 21, 2000, October 26, 2000, and April 9, 2001. The phenology at those dates was as follows: May 26 - flowering, August 21 - late season, full canopy, October 26 - 80% leaf drop, and April 9 - pre-bud break. The treatments were laid out in a randomized complete block with three replications. Each locust stem in each plot was cut, measured, and treated - both cambium and bark - with a 25:75 percent solution of Garlon 4 and Arborchem Basal Oil, respectively. The plots were of variable size and shape, and the number of stems cut for each treatment averaged from 35 to 70 per plot.

Resprouting was assessed on July 1 and 3, 2002. To characterize resprouting, a circular plot with a radius of 10 ft was selected in each plot, and each resprout and previously cut stump was

---

[2] Influence of basal bark applications of Garlon 4 and Stalker on tree-of-heaven resprouting. Roadside Vegetation Management Research Report - Fifteenth Year Report.

measured to determine basal area. Our intent was to select a sample area that was representative of the whole plot and had a stump density similar to other plots within the trial.

RESULTS AND DISCUSSION

During the 2001 growing season, we thought we observed some differences in the early growth of the suckers. However, by July 2002, visible differences between the plots could not be discerned. The number of sprouts made it necessary to try to select representative sampling areas within each plot and make the resprout measurements within this subplot. Resprout basal area (sum of [(stem diameter/2)$^2 * \pi$] was not affected by the timing treatments (Table 1). Original basal area and sample basal area (basal area of original stumps within the 10 ft radius sample area) did not have a significant impact on resprout basal area within the sample areas when they were used as a covariate in the analysis of variance.

CONCLUSIONS

The results of this trial do not support our hypothesis that application timing of cut surface treatments affects subsequent resprouting. Without observations of the root system and a more detailed characterization of the black locust stand, we are unable to determine what factors are most significant in contributing to this non-result - whether it is an issue of species and herbicide, research methodology, or if application timing truly does not have an impact on root suckering.

MANAGEMENT IMPLICATIONS

We are unable to provide clear data to support our recommendation that basal bark and cut surface applications made to suckering species such as tree-of-heaven or black locust be made during the latter part of the growing season. Further, refined investigation will be required to provide evidence to support or abandon this recommendation.

The influence of timing, if it is significant, will impact the *degree of effort* required for follow-up treatments. It is essential that managers understand that management of suckering species is a multi-stage operation and follow-up treatments are a requirement, regardless of the effectiveness of the initial treatment.

Table 1. Summary of precutting conditions and resprouting from black locust plots cut and stump treated with 25% Garlon 4 in Basal Oil at different dates. Resprout number and basal area, and stump basal area were measured within a 314 sq. ft sample area of each plot. Basal area is the cumulative cross-sectional area of the designated stems. Each value is the mean of three replications.

Treatment Date	Original Stem Number	Original Basal Area	Resprout Number	Resprout Basal Area	Sample plot Stump Basal Area
	(#/plot)	(in^2)	(#/sample)	(in^2)	(in^2)
May 26, 2000	35	648	53	17.3	60
Aug 21, 2000	70	931	111	30.9	96
Oct 26, 2000	67	947	72	32.1	43
Apr 9, 2001	61	675	61	28.0	78
LSD (p=0.05)			n.s.	n.s.	

A COMPARISON OF DIFFERENT GLYPHOSATE FORMULATIONS FOR CONTROL OF CANADA THISTLE AND CROWNVETCH

Herbicide trade and common chemical names: Escort (*metsulfuron*), GlyPro (*glyphosate, isopropylamine salt, surfactant-free*), Roundup PRO (*glyphosate, isopropylamine salt, surfactant-loaded*) Touchdown PRO (*glyphosate, diammonium salt, surfactant-loaded*).
Plant common and scientific names: Canada thistle (*Cirsium arvense*), crownvetch (*Coronilla varia*).

ABSTRACT

Touchdown PRO and Roundup PRO were compared alone at three rates, and at one rate in combination with Escort, for control of a mixed stand of Canada thistle and crownvetch. A single rate of GlyPro was applied as a standard treatment. Treatments were applied June 7, 2002. Crownvetch control on August 8, 2002, ranged from 96 to 99 percent for glyphosate-alone treatments, and 100 percent for the combinations including Escort. On September 6, 2002, Canada thistle control was rated at 92 to 95 percent for plots treated with the Escort combinations, and 23 to 60 percent for plots treated with glyphosate alone. Average thistle control ratings for Roundup PRO-alone treatments were higher than for Touchdown PRO, but the difference was not significant. There was a significant difference between the PRO formulations applied alone for vegetative cover on September 6. Roundup PRO-alone treatments averaged 23 to 28 percent cover, and Touchdown PRO treatments averaged 31 to 46 percent cover. Plots treated with combinations including Escort had 2 to 4 percent vegetative cover on September 6.

INTRODUCTION

The U.S. patents on glyphosate and the isopropylamine salt formulation of glyphosate expired in 1991 and 2000, respectively. Most glyphosate products on the market are isopropylamine salts, many of which are repackaging of product manufactured by Monsanto, utilizing the regulatory data generated by Monsanto[3]. Prior to 2000, the primary improvement in herbicides containing glyphosate for the non-crop market was surfactant-loaded technology, which eliminated the need to add surfactant to glyphosate spray mixtures. Syngenta (merger of Zeneca and Novartis) is the only herbicide manufacturer other than Monsanto to market a unique glyphosate formulation. Touchdown PRO is a surfactant-loaded diammonium salt formulation of glyphosate, that is a market equivalent of Roundup PRO or GlyPro Plus.

This trial was initiated to compare Touchdown Pro and Roundup PRO for control of the herbaceous perennials Canada thistle and crownvetch.

MATERIALS AND METHODS

The study was initiated June 7, 2002 in the median of SR 322, between the Port Royal and Thompsontown exits near the segment 270 marker. Treatments were applied to 12 by 30 ft plots arranged in a randomized complete block design with four replications, using a C02-powered, hand-held, fixed-boom sprayer equipped with Spraying Systems XR8002 VS flat fan spray tips,

[3] Barboza, D. A weed killer is a block to build on. New York Times, August 1, 2001. Text available at www.biotech-info.net/block.html

delivering 20 gal/ac at 26 psi. Crownvetch was up to 24 in tall, at bud to early bloom stage, and Canada thistle was 18 to 48 in tall, in bud to early bloom stage. Treatments included Touchdown PRO or Roundup PRO alone at 64, 128, or 160 oz/ac, equivalent to 1.5, 3.0, and 3.75 lb glyphosate acid equivalent (ae) per acre, respectively. The 128 oz/ac rate of Touchdown PRO or Roundup PRO was also combined with Escort at 1 oz/ac. GlyPro at 96 oz/ac (3 lb ae/ac) plus organosilicone-blend surfactant at 0.1 percent, v/v, was included as a standard treatment.

The following visual evaluations were taken: percent total cover, and percent cover from crownvetch or Canada thistle on June 7; percent control of crownvetch and Canada thistle on June 24, July 9, and August 8; and percent control of Canada thistle and percent cover on September 6, 2002. Data from the untreated check were not included in the analysis of percent control because a value of zero was arbitrarily assigned to these plots. Data were subject to analysis of variance, and means separated using Fisher's Protected LSD.

RESULTS

On June 24, 17 days after treatment (DAT), crownvetch control ranged from 92 to 97 percent (Table 1) The treated plots remained nearly free of crownvetch through the August 8 ratings (62 DAT), when control ranged from 96 to 100 percent.

Canada thistle control was rated between 98 and 99 percent on June 24, and 99 and 100 percent on July 9 (Table 2). Treatment effect was not significant for the August 8 rating of Canada thistle control, despite a range of 52 to 100 percent. The treatments including Escort were rated at 99 or 100 percent, while plots treated with glyphosate-alone were rated between 52 and 86 percent control. The addition of Escort had a significant effect on Canada thistle control rated September 6, 91 DAT. The plots treated with glyphosate plus Escort were rated at 92 or 95 percent control, while plots treated with glyphosate alone were rated from 23 to 60 percent Canada thistle control.

Plots treated with Escort averaged 2 or 4 percent vegetative cover, glyphosate alone treatments averaged 23 to 49 percent, and the untreated check had 45 percent cover. An orthogonal contrast used to test whether there were differences in ratings for vegetative cover between plots treated with Touchdown PRO or Roundup PRO was significant. Plots treated with Touchdown PRO had 31 to 46 percent cover, while plots treated with Roundup PRO had 23 to 28 percent cover.

CONCLUSIONS

In this trial, the presence or absence of Escort was the dominant factor affecting control of Canada thistle or vegetative cover. The effect of glyphosate formulation was not directly apparent, as there were no significant differences in control of crownvetch or Canada thistle.

MANAGEMENT IMPLICATIONS

We have compared different glyphosate formulations over the last three seasons, and to date have observed only subtle differences between them. We have not seen results suggesting across-the-board performance advantages for a particular formulation. At this time, we feel that that non-performance factors such as price, availability, and product support should be the criteria the Department uses to select glyphosate products for the state-wide contract.

Table 1: Response of crownvetch and vegetative cover to herbicide applications made June 7, 2002. Each value is the mean of four replications. The untreated check was not included in the analysis of variance for crownvetch control because a value of zero was assigned to all untreated plots.

Treatment	Application Rate	-------- Crownvetch Control -------- Jun 24	Jul 9	Aug 8	Veg. Cover Sep 6
	(oz product/ac)	%	%	%	%
Untreated Check	- - -	0	0	0	45
GlyPro[1]	96	92	97	96	49
Touchdown PRO	64	95	97	98	40
Touchdown PRO	128	96	99	98	46
Touchdown PRO	160	96	99	98	31
Roundup PRO	64	90	96	99	28
Roundup PRO	128	97	98	98	26
Roundup PRO	160	97	100	99	23
Touchdown PRO Escort	128 1	96	100	100	4
Roundup PRO Escort	128 1	97	100	100	2
LSD (p=0.05)		5	n.s.	2	16

[1] This treatment included Qwik-Wet 357, an organosilicone blend surfactant, at 0.1 % v/v

Table 2: Control of Canada thistle provided by herbicide applications made June 7, 2002. Each value is the mean of four replications. The untreated check was not included in the analysis of variance because a value of zero was arbitrarily assigned to the untreated plots.

Treatment	Application Rate	Canada Thistle Control Jun 24	Jul 9	Aug 8	Sep 6
	(oz product/ac)	%	%	%	%
Untreated Check	- - -	0	0	0	0
GlyPro[1]	96	99	100	52	23
Touchdown PRO	64	99	99	70	31
Touchdown PRO	128	99	100	61	35
Touchdown PRO	160	99	100	78	48
Roundup PRO	64	98	99	85	44
Roundup PRO	128	99	100	86	60
Roundup PRO	160	98	100	80	48
Touchdown PRO Escort	128 1	98	100	99	92
Roundup PRO Escort	128 1	98	100	100	95
LSD (p=0.05)		n.s.	n.s.	n.s.	39

[1] This treatment included Qwik-Wet 357, an organosilicone blend surfactant, at 0.1 % v/v

A COMPARISON OF PRE- AND POSTEMERGENCE HERBICIDE APPLICATIONS FOR CONTROL OF JAPANESE STILTGRASS

<u>Herbicide trade and common chemical names</u>: Assure II (*quizalofop-P*), Derringer (*glufosinate*), Endurance (*prodiamine*), Fusilade II (*fluazifop-P*), Goal 1.6E (*oxyfluorfen*), Pendulum 3.3 EC (*pendimethalin*), Plateau (*imazapic*), Poast (*sethoxydim*), Envoy [=Prism] (*clethodim*), Surflan (*oryzalin*), and Touchdown Pro (*glyphosate*).

<u>Plant common and scientific names:</u> black birch (*Betula lenta*), black oak (*Quercus velutina*), deertongue (*Panicum clandestinum*), garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Japanese honeysuckle (*Lonicera japonica*), Japanese stiltgrass (*Microstegium vimineum*), nimblewill (*Muhlenbergia schreberi*), oriental bittersweet (*Celastrus orbiculatus*), red maple (*Acer rubrum*), red oak (*Quercus rubra*), sassafras (*Sassafras albidum*), tree-of-heaven (*Ailanthus altissima*), white snakeroot (*Eupatorium rugosum*), and wild garlic (*Allium vineale*).

