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Art Gover
Jon M. Johnson
Larry J. Kuhns

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College of Agricultural Sciences
University Park, PA 16802

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The fifteenth 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, cut surface, and foliar herbicide applications, Review of native grass and forb planting demonstrations, Evaluation of the Sprout-Less Herbicide Applicator for controlling various tree species, Review of demonstration evaluating the conversion of ailanthus to low maintenance grasses, Evaluation of various herbicide treatments for controlling Tartarian Honeysuckle, Herbaceous weed control research evaluating conversion sequences on the control of Canada thistle, Evaluation of treatments and sequences for conversion of Japanese and Giant Knotweed into low maintenance grasses, Comparing various herbicides for pre and postemergence vegetation control under guiderails.
Review of 2000 Roadside Vegetation Management Conference Field Day demonstrations.

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

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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

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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
Accord	glyphosate	4 S	Monsanto
Arborchem Basal Oil	diluent	- - -	Arborchem Products, Inc.
Arsenal	imazapyr	2 S	American Cyanamid Co.
Basagran	bentazon	4 S	BASF Ag. Products
BK 800	dicamba + 2,4-D+2,4-DP	0.5+2+2 EC	PBI Gordon Corporation
BullsEye Basal 55	dye	- - -	Milliken Chemical
Endurance	prodiamine	65 WG	Novartis Crop Protection, Inc.
Escort	metsulfuron methyl	60 DF	E.I. DuPont de Nemours & Co.
ETK-2350	glyphosate + 2,4-D	----	United Agri Products
Exceed	primisulfuron + prosulfuron	57 WDG	Novartis Crop Protection, Inc.
Finale	glufosinate-ammonium	1 S	Aventis Envir. Sci, Inc.
Garlon 3A	triclopyr	3 S	DowAgroSciences Ltd.
Garlon 4	triclopyr	4 EC	DowAgroSciences Ltd.
Glyflo	glyphosate	4 S	Top-Pro
Hi-Dep	2,4-D	3.8 S	PBI Gordon Corp.
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.
Milestone VM	azafeniden	80 DG	E.I. DuPont de Nemours & Co.
M.U.P.	glufosinate	5 S	Aventis Envir. Sci., Inc.
Oasis	imazapic acid + 2,4-D	2+4 L	American Cyanamid Co.
Oust	sulfometuron methyl	75 DF	E.I. DuPont de Nemours & Co.
Pathfinder II	triclopyr	RTU	DowAgroSciences Ltd.
Pathway	picloram + 2,4-D	RTU	DowAgroSciences Ltd.
Pendulum	pendimethalin	3.3 EC	American Cyanamid Co.
Penevator Basal Oil	diluent	- - -	Exacto Chemical Company
Plateau	imazapic	2 S	American Cyanamid Co.
Polytex A1001	drift retardant	- - -	Exacto Chemical Company
QwikWet 357	adjuvant	- - -	Exacto Chemical Company
Rodeo	glyphosate	5.4 S	Monsanto
Roundup Pro	glyphosate	4 S	Monsanto
Roundup Pro Dry	glyphosate	71.4 DG	Monsanto
Sahara	diuron + imazapyr	DG	American Cyanamid Co.
Spike	tebuthiuron	20P, 80W	DowAgroSciences Ltd.
Stalker	imazapyr	2 EC	American Cyanamid Co.
Surflan	oryzalin	4 AS	DowAgroSciences Ltd.
SunIt II	methylated seed oil	- - -	American Cyanamid Co.
Thinvert RTU	invert emulsion	- - -	Waldrum Specialties, Inc.
Three-Way	2,4-D + MCPP, Dicamba	31,16,3 S	Lesco
Tordon K	picloram	2 S	DowAgroSciences Ltd.
Tordon 101M	picloram + 2,4-D	2.5S (0.5+2)	DowAgroSciences Ltd.
Transline	clopyralid	3 S	DowAgroSciences Ltd.
Vanquish	dicamba-glycolamine	4 S	Novartis Crop Protection, Inc.
Velpar L	hexazinone	2 S	E.I. DuPont de Nemours & Co.

INFLUENCE OF BASAL BARK APPLICATIONS OF GARLON 4 AND STALKER ON TREE-OF-HEAVEN RESPROUTING

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

ABSTRACT

The following treatments were applied on June 3, 1999 to the lower 12 inches of the stems of actively growing ailanthus: Garlon 4 at 15 percent v/v, alone or in combination with Stalker at 3% v/v; and Garlon 4 at 1 percent (v/v) plus Stalker at 3 percent, v/v. Evaluations taken 16 and 70 weeks after application showed that all treatments provided at least 95 percent control of treated stems, and the degree of resprouting was minimal for all treatments. Previous operations and trials on this species have shown prolific suckering after dormant season basal treatments. The reduction in suckering may be attributed to physiological activity correlated to the time of application, which was during active growth, near full leaf expansion, when translocation to the roots may have been occurring. It is not possible to evaluate the contribution of the Stalker in reducing suckering since the Garlon 4 alone was very effective at this time.

INTRODUCTION

Previous experimental and operational dormant season applications of 15 percent v/v Garlon 4 or greater to tree-of-heaven have been shown to effectively control the treated stems, but have resulted in prolific resprouting during the following growing season. This may be due to the herbicide providing a girdling effect only, leaving the root system unaffected. There are several ways in which herbicide could be introduced to the root system to limit its regrowth. One way is to change the timing of application to the growing season to examine the possibility that the herbicide would translocate down to the roots when the plant was physiologically more active. A second way would be to apply a lower rate of Garlon that would kill the tissue more slowly so that some translocation could occur. Another way is to apply an herbicide that is soil active and can be absorbed directly by the roots. Garlon has very little soil activity and is not absorbed by roots to any great extent. Stalker is readily absorbed by roots.

A study was established to study all of these possibilities. Garlon 4 and Stalker were applied in the growing season, alone or in combination, to determine if the timing of the application, or the addition of Stalker, would cause more injury to the root system and result in a reduction in the number of suckers produced by treated trees. A reduced rate of 1 percent v/v Garlon 4 was used in combination with Stalker to determine whether the Garlon 4 would provide partial control but still allow for the translocation of the Stalker to the root system. A previous study initiated in 1988[1] demonstrated that tree-of-heaven was susceptible to Garlon 4 concentrations as low as 5 percent, v/v. Our assumption was that the reduced Garlon 4 rate would cause non-lethal phloem injury, but allow downward translocation of the Stalker, if translocation could indeed occur.

[1] Basal Bark Brush Control Study: 1988 Basal Bark Study, Experiment I, (http://rvm.cas.psu.edu/1989/1989PDF/Brush.BasalBark.89.pdf)

MATERIALS AND METHODS

The study area was located on a cut slope on the westbound shoulder of SR 22 near Newport, PA. Treatments included an untreated check; 15 percent v/v Garlon 4; and 3 percent, v/v, Stalker with either 15 or 1 percent, v/v, Garlon 4. All treatments were diluted in a commercial basal oil. Treatments were applied on June 3, 1999. The treatments were applied to completely cover the lower 12 inches of each stem. Application equipment included backpack sprayers equipped with a Spraying Systems #5500 Adjustable ConeJet nozzle with a Y-2 tip. There were three replications arranged in a randomized complete block design. Treatments were applied to plots averaging 40 by 50 ft in size. A subplot 20 by 20 ft in size was located within each plot. Tree-of-heaven was at full canopy, with active leaf initiation still occurring. Each ailanthus stem within the subplots was measured for caliper at a height of six inches above the soil surface prior to treatment. Stem diameters within the subplots ranged from 0.5 to 11 inches. On September 20, 1999, 16 weeks after treatment, (WAT) and October 10, 2000 (70 WAT) ratings of percent canopy reduction of the treated stems plus the number, height, and caliper of all resprouts were taken within each subplot. Resprout counts 70 WAT distinguished between one-and two-year old resprouts. These values were used to determine resprout basal area, total resprout height, and resprout mortality (Tables 1 and 2). Percent resprout mortality represented the those sprouts counted 16 WAT that were not present at 70 WAT.

RESULTS AND DISCUSSION

All treatments provided at least 95 percent canopy reduction, as well as excellent suppression of suckering. The untreated check was not included in the statistical analysis because a zero value was assigned for canopy reduction and essentially no suckering occurred in the interior of the clone due to the intact canopy within those plots. There were no statistical differences between treatments at either rating period for any of the measurements recorded. Analysis of covariance using original basal area as the covariate revealed no effect on any dependent variable. Resprouts occurred in all treated plots, but the number of resprouts averaged 7 or fewer per sub-plot by 70 WAT. Resprout mortality between 16 and 70 WAT was 77 percent or greater for all treatments, suggesting that the sprouts that did occur were not vigorous.

Compared to previous dormant-season basal applications in the same area, the degree of resprouting was extremely low. The low rate of resprouting may be due to changes in physiological activity and translocation due to the late timing of the application. Individual leaves are not self-supporting until they are fully expanded. By extension, the canopy would not be self-supporting, and therefore capable of exporting photoassimilates to the root systems until enough leaf expansion has occurred to support the existing and still expanding leaves, and still produce a surplus that could be exported to the roots.

This timing effect has been observed in operational applications in districts employing growing season basal treatments, but has not yet been compared in research trials. Previous research by this project compared timings within the dormant season, but not between dormant and non-dormant timings.

CONCLUSIONS

All three herbicide treatments were very effective at controlling the treated stems, and suppression of resprouts through two growing seasons was excellent. In the absence of direct comparison with other application timings, we cannot definitively attribute the reduction in resprouting to differences in physiological activity and translocation to the roots due to timing of the application, but that is a distinct possibility at this time. It is possible that the effect of application timing will completely overshadow the effect of herbicide mixture. Garlon 4 alone in oil is the operational basal bark standard, and the 15 percent concentration we used in this trial was lower than the recommended 20 to 30 percent. Yet this reduced concentration was highly effective. Additional studies need to be conducted to refine our understanding of this timing effect, and establish the optimal operation window.

MANAGEMENT IMPLICATIONS

Preliminary results suggest that suckering of ailanthus can be effectively suppressed with basal bark applications made during active growth following leaf expansion. In hindsight, this seems obvious. Woody plants begin net export of photosynthetic products to the root system after a self-supporting canopy has been produced. Therefore, dormant season applications, whether basal bark or cut-stump, may not be as effective as applications made in the growing season.

This presents the issue of how to best utilize Department maintenance personnel in an ailanthus management program. Department forces are available in the dormant season, when basal bark or cut stump treatments will have little impact on the root system, and will therefore lead to prolific resprouting.

Where brushing by Department forces is desired, the ailanthus should be treated first during the preceding growing season.

Department forces should not be utilized for dormant season basal applications to ailanthus. Such an effort would be better directed against non-suckering species, where it would be highly effective.

Contract forces represent the best tool for ailanthus management. Contracts should be written so that contractors can be readily directed to treat ailanthus with basal bark, or foliar treatments using backpacks or high volume hose-and-handgun work.

Table 1. Canopy reduction provided by basal bark treatments applied to tree-of-heaven June 3, 1999. The original stem number was counted June 3, 1999, and resprout number was counted September 20, 1999 (16 WAT), and October 10, 2000 (70 WAT). The 70 WAT resprout count distinguished first year and second year resprouts. Percent resprout mortality represents the sprouts from 16 WAT that were not present 70 WAT. Each value is the mean of three replications.

Products	Application Rate	Canopy ----Reduction ---- 16 WAT	70 WAT	Original Stem Count	--- Resprouting --- 16 WAT	70 WAT	1st Year Resprout Mortality
	(% v/v)	(--------% -------)		($\#/400\ ft^2$)	(% of original stem #)		(%)
untreated[1/]	- -	0	0	36	0	1	0
Garlon 4 basal oil	15 85	100	99	46	33	7	77
Garlon 4 Stalker basal oil	15 3 82	100	100	36	38	7	90
Garlon 4 Stalker basal oil	1 3 96	95	95	33	8	2	96
LSD (p=0.05)		n.s.	n.s.	---	n.s.	n.s	n.s.

[1/] Data from the untreated check was not included in the analysis of variance.

Table 2. Effect of basal bark applications made to ailanthus June 3, 1999. Resprout basal area and cumulative height were measured September 20, 1999 (16 WAT) and October 10, 2000 (70 WAT). Each value is the mean of three replications.

Products	Application Rate	Original Basal Area	Resprout ----Basal Area --- 16 WAT	70 WAT	Total Resprout ------Height ------ 16 WAT	70 WAT
	(% v/v)	($in^2/400\ ft^2$)	($in^2/400\ ft^2$)		($in/400\ ft^2$)	
untreated [1/]	- -	137	0.0	0.2	1	31
Garlon 4 basal oil	15 85	123	1.0	1.2	196	161
Garlon 4 Stalker basal oil	15 3 82	209	1.8	0.9	185	118
Garlon 4 Stalker basal oil	1 3 96	145	0.2	0.1	47	35
LSD (p=0.05)		---	n.s.	n.s.	n.s.	n.s.

[1/] Data from the untreated check was not included in the analysis of variance.

AN EVALUATION OF VANQUISH AND EXCEED AS TANK MIX COMPONENTS FOR BRUSH CONTROL

Herbicide trade and common chemical names: Exceed (*primisulfuron* + *prosulfuron*), Garlon 4 (*triclopyr*), Escort (*metsulfuron*), Roundup Pro (*glyphosate*), Arsenal (*imazapy*r), Vanquish (*dicamba*), Krenite S (*fosamine*)

Plant common and scientific names: red maple (*Acer rubrum*), gray birch (*Betula populifolia*), hickory (*Carya* spp.), bigtooth aspen (*Populus grandidentata*), quaking aspen (*Populus tremuloides*), black cherry (*Prunus serotina*), white oak (*Quercus alba*), bear oak (*Quercus ilicifolia*), red oak (*Quercus rubra*), sassafras (*Sassafras albidum*)

ABSTRACT

Ten herbicide combinations were applied to a mixed stand of brush resprouts on July 29, 1999, along SR 80 in Luzerne County. Analysis of variance for canopy reduction data by species for Populus, red maple, and red oak, and total stems, showed a significant treatment effect for Populus only. The treatments Vanquish at 64 oz/ac plus Exceed at 2 oz/ac, Vanquish at 64 oz/ac plus Escort at 1 oz/ac, or Exceed plus Arsenal at 2 plus 10 oz/ac, respectively, were rated at 43, 43, and 69 percent canopy reduction, respectively. Escort plus Roundup Pro was rated at 99 percent canopy reduction of Populus. Ratings for canopy reduction averaged across all treated stems ranged from 66 percent for Exceed plus Vanquish, to 98 percent for Escort plus Roundup Pro.

INTRODUCTION

The agrichemical manufacturers CIBA and Sandoz merged into the new entity Novartis. This lead to a re-evaluation of each company's products to determine if additional uses could be found for them. Exceed is a premix of two sulfonylurea herbicides, used for broad spectrum postemergence weed control in corn. A trial was established to determine if it would provide some benefits if used in brush control tank mixes. In this study, additional data on the utility of Vanquish with different tank mix partners was evaluated.

MATERIALS AND METHODS

The study site was located on SR 80, mile 261, Luzerne County, on a south-facing cut slope. The brush on the slope had been cut during the winter of 1997/98. Resprouts ranged from 1 to 7 ft, with average height estimated to be about 4 ft. Plot size varied to account for brush density, and ranged from approximately 1200 to 4000 ft^2. The experimental design was a randomized complete block, with three replications. The treatments were applied July 29, 1999, with CO_2-powered, single nozzle, hand-held sprayers, equipped with a Spraying Systems #5500 Adjustable ConeJet with a Y-2 tip. The herbicide treatments are listed in Table 1, and were applied at a targeted volume of 20 gal/ac. The predominant brush species were quaking and bigtooth aspen, red maple, red oak, black cherry, gray birch, white oak, sassafras, and hickory. Bear oak was also common, but was not targeted.

Percent necrosis (brownout) was rated September 2, 1999 (not reported), and percent canopy reduction by stem was rated on June 15 (reps 1 and 2) and August 8 (rep 3), 2000. The data for total stems; and poplar, red maple, and red oak canopy reduction, were subjected to analysis of variance. The untreated checks were not included in the analysis of variance.

After the ratings were completed on August 8, 2000, the entire study (approximately 1.6 ac) was oversprayed with 13 gallons of a mixture of Garlon 4 plus Arsenal, at 3.0 plus 0.5 percent, v/v, on a low volume basis.

RESULTS AND DISCUSSION

The analysis of variance for canopy reduction on total stems was not significant, and ranged between 98 and 66 percent (Table 1). Treatment effect was also not signficant for canopy reduction for red maple or red oak. Treatment effect was only significant for canopy reduction in poplar. The highest rated treatment was Escort plus Roundup Pro, at 99 percent. Exceed plus Vanquish, Exceed plus Vanquish plus Arsenal, and Escort plus Vanquish were the lowest rated at 43, 69, and 43 percent, respectively.

In the absence of treatments consisting of the herbicides alone, we cannot clearly determine from this data if Exceed has utility as a brush control agent. When Exceed is compared to Escort, which does have demonstrated utility, using the same tank mix partners, there is no statistical difference between them. Where Exceed is added to Vanquish plus Roundup Pro, or Vanquish plus Garlon 4, there was no increase in activity - but it is not likely we could detect it if there was because those two herbicide combinations were effective without adding Exceed. The way the treatments were designed, we would only be able to detect a loss of performance.

CONCLUSIONS

Unfortunately, it is difficult to come away from this effort with conclusions regarding the utility of the herbicide mixtures. They were all effective enough that they could not be distinguished statistically.

MANAGEMENT IMPLICATIONS

This trial did not distinguish any herbicide treatments, but it does reinforce our ongoing assertion that backpack-based brush management on limited access corridors should become standard practice. This corridor is maintained to top-of-cut mechanically, on a periodic basis. The use of backpack based crews would cost less money, and be more selective. The most desirable vegetation in the study area, from a maintenance perspective, was found where an electric transmission line crossed the highway. There were no brush targets in that section, and it had to be skipped in our study. Such areas are periodically treated selectively, and the plant community responds by converting to low growing herbaceous species.

Table 1. Summary of percent canopy reduction, by species and average total, for brush treated July 29, 1999, and evaluated June 15 and August 8, 2000. Each 'Total' value is the mean of three replications. Not all species occurred in all plots. A value of '- -' indicates the species was not present in any plot for a given treatment. The values in parentheses represent the number of stems for the given species.

