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DEPARTMENT OF TRANSPORTATION

PENNDOT

ROADSIDE VEGETATION MANAGEMENT
RESEARCH REPORT
EIGHTEENTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY

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The eighteenth 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:
Large-scale demonstration to remove ailanthus from a limited access corridor.
Evaluating non-target injury due to Krenite S.
Controlling tree-of-heaven and converting the site to fine fescue.
Comparing different glyphosate formulations for controlling perennial plants.
Evaluating Overdrive and other standard mixtures for control of Canada thistle.
Controlling giant knotweed and converting to fine fescue.
Evaluating herbicides and treatment frequency for control of reed canarygrass in a created wetland.
Review of 2003 Roadside Vegetation Management Conference Field Day.

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

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Monsanto
Syngenta Professional Products

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TABLE OF CONTENTS

INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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- Tenth Year Report

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- Eleventh Year Report

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

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

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

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

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

Report # PA03-4620 + 85-08 - Roadside Vegetation Management Research Report
- Seventeenth 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 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 the 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 and roadside vegetation management demonstrations. Herbicides are referred to as product names for ease of reading. The herbicides used are listed on the following page by product name, active ingredients, formulation, and manufacturer.

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

Trade Name	Active Ingredients	Formulation	Manufacturer
Arborchem Basal Oil	diluent	- - -	Arborchem Products, Inc.
Arsenal	imazapyr	2 S	BASF Specialty Products
Escort	metsulfuron methyl	60 DF	E.I. DuPont de Nemours & Co.
Garlon 3A	triclopyr amine	3 S	DowAgroSciences LLC
Garlon 4	triclopyr ester	4 EC	DowAgroSciences LLC
Glyphosate	glyphosate	4 S	E.I. DuPont de Nemours & Co.
Glypro	glyphosate	5.4 S	DowAgroSciences LLC
Krenite S	fosamine ammonium	4 S	E.I. DuPont de Nemours & Co.
Overdrive	dicamba + diflufenzopyr	0.7S (0.5+0.2)	BASF Specialty Products
QwikWet 357	adjuvant	- - -	Exacto Chemical Company
Roundup PRO	glyphosate	4 S	Monsanto
Stalker	imazapyr	2 EC	BASF Specialty Products
Thinvert RTU	invert emulsion	- - -	Waldrum Specialties, Inc.
Tordon 101M	picloram + 2,4-D	2.5S (0.5+2)	DowAgroSciences LLC
Tordon K	picloram	2 S	DowAgroSciences LLC
Touchdown PRO	glyphosate	3 S	Syngenta Professional Products
Transline	clopyralid	3 S	DowAgroSciences LLC
Triclopyr 3A	triclopyr	3 S	BASF Specialty Products
Vanquish	dicamba-glycolamine	4 S	Syngenta Professional Products
Vista	fluroxypyr	1.5 S	DowAgroSciences LLC

REMOVAL OF WELL-ESTABLISHED AILANTHUS FROM A LIMITED ACCESS CORRIDOR: A PILOT PROJECT

Herbicide trade and common chemical names: Arsenal (*imazapyr*), Escort (*metsulfuron*), *glyphosate*, Garlon 4 (*triclopyr ester*)
Plant common and scientific names: ailanthus (*Ailanthus altissima*), crownvetch (*Coronilla varia*), Japanese honeysuckle (*Lonicera japonica*), smooth sumac (*Rhus glabra*), staghorn sumac (*Rhus typhina*).

ABSTRACT

An operational scale pilot project to clear a 14-mile stretch of SR 22 in Perry County of ailanthus was initiated in 2001. This is an extremely disturbed corridor that parallels the Juniata River. The control phase, consisting of a high volume foliar and a basal bark application, was completed on SR 22 W in August, 2003. The eastbound shoulder and portions of the median were treated with the high volume foliar application in 2001, but will not receive additional treatment until 2004. The project to date has cleared approximately one third of the corridor of ailanthus and has used 10,200 gallons of high volume foliar mixture applied in 364 man-hours, and 50 gallons of basal bark mixture applied in 156 man-hours.

INTRODUCTION

Ailanthus, or tree-of-heaven, is a fast-growing, weak-wooded tree species native to East Asia. It was introduced to the U.S. in the late 18th century for use as a pollution-tolerant urban tree. Ailanthus tolerates infertile, droughty sites, and reproduces by abundant, wind-borne seeds and by producing rapid-growing suckers from its root system. It is ideally suited to grow in disturbed highway corridors. Continued expansion of the U.S. interstate system has created an ideal mechanism to move ailanthus out of the urban areas of the Northeast U.S. and into the surrounding landscapes. Ailanthus is an acute threat to motorists because it can colonize areas adjacent to the roadway quickly, impacting line of sight and presenting a tort liability. Ailanthus also spreads onto adjacent properties quickly. Department ROW are certainly being infested from adjacent properties, but the ROW serves as a conduit to spread ailanthus and facilitate its movement onto uninfested neighboring properties. Failure to remove ailanthus as soon as possible increases maintenance efforts and liability, and hinders the Department's efforts to act as a good neighbor to the rest of the Commonwealth.

The current SR 22 (US Route 22) in Perry County was completed in 1965. This corridor follows the Juniata River through Ridge & Valley physiography. The disturbance to create this corridor included substantial cut and fill sections, with the face of some slopes measuring greater than 300 ft from top to bottom. Based on annual ring counts from a few large stems, it appears that ailanthus began to establish in the corridor on disturbed soils no later than 1972. By the early 1990's, the entire 14-mile corridor through Perry County featured some level of infestation. The infestation was heavy enough to warrant a species-specific management effort. Penn State research project activities in this corridor were initiated in April 1994 with a basal bark application to a two-mile segment that included the SR 34 interchange and the bifurcated median section to the west of the SR 34 interchange. This area was treated on a maintenance basis through 1999. These activities are documented in annual reports from 1995 through 2000. The primary lesson learned from these efforts was that well-established ailanthus infestations require intensive initial effort, and sustained maintenance to be effective. Where terrain permitted, the vegetation was converted from ailanthus to mowable herbaceous vegetation. Ailanthus persisted in cliff areas where applicators could not gain access to effectively treat the ailanthus. The treated ailanthus decayed quickly, and by the third season there were typically no standing remains of the original treated stems.

Between December 11, 1997 and April 29, 1998, Perry County maintenance forces cleared cut-slopes on the east-and west-bound lanes, and all median areas of ailanthus in an area about 3.0 miles in length, centered around the SR 34 interchange. This effort required 2,970 man-hours, and with equipment costs, represented an expenditure of $91,602 (MORIS summary). These areas resprouted vigorously during 1998, and most of the cleared area was treated by Penn State personnel on September 9, 1998 with a backpack-based, low-volume foliar application. This operation required 35 man-hours, and used 95 gallons of a mixture of Krenite S plus Arsenal, at 5 plus 0.5 percent, v/v.

Additionally, there were small-scale studies conducted in the corridor evaluating basal bark diluents, basal bark herbicide mixtures, and dormant stem application techniques. In the fall of 2000, it was decided to take the accumulated experiences and conduct an operational scale clearance of the entire 14-mile SR 22 corridor in Perry County. The setting provided the advantages of having a well-established infestation, challenging terrain, and a wide ROW - in effect, a worst-case scenario. Additional advantages to this location were county management interested in removing the species, and reasonable proximity to both Harrisburg and State College. The premise of the operation is that ailanthus justifies a species-specific effort, and that the infestation on a statewide basis was severe enough that extensive-scale efforts are needed. This pilot project would provide a means to evaluate a corridor-wide clearance project and provide baseline time and materials data.

The project was conceived as having two major phases - control and maintenance. The objective of the control phase was to clear the existing stems on the ROW, and the maintenance phase would consist of periodic operations to treat the inevitable resprouts and seedlings. The accepted premise of the control phase was that the infestation was severe enough that an aesthetic impact was unavoidable.

Due to the extensive nature of the infestation, a high-volume foliar application was selected as the initial clearance method. A high volume foliar treatment applied with a handgun attached to several hundred feet of hose provides the means to get to the targets, and reach most of the canopy of the targets. A basal bark application would be more selective, but due to the high stem density, this technique would be better suited as a follow-up treatment after the majority of the small stems have been eliminated.

MATERIALS AND METHODS

2001 Applications

Clearance treatments were initiated June 25, 2001, with two application crews. The Penn State research project crew had three people, and used a 150 gallon sprayer with a Bean R10 (10 gal/min) piston pump, 150 feet of 0.5 in diameter hose, and a Spraying Systems GunJet AA2AL with a AY-SS 90 spray tip. The second crew was District 8-0's application contractor, Mid-Atlantic Vegetation Management, which was equipped with a 300-gallon sprayer and a 10 gal/min HyPro diaphragm pump and 300 ft of 0.5 in diameter hose. Perry County provided a tank truck for the Penn State crew to refill, and the Mid-Atlantic crew was able to refill at stream access points using a suction pump. The Penn State crew treated the westbound shoulder, Mid-Atlantic treated the eastbound shoulder, and both crews treated some sections of the median during the initial treatment period.