ABSTRACT

Four field trials evaluating control of Japanese stiltgrass with pre- or postemergence herbicide treatments were conducted in wooded settings in Philadelphia or State College, PA. Complete control was observed with preemergence treatments of Plateau at 4, 6, or 8 oz/ac; Goal 1.6E at 60 oz/ac; and Pendulum at 78 oz/ac. Preemergence applications of Endurance at 16 or 24 oz/ac, and Surflan at 64 oz/ac provided 93, 97, and 98 percent control, respectively. Applied preemergence, corn gluten meal at 1160 lb/ac did not provide any observable reduction of stiltgrass. Plots treated with Touchdown Pro were rated from 98 to 100 percent control for applications made between July 15 and September 3, at rates of 16 or 32 oz/ac. When applied between July 29 and September 3, Derringer provided 100 percent control applied at either 32 or 64 oz/ac. String trimming on August 12 in two trials resulted in 92 and 93 percent control. An August 12 application of Plateau (4 or 6 oz/ac), Assure II (4 or 8 oz/ac), Fusilade II (16 oz/ac), Poast (16 oz/ac), or Envoy (13 oz/ac) provided injury that ranged from 15 to 85 percent when rated September 6, but all treatments prevented seed set.

INTRODUCTION

Japanese stiltgrass is a shade tolerant, C_4 annual grass first recorded in the US in 1919, in Tennessee. Its range has expanded from Florida to Texas, with a current northern limit of Illinois to Connecticut (7) and Massachusetts[4]. It occurs most commonly in areas of partial shade subjected to disturbance, such as roads, trails, rights-of-way, and flood-prone riparian corridors; as well as areas impacted by herbivory by white-tailed deer (*Odocoileus virginiana* Zimmerman)(1, 5, 6), turf areas, and ornamental beds (2, 4). Stiltgrass can produce up to 1000 seeds/plant, in terminal and axillary inflorescences, and seed viability in the soil has been demonstrated to be at least three years (1,6). It has a sprawling, decumbent growth habit, and was given the stiltgrass name because it produces reflexed processes (similar to 'prop roots' of maize) at the nodes that elevate the stems off the soil surface, and take root upon contact with the soil. Stiltgrass is able to form near-monocultures, displaces existing vegetation (1), has not been observed as serving as a wildlife food source (6), and alters soil chemistry functions (3).

[4] New England Invasive Plant Group. A newsletter of invasive plant control activities in New England. Volume 1, Spring 2002.

Stiltgrass is not problematic along roadsides, but failure to manage roadside stiltgrass will result in further spread and negative impact to adjacent properties.

As part of an ongoing effort to identify management approaches, trials evaluating pre- and postemergence herbicides, and resulting vegetation following treatments, were established in Philadelphia, PA in conjunction with a management workshop; and a trial evaluating the effect of application timing of postemergence herbicides on stiltgrass control was established near State College, PA.

MATERIALS AND METHODS

Preemergence Herbicide Comparison

The trial was located at the Schuylkill Center for Environmental Education (SCEE), Philadelphia, PA, on a NW facing slope, (approximately 10 percent) under a canopy of red oak, black oak, red maple, sassafras, and black birch. The treatments were applied to 12 by 25 ft plots, arranged in a randomized complete block with three replications, on April 11, 2002. In order to work around trees within the plots, a single-nozzle boom equipped with a Spraying Systems XR 8002 VS tip was utilized. The application was made with a CO_2-powered sprayer, at 24 psi, in the equivalent of 20 gal/ac of spray solution/ac. Understory vegetative cover was less than 1 percent. The most common species was garlic mustard, present both as overwintered rosettes as well as seedlings; followed by Japanese barberry, nimblewill, and deertongue.

Herbicide treatments included Pendulum 3.3E at 78 oz/ac; Surflan at 64 oz/ac; Endurance at 16 or 24 oz/ac; Goal 1.6E at 60 oz/ac; Plateau at 4, 6, or 8 oz/ac; and corn gluten meal at 1160 lb/ac. Stiltgrass germination was first observed at the SCEE on south-facing areas on April 3, 2002, and germinated stiltgrass at the coleoptile stage was observed in the trial area on the day of application. Soil temperatures at application were 58, 57, 56, and 52 degrees F at 0, 1, 3, and 6 in, respectively. Beginning immediately after application, plots treated with Pendulum 3.3E, Surflan, Endurance, or corn gluten meal were watered with the equivalent of 0.12 in of irrigation. In addition to the untreated control, a 4 ft wide untreated alley was left between each plot. Visual ratings of percent control were taken August 12, 2002, 122 days after treatment (DAT).

Resulting Vegetation Following Pre- or Postemergence Treatment

This trial was located adjacent to the preemergence trial at the SCEE, on the same NW facing slope. Site vegetation was similar, with the addition of tree-of-heaven. Preemergence treatments included Pendulum 3.3E at 78 oz/ac, and Plateau at 6 oz/ac, and were applied April 11, 2002, using the same spray equipment and technique described in the preemergence trial. Plots were 12 by 25 ft, arranged in a randomized complete block with three replications, with a 4 ft untreated alley between plots. Postemergence applications were made August 12, 2002, using the same spray apparatus used for the preemergence treatments, and included Plateau at 6 oz/ac plus a non-ionic surfactant[2] (NIS) at 0.1 percent (v/v), Derringer at 64 oz/ac, Touchdown Pro at 32 oz/ac, Assure II at 8 oz/ac plus a crop oil concentrate[3] (COC) at 1.0 percent (v/v), and mowing with a string trimmer at ground level. Understory vegetative cover was less than 1 percent on April 11, and ranged from 35 to 70 percent in the plots receiving treatment on August 12. Stiltgrass was by far the most prevalent species, followed by sassafras suckers and oriental

[2] Qwikwet 357 organosilicone-based non-ionic surfactant, Exacto Chemical Company, Richmond, IL.
[3] Clean Cut crop oil concentrate, Arborchem Products Company, Mechanicsburg, PA.

bittersweet. Stiltgrass was exhibiting symptoms of drought stress on August 12. Stiltgrass injury and botanical composition were evaluated September 5, 2002.

Postemergence Treatment Comparison

This trial was established on August 12, 2002, along an unpaved roadway at the SCEE, on both cut and fill material. Plots were 10 by 25 ft, arranged in a randomized complete block design with three replications. The stiltgrass canopy was 8 to 18 in tall, and drought symptoms were evident in most of the plots. Herbicide applications were made using the same spray apparatus described for the preemergence trial. The treatments included Touchdown Pro at 16 or 32 oz/ac, Derringer at 64 oz/ac, Plateau at 4 oz/ac, Assure II at 4 oz/ac, Fusilade II at 16 oz/ac, Poast at 16 oz/ac, Envoy at 13 oz/ac, and mowing at ground level with a string trimmer. Plateau and Fusilade II treatments included NIS[2], and Assure II, Poast, and Envoy treatments included COC[3] (Table 2). Ratings of stiltgrass injury were taken September 6 and 18, and final observations of stiltgrass seed production were made November 5, 2002.

Effect of Application Timing on Efficacy of Postemergence Treatments

Touchdown Pro at 16 oz/ac, Derringer at 32 oz/ac, or Assure II at 4 oz/ac, were each applied on July 29, August 15, and September 3, 2002, to 6 by 20 ft plots arranged in a randomized complete block design with three replications. The site was a right-of-way for an underground communications cable running through a forest. Stiltgrass comprised about 95 percent of the vegetation. Other species included white snakeroot, garlic mustard, wild garlic, and Japanese barberry. Applications were made with a CO_2-powered, hand held boom equipped with Spraying Systems XR 8002 VS tips, delivering 20 gal/ac at 26 psi. The stiltgrass canopy ranged from 10 to 24 in tall during the application window. Stiltgrass was vegetative on July 29 and August 15, and at boot stage on September 3. Ratings of stiltgrass injury and vegetative cover were taken October 17, 2002.

RESULTS

Preemergence Herbicide Comparison

Weed pressure in the study area was light, and the untreated check plots averaged 15 percent vegetative cover on August 12, 122 DAT, the corn gluten treated plots averaged 18 percent, and herbicide treated plots ranged from 1 to 3 percent (Table 1). The Pendulum 3.3E, Goal, and Plateau treatments provided complete control. Plots treated with Surflan, and Endurance at 16 or 24 oz/ac were rated at 98, 93, and 97 percent control, respectively. Corn gluten did not provide any observable effect on stiltgrass. Sassafras suckers were the most common vegetation in the study area, and the only species to establish in herbicide-treated plots after application. The only species observed to establish from seed during the trial in any plot were stiltgrass and garlic mustard, which was observed in the untreated, corn gluten-, and Endurance-treated plots.

Resulting Vegetation Following Pre- or Postemergence Treatment

Preemergence applications of Pendulum 3.3E or Plateau prevented stiltgrass establishment, and resulted in similar vegetation (Table 1). Derringer, Touchdown Pro, and mowing treatments were rated at 100 to 92 percent stiltgrass injury, and were not significantly different. None of these three treatments eliminated woody species such as sassafras or Oriental bittersweet, and only Touchdown Pro eliminated garlic mustard that was present. Assure II and post-applied Plateau caused significantly less injury than the other postemergence treatments, but seed set was prevented.

Table 1. Summary of treatment effects on stiltgrass (MCGVM) injury and remnant vegetation, Philadelphia, PA. Preemergence (PRE) treatments were applied April 11, 2002. Postemergence treatments (POST) were applied August 12, 2002. All plots were rated September 5, 2002. Each value is the mean of three replications. The analysis of variance did not include the untreated check.

Treatment	Application Rate	Application Timing	MCGVM Injury	Vegetative Cover	Prevalent Species*
	oz/ac		%	%	
untreated	- - -	- - -	0	2	MCGVM, ALAPE, CELOR
Pendulum	78	PRE	100	1	SSAAL, CELOR
Plateau	6	PRE	100	1	SSAAL, CELOR
Plateau + NIS	6	POST	43	4	MCGVM, CELOR
Derringer	64	POST	100	1	ALAPE, LONJA, CELOR
Touchdown Pro	32	POST	98	2	CELOR, SSAAL
Assure II + COC	8	POST	80	5	MCGVM, ALAPE, CELOR
string trim	- - -	POST	92	1	MCGVM, CELOR, ALAPE
LSD (p=0.05)			9	n.s.	

* Bayer Codes: ALAPE - garlic mustard, CELOR - oriental bittersweet, LONJA - Japanese honeysuckle, MCGVM - stiltgrass, SSAAL - sassafras.

Postemergence Treatment Comparison

When evaluated for seed production on November 5, 2002, filled-out seed was observed only in the untreated checks and buffer strips, and at the edge of a single Plateau treated plot. The treatments were all effective, and varied only in the amount of tissue necrosis and rate of symptom onset. Increased injury was observed when the plots treated with Plateau, Assure II, Fusilade II, Poast, and Envoy were evaluated September 18, 12 days after the initial injury rating (Table 2).

Table 2. Summary of postemergence treatment effects on stiltgrass injury, Philadelphia, PA. Treatments were applied August 12, 2002, and evaluated on September 6 and 12, 2002. Each value is the mean of three replications. The analysis of variance did not include the untreated check.

Treatment	Application Rate	Stiltgrass Injury Sep 6	Stiltgrass Injury Sep 18*
	oz/ac	%	%
untreated	- - -	0	0
Touchdown Pro	16	99	99
Touchdown Pro	32	100	100
Derringer	64	100	100
Plateau + NIS	4 0.1 % v/v	15	35
Assure II + COC	4 1.0 % v/v	85	95
Fusilade II + NIS	16 0.1 % v/v	33	48
Poast + COC	16 32	57	82
Envoy + COC	13 1.0 % v/v	55	62
string trim	- - -	93	93
LSD (p=0.05)		14	

* Original data was lost after means were generated, therefore no statistical analysis was possible.

Effect of Application Timing on Efficacy of Postemergence Treatments

When evaluated October 17, all stiltgrass florets examined in herbicide-treated plots were sterile, and had only emerged from the leaf sheath in a few individuals within plots treated with Assure II on September 3. From a control perspective, all treatments were effective - the differences were in how quickly the stiltgrass canopy was eliminated. There was a significant interaction between herbicide and application timing for stiltgrass injury, total vegetative cover, and stiltgrass cover. Touchdown Pro treated plots were rated at 100 percent injury for all application timings; while Derringer treatments were rated at 100, 99, and 100 percent; and Assure II treatments were rated at 99, 97, and 67 percent injury for the July 29, August 15, and September 3 applications, respectively.

