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DEPARTMENT OF TRANSPORTATION

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RESEARCH REPORT
FOURTEENTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY
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The fourteenth year report on a cooperative research project between the Pennsylvania Department of Transportation, Bureau of Maintenance and Operations; and the Pennsylvania State University, College of Agricultural Sciences; including:
Brush control research evaluating basal bark and dormant stem herbicide applications.
Herbaceous weed control research evaluating the effect of herbicides and conversion sequences on the control of Canada thistle.
Evaluation of 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 demonstration evaluating the control of Ailanthus using low volume backpack applications.
Evaluation of spring-applied herbicides for control of Giant knotweed.
Review of 1999 Roadside Vegetation Management Conference Field Day demonstrations.

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Novartis Crop Protection, Inc.
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Spraying Systems, Inc.
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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

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

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

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

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

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

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

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

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 below 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.
BK 800	dicamba + 2,4-D+2,4-DP	0.5+2+2 EC	PBI Gordon Corporation
BullsEye Basal 55	dye	- - -	Milliken Chemical
Clean Cut	adjuvant	- - -	Arborchem Products, Inc.
Endurance	prodiamine	65 WG	Novartis Crop Protection, Inc.
Escort	metsulfuron methyl	60 DF	E.I. DuPont de Nemours & Co.
Exceed	primisulfuron + prosulfuron	57 WDG	Novartis Crop Protection, Inc.
Finale	glufosinate-ammonium	1 S	AgrEvo USA Company
Garlon 3A	triclopyr	3 S	DowAgroSciences Ltd.
Garlon 4	triclopyr	4 EC	DowAgroSciences Ltd.
HyGrade	diluent	- - -	CWC Chemical, Inc.
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.
MON 59120	adjuvant	- - -	Monsanto
MON 59175	adjuvant	- - -	Monsanto
M.U.P.	glufosinate	5 S	AgrEvo USA Company
Northstar	primisulfuron + dicamba	47.4 WDG	Novartis Crop Protection, 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
Reward	diquat dibromide	2 S	Zeneca Professional Products
Roundup Pro	glyphosate	4 S	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.
Tordon K	picloram	2 S	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.

Precipitation Data

The majority of the activities in this report were related to the 1999 Roadside Vegetation Management Conference field day, which was predominantly in Northampton County. The table below provides and indication of the 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

Month	1998 Rainfall	1998 +/-	1999 Rainfall	1999 +/-
	(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

PRELIMINARY RESULTS:
EFFECT OF BASAL BARK APPLICATIONS OF
GARLON 4 PLUS STALKER ON SUCKERING OF AILANTHUS

Herbicide trade and common chemical names: Stalker (*imazapyr*), Tordon (*picloram*), Garlon 4 (*triclopyr* , Pathfinder II (*triclopyr*)
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*), black locust (*Robinia pseudoacacia*), sassafras (*Sassafras albidum*), staghorn sumac (*Rhus typhina*)

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% v/v, alone or in combination with Stalker at 3% v/v Stalker; and Garlon 4 at 1% v/v plus Stalker at 3% v/v. Initial evaluations taken 109 days 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 trials on this species have shown prolific suckering after dormant season basal treatments. The differences in suckering may be attributed to the time of application, during active growth, near full leaf expansion.

INTRODUCTION

Basal bark applications can be very effective for controlling treated stems of brush. The most commonly used basal bark treatment is the ester form of triclopyr, applied as either Garlon 4 in a basal oil or the ready-to-use product Pathfinder II. Basal bark applications are commonly made in the dormant season because there is more labor available at this time, and the target stems are more easily accessible when other groundcovers are dormant. Previous studies and operational applications have demonstrated that dormant-season applications of triclopyr ester kill only the stems of the plants above the treated area, and lead to suckering from the root systems of species such as ailanthus, black locust, sassafras, and staghorn sumac. Combining imazapyr or picloram with triclopyr has been suggested as a way to suppress suckering. An evaluation of operational and experimental applications, in which treatment dose is determined by stem caliper and applied by syringe, suggests that the reduction of suckering from the addition of imazapyr or picloram is due to root pickup of herbicide from the soil at the base of the treated stem. In a species with a high stem density such as ailanthus, this could deposit appreciable amounts of herbicide on the soil.

It has been suggested that in combinations of triclopyr and imazapyr, the triclopyr damages phloem tissue so fast that it interferes with the translocation of the imazapyr to the root system. This would account for the top kill and root-suckering following a basal bark application of triclopyr and imazapyr. Imazapyr alone is not an acceptable treatment because it does not provide control of some commonly occurring species. Broader spectrum control is achieved when it is combined with triclopyr.

This study was established to evaluate the effects of imazapyr plus a low rate of triclopyr to determine if it would provide adequate control of ailanthus while allowing translocation of the imazapyr to the root system.

MATERIALS AND METHODS

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% v/v alone, or in combination with Stalker at 3% v/v; and Garlon 4 at 1% v/v plus Stalker at 3% v/v. An untreated check was included. The diluent for each herbicide treatment consisted of a blend of three basal oil products; HyGrade EC with 10 percent emulsifiers, HyGrade EC with 17 percent emulsifiers, and Penevator Basal Oil; at 35, 35, and 30 percent, v/v, respectively. At the time of treatment, ailanthus shoot development was characterized by 7 to 8 fully expanded leaves, plus active expansion and initiation of additional leaves. Treatments were applied with backpack sprayers equipped with a Spraying Systems #5500 Adjustable ConeJet nozzle with a Y-2 tip.

The study area was located on the westbound shoulder of SR 22 near Newport, PA. Treatments were applied to plots averaging 40 ft by 50 ft in size. There were three replications arranged in a randomized complete block design. A 20 by 20 ft sub-plot was located within each plot. Each ailanthus stem within the subplots was numbered and its caliper was measured 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. A few of the smaller trees, usually less than 0.5 inch in caliper, within the subplots were also measured and counted, but not numbered. On September 20, 1999, 109 days after treatment (DAT), ratings of percent canopy reduction of the numbered stems plus the number, height, and caliper of all resprouts were taken. These values were used to determine resprout number, resprout basal area[1/], and total resprout height. The data were subjected to analysis of variance. The untreated check was not included in the analysis.

RESULTS AND DISCUSSION

There were no statistical differences between treatments for any of the measurements recorded. Analysis of covariance indicated that treated stem caliper did not have a significant effect on percent canopy reduction; and original stem number or basal area did not provide a significant effect on resprout number, resprout basal area, or total resprout height. Canopy reduction for the treated stems was 95 percent or greater for all three treatments. Resprouts occurred at a low frequency in all treated plots. The number of resprouts averaged from 8 to 38 per sub-plot, which was similar to or lower than the original stem count.

CONCLUSIONS

All three herbicide treatments were very effective at controlling the treated stems during the season of application, and suppression of resprouts was excellent. Though there was no statistical difference between treatments, there were fewer resprouts in plots receiving the Garlon 4 at 1% plus Stalker. The data to be collected during the summer of 2000 will provide more insight into whether any of the treatments provide an advantage in reducing sprouting from the root system after elimination of the canopy. In the absence of direct comparison, we cannot definitively attribute the reduction in resprouting to differences in physiological activity and translocation due to timing of

[1/] Basal area is the sum of cross sectional area of each of the stems in the subplot.

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. Additional studies will have to be conducted to further evaluate the effects of application rate and timing.

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 those made in the growing season.

Cutting ailanthus in the dormant season and treating the stumps has reduced stump sprouts, but has still resulted in prolific suckering. Dormant season basal bark treatments have also resulted in prolific suckering from uncontrolled root systems.

Where brushing is desired, the ailanthus should be treated first during the preceding growing season. Where dormant season basal bark applications are going to be practiced, the target species should be predominantly non-suckering species.

TABLE 1: Canopy reduction provided by basal bark treatments applied to ailanthus June 3, 1999. Treatments were evaluated on September 20, 1999, 109 days after treatment. The original stem number and resprout number was counted within each subplot. Each value is the mean of three replications.

Herbicide	Application Rate	Canopy Reduction	Original Stem Number	Resprout Number
	(% v/v)	(%)	(#)	(#)
Untreated Check[2/]	- -	0	36	<1
Garlon 4	15	100	46	33
Basal Oil	85			
Garlon 4	15	100	36	38
Stalker	3			
Basal Oil	82			
Garlon 4	1	95	33	8
Stalker	3			
Basal Oil	96			
LSD (p=0.05)		n.s.	---	n.s.

TABLE 2: Summary of treatment effects on ailanthus resprout basal area and cumulative height. Each value is the mean of three replications.

Herbicide	Application Rate	Original Basal Area	Resprout Basal Area	Total Resprout Height
	(% v/v)	($in.^2$)	($in.^2$)	(in.)
Untreated Check[2/]	- -	137	0.00	<1
Garlon 4	15	123	0.98	196
Basal Oil	85			
Garlon 4	15	209	1.78	185
Stalker	3			
Basal Oil	82			
Garlon 4	1	145	0.18	47
Stalker	3			
Basal Oil	96			
LSD (p=0.05)		---	n.s.	n.s.

[2/] The untreated check was not included in the statistical analysis

PRELIMINARY RESULTS:
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 25 percent (v/v) in basal oil. Garlon 4 provided 99 percent canopy reduction during the first growing season. Glufosinate treatments that included Clean Cut (a crop oil concentrate) were rated at 85 and 88 percent canopy reduction, which was not significantly different than the Garlon 4 treatment. Glufosinate diluted in water only was rated at 69 percent canopy reduction, which was significantly lower than the other three treatments. There was essentially no suckering observed, suggesting that basal applications during periods of active growth may be more effective on suckering species.

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[1/]. 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 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

[1/] Brush Control Provided By Low Volume Foliar Applications Using Finale with Translocated Herbicides, Thirteenth Annual Research Report 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. Average canopy reduction was calculated for each plot, and these average values were subject to analysis of variance.

RESULTS

Average canopy reduction and stem number are summarized in Table 1. Garlon 4 in oil provided 99 percent canopy reduction. When glufosinate was applied in a mixture containing 25 percent crop oil concentrate, the average canopy reduction was 88 and 85 percent for the M.U.P. and Finale treatments, respectively. Though the differences from the Garlon treatment are not statistically significant, they do approach the LSD. Finale in water was not as effective as the treatments containing Clean Cut. 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, which was an unexpected result. Our previous experience from treatments made prior to leaf-out was that prolific suckering would occur after basal treatments killed the existing stems. Delaying the applications until active growth occurred may have enhanced translocation of the herbicide in the phloem, particularly the Garlon 4. Final evaluations will be made during the summer of 2000.

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. It will not be apparent until the second growing season whether these initial results will translate into effective control of both the treated stems and the root-suckers. If subsequent evaluations demonstrate effective control, further investigations to attempt to refine the diluent mixture would be warranted.

Further investigation is clearly justified to investigate the influence of application timing on efficacy of basal bark applications. Review of basal bark applications to suckering species in Districts 9-0 and 12-0, in addition to the results of this and the Newport trial reported elsewhere in this report, suggest that growing season applications of basal bark treatments may provide control of the root system of suckering species.

MANAGEMENT IMPLICATIONS

Garlon 4 in basal oil is still clearly the standard for comparison for basal applications. In the absence of final results, as well as labeling, glufosinate as a basal bark treatment must be regarded as strictly experimental.

If subsequent evaluations confirm that growing season applications of basal bark treatments will provide control of the root system of suckering species, then the scheduling of basal bark applications would need to be changed so that most of the work is done during the growing season. This would emphasize the use of contract crews for basal work where suckering species such as ailanthus, black locust, and sumac are prevalent; and limit Department force dormant season applications 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. Canopy reduction values are the mean of three replications.

Treatment	Percent v/v	Number Stems Treated	Percent Canopy Reduction
Garlon 4/Hygrade EC	15/85	397	99
Finale/water	50/50	381	69
Finale/Clean-Cut/water	50/25/25	307	85
M.U.P./Clean-Cut/water	10/25/65	306	88
LSD (p=0.05)			16

BRUSH CONTROL WITH DORMANT SEASON HERBICIDE APPLICATIONS IN JANUARY AND APRIL

Herbicide trade and common chemical names: Accord (*glyphosate*), Arsenal (*imazapyr*), BK 800 (*dicamba plus 2,4-D plus 2,4-DP*), Garlon 4 (*triclopyr*), Vanquish (*dicamba*)
Plant common and scientific names: black cherry (*Prunus serotina*), black locust (*Robinia pseudoacacia*), red oak (*Quercus rubra*), sassafras (*Sassafras albidum*), staghorn sumac (*Rhus typhina*)

ABSTRACT

Two trials were established to compare the efficacy of Accord treatments made at two different times during the dormant season, as well as two experimental adjuvant formulations, MON 59120 and MON 59175. In addition to the Accord treatments, other mixes were also applied at each timing to determine their effectiveness. None of the January treatments provided significant control. The April applications of Accord and/or Arsenal were very effective on black cherry with control ratings ranging from 83 to 100 percent. The treated stems of the suckering species present in the April test, such as staghorn sumac and sassafras, were controlled by Accord, but resprouted vigorously. The addition of Arsenal to the Accord reduced resprouting. Operationally this only provided a one year delay on suckering species, as the sumac and sassafras resprouts were generally as tall as the original treated stems one year following the application.

INTRODUCTION

Dormant season brush control treatments provide vegetation managers a longer operational season, and more contractual flexibility. Currently, the only operationally viable dormant technique is basal bark application, which is useful for low to moderate density brush with stem diameters up to 6 inches Where the brush is small, and high density, such as resprout clusters, basal bark becomes very laborious. A dormant application that could be quickly applied to small, dense brush would facilitate follow-up herbicide applications to mechanical operations. Two trials were established to compare the efficacy of Accord treatments at two different times during the dormant season, as well as compare two adjuvant formulations, MON 59120 and MON 59175. In addition to the Accord treatments other mixes were evaluated, but not for both timings. Treatments made during the January test involved vertically swiping the stem due to the small stem size. The April treatments were directed at the canopy . Targeting select areas of the sprout cluster or individual stems allowed the applicator to apply the treatments quickly. The justification for these application methods was to make it operationally acceptable by reducing the time and effort involved in treating each individual stem.

MATERIALS AND METHODS

The application dates were January 16, and April 21, 1998. The first applications were made to first year resprouts on an electric distribution right-of-way (ROW) maintained by Duquesne Light, near Freedom, PA, on January 16, 1998. These applications included propylene glycol at 10 percent v/v. The targets ranged from 1 to 5 ft in height. Sprout cluster density averaged 1660/ac, and average application volume was 10 gal/ac. Predominant species were black cherry, sassafras, and red oak, with lesser amounts of black locust. Applications were made with a CO_2-powered, hand-held sprayer equipped with a single Spraying Systems #5500 Adjustable ConeJet with an X-6 tip. Plots were 75 ft long, and ranged from 15 to 20 ft wide, and were arranged in a randomized complete block design with two replications.

The April trial was established on an electric transmission ROW maintained by Duquesne Light, near Aliquippa, PA, on April 21, 1998. The brush was second-season resprouts, ranging from 3 to 10 ft in height. Phenology at the time of application ranged from bud swell to 10 percent leaf-out (flowering in sassafras). Applications were made with a CO_2-powered, hand-held sprayer equipped with a single Spraying Systems 1504 flat fan tip, providing an average application volume of 16 GPA. Plots were 32 ft wide, and 31 to 35 ft deep, arranged in a RCBD with two replications. Predominant species were staghorn sumac and sassafras, and black cherry, with lesser amounts black locust, and red oak.

Visual assessments of treatment effect were taken at both sites on August 6, 1998, using a 1 to 4 scale where '1'=no visible treatment effect, '2'=treatment effect, but the plant would recover, '3'=the plant was severely injured and would probably die, and '4'=dead. Percent control was calculated by dividing the number of plants rated '3' and '4' by the total number of plants.

RESULTS AND DISCUSSION

Results for average control at the January site, and black cherry results from the April trial are reported in Table 1. Control from the January treatments was unacceptable, though there appeared to be more activity from Accord or Arsenal, compared to Garlon 4 or BK 800 applied alone (Table 1).

The April treatments appeared to be much more active than the January treatments, as reflected by control of cherry (Table 1). However, sumac and sassafras were the major components of the April site, and control of these species was not acceptable. Visible differences were apparent between the treatments, but they are not reflected in the ratings, as sumac and sassafras were rated a '2' for all plots. Control of existing sassafras stems appeared to be excellent for all Accord based treatments, but root suckering was present in all plots. Treatment differences in sassafras were expressed in the degree of resprouting. Treatments without Arsenal appeared to have a net increase in the number of stems due to prolific suckering. The treatments including Arsenal provided visible reduction of the number of suckers, though effects on the vigor of suckers was not discerned. Failure to count treated stems and suckers eliminates the possibility of quantifying the effect the treatments had on suckering in sassafras. Subsequent work on suckering species will include this data. Control of sumac was variable, with control of the treated stems not as consistent as in sassafras. Quite often, an 'umbrella' effect was created, where the treated stem produced symptomatic foliage only from the uppermost buds. Suckering varied, with an apparent correlation between degree of injury to the treated stems and vigor of suckering. Reasons for the inconsistent control of sumac could include reduced uptake of herbicide due to the heavy pubescence on the new growth.