Products	Application Rate	Poplar	Red Maple	Red Oak	Cherry	Gray Birch	White Oak	Sassafras	Hickory	Total
		Canopy Reduction								
	(oz product/ac)	(%)								
1. untreated[2]	- - -	0 (n/c[3])	0 (n/c)	0 (n/c)	0 (n/c)	0 (n/c)	0 (n/c)	0 (n/c)	0 (n/c)	0 (n/c)
2. Exceed Vanquish	2 64	43 (116)	73 (18)	67 (39)	91 (10)	76 (39)	65 (3)	- -	- -	66 (225)
3. Escort Vanquish	1 64	43 (64)	67 (17)	81 (58)	100 (2)	92 (11)	43 (11)	98 (3)	10 (1)	78 (167)
4. Exceed Roundup Pro	2 128	87 (168)	95 (11)	88 (32)	98 (11)	99 (37)	98 (6)	98 (20)	100 (1)	89 (286)
5. Escort Roundup Pro	1 128	99 (76)	100 (13)	95 (63)	100 (1)	98 (17)	100 (1)	- -	- -	98 (171)
6. Vanquish Roundup Pro	64 96	87 (59)	87 (17)	83 (28)	90 (4)	98 (19)	58 (2)	100 (2)	- -	89 (131)
7. Exceed Vanquish Roundup Pro	2 64 96	80 (152)	81 (18)	82 (35)	75 (2)	97 (25)	98 (2)	100 (7)	- -	81 (241)
8. Vanquish Garlon 4	64 64	92 (49)	66 (18)	80 (19)	70 (1)	88 (16)	60 (1)	- -	- -	85 (104)
9. Exceed Vanquish Garlon 4	2 64 64	91 (140)	76 (9)	87 (43)	96 (9)	83 (14)	80 (2)	97 (3)	80 (2)	94 (222)
10. Exceed Vanquish Arsenal	2 64 10	69 (113)	75 (13)	82 (70)	88 (5)	90 (13)	57 (3)	98 (2)	- -	89 (219)
11. Vanquish Krenite S	64 192	86 (34)	73 (11)	87 (49)	100 (8)	98 (13)	57 (7)	93 (4)	- -	92 (126)
LSD (p=0.05)		27	n.s.	n.s.						n.s.

[2] The untreated check data were not included in the analysis of variance.

[3] Stem numbers were not counted in the untreated check plots.

EVALUATION OF HERBICIDES FOR CONTROL OF TARTARIAN HONEYSUCKLE USING LOW VOLUME BACKPACK APPLICATIONS

Herbicide trade and common chemical names: Garlon 4 (*triclopyr*), Escort (*metsulfuron*), Rodeo (*glyphosate*), Arsenal (*imazapy*r), Vanquish (*dicamba*), Transline (*clopyralid*), Krenite S (*fosamine*)
Plant common and scientific names: Tartarian honeysuckle (*Lonicera tatarica*)

ABSTRACT

Tartarian honeysuckle is one of several exotic bush-type honeysuckles that are invading Pennsylvania's landscape. The herbicide combinations Garlon 4 plus Escort, Rodeo plus Arsenal, Vanquish plus Transline plus Escort, and Krenite plus Arsenal were applied as low volume foliar treatments on August 10, 1999. Rodeo plus Arsenal provided 83 percent control, which was significantly higher than any other treatment. However, even this level of control is not acceptable from an operational perspective.

INTRODUCTION

Tartarian honeysuckle is one of several invasive *Lonicera* species spreading throughout wildlands and unmaintained landscapes. Exotic honeysuckles have a tangible negative impact on surrounding properties[4], and should be targeted wherever they exist on Department ROWs. The Department's selective weed and brush program has only been partially successful in controlling honeysuckle. Garlon plus Escort treatments usually provide control of the branch terminals, but regrowth occurs from further down the treated stems. Unsatisfactory control is a function of herbicide selection and application method. Most honeysuckles treated during the selective weed and brush program are only partially treated as they encroach into existing clear zones. Where the honeysuckles are mostly off of the ROW, such as secondary roadways, this is unavoidable. Where the honeysuckle is entirely within the ROW, the application method needs to be modified to address all of the honeysuckle. Whether this is done during the weed and brush application, or as a specific operation is dependent upon the inclination of, and resources at the disposal of the Roadside Specialist. In addition to modifying the application approach, the herbicide mixture needs to be addressed. This study was established to determine if any of the herbicide mixes tested would provide greater control of tartarian honeysuckle. Backpack sprayers were used along with lower carrier volumes in the hope that, if effective, it would offer flexibility in reaching areas outside the typical range of truck-based equipment.

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[4] A useful summary on the exotic bush honeysuckles:
Batcher, M.S, and S.A. Stiles. 2001. Element Stewardship Abstract for the Bush Honeysuckles. The Nature Conservancy. http://tncweeds.ucdavis.edu/esadocs/loni_spp.html

MATERIALS AND METHODS

The study was established along the shoulder of the SR 286 off-ramp of SR 119 S in Indiana County. Treatments were applied on August 10, 1999 using backpack sprayers with single nozzle handguns equipped with Spraying Systems #5500 Adjustable ConeJets with either X-4 or Y-2 tips, targeting an application rate of 20 gal/ac. The herbicide mixes listed in Table 1 are reported as product/ac, based on the 20 gal/ac carrier volume. Rodeo was used in place of Roundup Pro only because of immediate availability. The Rodeo rate of 96 oz/ac provided a glyphosate dosage equivalent to using 128 oz/ac of Roundup Pro. At the time of treatment the tartarian honeysuckle was fully leafed out, with ripened fruit. Individual plots were 100 by 20 ft, arranged in a randomized complete block with three replications. A single rating of percent canopy reduction was taken August 4, 2000.

RESULTS AND DISCUSSION

Plots treated with Rodeo plus Arsenal had a canopy reduction rating of 83 percent, which was significantly higher than any other treatment, and were the only plots where mortality was observed. The other treatments seemed to only cause a set back of growth at the terminals of the branches. Regrowth occurred from the interior of the shrub, and treatment effects could sometimes only be discerned through detailed observation as regrowth often obscured the dead branch tips. The lack of effect from the Krenite plus Arsenal treatment was surprising, as we have seen excellent control from this combination in previous brush trials[5], and have observed good control of honeysuckle from Department Krenite plus Arsenal applications. This may be a function of 'pattern compression' which occurs when a spray pattern calibrated on a vertical plane for brush side-trimming falls beyond the targeted vertical plane due to lack of target. Spray material from the upper and lower reaches of the vertically-oriented pattern come together on the horizontal plane, increasing the spray volume and the herbicide dosage. This would be a more common effect on understory plants such as honeysuckle.

CONCLUSIONS

None of the treatments provided acceptable control. Because of the lack of satisfactory control, all variables are left open to question, including herbicide mixture, application technique, and application timing. These evaluations should be considered as a necessary ongoing effort, as exotic bush honeysuckles are a target worthy of extensive control efforts.

5 Brush Control provided by Fall Broadcast Applications of Combinations of Krenite or Accord with Arsenal. 1994. Roadside Vegetation Management Research Report - Eighth Annual Report. http://rvm.cas.psu.edu/1993/AR1993.html.

MANAGEMENT IMPLICATIONS

Current practices employed by the Department that have demonstrated efficacy against Tartarian honeysuckle include basal bark using Garlon 4 in oil, and Krenite applications that include Arsenal. Additionally, based on the performance of the tractor-mounted Bar-None, which was viewed during the 1997 Roadside Vegetation Management Conference, we believe that stump treatment with triclopyr in oil, after cutting has potential to be effective.

Basal application can readily be done during the dormant season, though access to the base of the plant can be difficult on large plants with low-growing branches. The exotic bush honeysuckles should be cut whenever they are in an area being brushed. Where exotic bush honeysuckles are a component of the understory, they should be targeted during the Krenite plus Arsenal program using a directed application. Directed application of Krenite plus Arsenal, applied either by hose and handgun, backpack, or by multiple pattern spray heads that could avoid damage to desirable understory, may be effective. Rates of application required must be determined.

Until other techniques have been proven effective, the Department will have to rely on the limited selection of techniques available.

Table 1. Ratings of percent canopy reduction of Tartarian honeysuckle after herbicide treatments. Treatments were applied on August 10, 1999, and ratings were taken August 4, 2000. Each value is the mean of three replications.

Treatment	Application Rate	Canopy Reduction Aug. 4, 2000
	(oz/ac)	(%)
Untreated	---	0
Garlon 4	64	32
Escort	1	
Rodeo	96	83
Arsenal	8	
Vanquish	64	33
Transline	8	
Escort	1	
Krenite S	128	48
Arsenal	3	
LSD (p=0.05)		21

CONTROL OF TREE-OF-HEAVEN AND CONVERSION TO FINE FESCUE UPDATE

Herbicide trade and common names: Tordon 101M (*picloram + 2,4-D*), Garlon 3A & 4 (*triclopyr*), Roundup Pro (*glyphosate*), Escort (*metsulfuron*)

Plant common and scientific names: tree-of-heaven (*Ailanthus altissima*), hard fescue (*Festuca trachyphylla*), creeping red fescue (*Festuca rubra* ssp. rubra), poison ivy (*Toxicodendron radicans*), multiflora rose (*Rosa multiflora*), bush honeysuckle (*Lonicera* spp), black locust (Robinia pseudoacacia), privet (*Ligustrum* spp.), red maple (*Acer rubrum*), grape (*Vitis* spp.), flowering dogwood (*Cornus florida*), hawthorne (*Crataegus* spp.), sycamore (*Platanus occidentalis*).

INTRODUCTION

Tree-of-Heaven, or ailanthus, is a problematic tree species that continues to invade roadway corridors throughout the northeastern United States. It is a root-suckering species that forms large colonies where it becomes established. This tree, capable of growing to heights of 80 ft, is weak wooded and spreads readily. It is capable of spreading not only by the abundant seed it produces but, also through the distribution of root fragments. This tree has no significant insect or disease pests in the U.S. and has the ability to grow in poor soils and under stressful environmental conditions. Because it grows in full sun and thrives in poor growing conditions the roadside environment provides a tremendous opportunity for the establishment, growth, and spread of this tree. It's size, weak wood, rate of growth and spread, and it's difficulty to control, make this a truly problematic species. Mechanical and chemical control options have not provided complete control of this invasive plant. This demonstration investigated the addition of using cultural controls by converting an area infested with tree-of-heaven to fine fescue. These findings were first reported in the Roadside Vegetation Management Thirteenth Year Report. This report reviews the initial work and adds the details of a followup visit made on August 4, 2000.

MATERIALS AND METHODS

The demonstration site was located in an infield at the intersection of SR 22 West and SR 217. The ailanthus infestation was approximately 0.75 acres in size. The stand was divided into two distinct areas. One side had a dense understory of honeysuckle under the tree canopy. This side was not seeded during the course of the demonstration to determine whether the naturally occurring vegetation would provide a more competitive groundcover than that seeded to Formula L. The diameter of the ailanthus ranged from seedling stage to 12 inches at six inches above the soil surface. The first treatment was a basal bark application made on March 22, 1996. The solution used was 20% (v/v) Garlon 4 and 80% (v/v) Arborchem Basal Oil. The lower 15 to 18 inches of all the stems were treated. On September 4, 1996 all ailanthus resprouts were treated with a foliar application of 4% (v/v) Roundup Pro, 1% (v/v) Garlon 3A, and 0.25% (v/v) Formula 358 drift control applied at 20 gallons per acre (GPA). The foliar application also targeted other unwanted species including poison ivy. Species such as dogwood, hawthorne, and sycamore were not targeted by the application. Equipment for both treatments included backpack sprayers with basal wands or handguns and a Spraying Systems adjustable ConeJet nozzle with Y-2 tip. Half of the area was seeded to a mixture of 60% hard fescue and 40% creeping red fescue on September 19, 1996. The seed was applied at 115 lbs/ac using hand seeders. On September 18, 1997 the area was evaluated. On September 22, 1997, following this evaluation, a selective low volume foliar application was made to control existing ailanthus resprouts and other unwanted vegetation. The herbicide mixture was applied at 20 GPA and contained 4 qts/ac Garlon 4, 1 oz/ac Escort, 0.25% v/v Polytex A1001 drift control and 0.125% v/v QwikWet 357 surfactant.

Update:

On August 4, 2000 the site was visited and a selective low volume foliar treatment was applied. Backback sprayers equipped with Spraying Systems adjustable ConeJet nozzles and Y-2 tips were used. Four gallons of a 5%v/v Tordon 101M spray solution was applied to the site. The targets included not only the ailanthus, but also poison ivy, privet, red maple, grape, and some Japanese honeysuckle.

RESULTS

By September 18, 1997 the trees treated during 1996 were completely controlled and the fine fescue stand had become well established. The honeysuckle understory that dominated the other half of the demonstration area was thriving. Ailanthus resprouts were evident throughout both areas but were later controlled with the selective application made on September 22, 1997.

Update:

Four gallons of solution were sprayed on August 4, 2000 versus 1.6 gallons on September 22, 1997. Three years had past between these followup visits and ailanthus resprouts were present but, minimal. Other troublesome species were targeted during both visits. The area left with an understory of honeysuckle remained intact with scattered ailanthus resprouts. These resprouts were easily targeted with the low volume foliar application. The area seeded to fine fescue has largely been transformed to a stand of these grasses.

CONCLUSIONS

This demonstration proves that a stand of Ailanthus can be successfully converted to fine fescue. Selectively controlling the ailanthus and converting the area to a competitive groundcover is economically feasible and offers long term benefits. In some areas the ailanthus stand may actually have to be removed. This can be achieved by cutting the stand and treating the surface of the stump. Periodic followup visits with selective foliar applications will be necessary following basal or cut surface treatments for several years to prevent the ailanthus from reinfesting the area. The honeysuckle proved to be a competitive, naturally occurring groundcover. Where areas are devoid of an existing groundcover grasses are the most logical choice for establishment. They are competitive and selective chemistry can be used to control the ailanthus and other broadleaf weeds without destroying the integrity of the groundcover in future visits.

Update:

Even four years after the initial treatment the area has remained mostly clear of the ailanthus. Long-term management is necessary to deter ailanthus and other troublesome species from invading the site. Minimal time and material has gone into the maintenance of this location since it was converted. The approaches of leaving naturally occurring understory where it exists or establishing grasses have both proven successful with this demonstration. The original ailanthus stand has been controlled and periodic visits to manage ailanthus resprouts have been effective.

Table 1: Cost figures for converting an established stand of ailanthus to fine fescue. The treatments outlined are the five visits made during 1996, 1997, and 2000. Labor costs are based on $20.00/hour.

Treatment	Date	Material Cost	Manhours	Labor Costs
Basal Bark	3/26/96	$76.18	4	$80.00
Low Volume Foliar	9/04/96	$37.80	2	$40.00
Seeding	9/19/96	$79.90	2	$40.00
Low Volume Foliar	9/22/97	$7.64	1.5	$30.00
Low Volume Foliar	8/04/00	$6.66	1.5	$30.00

Total Cost (to date) = $428.18 for treating 0.75 ac and seeding 0.40 ac.

Based on these figures, it would cost $710.79/ac to initially treat, seed, and provide two subsequent followup treatments on a similar ailanthus infestation.

EVALUATION OF THE SPROUT-LESS HERBICIDE APPLICATOR

Herbicide trade and common chemical names: Garlon 4 (*triclopyr*), Tordon K (*picloram*), Stalker (*imazapyr*), Roundup Pro (*glyphosate*)

Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), eastern redbud (*Cercis canadensis*), sugar maple (*Acer saccharum*), striped maple (*Acer pensylvanicum*), green ash (*Fraxinus pennsylvanica*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), witch-hazel (*Hamamelis virginiana*), birch (*Betula* spp.)

ABSTRACT

Two separate studies were established to evaluate the effectiveness of the Sprout-Less Herbicide Applicator in 1999. Four treatments were evaluated. The treatments included no herbicide, 20% v/v Garlon 4 alone, or in combination with either 5% v/v Tordon K or 3% v/v Stalker. The first study was located along SR 22 near Newport, PA. This site was comprised predominately of ailanthus. The trees ranged from 1 to 8 feet in height. Treatments were made on March 22 and 23, 1999. The second site was located in Clearfield County along SR 3014 near Waukesha, PA. This was a mixed deciduous stand of smaller trees. The treatment was made to this site on August 18, 1999.

Difficulties with the gasket arrangement were encountered during the establishment of both tests. The proper dosages were not applied to many of the plots due to difficulties in calibrating the equipment. The results were disappointing. Even in the plots to which adequate amounts of material were applied. There was little difference in resprouting between the stumps that were cut and treated with herbicides compared to those that were cut and left untreated.

INTRODUCTION

Mechanical clearing of brush is a commonly performed operation along Pennsylvania's roads. The treatment of the remaining stumps with herbicides is critical to prevent vigorous sprouting from occurring on the stumps that remain. A device that allows the operator to both cut and treat the stump in a single operation would provide a very cost effective approach to dealing with clearing small trees. Currently, the clearing is performed separately from the herbicide treatment. Typically a clearing or chain saw is used to cut the tree and a spray bottle or backpack sprayer containing a cut surface herbicide mix is used to apply the material to the exposed stump. Two studies were established to determine the potential of this piece of equipment for use in roadside clearing operations. It also investigates the effectiveness of several herbicide mixes on a range of tree species using this equipment.

The Sprout-Less Herbicide Applicator was developed to provide a means to both cut and apply an herbicide treatment in one operation, through a process that could be described as controlled leakage. This system consists of a reservoir mounted to the blade of a clearing saw that contains an herbicide mixture. As the blade decelerates upon contact with a woody stem, solution leaks out of the reservoir onto the lower surface of the cutting blade. The herbicide solution is then wiped on the freshly exposed cut surface. The reservoir holds 110 mL, a quantity that is synchronized with the fuel consumption of the saw. When the saw needs to be refueled, the herbicide reservoir should need to be refilled.

MATERIALS AND METHODS

The first trial was established along the westbound shoulder of SR 22 near Newport, PA. The site consisted primarily of ailanthus. The trees were sprouts that resulted from an earlier clearing operation on this west facing slope. These trees were 1 to 8 feet in height with a diameter up to 1.5 inches at the initiation of the study. Other species present included black locust, multiflora rose, green ash, and eastern redbud. Treatments were applied March 22 and 23, 1999 to plots approximately 20 by 60 feet. A Stihl FS 550 clearing saw equipped with a clearing blade and Sprout-Less Herbicide Applicator was used. The untreated plots were cut with no herbicide applied. The herbicide treatments contained 20% v/v Garlon 4 alone or in combination with either 5% v/v Tordon K or 3% v/v Stalker. The remainder of the solution for each treatment was Arborchem Basal Oil. The gasket arrangement for the herbicide treatments included a textile against the brass fitting followed by a rubber gasket. The study was set up as a randomized complete block design with three replications. The volume of material applied was variable for the Garlon 4 alone, Garlon 4 + Tordon K, and Garlon 4 + Stalker treatments. Total amounts applied were 160, 175, and 95 mL, respectively. Data was recorded only in rep 1 because it was evident that the treatments had little effect. On May 30, 2000, 1 year after treatment (YAT), the stumps were evaluated for whether resprouting was occurring from them and the species was identified.

A second trial was established on a young stand of mixed deciduous trees along a secondary road near Waukesha, PA. The trees were up to 12 feet in height with an average diameter of 2 inches measured six inches above the soil. Stem density was high throughout the study area with approximately 10,000 stems per acre. The same treatments, experimental design, number of replications, and equipment were used to establish this study. Treatments were applied on August 18, 1999 to plots 150 by 15 feet. Tree species included sugar maple, striped maple, red oak, green ash, American beech, and witch-hazel. The volume of material applied was again variable for the Garlon 4 alone, Garlon 4 + Tordon K, and Garlon 4 + Stalker treatments. Total amounts applied were 320, 60,and 110 mL, respectively. Ratings were taken September 19, 2000, 1 YAT. In all plots, the stumps were evaluated for whether resprouting was occurring and the species was identified. In replication one, when sprouting did occur, the number, width of cluster, and height of the tallest resprouts was recorded.