The herbicide mixture was DuPont Glyphosate plus Arsenal, at 128 plus 4 oz/100 gal, plus non-ionic surfactant (CADCO 90) at 0.25 percent , v/v, and PolyControl deposition aid at 4 oz/100 gal. This mix was chosen in an attempt to optimize the balance between efficacy, selectivity, and cost.

Glyphosate plus Arsenal provides broad-spectrum activity against most brush species, but is non-selective. However, very little of the groundcover outside the mow lines in the SR 22 corridor is grass - the most common groundcovers are crownvetch and Japanese honeysuckle. In this setting, there is no advantage to using herbicides such as dicamba or triclopyr from a selectivity aspect. The glyphosate plus Arsenal combination was chosen because it has little soil activity, therefore when the understory is damaged during the application, it should revegetate more quickly. Additionally, the combination is inexpensive. Between July 25 and 27, the Penn State crew applied 1800 gallons of a mixture that included Escort at 0.38 oz/100 gal in addition to the Glyphosate plus Arsenal. Escort has been demonstrated to be very active against ailanthus, and was added in an attempt to extend the reach of the foliar treatments in the sense that a more lethal treatment should provide more injury when the canopy of a target stem was not completely treated.

Between June 25 and July 27, the two crews applied 10,200 gal of spray solution using 162 crew-hours, and treated both shoulders and part of the median (Table 1).

The intent was to treat all ailanthus on the ROW that could be treated. Much of the ailanthus was too tall to be effectively covered by the spray solution. Where well-established, distinct colonies were treated, the typical scenario was to treat as much of the canopy as possible, treat the sprouts in the understory and as much of the underside of the canopy as could be reached.

On October 25, 2001, Penn State personnel applied a basal bark treatment to surviving stems on the westbound shoulder, beginning at the Dauphin County line (Segment 311) and ending at Segment marker 251, using 10 gallons of Garlon 4 plus basal oil, at 25 plus 75 percent, v/v. Ailanthus was in the midst of leaf-drop when this application was made.

2002 Applications

The foliar applications made in 2001 did not provide enough coverage to be considered a one-step control treatment - there were too many stems that were either too tall to adequately cover or were too far from the road to be reached with the 150 ft of hose the Penn State crew had. Therefore, the 2002 applications were still part of the control phase of the project. Basal bark applications were made to the shoulder of SR 22 West on August 19, 21, and 23, beginning at the Dauphin County line, and extending about 6 miles to a large pull-off area in Segment 201. This operation required 77 man-hours, and used 21 gallons of a mix of Garlon 4 plus basal oil, at 25 plus 75 percent, v/v.

This application was not a simple 'mop-up' because the treatment area was expanded during this operation, and the terrain in this section was very challenging due to the size and grade of the cuts and fills. Additionally, many of the stems were quite large, up to 24 inches in diameter.

2003 Applications

When the project was initiated in 2001, it was not anticipated that we would still be in the control phase in the third growing season, on *one side* of the highway. The basal bark treatment resumed on the west-bound shoulder on August 19, 2003, and reached the Juniata County line on August 21. The herbicide mixture was changed to Garlon 4, Stalker, and basal oil, at 15, 3, and 82 percent, v/v, respectively. The Stalker provided another mode of action, as well as soil activity. The application used 40 gal of mix and required 66 man-hours. In addition to finishing the control phase between Segment 201 and the Juniata County line (approximately 8 miles), the previously treated area between the Dauphin County line and Segment 201 was scouted and misses and resprouts were treated. The section treated during this operation featured fewer large cuts and fills than the section treated in 2002, but there was still a significant expansion in the treatment area compared to the foliar application in 2001.

RESULTS AND DISCUSSION

2001 Applications

The Penn State crew had to leave some ailanthus untreated because the targets were too far from the truck, particularly on the larger cut sections. The Mid-Atlantic crew tended to limit application to ailanthus that could be reached from the road shoulder. In this terrain, the three-person crew used by Penn State had the advantage of allowing one person to apply, one person to assist in dragging and maneuvering the hose, and the third person to continually move the vehicle. This approach left the tall stems in the center of the clone intact, but eliminated the perimeter of the clone, and also opened up the interior of the clone to make subsequent basal bark treatments easier.

The high-volume approach occasionally hindered selectivity, particularly when hard-to-reach ailanthus was mixed with non-target species and the applicator tried to reach the target from some distance. Due the similar appearance of ailanthus and sumac species, smooth sumac and staghorn sumac were occasionally treated when applicators got a little 'trigger happy'. The high-volume technique was also limiting from a selectivity point of view at the Watts interchange, where small sprouts growing between two clones in the grass infield were treated, eliminating much of the grass. Clearly, these sprouts could have been left for a subsequent basal bark application and the turf would not have been injured. Such considerations need to part of the training application crews will receive when undertaking this type of treatment.

No attempt was made to systematically quantify the canopy reduction. A rough estimate summarizing the efforts on the west-bound shoulder would be that 90 percent of the ailanthus was targeted, 90 percent of the targeted stems were eliminated, and the ailanthus canopy was reduced 60 percent. A significant portion of the ailanthus was too tall to be effectively treated, and these large stems contributed significantly to the canopy. However, the foliar treatment greatly reduced the number of stems to be treated and made access to those remaining stems much easier.

The basal bark treatment applied in October 2001 was ineffective. We had hoped to make the application just prior to the onset of fall color, or very early in fall coloration. We were late, and did not get to apply until ailanthus was at the leaf-drop phase. We hypothesize that we were treating the ailanthus at the worst possible time - when the plant had just gone into dormancy.

The triclopyr in the spray mixture had five to six months to degrade before active growth began again in spring.

2002 Applications

The 2002 basal bark treatments were a combination of control and maintenance application. Both elements were effective as misses, sprouts, and seedlings were easily dispatched, and ailanthus that was too far up cut-slopes or too far down fill-slopes to be treated with the 2001 foliar operation could be reached with the backpack-based basal bark treatment.

Misses during the basal bark application were factor of probability and size. In large clones with hundreds of stems on steep terrain, misses are inevitable. Very large stems (greater than 20 in caliper) were not always killed when treated. Examination of the stems revealed that there were still areas of viable cambium, usually in areas with thicker bark where buttress roots came together or where injuries had occurred years before. These uncontrolled stems always had significant canopy reduction, usually in the 65 to 95 percent range.

The August timing provided excellent control of the treated stems and resprouting was minimal, compared to the April timings in 1994. Negative aspects of an August timing are heat, and dense ground level vegetation.

2003 Applications

The 2003 basal bark applications completed the control phase on the westbound shoulder of SR 22, and also served as another opportunity to scout for misses in the section treated in 2002. The 2003 section featured a greater proportion of large stems than the 2002 application as much of the treated area featured well established clones at the bottom of fill slopes and the top of cut slopes. The application was very successful, with non-control due to misses in dense areas, partial control of larger stems, and areas where stems were growing on cliff faces.

CONCLUSIONS

The applications to date have been highly effective. A quick visual comparison between the westbound shoulder and the much-less-treated median and eastbound shoulder reveals a striking difference - the difference between almost no ailanthus and an infestation that is thirty-plus years old. However, the ailanthus removal is not happening fast enough. In situations such as the Perry County SR 22 corridor, where the ROW and the infestation are extensive, the depth of clearance from the roadway needs to be reduced so that more miles can be treated.

Leaving ailanthus untreated on the ROW to produce suckers and rain seed into the cleared area has an element of counter productivity to it, but where infestations are severe, finite resources are best used eliminate the infestation in proximity to the roadway, then expand the treated area during follow-up visits.

MANAGEMENT IMPLICATIONS

Ailanthus is a species that is not effectively contained by the standard elements of the Department's roadside vegetation management program. It grows too large, too fast, and needs to be prevented from gaining any more of a foothold on the ROW. To effectively keep ailanthus in check, it will need to be specifically targeted. Therefore districts will need a large enough applicator complement on hand to complete the standard elements of the bareground, and weed and brush programs to leave sufficient time to target ailanthus prior to the beginning of the Krenite program in August. In a setting such as Perry County, with an established infestation in two highly disturbed corridors (SR 22, Juniata River; SR 11/15, Susquehanna River) and its proximity to a metropolitan area, a two-week block of time would probably be needed to accomplish a cycle of ongoing clearance as well as follow-up to previously cleared areas.

The ailanthus problem can only become more severe. The sooner a significant investment is made to begin an extensive control program, the less it will cost in the long term.