CONCLUSIONS

These trials reinforce results from previous work which indicated that treatments in late fall/early winter are not as effective as treatments applied closer to bud break. Although cherry was a relatively minor component of the stand, there were enough stems to indicate that Accord alone or combined with Arsenal will provide control.

Control of suckering species is an issue that needs to be resolved. There should be no translocation of a systemic herbicide from a treated stem to the root system early in the season, particularly in young resprouts. At this time of year net carbohydrate movement is upward from stored energy reserves in the roots. A broad spectrum dormant stem treatment effective on suckering species is going to have to include a soil active ingredient, such as Arsenal or Tordon K. This type of mixture should be applied in a manner to both address the more physiologically active tissue at the branch tips, as well as providing a dose at the base of the plant to facilitate root uptake.

Subsequent research should target suckering species, such as tree-of-heaven, sassafras, and black locust; and compare application methods. Application techniques to be compared would be a canopy-only treatment, and a canopy-basal treatment that would treat the canopy as well as direct solution at the base of the plant. The increased activity on sassafras and sumac observed at Aliquippa was likely due to root pick-up from the soil, rather than translocation, as understory reduction was readily apparent in treatments that included Arsenal.

MANAGEMENT IMPLICATIONS

Dormant stem treatments are still not viable operational applications. There were some promising results on control of black cherry. Continued research needs to be performed to see if effective herbicide combinations, application methods, and timings can be isolated to contend with the broad spectrum species found on the roadside.

Table 1: Summary of results from January, and black cherry control from April.

Product	Product Rate	January Trial Average Control	April Trial Black Cherry Control	
	(% v/v)	(%)	[% (no. of stems)]	
Accord	25	35	83	(6)
MON 59120	10			
Accord	25	20	90	(20)
MON 59175	10			
Accord	25	29	100	(19)
Arsenal	0.5			
MON 59120	10			
Accord	25	22	83	(41)
Arsenal	0.5			
MON 59175	10			
Accord	10	41	97	(18)
Arsenal	0.5			
MON 59120	10			
Arsenal	0.5	34	94	(18)
MON 59120	10			
Garlon 4	5	25	not applied	
Arsenal	0.5			
MON 59120	10			
Garlon 4	5	4	not applied	
MON 59120	10			
BK 800	7.5	5	not applied	
Arsenal	0.5			
MON 59120	10			
BK 800	7.5	2	not applied	
Vanquish	5	not applied	25	(14)
Arsenal	0.5			
Nu-Film	1.25			
Vanquish	5	not applied	38	(15)
Arsenal	0.5			
Sil-Wet	1.25			
Garlon 4	8	not applied	78	(18)
Arsenal	1			
Thinvert	91			
Garlon 4	8	not applied	0	(1)
Tordon K	2			
Thinvert	90			
LSD (p=0.05)		n.s.		

BRUSH CONTROL PROVIDED BY DORMANT AND EARLY SEASON FOLIAR APPLICATIONS

Herbicide trade and common chemical names: Accord (*glyphosate*), Arsenal (*imazapyr*), Tordon K (*picloram*)

Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*), black birch (*Betula lenta*), black locust (*Robinia pseudoacacia*), common witch hazel (*Hamamelis virginiana*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), quaking aspen (*Populus tremuloides*) and bigtooth aspen (*Populus grandidentata*)

ABSTRACT

Two trials were established to determine the effectiveness of various combinations of Accord plus MON 59120 alone or plus Arsenal or Tordon K for dormant and early season applications. These were dormant stem applications made from late dormant stage to leaf-out. Both the canopy and base of stems were treated. Several species were evaluated for control including several suckering species. All treatments provided similar control of the treated stems. The addition of at least 1 percent v/v Arsenal or Tordon K was necessary to substantially reduce resprouting of tree-of-heaven. Groundcover damage was observed in both trials and was affected by the target canopy and timing.

INTRODUCTION

Vegetation managers are always looking for treatments that will provide more options and expand the management window. The concept of dormant stem treatments, where herbicide is applied to the bark of the entire plant , potentially provides this desired operational flexibility. A concerns with the dormant stem technique is the amount of spray solution that is deposited off-target due to lack of foliage. To minimize this effect, the preferred application technique is a backpack-based, low volume treatment that is specifically directed at the target stems. Additionally, the preferred target is small brush, particularly young resprouts, which are as dense a target as can be achieved in the dormant season. Recent trials have demonstrated enough efficacy with this approach to justify continued evaluation of the technique. The herbicide of primary interest has been Accord, which is a surfactant-free glyphosate formulation, in combination with the adjuvant MON 59120. This combination has proven effective on species such as poplars, black cherry, ash, and even red and sugar maples. Top growth of suckering species such as staghorn sumac and sassafras has been controlled, but resprouting has been vigorous. These two trials were established to evaluate the control provided by herbicide treatments applied to brush resprouts while dormant, and early in the season prior to the 'full leaf expansion' stage recommended for foliar applications. One site consisted of mixed, mostly non-suckering species; while the second site was almost exclusively ailanthus and black locust resprouts. The soil active herbicides imazapyr and picloram were included in the trial to determine if improved suppression of root suckering could be achieved.

MATERIALS AND METHODS

One trial was located near Irvona, PA, on SR 3014, a secondary road that had been brushed in 1997. This site was populated predominately with 1 to 8 ft. resprouts of black birch, common witch hazel, black cherry, red oak, American beech, and quaking and bigtooth aspen. Plots were 150 by 15 ft., arranged in a randomized complete block design with three replications. The treatments were applied March 29, and May 14, 1999. All species appeared to be dormant on March 29. On May 14, phenology ranged from bud swell to 50 percent leaf-out, with an average of about 20 percent leaf-out. Both applications were made with backpack equipped with a single Spraying Systems #5500 ConeJet and a Y-2 tip. Average application volumes were 11 and 4 gal/ac respectively, for the two dates, and average densities were 1,283 and 1,194 plants/ac, respectively. The four treatments included Accord at 25 percent v/v alone and in combination with Arsenal at 0.25 or 0.5 percent v/v; and Accord at 10 percent plus Arsenal at 1 percent, v/v. All treatments included the adjuvant MON 59120 at 10 percent, v/v.

The second trial was located on a cut slope along SR 22, near Newport, PA. This site was mostly 3 to 10 ft. resprouts of ailanthus, with black locust and scattered black cherry. Applications at the Newport site were made March 22 and May 19, 1999, using a CO_2-powered, backpack sprayer equipped with a single Spraying Systems #5500 ConeJet and a Y-2 tip. Plot size was 20 by 20 ft., arranged in a randomized complete block design with three replications. All species appeared to be dormant on March 22. On May 19, tree-of-heaven had five to six leaves per shoot (compared to 13 to 18 on August 3), and black locust and black cherry were in bloom. Average plant densities at Newport were 3,376 and 4,362/ac, for the March and May applications, respectively. Average application volume for the May application was 9 gal/ac, but data is not available regarding the volume applied in the March application. Treatments included Accord at 25 percent v/v, alone and in combination with Arsenal at 0.5 percent v/v; Accord at 10 percent plus Arsenal at 1 percent v/v; Accord at 10 percent plus Tordon K at 2 percent v/v; and Tordon K at 2 percent plus Arsenal at 1 percent v/v.

Visual ratings of percent canopy reduction for each sprout cluster were taken August 3, and September 14, 1999, for the Newport and Irvona sites, respectively. Counts of root suckers of ailanthus and black locust were also taken at the Newport site. The data were subjected to analysis of variance, and are reported in Tables 1a and 1b.

RESULTS AND DISCUSSION

At Irvona, there were no significant differences between treatments at either application date. Canopy reduction ranged from 73 to 90 percent for the March applications, and 92 to 96 percent for the May application. The May application caused visibly more damage to the herbaceous understory than the March application, but the damage was localized to the immediate vicinity of the treated plants. At Newport, there was no significant difference in ailanthus canopy reduction at either application date, with values ranging from 84 to 96 percent. There was a significant difference in ailanthus resprout counts for the March application, with Accord alone and Accord plus Arsenal at 25 plus 0.5 percent v/v treatments allowing significantly more resprouts than the other treatments (Table 2). The groundcover effects were reversed compared to Irvona, due to the higher stem densities, and fuller canopy at the May application. The herbaceous groundcover was largely eliminated in the March treated plots, particularly those treated with solutions containing at least 1 percent v/v of Arsenal, or Tordon K.

CONCLUSIONS

There was similar efficacy between treatments and timing for all species. Applications including Arsenal at 1 percent v/v or Tordon K improved the suppression of suckers. There was variation in understory damage experienced at both sites. When treating species like tree-of-heaven, which commonly have high stem densities, understory damage is expected with dormant applications using these treatments. Once the trees have leafed out and the spray is intercepted, less understory damage occurs. The opposite is true when treating many other deciduous hardwood species. Most tree species have a more open canopy that allows some of the spray to get past the foliage. As a result, applications made after leaf out are more devastating to the understory that is actively growing at this time.

MANAGEMENT IMPLICATIONS

These treatments can be used from late dormant to leaf-out to control the species mentioned in this report. All were equally effective at controlling the unwanted stems. If treating suckering species, Arsenal or Tordon K should be added to improve control of suckers. The treatments should be made targeting both the canopy and the base of the stems. Earlier trials that targeted just the base were not as effective. Backpack sprayers equipped with either adjustable ConeJet nozzles with an orifice size up to X-6 or Spraying Systems flat fan tips up to size '02' have proven effective at delivering the low volumes needed for this application method.

Table 1: Effect of herbicide treatments applied to a mixed stand of brush resprouts March 29 or May 14, 1999, and evaluated August 3, 1999. Each value is the mean of three replications. This table represents data collected at Irvona, PA.

Treatment	Solution Concentration	Applied 3/29/99 Canopy Reduction	Applied 5/14/99 Canopy Reduction
	(% v/v)	(%)	(%)
Accord	25	90	96
MON 59120	10		
Accord	25	85	95
Arsenal	0.25		
MON 59120	10		
Accord	25	89	92
Arsenal	0.5		
MON 59120	10		
Accord	10	73	93
Arsenal	1		
MON 59120	10		
LSD (p=0.05)		n.s.	n.s.

Table 2: Effect of herbicide treatments applied to Ailanthus resprouts March 22 or May 19, 1999, and evaluated August 3, 1999. Resprout percent is based on number of resprouts compared to original plants. Each value is the mean of three replications. This table represents data collected at Newport, PA.

Treatment	Solution Concentration	Applied 3/22/99 Canopy Reduction	Applied 3/22/99 Resprouting	Applied 5/19/99 Canopy Reduction	Applied 5/19/99 Resprouting
	(%v/v)	(------------------------	%-------------------------		)
Accord	25	96	416	93	171
MON 59120	10				
Accord	25	92	481	84	48
Arsenal	0.5				
MON 59120	10				
Accord	10	87	176	88	56
Arsenal	1				
MON 59120	10				
Accord	10	87	117	90	11
Tordon K	2				
MON 59120	10				
Tordon K	2	86	37	89	6
Arsenal	1				
MON 59120	10				
LSD (p=0.05)		n.s.	196	n.s.	n.s.

ONGOING AILANTHUS MANAGEMENT DEMONSTRATION PROJECT - DISTRICT 8-0

Herbicide trade and common chemical names: Arsenal, (*imazapyr*), Roundup Pro (*glyphosate*), Garlon 3A (*triclopyr*), Garlon 4 (*triclopyr*), Tordon K (*picloram*),
Plant common and scientific names: tree-of-heaven or ailanthus (*Ailanthus altissima*), black locust (*Robinia pseudoacacia*), red maple (*Acer rubrum*), staghorn sumac (*Rhus typhina*)

ABSTRACT

An ongoing Ailanthus management demonstration was initiated with an April basal bark application in 1994, along SR 22 in Perry County. The basal treatment effectively controlled the existing stems but resprouting was prolific. Subsequent late-season low volume foliar applications have continued to reduce the ailanthus size and stem density, and allowed alternate vegetation to re-establish. However, it is apparent that only repeat applications will keep the corridor from being reinfested with ailanthus at levels equal to those at the beginning of the demonstration.

INTRODUCTION

Tree-of-heaven, also known as ailanthus, is an exotic, invasive tree species that is fast-growing and weak-wooded. Management of this species along roadsides should be a priority because it is a threat to fall into the roadway, and it is likely to move onto adjacent properties. A large population of ailanthus has become established along SR 22 in Perry County, between Millerstown and the SR 11/15 interchange. Much of this corridor was extensively disturbed during the construction process, providing an ideal setting for colonization by this opportunistic species. The ailanthus is in all stages of infestation, from dense groves of trees 50 ft tall, to pencil-thick root sprouts spreading into poorly vegetated, acidic subsoils on cut and fill slopes. This area provides an ideal setting to evaluate and demonstrate long-term management practices.

The demonstration was initiated on April 27, 1994 when a basal bark application was made to a two mile stretch of roadside. Since then low volume foliar applications have been made in 1994, 1996, 1998 and 1999. After a brief review of the initial efforts at establishing the demonstration this report provides a detailed account of the low volume foliar applications made since 1996 and describes observations made during that same period.

MATERIALS AND METHODS

On April 27, 1994, a basal bark application was made to ailanthus growing in a two mile stretch of median of SR 22 between Millerstown and Newport (SR 34 interchange), plus the Newport entrance and exit ramps. In addition, a few stems of red maple, black locust, and staghorn sumac were also treated. On August 19 and 23, 1994, a low volume foliar treatment was made to this same site, as well as the eastbound shoulder, to control prolific resprouts and uncontrolled stems from the basal bark application. Another low volume foliar application was made to the median area on October 1, 1996, to control any root sprouts or uncontrolled stems from the applications made in 1994. The eastbound shoulder area treated in August 1994 was not retreated. Treatments made in 1994 and 1996 are described in The Roadside Vegetation Management Eleventh Year Research Report.

Observations of the area were made August 19 and September 2, 1994; May 23 and October 3, 1995; and October 9, 1997.

On September 9, 1998 another low volume application was made to control ailanthus resprouts that emerged since the 1996 visit. A total of 9 gallons of solution was applied over the area. A combination of 1% (v/v) Tordon K plus either 3% (v/v) Garlon 3A or 2.25% (v/v) Garlon 4, and 0.10% (v/v) QwikWet 357 was used. The application was made in a total of 3.5 man hours by personnel equipped with backpack sprayers containing Spraying Systems #5500 adjustable ConeJets with Y-2 tips.

On August 17, 1999 an additional follow-up low volume foliar treatment was applied. A total of 16 gallons of solution was applied in 13.5 man hours. A mixture containing 5% (v/v) Roundup Pro, 0.5% v/v Arsenal, and 0.25% v/v Clean Cut surfactant was used. Again the personnel were equipped with backpack sprayers containing Spraying Systems #5500 adjustable ConeJets with either Y-2 or X-4 tips.

Table 1 summarizes the solution used and man hours required to treat the median portion of the demonstration area.

RESULTS

Basal bark applications require access to the lower 12 to 18 inches of the stem and are normally conducted during the dormant season from November to March. However, a continuous snow and ice cover from mid-December 1993 through March 1994 delayed all of the basal bark applications until April. At the time of this basal bark application, the ailanthus and other target tree species were in the late stages of bud break. By August 19, the ailanthus and sumac stems treated were controlled; however, vigorous resprouting occurred from both species; therefore, there was a need for the follow-up foliar treatment.

Since the initial treatments made to the site from 1994 to 1996, a reduction in the amount of ailanthus at the site is evident as the solution used and the man hours required is continually decreasing, and vegetation such as crownvetch, as well as naturalized species such as goldenrods and briars, is filling in the areas vacated by the ailanthus. A factor contributing variability to the applications is a median section with steep, barely traversable terrain as well some vertical cuts. There are scattered ailanthus in areas difficult to reach, and different applicators vary in the time and effort expended to attempt to control these stems. The results of the 1998 foliar application were not particularly satisfactory, especially in contrast to previous results. It should be noted that 1998 was a drought year and the ailanthus may have been under drought stress at the time of application. Without side by side comparisons, it cannot be determined if the reduction in control was caused by the drought, the herbicide, or the method of application.

CONCLUSIONS

The basal bark and low volume foliar applications have been successful in controlling the growth and spread of the ailanthus in the treatment area. However, resprouting has occurred and because the area is completely surrounded by other thriving ailanthus colonies, seeds are continually blown onto the site. Therefore, continued treatment will likely be required to manage this species within the test area.