RESULTS AND DISCUSSION

The lack of control was very evident for all treatments at both sites. As a result, data was not collected for replications 2 and 3 at the Newport site and detailed information was only recorded for the first rep at Waukesha. The ailanthus at the Newport site had sprouts on every stump when no herbicide was applied and even the best treatment resulted in only a 7 percent reduction in stumps with sprouts 1 YAT. Similar results were observed at Waukesha where a mixed stand of trees had been cut. The Garlon 4 alone provided the best control with 14.6% of the stumps still clear of resprouts 1 YAT. There were problems associated with treating both sites. The gasket arrangement and torque imposed on the seal were not ideal most of the time. This resulted in either too much or too little material being applied. Even the plots that were thought to have been applied correctly did not result in satisfactory control.

Our work to date has shown mixed results using this application device. The difficulty with this piece of equipment is related mainly to the gaskets. The series of gaskets used to form a seal between the reservoir and the blade is constructed by the applicator using a combination of paper, textile, and/or rubber gaskets. These need to be placed properly and the combination varies depending on the viscosity of the herbicide mixture. Improperly installed gaskets or too tight or loose an assembly and the material goes out at an inappropriate rate.

For research, continual changes needed to be made because of altering the herbicide mixes for tests. This was frustrating at best. Perhaps those using the applicator on a more frequent basis and staying with a single mix would find this unit more user friendly. In a separate demonstration the Sprout-Less Herbicide Applicator had provided fair control of quaking aspen stump sprouts using an herbicide mixture of 70% Roundup Pro, 5% Stalker, 22% MON 59120 (surfactant), and 3% water. The gasket arrangement and adjustments were consistent and the results reflected that.

MANAGEMENT IMPLICATIONS

The results in general have been too variable to recommend use of this equipment by PENNDOT. PENNDOT is not set up to designate a clearing saw to an individual for extended periods of time. Tests and applications conducted by the manufacturer often involve operators with dedicated clearing saws. This would help to eliminate many of the problems associated with calibration that have plagued this project and would no doubt cause erratic results for PENNDOT. Perhaps, the gaskets used in the current version will be replaced by more user friendly options for creating a seal in the future.

Table 1. Evaluations of control provided by the Sprout-Less Herbicide Applicator. These values were recorded 1 year after treatment. They represent data collected on ailanthus at the Newport, PA site. This data is from the first replication only.

		Rate	Stumps Total	Stumps w/ sprouts	Stumps w/o sprouts	Stumps Controlled	Root Sprouts
		(% v/v)	(------------------Number	-------------------	------------------)	(%)	(No.)
1.	untreated	---	25	25	0	0	52
2.	Garlon 4	20	41	38	3	7	68
3.	Garlon 4 Tordon K	20 5	37	35	2	5	45
4.	Garlon 4 Stalker	20 3	50	49	1	2	56

Table 2. Evaluations of control provided by the Sprout-Less Herbicide Applicator. These values were recorded 1 year after treatment. They represent data collected on a mixed deciduous stand at the Waukesha, PA site. This data is the total of 3 replications with the exception of 'sprouts/stump'. Data on sprouts was recorded only for the first replication.

		Rate	Stumps Total	Stumps w/ sprouts	Stumps w/o sprouts	Stumps Controlled	Sprouts/ Stump
		(% v/v)	(------------------Number	-------------------	------------------)	(%)	(Avg. No.)
1.	untreated	---	171	171	0	0	2.22
2.	Garlon 4	20	192	164	28	14.6	1.38
3.	Garlon 4 Tordon K	20 5	191	187	4	2.1	2.88
4.	Garlon 4 Stalker	20 3	233	231	2	0.9	2.79

CONTROL OF TREE-OF-HEAVEN WITH BASAL BARK APPLICATIONS OF GLUFOSINATE

Herbicide trade and common chemical names: Finale (*glufosinate*), M.U.P. (*glufosinate*), Garlon 4 (*triclopyr*)
Plant common and scientific names: Tree-of-heaven or ailanthus (*Ailanthus altissima*), black locust (*Robinia pseudoacacia*), and sumac (*Rhus* spp.)

ABSTRACT

On June 4, 1999, a trial comparing the efficacy of three basal bark treatments containing glufosinate at 0.5 lb/gal on tree-of-heaven were compared with a standard treatment of Garlon 4 at 15 percent (v/v) in basal oil. The Garlon 4 and glufosinate with Clean Cut (a crop oil concentrate) provided significant canopy reduction the first growing season. Glufosinate simply diluted in water yielded only 69 percent canopy reduction. There was essentially no suckering observed the first year, suggesting that basal applications during periods of active growth may be more effective on suckering species. First year data was included in a previous report[1/]. By the second growing season only the standard Garlon 4 treatment maintained satisfactory control with an average 96 percent canopy reduction. The glufosinate treatments tested in this study did not provide satisfactory long-term results.

INTRODUCTION

Glufosinate, in the form of the herbicide Finale, is regarded as a contact herbicide. However, in certain situations it has demonstrated utility in controlling woody vegetation[2/]. Basal bark applications, particularly during the dormant season when no translocation is occurring, work on woody plants by chemically girdling the stem. Therefore, limited translocation of an herbicide would not necessarily be a disadvantage for this application. The objective of this study was to determine if glufosinate has any utility as a basal bark material by evaluating different formulations and diluents for control of tree-of-heaven. The treatments were compared to the industry standard, Garlon 4E in basal oil.

MATERIALS AND METHODS

Three glufosinate treatments each contained 0.5 lb active ingredient/gal. Finale contains 1 lb of glufosinate per gallon. Fifty percent solutions of Finale were created by diluting it with either water or a 1:1 mixture of water and Clean Cut. The third treatment was a mixture of M.U.P., Clean Cut, and water at 10, 25 and 65 percent v/v, respectively. M.U.P. contains 5 lb/gallon of glufosinate. Garlon 4 at 15 percent v/v, diluted in HyGrade EC basal oil was included in the study as a standard treatment for comparison. The trial area consisted of a stand of ailanthus located on the shoulder of the off-ramp from SR 26 S to SR 550, near Bellefonte, PA. The treatments were applied June 4, 1999, to the lower 12 inches of each stem in each plot, using backpack sprayers with single nozzle wands equipped with a Spraying Systems #5500 ConeJet

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[1/] Preliminary Results: Control of Tree-of-Heaven with Basal Bark Applications of Glufosinate, Fourteenth Annual Research Report.
[2/] Brush Control Provided By Low Volume Foliar Applications Using Finale with Translocated Herbicides, Thirteenth Annual Research Report.

with a Y-2 tip. At the time of treatment, the ailanthus had developed a full canopy, but active leaf formation was still occurring. The experimental design was a randomized complete block with three replications. To accommodate two discrete colonies, plots in the northern-most replication were 40 feet wide, while the remaining plots were 30 feet wide. All plots were approximately 30 feet deep. Stem caliper ranged from 0.5 to 5 inches. Each stem in each plot was visually rated for percent canopy reduction on September 21 and 22, 1999 and again on August 21, 2000. Average canopy reduction was calculated for each plot, and these average values were subject to analysis of variance.

RESULTS

The number of stems treated and the average canopy reduction are summarized in Table 1. During the first growing season Garlon 4 in oil provided 99 percent canopy reduction. When glufosinate was applied in a mixture containing crop oil concentrate, the average canopy reduction was 88 and 85 percent for the M.U.P. and Finale treatments, respectively. These ratings were not significantly different from the Garlon 4 standard application. Finale in water alone was not as effective as the treatment containing M.U.P. Stem caliper appeared to affect herbicide injury, as glufosinate-treated stems in the 4 to 5 inch caliper range were less affected than smaller stems. However, many of these larger diameter plants were showing signs of chlorosis, and reduced leaf size. There was no sign of root suckering from the ailanthus in any of the plots during the September evaluation.

In the second year, ratings taken on August 21, 2000 demonstrated the standard Garlon 4 in oil treatment provided significantly better control than all other treatments with an average canopy reduction rating of 96 percent. The glufosinate treatments had a marked decrease in control of the treated stems. Glufosinate treatments ranged from 43 to 57 percent canopy reduction by this date. Plants showing injury in 1999 did not succumb, and regrew in 2000 with no indication of injury. Injury from 1999 was visible as dead branches.

CONCLUSIONS

Glufosinate as a basal bark treatment provided initial canopy reduction comparable to Garlon 4, provided there was 25 percent crop oil concentrate in the mixture. Second year results showed that the glufosinate symptoms initially observed were only a temporary setback. The canopies of trees with diameters greater than one inch, and even some smaller ones, ended up with only branch tip dieback. There was obvious basal injury, but enough cambium and vascular tissue survived to keep the canopy alive. The Garlon 4 treatment has long been the standard material for this type of application. It proved to be significantly better than the glufosinate treatments in controlling the treated stems. One problem with controlling ailanthus with basal bark applications has been the lack of control of the root system. Since the treated stems in this trial where largely uncontrolled by the glufosinate treatments the root sprouting was not evaluated.

MANAGEMENT IMPLICATIONS

Garlon 4 in basal oil is still clearly the standard for basal applications. Although first year results were promising, the final outcome of the basal bark applications using glufosinate on ailanthus at the rates tested in this trial were not acceptable. Garlon 4 treatments made during the growing season offer the best hope for control of both the treated tree and it's root system. The use of contract crews for basal work during the growing season where suckering species such as ailanthus, black locust, and sumac are prevalent should be emphasized. Department force applications during the dormant season should be limited to areas where non-suckering species are common.

Table 1. Summary of canopy reduction ratings, and stem numbers for tree-of-heaven treated June 4, 1999, and rated September 21 and 22, 1999 and August 21, 2000. Canopy reduction values are the mean of three replications.

Treatment	Percent v/v	Number Stems Treated Reps 1,2,3	Percent Canopy Reduction Sep 1999	Aug 2000
Garlon 4/Hygrade EC	15/85	153, 119, 125	99	96
Finale/water	50/50	134, 119, 128	69	43
Finale/Clean-Cut/water	50/25/25	87, 107, 115	85	57
M.U.P./Clean-Cut/water	10/25/65	59, 133, 114	88	53
LSD (p=0.05)			16	23

UPDATE: COMPARISON OF REHABILITATION SEQUENCES FOR GIANT KNOTWEED INFESTATIONS

Herbicide trade and common chemical names: Vanquish (*dicamba*), Transline (*clopyralid*), Tordon K (*picloram*)

Plant common and scientific names: Japanese knotweed (*Polygonum cuspidatum*), giant or Sakhalin knotweed (*Polygonum sachalinense*), hard fescue (*Festuca trachyphylla*), red fescue (*Festuca rubra* ssp. *rubra*), annual ryegrass (*Lolium multiflorum*), crownvetch (*Coronilla varia*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), exotic bush honeysuckle (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*), blackberry (*Rubus allegheniensis*)

ABSTRACT

Four operational sequences to convert roadside sites infested with Japanese knotweed and giant knotweed to a grass mixture were compared beginning in 1998, and first reported in the 14th annual report[6]. The four sequences were developed by varying the order of a primary herbicide treatment, grass seeding, and a follow-up herbicide treatment. Sixteen months after initiation of the trial, three sequences featuring primary treatment in the spring of the first year provided at least 60 percent fescue cover, and less than 10 percent giant knotweed cover at a southeastern PA site infested with giant knotweed. The fourth sequence, featuring a late summer primary treatment, provided equal knotweed suppression, but only 18 percent fescue cover. A second trial on Japanese knotweed in a highway interchange complex in southwestern PA was largely unsuccessful due to poor Japanese knotweed control. The Japanese knotweed site was abandoned. Review of the giant knotweed site in 2000 showed that the spring/fall treatment sequences had 89 to 92 percent fescue cover, and 1 percent or less knotweed cover, while the fall/spring treatment sequence had 60 percent fescue cover and 16 percent knotweed cover.

INTRODUCTION

Japanese and giant knotweeds are stout, erect, herbaceous perennial plants that commonly grow to heights of 6 to 10 ft. They spread vigorously by vegetative means, and are capable of producing dense monocultures covering areas an acre or more in size. Both species can occur on desolate, disturbed sites, and Japanese knotweed has been documented to tolerate sites with extremely low pH and fertility[7]. In a roadside setting, particularly in narrow rights-of-way, both species can pose a serious problem due to loss of sight distance, and damage to asphalt pavements from emerging shoots. Large infestations degrade habitat value by eliminating plant community diversity. Since knotweed infestations develop into near-monocultures, seeding of treated areas with a desirable species should be planned as part of the operation. Also, since it is practically impossible to eradicate an established stand of knotweed with a single herbicide application, particularly when little soil-active residue can be tolerated, follow-up treatments will be required. The groundcover species seeded must be tolerant of the follow-up herbicide

[6] Comparison of Rehabilitation Sequences for Japanese and Giant Knotweed Infestations. 2000. Roadside Vegetation Management Research Report-Fourteenth Year Report. http://rvm.cas.psu.edu/1999/AR1999.html

[7] McKee,G.W., J.V. Raelson, W.R. Berti, and R.A. Peiffer. 1982. Tolerance of Eighty Plant Species to Low pH, Aluminum, and Low Fertility. Agronomy Series No. 69, The Pennsylvania State University.

treatment. Using a grass mixture allows for the use of herbicides that are active only on broadleaf species, such as knotweed.

There are two critical elements in an operation designed to replace a stand of knotweed with grasses. The knotweed must be treated at a time when it will be significantly injured by the herbicides, and the grasses must be seeded in a season that is favorable for its establishment. The objective of this study was to compare four rehabilitation sequences designed to convert stands of knotweed to a mixture of low growing grasses.

MATERIALS AND METHODS

Four rehabilitation sequences to convert knotweed-infested roadsides to a grass mixture were compared. Each of the four rehabilitation sequences consisted of three operations; 1) a primary herbicide treatment to kill the above-ground growth of knotweed to prepare the site for the seed to become established; 2) the spreading of the seed; and 3) a follow-up herbicide application to control the inevitable knotweed resprouts and further reduce the vigor of the underground organs. Table 1 lists the code names and generalized timetable of the sequences used, as well as the treatment dates.

The study site was a southwest-facing fill slope along SR 611, near Doylestown, PA, originally seeded to crownvetch. The grass used in the study was PENNDOT Seeding Formula L, a 55/35/10 percent mixture, by weight, of hard fescue, creeping red fescue, and annual ryegrass, respectively; seeded at 100 lb/ac. Seed was pre-weighed for each plot, and distributed by hand. Both primary and follow-up herbicide treatments were a mixture of Vanquish plus Transline at 64 plus 8 oz/ac, respectively. Herbicide treatments were applied with backpack sprayers, equipped with a single Spraying Systems #5500 Adjustable ConeJet with an X-6 tip, with a targeted carrier volume of 20 gallons/ac. All applications included an organosilicone-based surfactant at 0.1 percent v/v.

Individual experimental plots were 20 by 30 ft., and were arranged in a randomized complete block with four replications. At study initiation on April 6, 1998, giant knotweed emergence was just beginning, with shoots extending up to 6 inches. Knotweed residue from previous seasons provided nearly complete cover of the soil. On April 30, when the first herbicide treatments were made, the knotweed shoots ranged in height from 0.5 to 3 ft. On August 31, previously untreated knotweed averaged 8 ft. in height.

Evaluations of knotweed control and fescue establishment were taken August 31 and October 28, 1998; June 10 and August 5, 1999; and August 7, 2000. Target vegetation in the study site will be treated each year when fescue and knotweed cover are rated.

On August 5, 1999, and August 7, 2000, the entire 0.5 ac site (trial plus surrounding area) was treated on a spot-basis with backpack sprayers, targeting spray coverage equivalent to 20 gal/ac. The 1999 treatment required 2.9 gallons of a mixture of Vanquish plus Tordon K plus an organosilicone surfactant at 2.0 plus 1.0 plus 0.1 percent, v/v, respectively. Targets included giant knotweed, crownvetch, common pokeweed, fireweed, and blackberry. The 2000 treatment required 1.8 gallons of a mixture of Vanquish plus Transline plus organosilicone surfactant at 2.5 plus 0.62 plus 0.1 percent, v/v, respectively. Primary targets were crownvetch, giant knotweed, bull thistle, Canada thistle, bush honeysuckle, multiflora rose, and garlic mustard.

RESULTS AND DISCUSSION

All four sequences provided 93 to 97 percent reduction of giant knotweed by August 5, 1999, 16 months after initiation of the trial (Tables 2 and 3). The S/P/F, P=S/F, and P/F/S sequences resulted in between 60 and 70 percent cover by the seeded grasses, while the P/S/F2 sequence was rated at only 18 percent cover. This was probably due to three factors; the later establishment date, the dry weather during the fall following the seeding, and most importantly because there was more fresh knotweed residue in the P/S/F2 plots at the time of seeding. In addition to residue already present at the initiation of the study, these plots had the residue from another season of growth, compared to the sequences initially sprayed in the spring. It appeared that this residue was abundant enough to inhibit establishment of the seed mix, rather than serving as a protective mulch.

Evaluations taken a year later, in August 2000, showed that the P/S/F2 sequence had significantly less fescue cover, and significantly more knotweed cover than the three sequences that were first treated in the spring. P/S/F2 plots had 60 percent fescue cover, while fescue cover in the other three sequences ranged from 89 to 92 percent. Giant knotweed cover in the P/S/F2 plots averaged 16 percent, compared to 1 percent or less in the other sequences. Though the results provided by the P/S/F2 were successful, they were inferior to the results provided by the sequences where the knotweed was initially treated in the spring. The ongoing near elimination of the knotweed is resulting in the emergence of crownvetch as the primary weed on the site. Though crownvetch was originally seeded to the site, it is highly undesirable in a Formula L stand, and ongoing maintenance will be performed to prevent the crownvetch from increasing on this site.

CONCLUSIONS

The results from this trial, in addition to previous results from a conversion trial in Luciusboro, Indiana County (see Twelfth and Thirteenth year reports), and herbicide screening trials in Doylestown (see Ninth year, and page 26 this report) and Leechburg, Armstrong County, indicate that giant knotweed is responsive to several herbicide combinations, and Formula L can be effectively established in these treated areas. Follow-up maintenance requires very little time or material, and ensures that the site will retain its desirable fine fescue cover.

MANAGEMENT IMPLICATIONS

Effective practices have been identified to convert giant knotweed to Formula L. Different practices will be required for stands of Japanese knotweed. At this point in time, it is critical that the species be identified prior to initiation of a rehabilitation program. Where giant knotweed is present, a spring primary application in conjunction with a spring or fall seeding and a followup herbicide treatment can produce a satisfactory stand of Formula L. If Japanese knotweed is present, spring herbicide applications should be avoided in favor of glyphosate-based summer or fall applications, with seeding being delayed until the Japanese knotweed is effectively suppressed.

Roadside Specialists are advised to refer to the PA Department of Agriculture publication "Two Troublesome *Polygonum* Species from Asia" which is included in the Roadside Vegetation Management Manual, to assist in the identification of knotweed species.