Table 1: Summary of time and materials for ailanthus management activities along the SR 22 corridor in Perry County. These efforts have resulted in complete initial treatment of the westbound shoulder, and partial treatment of the median and eastbound shoulder.

Date	Crew	Treatment	Mix	Gallons	Crew Hours	Total Hours
6/25/01	PSU	high volume foliar (HVF)	Glyphosate 4 qt/100 gal Arsenal 4 oz/100 gal (Gly/Ars)	700	8	24
6/25/01	M-A	HVF	Gly/Ars	400	8	16
6/26/01	PSU	HVF	Gly/Ars	450	7	21
6/26/01	M-A	HVF	Gly/Ars	500	9	18
6/27/01	PSU	HVF	Gly/Ars	600	8	24
6/27/01	M-A	HVF	Gly/Ars	600	9	18
6/28/01	PSU	HVF	Gly/Ars	150	2.25	6.75
6/28/01	M-A	HVF	Gly/Ars	400	8	16
6/29/01	PSU	HVF	Gly/Ars	600	8	24
6/29/01	M-A	HVF	Gly/Ars	400	8.5	17
7/2/01	PSU	HVF	Gly/Ars	600	8	24
7/2/01	M-A	HVF	Gly/Ars	500	10	20
7/9/01	M-A	HVF	Gly/Ars	200	4.5	9
7/10/01	M-A	HVF	Gly/Ars	400	8	16
7/12/01	M-A	HVF	Gly/Ars	500	9	17
7/13/01	M-A	HVF	Gly/Ars	400	8	16
7/16/01	M-A	HVF	Gly/Ars	600	9	18
7/17/01	M-A	HVF	Gly/Ars	400	7	14
7/25/01	PSU	HVF	Gly/Ars Escort 0.38 oz/100 gal (Gly/Ars/Escort)	600	6	12
7/26/01	PSU	HVF	Gly/Ars/Escort	600	8	16
7/27/01	PSU	HVF	Gly/Ars/Escort	600	8	16
10/25/01	PSU	Basal Bark	Garlon 4 25% v/v Basal Oil 75% v/v (G4/oil)	9.8	7	14
8/19/02	PSU	Basal Bark	G4/oil	10	7	28
8/21/02	PSU	Basal Bark	G4/oil	10	7	28
8/23/02	PSU	Basal Bark	G4/oil	10	7	21
8/19/03	PSU	Basal Bark	Garlon 4 15 % v/v Stalker 3 % v/v Basal oil 82 % v/v (G4/Stalker/oil)	12	7	21
8/20/03	PSU	Basal Bark	G4/Stalker/oil	16	7	21
8/21/03	PSU	Basal Bark	G4/Stalker/oil	12	6	24

EVALUATION OF NON-TARGET INJURY DUE TO APPLICATIONS OF KRENITE S

Herbicide trade and common chemical names: Arsenal (*imazapyr*), Krenite S (*fosamine*)
Plant common and scientific names: crownvetch (*Coronilla varia*), dandelion (*Taraxacum officinale*), plumeless thistle (*Carduus acanthoides*).

ABSTRACT

Krenite S applied September 4, 2003, alone or in combination with Arsenal caused near-complete non-selective injury to a mixed stand of roadside vegetation, and reduced crownvetch cover 92 to 98 percent by June 22, 2004. The addition of Arsenal to Krenite S applied at 192 oz/ac caused a significant decrease in groundcover and increase in injury to crownvetch, plumeless thistle, and dandelion, compared to Krenite S alone at that rate, when evaluated 33 days after treatment. Groundcover ratings returned to original levels by June 22, 2004, 41 weeks after treatment.

INTRODUCTION

Non-target injury is an ongoing concern with Krenite S applications used to sidetrim roadside brush. To achieve greater brush clearance, spray patterns are configured to reach increasingly higher and wider. As greater areas are targeted, there is greater potential for non-target contact.

When added as part of a Krenite-based mixture, application rate of the herbicide Arsenal is commonly regarded as the determining factor in phytotoxicity. Based on previous research results, and observations of operational applications, we believe that a more important factor influencing phytotoxicity is Krenite S application rates that are higher than those programmed into the spray control computer on the spray truck. In spray trucks that use a control system that modifies application rate based on ground speed and target width, the application rate is based on the swath width programmed into the computer. This swath width is typically determined by calibrating on a horizontal or vertical surface. The spray vehicle does not have a monitoring system to determine what the actual width of the spray pattern as it contacts the target- this is accomplished through operator input. Trucks calibrated for a horizontal, or vertical swath width will not be applying the projected rate on the majority of brush targets or contacted understory, as few roadside targets outside the mowed shoulder present themselves as a horizontal or vertical surface. Where the contacted surface is an upward slope, a horizontally calibrated pattern will be delivering a higher application rate because the pattern is falling on a smaller area.

The objective of this trial was to evaluate Krenite S alone and in combination with Arsenal on a groundcover typical of areas where brush is targeted - a mixed species stand of crownvetch. Applying these treatments with a fixed-pattern sprayer on a flat surface would provide information about what rates are injurious to groundcover. This information could be used as a benchmark to visually estimate application rates when understory damage does occur.

MATERIALS AND METHODS

The trial was initiated in the infield at the interchange of SR 26 and SR 64, near Pleasant Gap, PA. Krenite S was applied alone at 192, 256, or 384 oz/ac; at 192 oz/ac in combination with Arsenal at 1, 2, or 4 oz/ac; and Arsenal was applied alone at 1, 2, or 4 oz/ac. These treatments were applied at 30 gal/ac using a CO_2-powered, hand-held boom equipped with

TeeJet XR 8004 VS tips, to 6 by 20 ft plots arranged in a randomized complete block with three replications. All treatments included CADCO 90 nonionic surfactant at 0.25 percent, v/v.

Total cover, percent cover from crownvetch, and species present were rated for each plot on the day of treatment. Subsequent ratings included percent cover and percent injury to crownvetch, plumeless thistle, and dandelion on October 7; percent cover on May 6, 2004; and percent cover and percent crownvetch on June 22, 2004. Crownvetch cover data from June 22 was used to calculate percent of original using the formula [crownvetch cover June 22 (%)/crownvetch cover September 4 (%) * 100]. Data were subjected to analysis of variance and treatment means were compared using Fisher's Protected LSD (p=0.05). The untreated check plots were assigned ratings of zero, and therefore were not included in the analysis of percent injury on October 7.

RESULTS AND DISCUSSION

All herbicide treatments resulted in a significant reduction in cover when rated October 7, 33 days after treatment (DAT) (Table 1). There was no significant difference between rates of Krenite S alone, or between rates of Arsenal alone. Plots treated with Krenite S at 192 oz/ac plus Arsenal had the greatest reduction in groundcover, and these combination plots that were treated with the 2 or 4 oz/ac rate of Arsenal has significantly less cover than any rate of Krenite S or Arsenal alone. Injury ratings followed a similar trend in that there were no significant differences between rates of Krenite S alone, or between rates of Arsenal alone for any species. Plots treated with the combination of Krenite S at 192 oz/ac plus Arsenal at 4 oz/ac had significantly higher injury ratings than plots treated with Krenite S alone or Arsenal alone for all species.

The untreated plots averaged 95 percent cover on May 6, 2004, while the highest rating for plots treated with Krenite S, alone or in combination with Arsenal, was 4 percent. The plots treated with Arsenal alone ranged from 33 to 53 percent cover.

On June 22, 2004, cover ranged from 93 to 100 percent. Vegetative cover had returned to pretreatment levels, but species composition was significantly altered. The untreated check had a percent-of-original crownvetch cover of 142 percent (increase from 51 to 65 percent from September to June). Plots treated with Arsenal at 1 or 2 oz/ac were not significantly different from the untreated check, at 112 and 105 percent. Plots treated with Arsenal alone at 4 oz/ac had 70 percent of the original crownvetch. Plots treated with Krenite S, alone or in combination with Arsenal had percent-of-original crownvetch values from 2 to 8. Within the timeframe of the study the Krenite S treatments provided short-term results expected from a non-selective, non-residual treatment such as glyphosate, but they nearly eliminated crownvetch from the plots. It has been our observation that crownvetch areas treated with glyphosate usually recover to original or greater proportions of crownvetch (see 'Comparison of Different Glyphosate Formulations for Control of Canada Thistle and Crownvetch: Second Year Results' in this report). It appears that Krenite S may be much more lethal to crownvetch than glyphosate. The Krenite S dosages evaluated failed to identify a non-lethal rate.

CONCLUSIONS

When applied at 192 oz/ac or more, Krenite S, alone or with the addition of Arsenal, results in the near-elimination of crownvetch-dominated groundcover. Arsenal alone did little long-term damage to the crownvetch at the lower rates used in this study.