Observations will continue to be made in the upcoming years and the site will be maintained with all necessary treatments. It is expected that the amount of solution, man hours required, and the frequency of follow-up treatments will continue to show a downward trend over the duration of this demonstration.

Table 1: Summary of amounts of solution used and man hours required for the treatment of the median area near Newport, PA.

Application	Solution Used (gallons)	Man hours
Basal Bark (1994)	12	15
Low Volume Foliar (1994)	25.5	23
Low Volume Foliar (1996)	18	18
Low Volume Foliar (1998)	9	3.5
Low volume Foliar (1999)	16	13.5

EVALUATION OF HERBICIDE COMBINATIONS FOR CONTROLLING CANADA THISTLE IN TURFGRASS

Herbicide trade and common chemical names: Vanquish (*dicamba*); Exceed (*primisulfuron* plus *prosulfuron*), Northstar (*primisulfuron* plus *dicamba*); Escort (*metsulfuron*), Oust (*sulfometuron*), Plateau (*imazapic*)

Plant common and scientific names: Canada thistle (*Cirsium arvense*), crownvetch (*Coronilla varia*), hard fescue (*Festuca brevipila*), and creeping red fescue (*Festuca rubra* ssp. *rubra*). tall fescue (*Festuca arundinacea*)

ABSTRACT

Escort, and a wide variety of herbicide combinations were evaluated to determine their efficacy on Canada thistle and the tolerance of two fine fescues and 'Kentucky 31' tall fescue to them. Treatments including Escort provided excellent control of existing Canada thistle, but did not prevent resprouting. Escort alone, or in combination with Vanquish, did not injure the fine fescues. The combination of Escort plus Plateau injured the fine fescues. Exceed alone provided poor control of existing Canada thistle initially, but at 104 DAT control was very good. It caused slight injury to the fine fescues. The combinations of Exceed and Vanquish provided better initial control and excellent control of treated thistle 104 DAT. It also caused slight injury to the fine fescues. Exceed plus Plateau caused unacceptable injury to the fine fescues. Northstar provided good control of existing Canada thistle, and caused only slight injury to the grasses. Oust plus Vanquish provided excellent control of existing thistle, but severely injured the grasses. None of the treatments reduced the number of resprouts compared to the untreated control. In the Vanquish plus Escort treated plots the percent resprouting compared to initial stem numbers was 39 percent. Previous, similar trials at this location have shown resprouting percentages of less than five percent. Conditions were very dry at the time of application and may have contributed to the limited efficacy.

INTRODUCTION

Canada thistle is on Pennsylvania's Noxious Weed list, and is a common weed along Pennsylvania's roadsides. It is especially prevalent in stands of crownvetch**.** Since it is extremely difficult to selectively control Canada thistle in crownvetch, it is becoming more common to non-selectively control stands of crownvetch and Canada thistle and replant the treated areas with grasses. This study was designed to compare the efficacy and crop tolerance of two new premixed products containing the sulfonylurea herbicide primisulfuron, and several other herbicide combinations, to the control and crop tolerance provided by Escort plus Vanquish. Two of the herbicides that were included in this trial, Plateau and Oust, would not normally be used for broadleaf weed control in cool season turf, but were due to their similar mode of action to primisulfuron.

MATERIALS AND METHODS

The treatments included in the study are listed in Table 1. They were applied June 15, 1999 to Canada thistle in a stand of hard fescue and creeping red fescue established in September, 1996, at the Park Avenue interchange of SR 322, Centre County. The site was the infield of the onramp to

SR 322 W, on a slope with an approximately 25 percent slope and easterly aspect. Conditions were dry, with only 2.2 inches of rain falling in the area from May 1 to the application date. Canada thistle was at late vegetative to early bud stage, up to 36 inches tall. Average Canada thistle height was 24 inches. Treatments were applied in 40 GPA to plots that were 6 ft by 15 ft. The application was made using a CO_2 powered backpack sprayer and a hand-held boom equipped with XR 8004 VS tips and operating at 24 psi. Thistle stand counts were taken the day of treatment. Injury to Canada thistle and fine fescue were taken July 19, 34 days after treatment (DAT) and August 6, 1999 (52 DAT), using a scale of 0 to 10 as a simplified percent injury scheme. The Canada thistle injury was observed as a reduction or elimination of seed set, basal foliar necrosis, necrotic lesions on stems, stem twisting and leaf curling. Turf injury was evaluated for discoloration and stand reduction. Counts of uncontrolled original stems, new sprouts and fine fescue reduction were taken September 27, 1999 (104 DAT).

An identical trial was applied to a stand of 'Kentucky 31' tall fescue on June 9, 1999. This trial was established to determine the phytotoxicity of the treatments to tall fescue. The study site was located at the Landscape Management Research Center, University Park, PA. Turf injury, estimated by discoloration, was rated on June 18 and August 4, 1999, 9 and 56 DAT, respectively. Discoloration was rated on a scale of 0 to 10 where '0' indicates no effect and '10' is dead turf.

RESULTS

Early ratings at 34 and 52 DAT indicated that treatments containing Exceed plus Vanquish; Escort alone or in combination; and Oust plus Vanquish resulted in the greatest injury to the Canada thistle (Table 1). Exceed alone at 1 or 2 oz/ac, and the Northstar treatment, were ineffective. At 104 DAT all treatments provided good to excellent control of Canada thistle stems present at the time of application (Table 2). However, it was evident that only above ground tissue was killed, as the amount of resprouting from rhizomes was unacceptable for all treatments. Treatments that contained Plateau or Oust caused the most injury to the fine fescue. The Oust plus Vanquish in particular caused significant turf injury with 92 percent stand reduction by 104 DAT.

In the phytotoxicity trial on Kentucky 31 tall fescue, the Oust plus Vanquish combination was rated for discoloration at 2.0 at 9 DAT, and 7.7 at 56 DAT. The only other treatment to cause observable discoloration was the Exceed plus Plateau combination, rated at 1.0 at 56 DAT.

CONCLUSIONS

Exceed and Northstar did not demonstrate any utility for broadleaf weed control in turfgrasses growing in roadside conditions, even when compared to the disappointing results from the designated standard treatment, Escort plus Vanquish. Further evaluation of these materials for general roadside use is not warranted. Arguably, these products could find a fit in the Department's program only if they demonstrated an unusually high efficacy against some other problem species.

MANAGEMENT IMPLICATIONS

This trial was useful in demonstrating the influence of environmental conditions on herbicide efficacy, and reinforces the commonly held belief that systemic herbicide treatments should be avoided or delayed during stressful environmental conditions.

Table 1: Response of fine fescue and Canada thistle to herbicide treatments applied June 15, 1999, and evaluated July 19 and August 6, 1999, 34 and 52 DAT, respectively. Canada thistle and fine fescue injury were rated using a scale of 1 to 10 in which '0' indicates no injury, '5' represents moderate injury, and '10' complete necrosis. Values are the means of three replications.

Treatment	Application Rate	Canada thistle Injury 34 DAT	Canada thistle Injury 52 DAT	Fine Fescue Injury 34 DAT	Fine Fescue Injury 52 DAT
	(oz/ac)	(0-10)		(0-10)	
untreated	- - -	0.0	0.0	0.0	0.0
Escort	0.33	7.2	8.7	1.0	1.3
Escort Vanquish	0.33 24	8.2	9.0	1.3	1.0
Escort Plateau	0.33 4	8.0	9.0	5.7	4.3
Exceed	1	2.7	3.7	1.3	1.7
Exceed	2	3.0	2.0	2.3	1.7
Exceed Vanquish	1 24	6.0	6.0	2.0	1.7
Exceed Vanquish	2 24	7.2	6.0	2.3	1.3
Exceed Plateau	1 4	4.3	5.3	5.0	5.0
Exceed Plateau Vanquish	1 4 16	6.0	5.3	4.7	4.7
Northstar	5	3.5	3.0	1.7	1.7
Oust Vanquish	3 24	6.7	8.0	6.0	8.7
LSD (p=0.05)		2.5	3.4	1.8	1.7

Table 2: Response of fine fescue and Canada thistle to herbicide treatments applied June 15, 1999, and evaluated September 27, 1999, 104 DAT. Canada thistle control is the percentage of treated stems that were killed, and Canada thistle resprouting percent is based on the number of new sprouts counted September 27, compared to the original count on June 15. Fine fescue reduction values are the means of three replications, the Canada thistle data is the mean of two replications.

Treatment	Application Rate	Fine Fescue Reduction	Canada Thistle Control	Canada Thistle Resprouting
	(oz/ac)	(------------------	percent	------------------)
untreated	- - -	0	58	56
Escort	0.33	2	100	66
Escort Vanquish	0.33 24	0	100	39
Escort Plateau	0.33 4	28	100	104
Exceed	1	0	90	52
Exceed	2	10	89	62
Exceed Vanquish	1 24	0	96	60
Exceed Vanquish	2 24	5	99	46
Exceed Plateau	1 4	23	78	164
Exceed Plateau Vanquish	1 4 16	13	93	108
Northstar	5	3	88	105
Oust Vanquish	3 24	92	97	118
LSD (p=0.05)		17	15	67

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*)
Plant common and scientific names: Canada thistle (*Cirsium arvense*), crownvetch (*Coronilla varia*), flatpea (*Lathyris sylvestris*), hard fescue (*Festuca brevipila*), creeping red fescue (*Festuca rubra* ssp. *rubra*), annual ryegrass (*Lolium multiflorum*)

ABSTRACT

A study was initiated in April, 1998, in which three operational sequences to convert Canada thistle-infested crownvetch to PennDOT's Formula L seed mix were compared. 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 consisted of 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. On June 10, 1999, 58 weeks after trial initiation, Formula L cover for SEQ1, SEQ2, and SEQ3 was 68, 40, and 20 percent, respectively. These differences are likely transient, and due primarily to the difference in age of stand between SEQ1 and the other sequences (58 weeks compared to 38 weeks), and the amount of surface residue in SEQ3 compared to SEQ2, which probably delayed establishment.

INTRODUCTION

A chronic condition on 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 to 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 availability of selective, systemic herbicides.

This trial is an investigation of the conversion, or 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[1/] . This trial compares the effect of

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

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 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 annual maintenance program to prevent the reestablishment of the problem vegetation. This study investigates the effect of the order of the first three steps on the success of the establishment of the grass cover.

MATERIALS AND METHODS

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 ConeJet with X-6 tip. All applications were mixed to be applied at 20 gal/ac. Formula L seed mixture, 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. 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 August 31, 1998. Average vegetative cover was 95 percent, 78 percent from crownvetch. Spring growth of Canada thistle had senesced, and 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, and June 10, 1999.

RESULTS AND DISCUSSION

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, at the time 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. Canada thistle cover at this time was 12, 2, and 6 percent, respectively. Canada thistle control provided by the primary treatment was disappointing in SEQ1, and was probably due to the application being made too early. 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 dominant 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 seeded the same day, 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.

CONCLUSIONS

At this early stage, it appears all three sequences provided an effective conversion from thistle-infested crownvetch to Formula L. The effect of stand age on the grass cover should be minimal by the end of the 2000 growing season, and all plots should have a well-established stand of Formula L. Reducing vegetative residue was a key factor in establishment, as shown by the significantly higher ratings for May-treated SEQ2 compared to August-treated SEQ3 the following spring. SEQ1 may need to be modified. The seed needs to be applied early in the spring, but the herbicide application to the thistle and crownvetch should not be made until all of the thistle has emerged. If the grass seed is applied in early spring, and the herbicide applied in late spring, the non-selective herbicide glyphosate would need to be replaced in the primary herbicide treatment with a selective matierial.

MANAGEMENT IMPLICATIONS

These results are preliminary, but suggest that 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. Vegetative cover characteristics of three operational sequences for the conversion of Canada thistle-infested crownvetch to Formula L.

Treatment	Primary Treatment	Follow-up Treatment	Formula L Seeding	Vegetative Cover 8/31/98	Formula L Cover 8/31/98	C. Thistle Cover 8/31/98	Formula L Cover 6/10/99	C. Thistle Cover 6/10/99
				(---------------------------------%			--------------------------------)	
SEQ1	4/30/98	8/31/98	4/30/98	91	45	10	68	6
SEQ2	5/28/98	8/31/98	9/13/98	25	- -	1	40	2
SEQ3	8/31/98	6/10/99	9/13/98	97	- -	2	20	12
LSD (p=0.05)							34	n.s.

COMPARISON OF SPRING-APPLIED HERBICIDES FOR CONTROL OF GIANT KNOTWEED DURING ROADSIDE RENOVATION

Herbicide trade and common chemical names: Vanquish (*dicamba*), Transline (*clopyralid*), Tordon K (*picloram*), Roundup Pro (*glyphosate*), Arsenal (*imazapyr*), Plateau (*imazapic*).

Plant common and scientific names: Japanese knotweed (*Polygonum cuspidatum*), giant or Sakhalin knotweed (*Polygonum sachalinense*), hard fescue (*Festuca brevipila*), red fescue (*Festuca rubra* ssp. *rubra*), annual ryegrass (*Lolium multiflorum*), common pokeweed (*Phytolacca americana*), giant foxtail (*Setaria faberi*i), American burnweed (*Erechtites hieraciifolia*), and crownvetch (*Coronilla varia*).

ABSTRACT

Ten herbicide combinations, applied in the spring, were tested for control of giant knotweed at two locations. These spring treatments were then followed in the fall by a uniform spray over both sites and seeded to Formula L, as fine fescue seed mixture. This is one of several operational sequences available to convert either Japanese or giant knotweed to a grass mixture. In the fall of the first year all treatments provided 59 to 100 percent control. By the following season one site was eliminated by construction activity and the other had plots with significantly reduced stands of giant knotweed with cover ranging from 3 to 26 percent. An acceptable stand of fine fescue had become established at this site despite the severe drought conditions prevalent at the time.

INTRODUCTION

Two field trials were established to evaluate the efficacy of various herbicide combinations for the control of giant knotweed. The herbicide combinations were evaluated as part of a renovation scheme calling for spring primary treatments, with follow-up treatments and seeding of a grass mixture occurring in late summer. Giant knotweed and Japanese knotweed are herbaceous, perennial species growing in dense colonies reaching heights of 10 ft. When growing close to the road, these species cause reduction of sight distance and damage the road surface by growing up through the asphalt at the road edge. Making the primary treatment in the spring before the plants reach full height would make the application easier.

MATERIALS AND METHODS

The trials were established on April 30, 1998, in Doylestown, PA, on a north-facing fill slope; and May 14, 1998, near Leechburg, PA, on a fill shoulder above the east bank of the Kiskiminetas River. Herbicides included in the ten combinations were Transline, Vanquish, Roundup Pro, Plateau, Arsenal, and Tordon K (Table 1). Treatments at the Doylestown site were applied using a CO_2-powered, hand-held boom sprayer, equipped with Spraying Systems XR 8002 VS flat fan tips. The mixtures were applied at 20 gal/ac at 25 psi to 12 by 20 ft. plots arranged in a randomized complete block design with three replications. Giant knotweed ranged from just emerging to 3 ft. in height, with an average canopy height of 20 to 28 inches. Treatments at the Leechburg site were applied using a CO_2-powered, hand-held sprayer with a two-nozzle swivel valve equipped with a Spraying Systems 1504 flat fan and a #5500 Adjustable ConeJet with an X-6 tip. The plots were

46 ft. long, while the depth varied from 10 to 16 ft. The experimental design was a randomized complete block with two replications. At treatment, the knotweed was 5 to 7 ft. high.

At Doylestown, visual ratings of percent necrosis were taken May 28, and percent control and cover were taken August 31, 1998. At Leechburg, ratings were taken July 2 for percent control, and September 1, 1998 for percent control and cover. Immediately following the second rating, both sites were oversprayed with Roundup Pro plus Tordon K, at 128 plus 16 oz/ac. A mixture of hard fescue, creeping red fescue, and annual ryegrass was overseeded to Doylestown on September 14, and Leechburg on September 15.

On June 10, 1999 the Doylestown site was again rated for percent knotweed, fine fescue, and total cover. The Leechburg site was reviewed on November 5, 1998 and June 24, 1999. During the June 24th visit ratings of knotweed, fine fescue, and total cover were recorded.

RESULTS AND DISCUSSION

There was no significant difference between any of the treatments at the Leechburg site. Percent control of giant knotweed on September 1 ranged from 70 to 100 percent, and percent ground cover ranged from 1 to 19 percent (Table 1). Review of the Leechburg site on November 5, 1998 showed excellent control of the knotweed stand. This visit followed the overspray and reseeding done to this site in September. Establishment of the fine fescue was spotty. This was due in large part to the poor soil conditions, significant amount of leaf litter, and lack of rainfall. Where the soil was boggy, due to depressions and soil type, and leaf litter minimal the establishment of fine fescue was excellent. The site was evaluated again on June 24, 1999. It was discovered that the site had been severely disrupted by construction activity. It was nearly impossible to distinguish the construction impacts from the control or effects on fine fescue establishment.