CONCLUSIONS

These four trials add further evidence to the commonly reported experience that stiltgrass is readily controlled with many herbicides, as well as mowing. Stiltgrass was effectively controlled with rates of Touchdown Pro or Derringer below recommended label rates; and Envoy, Fusilade II, Plateau, Assure II, and Poast were effective when used at the lowest labeled rates. The caveat is timing. Postemergence herbicides can be applied too late to prevent viable seed set, and postemergence treatments made earlier in the season have been reported as less effective, particularly with Derringer (4). Stiltgrass tolerates mowing initiated early in the season, which allows it to be a weed in turf. In the settings where these trials were conducted, prevention of seed set without elimination of the treated plants was still a favorable outcome, as there was very little desirable vegetation to be released from competition. The combination of herbicide types and timings, and low use rates provides vegetation managers considerable flexibility in developing an integrated stiltgrass management program that incorporates mechanical, chemical, and cultural approaches such as establishing competing groundcover.

MANAGEMENT IMPLICATIONS

Being a good neighbor is a fundamental aspect of adopting an Integrated Pest Management-based program. Although stiltgrass does not pose a problem to the maintenance of the roadways, it will pose a significant threat to some adjacent properties. The Department has the tools at its disposal to effectively manage stiltgrass and prevent it from impacting its neighbors.

ACKNOWLEDGEMENTS

A special thanks to Dennis A. Burton of the Schuylkill Center for Environmental Education, Philadelphia, PA for providing the area, assistance, and expertise in establishing several of these trials. We would also like to thank Jonathan Henry for his assistance in conducting these trials.

LITERATURE CITED

1. Barden, L.S. 1987. Invasion of Microstegium vimineum (Poaceae), an exotic, annual, shade-tolerant, C_4 grass, into a North Carolina floodplain. American Midland Naturalist, 118:40-45.
2. Derr, J.F. 1999. Biology and management of Microstegium, a relatively unresearched turf weed. Proceedings of the Northeastern Weed Science Society, 53:100.
3. Ehrenfeld, J.G., P. Kourtev, and W.Z. Huang. 2001. Changes in soil functions following invasions of exotic understory plants in deciduous forests. Ecological Applications, 11:1287-1300.
4. Judge, C.A., and J.C. Neal. 2002. Preemergence and postemergence control of Japanese stiltgrass. Proceedings of the Northeastern Weed Science Society, 56:35.
5. Kyde, K.L, and Boucher, D.H. 2002. Japanese stiltgrass and disturbance: implications for management. Proceedings of the Northeastern Weed Science Society, 56:36.
6. Tu, M. 2000. Elemental stewardship abstract for Microstegium vimineum. The Nature Conservancy Wildland Invasive Species Program. (http://tncweeds.ucdavis.edu/esadocs/docmnts/micrvm.pdf).
7. USDA, NRCS. 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

SUPPRESSING TALL FESCUE SEEDHEADS USING PLATEAU HERBICIDE

Herbicide Trade and common chemical names: Embark (*mefluidide*), Escort (*metsulfuron*), Event (*imazethapyr + imazapyr*), Garlon 3A (*triclopyr*), Plateau (*imazapic*), Stronghold (mefluidide + imazethapyr + imazapyr), Telar (*chlorsulfuron*), Vanquish (*dicamba*).
Plant common and scientific names: creeping red fescue (*Festuca rubra* ssp. rubra), tall fescue (*Lolium arundinaceum[= Festuca arundinacea]*)

ABSTRACT

When evaluated as a growth regulator for suppression of tall fescue, Plateau applied alone at 2 oz/ac with surfactant, or 4 oz/ac without surfactant provided complete seedhead suppression but unacceptable injury. When tall fescue injury and growth suppression were evaluated, the combination of Plateau, Garlon 3A, and Vanquish at 2, 24, and 24 oz/ac, respectively provided results that were not different from the designated standard treatment of Embark T/O, Escort, Garlon 3A, and Vanquish at 60, 0.25, 24, and 24 oz/ac, respectively, or the combination of Escort, Garlon 3A, and Vanquish at 0.5, 24, and 24 oz/ac, respectively. The combination of Plateau and Escort, with Garlon 3A and Vanquish, at 2, 0.5, 24, and 24 oz/ac, respectively provided unacceptable injury. Plots treated with Garlon 3A plus Vanquish, with or without Embark T/O were indistinguishable from the untreated plots when evaluated for turf color, tall fescue injury, canopy height, seedhead suppression, or vegetative cover. Plots treated with Escort alone had excellent seedhead suppression, but unacceptable injury to tall fescue.

INTRODUCTION

Plateau has considerable activity on tall fescue, and is marketed as a 'tall fescue eraser' at high application rates. Reduced Plateau rates of 2 to 4 oz/ac are labeled for vegetative and seedhead reduction of tall fescue.

Several PENNDOT Districts apply growth regulator treatments to specific turf areas. If Plateau can provide results comparable to the commonly used treatment of Embark plus Escort in combination with a selective broadleaf herbicide, it would provide an easier to use (one liquid ingredient vs. one liquid and one dry ingredient) product at a comparable cost. An application of Embark 2S IVM plus Escort at 6 plus 0.25 oz/ac, respectively, has a material cost of $11.72/ac. Plateau at 2 or 4 oz/ac would be $4.68 or $9.36/ac, respectively.

The objective of this trial was to compare Plateau applied alone, and in combination with a broadleaf herbicide combination, to other growth regulator and herbicide combinations to demonstrate the effect of Plateau and the other components of a turf growth regulator program on tall fescue. The components of a growth regulator program that were evaluated included Plateau, Escort, Embark, and the broadleaf herbicide combination Garlon 3A plus Vanquish.

Escort is a widely used product that provides broadleaf weed control and turf growth inhibition, and is commonly used at reduced rates in combination with Embark for tall fescue growth regulation. Embark is a turf growth regulator that reduces seedhead development by inhibiting cell division. Research at Penn State and elsewhere demonstrated that turf suppression with Embark at reduced rates, in combination with Escort, Telar, or Event, was superior to Embark alone. The Embark plus Event combination has subsequently been premixed and is available as Stronghold.

Garlon 3A plus Vanquish is a broadleaf herbicide combination that will provide broad spectrum control without injuring turf. A broadleaf herbicide is required in a turf growth regulation program to prevent the release of broadleaf weeds after the turf has been suppressed.

MATERIALS AND METHODS

The treatments were applied to a stand of tall fescue and creeping red fescue in the infield of the SR 22/764/220 interchange, near Duncansville, PA, on May 10, 2002. The treated area was not routinely mowed, and appeared to have a greater proportion of creeping red fescue than the adjacent regularly mowed areas. Sampled stems indicated that the tall fescue seedheads had elongated about 2 inches, so application was well before boot stage.

The treatments included an untreated check, Plateau applied alone at 2 oz/ac with a methylated seed oil surfactant, and at 4 oz/ac without surfactant; Escort alone at 0.5 oz/ac; and a sequence including Garlon 3A plus Vanquish at 24 oz/ac each, applied alone or with the following additions: Escort at 0.5 oz/ac; Plateau at 2 oz/ac; Escort plus Plateau at 0.5 and 2 oz/ac, respectively; Embark T/O at 60 oz/ac; and Embark T/O plus Escort at 60 plus 0.25 oz/ac, respectively. Escort alone and all treatments with Garlon 3A plus Vanquish included an organosilicone-blend surfactant at 0.1 percent, v/v. The application was made to 6 by 20 ft plots, arranged in a randomized complete block design with three replications, using a CO_2-powered hand-held boom sprayer applying 40 gal/ac.

The plots were evaluated for response to the treatments by assessing turf color, tall fescue injury, canopy height, percent seedhead suppression, and percent green vegetative cover, on June 20, 2002, 41 days after treatment. At this date, the less injurious treatments were showing regrowth of tall fescue.

RESULTS AND DISCUSSION

Both treatments of Plateau alone provided complete seedhead suppression but severely injured tall fescue (Table 1). However, Plateau at 2 oz/ac combined with Garlon 3A plus Vanquish provided a much more acceptable tall fescue response, and was indistinguishable from the Garlon 3A plus Vanquish plus Escort, or Garlon 3A plus Vanquish plus Escort plus Embark combinations.

The addition of Garlon 3A plus Vanquish to Escort did not reduce activity on tall fescue to the same degree as they did when added to Plateau. Turf color, canopy height, seedhead suppression, and green cover were almost identical for Escort, with or without Garlon 3A plus Vanquish. In plots where Garlon 3A plus Vanquish was added to Plateau at 2 oz/ac, the ratings for turf color, canopy height, and green cover were significantly higher, and tall fescue injury was significantly lower than Plateau alone at 2 oz/ac.

The untreated check, Garlon 3A plus Vanquish, or Garlon 3A plus Vanquish plus Embark were very similar in appearance in terms of effects on tall fescue. It is not surprising that the Garlon/Vanquish combination did not affect the turf. It is also not unexpected that Embark T/O added at the Escort tank mix rate - without Escort - would not have a visible effect because the tank mix rate is 1/4 or less of the stand-alone Embark rate.

Much of the tall fescue effects observed on June 20 had diminished by the time of the July 18 field day, which was 69 days after treatment. Seedhead reduction was the only obvious visible effect remaining. Although most of the plots appeared acceptable 69 DAT, the most serioiusly affected plots looked to be near-death for a month-and-a-half during the greenest part of the growing season.

CONCLUSIONS

Plateau applied alone is too injurious to tall fescue, but when tank mixed with Garlon 3A and Vanquish, the effects on tall fescue are moderated. The combination is an effective growth regulator, and provides excellent weed control. The mechanism of this moderation is not clear from the results of this trial. This issue can only be addressed through further investigation.

MANAGEMENT IMPLICATIONS

The Department should continue to investigate the utility of Plateau as a growth regulator for tall fescue. This use is labeled, Plateau is on the state pesticide contract, and the manufacturer provides tangible product support to the Department. Additional field trials that refine the dosage and use conditions are warranted, including the effect of tank mixing and adjuvants.

Table 1. Response of a mixed species turf to growth regulator applications made on May 10, 2002. Effects were evaluated on June 20, 2002, 41 days after treatment. Turf color was rated on a 0 to 10 scale, with '0' indicating dead turf, and '10' being equal or better than the untreated check. Tall fescue injury was rated on a 0 to 10 scale with '0' no observable effect and '10' indicating dead turf. Vegetative canopy height was a visual estimate of average height of the non-seedhead component of the stand. Seedhead suppression was based on the untreated plots, which were assigned a '0' rating. Green cover is ground cover provided by green tissue, which would discount senesced or necrotic plant material. Each value is the mean of three replications.

Treatment[1]	Application Rate	Turf Color	Tall Fescue Injury	Vegetative Canopy Height	Seedhead Suppression	Green Cover
	oz product/ac	0-10	0-10	inches	%	%
1. Untreated[2]	- - -	10	0.0	12	0	40
2. Plateau	2	2.7	8.7	8	100	12
MSO	32					
3. Plateau	4	2.7	8.7	7	100	12
4. Escort	0.5	5.3	7.7	9	88	20
5. Garlon 3A	24	10	0.3	11	17	38
Vanquish	24					
6. Garlon 3A	24	5.3	6.3	9	88	25
Vanquish	24					
Escort	0.5					
7. Garlon 3A	24	5.0	6.7	9	95	27
Vanquish	24					
Plateau	2					
8. Garlon 3A	24	3.7	8.3	8	97	18
Vanquish	24					
Plateau	2					
Escort	0.5					
9. Garlon 3A	24	10	0.0	11	0	48
Vanquish	24					
Embark T/O[3]	60					
10. Garlon 3A	24	5.0	6.7	9	88	25
Vanquish	24					
Escort	0.25					
Embark T/O	60					
LSD (p=0.05)		1.5	1.5	0.8	19	14

[1] Plateau alone at 2 oz/ac (Treatment 2) included methylated seed oil adjuvant, Plateau alone at 4 oz/ac had no surfactant, and Treatments 4 through 10 included an organosilicone-blend surfactant at 0.1 percent, v/v.

[2] The untreated check plots were assigned arbitrary values for turf color, tall fescue injury, and seedhead suppression, and therefore were not included in the analysis of variance for those dependent variables.