MANAGEMENT IMPLICATIONS

The Krenite S sidetrim program conducted by the Department is relied upon to provide significant clearance of encroaching brush, and to prevent the need for mechanical clearance. The herbicide mixtures used for this application are non-selective and will cause substantial injury to herbaceous groundcover that is contacted. There are spray vehicles available with multiple-pattern, boomless spray heads with up to seven independent swaths. Equipment with this type of capability can provide the desired height and depth of spray coverage and provide the operator the flexibility to avoid treating areas of non-target vegetation. The Department should place a priority on specifying vehicles with this capability, and providing the training to applicators to most effectively use these vehicles.

Table 1. Vegetation response to herbicide treatments applied September 4, 2003, and evaluated October 7, May 6, 2004, and June 22, 2004. Percent injury was visually evaluated October 7 for crownvetch (CZRVA), plumeless thistle (CRUAC), and dandelion (TAROF). Each value is the mean of three replications. The untreated plots were assigned injury ratings of zero on October 7, and were not included in the analysis of variance.

Product	Application Rate	Sep 4 Total Cover	Oct 7 Total Cover	Oct 7 CZRVA Injury	Oct 7 CRUAC Injury	Oct 7 TAROF Injury	May 6 Total Cover	Jun 22 Total Cover
		%	%	%	%	%	%	%
untreated	- -	96	99	0	0	0	95	98
Krenite S	192	95	77	57	60	72	3	95
Krenite S	256	93	83	50	57	70	3	93
Krenite S	384	97	85	57	57	70	2	95
Arsenal	1	94	77	63	70	70	43	100
Arsenal	2	95	73	72	70	72	53	100
Arsenal	4	96	67	72	70	73	33	98
Krenite S Arsenal	192 1	95	60	73	73	77	4	95
Krenite S Arsenal	192 2	97	48	80	73	83	1	95
Krenite S Arsenal	192 4	95	37	92	83	87	2	97
Protected LSD (p=0.05)			13	14	11	9	14	4

Table 2. Response of crownvetch (CZRVA) to herbicide treatments applied September 4, 2003, when evaluated June 22, 2004. CZRVA percent of original was calculated as CZRVA cover June 22 (%)/CZRVA cover September 4 (%)*100. Each value is the mean of three replications.

Product	Application Rate	Sep 4 Total Cover	Sep 4 CZRVA Cover	Jun 22 Total Cover	Jun 22 CZRVA Cover	Jun 22 CZRVA Percent of Original
		%	%	%	%	%
untreated	- -	96	51	98	65	142
Krenite S	192	95	62	95	2	3
Krenite S	256	93	61	93	4	7
Krenite S	384	97	73	95	6	8
Arsenal	1	94	61	100	68	112
Arsenal	2	95	60	100	62	105
Arsenal	4	96	56	98	38	70
Krenite S Arsenal	192 1	95	55	95	3	6
Krenite S Arsenal	192 2	97	55	95	4	8
Krenite S Arsenal	192 4	95	63	97	2	2
Protected LSD (p=0.05)					18	48

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

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

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

ABSTRACT

A demonstration was established in March 1996 to investigate the long-term success of eliminating an existing ailanthus stand while using groundcovers and periodic, selective herbicide treatments to prevent reinfestations from occurring. Initially, the ailanthus stand was treated with a basal bark application followed later that year by a low volume foliar treatment. Half the site was seeded to PENNDOT Formula L seed mixture. Herbicide spot treatments were made in 1997, 2000, and 2003 to control ailanthus resprouts. There have been very few ailanthus stems to treat during the last two visits. Where naturally occurring groundcovers do not exist grasses should be seeded to compete against ailanthus resprouts that attempt to return.

INTRODUCTION

Tree-of-heaven, or ailanthus, is a problematic tree species along roadway corridors throughout the northeastern United States. It is a root-suckering species that forms large colonies where it becomes established. This tree, capable of growing to heights of 80 ft, is weak wooded and spreads readily. It is capable of spreading not only by the wind-borne seed it produces but also through vigorous suckering and transport of root fragments in soil. This tree has no significant insect or disease pests in the U.S. and has the ability to grow in poor soils and under stressful environmental conditions. Because it grows in full sun and thrives in poor growing conditions the roadside environment provides a tremendous opportunity for the establishment, growth, and spread of this tree. Its size, weak wood, rate of growth and spread, and its difficulty to control, make this a truly problematic species. This project was initiated for the 1997 Roadside Vegetation Management Conference field day to demonstrate the combination of chemical control of ailanthus with the cultural technique of establishing a competitive groundcover. Ailanthus is a species that can be characterized as an 'underground' perennial - the focus of a management program is the root system. After eliminating the canopy, management efforts must include follow-up treatment of suckers and periodic maintenance treatments to prevent reinfestation. A groundcover that competes with the ailanthus root system and facilitates selective control of suckers enhances long-term management.

Previous results from this site have been reported in the Roadside Vegetation Management Thirteenth[1/] and Fifteenth[2/] Year Reports.

[1/] Control of Tree-of-Heaven and Conversion to Fine Fescue. 1998. Roadside Vegetation Management Research Report - Thirteenth Year Report. http://rvm.cas.psu.edu/1998/AR1998.html

MATERIALS AND METHODS

The demonstration site was located in an infield at the intersection of SR 22 West and SR 217. The ailanthus infestation was approximately 0.75 acres in size. The stand was divided into two distinct areas by an old roadbed. One side had a dense understory of the vine Japanese honeysuckle, and the other side was a thin stand of mixed herbaceous vegetation. The honeysuckle side was not seeded during the course of the demonstration to determine whether the naturally occurring vegetation would provide a more competitive groundcover than that seeded to Formula L. The diameter of the ailanthus stems ranged from 0.25 to 12 in. The first treatment was a basal bark application made on March 22, 1996. The solution used was 20 percent (v/v) Garlon 4 and 80 percent (v/v) Arborchem Basal Oil. The lower 15 to 18 in of all the stems were treated. On September 4, 1996 all ailanthus resprouts were treated with a low volume foliar application of 4 percent (v/v) Roundup Pro, 1 percent (v/v) Garlon 3A, and 0.25% (v/v) Formula 358 drift control. The foliar application also targeted other unwanted species including poison ivy. Species such as dogwood, hawthorn, and sycamore were not targeted by the application. Equipment for both treatments included backpack sprayers with basal wands or handguns and a Spraying Systems adjustable ConeJet nozzle with Y-2 tip. The non-honeysuckle portion of the area was seeded to a mixture of 60% hard fescue and 40% creeping red fescue on September 19, 1996. The seed was applied at 115 lbs/ac using hand seeders. On September 22, 1997, a selective low volume foliar application Garlon 4 plus Escort at 5 percent, v/v, plus 1 oz/20 gal, respectively, was made to control existing ailanthus resprouts and other unwanted vegetation. This mixture included 0.25 percent v/v Polytex A1001 drift control and 0.12 percent v/v QwikWet 357 surfactant.

A low volume foliar treatment was applied on August 4, 2000, using backpack sprayers equipped with Spraying Systems #5500 Adjustable ConeJet nozzles and Y-2 tips. Four gallons of a 5 percent (v/v) solution Tordon 101M was applied to the site. The targets included not only the ailanthus, but also poison ivy, privet, red maple, grape, and some Japanese honeysuckle.

A basal bark application was made September 30, 2003, targeting ailanthus, multiflora rose, and privet. The herbicide mixture contained a 15:3:82 percent (v/v) mixture of Garlon 4, Stalker, and Arborchem Basal Oil. Approximately 1 quart of the herbicide solution was applied. The application equipment included a backpack sprayer equipped with a Spraying Systems Spraying Systems #5500 Adjustable ConeJet nozzles and Y-2 tips.

Activities at the site are summarized in by time and materials in Table 1.

RESULTS AND DISCUSSION

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

Four gallons of solution were sprayed on August 4, 2000 versus 1.6 gallons on September 22, 1997. Three years had past between these follow-up visits and ailanthus resprouts were present

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[2/] Update: Evaluation of Giant Knotweed Control and Conversion into Fine Fescues. 2000. Roadside Vegetation Management Research Report - Fifteenth Year Report. http://rvm.cas.psu.edu/2000/AR2000.html but, minimal. Other troublesome species were targeted during both visits. The area left with an understory of honeysuckle remained intact with scattered ailanthus resprouts. These resprouts were easily targeted selectively with the low volume foliar application. The area seeded to fine fescue has largely been transformed to a stand of these grasses.

Only five ailanthus stems were found during the treatment on September 30, 2003. The tallest was 7 feet. Japanese honeysuckle continued to thrive on one half of the infield area where it formed a nearly impenetrable groundcover. The infield was used as a staging area for construction activity in recent years. As a result, much of the fine fescue was destroyed. Japanese honeysuckle has infiltrated this part of the infield as well - possibly moved during the construction activity. It now occupies nearly 50 percent of the area seeded to fine fescue.