At the Doylestown site, the Roundup Pro-based treatments provided 59 to 76 percent control on August 31, while the treatments with growth-hormone type herbicides as the primary ingredient provided 86 to 99 percent control. Ground cover ratings ranged from 32 to 80 percent (Table 1). Common pokeweed was the predominant species colonizing the study area. Other species included giant foxtail, American burnweed, and crownvetch. By June 10, 1999 the site still had significant knotweed stand reduction. Knotweed cover ranged from 3 to 26 percent. Fine fescue had become established throughout the study area despite drought conditions experienced during the 1999 growing season. Cover from fine fescue ranged from 22 to 43 percent for the treatments.

CONCLUSIONS

None of the treatments will provide complete control of giant knotweed. Annual visits to touchup persistent resprouts is necessary for long term management of this species. The positive results provided by several of the treatments at both sites, at two different growth stages, indicates that roadside managers may have several options in the management of giant knotweed.

MANAGEMENT IMPLICATIONS

All of the treatments tested in this study will provide acceptable control of giant knotweed when applied in the spring. Followup treatments are a critical and necessary part of the management of this species. Establishing grasses in areas infested with giant knotweed provides a cultural control method and offers competition against the inevitable knotweed resprouts. With persistent, annual treatments and the establishment of a competitive grass stand the Roadside Manager will be able to keep undesirable knotweed populations under control.

Table 1. Summary of first and second season response of giant knotweed to herbicide treatments applied April 30, 1998, in Doylestown, PA. Percent groundcover and fine fescue (FF) cover are also reported. Summary of first year response of giant knotweed and groundcover to herbicide treatments applied May 14, 1998, in Leechburg, PA. All ratings were taken visually. Values for the Doylestown site are a mean of three replications. Values for the Leechburg site are a mean of two replications.

		Doylestown					Leechburg		
		May 28	Aug 31		Jun 10, 1999		Jul 2	Sep 1	
Product	Application Rate	Knotweed Necrosis	Knotweed Control	Ground Cover	Knotweed Control	FF Cover	Knotweed Control	Knotweed Control	Ground Cover
	(oz/ac)	(----------	----------	----------	----------	%	----------	----------	----------)
Vanquish Transline	96 8	97	88	80	5	26	73	82	19
Vanquish Transline	48 12	96	95	80	3	30	83	96	5
Tordon K Transline	64 8	98	99	32	5	37	73	92	7
Roundup Pro Transline	128 12	52	75	56	20	22	55	72	7
Roundup Pro Tordon K	128 32	88	76	60	24	43	93	98	6
Roundup Pro Arsenal	128 16	62	60	73	6	27	70	96	3
Roundup Pro Plateau	128 12	63	59	70	9	23	45	70	18
Transline Arsenal	12 16	59	86	48	26	37	60	96	4
Tordon K Arsenal	32 16	83	88	65	19	42	97	99	1
Vanquish Tordon K	48 32	86	86	55	4	43	100	100	2
LSD (p=0.05)		n.s.	25	22	n.s.	n.s.	n.s.	n.s.	n.s.

COMPARISON OF REHABILITATION SEQUENCES FOR JAPANESE AND GIANT KNOTWEED INFESTATIONS

Herbicide trade and common chemical names: Vanquish (*dicamba*) and Transline (*clopyralid*)
Plant common and scientific names: Japanese knotweed (*Polygonum cuspidatum*), giant or Sakhalin knotweed (*Polygonum sachalinense*), hard fescue (*Festuca brevipila*), red fescue (*Festuca rubra* ssp. *rubra*), and annual ryegrass (*Lolium multiflorum*)

ABSTRACT

Four operational sequences to convert roadside sites infested with Japanese knotweed and giant knotweed to a grass mixture were compared. The four sequences were developed by varying the order of a primary herbicide treatment, grass seeding, and a follow-up herbicide treatment. Sixteen months after initiation of the trial, three sequences featuring primary treatment in the spring of the first year provided at least 60 percent grass cover, and less than 10 percent 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 grass cover. A second trial on Japanese knotweed in a highway interchange complex in southwestern PA was largely unsuccessful due to poor Japanese knotweed control.

INTRODUCTION

Japanese and giant knotweeds are stout, erect, herbaceous perennial plants that commonly grow to heights of 7 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[1/]. 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 monocultures, seeding of treated areas with a desirable species should be planned as part of the operation. Also, since it is extremely difficult (impossible?) to eradicate an established stand of knotweed with a single application, particularly when little soil-active residue can be tolerated, follow-up treatments will be required. The species seeded must be tolerant of the follow-up herbicide treatment.

The knotweeds are sensitive to the broadleaf specific herbicides, so grasses work best as replacement vegetation for the knotweeds. 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 that it is most sensitive to the herbicides, and the grasses must be seeded in a season that is favorable for its germination and growth. The objective of this study was to compare four rehabilitation sequences designed to convert stands of knotweed to a mixture of low growing grasses.

[1/] 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.

MATERIALS AND METHODS

Two sites were selected for the study; a giant knotweed infestation near Doylestown, Bucks County, PA; and a Japanese knotweed infestation near Etna, Allegheny County, PA. 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 for both sites.

The grass used in the study was PennDOT's 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.

The Doylestown site was located on a fill slope originally seeded to crownvetch along SR 611. 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.

The Etna site was located in the interchange complex of SR 8 and SR 28, near the north bank of the Allegheny River. Each of the three replications were located in separate stands of Japanese knotweed. Average plot size was 1020 ft^2. Two of the knotweed patches were undisturbed, while the third was located at the convergence of two on-ramps and historically has been cut down two to three times per year. The P/S/F2 sequence plots were cut to a height of about 1 ft. on May 14 in all three replications, to simulate the mowing that untreated knotweed would otherwise receive where sight distance would be compromised. At study initiation on April 15, 1998, knotweed was already 3 to 4 ft. in height in the undisturbed areas. The canopy was still somewhat open as Japanese knotweed shoots appear to elongate more before leaf expansion, compared to giant knotweed. When the primary herbicide treatments were made to the S/P/F, P=S/F, and P/F/S sequences on May 14, 1998, the knotweed ranged from 6 to 8 ft. in the undisturbed areas, and 2.5 to 6 ft. in the on-ramp area. The previously cut knotweed in the P/S/F2 plots was 5 to 6.5 ft. on September 1, 1998.

RESULTS AND DISCUSSION

There was considerable contrast in the outcome between the two sites. At Doylestown, all four sequences provided 93 to 97 percent reduction of 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 fall following the seeding, and 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 an 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.

The Japanese knotweed at the Etna site was not satisfactorily controlled, particularly in the undisturbed areas, and the grass mixture apparently never had an opportunity to establish. Knotweed in the undisturbed stands was reduced in height by about 20 percent compared to the height at treatment on May 14, 1998, but provided greater than 90 percent cover. In the on-ramp area, which was somewhat open to begin with, cover from the grass mixture was 90 to 95 percent for the S/P/F, P=S/F, and P/F/S sequences on June 24, 1999, 14 months after study initiation. Knotweed cover averaged 25 percent for these three sequences, and retreatment was definitely needed. An integral element of any invasive species rehabilitation project is continued maintenance after the desired replacement species has been established.

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

CONCLUSIONS

The results from Doylestown, 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. Japanese knotweed, on the other hand, has been more difficult to control. The experiences in Etna are comparable to those in Wilkes-Barre in 1994 (field day demonstration), and Hellertown, Northampton County (page 61, this report) where control of Japanese knotweed with Vanquish and Transline was unsatisfactory, regardless of whether the treatments were applied in the spring or fall. Previous efforts to identify effective herbicide combinations and applications were conducted on giant knotweed, and the results have not translated well to Japanese knotweed. A similar line of investigation will need to be pursued targeting Japanese knotweed.

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 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 for the Doylestown and Etna sites. In the sequence codes, 'P' indicates primary herbicide treatment, 'F' follow-up herbicide treatment, and 'S' seeding, and '=' indicates the two operations occurred during the same site visit.

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

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. 1 Summary of 1999 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
	(-----------------------------------%------------------------------------)			
S/P/F	4	63	7	60
P=S/F	5	64	7	61
P/F/S	6	65	7	70
P/S/F2	20	26	3	18
L.S.D. (p=0.05)	4	22	NS	27

EVALUATION OF OASIS AND SAHARA FOR TOTAL VEGETATION CONTROL UNDER GUIDERAILS

Herbicide trade and common chemical names: Karmex (*diuron*), Oasis (*imazapic + 2,4-D*), Oust (*sulfometuron*)**,** Pendulum 3.3EC (*pendimethalin*), Roundup Pro (*glyphosate*), Sahara (*diuron + imazapyr*),

Plant common and scientific names: birdsfoot trefoil (*Lotus corniculatus*)., crownvetch (*Coronilla varia*), yellow toadflax (*Linaria vulgaris*), annual dropseed (*Sporobolus vaginiflorus*), and common ragweed (*Ambrosia artemisiifolia*).

ABSTRACT

On a site on which birdsfoot trefoil was the predominant species, plots treated with Oust at 3 plus Karmex at 128 plus Roundup Pro at 48 oz/ac were rated as having the least amount of vegetative cover at 36 and 70 days after treatment. Roundup Pro alone at 128 oz/ac, and Oasis at 12 plus Karmex at 128 oz/ac, provided control comparable to the Oust, Karmex, Roundup Pro combination. The control provided by these three treatments could be considered to be marginally acceptable on an operational scale. None of the other treatments provided an acceptable level of control. When total vegetation was broken down into cover provided by birdsfoot trefoil and cover provided by other species, it was found that birdsfoot trefoil was not effectively controlled by any combination. The best control of birdsfoot trefoil was provided by the same three treatments previously mentioned. Oasis plus Karmex at 12 plus 128 oz/ac provided significantly better reduction of total cover and birdsfoot trefoil than Sahara at 160 oz/acre, which contains the same rate of Karmex, suggesting that imazapic plus 2,4-D ester is more active than imazapyr on the species present. The resilience of birdsfoot trefoil after treatment was disconcerting, though it was a confirmation of results from a similar trial in 1998[1/]. Species other than birdsfoot trefoil were controlled equally well by all treatments.

INTRODUCTION

Legumes such as crownvetch and birdsfoot trefoil are commonly used in seed mixtures planted along roadsides. Though attractive plants in their place, they can become undesirable weeds when growing under and over guiderails. In previous testing on sites without a lot of weed pressure from legumes, the combination of Plateau plus Karmex was quite effective[2/], but when applied to guiderails infested with birdsfoot trefoil, the combination was largely ineffective.

Oasis is an herbicide pre-mix containing 2 lbs/gal imazapic acid, the active ingredient in Plateau, and 4 lbs/gal 2,4-D ester. This combination was developed to provide additional postemergence activity to Plateau, and improve control of legumes. To evaluate the effectiveness of the 2,4-D ester in the mixture, Oasis was combined with two rates of Karmex, and compared to a standard treatment of Oust plus Karmex plus Roundup Pro. When compared to Sahara at 160 oz/ac, the

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[1/] Evaluation Of Plateau And Sahara For Total Vegetation Control Under Guiderails, Thirteenth Annual Research Report, pages 37-40

[2/] Evaluation Of Plateau For Total Vegetation Control Under Guiderails, Twelfth Annual Research Report, pages 20-21.

combination of Oasis plus Karmex at 128 oz/ac demonstrated the contribution to control provided by the Oasis, as both treatments contained the same amount of diuron.

MATERIALS AND METHODS

The test area selected was a guiderail near University Park, PA that was heavily infested with birdsfoot trefoil . Treatments were applied to 5 by 25 ft plots on May 26, 1999. The study was arranged in a randomized complete block design with three replications.

Oasis was applied at 12 oz/ac in combination with Karmex at 96 or 128 oz/ac, or Pendulum 3.3EC at 154 oz/ac. Sahara was applied alone at rates of 106 and 160 oz/ac. Sahara was also applied at 88 oz/ac in combination with Oust at 1 oz/ac, and at 53 oz/ac with Oust at 1 oz/ac and Karmex at 72 oz/ac. Roundup Pro was applied alone at 128 oz/ac, and at 48 oz/ac in combination with Oust at 3 oz/ac plus Karmex at 48 oz/ac. The Roundup Pro, Karmex, Oust combination was considered the current PennDOT standard guiderail treatment. An untreated check was also included.

The treatments were applied using a CO_2-powered hand held sprayer equipped with a single Spraying Systems OC-12 spray tip. The equipment was calibrated to deliver 40 GPA at 34 psi. The percent of the area treated that was covered by birdsfoot trefoil, and the percent covered by other weed species, were estimated on May 25, the day prior to treatment; July 1, 36 days after treatment (DAT); and August 4, 70 DAT. The predominant weed species at the site were birdsfoot trefoil, crownvetch, yellow toadflax, annual dropseed, and common ragweed.

RESULTS AND DISCUSSION

There were no significant differences in total vegetative cover, birdsfoot trefoil cover, or cover from other species at the initiation of the study (Table 1). At 36 and 70 DAT, all of the treatments except Oasis plus Pendulum resulted in a similar reduction in cover of the other species compared to the untreated control. At 70 DAT plots treated with the Oasis plus Pendulum had the same cover of other species as the untreated control.

At 36 DAT all of the treatments reduced the total cover of weeds compared to the control. Since there was no difference in the cover provided by the other weeds, all of the differences were primarily due to the differences in birsfoot trefoil cover. The treatments that provided the best control of birdsfoot trefoil, and in turn the best overall control, were Oust/Karmex/Roundup Pro, the two Oasis plus Karmex treatments, and Roundup Pro alone.

At the final rating 70 DAT, all of the treatments except Oasis plus Pendulum and Sahara plus Oust resulted in a reduction in total weed cover compared to the untreated control. Again, the treatments that provided the best control of birdsfoot trefoil, and in turn the best overall control, were Oust/Karmex/Roundup Pro, Oasis plus the high rate of Karmex, and Roundup Pro alone. These same three treatments were the only three treatments to have significantly less trefoil cover than the untreated check.

Several treatments were ineffective, receiving cover ratings so high that they were not significantly different from the untreated check. These treatments included Oasis plus Pendulum;

and Sahara plus Oust. Sahara at 160 oz/ac was rated at 58 percent cover 70 DAT, with over 90 percent of that cover coming from birdsfoot trefoil. Oasis was more effective than the imazapyr included in Sahara, as the Oasis plus Karmex at 12 plus 128 oz/ac was rated for total and birdsfoot trefoil cover at 30 and 23 percent respectively; while Sahara at 160 oz/ac, containing the same rate of diuron, was rated at 58 and 53 percent, respectively.

Plots treated with Oasis plus Karmex at 12 plus 128 oz/ac were rated significantly lower for birdsfoot trefoil cover than both Sahara at 160 oz/ac, which contained the same amount of diuron, and Oasis plus Pendulum EC at 12 plus 154 oz/acre, respectively. Oasis in combination with diuron was more effective than imazapyr plus diuron; and adding diuron to Oasis was much more effective than tank mixing with Pendulum.

CONCLUSIONS

The amount of birdsfoot trefoil present on the study site was unusual. No treatment provided satisfactory control of this species. It is fortunate that birdsfoot trefoil is not a common component under guiderails, and that it is low growing, so that when it is present and probably uncontrolled, it will not pose a visibility issue with the guiderail.

Although the control of birdsfoot trefoil was disappointing, when it is subtracted from the total cover values, the only treatment that was rated significantly higher than the best-rated Oust/Karmex/Roundup Pro treatment was Oasis plus Pendulum and the untreated check.

MANAGEMENT IMPLICATIONS

Arguably, the combination of Oust, Karmex, and Roundup Pro remains the standard for guiderail applications, due to its effectiveness and low cost. Plateau plus Karmex is an inexpensive treatment with a broad spectrum, however it is weak on legume species, such as birdsfoot trefoil and crownvetch. Clearly, an additional component will need to be identified for the mixture before it can be widely used. Based on the results of this trial, it is apparent that 2,4-D is not that component, and additional studies need to be conducted.

TABLE 1: Green cover ratings of total vegetation and birdsfoot trefoil located under a guiderail near University Park, PA. Treatments were applied May 26, 1999. Green cover ratings were taken 0, 36, and 70 DAT. Ratings are the mean of three replications.