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

Sequence	Primary Treatment	Follow-up Treatment	Grass Seeding
S/P/F	knotweed leaf-out *4/30/98*	late summer *8/31/98*	early spring *4/6/98*
P=S/F	knotweed leaf-out *4/30/98*	late summer *8/31/98*	knotweed leaf-out *4/30/98*
P/F/S	knotweed leaf-out *4/30/98*	late summer *8/31/98*	late summer *9/14/98*
P/S/F2	late summer *8/31/98*	spring, year 2 *6/10/99*	late summer *9/14/98*

Table 2. Summary of 1998 evaluations of giant knotweed suppression and Formula L establishment at the Doylestown site.

Sequence	8/31/98 Knotweed Reduction	8/31/98 Knotweed Height	8/31/98 Formula L Cover	10/28/98 Formula L Cover
	(%)	(ft)	(%)	(%)
S/P/F	90	3.1	35	58
P=S/F	93	3.4	51	68
P/F/S	93	3.3	. [a]	5
P/S/F2	0	8.3	. [a]	5
L.S.D. (p=0.05)	4	0.8	NS	27

[a] Formula L was seeded on this date.

Table 3. Summary of 1999 and 2000 evaluations of giant knotweed suppression and Formula L establishment at the Doylestown site.

Sequence	6/10/99 Knotweed Cover	6/10/99 Formula L Cover	8/5/99 Knotweed Cover	8/5/99 Formula L Cover	8/7/00 Knotweed Cover	8/7/00 Formula L Cover
	(%)					
S/P/F	4	63	7	60	1	91
P=S/F	5	64	7	61	0	93
P/F/S	6	65	7	70	0	89
P/S/F2	20	26	3	18	16	60
L.S.D. (p=0.05)	4	22	NS	27	8	25

RESPONSE OF JAPANESE KNOTWEED TO SPRING-APPLIED HERBICIDE TREATMENTS

Herbicide trade and common chemical names: Vanquish (*dicamba*), Roundup Pro Dry (*glyphosate*), Tordon K (*picloram*), Transline (*clopyralid*)
Plant common and scientific names: Japanese knotweed (*Polygonum cuspidatum*), Sakhalin knotweed (*Polygonum sachalinense*), hard fescue (*Festuca trachyphylla*), creeping red fescue (*Festuca rubra*), annual ryegrass (*Lolium multiflorum*), black locust (*Robinia pseudoacacia*)

ABSTRACT

A seeding of PENNDOT Formula L and three Transline-based herbicide mixtures were applied to Japanese knotweed on May 5, 2000, when knotweed height ranged from emerging to 4 ft. Knotweed injury was primarily expressed as foliar reduction, and flowering and seed set occurred in all plots. Formula L did not establish in any plots. In 2001, regrowth of knotweed treated in 2000 was indistinguishable from previously untreated knotweed.

INTRODUCTION

Previous trials demonstrated that Sakhalin knotweed stems could be effectively controlled both early and late in the season with systemic herbicides[8], while only late–season applications have provided acceptable control of Japanese knotweed. Discovering an effective early season treatment has been an ongoing objective because treating Japanese knotweed early in the season while it is still relatively small would be easier from an operational perspective. A trial was established to evaluate the early season susceptibility of Japanese knotweed to three Transline-based herbicide mixtures, as well as evaluate potential herbicide effects on the establishment of Seeding Formula L (hard fescue, red fescue, annual ryegrass at 55, 35, 10 percent, respectively). An additional element of the trial was treating only the outer portion of a knotweed colony, which would be the situation when knotweed occurs within a narrow ROW, such as a secondary road. A successful program would foster establishment of a competitive groundcover that would inhibit reestablishment of knotweed, and allow selective treatment of the knotweed that does encroach.

MATERIALS AND METHODS

This study was applied to an established stand of Japanese knotweed located along SR 3005 (Fox Hollow Road), near State College, PA. The herbicide mixtures included Transline at 16 oz/ac plus, either Vanquish at 64 oz/ac, Roundup Pro Dry at 72 oz/ac, or Tordon K at 48 oz/ac. These mixtures were applied on May 5, 2000, at 50 gal/ac, to knotweed stems ranging from just-emerging to 4 ft in height. Formula L was hand-broadcast to each plot at a rate of 100 lb/ac immediately after herbicide treatment.

[8] Comparison of Rehabilitation Sequences for Japanese and Giant Knotweed Infestations. 2000. Roadside Vegetation Management Research Report-Fourteenth Year Report. http://rvm.cas.psu.edu/1999/AR1999.html

RESULTS AND DISCUSSION

Herbicide symptoms were evident within two days, but there was very little necrosis of the treated stems. Knotweed injury was characterized by canopy reduction, as injury was primarily expressed as leaf reduction, stunting, or abnormalities; in conjunction with stem curling and twisting. Canopy reduction caused by the Transline treatments was 73, 63, and 33 percent, for the Tordon K, Vanquish, and Roundup Pro Dry combinations, respectively. Abundant knotweed flowering, and moderate seed set occurred in all plots, and the Formula L did not establish to any extent in any plot. Knotweed growth in the treated plots in 2001 was indistinguishable from previously untreated knotweed. The relative lack of injury to the knotweed, particularly from the treatment including Tordon K was notable, as a 3-inch caliper black locust stem at the back edge of one the Tordon K plots died during the course of the trial, presumably from root pickup of the picloram.

These Japanese knotweed control and seed mix establishment results are similar to other reports[9]. These results are in contrast to those achieved against Sakhalin knotweed with a similar spectrum of herbicide treatments, the same seed mix, and sites with more adverse growing conditions. In both trial and operational settings, we have successfully controlled Sakhalin knotweed, and successfully established a fine fescue groundcover with dormant, spring, or fall seeding. To date, we have not been able to achieve the same results against Japanese knotweed with the same level of inputs.

CONCLUSIONS

Spring application of growth regulator herbicides or glyphosate is not effective against Japanese knotweed, and Formula L does not appear to be able to become established underneath a viable stand of Japanese knotweed. Pursuit of a spring-initiated approach will require different tactics. Future investigations will include evaluation of non phloem-mobile herbicides such as Derringer and Velpar DF as 'chemical mowing' agents, as well as the effect of timing of cutting on regrowth and subsequent, later-season herbicide treatment.

MANAGEMENT IMPLICATIONS

Relying on the commonly implemented Selective Weed/Brush program to control Japanese knotweed in ROWs where sight distance will be compromised is not an effective option. Japanese knotweed will not be sufficiently injured, and the existing stems will not go away - leaving the sight distance problem. Management of Japanese knotweed in narrow corridors will require cutting, or the use of an herbicide that will effectively kill the top growth while the plants are still small enough to not compromise line-of-sight.

Where knotweed rehabilitation is desired, identification to species level is important. Where stands of Japanese knotweed occur, establishing the replacement vegetation should not be initiated until the knotweed has been greatly suppressed. Conversely, where giant knotweed occurs, the previous efforts referenced in this report can be used as a guideline to rehabilitate these sites.

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[9] Rehabilitation of a Japanese Knotweed Infestation with a Native Species Mixture and Formula L. 2000. Roadside Vegetation Management Research Report-Fourteenth Year Report. http://rvm.cas.psu.edu/1999/AR1999.html

UPDATE:
EVALUATION OF GIANT KNOTWEED CONTROL AND CONVERSION INTO FINE FESCUES

Herbicide trade and common chemical names: Vanquish (*dicamba*), Transline (*clopyralid*), Roundup Pro (*glyphosate*), Arsenal (*imazapyr*), Tordon 101M (*picloram + 2,4-D*)
Plant common and scientific names: Japanese knotweed (*Polygonum cuspidatum*), giant knotweed (*Polygonum sachalinense*), hard fescue (*Festuca trachyphylla*), creeping red fescue (*Festuca rubra* ssp. *rubra*), crownvetch (*Coronilla varia*), switchgrass (*Panicum virgatum*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), Canada wildrye (*Elymus canadensis*)

INTRODUCTION

Giant knotweed and Japanese knotweed are becoming an increasing problem along Pennsylvania's roadways. Complete control of a knotweed stand along the road is difficult since much of a population may exist outside the right-of-way. A combination of chemical and cultural practices may help to improve the long-term goal of managing these knotweed stands. The cultural practice of planting grasses in these areas would provide the benefit of forming a competitive groundcover where selective materials can later be applied to control any knotweed resprouts. A study was established to determine the effectiveness of different herbicide combinations for converting a stand of giant knotweed to 'Formula L'[1/]. The results of this study can be referenced in The Roadside Vegetation Management Research Twelfth Year Report. Since the study ended in July 1997, the area has been maintained as a demonstration to monitor long-term control and maintenance inputs. The Roadside Vegetation Management Thirteenth Year Report summarizes the findings of the initial study and details the events and findings that have occurred from July 1997 to August 1999. This report details the spot treatment and observations made during a visit to the site on August 4, 2000.

MATERIALS AND METHODS

The 0.65 ac study area is located in an established giant knotweed stand along SR 2019 near Luciusboro, PA. The entire study area was seeded with 100 lb/ac of 'Formula L' on March 22, 1996, with hand-held rotary spreaders. Approximately 2-4 inches of snow was present at the time of seeding. The area was divided into plots and five separate herbicide treatments were applied on July 17, 1996, as part of the initial study to evaluate the effectiveness of the treatments and the amount of turf that established.

On July 2, 1997, at the conclusion of the study, the treated plots were sprayed with 0.75% (v/v) Vanquish and 0.0625% (v/v) Transline. Previously untreated areas were sprayed with 1% (v/v) Roundup Pro and 0.0625% (v/v) Arsenal. The treatments were applied using a truck-mounted sprayer equipped with a hose reel and GunJet handgun with a D6 spray tip, at 60 psi and approximately 100 gal/ac. All treatments included 0.125% (v/v) QwikWet 357 surfactant and 0.25% (v/v) Polytex A1001 drift control agent. Fifty gallons of solution was applied to approximatley 0.5 ac. On September 18, 1997 all areas devoid of turf were seeded with Formula L. This mix was hand seeded with approximately 75 lbs of seed using hand-held rotary spreaders.

[1/] Formula L contained 60% hard fescue and 40% creeping red fescue by weight.

On September 15, 1998 5.0 gallons of a mixture containing 2.5% (v/v) Vanquish, 0.31% (v/v) Transline, 0.1% (v/v) QwikWet 357 surfactant, and 0.25% (v/v) Polytex A1001 drift control agent was applied using backpacks, targeting 20 gal/ac. An additional 45 lbs of Formula L was seeded to areas sprayed on this date.

On August 10, 1999 4.5 gallons of a spray mixture containing 4 qts/ac Garlon 4, 8 oz/ac Transline and 0.125% (v/v) QwikWet 357 was applied using backpack sprayers, targeting 20 gal/ac spray coverage.

During a visit made on August 4, 2000 the area was spot sprayed to selectively remove any knotweed and crownvetch that was infesting the site. A low volume backpack application was made using a 5 percent, v/v, Tordon 101M solution. The total volume sprayed was 4 gallons.

RESULTS

By July 2, 1997 (350 DAT) the knotweed cover was significantly reduced by all treatments compared to the untreated check; and there were no differences among treatments in the percentage of fine fescue cover that had become established. The knotweed cover ranged from 6 to 27 percent and fine fescue cover was between 20 and 42 percent for the treated plots. The establishment of the fine fescue had been significantly reduced during the initial trial. This was in part due to the late initial application which resulted in a shading effect by the knotweed and also the high volume application of a Roundup Pro based mixture applied after turf establishment that provided further damage to the developing turf stand. Since the trial was completed and the demonstration established in July 1997, a slow progression has taken place toward a solid turf stand replacing the knotweed. By September, 1997 about 50 percent of the area was covered by Formula L with the remainder of the area infested with knotweed. By this date, the knotweed was in varying stages of injury from the July, 1997 herbicide treatment. Injury ranged from 50 to 99 percent across the demonstration site. During the September 1998 visit the area was approximately 30 percent knotweed with the remaining area predominately covered with Formula L.

On August 4, 2000 the demonstration area had approximately 5 percent cover by knotweed. Some of the knotweed had curled leaves, symptoms of the phenoxy herbicides used. The knotweed was 4 to 5 feet tall, though stems were longer but drooping. The knotweed was in early bloom. The fine fescue stand was thinning at one end of the study, where the soil was stonier and shallower. As the knotweed has been reduced, crownvetch has become a more prominent weed.

CONCLUSIONS

All treatments effectively reduced the knotweed stand and a significant amount of fine fescue was established in the voids. The spring applied broadcast seeding of fine fescue performed well; however, an earlier foliar herbicide treatment that selectively removes broadleaf weeds while leaving grasses would probably have helped the developing turf. After four years of annual followup spot treatments the area is now predominately turf. The amount of seed and herbicide applied to the site has diminished with each visit. Because of the extremely competitive nature of the knotweed, it is imperative that selective followup treatments be made to totally eliminate the knotweed from the site to get the desired long-term effect.

The knotweed was still present at the site as predicted. The knotweed has been reduced to 5 percent cover, and is easily dealt with by the spot treatment approach. Annual visits to the site to monitor and provide followup treatments continue to be an integral part of the management of this species. Also, when turfgrass is established as a groundcover it is imperative that the crownvetch be targeted during these visits. Otherwise, the preferred turfgrass groundcover will be lost. The cost of these annual visits is minimal and they cannot be overlooked without the consequence of losing the turfgrass stand to the knotweed and crownvetch.

This area is two years older than the site we have established near Doylestown, and described elsewhere in this report. We are seeing the decline of fine fescue stands where establishment was originally satisfactory. We are reevaluating our groundcover approach to knotweed rehabilitation, and investigating the use of grasses such as switchgrass, big bluestem, little bluestem, Indiangrass, and Canada wildrye in addition to Formula L. These native grasses are better adapted to poor sites than fine fescues, but are slower to fully establish. The combination of the quicker establishing fine fescues and the better adapted native grasses may provide the more permanent groundcover we seek in rehabilitating these poor quality sites that have been overrun by knotweed.

COMPARING SEQUENCES TO CONVERT CANADA THISTLE -INFESTED CROWNVETCH TO A COOL-SEASON GRASS MIXTURE

Herbicide trade and common chemical names: Vanquish (*dicamba*), Roundup Pro (*glyphosate*), Transline (*clopyralid*), Velpar (*hexazinone*), Basagran (*bentazon*), Plateau (*imazapic*), Tordon 101M (*2,4-D, picloram*), BK 800 (*2,4-D, 2,4-DP, dicamba*)
Plant common and scientific names: Canada thistle (*Cirsium arvense*), crownvetch (*Coronilla varia*), flatpea (*Lathyris sylvestris*), hard fescue (*Festuca trachyphylla*), creeping red fescue (*Festuca rubra* ssp. *rubra*), annual ryegrass (*Lolium multiflorum*), Johnsongrass (*Sorghum halepense*)

ABSTRACT

A study was initiated in 1998, and repeated in 1999, to compare three operational sequences to convert Canada thistle-infested crownvetch to PENNDOT's Formula L seed mix. Each sequence consisted of a primary herbicide application to eliminate the existing cover, a follow-up herbicide application to suppress the inevitable regrowth, and a seeding operation. The sequences were developed by altering the order of the operations, and were designated as SEQ1 - primary treatment and seeding in early spring, and follow-up treatment in late summer; SEQ2 - primary treatment in late spring, follow-up treatment and seeding in late summer; and SEQ3 - primary treatment and seeding in late summer, and follow-up treatment the following spring. The initial data for the 1998 trial was reported in the Fourteenth Year Annual Report[1/]. Both the 1998 and 1999 trials had significant differences among sequences in fine fescue cover a year after initiation of the studies. These differences are transient, and due primarily to the difference in age of the grass stand between SEQ 1 and the other sequences. By 69 WAI, weeks after initiation, all sequences in the 1999 trial had a well-developed stand of fine fescue with percent fine fescue cover ratings from 72 to 98 percent. Two years after initiating the 1998 trial the fine fescue cover ranged from 94 to 96 percent.

INTRODUCTION

A chronic condition along PA roadsides is the infestation of crownvetch by thistles, particularly the perennial species Canada thistle. This situation has been a priority of the research project since its inception in 1985. To date, two approaches have been taken. The first is the use of selective herbicides such as Velpar, Basagran, or Plateau to suppress Canada thistle prior to flowering in the spring. The potential drawback of this method is that these products act primarily as burndown materials in the spring, and it is not currently known if this approach will eventually eliminate the thistle, or whether it must be done every year in perpetuity to prevent seed set. The second approach is rehabilitation - eliminate the crownvetch and thistle and replace them with a cool-season grass mixture such as the Department's Formula L or D seeding mixtures. The drawback to this approach is the relatively intensive effort and cost required to make the conversion. In a longer term, the establishment of a grass cover provides more management options due to increased tolerance to mowing and greater availability of selective, systemic herbicides.

[1/] Comparing Sequences to Convert Canada Thistle-Infested Crownvetch to a Cool-Season Grass Mixture, Fourteenth Annual Research Report, pages 23-25.

These trials are an investigation of the rehabilitation approach. Operational scale conversions have been achieved in Districts 2-0 and 8-0, and herbicides available for the establishment process have been identified in previous research[2/]. These trials compare the effect of the order of the fundamental operations on the success of the rehabilitation process, to determine what sort of flexibility managers have in implementing rehabilitation projects.

The basic premise of this work, and related efforts, is that rehabilitation is a four-step process. The four steps consist of 1) a primary herbicide treatment to eliminate the existing problem vegetation, 2) a follow-up herbicide application to control the inevitable regrowth from the troublesome species, 3) the seeding of desirable vegetation, and 4) the inclusion of the converted area into the maintenance program to prevent the reestablishment of either the Canada thistle or crownvetch. These studies investigate the effect of the order of the first three steps on the success of the establishment of the grass cover. The condition of the grass stand over time in the maintenance phase will be monitored.

MATERIALS AND METHODS

1998 Trial

The study site was a 12 year-old stand of thistle-infested crownvetch and flatpea on a north-facing earthen berm, approximately 45 percent slope, at the interchange of SR 78 and SR 412, in Hellertown, PA. Individual plots were 30 by 50 ft, arranged in a randomized complete block with three replications. The herbicide treatment used for all primary applications as well as the secondary application for SEQ2 was Roundup Pro plus Transline at 128 plus 8 oz/ac, respectively. The secondary treatment for SEQ1 and SEQ3 was Vanquish plus Transline at 32 plus 8 oz/ac, respectively. All herbicide treatments included an organosilicone-based surfactant at 0.1 percent v/v.

Herbicide applications were made using a backpack sprayer, equipped with a single spray tip. Spray tip selection varied with target conditions and applicator preference, and included Spraying Systems OC-04 off-center flat fan, 4004 flat fan, or #5500 Adjustable ConeJet with X-6 tip. All applications were mixed to be applied at 20 gal/ac. PENNDOT Seeding Formula L, which is by weight a 55/35/10 percent mixture of hard fescue, creeping red fescue, and annual ryegrass, respectively, was distributed by hand at the rate of 100 lb/ac. At the time of seeding each plot was fertilized with Nitroform (38-0-0) at 111 lb/ac. SEQ1 received a follow-up treatment of urea (46-0-0) at 96 lb/ac on September 13, 1998. Follow-up fertilization of SEQ2 and SEQ3 was omitted due to an oversight.

SEQ1 received the primary treatment and was seeded April 30, 1998. Canada thistle was up to 8 inches tall, and crownvetch was elongated up to 10 inches. When the secondary treatment was applied August 31, 1998, average cover from total vegetation and fine fescue was 91 and 45 percent, respectively.