[3] Embark T/O is a 0.2 lb/gallon formulation of mefluidide, while Embark 2S IVM is a 2 lb/gallon formulation. We were simulating an Embark 2S IVM application rate of 6 oz/acre.

COMPARISON OF SULFOMETURON FORMULATIONS FOR BAREGROUND WEED CONTROL

Herbicide trade and common chemical names: Glypro (*glyphosate*), Karmex (*diuron*), Krovar I (*bromacil+diuron*), Milestone VM (*azafenidin*), Oust DFand Oust XP (*sulfometuron*).
Plant common and scientific names: catnip (*Nepeta cataria*), common burdock (*Arctium minus*), common ragweed (*Ambrosia artemisiifolia*), giant foxtail (*Setaria faberi*), green foxtail (*Setaria viridis*), horseweed (*Conyza canadensis*), kochia (*Kochia scoparia*), poison hemlock (*Conium maculatum*), smooth brome (*Bromus inermis*), wild garlic (*Allium vineale*), wild parsnip (*Pastinaca sativa*).

ABSTRACT

Oust XP (75% ai) is a new extruded paste formulation of sulfometuron that will replace the dry flowable formlation. Both Oust formulations were applied alone and in combination with other preemegence herbicides on April 2, 2002 to a guiderail site. On May 30, 58 days after treatment, there were no signficant difference between treatments, and control ranged from 92 to 100 percent

INTRODUCTION

Oust XP was introduced by DuPont in 2002. "XP" stands for extruded paste. The extruded paste formulation is improves mixing and suspension of this herbicide compared to the dry flowabe formulation. The extruded paste also results in less dust for added safety to the applicator. These features are meant to enhance both the effectiveness and handling of the product. This study was established to compare the dry flowable formulation of Oust against this new extruded paste formulation for bareground weed control.

MATERIALS AND METHODS

This trial was established under a guiderail along SR 3005, in State College, PA. Treatments included Oust DF or Oust XP applied at 3 oz/ac, alone or in combination with either 160 oz/ac Krovar I, 160 oz/ac Karmex, 8 oz/ac Milestone VM, or 160 oz/ac Karmex plus 48 oz/ac Glypro, and a non-ionic surfactant at 0.1 percent, v/v.[5]. Treatments were applied April 2, 2002, to 3 by 25 ft plots arranged in a randomized complete block design with three replications, in the equivalent of 40 gal/ac of water. Application equipment was a CO_2-powered, hand-held sprayer equipped with a single Spraying Systems OC-12 off-center flat fan nozzle. The most common species at the start of the study were smooth brome, wild garlic, poison hemlock, and common burdock. Initial vegetative cover was rated on April 8, 6 days after treatment, DAT. Percent control of weeds from seed was visually evaluated on May 6 and 30, 2002, 34 and 58 DAT, based on germination in the untreated checks. Weeds growing from seed after treatment will referred to as 'germinants'. The data were subjected to analysis of variance. The untreated checks were not included in the analysis of variance because they were abritrarily assigned a value of zero.

[5] Qwikwet 357, an organosilicone-blend, Exacto Chemical Company, Richmond, IL.

RESULTS AND DISCUSSION

On April 8, 6 DAT, vegetative cover ranged from 0 to 20 percent for the plots, with most having less than 1 percent. On May 6, 34 DAT, there were no significant differences between treatments, and all but one treatment ranged from 92 to 100 percent control (Table 1). The only germinants observed on May 6 were common ragweed, horseweed, and green foxtail. Ragweed phenology ranged from cotyledon to third set of true leaves, horseweed was up to five leaves, and the foxtail varied from coleoptile to 2-leaf stage. The only treated plots with germinants were the Oust-alone plots of both formulations. The ragweed in these plots was at the cotyledon stage, with purpling on the leaf margins.

All treatments provided excellent control by May 30, 58 DAT with weed control ratings from 90 to 100 percent. Common ragweed was by far the most common germinant in the test, and ranged up to 3.5 inches tall, with secondary branching visible in the most developed plants. Other species to germinate included horseweed, green foxtail, giant foxtail, common burdock, wild parsnip, catnip, and kochia.

CONCLUSIONS

There were no differences in effectiveness observed between Oust DF and Oust XP. Oust and Oust XP applied alone will not provide complete control of all species. When combined with the other preemergence herbicides tested in this study, adequate broad spectrum control can be expected in most bareground maintenance situations.

MANAGEMENT IMPLICATIONS

Oust XP can be substituted for the original Oust formulation without concern of losing effectiveness.

Table 1: Control of germinating vegetation provided by treatments applied April 2, 2002 to a guiderail site. Visual ratings of percent control were taken May 6, and May 30, 34 and 58 days after treatment, DAT, respectively. Each value is the mean of three replications. The untreated control was not included in the analysis of variance.

		Weed Control	
	Application	May 6	May 30
Product	Rate	34 DAT	58 DAT
	oz product/ac	%	%
untreated	---	0	0
Oust	3	92	92
Oust XP	3	98	90
Oust Krovar I	3 160	100	100
Oust XP Krovar I	3 160	100	100
Oust Karmex	3 160	100	100
Oust XP Karmex	3 160	100	100
Oust Milestone VM	3 8	100	100
Oust XP Milestone VM	3 8	100	100
Oust Karmex Glypro	3 160 48	100	100
Oust XP Karmex Glypro	3 160 48	100	97
LSD (p=0.05)		n.s.	n.s.

EVALUATION OF A PROMETON/DIURON PREMIX FOR BAREGROUND WEED CONTROL

Herbicide trade and common chemical names: Hi-Dep (*2,4-D*), Glyphosate (*glyphosate*), Krovar I (*bromacil+diuron*). Metgard (*metsulfuron*), Plateau (*imazapic*), Pramitol/Diuron 4L (*prometon + diuron*), Sahara (*imazapyr + diuron*), Vanquish (*dicamba*).
Plant common and scientific names: crownvetch (*Coronilla varia*), goldenrod (*Solidago* spp.), spotted knapweed (*Centaurea maculosa*), tall fescue (*Lolium arundinaceum* [=*Festuca arundinacea*]).

ABSTRACT

A trial was conducted to evaluate the bareground utility of Pramitol/Diuron 4L, a premix of prometon and diuron. The treatments included the premix at two rates, alone or in combination with Glyphosate, 2,4-D, Plateau, 2,4-D plus Vanquish, or MetGard; and two standard treatments - Sahara and Krovar I. The treatments were applied July 10, 2002 to a mixed stand of crownvetch, spotted knapweed, goldenrod and tall fescue. Total vegetative cover on September 10 ranged from 1 to 8 percent for the treated plots, and 79 percent for untreated plots. On October 21, 103 days after treatment, cover ratings for the Sahara and Krovar treated plots were 1 and 22 percent, respectively. Plots treated with combinations including Pramitol/Diuron at 256 oz/ac had cover ratings ranging from 7 to 25 percent, while combinations including Pramitol/Diuron at 640 oz/ac were rated between 1 and 6 percent cover.

INTRODUCTION

Prometon is a triazine herbicide that has been commercially available since 1959. Due to factors such as high application rates and an unpleasant-to-use, xylene-containing formulation that was flammable, prometon has not been widely used. Control Solutions, Inc. has developed a flowable formulation of prometon called Sonora 4SC, and is evaluating a 4L formulation of prometon:diuron containing 2 lb/gal of each herbicide. The objective of this trial was to evaluate the efficacy of Pramitol/Diuron 4L in a bareground setting, alone and in combination with commonly used non-crop herbicides, and use Sahara (imazapyr:diuron) and Krovar I (bromacil:diuron) as standards for comparison.

MATERIALS AND METHODS

This study was established along guiderail and shoulder areas at an abandoned rest area on SR 80 W, Centre County. Treatments were applied on July 10, 2002 using a CO_2-powered, hand-held sprayer. The study was arranged in a randomized complete block design, with four replications. Plots in three of the replications were 6 by 25 ft, and sprayed using a fixed boom equipped with four Spraying Systems XR 8006VS tips. Plots in the fourth replication were 3 by 25 ft. and were treated using a single OC-08 tip. The application volume for both spray configurations was 50 gal/ac. Predominant weed species included spotted knapweed, crownvetch, goldenrod, and tall fescue. Percent vegetative cover and cover by species was rated July 10, September 10, and October 21; 0, 62, and 103 days after treatment (DAT). Percent control by species was visually rated July 25, August 9, and September 10, 2002; 15, 30, and 62 DAT. Data were subjected to analysis of variance. A single degree-of-freedom contrast comparing Pramitol/Diuron 4L application rates was run for the October 21 cover data. Where treatment effect was significant, treatment means were compared using Fisher's Protected LSD.

RESULTS AND DISCUSSION

Initial vegetative cover was rated between 58 to 93 percent on July 10. Total vegetative cover on September 10, 62 DAT, ranged from 1 to 8 percent for the treated plots and 79 percent for the untreated check (Table 1).

On October 21, ratings for vegetative cover in the treated plots ranged from 1 to 25 percent, and the untreated check was rated at 76 percent cover. The orthogonal contrast testing the effect of the application rate of Pramitol/Diuron was significant. Plots treated with Pramitol/Diuron at 640 oz/ac were rated from 1 to 6 percent cover, while combinations including Pramitol/Diuron at 256 oz/ac were rated from 7 to 25 percent cover. Plots treated with Sahara or Krovar were rated at 1 and 22 percent cover, respectively.

Control of crownvetch was rated between 90 and 100 percent at 62 DAT. The greatest distinction between treatments was the rate of decline of treated crownvetch (Table 2). At 15 DAT, the range of control ratings was 53 to 98 percent. When rated at 30 DAT, control ratings ranged from 91 to 100 percent. When crownvetch cover was rated 103 DAT, plots treated with Krovar at 128 oz/ac, and Pramitol/Diuron at 256 oz/ac, alone or in combination with Glyphosate at 32 oz/ac, had 16, 18, and 19 percent crownvetch cover. These ratings were not significantly different from the ratings for the untreated check. Crownvetch cover ratings for all other treatments ranged from 0 to 12 percent, and were all signficantly lower than the untreated plots.

Spotted knapweed was largely eliminated by all treatments (Table 3). Initial knapweed cover ranged from 13 to 39 percent on July 10, and had been reduced to 1 percent or less for all treatments by 103 DAT.

CONCLUSIONS

In terms of reducing vegetative cover, all herbicide treatments were effective. Treatment effects on crownvetch and spotted knapweed differed only the speed of symptom onset - all treatments effectively controlled both species 62 DAT.

MANAGEMENT IMPLICATIONS

Pramitol/Diuron 4L is not on the market as of this writing (June, 2003). If it does enter the market, and the pricing is comparable, the Department should regard this product as an alternative to Krovar I.

LITERATURE CITED

Weed Science Society of America. 1994. Diuron. In: Ahrens, W.H., editor. Herbicide handbook, 7th edition. Champaign, IL. p. 113-115.

Table 1: Response of vegetative cover to herbicide treatments applied July 10, 2002. Visual ratings were taken July 10, September 10, and October 21, 2002; 0, 62, and 103 days after treatment (DAT), respectively. Each value is the mean of four replications.

		Total Vegetative Cover		
Product	Application Rate	Jul 10 0 DAT	Sep 10 62 DAT	Oct 21 103 DAT
	oz product/ac	%		
untreated	---	93	79	76
Sahara	208	78	1	1
Pramitol/Diuron 4L	256	78	8	21
Pramitol/Diuron 4L Glyphosate	256 32	78	6	25
Pramitol/Diuron 4L 2,4-D	256 32	88	8	12
Pramitol/Diuron 4L Plateau	256 4	65	4	14
Pramitol/Diuron 4L Vanquish Hi-Dep	256 6 18	71	5	10
Pramitol/Diuron 4L MetGard	256 0.5	89	4	7
Pramitol/Diuron 4L	640	61	7	6
Pramitol/Diuron 4L Glyphosate	640 32	71	3	4
Pramitol/Diuron 4L 2,4-D	640 32	60	2	1
Pramitol/Diuron 4L Plateau	640 4	58	1	1
Pramitol/Diuron 4L Vanquish Hi-Dep	640 6 18	80	1	2
Pramitol/Diuron 4L MetGard	640 0.5	75	1	1
Krovar I	128	85	7	22
LSD (p=0.05)			9	22
Orthogonal Contrast 'Pramitol/Diuron, 256 oz/ac vs 640 oz/ac'				0.008

Table 2: Response of crownvetch (CZRVA) to herbicide treatments applied July 10, 2002. Visual ratings were taken July 10 and 25, August 9, September 10, and October 21, 2002 or 0, 15, 30, 62, and 103 days after treatment (DAT). Each value is the mean of four replications. Data from the untreated plots was included in the analysis of variance for cover ratings, but not for control ratings.