Treatment	Application Rate	Total Cover			Birdsfoot trefoil cover			Other species		
		0 DAT	36 DAT	70 DAT	0 DAT	36 DAT	70 DAT	0 DAT	36 DAT	70 DAT
	(oz/ac)	(---			%			--)		
Untreated	----	70	95	96	42	63	59	28	32	37
Roundup Pro	128	68	20	32	36	8	14	32	12	18
Oasis Karmex	12 96	70	23	54	57	17	43	13	6	11
Oasis Karmex	12 128	66	14	30	47	11	22	19	3	8
Oasis Pendulum	12 154	63	62	87	41	49	57	22	13	30
Sahara	106	60	57	72	41	40	66	19	17	6
Sahara	160	62	39	58	35	26	52	27	13	6
Sahara Oust	88 1	66	55	87	44	38	81	22	17	6
Sahara Oust Karmex	53 1 72	61	34	60	40	28	58	21	6	2
Oust Karmex Roundup Pro	3 96 48	69	7	21	48	5	19	21	2	2
LSD (p=0.05)		n.s.	15	20	n.s.	19	24	n.s.	15	17

EVALUATION OF HERBICIDE COMBINATIONS INCLUDING MILESTONE VM FOR WEED CONTROL UNDER GUIDERAILS

Herbicide trade and common chemical names: Garlon 3A (*triclopyr*), Karmex (*diuron*), Milestone VM (*azafenadin*), Roundup Pro (*glyphosate*), Oust (*sulfometuron*)**,** Vanquish (*dicamba*)
Plant common and scientific names: Canada thistle (*Cirsium arvense*), crownvetch (*Coronilla varia*), goldenrod (*Solidago* spp.) Japanese bromegrass (*Bromus japonicus*), spotted knapweed (*Centaurea maculosa*)

ABSTRACT

A site was selected for the study in which the predominant weed species were crownvetch, Canada thistle, Japanese bromegrass, spotted knapweed, and goldenrod. Herbicide treatments included Milestone VM in various combinations with Garlon 3A, Karmex, Roundup Pro, Oust, and Vanquish. A combination of Oust and Roundup Pro was used as a standard treatment. Treatments were applied on May 6, 1999 and evaluated 35, 63, 91, 119, and 161 days after treatment. All of the treatments provided excellent control of existing vegetation, and residual control the entire season. The residual control was aided and enhanced by below normal rainfall during most of the season.

INTRODUCTION

In research trials dating back to 1992, Milestone VM (formerly R-6447) has been an effective preemergence material for use in bareground situations. In these studies it has proven to be most effective when combined with other herbicides commonly used along roadsides such as Oust, Karmex, or Roundup Pro. Preemergence activity of Milestone VM is well established. This study was designed to further elucidate the weed control strengths and weaknesses of different herbicide combinations including Milestone VM.

MATERIALS AND METHODS

The study was located along SR 33, near Nazareth, PA. Treatments were applied to 5 by 25 ft plots using a CO_2-powered backpack sprayer equipped with a single Spraying Systems OC-12 spray tip, delivering 40 GPA at 34 psi, on May 6, 1999. Treatments were arranged in a randomized complete block design with three replications. The treatments included Milestone VM plus Karmex or Oust, with or without Roundup Pro; Milestone VM plus Vanquish or Garlon 3A; and Oust plus Roundup Pro. A summary of the treatment list can be found in Table 1. Surfactant was added to combinations that did not include Roundup Pro.

Total green cover and percent cover by crownvetch was recorded on May 6, the day of application; June 10, 35 days after treatment (DAT); July 8, 63 DAT; August 5, 91 DAT; September 2, 119 DAT; and October 14, 161 DAT. Predominant weed species were crownvetch, Canada thistle, Japanese bromegrass, spotted knapweed, and goldenrod.

Based on Allentown rainfall data from the PA Agricultural Statistics Service, 7.88 inches of rain fell between April 1 and September 5, which was 13.03 inches below normal. By the completion of the trial, the season total was only 4.58 inches below normal, but this dramatic change was due to a hurricane that dropped 7.6 inches of rain on September 16 and 17.

RESULTS

Green cover ratings of vegetation in the plots ranged from 32 to 50 percent at the initiation of the study. By 35 DAT all treatments effectively controlled the existing vegetation. Percent green cover by weeds for all treatments was 2 percent or less at this date. Throughout the remainder of the study there were no significant differences in any of the subsequent ratings. The combination of Milestone VM plus Karmex provided control of the existing vegetation better than would be expected from Karmex alone. This result confirms observations from 1995 research that showed considerable postemergence activity of Milestone VM on crownvetch and Canada thistle.

CONCLUSIONS

The dry season would not be expected to have any effect on the initial kill of the vegetation provided by the herbicides. The excellent postemergence performance of the herbicide treatments should be reproducible. However, he residual control was undoubtedly aided and enhanced by the below normal rainfall during most of the season. The length and degree of control achieved by all of the treatments should not be expected to occur on a reliable basis in future treatments. It is not possible to determine how much of the residual control was due to herbicide, and how much was due to drought.

MANAGEMENT IMPLICATIONS

Based on the performance of the combination of Milestone VM plus Karmex on the perennial species that were present, it appears Milestone VM does provide significant postemergence activity. Further investigation could be pursued to determine if the rate of glyphosate needed for control of existing vegetation could be reduced when Milestone VM is used as part of a herbicide combination.

TABLE 1: Green cover of weed species located under a guiderail near Nazareth, PA. Treatments were applied May 6, 1999. Green cover ratings were taken 0, 35, 63, 91, 119, and 161 DAT. Each value is the mean of three replications.

Treatment	Application Rate	Green Cover of Weeds					
		0 DAT	35 DAT	63 DAT	91 DAT	119 DAT	161 DAT
	(oz/ac)	(----------------------	--------------------	--------------------	%	--------------------	----------------------)
Milestone VM[a] Karmex	10 96	38	1	1	0	1	1
Milestone VM Karmex Roundup Pro	10 96 64	35	1	1	1	1	1
Milestone VM[a] Oust	10 3	42	1	2	0	0	1
Milestone VM Oust Roundup Pro	10 3 64	32	1	1	0	0	1
Milestone VM[b] Vanquish	10 16	47	2	6	2	8	4
Milestone VM[b] Garlon 3A	10 64	50	2	3	1	4	1
Oust Roundup Pro	3 64	38	2	3	0	2	1
LSD (p=0.05)		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

[a] Treatment included Clean Cut crop oil concentrate at 0.5 percent v/v.

[b] Treatment included QwikWet surfactant at 0.25% v/v.

EVALUATION OF MILESTONE VM FOR
PREEMERGENCE WEED CONTROL UNDER GUIDERAILS

Herbicide trade and common chemical names: Karmex (*diuron*), Milestone VM (*azafeniden*), Roundup Pro (*glyphosate*), Oust (*sulfometuron*), Sahara (*diuron + imazapyr*)

Plant common and scientific names: crownvetch, Canada thistle (*Cirsium arvense*), prostrate spurge (*Euphorbia humistrata*), spotted knapweed (*Centaurea maculosa*), goldenrods (*Solidago* spp.), dandelion (*Taraxacum officinale*), common burdock (*Arctium minus*), dropseed (*Sporobolus vaginiflorus*), kochia (*Kochia scoparia*), and chicory (*Chicorium intybus*)

ABSTRACT

A site was selected for the study in which the predominant weed species were crownvetch, Canada thistle, prostrate spurge, spotted knapweed, goldenrods, dandelion, common burdock, dropseed, kochia, and chicory. Herbicide treatments included Milestone VM alone or in combination with Oust or Karmex; and Oust and Karmex alone or in combination with each other. An untreated check and Sahara were included in the study for comparative purposes. Treatments were applied on May 6, 1999 and evaluated 35, 63, 91, 119, and 161 days after treatment. All of the treatments provided excellent weed control compared to the untreated check through 119 days. At the completion of the trial 161 DAT, the plots treated with combinations of Oust plus Karmex or Oust plus Milestone, and the Sahara treatment, had cover of 4 percent or less. Milestone at 8 or 10 oz/ac, alone or in combination with Karmex, provided levels of control that were higher, but not statistically different from these treatments. The residual control provided by all of the treatments was aided and enhanced by below normal rainfall during most of the season.

INTRODUCTION

Milestone VM is a soon-to-be-registered herbicide that will be available for non-crop uses, and is being targeted for the bareground market at use rates up to 10 oz/acre. It is intended to be a potential replacement for diuron, most commonly purchased as Karmex DF, though it is available under several other brand names. The potential advantage of Milestone VM is its low use rate compared to Karmex, which is typically applied at 6 to 8 lbs/acre. This not only reduces the amount of active ingredient applied to the environment, but greatly facilitates the mixing process. Though research trials dating back to 1992 document that Milestone VM (formerly R-6447) has been an effective preemergence material for use in bareground situations, there can be great differences in weed populations, and soil and environmental conditions in different studies. The objective of this trial was to further evaluate the performance of Milestone VM compared to Karmex, particularly in combination with Oust.

MATERIALS AND METHODS

The study was located along SR 33, near Nazareth, PA. Treatments were applied to 5 by 25 ft plots using a CO_2-powered backpack sprayer equipped with a single Spraying Systems OC-12 spray tip, delivering 40 GPA at 34 psi, on May 6, 1999. Treatments were arranged in a randomized complete block design with three replications.

Treatments included an untreated check; 4, 6, 8, or 10 oz/ac Milestone VM alone or in combination with either 3 oz/ac Oust or 128 oz/ac Karmex; 3 oz/ac Oust or 128 oz/ac Karmex alone and in combination with each other; and 160 oz/ac Sahara. All treatments except the untreated check included 2 qts/ac Roundup Pro to control existing vegetation. Green cover ratings were taken on May 13, 7 days after treatment (DAT); June 10, 35 DAT; July 7, 62 DAT; August 5, 91 DAT; September 2, 119 DAT; and October 14, 161 DAT. Predominant weed species were crownvetch, Canada thistle, prostrate spurge, spotted knapweed, goldenrods, dandelion, common burdock, dropseed, kochia, and chicory. Data were subjected to analysis of variance.

Based on Allentown rainfall data from the PA Agricultural Statistics Service, 7.88 inches of rain fell between April 1 and September 5, which was 13.03 inches below normal. By the completion of the trial, the season total was only 4.58 inches below normal, but this dramatic change was due to a hurricane that dropped 7.6 inches on September 16 and 17.

RESULTS AND DISCUSSION

The baseline rating 7 DAT (Table 1) accounted for vegetation present at treatment. It showed there were no significant differences among the treatments at the initiation of the study, with green cover ranging from 30 to 55 percent. At all of the other rating dates, all treatments had significantly less weed cover than the untreated check. The data for these dates were analyzed without the check, and are reported in Table 1.

Although there were few statistical differences among the treatments, by 161 DAT there were trends. Plots treated with Oust plus Karmex, Oust plus Milestone, or Sahara had 4 percent or less cover. Plots treated with Oust or Karmex alone had 21 and 19 percent cover, respectively; and plots treated with Milestone alone ranged from 10 to 21 percent cover. The treatments combining Milestone VM and Karmex had cover ratings ranging from 14 to 38 percent. Ratings for combinations including Oust were lower than combinations including Karmex. Plots treated with the combination of Oust plus Milestone VM at 6 oz/ac had significantly less cover than either product used alone at the same rate.

Another potential advantage of Milestone VM is its activity on kochia. Based on our observations, as well as anecdotal accounts from others, we feel kochia is increasing in abundance along guiderails in the Commonwealth. Populations of this plant in other states have been confirmed to be resistant to Oust, Arsenal, Telar, and Vanquish, as well as herbicides such as atrazine and simazine. Though resistance to diuron, which has a mode of action similar to atrazine and simazine, has not been confirmed, it could appear at any time. Where kochia was present in this trial, Oust alone was ineffective, but combinations including Karmex or Milestone did provide effective control. We must be prepared to deal with kochia appearing in the state. Several genotypes of kochia have been identified which may react differently to the herbicides used in the bareground program. Resistance management may become more than a concept for the Department.

CONCLUSIONS

The dry season would not be expected to have any effect on the initial kill of the vegetation provided by the Roundup Pro. However, he residual control was undoubtedly aided and enhanced by the below normal rainfall during most of the season. The length and degree of control achieved by all of the treatments should not be expected to occur on a reliable basis in future treatments. It is not possible to determine how much of the residual control was due to herbicide, and how much was due to drought.

However, this study supports the results of similar studies performed in 1997 and 1998 that suggest Milestone VM plus Oust can provide excellent long term weed control comparable to that provided by Milestone VM and Karmex, as currently used by PennDOT.

MANAGEMENT IMPLICATIONS

If Milestone VM is registered, and if the price is competitive, it will be a new, viable product for PennDOT's bareground program. It has been efficacious in research trials, features easy-to-use low application rates, and is from a manufacturer that already has a strong presence in the Department's vegetation management program.

TABLE 1: Green cover ratings of weed species located under a guiderail near Nazareth, PA. Treatments were applied May 6, 1999. All of the treatments except the untreated check included Roundup Pro at 2 qts./ac. Green cover ratings were taken 7, 35, 62, 91, 119, and 161 DAT. Each value is the mean of three replications.

	Application	Green Vegetative Cover					
Treatment[a]	Rate	7 DAT	35 DAT	62 DAT	91 DAT	119 DAT	161 DAT
	(oz/ac)	(--		-%-		--)	
Untreated Check	---	42	50[b]	35[b]	28[b]	60[b]	65[b]
Milestone VM	4	33	4	3	3	6	19
Milestone VM	6	55	4	6	6	9	21
Milestone VM	8	33	5	3	4	6	12
Milestone VM	10	32	3	3	3	4	10
Oust	3	32	1	2	7	16	21
Milestone VM Oust	4 3	30	1	1	1	1	3
Milestone VM Oust	6 3	38	1	1	1	1	2
Milestone VM Oust	8 3	37	2	1	1	2	3
Milestone VM Oust	10 3	42	2	1	1	1	4
Oust Karmex	3 128	33	1	1	1	1	2
Karmex	128	50	7	6	4	10	19
Milestone VM Karmex	4 128	37	6	6	7	12	25
Milestone VM Karmex	6 128	40	4	7	7	13	38
Milestone VM Karmex	8 128	40	1	1	1	6	17
Milestone VM Karmex	10 128	40	2	2	1	6	14
Sahara	160	37	2	1	1	1	3
LSD (p=0.05)		n.s.	3	4	n.s.	n.s.	19

[a] All treatments except the untreated check included Roundup Pro at 2 qts/acre.

[b] After initial analysis of variance confirmed that herbicide treatments significantly reduced cover compared to the check, the untreated check was deleted from the reported analyses.

LONG TERM EVALUATION OF BAREGROUND HERBICIDES

Herbicide trade and common chemical names: Arsenal (*imazapyr*), Endurance (*prodiamine*), Karmex (*diuron*), Krovar I (*bromacil + diuron*), Oust (*sulfometuron*), Pendulum (*pendimethalin*), Plateau, Roundup Pro (*glyphosate*), Sahara (*diuron + imazapyr*), Spike (*tebuthiuron*), Surflan (*oryzalin*)
Plant common and scientific names: dandelion (*Taraxacum officinale*), orchardgrass (*Dactylis glomerata*), tall fescue (*Festuca arundinacea*), wirestem muhly (*Muhlenbergia frondosa*)

ABSTRACT

A trial designed to evaluate control provided by bareground herbicides after repeated annual applications was initiated on May 26, 1999. The primary objective was to determine what species would appear in the various plots over time. The trial was established on an agricultural soil with well established perennial vegetation present. Initial results were not satisfactory as the existing vegetation was not controlled by the Roundup Pro at 48 oz/ac that was included in each treatment for initial kill. None of the residual herbicides had enough postemergence activity to eliminate the existing vegetation. The characterization of infestation by weeds from seed was therefore confounded by the presence of existing, competing vegetation. The best rated plots were those treated with Sahara plus Roundup Pro at 160 plus 48 oz/ac, respectively. They had 28 percent cover 127 days after treatment. Ratings for all other treatments were significantly higher, and ranged from 67 to 95 percent cover.

INTRODUCTION

Many studies have been undertaken to evaluate tank mixes for bareground weed control applications. Because these studies are terminated when weeds encroach into the plots, and this is usually by the end of the growing season following application, the studies rarely last more than one year. 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 use of herbicides is the development of tolerant or resistant populations. Repeated use of the same herbicides season after season could potentially eliminate susceptible species and allow the development of a plant community that is tolerant to the herbicide mixture; or it could allow the increase of resistant biotypes of a species previously regarded as susceptible. Knowledge of the long-term weaknesses of herbicides allows for informed decisions when product subsititutions should be made as part of a resistance management program.

This study was established to evaluate the long-term effectiveness of various bareground herbicides after repeated annual application. The plots will be observed to determine which weeds are currently resistant to the herbicides used, and which weeds may develop resistance with time.