CONCLUSIONS

Seven years after the initial treatment the area still remains nearly free of ailanthus. Periodic management is necessary to prevent ailanthus and other troublesome species from invading the site. Minimal time and material has gone into the maintenance of this location since the ailanthus was controlled. The approaches of leaving naturally occurring understory where it exists or establishing grasses have both proven successful with this demonstration.

MANAGEMENT IMPLICATIONS

This project demonstrates that a stand of ailanthus can be successfully converted to fine fescue. Selectively controlling the ailanthus and converting the area to a competitive groundcover is economically feasible and offers long-term benefits. The Japanese honeysuckle proved to be a competitive, naturally occurring groundcover, though in many settings this species is an invasive species and may warrant removal. Where areas are devoid of an existing groundcover grasses are a logical choice for establishment. They are competitive and selective chemistry can be used to control the ailanthus and other broadleaf weeds without destroying the integrity of the groundcover.

Table 1: Cost figures for converting an established stand of ailanthus to fine fescue. The treatments outlined are the five visits made from 1996 to 2003. Labor costs are based on $20.00/hr.

Treatment	Date	Material Cost	Man-hours	Labor Costs
Basal Bark	3/26/96	$76.18	4	$80.00
Low Volume Foliar	9/04/96	$37.80	2	$40.00
Seeding	9/19/96	$79.90	2	$40.00
Low Volume Foliar	9/22/97	$7.64	1.5	$30.00
Low Volume Foliar	8/04/00	$6.66	1.5	$30.00
Basal Bark	9/30/03	$7.38	0.5	$10.00

Total Cost (to date) = $445.56 for treating 0.75 ac and seeding 0.40 ac.

Based on these figures, it would cost $733.96/ac to initially treat, seed, and provide three subsequent follow-up treatments on a similar ailanthus infestation.

A COMPARISON OF DIFFERENT GLYPHOSATE FORMULATIONS FOR CONTROL OF CANADA THISTLE AND CROWNVETCH: SECOND-YEAR RESULTS

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

ABSTRACT

Touchdown PRO and Roundup PRO were compared alone at three rates, and at one rate in combination with Escort, for control of a mixed stand of Canada thistle and crownvetch. A single rate of GlyPro was applied as a standard treatment. Treatments were applied June 7, 2002. On August 8, 2002, crownvetch control ranged from 96 to 99 percent for glyphosate-alone treatments, and 100 percent for the combinations including Escort. On September 6, 2002, Canada thistle control was rated at 92 to 95 percent for plots treated with the Escort combinations, and 23 to 60 percent for plots treated with glyphosate alone. Average thistle control ratings for Roundup PRO-alone treatments were higher than for Touchdown PRO, but the difference was not significant. There was a difference between the PRO formulations applied alone for vegetative cover on September 6. Roundup PRO-alone treatments averaged 23 to 28 percent cover, and Touchdown PRO treatments averaged 31 to 46 percent cover. Plots treated with combinations including Escort had 2 to 4 percent vegetative cover on September 6. When rated July 10, 2003, 13 months after treatment, plots treated with combinations including Escort had significantly less total cover and less crownvetch cover than plots treated with similar rates of glyphosate alone. There were no cover differences between plots treated with different glyphosate formulations. Plots treated with glyphosate alone had similar ratings for total cover at the beginning and end of the trial, and crownvetch cover increased in all glyphosate-alone treatments, regardless of rate.

INTRODUCTION

The U.S. patents on glyphosate and the isopropylamine salt formulation of glyphosate expired in 1991 and 2000, respectively. Most glyphosate products on the market are isopropylamine salts, many of which are repackaging of product manufactured by Monsanto, utilizing the regulatory data generated by Monsanto[1]. Prior to 2000, the primary improvement in herbicides containing glyphosate for the non-crop market was surfactant-loaded technology, which eliminated the need to add surfactant to glyphosate spray mixtures. Syngenta (merger of Zeneca and Novartis) is the only herbicide manufacturer other than Monsanto to market a unique glyphosate formulation. Touchdown PRO is a surfactant-loaded diammonium salt formulation of glyphosate, and is a market equivalent of Roundup PRO or GlyPro Plus.

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

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

MATERIALS AND METHODS

The study was initiated June 7, 2002 in the median of SR 322, between the Port Royal and Thompsontown exits near the segment 270 marker. Treatments were applied to 12 by 30 ft plots arranged in a randomized complete block design with four replications, using a CO_2-powered, hand-held, fixed-boom sprayer equipped with Spraying Systems XR8002 VS flat fan spray tips, delivering 20 gal/ac at 26 psi. Crownvetch was up to 24 in tall, at bud to early bloom stage, and Canada thistle was 18 to 48 in tall, in bud to early bloom stage. Treatments included Touchdown PRO or Roundup PRO alone at 64, 128, or 160 oz/ac, equivalent to 1.5, 3.0, and 3.75 lb glyphosate acid equivalent (ae) per acre, respectively. The 128 oz/ac rate of Touchdown PRO or Roundup PRO was also combined with Escort at 1 oz/ac. GlyPro at 96 oz/ac (3 lb ae/ac) plus organosilicone-blend surfactant at 0.1 percent, v/v, was included as a standard treatment.

The following visual evaluations were taken: percent total cover, and percent cover from crownvetch or Canada thistle on June 7; percent control of crownvetch and Canada thistle on June 24, July 9, and August 8; and percent control of Canada thistle and percent cover on September 6, 2002. Final ratings of percent total cover, crownvetch cover, and Canada thistle cover were taken July 10, 2003. Data from the untreated check were not included in the analysis of percent control because a value of zero was arbitrarily assigned to these plots. Data were subject to analysis of variance, and means compared using Fisher's Protected LSD.

RESULTS

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

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

Plots treated with Escort averaged 2 or 4 percent vegetative cover at the September 6 rating, glyphosate alone treatments averaged 23 to 49 percent, and the untreated check had 45 percent cover. An orthogonal contrast used to test whether there were differences in ratings for vegetative cover between plots treated with Touchdown PRO or Roundup PRO was significant. Plots treated with Touchdown PRO had 31 to 46 percent cover, while plots treated with Roundup PRO had 23 to 28 percent cover.

There was no difference in total cover or crownvetch cover between the untreated plots and plots treated with glyphosate alone on July 10, 2003, 13 months after treatment (Table 3). The plots that had been treated with glyphosate plus Escort had significantly less total cover and cover from crownvetch at this rating. There was no significant treatment effect for Canada thistle cover on July 10. Canada thistle had largely senesced by the July 10 rating, so evaluating cover was more difficult than compared to species with foliage.

CONCLUSIONS

In this trial, the presence or absence of Escort was the dominant factor affecting first-season control of Canada thistle or vegetative cover. The effect of glyphosate formulation was not directly apparent, as there were no significant differences in control of crownvetch or Canada thistle, or on subsequent regrowth when evaluated 13 months after the original treatment.

MANAGEMENT IMPLICATIONS

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

In situations where crownvetch removal is desired, clearly glyphosate alone is not effective - in fact, glyphosate could almost be considered as a viable treatment to remove other species from crownvetch

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

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

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

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

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

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

Table 3: Response of a mixed stand of crownvetch and Canada thistle treated with herbicides on June 7, 2002. Total cover, and cover from crownvetch (CZRVA) and Canada thistle (CIRAR) was visually rated June 7, 2002 (day of treatment) and July 10, 2003. Each value is the mean of four replications.

		Cover					
	Application	June 7, 2002			July 10, 2003		
Treatment	Rate	Total	CZRVA	CIRAR	Total	CZRVA	CIRAR
	oz/ac	%					
untreated check	- -	86	21	52	91	60	9
GlyPro	96	75	12	53	88	46	16
Touchdown PRO	64	81	22	52	77	45	18
Touchdown PRO	128	83	16	53	80	48	16
Touchdown PRO	160	78	7	63	76	33	7
Roundup PRO	64	84	15	52	77	41	9
Roundup PRO	128	80	27	34	86	54	6
Roundup PRO	160	78	20	40	78	44	11
Touchdown PRO Escort	128 1	79	26	37	53	10	3
Roundup PRO Escort	128 1	80	28	40	54	8	2
LSD (p=0.05)					16	34	n.s.

CONTROL OF CANADA THISTLE PROVIDED BY OVERDRIVE HERBICIDE AND STANDARD MIXTURES

<u>Herbicide trade and common chemical names</u>: Overdrive (*dicamba plus diflufenzopyr*), Transline (*clopyralid*), Triclopyr 3A (*triclopyr amine*) and Vanquish (*dicamba*)
<u>Plant common and scientific names:</u> bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), fineleaf fescues (*Festuca* spp.), plumeless thistle (*Carduus acanthoides*), prickly lettuce (*Lactuca serriola*), tall fescue (*Lolium arundinaceum* [=*Festuca arundinacea*]), and wild carrot (*Daucus carota*).