Product	Application Rate	------- CZRVA Control ------- Jul 25 15 DAT	Aug 9 30 DAT	Sep 10 62 DAT	--- CZRVA Cover --- Jul 10 0 DAT	Oct 21 103 DAT
	oz product/ac	---% ---				
untreated	---	0	0	0	39	28
Sahara	208	53	95	100	27	0
Pramitol/Diuron 4L	256	83	91	90	32	18
Pramitol/Diuron 4L Glyphosate	256 32	88	98	95	39	19
Pramitol/Diuron 4L 2,4-D	256 32	96	99	97	30	5
Pramitol/Diuron 4L Plateau	256 4	88	96	95	26	12
Pramitol/Diuron 4L Vanquish Hi-Dep	256 6 18	96	100	98	25	3
Pramitol/Diuron 4L MetGard	256 0.5	93	99	100	31	0
Pramitol/Diuron 4L	640	93	97	95	23	5
Pramitol/Diuron 4L Glyphosate	640 32	94	99	95	29	3
Pramitol/Diuron 4L 2,4-D	640 32	97	100	98	20	1
Pramitol/Diuron 4L Plateau	640 4	93	99	98	13	1
Pramitol/Diuron 4L Vanquish Hi-Dep	640 6 18	98	100	98	30	2
Pramitol/Diuron 4L MetGard	640 0.5	94	100	100	18	0
Krovar I	128	53	92	94	37	16
LSD (p=0.05)		7	5	5	- -	15

Table 3: Response of spotted knapweed (CENMA) to herbicide treatments applied July 10, 2002. Visual ratings were taken July 10 and 25, August 9, September 10, and October 21, 2002, or 0, 15, 30, 62, and 103 days after treatment (DAT). Each value is the mean of four replications. Data from the untreated plots was included in the analysis of variance for cover ratings, but not for control ratings.

		------ CENMA Control-------					---CENMA Cover---	
	Application	Jul 25		Aug 9		Sep 10	Jul 10	Oct 21
Product	Rate	15 DAT		30 DAT		62 DAT	0 DAT	103 DAT
	oz product/ac	----------------------------%					----------------------------	
untreated	---	0		0		0	38	19
Sahara	208	53	f	79	c	100	35	0
Pramitol/Diuron 4L	256	68	e	93	ab	99	34	1
Pramitol/Diuron 4L Glyphosate	256 32	75	cde	98	a	100	26	0
Pramitol/Diuron 4L 2,4-D	256 32	87	ab	100	a	100	34	0
Pramitol/Diuron 4L Plateau	256 4	73	de	91	b	99	35	1
Pramitol/Diuron 4L Vanquish Hi-Dep	256 6 18	85	abc	98	a	100	38	1
Pramitol/Diuron 4L MetGard	256 0.5	78	b-e	98	ab	99	49	0
Pramitol/Diuron 4L	640	81	a-d	99	a	100	32	0
Pramitol/Diuron 4L Glyphosate	640 32	88	ab	98	a	100	36	0
Pramitol/Diuron 4L 2,4-D	640 32	91	a	100	a	100	36	0
Pramitol/Diuron 4L Plateau	640 4	81	a-d	98	a	100	34	0
Pramitol/Diuron 4L Vanquish Hi-Dep	640 6 18	88	ab	99	a	100	46	0
Pramitol/Diuron 4L MetGard	640 0.5	84	abc	99	a	100	33	0
Krovar I	128	30	g	99	a	100	35	0
LSD (p=0.05)		- -		- -		n.s.	- -	n.s.

COMPARISON OF DIURON PRODUCTS FOR BAREGROUND WEED CONTROL

Herbicide trade and common chemical names: Karmex DF, Direx 4L, MANA-202 7F, and MANA-203 90DF (*diuron*), Touchdown Pro (*glyphosate*).
Plant common and scientific names: birdsfoot trefoil (*Lotus corniculatus*), poverty dropseed (*Sporobolus vaginiflorus*), spotted knapweed (*Centaurea maculosa*), white sweetclover (*Melilotus alba*).

ABSTRACT

A trial was established on July 2, 2002 to compare four products in which diuron is the active ingredient, at both 2 and 8 lb diuron/ac. There were no differences in vegetative cover between the treated plots, and all treatments had significantly less cover than the untreated check on September 10, 70 days after treatment (DAT). On October 15, 105 DAT, there was no significant treatment effect on vegetative cover. On August 9, 38 DAT, ratings for average control of spotted knapweed were 86 percent for the 2 lb/ac treatments, and 97 percent for the 8 lb/ac treatments. This rate effect was not evident on September 10. Spotted knapweed seedlings were present in plots of all diuron treatments by completion of the trial on October 15.

INTRODUCTION

Herbicidal properties of diuron were first reported in 1951 (1), and it has long been a standard component of bareground herbicide mixes, providing preemergence and early postemergence control of annual weeds. Karmex DF, an 80 percent dry flowable, has been the formulation used by the Department. Direx 4L, a 4 lb/gal flowable, is another currently available formulation. Makhteshim-Agan of North America is evaluating two new diuron products; MANA-202, a 7 lb/gal flowable, and MANA-203, a 90 percent dry flowable. The objective of this trial was to compare the efficacy of the new diuron formulations with the existing products in a bareground setting.

MATERIALS AND METHODS

This trial was established along a guiderail on SR 3007, State College, PA, on July 2, 2002. Herbicide treatments included Karmex DF, Direx 4L, MANA-202, and MANA-203, each applied at 2 or 8 lb diuron/ac. Each herbicide treatment included Touchdown Pro at 64 oz/ac.

The study was arranged as a randomized complete block design with three replications. Treatments were applied with a CO_2 powered hand-held sprayer equipped with a single Spraying Systems OC-12 tip, delivering the equivalent of 50 gal/ac. Predominant weed species included spotted knapweed, birdsfoot trefoil, annual dropseed, and white sweetclover. Due to the late date of establishment, the vegetation was cut to a height of 6 in several days prior to herbicide application. A rating of percent total vegetative cover and cover by species was taken on July 2, September 10, and October 15, 2002, or 0, 70, and 105 days after treatment (DAT). Visual ratings of percent control by species were taken on July 22, August 9, and September 10, or 20, 38, and 70 DAT. Data were subjected to analysis of variance, and where treatment effects were significant, treatment means were compared using Fisher's Protected LSD test. A single degree of freedom contrast was run comparing the high and low rates of diuron for each dependent variable.

RESULTS AND DISCUSSION

The average vegetative cover for the plots at the initiation of the study on July 2 ranged from 45 to 58 percent. Throughout the study there were no significant differences among the treatments for percent vegetative cover, and by October 15 the effect of treatment on vegetative cover was not significant.

When control ratings were taken on August 9, the only species for which there was a significant treatment effect was spotted knapweed. The 2 lb diuron/ac treatments were rated between 72 and 97 percent control, while the 8 lb diuron/ac applications were rated between 91 and 99 percent. Application rate was a significant effect as the 8 lb diuron/ac treatments averaged 97 percent control, and the 2 lb diuron/ac treatments averaged 86 percent control.

On the last evaluation of percent control by species on September 10, 70 DAT, percent control ranged from 90 to 100 percent for birdsfoot trefoil, 90 to 100 percent for white sweetclover, and all treatments completely controlled poverty dropseed (data not shown). Control of spotted knapweed in plots treated with Direx 4L at 2 lb diuron/ac averaged 65 percent, while all other treatments were rated at 96 percent or higher (Table 2). Seedlings of spotted knapweed were observed in plots of all treatments on October 15.

CONCLUSIONS

The only significant differences observed during this trial were for control of spotted knapweed 70 DAT. These differences were transient, and by 105 DAT there were no differences in average cover or cover by species.

MANAGEMENT IMPLICATIONS

There was no performance difference between the diuron formulations evaluated in this trial. The Department can rely on factors such as price, formulation, and manufacturer support when determining which product will be on the state pesticide contract.

LITERATURE CITED

Weed Science Society of America. 1994. Diuron. In: Ahrens, W.H., editor. Herbicide Handbook, 7th edition. Champaign, IL. p. 113-115.

Table 1: Response of vegetative cover to diuron treatments applied July 2, 2002. Visual ratings were taken July 2, September 10, and October 15, 2002, or 0, 70, and 105 days after treatment (DAT). Each value is the mean of three replications.

		---------total vegetative cover --------		
product	diuron application rate	Jul 2 0 DAT	Sep 10 70 DAT	Oct 15 105 DAT
	lbs/ac	------------------ % -----------------		
untreated	- -	50	50	47
Karmex DF	2	47	3	13
Direx 4L	2	45	8	15
MANA-202 (7F)	2	55	3	25
MANA-203 (90DF)	2	58	3	37
Karmex DF	8	50	2	24
Direx 4L	8	58	1	6
MANA-202 (7F)	8	47	2	23
MANA-203 (90DF)	8	50	2	8
LSD (p=0.05)		n.s.	11	n.s.

Table 2: Response of spotted knapweed (CENMA) to diuron treatments applied July 2, 2002. Visual ratings of control were taken July 22, August 9, September 10, or 20, 38, and 70 days after treatment (70 DAT). Visual ratings of cover were taken July 2 and October 15, 2002, or 0 and 105 DAT. Each value is the mean of three replications. The untreated checks were not included in the analysis of variance for percent control.

		----- CENMA control ----			- CENMA cover -	
product	diuron application rate	Jul 22 20 DAT	Aug 9 38 DAT	Sep 10 70 DAT	Jul 2 0 DAT	Oct 15 105 DAT
	lbs/ac	-------------------------- % --------------------------				
untreated	- -	0	0	0	17	23
Karmex DF	2	82	72	96	16	10
Direx 4L	2	92	83	65	12	12
MANA-202 (7F)	2	88	91	99	22	19
MANA-203 (90DF)	2	93	97	98	14	30
Karmex DF	8	97	99	99	7	21
Direx 4L	8	95	99	99	12	5
MANA-202 (7F)	8	92	99	99	10	21
MANA-203 (90DF)	8	90	91	99	35	8
LSD (p=0.05)		n.s.	16	n.s.	n.s.	n.s.

2002 ROADSIDE VEGETATION MANAGEMENT CONFERENCE (RVMC)
FIELD DAY REVIEW

'ROADSIDES FOR WILDLIFE' NATIVE SPECIES PLANTING DEMONSTRATION

Herbicide Trade and common chemical names: GlyFlo or Roundup Pro Dry (*glyphosate*), Garlon 4 (*triclopyr*), and Plateau (*imazapic*).
Plant common and scientific names: Canada thistle (*Cirsium arvense*), creeping red fescue (*Festuca rubra* ssp. *rubra*), crownvetch (*Coronilla varia*), quackgrass (*Elytrigia repens*), tall fescue (*Festuca arundinacea*), teasel (*Dipsacus sylvestris*), plus planted species listed in Table 1.

INTRODUCTION

This demonstration was established as a cooperative effort between PENNDOT, the Roadside Research Project, and the PA Game Commission. This five acre native planting was established as a pilot project to enhance wildlife habitat along roadsides. Native, warm season grasses not only provide long-lasting benefits for wildlife, but also the roadside manager and the motoring public. The grass species used encourage nesting of birds and provide habitat for small mammals and insects without enhancing deer habitat. The planting is also meant to provide an aesthetically pleasing, low maintenance groundcover. The native grasses are tall-growing with seedheads up to 6 feet high. This limits their use to areas that are further than 30 feet from the roadway. In Pennsylvania, these would be a potential substitute for many areas commonly planted to crownvetch. These native grasses can tolerate low fertility and low pH. Although slow to fill in after seeding, they ultimately provide a competitive groundcover that provides benefits for wildlife, acts as a snow fence, and require minimal maintenance. Periodic mowing (or burning!) or selective herbicide application eliminates encroaching brush species. Ideally, the mowing height would be at least 6 inches, and cutting would be done after July 15 when ground nesting birds have completed the nesting cycle. Most of the species and cultivars of native grasses have durable stems that remain upright throughout the winter months providing cover for wildlife, and also serve to capture drifting snow.