MATERIALS AND METHODS

This study was established at the Landscape Management Research Center, at the Pennsylvania State University. 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 amout of preemergence activity to the treatment. Arsenal, Krovar I, Oust, Sahara, and Spike were tanked mixed with Roundup Pro. Endurance, Karmex, Pendulum, Surflan, and Plateau were tank mixed with both Roundup Pro and Arsenal. Treatment rates are listed in Table 1. The Roundup Pro plus Arsenal combination was also applied alone as a check.

Treatments were applied May 26, 1999, 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.

Plots were rated for percent vegetative cover on July 1 and September 30. On September 30, percent cover by annual weeds, and percent cover by perennial weeds were also evaluated. Following the rating on September 30, the entire site was string trimmed and then sprayed on October 5 with 4 qts/ac Roundup Pro to eliminate existing perennial vegetation not initially controlled. This was done in preparation for applications to be made the following spring.

RESULTS AND DISCUSSION

On July 1, 35 days after treatment (DAT), the total vegetative cover for all treatments ranged from 7 to 23 percent. Though there were statistical differences between some of the treatments, they were small. Arsenal at 48 oz/ac, Oust, Plateau, and Sahara provide some postemergence activity, and plots treated with them had the lowest weed cover.

At the September 30 rating, 127 DAT, none of the treatments provided satisfactory control. Sahara at 160 oz/ac provided the best control, with only 28% of the plots covered by any vegetation. Total vegetative cover in the plots receiving the other treatments ranged from 67 to 96 percent. Plots treated with Plateau, Sahara, and Spike had the lowest cover of annual weeds, though statistically they were not any better than plots treated with Arsenal, Karmex, or Krovar.

Plots treated only with Roundup Pro at 48 oz/ac plus Arsenal at 4 oz.ac, had the lowest perennial weed cover, but it was not statistically lower than plots receiving Oust, Pendulum, Sahara, or Surflan. Overall, cover from perennial species ranged from 25 to 91 percent. This variation is hard to explain because plots receiving the standard treatment alone had the lowest perennial weed cover. Three other treatments that included these same materials at the same rates had significantly higher perennial weed cover. This variation in perennial weed cover could have affected the growth of annual weeds.

CONCLUSIONS

The postemergence component of each of the herbicide treatments in this trial, Roundup Pro at 48 oz/ac, was too conservative in application rate, and was not effective against the well-established vegetation at this site. Therefore a reliable reading of the preemergence capabilities of each treatment was not provided. The late season Roundup Pro application, in addition to postemergence components of subsequent applications will place more emphasis on eliminating the existing vegetation so that viable comparisons of residual activity can be made. Though little useful data was collected this first season, the sequence of annual applications was begun and the cumulative effects of repeated application of the same herbicide have begun to take place.

MANAGEMENT IMPLICATIONS

It is much too early to see the intended effects of this trial, even if the existing vegetation had been controlled. What is plainly apparent is that the combination of Roundup Pro plus Arsenal at 48 plus 4 oz/ac, respectively, is not sufficient to control well established perennial vegetation. Neither is Roundup Pro at 48 oz/ac in combination with products such as Oust, Arsenal, Krovar I, Sahara, or Spike at the rates used in this study.

Table 1: Weed control provided by 11 herbicide treatments applied to well-established perennial weeds on May 26, 1999. 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)	(---	--- % ---	---	---)
Oust Roundup Pro	3 48	8	75	40	35
Krovar I Roundup Pro	160 48	15	96	13	83
Arsenal Roundup Pro	48 48	8	67	15	52
Sahara Roundup Pro	160 48	7	28	1	27
Spike 80W Roundup Pro	64 48	20	94	3	91
Karmex Roundup Pro Arsenal	128 48 4	17	96	13	83
Endurance Roundup Pro Arsenal	25 48 4	23	88	32	57
Pendulum 3.3EC Roundup Pro Arsenal	155 48 4	12	85	49	36
Surflan Roundup Pro Arsenal	128 48 4	18	88	53	35
Plateau Roundup Pro Arsenal	12 48 4	10	78	3	75
Roundup Pro Arsenal	48 4	15	95	70	25
LSD (p=0.05)		8	24	24	24

1999 ROADSIDE VEGETATION MANAGEMENT CONFERENCE FIELD DAY REVIEW

This section includes summaries of the demonstrations and trials that were established, in part, for the Roadside Vegetation Management Conference held July 21-23, 1999 in Allentown, PA. The event was co-sponsored by The Pennsylvania Department of Transportation; The Pennsylvania State University; and FHWA, Eastern Resource Center. Many different aspects of vegetation management are investigated throughout this section from timing of stump treatments to seeding flowers into herbicide suppressed turf. One item that is common to all of these are the drought conditions that were prevalent at times in 1998, and particularly in1999. Several of the studies were affected by the lack of precipitation. Rainfall data is summarized in the introduction to this report and mentioned repeatedly where it was thought to have impacted the study.

Athough most of these demonstrations are not replicated they provide information useful to the vegetation manager and a basic understanding that will give us direction for future research efforts.

1999 RVMC FIELD DAY REVIEW:

EFFECT OF THE INTERVAL BETWEEN CUTTING AND TREATMENT ON RESPROUTING OF BLACK LOCUST

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

INTRODUCTION

Treating cut stumps can greatly reduce the number of sprouts that grow following a mechanical brushing operation. Herbicide treatments for cut stumps can be water- or oil-based. Oil-based treatments are able to penetrate bark much more effectively than water-based treatments. The precise window of the application for water-based treatments is not known, but is widely accepted to be 'as soon as possible' after cutting. The cut surface desiccates quickly, and during the growing season the tree responds to injury by quickly establishing a barrier at the cut. Even during the dormant season it is assumed that water-based treatments will be less effective at diffusing through the desiccated surface layer to be absorbed by the vascular system if treatment is delayed. The use of oil-based treatments such as Garlon 4 in oil or Pathfinder II minimize timing concerns to an extent because they will penetrate through the bark and can simply be applied as a basal bark treatment to the cut surface and the remainder of the trunk to provide control.

Timing is not regarded as an issue in terms of controlling growth from the stump, and therefore not an issue in species such as oaks, maples, ash, or black cherry where regrowth must arise from stem tissue. Cut surface applications made to these species are very effective because the sprouting is limited to the stump. Once the tree is cut and the surface of the stump is treated the tree has no opportunity to recover.

Where timing is more of a concern is with suckering species that regenerate from the root system. Does the time that elapses between the cutting and treatment of the stump affect control of the root system? This demonstration addresses that question by comparing application timings to a stand of black locust. Black locust is a common roadside tree species with tremendous suckering capacity, and would be the second best species for such a demonstration, after tree-of-heaven.

There were several premises that this demonstration was based upon. These include that aqueous cut-surface treatments must be applied immediately, regardless of species. Oil-based treatments, applied to cut surface and bark, will control resprouts on non-suckering species when application is delayed. Delay in applying oil-based treatments to suckering species will reduce suppression of root suckering. The radius of control around the treated stump will be reduced.

An oil-based treatment was applied because it is believed that this provides better uptake on stumps where the treatment has been delayed. Although we are not aware of any work that has been done to compare water versus oil-based cut surface mixtures, it is our feeling that oil-based mixes would provide better uptake by a stump that has formed a barrier over the cut. This particular question is something that the project would like to investigate in future seasons.

MATERIALS AND METHODS

The demonstration was located along I-78 in Northampton Co. An isolated black locust stand was divided into four plots and the entire area was cut using chain saws on April 8, 1999. Each plot was treated on a different date. The stumps within each plot were either untreated or treated April 8, April 15, or May 6; 0, 7, or 28 days after cutting (DAC), respectively. The treatment mix used on the day of application was Pathfinder II with blue colorant. Treatments made 7 and 28 DAC were a mixture of 25% Garlon 4, 75% Arborchem Basal Oil and Bullseye 55 Blue Basal Colorant. The trees were initially counted in each plot and it was established that there were 64, 60, 36, and 33 trees in the 0, 7, 28 DAC and untreated plots, respectively. Treatments were made with a hand-held squirt bottle, and included the bark and perimeter of the cut surface.

RESULTS AND DISCUSSION

By the end of the 1999 season the stumps remained clean in all treated plots. As expected there was stump sprouting in the untreated check. Root sprouting was prevalent throughout the study area. None of the treatments were effective at controlling root sprouts and the sphere of influence around the treated stumps was highly variable. The bottom line is that the oil based treatments containing triclopyr, the active ingredient used in the demonstration, provided control of stump sprouts even when applied 28 days after cutting. Foliar follow-up treatments will be necessary to gain control of black locust resprouts from roots.

Based on the results of other studies, timing of applications with regard to season should be evaluated to determine if triclopyr will more readily translocate to the roots if applied to cut stumps after full leaf out.

1999 RVMC FIELD DAY REVIEW:

FALL APPLICATIONS OF PLATEAU FOR SELECTIVE MANAGEMENT OF CANADA THISTLE IN CROWNVETCH

Herbicide trade and common chemical names: Plateau (*imazapic*)
Plant common and scientific name: Canada thistle (*Cirsium arvense*), crownvetch (*Coronilla varia*)

INTRODUCTION

Crownvetch has been planted widely on PA roadsides since commercial quantities of seed became available in the 1950s, and has been very successful for use in stabilizing highly disturbed soils on cut and fill slopes. However, where crownvetch is located on higher quality soils, it is prone to weed infestation, notably by the Noxious Weed Canada thistle.

Since the mid 1980's the Research Project has evaluated many herbicides in an attempt to selectively remove Canada thistle from crownvetch. In those early years it was found that spring applications of Velpar L at 2 qts/ac burned down the thistle while causing only slight injury to crownvetch. Due to net movement of photoassimilates from root to shoot in the spring, as well as the lack of phloem movement of Velpar L, the spring applications do not injure the root system of thistle, and the normal flush of late season growth still occurs.

Plateau is a recent introduction to the market and is labeled for use on Canada thistle, and is also safe on crownvetch even at the maximum rate of 12 oz/ac. In previous testing, spring-applied Plateau has shown effective control of Canada thistle plants, but vigorous resprouting did occur. In 1996 there was a small demonstration area that was treated twice with Plateau near State College, PA. The timings were June 3rd and September 25th. Surprisingly, the Canada thistle has been eliminated from this site and the crownvetch is healthy and vigorous. It was felt that it was not the two sprays as much as the second timing that played a role. This study was established to evaluate Plateau applied in the fall for controlling Canada thistle in crownvetch. The rationale was that fall treatments would be translocated to the root system, and perhaps attain the elusive goal of a selective, systemic treatment for Canada thistle in crownvetch.

MATERIALS AND METHODS

A study was established along I-78 in Northampton County on October 28, 1998. The treatments consisted of an untreated check; and Plateau at 12 oz/ac, Sun-It II methylated seed oil at 32 oz/ac, and Polytex A1001 drift control agent at 0.25% v/v. The study was arranged in a randomized complete block design with three replications. Plot size was 35 by 80 ft. The application rate was targeted at 75 gallons per acre using an Echo motorized backpack sprayer equipped with a handgun with an adjustable-cone tip. Canada thistle was 12 to 24 in tall, and appeared to still be growing.

Subplots were established within each plot to quantify the amount of Canada thistle initially present. The subplots were 5 by 5 ft. in size. At the time of application the number of Canada thistle stems and percent Canada thistle infestation was determined within each subplot.

RESULTS AND DISCUSSION

Initially each subplot had from 61 to 179 Canada thistle stems and percent Canada thistle infestation ranged from 35% to 85%. At the time of the field day on July 22, 1999 all subplots were heavily infested with Canada thistle, with no visible difference between treated and untreated.

We do not know why a systemic herbicide, applied at a time when there should be translocation to the root system, would appear to have no affect at all. This is particularly vexing in light of the activity observed previously in trials and demonstrations, even with spring applications. We can only speculate. The primary avenue of speculation is that despite the apparent healthy appearance of the thistle at the time of application, it was suffering the effects of a drought year. We will only be able to come to some conclusion by repeating this work.

1999 RVMC FIELD DAY REVIEW:

FIRST YEAR ESTABLISHMENT OF A NATIVE SEED MIX USING PLATEAU HERBICIDE

Herbicide trade and common chemical names: Plateau (*imazapic*), Roundup Pro (*glyphosate*)
Plant common and scientific names: tall fescue (*Festuca arundinacea*), creeping red fescue (*Festuca rubra* ssp. *rubra*), common milkweed (*Asclepias syriaca*), crownvetch (*Coronilla varia*), bull thistle (*Cirsium vulgare*), plumeless thistle (*Carduus acanthoides*)

INTRODUCTION

Perennial, warm-season grasses are well adapted to dry, infertile, acidic soils; provide desirable habitat to ground-nesting and grassland songbirds that are losing habitat; and though an acquired taste for many, they are very aesthetic. Establishment of theses 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 native forbs, and three nurse crop species (Table 1) was seeded May 13, 1999 to the infield of the SR 33 S/SR 248 interchange. The existing vegetation was the original Formula D seeding, as well as a bonus - an extensive patch of the native common milkweed. The site was sprayed immediately prior to seeding with a mixture of Roundup Pro plus Plateau at 6 qts plus 6 oz/acre, respectively. The seeding was done with a Truax Flex II 88 no-till drill, generously provided by Ernst Conservation Seeds. The Truax drill has three seed boxes, designed for seeding of small seed, large smooth seed, and fluffy seed. The seed mix used was divided between the small and the fluffy seed boxes. Inexplicably, the demonstration area was mowed by Department contractors just prior to the field day.

Similar interchange seedings were made in Aliquippa, Beaver County, and State College, Centre County, for viewing at the 2000 and 2001 field days.

RESULTS AND DISCUSSION

Operationally, this site would be an unlikely candidate for a native species planting because the existing vegetation was desirable, and the soil was reasonably productive - the existing cool-season grass mixture or Formula L are well suited to this site. The site was chosen primarily because it was well placed for the tour, and because the desired maintenance level, and appearance of a warm-season grass planting is compatible with the site.

Another aspect of this demonstration that is not recommended is spring weed control. The soil would have had more moisture and been more friable, 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 we made the decision to establish these plots in March, 1999.

Initial control of the unwanted vegetation was good but, the extreme drought conditions experienced during the 1999 season resulted in poor establishment of the natives. Due to timing of herbicide treatment - very early emergence - it served as a release treatment for the milkweed. Until it was mowed, the milkweed was providing essentially the only cover on the site. There were few other desirable species that got established at the site during 1999. The most common were blackeyed Susan, showy ticktrefoil, and little bluestem.

The Aliquippa and State College seedings were much more successful, as the drought was less severe, particularly in State College. At these sites a satisfactory stand developed, though control of existing crownvetch and tall fescue was not complete, and seedlings of biennial thistles such as bull thistle and plumeless thistle were common in the State College site.

A drawback of using Plateau is that to date no tolerant cover crop species have been identified. To date, only a few individuals of the cover crops in the seed mix have been observed in any of the Plateau-treated seedings. We are considering increasing the rate of blackeyed Susan in the seed mix and using it as a cover crop.

It is our hope that most of the grass seed is lying ungerminated, waiting for better days, and rain, in the spring of 2000. This site will be overseeded with more grass seed during the early spring of 2000, and treated for weeds if necessary.

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 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.

1999 RVMC FIELD DAY REVIEW:

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

Herbicide Trade and common chemical names: Krenite S (*fosamine*), Arsenal (*imazapyr*), Garlon 4 (*triclopyr*), Escort (*metsulfuron*), Pathway RTU (*2,4-D + picloram*)
Plant common and scientific names: staghorn sumac (*Rhus typhina*), black locust (*Robinia pseudoacacia*), boxelder maple (*Acer negundo*), tree-of-heaven or ailanthus (*Ailanthus altissima*), paulownia (*Paulownia tomentosa*), shrub-type willows (*Salix* spp.), black birch (*Betula lenta*), tulip tree (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), multiflora rose (*Rosa multiflora*), Canada thistle (*Cirsium arvense*), Japanese knotweed (*Polygonum cuspidatum*), purple loosestrife (*Lythrum salicaria).*

INTRODUCTION

Within a limited access right-of-way, at least three vegetation management zones should be designated. These management zones include a non-selective zone addressing the shoulders and guiderails that is kept free of vegetation; a safety clear zone extending at least 30 feet from the road edge that is kept free of all woody vegetation; and a selective zone extending to 80 feet from road edge, where tall growing woody species, as well as any other undesirable species would be suppressed. With this zone concept in mind a large scale demonstration of selective brush control techniques was initiated on a recently constructed interstate undergoing the early phases of brush encroachment.