SEQ2 received the primary treatment May 28, the secondary treatment August 31, and was seeded September 13, 1998. At primary treatment, the Canada thistle and crownvetch canopy was 30 to 36 inches tall. Average vegetative cover at the secondary treatment was 25 percent.

The primary treatment was applied to SEQ3 on August 31, 1998. Average vegetative cover was 95 percent, 78 percent from crownvetch. Spring growth of Canada thistle had senesced, and

[2/] Effect of Herbicide and Pre-plant Application Timing on Establishment of Fine Fescues, Thirteenth Annual Research Report, pages 19-26.

late season resprouts provided 2 percent cover. Seeding was done September 13, 1998, and the secondary treatment was applied on June 10, 1999.

Ratings of vegetative cover were taken August 31 and October 28, 1998; June 10, 1999, and August 7, 2000. A spot treatment was conducted across the entire study on May 11 and August 7, 2000 to control broadleaved weeds in the Formula L. The two maintenance applications made in 2000 would not be a typical practice. The May 11 application coincided with a treatment being made to the adjacent1999 trial, and was regarded as an opportunity that should not be passed up, while the August 7 treatment was applied as a maintenance treatment to both trials. The May 11 treatment was a mixture of Garlon 3A, BK800, and LI-700 surfactant at 2.5, 2.5 and 0.5 percent v/v, respectively. The August 7 treatment was 5 percent v/v Tordon 101 M. Target coverage for both dates was 20 gal/ac.

1999 Trial

This study was located immediately adjacent to the 1998 trial, on the same earthen berm. Plots were 32 by 50 ft, arranged in a randomized complete block design with three replications. The primary and secondary herbicide treatment for all sequences was Vanquish, Tordon K, and Transline at 32, 16, and 8 oz/ac, respectively. Primary treatments were broadcast, and secondary treatments were spot-applied to target weeds. All treatments included 0.1 percent v/v organosilicone-based surfactant. The change to a broadleaf-only mixture was made so that any grasses that were present would be retained. If troublesome grass species such as johnsongrass were present, then the glyphosate-based mixture would be recommended.

Herbicide applications were made using a backpack sprayer equipped with a single spray tip. Spray tip selection was either an OC-06 off-center flat fan on a GunJet 30 spray gun or OC-04 attached to an ultra low volume wand. Applications were mixed on a 20 gal/ac basis. Formula L was distributed by hand at the rate of 100 lb/ac. At seeding, each plot received Nitroform (38-0-0) at 116 lb/ac, and an 8-32-16 fertilizer at 138 lb/ac.

SEQ 1 was seeded on April 15, 1999. The Canada thistle was approximately 3 inches tall by this date and not yet tall enough for the primary treatment. As a result, the primary spray was delayed until May 6, 1999. Canada thistle plants were 6 inches in height or shorter. The secondary treatment was made on September 2, 1999.

SEQ 2 was initially treated on June 10, 1999. The Canada thistle was at bud stage, while the crownvetch and flatpea were in bloom. Canopy height from the vegetation was up to 30 inches. The seeding and secondary treatments were made on September 2, 1999.

SEQ 3 was treated first on August 5, 1999. The canopy height within the plots was 24-40 inches. The Canada thistle had largely senesced. Seed was applied on September 2, 1999. The secondary herbicide treatment for SEQ 3 was made on May 11, 2000.

Ratings of percent weed cover, Formula L, and fine fescue were taken on May 11, 2000. During the August 7, 2000 visit the study was rated for percent total vegetative and fine fescue cover.

Rainfall was short throughout the first half of the growing season in 1999, with a 9.2 inch rainfall deficit occurring in April through July (Table 1).

RESULTS AND DISCUSSION

1998 Trial

During the 1998 growing season, only SEQ1 had Formula L cover to evaluate. This cover was rated at 45 percent on August 31 and 55 percent on October 28. The Formula L was just beginning to grow in SEQ2 and SEQ3 plots. Fine fescue cover for SEQ1, SEQ2, and SEQ3 on June 10, 1999 was 68, 40, and 20 percent, respectively (Table 2). Canada thistle cover at this time was 6, 2, and 12 percent, respectively. SEQ 3 only had a primary treatment by this date. As of June 10, 1999, the trial had been ongoing for only 58 weeks, and SEQ2 and SEQ3 had been seeded for only 38 weeks. The 20 week longer growing period for SEQ1 was the primary reason for the cover differences, especially in light of the dry fall in the southeastern part of the state in 1998. The difference in fine fescue establishment between SEQ2 and SEQ3, which were both seeded September 13, appeared to be due to the amounts of vegetative residue present at the time of seeding. The amount of residue in the May-treated SEQ2 plots acted more as mulch, while the August-treated, full-canopy residue in SEQ3 appeared to be so thick it may have inhibited seed establishment. By August 7, 2000, all sequences had between 94 and 96 percent fine fescue cover, confirming the transient nature of the earlier establishment differences.

1999 Trial

All three sequences had some level of fine fescue establishment by the end of the 1999 growing season. At the first rating on May 11, 2000, Formula L cover was 66, 9, and 22 percent, for SEQ1, SEQ2, and SEQ3, respectively (Table 3). As observed in the 1998 trial, this difference in establishment was due to SEQ1 being seeded 20 weeks sooner than SEQ2 and SEQ3. Weed cover values ranged from 2 to 20 percent, but were not significantly different.

When rated August 7, 2000, 13 weeks after the initial rating, all three sequences had a high percentage of vegetative cover, comprised almost entirely of fine fescue (Table 3). The annual ryegrass component of the Formula L had almost completely disappeared. Fine fescue cover on this date was 98, 72, and 93 percent, for SEQ1, SEQ2, and SEQ3, respectively, demonstrating that the initial differences in establishment were transient. Given adequate moisture during the growing season, the fine fescue can be expected to adequately cover an area.

CONCLUSIONS

All three operational sequences provided an effective conversion from thistle-infested crownvetch to Formula L. The effect of stand age on the grass cover was negligible by the end of the second growing season.

MANAGEMENT IMPLICATIONS

There is considerable flexibility available in managing Canada thistle infestations. It appears that as long as seeding occurs during the recommended windows of spring or late summer, and initial suppression of the thistle/crownvetch stand is successful, successful establishment of Formula L will occur.

Table 1. Rainfall during the growing season, and the departure from normal, for Northampton County for 1998 and 1999. Data from Middle Atlantic Forecast Center, via PA Agricultural Statistics Service

	- - - - - 1998 - - - - -		- - - - - 1999 - - - - -	
Month	Rainfall	+/-	Rainfall	+/-
	(--------------------------- inches		---------------------------)	
April	5.5	2.0	2.7	-0.8
May	6.1	1.7	3.2	-1.2
June	5.8	2.0	1.0	-2.8
July	1.9	-2.1	0.6	-3.4
August	5.1	0.9	4.4	0.2
September	2.7	-1.4	10.8	6.7
October	4.2	1.1	2.6	-0.5

Table 2. Summary of the 1998 trial evaluating vegetative cover characteristics following three operational sequences for the conversion of Canada thistle-infested crownvetch to Formula L.

Sequence	Primary Treatment	Follow-up Treatment	Formula L Seeding	Fine Fescue Cover 6/10/99	C. Thistle Cover 6/10/99	Fine Fescue Cover 8/07/00
				(----------------	%	----------------)
SEQ1	4/30/98	8/31/98	4/30/98	68	6	96
SEQ2	5/28/98	8/31/98	9/13/98	40	2	95
SEQ3	8/31/98	6/10/99	9/13/98	20	12	94
LSD (p=0.05)				34	n.s.	n.s.

Table 3. Summary of the 1999 trial evaluating vegetative cover characteristics following three operational sequences for the conversion of Canada thistle-infested crownvetch to Formula L.

Sequence	Primary Treatment	Follow-up Treatment	Formula L Seeding	Weed Cover 5/11/00	Formula L Cover 5/11/00	Total Cover 8/07/00	Fine Fescue Cover 8/07/00
				(------------------	%	------------------)	
SEQ1	5/06/99	9/02/99	4/15/99	2	66	99	98
SEQ2	6/10/99	9/02/99	9/02/99	8	9	80	72
SEQ3	8/05/99	5/11/00	9/02/99	20	22	95	93
LSD (p=0.05)				n.s.	44	n.s.	n.s.

AN EXAMINATION OF POTENTIAL GIANT FOXTAIL RESISTANCE TO COMBINATIONS OF BAREGROUND HERBICIDES

Herbicide trade and common chemical names: Oust (*sulfometuron*), Velpar (*hexazinone*), Karmex DF (*diuron*), Milestone (*azafenidin*), Pendulum 3.3E (*pendimethalin*), Krovar I (*bromacil + diuron*), Sahara (*imazapyr + diuron*), Plateau (*imazapic*)

Plant common and scientific names: giant foxtail (*Setaria faberi*), purpletop (*Tridens flavus*), orchardgrass (*Dactylis glomerata*), quackgrass (*Elytrigia repens*), red fescue (*Festuca rubra*), switchgrass (*Panicum virgatum*)

ABSTRACT

To determine if giant foxtail is becoming resistant to herbicides commonly used by PENNDOT, a trial comparing a standard total vegetation control guiderail treatment and alternate herbicide mixtures was initiated along a route where giant foxtail control failures were observed in 1999. All herbicide mixtures were effective in 2000. There were no indications that herbicide resistant weeds were present in the treated area.

INTRODUCTION

Giant foxtail is one of the more prevalent weed species found under guiderails in Pennsylvania. Several plant species have developed resistance to particular herbicide chemistry. The threat of common species, such as giant foxtail, forming herbicide resistance is a real concern. Many of the guiderail treatments made on PENNDOT rights-of-way rely on Karmex and Oust, and giant foxtail resistance to herbicides with the same modes-of-action have been reported in the US[10]. The repeated use of the same chemistry increases the possibility of plant populations developing resistance.

District 12-0 reported that an unacceptable amount of giant foxtail grew along guiderails late in the season following an application of their standard herbicide combination in the spring. They also indicated that giant foxtail was the only species of note in the treated area. A test was established to determine whether a resistant biotype of giant foxtail had been selected. The alternate mixtures were developed so that the material cost was similar to the standard treatment of Oust, Karmex DF, and Velpar DF at 3 oz, 8 lb, and 21 oz/acre, respectively.

MATERIALS AND METHODS

The trial was established on the eastbound shoulder of SR 40, segment 80, in Washington County. This area had been infested with giant foxtail the previous season despite being treated with the standard preemergence herbicide program. Herbicide treatments were applied on April 13, 2000 to 3 by 33 ft. plots. The study was arranged in a randomized complete block design with three replications and applied using a CO_2-powered sprayer equipped with a single nozzle wand with a Spraying Systems OC-12 tip. The carrier volume was 40 gal/ac applied at 30 psi. Clean Cut, a crop oil concentrate, was added to all treatments at 0.5 percent v/v. The most common species present at the time of treatment were orchardgrass, quackgrass, red fescue, and still-dormant purpletop.

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[10]International Survey of Herbicide Resistant Weeds, http://www.weedscience.org/Summary/USpeciesCountry.asp?lstWeedID=149&FmSpecies=Go

Percent total green cover was rated April 13, June 29, August 10, and November 29; 0, 77, 119, and 230 days after treatment (DAT). Percent cover by purpletop was rated at 77, 119, and 230 DAT while percent cover by giant foxtail was rated 230 DAT.

RESULTS AND DISCUSSION

Initial vegetative cover ranged from 13 to 25 percent on April 13, 2000. When rated 77 DAT the vegetation in all plots was reduced with vegetative cover ranging from 3 to 10 percent. Although slight increases in vegetative cover occurred for all treatments throughout the growing season, all maintained acceptable levels of control even 230 DAT (Table 1). Untreated areas adjacent to the plots had high infestations of both giant foxtail and purpletop. All treatments were highly successful at preventing the establishment of giant foxtail. Unsatisfactory control of giant foxtail in 1999 was probably due to environmental factors, such as loss of unincorporated herbicide due to an intense rainfall event; or application factors such as improper mixing or agitation. The personnel responsible for inspection of the herbicide applications have discounted application factors, which leaves environmental factors. However, the spring of 1999 was not unusual in southwestern PA. In April, 4.13 inches of rain fell, and in May there was 4.04 inches (Table 2). There was a 13-day rain-free period from April 25 to May 7. Diuron, the active ingredient in Karmex, requires rainfall incorporation for effectiveness, and prolonged exposure on the soil surface enhances photodegradation[11]. Performance of applications made April 25-27 could conceivably have been compromised. June was very dry (1.33 inches), but the herbicides should have been well incorporated at that point, and therefore unaffected. We are really left with no clear-cut environmental explanation of unsatisfactory results in 1999.

The treatments did not control existing purpletop, which is a perennial, warm-season grass that was not actively growing when treatments were applied. We are increasingly observing purpletop and switchgrass adjacent to guiderails. We believe that the Department's non-selective program is fostering perennial warm-season grasses because treatments are typically applied before these grasses initiate growth, and lack the soil activity needed to control well established perennials.

CONCLUSIONS

All treatments were effective against giant foxtail. Based on these results, we believe that the unsatisfactory control of giant foxtail in 1999 was due to factors other than the activity of the applied herbicides.

MANAGEMENT IMPLICATIONS

Three points can be made. The first point is the 'simple' act of applying bareground herbicides can be complex when you consider what could conceivably go awry. Rigorous inspection and record keeping are essential to the Department's vegetation management program. However, as we saw in this case, a well executed program will still produce mysterious results - Nature does not read the District Roadside Plan. Second, the favorable results seen in this trial were a result of effective preemergence control on a guiderail with light to moderate weed pressure. These treatments would differ somewhat in their postemergence activity. The Krovar I

[11] Weed Science Society of America. 1994. Herbicide Handbook, 7th Edition. W.H. Ahrens, editor. WSSA, Champaign, IL, USA.

treatment would have much less foliar activity than treatments containing Oust plus Velpar, Sahara (with the equivalent of 1 qt/acre Arsenal), or Oust plus Plateau. Third, and finally, is the issue of herbicide resistance management. To date, we are not aware of any common roadside weeds developing resistance to commonly used herbicides in Pennsylvania. Oust, Arsenal, and Plateau have the same mode of action, but combining any of these with Karmex provides two distinct modes of action. Rotating from Oust to a Krovar I-based treatment every few years provides another avenue of resistance management. If Milestone VM becomes available, that will provide another unique mode of action, and will increase the options for resistance management.

Table 1. Summary of vegetative cover and giant foxtail establishment after applying herbicides on April 13, 2000. Ratings were taken 0, 77, 119, and 230 days after treatment (DAT). Each value is the mean of three replications.

Material[12] Cost/ac	Product	Application Rate	Total Vegetative Cover 0 DAT	77 DAT	119 DAT	230 DAT	Giant Foxtail Cover 230 DAT
		(oz/ac)	(%)				
$87	Oust	3	17	4	7	9	1
	Velpar DF	20					
	Karmex DF	128					
$83	Oust	3	25	3	9	12	1
	Velpar DF	20					
	Milestone VM[13]	5					
$88	Oust	3	23	4	8	6	0
	Velpar DF	20					
	Pendulum 3.3E	128					
$91	Oust	3	17	9	13	10	0
	Velpar DF	20					
	Pendulum 3.3E	78					
	Karmex DF	64					
$86	Krovar I	154	17	7	11	12	5
$90	Sahara	100	13	10	13	9	0
	Pendulum 3.3E	128					
$91	Oust	3	15	4	5	4	0
	Plateau	12					
	Karmex DF	128					
$53	Oust	3	13	10	13	13	2
	Velpar DF	20					
LSD (p=0.05)			n.s.	n.s.	n.s.	n.s.	n.s.

[12] Prices based on Commonwealth of PA, Department of General Services, Herbicide Contract, #6840-02, effective 2/23/01. Milestone VM cost was estimated at 6.00/oz product.
[13] Milestone VM is not available at this time.

Table 2. Rainfall data, in inches, for Washington, PA, from the PA State Climatologist (http://pasc.met.psu.edu/PA_Climatologist) for April through September 1999. 'T' = trace.

Day	April	May	June	July	August
1	0.02	0	T	0	0
2	T	0	0.07	1.03	0.3
3	0	0	0.19	0.72	0
4	0.09	0	T	0	0
5	0.31	0	0	0	0.15
6	T	T	0	0	0
7	0.06	0	0	0.06	0
8	0	0.25	T	0	0.03
9	0.18	0.19	0	0	0.03
10	1.18	0	0	0.84	0
11	0.28	0	0	T	0.04
12	0.1	0	0	0	0
13	0.02	0	0	0	0
14	0	0.34	0	0	1.11
15	0	0.01	0.32	0	0.11
16	0.3	0	0	0	0.01
17	0.05	0	0	0	0
18	0.14	0	T	0	0
19	0.07	1.42	0	0	0
20	0.61	0	0	0	0
21	0	0	0	0	0
22	0.14	0	0	0.03	T
23	0.23	0.62	0	0	0
24	0.35	0.34	0	0.07	0
25	0	0.86	0	0	0.33
26	0	0.01	0	0	0.4
27	0	0	0	0	0.05
28	0	0	0.25	0	0.01
29	0	0	0.32	2.16	0
30	0	0	0.18	0	0
31		0		0	0
Total Inches	4.13	4.04	1.33	4.91	2.57

EVALUATION OF HERBICIDES FOR CONTROL OF KOCHIA UNDER GUIDERAILS

Herbicide trade and common chemical names: Oasis (*imazapic plus 2,4-D*), Karmex (*diuron*), Oust (*sulfometuron*), Roundup Pro Dry (*glyphosate*), Plateau (*imazapic*), Sahara (*imazapyr plus diuron*)
Plant common and scientific names: kochia (*Kochia scoparia*), common ragweed (*Ambrosia artemisiifolia*), Canada bluegrass (*Poa compressa*), wild radish (*Raphanus raphanistrum*), tall fescue (*Festuca arundinacea*), Tartarian honeysuckle (*Lonicera tatarica*).

ABSTRACT

A study was established on a kochia-infested site to evaluate the effectiveness of Oasis, a pre-mix of imazapic and 2,4-D, in a bareground setting and several other pre- and postemergence herbicide treatments. Preemergence application of mixtures with Oasis, Oust, or Plateau were not effective against kochia if they did not contain diuron (Karmex or Sahara). Postemergence applications that did not contain diuron were inconsistent, ranging from 75 to 92 percent control.

INTRODUCTION

Oasis is a new formulation of imazapic (Plateau herbicide) containing 2,4-D. The imazapic concentration in Oasis is the same as in Plateau, so product per acre rates are the same. A 12 oz/acre rate provides 0.19 lb imazapic plus 0.38 lb 2,4-D per acre. The addition of 2,4-D provides additional activity against legume (Fabaceae) species, which are generally tolerant of imazapic. These trials were established to evaluate Oasis in pre- and postemergence applications, alone and in combination with other common bareground products. The presence of kochia on the test sites was good fortune, as this is a species of increasing concern. Kochia biotypes seen in PA to date are resistant to Oust, and therefore may also be resistant to herbicides with the identical mode of action, such as Arsenal, Plateau, Escort, and Telar.