The Roadsides for Wildlife Program is a pilot project with the goal of demonstrating the utility of native, warm season grasses and forbs for both operational and habitat mitigation functions. The intended fit for plantings such as this would be in interchanges or wide rights-of-way that provide the space needed to support wildlife and will not interfere with visibility for the motorist. As we have stated in the past, the intent of our ongoing efforts with warm-season grasses is not to renovate existing areas of intact vegetation. However, to get plots established at this stage it is easier to revegetate existing areas within a maintenance context than it is to utilize ongoing construction projects - but ultimately the aim is to have this type of mix available as a specification and installed during construction.

MATERIAL AND METHODS

The planting was established in a five acre plot in the infield of the interchange of SR 22/220/764, near Duncansville, PA. The species originally present included many undesirable species encroaching on the original seeding of tall fescue and creeping red fescue. Predominant species included teasel, Canada thistle, and quackgrass. The site was first treated with glyphosate in the fall of 1999 by PENNDOT contractors to eliminate the existing vegetation. On May 12, 2000 the area was retreated by Roadside Research Project personnel to address areas missed and annuals beginning to emerge. A tank mix of glyphosate (either 4 qt/ac of GlyFlo or 72 oz/ac of Roundup PRO Dry), 1 qt/ac Garlon 4, and 4 oz/ac Plateau was applied at 5 gal/ac in Thinvert. The application was made with a Radiarc with the spray fan oriented horizontally. The area was then seeded in mid-May, 2000 by Pennsylvania Game Commission personnel using a tractor mounted Truax Flex 88 no-till drill. The seed mix used is listed in Figure 1. A mixture containing native forbs and little bluestem was seeded along the periphery of the demonstration area while taller grasses were seeded in the interior of the plot. On June 8, 2001 the entire area was treated with Plateau at 6 oz/ac to address weeds that were present in the planting. A total of 26 gallons was applied at a targeted rate of 5 gal/ac, using the same Radiarc configuration that was used on May 12.

RESULTS AND DISCUSSION

The results at the Duncansville site are satisfactory in terms of establishment, despite the somewhat marginal initial weed control in the fall of 1999. There will be long term weed control issues, particularly with crownvetch, which is a good argument to not utilize existing crownvetch sites for revegetation, particularly when you intend to include forb species in the planting mix. Eliminating crownvetch where desirable forbs exist not economically feasible.

Table 1: Seed mix planted by the Pennsylvania Game Commission in mid-May using a tractor mounted Truax Flex 88 no-till drill

Interior of Plot

Common Name	Latin Name	lbs. PLS/acre
big bluestem	*Andropogon gerardii*	3-4
Indiangrass	*Sorghastrum nutans*	3-4
switchgrass	*Panicum virgatum*	3-4

Perimeter of Plot

Common Name	Latin Name	lbs. PLS/acre
little bluestem	*Schizachyrium scoparium*	3-4
blackeyed Susan	*Rudbeckia hirta*	0.5
oxeye sunflower	*Heliopsis helianthoides*	0.25
wild bergamot	*Monarda fistulosa*	0.25
showy ticktrefoil	*Desmodium canadense*	0.5
roundheaded bushclover	*Lespedeza capitata*	0.25

2002 RVMC FIELD DAY REVIEW (continued):

SWITCHGRASS FOR SLOPE STABILIZATION

Plant common and scientific names: annual ryegrass (*Lolium multiflorum*), big bluestem (*Andropogon gerardii*), crownvetch (*Coronilla varia*), Indiangrass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), and switchgrass (*Panicum virgatum*).

For almost 50 years, the standard for vegetating cut and fill slopes created by road construction has been crownvetch. It is currently used as Seeding Formula C, which includes annual ryegrass and crownvetch at 5 and 4 lb/1000 square yards, respectively. Crownvetch is a legume, and fixes its own nitrogen. It has a prostrate growth habit, and produces new shoots from its thick roots. Crownvetch is tolerant of a wide range of site conditions, and is very effective at providing groundcover relatively quickly, and eventually fills in all areas where it is capable of growing. It has a hard-seed component of about 90 percent, so it can be seeded at almost any time during the season. It is reasonable to assume that if crownvetch will not establish in an area, then almost nothing else will.

The use of crownvetch is coming under increasing scrutiny, however, due to its weedy nature. Any effective groundcover is, almost by definition, weedy. Crownvetch is native to Eurasia and North Africa, and in our setting lacks diseases, insect pests, or significant herbivores. Its creeping habit allows it to expand into adjacent areas, and its hard seed ensures that propagules will be present on a site where it is established long beyond our lifetime. Where it is unwelcome, it is a hellacious weed that crawls up to and over most herbaceous species, and provides cover for rodents (they won't eat it) so that woody plants surrounded by crownvetch are often girdled. Seeding contractors who are not forced to clean their hydraulic seeders before seeding other mixes have seeded many acres with crownvetch where it was not intended, and crownvetch becomes the groundcover in many tree and shrub beds where hydraulic seeders are used to water plants.

Crownvetch is appearing more frequently on lists of invasive species, and appears as a 'situational invasive' on the list developed by the PA Department of Conservation and Natural Resources, which is the closest thing to an official PA list. At this time, there is no OFFICIAL PA or Federal List of invasive species.

Warm-season grasses such as switchgrass, big bluestem, little bluestem, and Indiangrass are also well-adapted to a wide range of sites, and can tolerate soil with lower pH than crownvetch can. In addition to their adaptation, these grasses are native and provide desirable habitat for non-deer wildlife, particularly ground nesting birds.

The warm-season grasses provided a desirable alternative to crownvetch, but establish differently, and more slowly. Crownvetch creeps along the soil surface and covers the soil fairly soon after establishment, while these grasses remain upright, and their early growth will cover much less soil than crownvetch. To be effective, seed mixes that include quick establishing cover crops as well as species to provide early-to-intermediate term soil cover will need to be developed.

As part of the construction of SR 99 between Grazierville and Altoona, a switchgrass mixture was used as part of the Terrestrial Mitigation plan. Many of these areas have a very well developed population of switchgrass. A slope was viewed where switchgrass and crownvetch are present in close proximity, so that participants could observe first hand the type of sites these species will grow on, and and the type and extent of groundcover provided.

ESTABLISHMENT OF FORMULA L WITH HYDRAULIC AND TERRA-SEEDING APPLICATIONS

Plant common and scientific names: annual ryegrass (*Lolium multiflorum*), creeping red fescue (*Festuca rubra* ssp. rubra), and hard fescue (*Festuca trachyphylla*).

INTRODUCTION

Plant establishment during construction is a seemingly endless source of frustration for those charged with the establishment and maintenance of roadside vegetation. The current construction inspection system is generally not well suited to insure the quality of the materials and application of establishment amendments. Certainly there are knowledgeable inspectors doing conscientious work, but there are more inspectors who are unfamiliar with plant materials and planting practices who therefore do not have the knowledge base to ensure adherence to specifications.

Finn Corporation, one of the leading manufacturers of hydraulic seeders and seeding products, has a vested interest in seeing that roadside seedings have a successful outcome. There is an expressed suspicion that there is a widespread tendency for seeding applications to be done with sub-optimal (and sub-specified) mulch rates, which reduces establishment success, and reduces the likelihood that hydraulic seedings will be specified in the future.

This site was established as an opportunity to demonstrate the potential utility of increased hydromulch application rates, as well as increased seed rates, and the addition of specialized products designed to enhance the early establishment of seed while it's still in the 'cocoon' provided by the mulch. Any early growth advantages would translate into quicker establishment, a more uniform stand, and better long term performance of the planting.

A related issue is the use of compost for soil amendment, erosion control, and for enhancing establishment. This site was also used to demonstrate 'Terraseeding', the incorporation of seed into a pneumatically-applied blanket of compost. The compost is intended to provide erosion control, long-term soil improvement, and a desirable growing medium for the young seedlings. In addition to blanket applications, compost can be used to create berms, as well as to fill erosion control socks, which provide both structure as well as a growing medium.

The compost was applied on June 27 with a Finn Bark Blower, provided by Finn, using Laurel Valley's Erosion Control blend compost. An installation was done during the field day with a Rexius Express Blower, provided by Doug Caldwell of River Valley Organics. These units are similar in concept, and both have the capability of metering seed into the material stream at a controlled rate.

MATERIALS AND METHODS

All seeding was done on June 27, 2002. This is not an ideal date, and it is outside the specified seeding date for Formula L (55/35/10 mixture of hard fescue, creeping red fescue, annual ryegrass, respectively) as specified in Publication 408, PENNDOT's construction specifications manual. However, this was the soonest this demonstration could come together, and we felt it worth the risk compared to having no established demonstration come Field Day on July 18.

RESULTS AND DISCUSSION

The lack of rainfall throughout the remainder of the 2002 growing season resulted in failure of all treatments. Very little grass established on the site. The grass that did germinate was soon lost to drought. The materials, concepts, and equipment demonstrated at this site have merit and should be evaluated further. Finn Corporation is interested in continued evaluation of their products. Plans are being made to retest several of these products during for subsequent field days, using a more optimal timing.

Table 1: The following is a summary of the products and objectives of the plots.

Item	Description
Formula L	A mixture of hard fescue (*Festuca trachyphylla*), creeping red fescue (*Festuca rubra* ssp. *rubra*) and annual ryegrass (*Lolium multiflorum*) at a 55:35:10 ratio. Pub 408 calls for 24 lb of Formula L per 1000 square yards (MSY). The PA Turnpike Commission specifies 48 lbs MSY. Finn reps and some PENNDOT Districts opt for higher seed rates as well in their revitalization contracts. The logic there is 'seed is cheap'. The counter argument is that 'there is such a thing as too much seed'. Excessive plant counts cause competition between the seedlings, resulting in a higher number of less vigorous plants. Who's right is a function of how many plants get started on the site. On a low quality site (such as this one) the high seed count may be an advantage.
Fertilizer	10-20-20 at 140 lbs MSY is providing 14, 28, and 28 lbs MSY of N, P, and K, respectively. Finn HPN is a more soluble starter product, with a 10-44-6 analysis and a more soluble P source. It is applied to provide 0.75, 3.3, and 0.45 lbs/MSY of N, P, and K, respectively.
Lime	Pub 408 calls for 800 lb of pulverized lime per MSY. In this case, that is 800 lbs per MSY of calcium carbonate, but its availability for soil reacation is limited. Finn HLL is a liquid lime product that applied at a rate of only 12 lbs calcium carbonate/MSY. The theory is that the HLL will have almost instant effect.
Conwed 2000	This is a virgin wood fiber mulch with tackifier that meets Pub 408 specs. Pub 408 and PTC call for 320 lbs/MSY. Finn recommends 454 lb/MSY for optimum performance.
Finn HydroGel	A water-retention polymer designed to help the mulch blanket retain moisture, and release it to the seed. At recommended rates, the mulch would hold an additional 800 lb of water/MSY.
Finn HydroMax	This is combination product designed to enhance early growth while the seed is still in the protective blanket of the mulch. It contains gibberellic acid (a plant hormone that enhances germination); humic acids, which have been shown to be effective in impoverished growing media (sand); microbes that will begin to digest the additives and the mulch to release nutrients, as well as perhaps antagonize pathogens; and a surfactant that aids in re-wetting of the mulch blanket.
Conwed 3000	A ready-to-use mechanical-bonded fiber matrix. This is a BFM (wood fiber, guar gums, polymers) enhanced with mechanical fibers that aid in the cross linking of the wood fibers, creating a more integral blanket.
Finn Fiber Plus	Where a tackifier is already present (such as Conwed 2000), the addition of Fiber Plus creates 'tank mixed' mechanical bonded fiber matrix.
Finn Stik Plus	A combination of Fiber Plus and HydroStik (guar gum tackifier). When added to a tackifier free mulch, it will create a mechanical bonded fiber matrix.
Laurel Valley 'Erosion Control Blend' compost	A mixture of fully composted mushroom 'soils' (mushroom compost is only barely composted when used to produce mushrooms) intended for erosion control blanket applications.

Table 2: Treatments applied in the seed establishment demonstration.