MATERIALS AND METHODS

A 14 mile stretch of I-78 in Northampton County was chosen for the demonstration. For tracking purposes, the area was designated as eastbound shoulder, westbound shoulder, and median sections, accounting for 42 miles of treatment area. This section of I-78 was first opened to traffic in November, 1987. Table 1 summarizes all management activities performed by the research project to date. The initial applications were low-volume foliar treatments made in October, 1993, covering 17 miles of shoulder. At that time, the most common brush species were staghorn sumac and black locust. Other species included boxelder maple, shrub-type willows, black birch, tuliptree, sycamore, ailanthus, and paulownia. The following spring, 16 miles of shoulder was treated with a basal bark application. Except for a three mile stretch of grass median, the entire corridor was covered with a low volume foliar treatment in August, 1994. This application established the treatment areas and targeting standards for subsequent applications. This application covered areas previously untreated as well The Zone Concept clearance distances stated above were generally followed, though the Selective Zone depth varied with terrain. Much of the corridor is flanked with earthen berms, and even small brush such as sumac was cleared from the berm slopes even if the distance to the top of the berm was greater than 30 ft.

The primary target for all applications was brush. The mix used for the low volume foliar applications was Krenite S plus Arsenal, which is very effective on brush, but less so on herbaceous vegetation. Therefore undesirable herbaceous species such as Canada thistle or Japanese knotweed were not targeted.

Additional treatments to the corridor included treating a 1.0 mile area of large black locust, paulownia, and ailanthus that was not effectively controlled by the August, 1994 foliar treatment. The corridor was treated again in July, 1998 and June, 1999, with foliar treatments. The 1998 treatment addressed escapes/misses from 1994, as well as encroachment from the edges of the previous applications. It was a very dry period, with significant moisture stress observed in some of the target species. There was also a brief, but intense rain event during the application that further compromised the effectiveness of the treatment. The situation was even more difficult in 1999, as it was a drier season than 1998, and most of the second day's work was probably lost due to rain beginning around noon.

RESULTS AND DISCUSSION

Based on rough area estimates using the most expensive visit (July, 1998), the cost of managing brush in this corridor works out to about $6.50/acre per operation. This cost was arrived at using the following estimates:

14 miles long, two 80 ft shoulders, a 50 ft median = 356 acres
$24/hour x 77 hours = $1848
Herbicide cost = $436
$1848 + $436 = $2284 total cost; $2284/356 acres = $6.42/acre

This figure then reflects the total acres *monitored and treated, if necessary.* This is a key concept of Integrated Vegetation Management. The acres are scouted during the operation, and treatment occurs where targets occur. This is preventive maintenance - it prevents establishment of tall, troublesome brush. The benefit of preventing future problems justifies the cost of applicators 'doing nothing' as they walk management areas where targets are small, or at very low density.

This effort has been very successful at essentially eliminating the first flush of brush encroachment that begins during the construction process. Even though cut and fill slopes are seeded at final grade, this phase of road construction is an ideal opportunity for early-succession woody species to gain a foothold since the seed mixtures take at least a full growing season to fill in. The reduction of the initial population of sumac and locust has led to colonization by weedy shrubs such as multiflora rose and bush honeysuckles. These species have been suppressed, but there is still considerable infestation pressure. The 1998 and 1999 foliar applications were negatively impacted by both drought effects on the target vegetation, as well as rainfall during the operation. The degree of infestation pressure in this corridor can be gauged by traveling west on I-78 to the western boundary of Northampton County, where the demonstration site ends. The brush is much larger in this area since it has been growing unchecked since the completion of construction, sometime between 1985 and 1987.

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

This demonstration has been effective on brush, but has not had an impact on undesirable herbaceous vegetation because the Krenite S-based applications used in this demonstration were specific to brush. To address the herbaceous species such as Canada thistle, Japanese knotweed, or purple loosestrife growing in the ditches at the same time as brush, a mix based around glyphosate or broadleaf chemistry should be employed. Where colony-forming herbaceous vegetation is treated, reseeding desirable species will be necessary.

For contracting purposes, an application crew treating the Selective Zone should be able to switch between backpacks and truck-based hoses based on the vegetation. These methods of application provide flexibility, greater selectivity and are relatively inexpensive, particularly when employed in a preventive manner.

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

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

1999 RVMC FIELD DAY REVIEW:

REHABILITATION OF A JAPANESE KNOTWEED INFESTATION WITH A NATIVE SPECIES MIXTURE AND FORMULA L

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

Plant common and chemical names: Japanese knotweed (*Polygonum cuspidatum*), giant knotweed (*Polygonum sachalinense*), multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*), Tartarian honeysuckle (*Lonicera tatarica*), hard fescue (*Festuca brevipila*), creeping red fescue (*Festuca rubra* ssp. *rubra*), annual ryegrass (*Lolium multiflorum*).

INTRODUCTION

Japanese knotweed is a problematic herbaceous species that grows 5 to 10 ft tall, in dense monocultures. It has thick rhizomes that continually extend the colony into adjacent plant communities, and provide a seemingly bottomless supply of resprouts after knotweed is cut. Japanese knotweed, and the similar species giant knotweed, is very common in riparian corridors, but is adapted to a wide range of soil and environmental conditions, including the highly disturbed soils remaining after road construction. In narrow rights-of-way (ROW), knotweed can severely impede sight distance, as well as cause damage to the pavement edge with its emerging shoots. Although knotweed may not pose an immediate threat to the function of the roadway in a wider ROW, it should be regarded as a form of pollution that will degrade the ecological quality of the ROW, as well as neighboring properties. Japanese knotweed is considered to be one of the worst invasive species, plant or animal, on a *global* basis[1/]. Therefore, regardless of its location within the Department's ROW, Japanese knotweed should be targeted for removal.

A key element of removing knotweed, or any undesirable plant from an area is *replacement* - a well adapted species must be established in place of the invader to reduce opportunities for its reestablishment. A grass mixture is a viable selection for such a planting due to the commercial availability of competitive, adapted species for almost any site condition. Additionally, a grass groundcover makes it easier to selectively manage undesirable weeds and brush through mowing or herbicide applications. The Department's fine fescue-based Formula L seed mixture has been successfully used by the research project, as well as several of the Engineering Districts as replacement plant material in rehabilitation projects. A recent initiative has been the investigation of the viability of perennial warm-season grasses, as well as native forbs for use in reclamation and rehabilitation of ROWs. A mixture of introduced cool-season grasses, such as the economic fescues, will establish more quickly than native grasses. Where a native-based mixture, particularly one featuring warm season grasses, has a potential advantage is in adaptation to poor sites, especially dry sites. The objective of this demonstration was to attempt to convert a stand of Japanese knotweed to a mixture of native grasses and forbs.

[1/] Global Invasive Species Database, Invasive Species Specialist Group, International Union for the Conservation of Nature. http://www.issg.org/database/welcome/

MATERIALS AND METHODS

On April 30, 1998 an area of Japanese knotweed, approximately 6000 ft^2, was treated with a mixture of Roundup Pro plus Transline, at 5.0 plus 0.31 percent, v/v, respectively. The application was made with backpack sprayers equipped with a single Spraying Systems #5500 Adjustable ConeJet with X-6 tips, targeting a carrier volume of 20 gal/ac. The knotweed was already six feet tall, making a thorough, low volume application difficult. Following this application the area was hand-seeded to a native grass and forbs mixture (Table 1). This mix was seeded at approximately 16 lb/ac.

A high volume application of Roundup Pro, at 1.0 percent, v/v, was made on September 14, 1998. On April 15, 1999 there was no indication of establishment from the native seed mix, so a second seeding was made using Formula L (hard fescue, creeping red fescue, and annual ryegrass at 55, 35, and 10 percent, respectively, by weight). The seed was spread by hand at a rate of 110 lbs/ac. The dead knotweed canes from 1998 were then kicked down in an attempt to improve access for a later follow-up spray .

On May 6, 1999 there was a follow-up treatment of 10% Vanquish, 2.5% Tordon K and 1.25% Transline using Thinvert as the carrier. The knotweed ranged from emerging to 24 inches tall. This was a low volume application sprayed at 3.4 gal/ac. The Japanese and Tartarian honeysuckles, and multiflora rose at the fringes of the site were also treated during this application. Annual ryegrass from the Formula L seeding was up to three inches tall, but no fine fescue seedlings were apparent.

RESULTS AND DISCUSSION

Injury to the knotweed from the April 30, 1998 application was limited to curling and twisting of the existing foliage, malformation of new terminal growth, and apparent suppression of new growth. The treated stems remained green and upright, canopy reduction was in the 10 to 15 percent range, and only a few plants from the seed mixture could be found. The rationale for the September 14, 1998 high volume application was that the knotweed was not effectively suppressed with the initial application, and there was no desirable understory to protect, justifying the use of the non-selective Roundup Pro treatment.

The area was next reviewed on April 15, 1999 and there was no apparent indication that the natives were present at the site. The Formula L seeding was made due to the lack of establishment from the native seed mixture. The knotweed was very sparse, and showed signs of stunting and twisting from the 1998 herbicide applications.

When viewed during the Field Day, July 22, 1999, previously undetected individuals of several native species were apparent including little bluestem, wildrye and showy ticktrefoil. The annual ryegrass from the Formula L was well established, and fine fescue seedlings were present. Due to the extremely dry summer in that area, the fate of the fine fescue is in question. If there is enough rainfall, there appeared to be enough fine fescue to eventually become a full stand. Knotweed response to the May, 1999 treatment was much like the April, 1998 herbicide application - the treated knotweed was significantly injured, but did not die. The experience from this particular site suggests that late season treatments are more injurious, although time of application is confounded with carrier volume when the September, 1998 application is compared to the April, 1998 or May, 1999 treatments. As is mentioned elsewhere in this report, Japanese knotweed responds differently than giant knotweed to herbicide treatments. In our experience, giant knotweed has been severely injured with high or low volume applications, as well as early or late in the season. Our experience with Japanese knotweed is limited, and we have only observed satisfactory control with later season applications, which have always been high volume.

In the absence of adequate knotweed control, establishing a replacement groundcover is extremely difficult. Unlike the giant knotweed conversion shown at the 1997 Field Day, at Luciusboro, Indiana County, where seeding of Formula L was done in March, prior to knotweed emergence; it appears that Japanese knotweed stands should not be seeded until the knotweed has been substantially reduced with a previous herbicide application.

Issues of herbicide treatment and application timing and methodology will have to be resolved before the comparative advantages of Formula L, a native-based mix, or perhaps a combination of the two can be determined.

Table 1: Grass and forb species, list by common and scientific name, and percent of respective seed mix.

Common Name	Scientific Name	lb seed/acre[1/]
Grass Mixture		
big bluestem	*Andropogon gerardii*	2
Canada wildrye	*Elymus canadensis*	2
Virginia wildrye	*Elymus virginicus*	2
'Tioga' deertongue	*Panicum clandestinum*	2
switchgrass	*Panicum virgatum*	0.5
little bluestem	*Schizachyrium scoparium*	2
Indiangrass	*Sorghastrum nutans*	2
Forb Mixture		
partridge pea	*Chamaecrista fasciculata*	0.36
showy ticktrefoil	*Desmodium canadense*	0.36
spotted joepye weed	*Eupatorium fistulosum*	0.36
oxeye sunflower	*Heliopsis helianthoides*	0.36
roundheaded bushclover	*Lespedeza capitata*	0.36
dense blazingstar	*Liatris spicata*	0.36
perennial lupine	*Lupinus perenne*	0.36
wild bergamot	*Monarda fistulosa*	0.3
blackeyed Susan	*Rudbeckia hirta*	0.3
Canada goldenrod	*Solidago canadensis*	0.1

[1/] The grasses were seeded on a pure live seed basis.

1999 RVMC FIELD DAY REVIEW:

COMPARISON OF LOW- AND HIGH-VOLUME HERBICIDE APPLICATIONS TO GIANT KNOTWEED

Herbicide trade and common chemical names: Tordon K (*picloram*), and Transline (*clopyralid*), Vanquish (*dicamba*)
Plant common and scientific names: Giant knotweed (*Polygonum sachalinense*), Japanese knotweed (*Polygonum cuspidatum*)

INTRODUCTION

High volume foliar applications have long been the standard approach for dealing with tall, dense vegetation, such as stands of Japanese or giant knotweed. It is relatively easy to train applicators to perform high volume applications because spraying to the point of runoff is easily understood. Under-application is not very likely as long as the 'to the point of runoff' standard is followed. Overapplication is arguably a minor concern because the solution is very dilute, therefore increased costs are minor. Also, any applicator desiring a “job-well-done” can improve efficiency to minimize material usage and time expended while maintaining the desired coverage. Due to the relatively high pressures used, high volume applications also allow the applicator to reach greater distances with the spray. This provides an advantage over low volume applications when vegetation is tall and/or dense. Disadvantages of high volume application include loss of selective placement of the spray solution, and increased hardware needs, including a large spray tank, high capacity pump, several hundred feet of hose, and a truck capable of hauling the spray equipment. Additionally, due to 'hose management' issues, high volume applications to dense stands of vegetation are best made with two people if a single gun system is used, or three people if two hoses are run simultaneously.

Backpack-based low volume applications provide portability, increased selectivity of placement, and greatly reduced hardware requirements. However, throw distance is reduced compared to high volume, therefore the applicator must traverse more of the target area. Additionally, coverage of tall and dense vegetation is difficult, and adequate coverage with low volume is more difficult to teach. Under-application would occur more readily than in a high volume situation, and over-application is costly due to the high herbicide concentrations of the spray mixtures.

This demonstration looks at the comparison between high volume applications using water as a carrier versus low volume with Thinvert, a proprietary thin invert emulsion herbicide carrier developed for use with specially designed nozzles. Thinvert as a carrier provides several benefits over water, including reduced drift, uniformity of droplet size and increased control of deposition, and reduction in spray volumes from 10 to 20 gallons/ac for aqueous solution to 3 to 5 gal/ac. The tradeoff is cost. Thinvert is approximately $8/gallon.

This demonstration compared high volume and Thinvert applications side by side, using the same herbicides, to provide Roadside Specialists an opportunity to see the results and determine the relative merits of each system for their own program.

MATERIALS AND METHODS

A stand of giant knotweed located along SR 78 E, at the Lehigh/Northampton county line was treated on May 6, 1999. The vegetation was already 5 to 6 feet tall. The stand was divided into two plots. One plot, approximately 2,850 ft^2 in size, received a high volume treatment and the other 2,730 ft^2 plot received the low volume treatment. The high volume application was made using an Echo motorized backpack sprayer equipped with a foliage gun and AYSS60 tip. The low volume Thinvert application was made with a CO_2-powered backpack sprayer equipped with a basal wand and 73031 Thinvert nozzle. The targeted rates were 100 and 5 GPA for the high and low volume treatments, respectively. Based on the estimated area, and volumes used the actual rates applied were approximately 111 and 5.4 GPA.

The herbicide mixture for both application volumes was Vanquish, Tordon K, and Transline at 64, 16, and 8 oz/ac respectively.

RESULTS AND DISCUSSION

The herbicide mix used in this demonstration is one of the more effective combinations for this species, and control of treated stems was excellent, probably in the 95 percent range, for both treatments. One advantage of this combination is the selectivity it has for grasses that may be in the treated area, or seeded soon after treatment.

Although results look similar for both application methods there was a relatively high proportion of edge, making the Thinvert application easier than it would be in a larger patch. In a large patch, where the vegetation is taller than the applicator, it is easier to drag a hose than it is to wear a backpack. Therefore it would be more desirable to use a hose and high volume application for large patches and low volume applications in more accessible areas.

Though not addressed in this demonstration, species is an issue. To date, efforts to control giant knotweed have been largely successful over a range of conditions and methods. Japanese knotweed has been more difficult to control, as will be described in a following report. Our experience to date has been that Japanese knotweed is injured by high volume, late season applications using glyphosate-based mixtures; and the earlier, low volume applications with broadleaf herbicides have been ineffective. The comparative effects of application volume, time of application, and herbicide have not been characterized for Japanese knotweed. This is due primarily to the erroneous assumption by the Project staff that giant and Japanese knotweed would respond similarly to treatment, and that the work done primarily on giant knotweed would translate directly to Japanese knotweed. Our experience is that this is not the case, and results from this demonstration should not be broadly applied to other species.

1999 RVMC FIELD DAY REVIEW:

BRUSH CUTTER/HERBICIDE APPLICATOR DEMONSTRATION

Herbicide trade and common chemical names: Roundup Pro (*glyphosate*), Stalker (*imazapyr*),
Plant common and scientific names: staghorn sumac (*Rhus typhina*), boxelder maple (*Acer negundo*), black walnut (*Juglans nigra*), bush honeysuckles (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), black locust (*Robinia pseudoacacia*), trembling aspen (*Populus tremuloides*)

INTRODUCTION

The Research Project evaluated the Sprout-Less Herbicide Applicator on several small scale demonstrations, as well as replicated trials in 1999. This system was developed to provide a means to both cut and apply a herbicide treatment in one operation, through a process that could be described as controlled leakage. There is a reservoir mounted to the blade of a clearing saw blade that contains the 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 will need to be refilled.