MATERIALS AND METHODS

Pre- and postemergence trial areas were located along a guiderail on SR 81 S, segment 1561, in Luzerne County. The area had not been treated during 1999. Preemergence treatments were applied April 20, 2000 to 3 by 33 ft plots. The study was arranged in a randomized complete block design with three replications. Treatments were applied with a CO_2-powered sprayer with a single Spraying Systems OC-12 spray tip, in a carrier volume of 40 gal/ac. There was less than 5 percent green cover in the plots, provided by perennials or rosettes of overwintering biennials. Kochia seedlings were emerging, with the most developed plants at the 2-leaf stage, and 0.25 to 0.5 inch tall.

Postemergence treatments were applied May 18, 2000, using the same plot design, equipment, and carrier volume as was used for the preemergence applications, with a plot size of 4 by 25 ft. Kochia seedlings ranged from 0.25 by 0.25 inches to 3 by 2 inches, with most being closer to the former in size; common ragweed was at the second set of true leaves; Canada bluegrass ranged from seedhead emergence to expansion; wild radish was at early bloom; tall fescue was at seedhead emergence; and Tartarian honeysuckle was at early bloom.

The preemergence trial was rated for percent control on May 18, 28 days after treatment (DAT), and the postemergence trial was rated June 15, 28 DAT. The study area was mistakenly oversprayed by the Department after the June 15 rating. No more ratings of the postemergence trial were possible. A rating of kochia control was taken in the preemergence study on August 8, 110 DAT, in a portion of the plots behind the rail where the Department overspray did not overlap with the original treatments.

RESULTS AND DISCUSSION

All of the pre and postemergent treatments containing Karmex at 8 lbs/ac, or Sahara at 5 lbs/ac, provided almost total control of all weeds, including Kochia. Due to a mixing error, the preemergence application of Karmex plus Oasis and Oust was made with 8 oz/ac of Karmex instead of 8 lbs. It still provided significantly better control than Oasis and Oust alone.

At 28 and 110 DAT the preemergence treatments containing Oasis or Plateau alone, or Oasis plus Oust, did not provide acceptable control of the weed species present, which were mostly kochia. Oasis did provide better preemergence control than Plateau at 28 DAT.

Applied postemergence, Plateau alone provided 83 percent control. Oasis alone, which is equivalent to Plateau plus 2,4-D, was rated at 92 percent control, and Oasis plus Oust was rated at 75 percent control. Neither treatment provided a level of control that was significantly different from Plateau alone.

The reduction in control provided by Oasis that resulted when Oust at 1 oz/acre was added is not readily explainable. It is possible that Oust is antagonistic to Oasis because the sulfometuron and the imazapic would be binding to the same site on the affected enzyme. Binding sites occupied by the ineffective sulfometuron molecule would not be available to the possibly slightly less ineffective imazapic molecule. However, the existing data was from too few plants that were too small to be able to resolve this inconsistency conclusively.

CONCLUSIONS

The diuron in Karmex and Sahara provides excellent pre or postemergence control of kochia. Kochia is not effectively controlled by preemergence applications of Plateau, Oasis, or Oust at the rates used in this study. Plateau, and Oasis plus Oust, were more effective when applied postemergence. Though Oasis provided better control than Plateau when applied preemergence, the level of control provided was not at a commercially acceptable level.

MANAGEMENT IMPLICATIONS

In trials to date, kochia has not been adequately controlled by preemergence applications of Oust or Plateau. The herbicide Arsenal has the same mode of action, and may be ineffective as well. Currently, the preemergence control of kochia is accomplished with diuron, the active ingredient in Karmex, and one of the components of the premix products Sahara and Krovar I. One of these products must be included in the non-selective program to control kochia.

A near term objective of the Project will be to evaluate the effectiveness of all the currently (and soon to be) available products for their efficacy against kochia.

Table 1. Evaluations of weed control provided by pre- and postemergence herbicide applications to a highway guiderail. Preemergence applications were made April 20, and postemergence applications were made May 18, 2000. Each value is the mean of three replications.

Product	Application Rate	------ Preemergence ------ Control 28 DAT	Kochia Control 110 DAT	Postemergence[1/] Control 28 DAT
	(oz product/ac)	(---------------------	%	---------------------)
1. untreated		0	0	0
2. Oasis	12	37	18	92
3. Oust Karmex	2 128	100	100	96
4. Oasis Oust	12 1	33	20	75
5. Oasis Karmex	12 128	100	100	100
6. Oasis Oust Karmex	12 0.5 8	85	73	97
7. Oasis Oust Karmex	12 1 128	100	100	97
8. Oasis Roundup Pro Dry Karmex	12 18 128	100	100	99
9. Plateau	12	0	20	83
10. Sahara Oust	80 2	100	100	100
LSD (p=0.05)		31	35	14

[1/] Postemergence data from the untreated check was not included in the analysis of variance.

COMPARISON OF AN EXPERIMENTAL GLYPHOSATE:2,4-D ACID FORMULATION WITH EXISTING PRODUCTS IN A GUIDERAIL SETTING

Herbicide trade and common chemical names: ETK-2350 (*glyphosate acid + 2,4-D*), Roundup Pro Dry (*ammonium salt of glyphosate*), Hi-Dep (*2,4-D*)
Plant common and scientific names: spotted knapweed (*Centaurea maculosa*), wild parsnip (*Pastinaca sativa*), white sweetclover (*Melilotus alba*), yellow sweetclover (*Melilotus officinalis*), common ragweed (*Ambrosia artemisiifolia*), chicory (*Chicorium intybus*), annual dropseed (*Sporobolus vaginiflorus*)

ABSTRACT

ETK-2350, a glyphosate:2,4-D premix of the herbicide acids rather than formulated amine salts, was compared to equal application rates of the tank mix of the labeled components, and glyphosate alone. The rates were lower than commonly used operationally (equivalent to one pint and one quart per acre of Roundup Pro), to make it easier to distinguish efficacy differences. ETK-2350 applied at 128 oz/ac (glyphosate plus 2,4-D at 0.75 plus 0.75 lb acid equivalent (ae)/ac) provided greater vegetative reduction than all other treatments, due primarily to greater control of spotted knapweed compared to the other treatments.

INTRODUCTION

The most common formulation of glyphosate is the isopropylamine salt, available in what is commonly referred to as a 'four pound gallon' because it contains four pounds of the formulated salt (or three pounds of the glyphosate acid) in each gallon of product. Recently, a dry formulation of glyphosate became available (Roundup Pro Dry) which is formulated as the ammonium salt.

An integral step in the control of weeds with glyphosate is the formulated salt losing its amine 'tail' to take the form of the acid, which is the herbicidal form of the molecule. United Agricultural Products is evaluating a glyphosate:2,4-D premix that is formulated as the acid of each herbicide. The premise is that the herbicide acid will enter the plant more readily than the formulated salt. The tradeoff has always been that the formulated salt product is easier to manufacture than a product using glyphosate acid. ETK-2350 is a glyphosate:2,4-D product featuring each herbicide in its acid form at 0.75 lb gallon each. This trial was conducted in a guiderail setting, and compared ETK-2350 with a tank mix of glyphosate plus 2,4-D; and to glyphosate alone, to assess the utility of 2,4-D in the formulation.

MATERIALS AND METHODS

The trial was established along Park Avenue (SR 3007) near University Park, PA. On June 16, 2000, 4 days prior to spraying, the study area was cut to a height of 6 to 8 inches using a motorized trimmer, to provide for more uniform spray coverage. Initial vegetative cover ratings were somewhat lower than they would have been as a result of the cutting. Herbicide treatments were applied on June 20, 2000 to 3 by 33 ft. plots. The treatments included ETK-2350 at 64 or 128 oz/ac, Roundup Pro Dry plus Hi-Dep at 9.2 plus 12.6 or 18.4 plus 25.2 oz/ac, respectively, and Roundup Pro Dry alone at 9.2 or 18.4 oz/ac. The low and high glyphosate rates for each of the three pairings was 0.38 and 0.75 lb ae/ac (equivalent to 16 or 32 oz/ac of Roundup Pro). The low and high 2,4-D rates for the ETK-2350 and tank mix treatments were 0.38 and 0.75 lb ae/ac.

The study was arranged in a randomized complete block design with three replications. Treatments were applied using a CO_2-powered sprayer equipped with an ultra low volume wand and single OC-08 tip, at 40 gal/ac. LI-700 surfactant and Polytex A1001 were added to all treatments at 0.25% v/v for drift control. The most common species present were spotted knapweed, wild parsnip, and yellow and white sweetclover. Other species included common ragweed, chicory, and annual dropseed.

Percent total vegetative cover and cover by spotted knapweed, wild parsnip, and sweetclover were rated June 21, July 5, August 1, and September 15; or 1, 15, 42, and 87 days after treatment (DAT), respectively. Vegetative cover, expressed as percent of original cover, was determined for ratings taken 15, 42, and 87 DAT using the following formula:

*Percent of Original Cover = [Current Cover (%)/Cover on June 21 (%)]*100.*

Data were subject to analysis of variance, and means were compared using Fisher's Protected LSD.

RESULTS AND DISCUSSION

Initial vegetative cover ratings (1 DAT) ranged from 37 to 52 percent (Table 1). There were no differences in vegetative cover ratings in any of the treatments at 15 or 87 DAT. At 42 DAT plots treated with ETK-2350 at 128 oz had a cover rating significantly lower than any other treatment. The percent-of-original-cover ratings, which adjust cover in terms of what was present initially, showed significant differences at 42 and 87 DAT, when plots treated with the high rate of ETK had significantly lower ratings than any other treatment. The lower cover ratings in plots treated with the high rate of ETK-2350 were due to a significant reduction in spotted knapweed, compared to all other treatments. At 42 DAT, ETK-2350 at the high rate had reduced knapweed to a cover level significantly lower than all other treatments (Table 2). At 87 DAT, only the untreated check had a knapweed cover rating that was not significantly higher than ETK-2350 at the high rate. This is due to flowering and senescence in the untreated plot, which reduced knapweed cover. The other treated plots showed more of a growth regulator effect, in which the knapweed was injured enough to prevent it from completing its life cycle, but not enough to cause mortality and cover reduction. There were no significant differences noted in cover of wild parsnip or sweetclover at any rating date.

CONCLUSIONS

This trial supports the hypothesis that the acid form of glyphosate is more active than the ammonium salt formulation (which has been demonstrated to show activity equivalent to the isopropylamine salt). In this trial, this differential activity was demonstrated on spotted knapweed. There was no differential observed with wild parsnip or the sweetclovers.

MANAGEMENT IMPLICATIONS

There is no immediate management implication from this work. This trial was more basic in nature, and the product evaluated is still experimental. Future impact may be the availability of glyphosate formulations, and competing marketing and performance claims. Due to the involvement of the Research Project in trials that are not immediate in their application but relevant to roadside vegetation management, the Department will have information and counsel already on-hand should ETK-2350, or similar products reach the market.

Table 1. Summary of percent vegetative cover and change in cover, at the time of treatment (1 day after treatment [DAT]), and 15, 42, and 87 DAT. Percent of original cover was calculated, by plot, as [P.O.O.(%)=(current %/original %)*100][1/]. Each value is the mean of three replications.

Treatment	Application Rate	Vegetative Cover (DAT)				Percent of Original Cover (DAT)		
		1	15	42	87	15	42	87
	(oz /ac)							
untreated	---	47	48	50	42	110	107	84
ETK-2350	64	52	42	42	47	83	83	88
ETK-2350	128	47	33	12	23	76	26	50
Roundup Pro Dry Hi-Dep	9.2 12.6	37	35	38	33	93	100	90
Roundup Pro Dry Hi-Dep	18.4 25.2	48	43	43	42	89	90	86
Roundup Pro Dry	9.2	48	55	60	50	117	131	105
Roundup Pro Dry	18.4	43	43	42	43	104	97	100
LSD (p=0.05)		n.s.	n.s.	22	n.s.	n.s.	28	26

[1/] Average values for cover do not correspond with average reduction values because the calculations were done on a by-plot basis (e.g., at 15 DAT, cover in the untreated plots averaged 48 percent, which is a one percent increase in cover from 1 DAT, yet percent of original was 110, rather than 102 percent).

Table 2. Summary of the species composition by percent cover at the time of treatment (1 day after treatment [DAT]), and 42 and 87 DAT. Sweetclover data represents both white and yellow sweetclover. Each value is the mean of three replications.

Treatment	Application Rate	Spotted Knapweed Cover (DAT)			Wild Parsnip Cover (DAT)			Sweetclover Cover (DAT)		
		1	42	87	1	42	87	1	42	87
	(oz product /ac)	(	-------------	-------------	-------------	%	-------------	-------------	-------------	)
untreated	---	25	21	13	7	5	9	6	10	4
ETK-2350	64	31	29	30	7	2	5	8	6	3
ETK-2350	128	28	7	11	8	1	4	8	2	3
Roundup Pro Dry Hi-Dep	9.2 12.6	27	30	25	6	2	5	3	4	1
Roundup Pro Dry Hi-Dep	18.4 25.2	19	24	29	15	3	4	6	6	5
Roundup Pro Dry	9.2	29	37	29	8	7	13	9	11	2
Roundup Pro Dry	18.4	24	23	25	9	5	12	3	6	2
LSD (p=0.05)		n.s.	13	14	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

LONG TERM EVALUATION OF BAREGROUND HERBICIDES

Herbicide trade and common chemical names: Arsenal (*imazapyr*), Endurance (*prodiamine*), Karmex (*diuron*), Krovar I (*bromacil + diuron*), Milestone VM (*azafenidin*), Oust (*sulfometuron*), Pendulum 3.3EC (*pendimethalin*), Plateau (*imazapic*), Roundup Pro (*glyphosate*), Sahara (*diuron + imazapyr*), Spike (*tebuthiuron*), Surflan (*oryzalin*)

Plant common and scientific names: annual fleabane (*Erigeron annuus*), barnyardgrass (*Echinochloa crus-galli*), common ragweed (*Ambrosia artemisiifolia*), dandelion (*Taraxacum officinale*), giant foxtail (*Setaria faberi*), orchardgrass (*Dactylis glomerata*), Pennsylvania smartweed (*Polygonum pennsylvanicum*), smooth groundcherry (*Physalis subglabrata*), tall fescue (*Lolium arundinacea*), tumble pigweed (*Amaranthus album*), wirestem muhly (*Muhlenbergia frondosa*), yellow foxtail (*Setaria lutescens*)

ABSTRACT

A study designed to evaluate the response of different weed species to repeated annual applications of bareground herbicides was initiated on May 26, 1999. The trial was established on an agricultural soil with well established perennial vegetation present. In 1999, the Roundup Pro plus Arsenal at 48 and 4 oz/ac, respectively, was considered to be the control treatment that provided initial postemergence control with little preemergence activity. At 35 DAT vegetative cover ranged from 7 to 23 percent. Only Sahara provided better weed control than the control treatment, and only Endurance provided less weed control. At 127 DAT Sahara, with 28 percent cover, again provided the best control. Arsenal at 48 oz/ac was the only other treatment that had less weed cover than the control. Overall cover in the remaining treatments ranged from 75 to 96 percent. All of the treatments except Pendulum and Surflan provided better control of annual weeds than the control.

In 2000 Krovar I provided excellent long-term weed control (1 percent cover rating at 160 DAT). Only two other treatments had significantly lower weed cover ratings than the control. Plots treated with Oust or Spike had cover ratings of 32 and 38 percent, respectively. All other treatments provided cover ratings similar to the treated check. The most common weeds were the same ones found in 1999.

INTRODUCTION

The Penn State Roadside Vegetation Management Project has conducted many studies in which tank mixes for bareground weed control applications were evaluated. These trials were conducted for one season, then terminated. However, in practice, the best of the herbicide combinations may be used for several to many years in succession on the same areas. A concern inherent in the repeated use of the same herbicides on a site is the development of weed populations resistant to the herbicides being used. Resistant populations can develop in two ways. Weed species that are naturally resistant to the herbicides may be released when all other weeds are controlled. An example is the proliferation of boxelder maple in areas that are regularly treated with Krenite alone. Resistant biotypes may also occur within a species. Repeated use of the same herbicide may kill most of the plants of a species, but leave the resistant biotypes to reproduce and build up a bank of seeds that will produce plants that will gradually cover the treated area. The most common examples are the pigweeds and smartweeds that are resistant to the triazine herbicides.

Knowledge of the weed problems than can develop after the long-term use of herbicides allows for informed decisions to be made when product substitutions are made as part of a resistance management program. This study was established to evaluate the long-term effectiveness of several bareground herbicides after repeated annual applications, and identify potential weaknesses in their control spectrum.

MATERIALS AND METHODS

This study was established at the Landscape Management Research Center, at the Pennsylvania State University. In addition to a variety of annual weeds, the trial area had well-established perennial herbaceous species such as orchardgrass, tall fescue, wirestem muhly, and dandelion. In an attempt to control this existing vegetation, Roundup Pro at 48 oz/ac was added to all treatments. Herbicides with preemergence activity only were also supplemented with Arsenal at 4 oz/ac. It was felt that this rate would enhance the control of existing vegetation without adding a significant amount of preemergence activity to the treatment. Arsenal, Krovar I, Oust, Sahara, and Spike were tanked mixed with Roundup Pro alone. Endurance, Karmex, Pendulum, Surflan, and Plateau were tank mixed with both Roundup Pro and Arsenal. The Roundup Pro plus Arsenal combination was also applied alone as a treated, non-residual check.

On May 26, 1999, treatments were applied to 6 by 15 ft plots arranged in a randomized complete block design with three replications, using a CO_2 powered backpack sprayer equipped with Spraying Systems XR8004 VS tips delivering 40 gal/ac at 34 psi. Visual ratings of vegetative cover were taken July 1 and September 30, 35 and 127 days after treatment (DAT), respectively. Cover was characterized as annual or perennial species for the September 30 rating. Following the September rating, Roundup Pro at 4 qt/ac was applied over all of the plots.

Treatments were re-applied with the same equipment on April 11, 2000. Milestone VM was added to the trial, using the plots treated with Roundup plus Arsenal in 1999. The study area was expanded to accommodate two Roundup plus Arsenal treatments. Other than the treatments mentioned, all other plots were treated with the same residual herbicides used in 1999.

The 1999-treated plots were mostly bare because of the Roundup Pro application the previous September. However, the newly created treated-check plots had nearly 100 percent vegetative cover. A single rating was done on September 18, 2000; 160 DAT to evaluate percent cover and identify species present within each plot.

RESULTS AND DISCUSSION

In 1999, the Roundup Pro plus Arsenal at 48 and 4 oz/ac, respectively, was considered to be the control treatment that provided initial postemergence control with little preemergence activity. At 35 DAT vegetative cover ranged from 7 to 23 percent. Only Sahara provided better weed control than the control treatment, and only Endurance provided less weed control.

At 127 DAT Sahara, with 28 percent cover, again provided the best control. Arsenal at 48 oz/ac was the only other treatment that had less weed cover than the control. Overall cover in the remaining treatments ranged from 75 to 96 percent. All of the treatments except Pendulum and Surflan provided better control of annual weeds than the control. The most common annual weed species were common ragweed, giant foxtail, and yellow foxtail. The occurrence of perennial weeds in the plots was very erratic, and the treated check actually had the lowest perennial weed cover of any of the plots. Dandelion was the most commonly occurring perennial weed in the treated plots.