TREATMENT	MATERIALS	APPL. RATE LB 1000 SY	UNIT IF NOT LBS
PUB 408 STANDARD	FORMULA L	24	
	10-20-20	140	
	AG LIME	800	
	CONWED 2000	320	
PA TURNPIKE STANDARD	FORMULA L	48	
	10-20-20	140	
	AG LIME	800	
	CONWED 2000	320	
FINN REC MULCH RATE	FORMULA L	48	
	10-20-20	140	
	AG LIME	800	
	FINN FIBER PLUS	4.1	
	CONWED 2000	454	
FINN REC'D MULCH, AMENDMENTS, & ADDITIVES	FORMULA L	48	
	FINN HPN	1.5	
	FINN HLL (1 GAL MSY)	128	FL OZ
	FINN FIBER PLUS	4.1	
	CONWED 2000	454	
	FINN HYDRO GEL B	2	
	FINN HYDROMAX (1GAL/MSY)	128	FL OZ
FINN REC'S PUB 408 SEED RATE	FORMULA L	24	
	FINN HPN	1.5	
	FINN HLL (1GAL/MSY)	128	FL OZ
	FINN FIBER PLUS	4.1	
	CONWED 2000	454	
	FINN HYDRO GEL B	2	
	FINN HYDROMAX (1 GAL/MSY)	128	
PUB 408 STRAW	FORMULA L	24	
	10-20-20	140	
	AG LIME	800	
	STRAW	1200	
	CONWED PAPER MULCH	160	
	FINN STIK PLUS	6.2	
PUB 408 STRAW ADDITIVE SYSTEM	FORMULA L	24	
	FINN HPN	1.5	
	FINN HLL (1 GAL MSY)	128	FL OZ
	STRAW	1200	
	CONWED PAPER MULCH	160	
	FINN STIK PLUS	6.2	
	FINN HYDRO GEL B	2	
	FINN HYDROMAX (1 GAL/MSY)	128	FL OZ
CONWED MBFM	FORMULA L	48	
	10-20-20	140	
	AG LIME	800	
	CONWED 3000	620	

Table 2 (cont.): Treatments applied in the seed establishment demonstration.

TREATMENT	MATERIALS	APPL. RATE LB 1000 SY	UNIT IF NOT LBS
TERRASEED		FORMULA L	24
2-INCH BLANKET	LAUREL VALLEY 'EROSION CONTROL'	56	YD^3
408 SEED RATE	COMPOST BLEND		
TERRASEED	FORMULA L	48	
2-INCH BLANKET	LAUREL VALLEY 'EROSION CONTROL'	56	YD^3
HI SEED RATE	COMPOST BLEND		
TERRASEED	FORMULA L	24	
1-INCH BLANKET	LAUREL VALLEY 'EROSION CONTROL'	28	YD^3
408 SEED RATE	COMPOST BLEND		

THE ROLE OF SPRING-APPLIED HERBICIDES FOR JAPANESE KNOTWEED MANAGEMENT

Herbicide trade and common chemical names: Roundup, Rodeo (*glyphosate*), Velpar (*hexazinone*), Derringer (*glufosinate*)

Plant common and scientific names: Japanese knotweed (*Polygonum cuspidatum*), giant knotweed (*Polygonum sachalinense*), Canada thistle (*Cirsium arvense*), poison hemlock (*Conium maculata*).

INTRODUCTION

Japanese knotweed is an aggressive, tall-growing, clone forming, herbaceous perennial, native to Japan that is regarded as a pest on a global scale. On narrow rights-of-way (ROW), it is acutely problematic because it limits sight distance, encroaches into the travel lanes, and will sprout through asphalt. On wider ROW, knotweed is often not an acute problem in terms of maintaining the roadway, but definitely represents a threat to become an acute problem, as well as a threat to move off the ROW and degrade adjacent properties.

Japanese knotweed is one of two knotweed species in PA - the other is giant knotweed, which is very similar to Japanese knotweed. One distinct difference we have demonstrated is that giant knotweed is more responsive to spring-applied herbicides, and has been easier to control in efforts to date.

Repeated trials and demonstrations evaluating spring-applied, phloem-mobile, systemic herbicides on Japanese knotweed have shown such applications to be ineffective. Applications made later in the season, particularly in September, have been effective and have provided greater than 90 percent reduction when evaluated the following spring. In a trial conducted in State College in 2001, an October 3 application of glyphosate at 3 lb ae/ac (4 qts of a 'Roundup' equivalent, 3 qts of a 'Rodeo' equivalent) in 200 gallons/ac of water provided 97 percent reduction when evaluated in July 2002.

Despite the utility of later season practices, we view spring as a valuable opportunity to set back the knotweed to boost the efficacy of later-season efforts. From an operational perspective, properly-timed (late May onwards) mowing is very effective as the knotweed regrowth is only 3 to 4 ft high, as opposed to the 6 to 8 ft at the time of cutting. This makes subsequent spray operations much easier to accomplish. It also would provide sight distance where knotweed occurs on secondary roadways.

Another avenue we are investigating is the use of non-phloem-mobile herbicides. Small scale efforts in 2001 demonstrated that Velpar will effectively burn-down Japanese knotweed in the spring, as well provide satisfactory reduction the following season. However, the rates applied were much higher than intended, as we ended up applying Velpar at an average of 3 lb ai/ac, rather than the 1 lb ai we were targeting.

This objective of this demonstration was to evaluate Velpar DF at 20 oz/ac (0.94 lb ai), which would the recommended rate for management of Canada thistle or poison hemlock. If effective, spray crews could target knotweed while conducting thistle and poison hemlock operations - or it would provide one more argument to implement a Velpar program in the spring.

Derringer (formerly available as Finale) is a quick-acting contact herbicide that we thought might provide effective burndown.

A mowed plot was included for comparison. Being able to treat knotweed with a burn-down type herbicide in the spring would provide a means to 'chemically mow' knotweed, which might be easier to accomplish than actual mowing of knotweed.

MATERIALS AND METHODS

A patch of knotweed near mile marker 49 of SR 99 N, straddling a concrete lined ditch was divided into quadrants, with the ditch serving as one of the borders. Each plot was measured so that the herbicide treatments could be applied at the target dosage and volume. Treatments were applied June 4, 2002. One plot was untreated. The mow plot was cut by hand, as close to the soil surface as practical. The herbicide plots were treated with the equivalent of 100 gal/ac spray solution, using a CO_2-powered, single wand sprayer equipped with a Spraying Systems #5500 Adjustable ConeJet with an X-12 tip. Velpar DF was applied at 20 oz/ac, with the addition of an organosilicone-based surfactant at 0.1 percent, v/v. Derringer was applied at 128 oz/ac, which was equivalent to a 1 percent solution, without additional surfactant.

The Japanese knotweed ranged from 3 to 7 ft tall, and was undergoing active growth. Some plants were undergoing secondary branching (branches on their branches), but most plants only had branches on the primary stem. There was no apparent sign of frost damage. Plants in the State College area were frost damaged twice in May this year, and were much shorter on this date.

RESULTS AND DISCUSSION

Neither herbicide treatment appears to have had a significant impact on the knotweed. Only a small proportion of the Derringer-treated foliage showed necrosis. The Velpar treatment yellowed some of the foliage, but neither treatment seemed to inhibit ongoing growth. Operationally, the cut plot provided the most effect.

Based on this effort, we did learn the following:

- 100 gal/ac is not enough solution to cover developed knotweed. Crews who are going to treat knotweed on a 'spray-to-wet' basis will probably apply 200 to 300 gallons/ac, and should mix accordingly.
- An effective Velpar DF rate appears to be somewhere between 20 and 60 oz/ac, although the spray volume factor needs to be evaluated concurrently.

THE EFFECT OF BASAL BARK APPLICATION TIMING ON AILANTHUS AND BLACK LOCUST RESPROUTING

Herbicide trade and common chemical names: Garlon 4 (*triclopyr*)
Plant common and scientific names: ailanthus, or tree-of-heaven (*Ailanthus altissima*), black locust (*Robinia pseudoacacia*), boxelder maple (*Acer negundo*), bull thistle (*Cirsium vulgare*), common buckthorn (*Rhamnus cathartica*), green ash (*Fraxinus pennsylvanica*), Japanese barberry (*Berberis thunbergii*), staghorn sumac (*Rhus typhina*), and Tartarian honeysuckle (*Lonicera tatarica*).

INTRODUCTION

Both ailanthus and black locust are troublesome, root-suckering tree species. A basal bark application is one technique that can be used to control these trees. When using this method the herbicide is applied to the lower 12-18 inches of the trunk. This application approach is commonly done in the dormant season. It is very effective at controlling non root-suckering species at any time of the year because it easily controls the above ground portions of the plant. Root-suckering species often respond with prolific resprouting. Earlier work by this project and others has shown evidence that suckering may be reduced by applications made during the growing season, when, presumably, the bark-applied herbicide is translocated to the root system. This demonstration compares dormant versus growing season basal bark applications on ailanthus and black locust.

MATERIAL AND METHODS

An area along the northbound shoulder of I-99, at mile marker 49 near Tyrone, PA was chosen as the site for this demonstration. Distinct colonies of both ailanthus and black locust were present. Three plots of each species were established. Each species was treated at three different timings. Treatment timings in 2001 were April 23 and August 21. These timings correspond to pre bud-break and full leaf-out stages. A third application was made July 9, 2002, so that injury symptoms could be viewed during the field day. The herbicide mix used was 25% v/v Garlon 4, 75% v/v Arborchem Basal Oil, and basal colorant. Treatments were applied using a backpack sprayer equipped with an ultra low volume wand, a Spraying Systems #5500 Adjustable ConeJet nozzle, and a Y-2 tip. Target trees were treated to 12 inches above the soil line.

The July 9 application was also used to demonstrate the Zone Concept approach, where the roadside is viewed as consisting of a Safety Clear Zone extending from 0 to 30 ft from the road edge, and a Selective Zone extending from 30 to 80 ft from the road edge. All woody stems are controlled in the Clear Zone, to reduce collision hazards for errant motorists. In the 30 to 80 ft zone, tall growing or troublesome species are controlled, while smaller-growing species such as staghorn sumac are left untreated. Green ash and boxelder maple are controlled in the Selective Zone, but left untreated when they occur more than 80 ft from the road edge.

This application also demonstrates a Target List approach, where some species, regardless of their location, are controlled on the ROW. On this site, species that fell on this list included ailanthus, Tartarian honeysuckle, Japanese barberry, common buckthorn, and bull thistle, a PA Noxious Weed.

RESULTS AND DISCUSSION

This demonstration is relatively small and unreplicated but showed some of the tendencies observed at other locations. Ailanthus resprouting was considerable in the plot treated in April 2001, but was very sparse in the plot treated in August 2001. The plots treated on July 9 showed dramatic foliar symptoms, very similar to a foliar application. If a 'low profile' application (i.e. no foliar symptoms) is desired, it must be made prior to leaf-out, or immediately before leaf drop. In research previously reported by this project[6], basal bark applications made after full leaf expansion have provided greater control of root sprouts for ailanthus. However, studies performed in 2001/2002 to investigate the timing effects of basal bark applications on ailanthus, detailed elsewhere in this report, did not substantiate this claim. Further testing should be done to determine whether there is a correlation between treatment timing and root sprouting with ailanthus.

Black locust root sprouts were evident with both timings. This is comparable to the black locust cut surface timing trial observed earlier in the field tour at Duncanville.

Despite mixed results, we still recommend ailanthus control efforts to be concentrated during the latter part of the growing season, whether foliar, basal bark, or cut surface.

Black locust may be less responsive to application timing than ailanthus, and therefore there may not be a need to concentrate black locust control efforts during a particular period.

[6] Influence of basal bark applications of Garlon 4 and Stalker on tree-of-heaven resprouting. Roadside Vegetation Management Research Report: Fifteenth Year Report, pages 1-4.

2002 RVMC FIELD DAY REVIEW (continued):

PREEMERGENCE HERBICIDE MIXES FOR BAREGROUND WEED CONTROL

Herbicide trade and common chemical names: Oust (*sulfometuron*), Karmex (*diuron*), Krovar I (*bromacil + diuron*), Sahara (*imazapyr + diuron*), Spike 80DF (*tebuthiuron*), Plateau (*imazapic*), Milestone (*azafenidin*).