MATERIALS AND METHODS

An area along SR 33 North, segment 140, in Northampton County was chosen as a demonstration site. The area was approximately one acre in size. It was divided into three sections. The trees in the middle section were cut using a chain saw and no follow-up herbicide treatments were made to the stumps. The sections on either end were cut using a Stihl FS 550 clearing saw equipped with a Sprout-Less Herbicide Applicator. The gasket arrangement going from blade to hub included one textile, one thin paper, and one thick paper gasket. The treatment mix used in the Sprout-Less System included 70% v/v Roundup Pro, 5% v/v Stalker, 22% v/v MON 59120 (surfactant), and 3% v/v water. There was a total of 95 milliliters of solution applied in the demonstration area and just short of a full tank of fuel.

Target tree and brush species present included staghorn sumac, boxelder maple, black walnut, bush honeysuckle, and multiflora rose. The trees averaged 2 inches in caliper.

RESULTS AND DISCUSSION

The gasket arrangement was successful in this particular demonstration. It effectively released the appropriate amount of herbicide. Few of the stumps treated with the Sprout-Less sprouted during the 1999 season. There have been problems associated with this system at other sites, however.

Our work to date has shown mixed results. 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 and textile 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 has been frustrating at best. Those using the applicator on a more frequent basis and staying with a single mix would find this unit more user-friendly, and the manufacturer estimates that there is a two week acclimation phase for the operator to develop the right touch in setting up the unit.

Near State College, PA we had the opportunity to review two sites treated with the applicator this year. One was a stand of black locust treated on February 11th, using the same herbicide mixture described above for the SR 33 site. There was no apparent differences between the treated plot and the untreated check, as both had considerable resprouting from the stumps and roots. However, this cannot be attributable to the Sprout-Less system as only a fraction of the intended volume was actually applied. The adjustments were incorrect on the system to apply the desired amount. A plot treated with a chain saw and stump treated with the same herbicide mixture was free of stump sprouts.

The second site was comprised of quaking aspen and was treated on March 18th using the same herbicide mixture. The gasket arrangement and adjustments were correct and the results reflect that. There were fewer stump sprouts visible in the treated area. Root sprouts were evident though. The adjacent cut -only plot was heavily infested with both stump and root sprouts.

When properly set up it appears the Sprout-Less will provide control of stump sprouts. However, due to the degree of 'feel' needed for successful operation, this tool would only have a fit in programs where it is going to be used constantly. Such a scenario is not likely in Department vegetation management operations.

1999 RVMC FIELD DAY REVIEW:

COMPARISON OF PRE- AND POSTEMERGENCE APPLICATIONS TO GUIDERAILS

Herbicide trade and common chemical names: Oust (*sulfometuron*), Arsenal (*imazapyr*), Karmex (*diuron*), Milestone VM (*azafeniden*), Plateau (*imazapic*), Endurance (*prodiamine*), Pendulum (*pendimethalin*), Surflan (*oryzalin*), Sahara (*diuron* plus *imazapyr*), Roundup Pro (*glyphosate*), Finale (*glufosinate*), Velpar L (*hexazinone*), Reward (*diquat*)

Plant common and scientific names: common mullein (*Verbascum thapsus*), Japanese brome (*Bromus japonicus*), shepherdspurse (*Capsella bursa-pastoris*), tall fescue (*Festuca arundinacea*), wild carrot (*Daucus carota*), crownvetch (*Coronilla varia*), Canada thistle (*Cirsium arvense*), giant foxtail (*Setaria faberi*), yellow foxtail (*Setaria lutescens*), common ragweed (*Ambrosia artemisiifolia*), annual dropseed (*Sporobulus vaginiflorus*), white sweetclover (*Melilotus alba*)

INTRODUCTION

After several years of not having guiderail treatments at the field day, this demonstration provided an opportunity to view some new herbicide chemistry next to familiar treatments under similar conditions. The demonstration area had been under construction during 1998, and was not treated. The hope was that this would result in higher weed pressure in 1999.

The preemergence herbicide demonstration was applied very early, March 11, 1999 with the intent of having any weak combinations lose effectiveness by the field tour on July 22. The postemergence demonstration was established to show the control provided by several of the most commonly used postemergence herbicides.

MATERIALS AND METHODS

Pre- and postemergence herbicide applications were made to a guiderail along SR 33 N, just past the SR 191 interchange. The preemergence treatments were applied March 11, 1999, to single 5 by 90 ft plots, with a 10 ft check in between each treatment. The treatments were applied at 40 GPA with a CO_2-powered backpack sprayer, equipped with a single Spraying Systems OC-12 spray tip. Species present at treatment included common mullein, Japanese brome, shepherdspurse, tall fescue, and wild carrot. Previous year's growth suggested pressure would also come from crownvetch, Canada thistle, giant foxtail, yellow foxtail, common ragweed, and annual dropseed.

The preemergence area featured three different soils, which appeared to influence seed bank pressure. The Oust/Karmex and part of the Sahara plot contained what might be called the 'original soil'. Newer material appears to have been overlaid in part of the Sahara plot and through the Oust/Milestone VM, Plateau/Karmex, and part of the Oust/Karmex/Endurance plots. An even newer material overlay begins in the Oust/Karmex/Endurance plot and continues through the Oust/Karmex/Pendulum 3.3E and Oust/Karmex/Surflan plots. The preemergence treatments, and control observations are reported in Table 1.

Postemergence treatments were applied May 6, 1999, using the same sprayer set-up as the preemergence plots. A surfactant was added to treatments not containing Roundup Pro or Finale. The Oust/Karmex, Oust/Karmex/Reward, and Oust/Karmex/Velpar L mixes contained QwikWet 357 at 0.25% v/v, while Sun-It II (methylated seed oil) was added to the Sahara and Plateau/Karmex treatments. Predominant species included Canada thistle, Japanese brome, crownvetch, and white sweetclover. Postemergence treatments and control observations are listed in Table 2.

RESULTS AND DISCUSSION

The preemergence demonstration provided mixed results. By July 7, four months had elapsed since the application. Several herbicide combinations began to provide unacceptable control. The Sahara, Oust/Milestone VM, Plateau/Karmex, and Oust/Karmex/Endurance were rated at 20, 15, 35, and 12 percent total cover, respectively. However, when the ratings for vegetation arising from seed is examined, only the Plateau/Karmex was truly unsatisfactory, with a rating of 19 percent. The majority of the vegetation in the other three treatments was from established perennial vegetation, particularly Canada thistle, which had no above-ground parts at treatment time. The very early application date drastically limited the activity of the treatments on the existing vegetation that was either dormant, or simply not yet growing as would be the case for rosette-forming species such as common mullein.

The postemergence treatments all provided good control of the existing weed species. For the two months these plots were observed an acceptable level of control was maintained. All treatments had 4 percent or less green cover 2 months after treatment.

Table 1: Summary of control provided by preemergence herbicide applications to guiderails. Treatments were applied March 11, 1999. Application rates are in ounces of product per acre.

		June 10, 1999, 91 DAT			July 7, 1999, 118 DAT		
Treatment	Application Rate	Total Green Cover	Cover from Established Plants	Cover[1] from Annuals	Total Green Cover	Cover from Established Plants	Cover[1] from Annuals
	(oz/ac)						
Oust Karmex	3 128	1	0.95[2]	0.05	5	4.8	0.2
Sahara	160	15	10	5	20	12	8
Oust Milestone VM	3 10	12	6	6	15	13.5	1.5
Plateau Karmex	12 128	25	11	14	35	16	19
Oust Karmex Endurance	3 64 16	10	8.5	1.5	12	7	5
Oust Karmex Pendulum 3.3E	3 64 128	5	4.8	0.2	5	4.8	0.2
Oust Karmex Surflan	3 64 64	1	0.95	0.05	2	1	1

[1] Includes all plants emerging from seed this season.

[2] Cover values were derived by estimating the total percent cover in the plot, then estimating the proportion of the vegetation that was previously established compared to arising from seed. The total cover was multiplied by the respective fractions to generate the percent cover for established vs. 'from seed' vegetation.

Table 2: Summary of control provided by postemergence applications to a guiderail. Treatments were applied May 6, 1999. Application rates are reported in ounces of product/acre.

Treatment	Application Rate	Total Green Cover		
		May 13	June 10	July 7
	(oz/acre)			
Oust + Karmex	3 + 128	25	1	1
Oust + Karmex + Roundup Pro	3+128+64	35	1	1
Oust + Karmex + Finale	3+128+64	25	2	2
Oust + Karmex + Reward	3+128+32	25	2	1
Oust + Karmex + Velpar L	3+128+48	50	5	1
Oust + Karmex + Roundup Pro + Arsenal	3+128+32+6	25	12	3
Sahara	160	50	7	4
Plateau + Karmex	12+128	40	4	4

1999 RVMC FIELD DAY REVIEW:

LOW VOLUME APPLICATION EQUIPMENT FOR GUIDERAIL TREATMENTS

Herbicide trade and common chemical names: Milestone VM (*azafeniden*), Oust (*sulfometuron*), Roundup Pro (*glyphosate*), Karmex (*diuron*), Krovar I (*bromacil + diuron*), Sahara (*diuron + imazapyr*)

INTRODUCTION

Any time the carrier volume for an herbicide application can be effectively reduced, it improves the efficiency of an operation, either through reduced mixing episodes per unit area, the downsizing of equipment, or both.

To date, low volume applications to guiderails have been limited at least partially by the sheer volume of herbicide product that had to be suspended in the carrier when diuron based products such as Karmex, Krovar I, or Sahara are used. These products are commonly used at rates between 6 and 12 lbs per acre. With the impending introduction of Milestone VM herbicide, which is projected as a replacement for diuron at use rates of 10 *ounces* per acre, the suspended herbicide bulk in a spray mixture will be substantially reduced.

The Thinvert system is a carrier and nozzle system designed for low-volume applications in the 3 to 5 gallon/acre range, which would provide a several-fold reduction in carrier volume needed compared to most guiderail applications. The introduction of Milestone VM makes Thinvert a much more viable option for broadcast guiderail applications.

MATERIALS AND METHODS

A mixture of Roundup Pro plus Oust plus Milestone VM at 64, 2, and 10 oz/ac, respectively, in Thinvert was applied to a guiderail on I-78 E in Northampton County from the overpass of SR 3004 to the SR 412 interchange at Hellertown. The rip-rap ditch adjacent to the off-ramp was treated, as well as a portion of the ROW fence along SR 412 N. Application volume was 5 GPA at 10 mph. The application was made from a pickup truck, with the sprayer powered by an electric diaphragm pump, through a WideCast #1534 nozzle, which is designed specifically for use with Thinvert, with a swath width of 4 ft. The application was made on May 10, 1999. Vegetation present was 6 to 8 inches tall.

RESULTS AND DISCUSSION

This demonstration did show the potential utility of Thinvert-based applications relying on Milestone VM as a diuron replacement, but efficacy was difficult to assess. First, it was viewed July 22, 1999 as part of the Roadside Vegetation Management Conference field day tour. Therefore, only two months had elapsed since the application. The southeast portion of Pennsylvania, where this demonstration was located, was under a severe drought during the 1999 growing season. Also, weed pressure at the site was low since a guiderail treatment is made annually to this roadway and rainfall was below normal.

Although the results observed at this site are not conclusive, there are reasons to believe that these materials together with this application method have promise. Similar treatments have been made in other areas of the state with more successful results. Milestone VM, as a replacement for diuron, offers an opportunity to go ultra low volume. The Oust and Milestone are both used at rates of oz/ac versus lbs/ac. The materials have been proven to provide season long vegetation control in other guiderail studies conducted in 1997, 1998, and 1999 at similar rates. At these low use rates they can be effectively applied preemergence. There is reason to believe that this application method and these materials will provide adequate control for use in managing vegetation under guiderails.

1999 RVMC FIELD DAY REVIEW:

SEEDING FLOWERS INTO A HERBICIDE-SUPPRESSED ROADSIDE TURF

Herbicide trade and common chemical names: Roundup Pro (*glyphosate*), Transline (*clopyralid*),
Plant common and scientific names: tall fescue (*Festuca arundinacea*), creeping red fescue (*Festuca rubra* ssp. *rubra*), Kentucky bluegrass (*Poa pratensis*), crownvetch (*Coronilla varia*)

INTRODUCTION

In the pursuit of roadside beautification, annual flower mixes arguably provide the cheapest 'show'. However, at the conclusion of the growing season, the only perennials in the flower plots are weeds. If the area is going to be reused continually, this is not a problem, as the perennial weeds will be eliminated prior to reseeding the following spring. However, should the program be discontinued, the planting area, now free of permanent vegetation, will need to be re-established.

The objective of this demonstration was to temporarily suppress roadside turf with an herbicide application to allow the establishment of a flower mixture, but have the turf recover by season's end. With the turf remaining as a groundcover, it could reduce weed competition with the flowers and provide the flexibility of changing the location of the wildflower planting each year. If the flower planting is going to be discontinued, the area can simply be integrated back into the regular maintenance program.

Prior to this effort, the Project had successfully established flowers in suppressed tall fescue for two successive years at the Landscape Management Research Center at Penn State. A field demonstration for the 1997 Roadside Vegetation Management Conference in Indiana, PA, was less successful, due apparently to insufficient suppression of the tall fescue turf. With these experiences in mind, it was our intent to establish both an annual and perennial flower mix in a suppressed turf. The annual plot would be reseeded each season after the turf had been suppressed. The perennial plot was intended to be more along the lines of a meadow, where the grass would be suppressed to allow establishment of the perennial forbs, but would then recover and be the primary component of the stand, and would not be subsequently suppressed.

MATERIALS AND METHODS

The plots were located along the on-ramp to I-78 W at the Hellertown (SR 412) interchange. The 270 by 30 ft plots were sprayed April 23, 1998, with Roundup Pro plus Transline at 49 plus 3 ounces/ac, respectively, with a motorized backpack sprayer and a hand-held boom. Species present included tall fescue, creeping red fescue, crownvetch, and Kentucky bluegrass. Average canopy height was about 8 inches. Bluegrass was at seedhead emergence, all other grasses were pre-boot stage. The areas were broadcast seeded by hand, and sliced several times with an Olathe 93 overseeder, set to produce 0.5 inch deep grooves on 3 inch centers. Each flower mixture was seeded at 10 lb/ac. The annual and perennial flower mixes are shown in Tables 1 and 2.

RESULTS AND DISCUSSION

The herbicide application appeared to kill the bluegrass, suppressed the tall fescue quite well, but acted as a release program for the creeping red fescue. In spots where the red fescue was thin, there was some establishment of cosmos and sulfur cosmos in the annual mix plots, and some blackeyed Susan in the perennial plots. Otherwise, the creeping red fescue grew unimpeded and made it nearly impossible for any flowers to become established. Although a broadleaf herbicide was necessary to suppress the crownvetch, Transline was a poor choice, as even the 3 oz rate left enough active residue to cause symptoms on about 50 percent of the annuals observed. Herbicides with less soil activity that might be better alternatives for this type of application include 2,4-D or triclopyr.

Trying to *suppress* a multi-species stand of turf to establish flowers is very difficult, due to the varying tolerances of each species to glyphosate. Most areas of roadside turf have been seeded to Formula D, a mixture of tall fescue and creeping red fescue. Although the creeping red fescue is not always readily apparent, it is there, and suppression of this mixed stand will probably results in release of the red fescue, and most likely few flowers. Therefore, it is unlikely that a stand of roadside turf could be successfully suppressed enough to allow establishment of flowers without eliminating all but the creeping red fescue.

Perhaps the best place to maintain plantings of annual flowers is in designated permanent plots in interchanges that have been beautified with judicious plantings of trees, shrubs, and low maintenance groundcovers. These areas would become known focal points, and would allow a DOT to have a very visible beautification effort, on fewer acres.

Table 1: Annual seed mix, seeded at 10 lb/ac.

Common Name	Latin Name	Percent of Mix
cosmos	*Cosmos bipinnatus*	40
sulfur cosmos	*Cosmos sulphureus*	40
cornflower	*Centaurea cyanus*	13
blackeyed Susan	*Rudbeckia hirta*	7

Table 2: Perennial seed mix, seeded at 10 lb/ac.

Common Name	Latin Name	Percent of Mix
oxeye daisy	*Leucanthemum vulgare*	16
purple coneflower	*Echinacea purpurea*	16
blackeyed Susan	*Rudbeckia hirta*	16
perennial lupine	*Lupinus perenne*	16
dense blazingstar	*Liatris spicata*	16
lance-leaved coreopsis	*Coreopsis lanceolata*	16
New England aster	*Aster novae-angliae*	2
Canada goldenrod	*Solidago canadense*	2