In 2000 Krovar I provided excellent long-term weed control. At 160 DAT plots treated with Krovar I had a cover rating of only 1 percent (Table 2). Only two other treatments had significantly lower weed cover ratings than the control. Plots treated with Oust or Spike had cover ratings of 32 and 38 percent, respectively. All other treatments provided cover ratings similar to the treated check. The most common weeds were the same ones found in 1999.

The 2000 trial was established much earlier in the season than the 1999 trial, but rated at about the same time in the fall as the 1999 trial. The extra time the treatments were on the ground resulted in most of them breaking down, which made it difficult to detect subtle differences between treatments. In future years the plots should be rated least one more time, earlier in the season.

It must be understood that preemergence herbicides are rarely used alone. It is well understood that each herbicide has its specific strengths and weaknesses. In this study the herbicides are used alone to specifically identify these strengths and weaknesses, and that the weed control ratings during the study are not the most important information learned from it.

CONCLUSIONS

At the time of the final rating in 1999 (127 DAT) most of the plots were dominated by perennial weeds. All but two of the treatments provided good to excellent control of the annual weeds. The two treatments that did not provide good control of the annual weeds were dinitroanaline herbicides that are never used alone in bareground applications because they are very weak in controlling broadleaved weeds.

In 2000, the treatment that provided the best control by far was a product that is a combination of two herbicides created to provide broad-spectrum control of broadleaved weeds and grasses. The other treatments that had less cover than the control were products known to have long-term residual activity in the soil.

The study is now well-established and treatments will continue to be applied to the same plots to determine which weeds build up in them. To date, the weedy status of giant foxtail has been established. It was one of the most common species for every treatment except for Plateau.

MANAGEMENT IMPLICATIONS

Eventually, this trial will provide information on the relative effectiveness of common bareground herbicides, in terms of length of active residue and species weaknesses. It is too early in the life of this trial to discern this information. Over time, we anticipate a shift of species appearing in each treatment area to occur as the proportions of the existing seedbank changes in response to the different herbicides. This will provide data useful in addressing species shifts that may occur in the field.

Table 1: Weed control provided by 11 herbicide treatments applied to well-established perennial weeds on May 26, 1999. Roundup Pro at 48 oz/ac was added to all treatments. Percent total vegetative cover was rated July 1, 35 days after treatment (DAT). Percent total vegetative, annual, and perennial cover were rated on September 30, 127 DAT. Each value is the mean of three replications.

Treatment	Application Rate	Total Vegetative Cover July 1	Total Vegetative Cover Sept 30	Annual Cover Sept 30	Perennial Cover Sept 30
	(oz/ac)	(%)			
Arsenal	4	15	95	70	25
Arsenal Surflan	4 128	18	88	53	35
Arsenal Endurance	4 25	23	88	32	57
Arsenal Pendulum 3.3EC	4 155	12	85	49	36
Arsenal Karmex	4 128	17	96	13	83
Arsenal Plateau	4 12	10	78	3	75
Arsenal	48	8	67	15	52
Sahara	160	7	28	1	27
Spike 80W	64	20	94	3	91
Oust	3	8	75	40	35
Krovar I	160	15	96	13	83
LSD (p=0.05)		8	24	24	24

Table 2: Weed control provided by 12 herbicide treatments applied on April 11, 2000. Roundup Pro at 48 oz/ac was added to all treatments. Percent green vegetative cover was rated September 18, 160 days after treatment (DAT). Each value is the mean of three replications.

Treatment	Application Rate	Green Cover 9/18/00	Predominant species
	(oz/ac)	(%)	
Arsenal	4	98	yellow foxtail, giant foxtail, tall fescue
Arsenal Surflan	4 128	95	common ragweed, giant foxtail
Arsenal Endurance	4 25	93	common ragweed, giant foxtail, yellow foxtail
Arsenal Pendulum 3.3E	4 155	90	common ragweed, yellow foxtail, giant foxtail
Arsenal Milestone VM	4 8	88	giant foxtail, common ragweed, PA smartweed
Arsenal Karmex	4 128	77	giant foxtail, smooth groundcherry, yellow foxtail
Arsenal Plateau	4 12	92	annual fleabane, barnyardgrass, common ragweed
Arsenal	48	83	common ragweed, dandelion, giant foxtail
Sahara	160	68	giant foxtail, yellow foxtail, common ragweed
Spike 80W	64	38	giant foxtail, wirestem muhly
Oust	3	32	yellow foxtail, giant foxtail, plumeless thistle
Krovar I	160	1	giant foxtail, wirestem muhly, tumble pigweed
LSD (p=0.05)		19	

ESTABLISHMENT OF NATIVE SPECIES MIXTURES WITH SPRING SEEDINGS

Herbicide trade and common names: Accord, Roundup Pro, Roundup Pro Dry (*glyphosate*), Garlon 4 (*triclopyr*), Plateau (*imazapic),* Three-Way (*2,4-D, dicamba, MCPP*).
Plant common and scientific names: bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), common milkweed (*Asclepias syriaca*), swamp milkweed (*Asclepias incarnata*), New York ironweed (*Vernonia noveboracensis*), New England aster (*Aster novae-angliae*), crownvetch (*Coronilla varia),* plumeless thistle (*Carduus acanthoides*), musk thistle (Carduus nutans), prickly lettuce (*Lactuca serriola*), tall fescue (*Lolium arundinacea).*

ABSTRACT

Three sites were spring-treated and seeded to demonstrate the potential utility of a seed mixture composed primarily of species native to Pennsylvania, and considered to be adapted to the poor, disturbed soils that are created during road construction. These sites were established near Nazareth, Northampton County; Aliquippa, Beaver County; and State College, Centre County.

These demonstrations resulted in varying degrees of success. The Nazareth site was a nearly complete failure due the extreme drought in 1999, but was salvaged to an extent by the presence of an impressive stand of common milkweed-until the mowing contractor was instructed to mow it. The Aliquippa and State College sites were moderately successful in terms of establishment. The stand density at Aliquippa is a little thin, and the State College site is subject to weed pressure from crownvetch and plumeless thistle.

INTRODUCTION

Perennial, warm season grasses are well adapted to dry, infertile, acidic soils; provide desirable habitat for ground-nesting and grassland songbirds that are losing habitat; and though an acquired taste for many, they are very aesthetic. Establishment of these grasses is relatively slow, especially when compared to cool-season mixtures such as the Department's Formula D (tall fescue and creeping red fescue) or Formula L (hard fescue and creeping red fescue) seed mixtures. Therefore, weed control is often the critical factor affecting successful establishment of warm-season grasses. Plateau is a relatively new herbicide product that provides both pre- and postemergence weed control in warm-season grass seedings. Plateau is also tolerated by many legume species, as well as other selected forbs.

A mix tolerant to Plateau herbicide was developed, and seeded at the sites of the next three Roadside Conferences during May 1999 to provide an opportunity to see the mix develop during its first three growing seasons.

MATERIALS AND METHODS

A seed mix comprised of six native, perennial grasses (five warm-season species, and the cool-season species Canada wildrye), four forbs, and three nurse crop species (Table 1) was seeded in 1.0 to 1.5 ac sites at each of three separate locations - the interchange of SR 33/SR 248 near Nazareth, the interchange of SR 60/SR 3016 near Aliquippa, and the Oak Hall interchange of SR 322, near State College. Seeding was done using a Truax Flex II 88 no-till drill. An application of Roundup Pro plus Plateau at 4 qts plus 4 oz/ac, respectively, was intended for the Nazareth and Aliquippa sites the same day as seeding, but the herbicide mixture was applied at

1.5X because the sites were smaller than originally estimated and we did not wish to transport the already-mixed herbicide solution. The Nazareth site was treated and seeded May 13, and the Aliquippa site was done May 27, 1999.

The State College site was treated May 4, and seeded May 18, 1999. In addition to Roundup Pro plus Plateau, Three-way herbicide was added at 1 qt/ac.

The Nazareth site was overseeded on April 20 with the mixture of the species that were originally seeded in the fluffy seed box of the Truax drill (Table 1), at the same proportion as the original seeding, at about 10 lb PLS/ac. The site was retreated with a mixture of Roundup Pro Dry, Garlon 4, and Plateau at 72, 48, and 3 oz/ac, respectively, on May 3, 2000. The primary target was musk thistle, and remnant tall fescue. Any warm season grasses that were present were spared because they had not yet developed significant leaf area.

The State College site received a spot treatment of Roundup Pro Dry, Garlon 4, and Plateau at 72, 48 and 3 oz/acre, respectively, on June 9, 2000. This treatment was necessary to control primarily plumeless, bull, and Canada thistles, plus prickly lettuce and crownvetch that were overtaking the site. A total of 5 gallons was applied.

RESULTS AND DISCUSSION

Late control of the unwanted vegetation plus the extreme drought conditions experienced during the 1999 season resulted in the establishment of fewer natives, particularly at Nazareth where the drought was acute, and establishment was almost nil. Establishment at the Aliquippa site was the best of the three sites, though the stand density was lighter than desired. The area is basically flat, and once the grasses reach mature size, the area will be a good example of a habitat planting. The State College site establishment was patchy, ranging from satisfactory to poor, due to soil variation and weed pressure. Some areas of the State College site had very shallow soil and featured limestone outcrops, and other areas had a vigorous stand of crownvetch that was only temporarily set back by the herbicide treatment.

Annual weed control was effective through the summer at all sites, but both Nazareth and State College were infested with biennial thistle seedlings by fall. The Plateau appears to have provided the needed window of opportunity for the seedlings to establish.

A drawback of using Plateau is that none of the traditional nurse crop species, such as cereal grains, annual ryegrass, or Japanese millet, are tolerant to it. Only a few individuals of the cover crops in the seed mix have been observed in any of the Plateau-treated seedings. An increased rate of black-eyed Susan in the seed mix may serve as an effective cover crop.

One positive observed with the spring herbicide application was the release of desirable forb species, such as common milkweed at Nazareth; and common and swamp milkweeds, New York ironweed, and New England aster at Aliquippa. These species were just emerging at the time of application and were only set back, not controlled, and subsequently thrived in the absence of the tall fescue after treatment.

Operationally, these sites would not have been candidates for a native species planting because the existing vegetation was intact and functional. The sites were chosen primarily because they were well placed for the tour, and because the desired maintenance level, and appearance of warm-season grass plantings were compatible with the sites.

Another aspect of these demonstrations that is not recommended is spring weed control. The soil would have been more friable - allowing the seed drill to place the seed better - and the new seeding would have been exposed to less competition if the weed control had been done in the fall. In this case, we could not do that because the decision was made to establish these plots in March 1999.

MANAGEMENT IMPLICATIONS

The Department is going to come under increasing pressure to limit the use of crownvetch for slope seedings, due to its weediness outside of slope stabilization settings. There are native species adapted to growing on disturbed sites with less weedy tendencies than crownvetch, and use of these species will provide habitat benefits that crownvetch cannot. However, developing a mix and establishment procedure to provide the consistent results achieved by crownvetch will take considerable time and effort. The plantings described above represent 'early phase' efforts.

Plateau provides an effective weed control tool where warm season grasses and selected forbs will be planted in areas where weed pressure is anticipated.

Table 1: Composition of a mixture of native grasses and forbs, and three nurse crops, listing common name, scientific name, seeding rate, and seed box used on Truax Flex II 88 drill.

Truax Seed Box	Common Name	Scientific Name	Seeding Rate
			lb PLS/acre[1/]
Grasses			
Fluffy	big bluestem	*Andropogon gerardii*	4
Small	deertongue	*Dicanthelium clandestinum*	1
Fluffy	Canada wildrye	*Elymus canadensis*	1
Small	switchgrass	*Panicum virgatum*	1
Fluffy	little bluestem	*Schizachyrium scoparium*	4
Fluffy	Indiangrass	*Sorghastrum nutans*	4
Forbs			
Small	showy ticktrefoil	*Desmodium canadense*	0.4
Small	roundheaded bushclover	*Lespedeza capitata*	0.4
Small	perennial lupine	*Lupinus perenne*	0.4
Small	blackeyed Susan	*Rudbeckia hirta*	0.8
Cover Crops			
Small	Japanese millet	*Echinochloa crusgalli* ssp. *frumantacea*	1
Small	foxtail millet	*Setaria italica*	1
Small	annual ryegrass	*Lolium multiflorum*	1

[1/]PLS=Pure Live Seed=[(% germination/100) * (% purity/100)] * 100. The cover crop species seeding rates are in lbs raw seed/acre.

ROADSIDES FOR WILDLIFE
NATIVE PLANTING DEMONSTRATION

Herbicide trade and common names: Roundup Pro Dry and Glyflo (*glyphosate*), Plateau (*imazapic*), Garlon 4 (*triclopyr*)
Plant common and scientific names: See Table 1., crownvetch (*Coronilla varia)*, red fescue (*Festuca rubra*), reed canarygrass (*Phalaris arundinacea*), teasel (*Dipsacus sylvestris*), Canada thistle (*Cirsium arvense*), quackgrass (*Elytrigia repens*).

INTRODUCTION

This demonstration was established as a cooperative effort between PENNDOT, the Roadside Research Project, and the PA Game Commission. A five acre native planting was seeded at the interchange of SR 22/764/220 near Duncansville, in Blair County. It was established as a pilot project to demonstrate the use of a warm-season grass-based planting 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 while not encouraging use by deer. The planting is also meant to provide an aesthetically pleasing, low maintenance groundcover. The native grasses are tall growing, with seedheads up to six 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 mature and fill in, often taking two full growing seasons, they ultimately provide a competitive groundcover that provides benefits for wildlife, acts as a snow fence, and require minimal maintenance. Cutting (or burning!) every few years helps eliminate encroaching brush species. Ideally, the cutting height would be greater than 6 inches and performed after July 15 when ground nesting birds have already fledged. Most of the species and available cultivars of native grasses have culms that remain upright throughout the winter months providing cover for wildlife, an aesthetically appealing landscape, and also serve to capture drifting snow.

MATERIALS AND METHODS

The site to be planted was a five acre, unmowed infield area of a large interchange that had reverted to a meadow-like appearance. Many undesirable species were present in the area. Predominant species included teasel, Canada thistle, crownvetch, reed canarygrass, and quackgrass. The site was first broadcast sprayed 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 either 4 qts/ac Glyflo, 1 qt/ac Garlon 4, and 4 oz/ac Plateau or 72 oz/ac Roundup Pro Dry, 1 qt/ac Garlon 4, and 3 oz/ac Plateau was used. Thinvert was the carrier. This application was made using a truck-mounted Radiarc, oriented horizontally with a pattern width of 32 feet and a carrier volume of 5 gal/ac. The area was then seeded in mid-May, 2000 by Pennsylvania Game Commission personnel using a tractor mounted Flex II 88 no-till seeder. The seed mix used is listed in Table 1. A mixture containing wildlfowers and little bluestem was seeded along the periphery of the demonstration area while taller, warm season grasses were seeded in the interior of the plot.

On June 8, 2001 the entire area was treated with a selective herbicide application to address weeds that were present in the planting. A total of 26 gallons of solution was applied at a targeted rate of 5 gal/ac. The treatment included 6 oz/ac Plateau combined with either water and 5 percent v/v Sun It II surfactant, or Thinvert. 7.5 gallons were applied using water as a carrier while, 18.5 gallons was applied with Thinvert. The treatment was applied using a truck-mounted Radiarc, oriented horizontally to provide a 32 foot swath.

RESULTS AND DISCUSSION

This pilot project provided mixed results. Native grasses and forbs are present throughout the site. While the planted natives comprise a significant amount of the groundcover, the fine fescue, crownvetch, and reed canarygrass that were among those plants originally prevalent at this location remain significant components of the stand.

Based on this and similar demonstrations, native species have a fit in roadside plantings. Site and species selection is going to be critical. Newly constructed sites with no existing vegetation and marginal quality soils should be the focus of the native plantings in the future. Eliminating existing stands of crownvetch and fine fescue is problematic. It is the authors suspicion that it will be a continual battle to stave off these unwanted, previously existing plants. Continued efforts are needed to isolate the proper mix of native grasses that will establish themselves over a wide range of environmental conditions. Future activities and observations at this site will be documented and presented in subsequent years to determine the long-term success of this planting.

Table 1: Composition of two separate native mixtures, listing common name, scientific name, seeding rate, and seed box used on the no-till drill. Seeding was done in mid-May, 2000 by the PA Game Commission.

Truax Seed Box	Common Name	Scientific Name	Seeding Rate
			lb PLS/acre[1/]
Interior of Plot			
Fluffy	big bluestem	*Andropogon gerardii*	3-4
Small	switchgrass	*Panicum virgatum*	3-4
Fluffy	Indiangrass	*Sorghastrum nutans*	3-4
Perimeter of Plot			
Fluffy	little bluestem	*Schizachyrium scoparium*	3-4
Small	blackeyed Susan	*Rudbeckia hirta*	0.5
Small	oxeye sunflower	*Heliopsis helianthoides*	0.25
Small	wild bergamot	*Monarda fistulosa*	0.25
Small	showy ticktrefoil	*Desmodium canadense*	0.5
Small	roundheaded bushclover	*Lespedeza capitata*	0.25

[1/]PLS=Pure Live Seed=[(% germination/100) * (% purity/100)] * 100.

2000 ROADSIDE VEGETATION MANAGEMENT CONFERENCE (RVMC)
FIELD DAY REVIEW:

OVERSEEDING A POORLY VEGETATED SLOPE WITH NATIVE GRASSES, USING SOIL-GUARD AS A MULCH

<u>Plant common and scientific names:</u> big bluestem (*Andropogon gerardii*), Canada wildrye (*Elymus canadensis*), switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), annual ryegrass (*Lolium multiflorum*), crownvetch (*Coronilla varia*), rough-leaved goldenrod (*Solidago rugosa*), butterfly milkweed (*Asclepias tuberosa*).

INTRODUCTION

One of the long-term goals of the Penn State Roadside Vegetation Management Research Project is to develop an alternative seeding formula to the crownvetch/annual ryegrass mixture that is commonly seeded to cut and fill slopes after construction. A grass-based mix with a significant portion consisting of warm-season grasses would provide the potential benefits of improved soil stability due to the deep and fibrous nature of the grass's root system; easier maintenance of broadleaf weeds and brush using selective herbicides that do not injure grasses; and the ecological and mitigation effects of using a seed mixture that can provide desirable habitat for ground nesting birds. Warm-season grass species such as big bluestem, little bluestem, switchgrass, and Indiangrass will establish on a wide range of disturbed sites, and have been documented to tolerate sites with extremely low pH and fertility[14]. A poorly vegetated cut-slope along SR 60 in Beaver County, and the desire of MAT, Inc. to showcase Soil Guard for the field day provided an opportunity to demonstrate the adaptation of a warm-season grass-based mixture to very poor sites, and the durability of Soil Guard, a bonded-fiber matrix product that provides an integral, woven soil cover that is hydraulically applied.