ABSTRACT

Spring application of five different herbicide combinations to bud-stage Canada thistle resulted in control of the treated stems, but no significant effect on same-season regrowth or stem density one year later. Significant treatment effects were only observed at 16 and 32 days after treatment (DAT).

INTRODUCTION

Diflufenzopyr is an herbicide additive that has been found to enhance the activity of synthetic auxin herbicides such as 2,4-D or dicamba. This additive enhances is the inhibition of polar transport of the herbicide molecule between plant cells, which results in more of the applied herbicide being translocated in the phloem and accumulating in plant meristems. Overdrive is a premix of dicamba and diflufenzopyr (50 plus 20 percent), with labeled application rates of 4 to 8 oz/ac, and a maximum total application rate of 10 oz/ac per year. One ounce of Overdrive contains the same amount of dicamba as one fluid ounce of Vanquish. By contrast, the maximum label rate for Vanquish is 64 oz/ac, or 6.4 times the dicamba rate per acre per year. This study compares the activity of Overdrive against dicamba alone and a designated standard treatment.

MATERIALS AND METHODS

This trial was established at the Penn State Landscape Management Research Center in a mixed stand of fineleaf and tall fescues infested with Canada thistle. After establishment of the experimental area, a permanent 1 m^2 sampling area was established in each plot. On June 16, 2003, counts of Canada thistle stems, measurement of maximum Canada thistle height, visual estimation of average Canada thistle height, and a census of plant species present was taken for each sampling area within each plot. Herbicide treatments included Overdrive at 4, 6, or 8 oz/ac; Vanquish at 6 oz/ac; and the designated standard treatment of Vanquish plus Transline at 16 plus 8 oz/ac, respectively. The treatments were applied on June 23, using a CO_2-powered, hand-held, fixed boom equipped with TeeJet 11015 LP spray tips, delivering 20 gal/ac at 25 psi. Experimental plots were 6 by 20 ft, separated by 1.5 ft alleys, arranged in a randomized complete block with three replications.

Canada thistle was at flower bud stage, and up to 4 ft tall at the time of treatment. Other species present included bull thistle, plumeless thistle, prickly lettuce, wild carrot, and varying amounts of fineleaf and tall fescue. Visual ratings of Canada thistle injury were taken July 9 on a 0-10 scale, and on a percent basis on July 25. Follow-up stem counts were taken October 7, 2003, and used to calculate percent mortality of treated stems, percent resprouting (new stem #/original stem # * 100), and percent Canada thistle reduction ([original stem # - Oct 7 stem #]/[original stem #]*100). Final stem counts were taken May 12, 2004, and were used to calculate percent of original stem density ([May 12 stem #/original stem #]*100). Data were subjected to analysis of variance. The untreated check was arbitrarily assigned a value of '0' for the July 9 and July 25 injury ratings, and was therefore not included in the analysis. When the calculated Canada thistle reduction values were negative, they were changed to zero prior to analysis of variance.

RESULTS AND DISCUSSION

The only dependent variables with a significant treatment effect were Canada thistle injury on July 9 and July 25, 16 and 32 DAT (Table 1). On July 9, Vanquish plus Transline was rated as the most injurious treatment at 4.7 out of 10, and was rated significantly higher than Overdrive at 4 oz/ac and Vanquish at 6 oz/ac, which were rated at 3.3 and 3.0, respectively. Ratings of percent injury on July 25 fell into three distinct groups. Vanquish and Transline was rated significantly higher than all other treatments at 88 percent. Overdrive at 6 or 8 oz/ac was rated at 70 percent injury, and Overdrive at 4 oz/ac and Vanquish at 6 oz/ac were rated at 58 and 53 percent injury, respectively.

These early differences in treatment response were transient. By October 7, all treatments provided at least 99 percent mortality of treated stems. There were no significant treatment effects found based on stem counts taken October 7, 2003 (106 DAT), or May 12 (46 weeks after treatment).

CONCLUSIONS

Within the timeframe of one year, there was no significant effect from any of the herbicide treatments on Canada thistle density compared to no treatment.

MANAGEMENT IMPLICATIONS

The herbicides used eliminated the treated thistle and prevented seed set, but did not have an effect on the above-ground growth of Canada thistle later in the treatment year, or in the spring of the next season. Without assessing the impacts on the root system, we cannot determine if the treatments had a net effect.

Despite anecdotes to the contrary, it is best to assume that established Canada thistle will require several seasons and a multi-faceted approach to be eliminated from a site. The target for Canada thistle treatment is the root system - and direct assessment of the root system is very difficult and cumbersome. It is our current belief that any herbicide comparison will need to take place over several seasons with repeated treatments, and that treatment differences will be apparent as the number of annual repetitions needed to eliminate a stand. This particular study is being repeated in this manner.

Table 1. Response of Canada thistle (CIRAR) to herbicide treatments applied June 23, 2003. CIRAR was visually rated for injury on July 9 and July 25. Stem counts were taken June 16, prior to treatment; and October 7, 2003, and May 12, 2004. The October 7 counts were used to calculate percent mortality of treated stems, percent resprouting (new stem #/original stem # *100), and percent reduction ([[original stem # - Oct 7 stem #]/original stem #] * 100; converted to zero prior to AOV if negative). The May 12, 2004 counts were used to compute percent change of CIRAR density (May 12 count/original count * 100). The untreated check was assigned a zero value and was not included in the AOV for CIRAR injury on July 9 or July 25. Each value is the mean of three replications.

Product	Application Rate	Jul 9 CIRAR Injury	Jul 25 CIRAR Injury	Oct 7 CIRAR Mortality	Oct 7 CIRAR Resprouting	Oct 7 CIRAR Reduction	May 12, 2004 CIRAR % of Original Stand
	oz/ac	0-10	%	%	%	%	%
untreated	- -	0	0	66	46	20	142
Overdrive	4	3.3	58	100	98	18	176
Overdrive	6	3.7	70	100	79	25	125
Overdrive	8	4.3	70	100	84	29	105
Vanquish	6	3.0	53	99	130	6	167
Vanquish Transline	16 8	4.7	88	100	52	51	137
Fisher's Protected LSD (p=0.05)		1.4	9	n.s.	n.s.	n.s.	n.s.

MANAGING A GIANT KNOTWEED STAND CONVERTED TO FINE FESCUES

Herbicide trade and common chemical names: Garlon 3A (*triclopyr*), Transline (*clopyralid*), Vanquish (*dicamba*), Vista (*fluroxypyr*)

Plant common and scientific names: annual ryegrass (*Lolium multiflorum*), blackberry (*Rubus allegheniensis*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), common pokeweed (*Phytolacca americana*), creeping red fescue (*Festuca rubra*), garlic mustard (*Alliaria petiolata*), giant foxtail (*Setaria faberi*), giant knotweed (*Polygonum sachalinense*), hard fescue (*Festuca trachyphylla*), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), Tatarian honeysuckle (*Lonicera tatarica*), wineberry (*Rubus phoenicolasius*), yellow rocket (*Barbarea vulgaris*)

ABSTRACT

A roadside fill slope infested with giant knotweed was successfully converted to Formula L during rehabilitation trials during 1998 and 1999. In August 2000, when the site reverted to a maintenance demonstration, fineleaf fescue cover on the site was greater than 90 percent, and giant knotweed cover was less than 5 percent. Annual maintenance from 2000 through 2003 including spot application of herbicides kept the site nearly free of knotweed (less than 0.1 percent cover), and required between 0.8 and 1.6 man-hours per acre on each occurrence. Establishment and growth of the grass mixture was satisfactory, but the site was increasingly re-infested by crownvetch (50 percent cover in 2003), despite the crownvetch being targeted during maintenance visits. Beginning in 2003, crownvetch was no longer targeted during maintenance applications, and will be allowed to become the dominant groundcover on the site.

INTRODUCTION

The fundamental premises of converting a site infested with a problem species to an alternate groundcover is that the problem species needs to be removed; and that installing a new groundcover will, on a net-basis, reduce maintenance effort and expense, and significantly reduce the chances of the site being re-infested by the original problem species.

Giant knotweed, and the closely related Japanese knotweed are tall growing, rhizomatous, herbaceous perennials native to East Asia. Both species spread vigorously, and will form dense, monotypic stands up to 10 ft tall, on sites of almost any quality - ranging from partially shaded riparian corridors to sun-baked construction spoil. On the roadside, the knotweeds are problematic when close to the roadway because they reduce sight distance and grow up to, if not through the shoulder material and even begin to damage the asphalt roadway. If knotweeds are not close to the roadway, but still on the ROW, they are a problem waiting to happen. In this condition, they represent an impending problem to the Department, and to the adjacent property, and still justify the effort to remove them.

The rationale for using PENNDOT Formula L (55:35:10 percent mixture, by weight, of hard fescue:creeping red fescue:annual ryegrass) to rehabilitate a site after removing a problem weed species is that it is low-growing, adapted to mowing if needed, adapted to moderately-poor sites, and provides the flexibility to use selective herbicides to remove broadleaf weed species that encroach.