Plant common and scientific names: bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), common mugwort (*Artemesia vulgaris*), common teasel (*Dipsacus sylvestris*), crownvetch (*Coronilla varia*), goldenrod species (*Solidago* spp.), smooth brome (*Bromus inermis*), spotted knapweed (*Centaurea maculosa*), tall fescue (*Festuca arundinacea*), white sweetclover (*Melilotus alba*), wild carrot (*Daucus carota*).

INTRODUCTION

The combination of Oust plus Karmex is the bareground treatment most commonly used by PENNDOT. This combination has provided effective and economical results. We feel it is beneficial to periodically compare other treatments to Oust plus Karmex to aid the Districts in their treatment selection process. This demonstration featured nine herbicide combinations that were assembled using seven different products - Karmex, Krovar I, Milestone VM, Oust, Plateau, Sahara, and Spike 80DF. The material cost per acre for the combinations ranged from $61.36 to $65.76.

MATERIAL AND METHODS

This demonstration was established along the shoulder of the Grazierville exit, I-99 southbound off ramp. The application was made on April 10, 2002 using a CO_2 powered backpack sprayer equipped with an ultra low volume wand and single Spraying Systems OC-12 tip. Plot size was 5 by 50 ft with 5 ft skips between each plot to serve as additional check plots. The targeted application volume was 28 gal/acre. All treatments included 0.1% v/v QwikWet 357 surfactant. Plots were rated for percent green cover on July 3, 2002, 12 weeks after treatment. Predominant weed species at the time of application were spotted knapweed, crownvetch, and tall fescue, and vegetative cover ranged from 1 to 3 percent.

RESULTS AND DISCUSSION

When evaluated at 12 weeks later, the percent green cover within each plot ranged from 0 to 10 percent, with a rating of 5 percent for the untreated check. Weed pressure was very low, and the species spectrum was limited, therefore the comparative value of the demonstration was limited.

The timing of the application was too early for signficant postemergence activity, therefore the established plants present at treatment were not controlled. The exception was the Spike 80DF treatment, which did eliminate the crownvetch and knapweed present at treatment. The Spike treatment was also notable because there was visible movement of the material, downslope beyond the applied pattern. Such movement was not visible with any other treatment.

Table 1: Response of vegetation to herbicide treatments applied April 10, 2002. Visual ratings of percent cover were taken at treatment and July 3, 2002, 84 days after treatment.

Treatment	Rate	Material Cost	Cover Apr 10	Cover Jul 3	Species present*
	oz/ac	$/ac	%	%	
1. Untreated	----	----	1	5	CZRVA, CENMA, FESAR, MELAL, PHLPR, SPOVA
2. Oust Karmex	3 128	62.83	2	10	CZRVA, TRSFL
3. Krovar I	112	62.72	2	5	CZRVA, SOLXX, PANCA
4. Sahara	112	61.60	1	3	CZRVA, FESAR, CIRAR, DAUCA, DIWSI
5. Spike 80DF	48	65.76	1	0	
6. Plateau Karmex	12 128	61.36	1	1	CENMA, CZRVA, PLAMA
7. Plateau Oust Karmex	12 2 64	64.42	1	7	CENMA, CZRVA, FESAR, SETFA, SOLXX
8. Oust Krovar I	2 80	64.50	2	5	CENMA, CZRVA, DAUCA, ARTVU, BROIN, PLALA, SOLXX
9. Oust Sahara	2 80	63.70	3	5	CZRVA, DAUCA, FESAR, SETFA, CIRVU
10. Oust Milestone	3 5	62.35	1	5	CENMA, SETFA, SOLXX, DAUCA

* Species Bayer codes: ARTVU - mugwort, BROIN - smooth brome, CENMA-spotted knapweed, CIRAR - Canada thistle, CIRVU - bull thistle, CZRVA-crownvetch, DAUCA - wild carrot, DIWSI - common teasel, FESAR - tall fescue, MELAL - white sweetclover, PANCA - witchgrass, PLALA - buckhorn plantain, PLAMA - broadleaved plantain, SETFA - giant foxtail, SOLXX - goldenrod species, SPOVA - poverty dropseed, TRSFL - purpletop

2002 RVMC FIELD DAY REVIEW (continued):

COMPARISON OF HERBICIDES AND TREATMENT FREQUENCY FOR CONTROL OF REED CANARYGRASS IN A CREATED WETLAND

Herbicide trade and common chemical names: Glypro (glyphosate), Arsenal (imazapyr)
Plant common and scientific names: reed canarygrass (*Phalaris arundinacea*), phragmites (*Phragmites australis*), plus species listed in Table 1.

INTRODUCTION

Reed canarygrass is a perennial, cool-season grass species that often invades wetland areas. It is well adapted to wet sites but, will also tolerate upland terrain. These plants can grow to heights in excess of six feet and often form large monocultures where they exist. The species is considered a native of Pennsylvania, as well as most boreal latitudes of the northern hemisphere. What is not known is if all the canarygrass in PA is native. There is conjecture that much of the 'weedy' reed canarygrass is a non-native genotype, which contributes to its weediness. This situation has been demonstrated with phragmites. Regardless of its natural heritage, reed canarygrass is problematic in areas like created wetlands where plant species diversity is essential to the intended function of the site. This trial was established to compare herbicides and treatment frequency. Additionally, a comparison of several seed mixes and site preparation methods was incorporated into the trial. At the time of the 2002 RVMC field day the seed mixes had not been planted, so we can only discuss response of reed canarygrass to herbicide treatments.

MATERIAL AND METHODS

The site was located at a created wetland near the Grazierville exit of I-99. The study area had been originally seeded to Formula W, but over time developed into a near monculture of reed canarygrass. The initial treatments were applied on June 15, 2001. GlyPro at 128 oz/ac, alone or in combination with Arsenal at 16 oz/ac was applied to 30 by 180 ft plots, arranged in what will ultimately be a randomized complete block with a split-block treatment arrangement with three replications, when the seed mix and site preparation treatments are implemented. Both treatments contained a 0.1% v/v organosilicone surfactant. The reed canarygrass was 6 ft tall, in full seedhead, and shedding abundant quantities of pollen. Treatments were applied using an Echo motorized backpack sprayer equipped with a fixed boom and 8002 VS tips, delivering 30 gal/acre.

The entire site was retreated on August 29, 2001 with 110 oz/acre Glypro plus 0.25% v/v non-ionic surfactant. This was applied using a tractor mounted sprayer and Chemlawn Gun. The targeted application rate was 100 gal/acre. Canarygrass regrowth was sparse, probably accounting for 1 percent or less of the original biomass, but occurred throughout the trial area. The trial was divided into 18 by 60 ft plots to accomodate four unseeded treatments that would be tilled or untilled, and would or would not receive a third treatment; two treatments comparing a seed mix developed by the Penn State Project that was to be seeded into plots that did receive a third treatment that were tilled or untilled; and four treatments comparing seed mixes developed by District 9-0 to be seeded into thrice-treated, tilled plots.

The plots intended to receive a third herbicide application prior to seeding were treated April 24, 2002, with 83 oz/ac of GlyPro plus an organosilicone surfactant at 0.1 percent, v/v. This application was made with a motorized backpack with a fixed boom equipped with Spraying Systems XR 8002VS tips, delivering 15 gal/ac to 18 by 60 ft plots. Reed canarygrass was sparse, and averaged about 4 in tall. Parts of the site remained inundated well into June, so seeding of the mixtures was postponed until at least late summer of 2002. All plots were visually rated for percent reed canarygrass reduction on July 3, 2002.

RESULTS AND DISCUSSION

The only treatment effects to be compared with the July 3 data were the effects of adding Arsenal for the first treatment in June 2001, and of the third herbicide application. There was no significant effect due to the presence or absence of Arsenal. The retreatment effect was significant. Plots treated in April 2002 were rated at 100 percent reed canarygrass reduction, and those only treated in 2001 were rated at 97 percent reduction.

Due to the extensive nature of the canarygrass rhizome system, these results are to be considered a short-term effect. A better indication of the effect of the herbicide treatments will be apparent from ratings taken in 2003 after the reed canarygrass has had a season to recover.

POSTEMERGENCE HERBICIDES FOR USE IN BAREGROUND WEED CONTROL

Herbicide trade and common chemical names: Arsenal (*imazapyr*), Derringer (*glufosinate*), Glyphosate (*glyphosate*), Karmex (*diuron*), Oust (*sulfometuron*), andVelpar DF (*hexazinone*).
Plant common and scientific names: birdsfoot trefoil (*Lotus corniculata*), crownvetch (*Coronilla varia*), poverty dropseed (*Sporobolus vaginiflorus*), spotted knapweed (*Centaurea maculosa*), and tall fescue (*Lolium arundinaceum* [=*Festuca arundinacea*]).

INTRODUCTION

Bareground weed control is a standard part of the roadside vegetation management program. Once weed emergence occurs postemergence herbicides are a necessary component of the mix. This demonstration compares the strengths and weaknesses of four postemergence herbicides alone and in combination with a standard premergence herbicide component.

Glyphosate is the standard postemergence component in a bareground herbicide mixture. It is non-selective, systemic, has no soil activity, and due to the expiration of the patent on the isopropylamine salt formulation in 2000, it is remarkably inexpensive. Derringer is a non-selective, contact herbicide with no soil activity that is faster-acting than glyphosate, but less effective on established plants. Arsenal is best described as being selective to a limited spectrum of plants, particularly legumes. It is systemic, slow-acting, and soil active. When used to provide significant preemergence activity, it is applied at 32 to 48 oz/ac. The 13 oz/ac rate used in this study would be expected to provide more post- than preemergence activity. Velpar DF is another herbicide that is selective to a narrow range of species, notably crownvetch. It does have soil activity. The 20 oz/ac rate used in this demonstration is the 'selective' end of the rate spectrum.

MATERIAL AND METHODS

This demonstration was established along the shoulder of the Grazierville exit, I-99 south on ramp. The herbicide treatments included Glyphosate at 128 oz/ac, Velpar DF at 20 oz/ac, Arsenal at 13 oz/ac, and Derringer at 78 oz/ac, alone or in combination with Oust plus Karmex at 3 plus 128 oz/ac. Also included was Oust plus Karmex alone, and in combination with Glyphosate at 64 oz/ac. The rates of the postemergence herbicides were selected to similar to the cost of Glyphosate at 128 oz/ac. The application was made on June 11, 2002 using a CO_2 powered backpack sprayer equipped with an ultra low volume wand and single Spraying Systems OC-12 tip, delivering 30 gal/ac.. Plot size was 5 by 55 ft. with 10 ft. skips between each plot to serve as untreated checks. All treatments except for those including Derringer included an organosilicone-blend surfactant at 0.1 percent, v/v. Plots were rated for percent necrosis on July 3, 2002, 3 weeks after treatment. The most common weed species present at the time of application included spotted knapweed, annual dropseed, tall fescue and birdsfoot trefoil.

RESULTS AND DISCUSSION

At the time of treatment, plots ranged from 10 to 65 percent vegetative cover with an average of 37 percent cover among the plots. Three weeks after treatment, all treatments were rated from 92 to 100 necrosis, except for the Arsenal-alone plot, which was rated at 80 percent. Arsenal did not control birdsfoot trefoil, resulting in the lower rating.

Oust plus Karmex, without an additional postemergence herbicide, burned down 98 percent of the vegetation in a sparse plot. In this setting, the postemergence herbicides did not provide a benefit over Oust plus Karmex. Plots with denser vegetation and a wider species spectrum would be necessary to better demonstrate the utility of the postemergence herbicides for bareground situations.

Table 1: Response of vegetation to treatments applied June 3, 2002. Visual ratings of percent necrosis were taken July 3, 2002, three weeks after application.

Treatment	Application Rate	Material Cost	Green Cover Jun 11	Necrosis Jul 3
	oz/ac	$/ac	%	%
1. Oust	3	62.83	10	98
Karmex	128			
2. Glyphosate	128	25.60	25	100
3. Oust	3	75.63	20	99
Karmex	128			
Glyphosate	64			
4. Oust	3	88.43	25	99
Karmex	128			
Glyphosate	128			
5. Velpar DF	20	23.80	45	95
6. Oust	3	86.63	50	99
Karmex	128			
Velpar DF	20			
7. Arsenal	13	24.05	65	80
8. Oust	3	86.88	45	99
Karmex	128			
Arsenal	13			
9. Derringer	78	24.18	45	92
10. Oust	3	87.01	35	99
Karmex	128			
Derringer	78			