MATERIALS AND METHODS

This site had been seeded to crownvetch after construction of the road in the 1970's, but it never became well established. Percent cover from crownvetch, rough-leaved goldenrod and butterfly milkweed was less than five percent. Soil testing provided the following results: organic matter - 1.1 percent; pH - 7.6; Phosphorous (P_20_5) - 5 lb/ac; Cation Exchange Capacity - 17.8 meq/100 grams; and Potassium (K_2O), Magnesium, and Calcium saturations of 1.9, 13.8, and 84.2 percent, respectively. In practical terms, this means the pH was high, organic content low (but higher than anticipated), phosphorous extremely low, potassium and magnesium were in the optimal range, and calcium was excessive. On May 4, 2000, a mixture of big bluestem, little bluestem, Indiangrass, and Canada wildrye, was hand-seeded at a rate of 4, 4, 4, and 1 lb pure live seed/ac, respectively, to 4500 sq. ft. Due to the relatively slow establishment rate of these grasses, we wanted to have them in contact with the soil surface, rather than embedded in the fiber matrix. Annual ryegrass equivalent to 10 lb/ac was added to the slurry in the hydroseeder and applied with the Soil Guard. Soil Guard was applied at a rate of 2000 lb/ac.

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[14] McKee,G.W., J.V. Raelson, W.R. Berti, and R.A. Peiffer. 1982. Tolerance of Eighty Plant Species to Low pH, Aluminum, and Low Fertility. Agronomy Series No. 69, The Pennsylvania State University.

The recommended application rate is 3000 lb/ac. Soil temperatures at the time of seeding at 0, 1, 3, and 6 inches depth were 63, 63, 59, and 58 degrees F, respectively.

RESULTS AND DISCUSSION

At the time of the field day, 76 days after seeding, the best-established grass plants were 4 inches tall, although most were in the 1 to 2 inch range. The annual ryegrass was very sparse, and not vigorous. The grasses were not vigorous, but if the plants present develop into mature-sized plants, the cover will be quite satisfactory, and will be a substantial improvement over the non-cover that was there. That is a big 'if', and only future observations will determine if the grasses can grow well enough to vegetate such a poor site.

The Soil Guard was still present, providing between 25 and 50 percent of the orginal cover, even after a light (2/3 recommended rate) application. Bonded fiber matrix products have already demonstrated their utility to the erosion control industry, and should be considered in any seeding situation where an integral blanket that conforms to the soil surface is called for.

Our intent with this demonstration is not to advocate the use of warm season grasses to reclaim areas where crownvetch will not grow - we advocate them as part of the original seed mix for areas where crownvetch is currently being specified. However, our working in a maintenance setting lends itself more to 'rescue' seedings, rather than original conservation seedings after construction. Should the grasses continue to grow on this site, it will provide a convincing data point demonstrating the range of site adaptation of these grasses.

2000 RVMC FIELD DAY REVIEW:

COMPARING THE EFFECT OF BASAL BARK HERBICIDE MIXTURES ON AILANTHUS ROOT SUCKERING

Herbicide Trade and common chemical names: Pathfinder II (*triclopyr*), Garlon 4 (*triclopyr*), Stalker (imazapyr), Tordon K (*picloram*), Arborchem Basal Oil (*oil penetrant with emulsifier*).
Plant common and scientific names: ailanthus, or tree-of-heaven (*Ailanthus altissima*).

INTRODUCTION

Ailanthus is a roadside plague. It is fast growing, weak wooded, and adapted to the poor soil conditions typical of roadsides. Ailanthus spreads vegetatively by producing new shoots from its root system. Therefore, the key to controlling established ailanthus is controlling the root system. Basal bark applications are very effective at controlling ailanthus stems, but dormant and spring applications have repeatedly demonstrated that applications during these time periods do not control the roots, and prolific suckering (production of new shoots from the roots) occurs.

Applying treatments in the summer and fall appears to be the key to effective control of ailanthus with the basal bark technique. However, the dormant season represents a vast, largely untapped (for roadsides, at least) time resource to manage vegetation, and efforts to better utilize this period are warranted. This demonstration was established to determine if adding the herbicides Stalker or Tordon K to triclopyr would substantially reduce suckering after an early spring treatment of ailanthus. Both Stalker and Tordon K are systemic, and soil active. Previous research[15] and demonstrations suggest that the primary mechanism of sucker suppression with picloram from dormant season applications is root absorption of soil-borne herbicide, rather than translocation of bark absorbed chemical. The basal bark treatment utilizes relatively high concentrations of herbicide, and when applied in a high stem density situation, which would be common for ailanthus, a relatively high amount of herbicide will be on the soil surface after application.

MATERIALS AND METHODS

The treatments consisted of Pathfinder II, a ready-to-use triclopyr formulation; Garlon 4/Stalker/Arborchem Basal Oil (ABO) at 15/3/82 percent, v/v, respectively; Stalker/Garlon 4/ABO at 4/1/96 percent, v/v, respectively; and Garlon 4/Tordon K/ABO at 20/5/75 percent, v/v, respectively.

Applications were made April 29, 1999, using backpack sprayers, with ULV wands equipped with Spraying Systems #5500 ConeJet nozzles with Y-2 tips, treating the lower 12 inches of each stem. On April 13, 2000, employees of the adjacent property owner cut down the standing dead stems in the Garlon 4/Stalker/ABO at 15/3/82, and Garlon 4/Tordon K plots, seemingly to improve visibility of their billboard.

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[15] Effect of Basal Bark Application Timings on the Control of Tree-of-heaven and Sumac. Tenth Annual Research Report. http://rvm.cas.psu.edu/1995/AR1995.html

RESULTS AND DISCUSSION

All four treatments controlled the treated stems. Suckering was evident in all four treatments, with no obvious differences apparent in terms of size or density. With the trampling of the plots associated with the unauthorized removal of the treated stems by the adjacent property owner, we elected not to characterize the suckering density between the plots.

As this demonstration proceeded, it became apparent from other basal bark trials conducted in 1999-2000 that application timing probably plays a much greater role than herbicide mixture in injuring the root system of ailanthus with basal bark treatments.

Based on our observations to date, the best way to manage ailanthus with basal treatments is to apply them during the summer, or fall before leaf coloration. If ailanthus is treated outside of that window, a soil active herbicide such as Stalker or Tordon K will probably reduce the amount of suckering, but a followup foliar application to the resprouts during the growing season is still necessary.

2000 RVMC FIELD DAY REVIEW:

A COMPARISON OF THE SPROUT-LESS APPLICATOR AND STUMP TREATMENT FOR CONTROL OF AILANTHUS RESPROUTS

Herbicide Trade and common chemical names: Garlon 4 (*triclopyr*), Arborchem Basal Oil (*oil penetrant with emulsifier*), Penevator Basal Oil (*oil penetrant*)
Plant common and scientific names: ailanthus, or tree-of-heaven (*Ailanthus altissima*).

INTRODUCTION

The Sprout-Less applicator is a novel device that has been used primarily in forestry settings in Canada. It is an herbicide reservoir that is attached to the bottom of a clearing saw, and through a process that could be described as controlled leakage, the bottom surface of the cutting blade is coated with herbicide as the blade is vibrated upon contact with the woody stem. This herbicide is then wiped on the freshly cut surface. It does not release material when the blade is not in contact with stems, so herbicide is provided only when needed. Results in Canada for release treatments have been encouraging[16]. This equipment was operationally demonstrated during the 1998 and 1999 field days. This demonstration was established to evaluate the effectiveness of the Sprout-Less system on ailanthus. Most data in the literature has been on non-suckering species such as maples, alders, birches, and willow. Controlling an established suckering species is a different situation than controlling single stems or sprout clusters. The target is the root system, so the goal is to get enough active ingredient on the cut surface to translocate into and kill, the roots.

MATERIALS AND METHODS

The demonstration site was along SR 60 N, near the Brighton exit, in a patch of ailanthus resprouts. On May 27, 1999, three 30 by 60 ft plots received the following treatments - chainsaw-cut only, chain-saw cut and stump treat with a 25:75 mixture of Garlon 4:Arborchem Basal Oil, and the use of the Sprout-Less System with the same herbicide mixture. The Sprout-Less treatment was suspect, as the herbicide was applied at too low a rate - the reservoir should be near empty when the fuel tank empties. On September 9, 1999, two more plots were established; a chainsaw-cut and stump treatment with a 25:75 mixture of Garlon 4:Penevator Basal Oil, and Sprout-Less using the same herbicide mixture. The September 9 Sprout-Less application used 250 mL of solution; and the cut and stump treated plot required 650 mL to treat 82 stems.

[16] Lenteigne, L., D. Pitt, A. Mubareka, and T.O'Brien. 1999. Newly developed brush-saw mounted applicator for vegetation control products. Proceedings of the Northeastern Weed Science Society. 53:42.

RESULTS AND DISCUSSION

The only treatment to effectively suppress ailanthus sprouts was the September 1999 chainsaw-cut and stump treat plot. The Sprout-Less treatment from the same date did not prevent root suckering, and did not completely prevent the development of stump sprouts. The treatments applied in May were ineffective, regardless of method. The May chainsaw-cut and stump treatment plot was free of stump sprouts, but root suckering was not prevented. Our suspicions about the herbicide flow rate for the Sprout-Less System were confirmed - very little effect was observed. The timing effect is not surprising, as we would expect systemic herbicides to be translocated to the roots in the fall, but not in the spring before full leaf-out. The lack of effect from the Sprout-Less in September was probably due to reduced herbicide dosage compared to the cut and stump treat operation.

A drawback with the Sprout-Less System that we have experienced is that the set-up is touchy, since the gasket configuration changes with the herbicide used. We have done primarily smaller-plot work, comparing herbicide mixtures, while the intent behind the equipment is to have a dedicated operator, who would be using it routinely. Consequently we have had difficulties getting the set-up calibrated, as there is a definite 'feel' required, which is acquired through experience. The operator evaluates flow based on the wetting pattern of the blade (enhanced by using a colorant), and coverage of stems by coloration. The applicator is expected to adjust work speed to facilitate proper coverage. For example, if colorant is not observed on the stems, the operator cuts through the stems more slowly, until coloration is visible on the cut surface after the cut.

The concept of the Sprout-Less System is sound, but the operation of the device does not lend itself to small scale demonstrations. Therefore, we will not attribute our consistently disappointing results to the device itself - we really have not been able to operate it under the conditions for which it was intended. Recent work by other investigators with the Sprout-Less has featured Garlon 4 treatments that were undiluted, as opposed to the 25 percent concentrations we used. That would have been a more valid treatment in this situation, as the device delivers very small amounts of material compared to conventional stump treatment with a squirt bottle.

Although we could argue that more concentrated solutions and a familiar operator might improve the results we have seen, the Sprout-Less System does not seem to have a good fit in the PENNDOT program. It is well suited to selective removal of small stems such as thinning and release treatments in forestry, but has size limitations that a chainsaw would not, and woody stems are not often removed selectively along roadsides - they are removed wholesale from extensive areas, or they are of varying size. Such situations are better served with a tractor-mounted mower, operators equipped with chainsaws, or the combination of the two.

2000 RVMC FIELD DAY REVIEW:

COMPARISON OF SPRING-APPLIED CUT SURFACE TREATMENTS FOR CONTROL OF AILANTHUS

Herbicide trade and common names: Pathway (*picloram + 2,4-D*), Pathfinder II and Garlon 4 (*triclopyr*), Vanquish (*dicamba*), Roundup Pro (*glyphosate*), Arsenal (*imazapyr*), Krenite S (*fosamine*), Finale (*glufosinate*), BK 800 (*2,4-D, 2,4-DP, and dicamba*)
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*).

INTRODUCTION

Mechanical brushing operations are an integral part of Pennsylvania's roadside vegetation management program. During these operations the trees are cut and usually removed from the right-of-way. The remaining stumps must be chemically treated to prevent vigorous regrowth. Ailanthus is a tree species that poses particular concerns because of its ability to resprout prolifically from both the stump and root system. Sprout growth after cutting established ailanthus can exceed 15 feet during the first growing season after cutting. Failure to prevent this regrowth will render the substantial investment in such operations useless within three seasons. Repeatedly exposing workers to the hazard of operating chainsaws on difficult terrain and brush chippers is not good policy.

Most tree species are incapable of sprouting new shoots from their root system and therefore can be effectively controlled anytime of the year using cut surface treatments. Herbicides correctly applied to the stump will prohibit sprouting from the above ground portions of the tree. Root suckering species, such as ailanthus or black locust, need to have the herbicide translocate to the root system in order to achieve effective control.

The majority of brushing that is done by PENNDOT employees is a wintertime activity. Dormant season treatments have proven to be less effective at controlling resprouting that occurs from the root system. This is because there is no movement occurring within the vascular system at this time of year. This demonstration investigates whether any of the herbicide treatments tested will help to reduce resprouting from ailanthus when applied in the dormant season despite immediate lack of movement. By reducing resprouts followup foliar treatments are reduced both in terms of time and material necessary to treat the area.

MATERIALS AND METHODS

The site was located on a west facing fill slope on SR 4035. On April 29, 1999 the demonstration area was cut and treated with nine herbicide treatments. The herbicides and corresponding concentrations are listed in Table 1. Larger ailanthus trees were slashed into smaller pieces and all brush was left on site. The number of stumps and diameter of each was recorded for each plot. On April 13 and May 4, 2000 data was collected on resprouting. During these visits the number and diameter of resprouts was collected in a 42.5 sq. ft. area that was selected as a representative sample of the plot.

RESULTS AND DISCUSSION

The initial number of trees in each plot ranged from 27 to 74. Resprout counts ranged from 23 to 73 per 42.5 sq. ft. This is a significant number of resprouts even for the lowest count of 23 considering that this would represent a stem density of approximately 23,000 stems/acre. Clearly, none of the treatments were effective at suppressing root suckers. The value of the dormant cut surface treatment on ailanthus is the prevention of resprouts from the stump. Resprouting from the stump would result in a more vigorous sprout the first year. Stump sprouts are capable of attaining heights of 12-15 ft during the first growing season, while sprouts from the roots are somewhat shorter. At best, stump treating during dormant season cutting will delay the onset of sprouting and reduce the vigor and density somewhat, but this advantage would be transient. An impenetrable thicket will develop in either scenario if a foliar follow-up treatment is not applied during the first growing season after cutting. The basal bark vs. cut surface comparison that was located adjacent to this demonstration and applied in September demonstrated that a fall application timing was very effective at suppressing suckers. Our observations to date indicate that application timing is vastly more important than the herbicide used when trying to control ailanthus suckers.

Table 1: Original stem count, and number of resprouts counted in a 42.5 sq ft sub-plot. Stems were cut and treated April 29, 1999; and resprouts were counted April 13 and May 4, 2000.

Treatment	Rate	Original Stumps	Resprouts
	(% v/v)	(#)	(#/42 ft^2)
Pathway	RTU	74	37
Pathfinder II	RTU	63	73
Garlon 4	25	37	36
ABO*	75		
Vanquish	50	55	23
Water	50		
Roundup Pro	50	49	36
Water	50		
Arsenal	8	47	34
Water	92		
Krenite S	50	27	43
Water	50		
Finale	50	40	58
Water	50		
BK 800	33	71	52
ABO	67		

* Arborchem Basal Oil

2000 RVMC FIELD DAY REVIEW:

INEFFECTIVE CONTROL OF AILANTHUS WITH REDUCED-RATE SPIKE APPLICATIONS

Herbicide trade and common names: Spike 20 P (*tebuthiuron*)
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*), garlic mustard (*Alliaria petiolata*), black cherry (*Prunus serotina*).

INTRODUCTION

Spike is a soil-active herbicide with very little foliar activity. It has a long soil half-life, and is commonly used at non-selective rates for spot control of well established perennial weeds. Late fall treatments using a 6 lb ai/ac rate have been used in some of the Districts to good effect to control ailanthus. This demonstration was established to determine if a 4 lb ai/ac rate would be effective. Another concern was that there was a desirable, mature stand of black cherry at the top of the cut slope, behind the ailanthus being targeted. We wanted to see if an application to just the front of the ailanthus patch would still control the ailanthus but spare the cherry.

MATERIALS AND METHODS

The area of the ailanthus patch was approximately 2800 sq. ft. The Spike pellets were weighed, and applied uniformly by hand to the area on May 27, 1999, to deliver 20 lbs of pellets/ac, or 4 lb ai/ac.

RESULTS AND DISCUSSION

Treatment effects on ailanthus were limited during the summer of 2000. Some of the branches at the top of the canopy were dead, but none of the trees were killed. The understory was also largely intact, and consisted primarily of garlic mustard. These results were unexpected. We have reviewed the measurements and weights of material, and cannot explain the lack of activity. The reduced rate could be attributed for the lack of control of the ailanthus, but 4 lbs of tebuthiuron/ac should have had a dramatic effect on the understory.

2000 RVMC FIELD DAY REVIEW:

CONTROL OF AILANTHUS WITH BASAL BARK OR CUT SURFACE TREATMENTS APPLIED IN SEPTEMBER

Herbicide trade and common names: Garlon 4 (*triclopyr),* Penevator Basal Oil (*oil penetrant*)
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*)

INTRODUCTION

The Penn State Roadside Research project has conducted research on many issues associated with basal bark applications made during the dormant season. The premise was that basal bark applications provided a means to control brush during the dormant season, which is five to six months long, greatly expanding the window of opportunity to manage vegetation. This focus on the dormant season and utilizing Department forces to conduct the work produced a mind-set that basal bark applications were not effective at controlling suckering species. On several operational scale projects we saw staghorn sumac or ailanthus become a worse problem where we treated because the dormant-treated stems were engulfed in a thicket of suckers the following growing season. After making some basal applications during the growing season, we realized that trying to control the root system with a phloem-mobile herbicide would be easier if phloem transport was occurring to the roots at the time of treatment. The timing effect issue also shed light on anecdotal accounts of good control of suckering species with basal bark treatments, which were counter to our experience. With our new-found grasp of the seemingly obvious, we wanted to evaluate the efficacy of basal bark and cut stump treatments applied in the late summer.

MATERIALS AND METHODS

On September 9, 1999, a colony of ailanthus on SR 4035, near the Brighton exit of SR 60, was divided into two 20 by 40 ft plots, and treated with a 25:75 mixture of Garlon 4:Penevator Basal Oil, either as a basal bark treatment to the lower 12 in of each stem, or as a cut surface treatment after cutting as close the ground as practical with a chainsaw. Stems were not counted, but stem numbers between the two plots appeared similar. In the basal bark plot, 2 qts of solution was applied, and 11 oz was applied to the cut surface plot. The basal bark treatment was applied with a backpack sprayer equipped with a Spraying Systems #5500 Adjustable ConeJet with a Y-2 tip, and the cut surface treatments were applied with a squirt bottle. District 11-0's tree contractor chipped the brush in the cut surface plot sometime after completion of the treatment.

RESULTS AND DISCUSSION

Both the basal bark and cut surface treatments were very effective, and resprouting was minimal both in number and size (up to 2 ft), when viewed in July 2000. Whether to choose basal bark or cut surface treatments for late summer ailanthus control will depend on factors other than efficacy, such as the proximity of the stems to the roadway. Dead ailanthus is even more of a hazard than live ailanthus in terms of dropping limbs or falling on the roadway.

The management calendar we have embraced in the past - utilizing Department forces during the winter months to do basal bark or cut surface work - is counterproductive for ailanthus management. Dormant season approaches do not address the ailanthus root system. Ailanthus is most effectively dealt with in the summer and early fall, therefore District's will have to utilize contractors to address ailanthus infestations, and reserve Department force labor for areas where non-suckering brush species are present.