The objective of this demonstration project is to evaluate the effort required to maintain the site in a knotweed-free condition, and to evaluate the effectiveness of Formula L as a groundcover in terms of maintenance resources expended.

MATERIALS AND METHODS

The demonstration area is approximately 0.5 ac, and is located on a southwest-facing fill slope along SR 611 South, at the end of the on-ramp from SR 202 East, near Doylestown, PA. Originally the site was seeded to crownvetch, but became severely infested with giant knotweed. The knotweed stand was largely eliminated in the course of conducting herbicide screening[2] and rehabilitation sequence[3] trials beginning in 1998, and both trials included overseeding with Formula L. In addition, the areas bordering the trials were treated and seeded as well, so that all the giant knotweed on the ROW was treated. The final data was collected from the trials on August 7, 2000, and the entire site was then designated as a single demonstration site. At the conclusion of the rehabilitation sequence trial, average knotweed cover in that area was 4 percent, with the four sequence treatments averaging 0, 0, 1, and 15 percent knotweed cover. At the completion of the trial, 1.75 gal of a mixture of Vanquish plus Transline at 2.5 plus 0.031 percent, v/v, was applied with backpack sprayers as a low-volume spray to the entire site, targeting giant knotweed, crownvetch, bull thistle, Canada thistle, Japanese honeysuckle, multiflora rose, and garlic mustard. The application took about 1.0 man-hours. This application, and subsequent activities from 2001 to 2003 are summarized in Table 1.

Low volume foliar applications were made to the site on August 28, 2001, July 29, 2002, and August 28, 2003, using 4.0, 3.0, and 0.3 gal of solution, respectively (Table 1). Total man-hours was less than 1.0 for each visit. In 2001 and 2002, all broadleaf weed species were targeted, including giant knotweed, bull thistle, Canada thistle, blackberry, wineberry, Japanese honeysuckle, Tartarian honeysuckle, yellow rocket, and garlic mustard. Crownvetch was by far the most common target. In 2003, crownvetch comprised 50 percent of the cover on the site, and was not targeted.

Table 1: Summary of maintenance efforts on a site converted from giant knotweed to Formula L, beginning two seasons after seeding.

Date	Products	Application Time	Material Used	Comments
8/7/00	Vanquish @ 2.5 % v/v Transline @ 0.62% v/v	0.8 MH	1.75 gal	Low volume foliar (LVF), knotweed most common target
8/28/01	Vanquish @ 2.5 % v/v Transline @ 0.62% v/v	0.8 MH	4 gal	LVF. Crownvetch most common target. Few knotweed plants.
7/29/02	Vanquish @ 4 % v/v Garlon 3A @ 4 % v/v Vista @ 1% v/v	0.8 MH	3 gal	Ultra-LVF, using Thinvert as carrier. Crownvetch by far the most common target. Knotweed probably about 0.1% cover for site.
8/28/03	Vanquish @ 1.25% v/v Transline @ 0.62% v/v	0.4 MH	0.3 gal	Did not spray crownvetch as it comprises 50 percent of the site.

[2] Comparing Spring-applied Herbicides for Control of Giant Knotweed During Roadside Renovation. 2000. Roadside Vegetation Management Research Report - Fourteenth Year Report. http://rvm.cas.psu.edu/1999/AR1999.html

[3] Update: Comparison of Rehabilitation Sequences for Giant Knotweed Infestations. 2001. Roadside Vegetation Management Research Report-Fifteenth Year Report. http://rvm.cas.psu.edu/2000/AR2000.html

RESULTS AND DISCUSSION

After the 2000 maintenance application, knotweed cover has remained at less than 1 percent, and would be better described as 0.1 percent cover, which would be equivalent to a patch of knotweed covering 21 ft^2. Despite being targeted in 2000-2002, crownvetch cover increased each year, and comprised 50 percent cover of the site in August 2003. At this point, it seemed futile to target crownvetch, and we decided to allow crownvetch to reclaim the site, and continue selective treatment of any knotweed or any undesirable species that occur. The Formula L was growing well, but crownvetch was clearly the more vigorous species on this site, and was displacing the grass by growing over top of it. The majority of this site is outside the reach of a truck-based broadcast treatment. Under these conditions, it is easier to maintain the site to prevent knotweed from infesting crownvetch than to prevent crownvetch from infesting a Formula L planting.

CONCLUSIONS

Giant knotweed can be virtually eliminated from a site, and minimal maintenance will prevent its reestablishment. Our experiences on this site are similar to our other experiences converting weed-infested sites to Formula L - after removing the weed species and establishing a satisfactory stand of Formula L, crownvetch becomes the prominent weed. On this site, allowing the site to revert to crownvetch is the easiest course and still allows for effective management of giant knotweed.

MANAGEMENT IMPLICATIONS

Giant knotweed can be effectively controlled and managed. The question has become "what groundcover do I replace the knotweed with?" Formula L (or Formula D) provides a means to easily manage all broadleaf species. However, sites that were originally established to crownvetch appear to revert to crownvetch after the undesirable species are removed, due to the persistent seedbank. What we cannot answer right now is whether establishing a grass groundcover facilitates a transition to an intact, relatively weed-free stand of crownvetch, or whether just selectively removing the undesirable species will result in reestablishment of an intact crownvetch stand.

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

Herbicide trade and common chemical names: Glypro (glyphosate), Arsenal (imazapyr)
Plant common and scientific names: reed canarygrass (*Phalaris arundinacea*), phragmites (*Phragmites australis*)

INTRODUCTION

Reed canarygrass is a perennial, cool-season grass species that has been observed to become a dominant species in created wetlands. It is well adapted to wet sites but, will also thrives on upland terrain. These plants can grow to heights in excess of six feet and often form large monocultures where they exist. The species is considered a native of Pennsylvania, as well as most boreal latitudes of the northern hemisphere. What is not known is if all the canarygrass in PA is native. There is conjecture that much of the 'weedy' reed canarygrass is a non-native genotype, which contributes to its weediness. This situation has been demonstrated with phragmites. Regardless of its natural heritage, reed canarygrass is problematic in areas like created wetlands where plant species diversity is desirable to fulfill the intended function of the site. This trial was established to compare herbicides and treatment frequency to remove a reed canarygrass infestation from a created wetland.

MATERIAL AND METHODS

The site was located at a created wetland near the Grazierville exit of SR 99, in Blair County. The study area had been originally seeded to PENNDOT Seeding Formula W (birdsfoot trefoil, tall fescue, redtop), in approximately 1991, but over time developed into a near monoculture of reed canarygrass. The initial treatments were applied on June 15, 2001. GlyPro at 128 oz/ac, alone or in combination with Arsenal at 16 oz/ac was applied to 30 by 180 ft plots. Both treatments contained a 0.1% v/v organosilicone surfactant. The reed canarygrass was 6 ft tall, in full seedhead, and shedding abundant quantities of pollen. Treatments were applied using an Echo motorized backpack sprayer equipped with a fixed boom and TeeJet XR8002 VS tips, delivering 30 gal/acre.

The entire site was retreated on August 29, 2001 with 110 oz/acre Glypro plus 0.25% v/v non-ionic surfactant. This was applied using a tractor mounted sprayer and Chemlawn-type handgun, with the applicator walking behind the tractor. The targeted application rate was 100 gal/acre. Reed canarygrass regrowth was sparse, probably accounting for 1 percent or less of the original biomass, but occurred throughout the trial area. The trial was divided into 18 by 60 ft plots to accomodate four unseeded treatments that would be tilled or untilled, and would or would not receive a third treatment.

The plots intended to receive a third herbicide application prior to seeding were treated April 24, 2002, with 83 oz/ac of GlyPro plus an organosilicone surfactant at 0.1 percent, v/v. This application was made with a motorized backpack with a fixed boom equipped with TeeJet XR 8002VS tips, delivering 15 gal/ac to 18 by 60 ft plots. Reed canarygrass was sparse, and averaged about 4 in tall. Parts of the site remained inundated well into June, so seeding of the mixtures was postponed indefinitely. All plots were visually rated for percent reed canarygrass reduction on July 3, 2002. Visual ratings of percent vegetative cover and percent cover from reed canarygrass were taken July 11, 2003.

Due to canarygrass reestablishment, the seeding and tillage treatments were never implemented. The analysis of variance only accounted for the effects of adding Arsenal at the initial treatment, and the effect of the April 2002 retreatment, for a total of four treatments. Prior to analysis, the average value for each treatment was calculated by replication to generate twelve observations, rather than the sixty that would have resulted from the original treatment scheme.

RESULTS AND DISCUSSION

There was no significant treatment effect for any dependent variable, and no interaction effect between using Arsenal and applying the third treatment (Table 1). The effects of the retreatment were transient and only apparent soon after the treatment.

Table 1. Summary of reed canarygrass response to herbicide mixture and frequency of application. Plots were treated with GlyPro at 128 oz/ac, with or without Arsenal at 16 0z/ac, on June 15, 2001. All plots were retreated with GlyPro at 110 oz/ac on August 29, 2001. Selected plots were retreated with GlyPro at 83 oz/ac on April 24, 2002. Each value is the mean of three replications.

		July 2002	-------------------- July 2003 --------------------	
Arsenal June 2001	Retreatment April 2002	Reed Canarygrass Control	Total Vegetative Cover	Reed Canarygrass Cover
		---------------------------------	%	---------------------------------
no	no	98	75	45
no	yes	100	70	21
yes	no	97	69	56
yes	yes	100	61	35

CONCLUSIONS

The initial success of the June 2001 treatment leaves us encouraged that a glyphosate treatment is an effective beginning to a reed canarygrass conversion program. The subsequent canarygrass regrowth in late 2002 and 2003, despite retreatment leaves us questioning the choice of timing. There was little reed canarygrass biomass present at either retreatment. If future work with this species is pursued, we will evaluate the effect of delaying follow-up treatments to anthesis of the next growing season.

MANAGEMENT IMPLICATIONS

Based on this experience, we would only suggest reed canarygrass management on properties that justify relatively intensive management. Due to its regenerative capacity, reed canarygrass management will be an ongoing program wherever it is undertaken. Initial stand reduction is feasible, but regeneration appears to be inevitable. Once desirable plant communities have re-established, canarygrass management will most likely be based on selective applications of non-selective herbicides such as glyphosate. This will require regularly scheduled visits with backpack-equipped applicators who can distinguish and selectively treat reed canarygrass.

2003 ROADSIDE VEGETATION MANAGEMENT CONFERENCE (RVMC)
FIELD DAY REVIEW

Herbicide trade and common names: Garlon 3A (*triclopyr*), Tordon K (*picloram*)
Plant common and scientific names: Tartarian honeysuckle (*Lonicera tatarica*), staghorn sumac (*Rhus typhina*), black cherry (*Prunus serotina*), dewberry (*Rubus* spp.), garlic mustard (*Alliaria petiolata*), yellow woodsorrel (*Oxalis stricta*), yellow rocket (*Barbarea vulgaris*), giant foxtail (*Setaria faberi*), spotted knapweed (*Centaurea maculosa*), fall panicum (*Panicum dichotomiflorum*), yellow foxtail (*Setaria glauca*), common pokeweed (*Phytolacca americana*), curly dock (*Rumex crispus*).

Roadside Brush Clearance SR 87/SR 2039

There is much debate over roadside brush clearance. One key issue is whether to skylight roadways covered by tree canopies or limit the clearance operation to a particular height from the road surface. Skylighting operations involve removing the canopy of the trees completely on the side facing the road. While this allows more light onto the road surface and eliminates potential hazards from overhanging limbs, it is arguably more destructive to the tree. The alternative is a limited clearance operation. In this case limbs were eliminated up to 30 feet above the pavement. All tree limbs beyond that height were left. The thought behind this approach is that it is healthier for the tree and in later years there will be fewer trees decline and potentially fail as a result of the clearance operation.

The tour along sections of SR 87 and SR 2039 in Lycoming and Sullivan Counties showed both practices. Skylighting was performed on several segments from 1993 through the year 2000. In 2001, a 30-foot clearance standard was established within District 3-0. Three miles of SR 2039 were cleared using this approach. Costs listed below are not for comparative purposes.

Table 1: Summary of scope and expense of mileage tree clearing areas viewed during the 2003 Roadside Vegetation Management Field Day.

Method	SR	Segment	Date Finished	Cost	Man-hours
Skylighting	87	310-400	1993	$28,000	---
Skylighting	87	10-60	June 1995	---	---
Skylighting	87	160-180,260-310	Aug. 1996	---	---
Skylighting	2039	10-50	2000	$13,750	728
30 Ft. Clearance	2039	90-120	2001	$13,580	910

The debate will only be resolved from the Department's perspective when actuarial data can be used to determine which method reduces risk more effectively.

Corridor Clearance with Brown Tree Cutter

The Brown Tree Cutter has been extensively used in Districts 3 and 12. It has been demonstrated to be both effective and efficient in cutting vegetation up to 8 inches in diameter. This is a first step in clearing overgrown corridors. In addition to the Brown Tree Cutter, a chain saw operator can be used to drop larger trees that must be removed.

The Brown Tree Mower (Model TCF 2620) is a 6 ft wide, rotary mower equipped with a hydraulically-actuated, two-piece rear deck. When larger trees are encountered the operator simply backs up to the tree, opens the rear deck and backs into the tree with the exposed blade.

The Model TCF 2620 requires a tractor with 80 to 100 HP. A four-wheel drive tractor equipped with dual rear wheels and a front mounted hydraulic loader frame and heavy-duty brush/log rake is recommended by those familiar with the unit. This tractor would be capable of moving the debris cut by the mower and traversing the right-of-way.

A tree cutting unit, like that described above, was used to clear brush along I-180 in Northumberland County, north of I-80. These areas had been cut twice in recent years. In 1995 and again in March through May, 2002 a Brown Tree Cutter was used to mow the right-of-way along the westbound shoulder of I-180 for several miles. The same operation was conducted on the eastbound shoulder, except the second mowing took place in June through July 2002. A selective herbicide application and spot broadcast seeding was made to all cleared areas in the fall of 2002. Eight hundred pounds of Formula L was seeded in 2002. An additional 400 lbs of Formula L was applied on July 10, 2003 to areas not previously seeded. The seeding was done only in areas where desirable groundcovers were absent. By August 2003, the fine fescue had established well where it was seeded in 2002. After reclamation, ROW such as I-180 can be included in the roadside mowing program on a limited frequency to prevent reestablishment of brush where terrain permits, and selectively treated with herbicides on steeper terrain.

Brown Brush Monitor Results, One Year After

The Brown Brush Monitor is a fairly recent development in the industry's effort to combine mowing and herbicide applications into a single operation. The Brown Brush Monitor combines the technology of Brown's tractor-mounted, three point hitch brush mower with an application system that brushes herbicide solution onto the just cut stumps. This approach differs from two similar units referred to as Lucas-64 and the Burch Wet Blade. The Lucas-64 sprays herbicide solution under the mowing deck and it is deposited on all surfaces under the deck, including the vegetation. The Burch Wet Blade system relies on the aerodynamic qualities of its blades to keep herbicide solution on the lower surface of the blade, which is deposited on the surface of the cut stem as the blade passes through it.

The Brush Monitor relies on two chambers - the cutting and discharge chamber, and the herbicide application chamber. This system keeps the herbicide application equipment separate from the flying debris in the cutting chamber. The application chamber features nozzles directed at the cut stems, as well as scrapers and brushes to further expose and treat cambium tissue on the remaining stumps.

The Brush Monitor can handle brush up to three inches in diameter. Herbicide solution is supplied to the mower at a fixed flow rate, so application rate is dependent upon ground speed. Where brush density is low, ground speed will be faster, and application rate will be lower. Conversely, where brush density is high, ground speed will be reduced, and application rate will be higher.

The unit was first demonstrated during the Roadside Vegetation Management Conference Field on July 19, 2001 near Bellefonte, PA[1/]. The area was marginal in terms of brush size. The Tartarian honeysuckle and staghorn sumac were in the effective size range, but some of the

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[1/] 2001 Roadside Vegetation Management Conference Field Day Review. 2001. Roadside Vegetation Management Report - Sixteenth Year Report. http://rvm.cas.psu.edu/2001/AR2001.html.

ailanthus was at the large end of the spectrum. To be in the suitable size range, the tractor must be able to readily push over the brush to be mowed. This mower does not have the cutting capacity of the Brown Brush Cutter, which allows the operator to hydraulically lift a corner of the mower deck to expose the blade and back into larger stems.

This latest demonstration was established in the fall of 2002. It was located on the shoulder of I-80 E in Montour County. The site was previously cut using a Brown Brush Cutter in 1998 as part of a construction project. On September 10, 2002 two plots were established. One was simply cut using the Brown Brush Monitor with no herbicide applied. The other was cut and treated with Garlon 4 plus Tordon K at 4 plus 2 qts/ac, at a targeted application volume of 20 gal/ac.

Prevalent brush species included Tartarian honeysuckle, staghorn sumac, black cherry, and dewberry. Herbaceous species included garlic mustard, yellow woodsorrel, yellow rocket, giant foxtail, spotted knapweed, fall panicum, yellow foxtail, common pokeweed, and curly dock.

There was a noticeable difference between the two plots when viewed almost one year after treatment. The herbicide-treated plot had visibly less sprouts than the cut-only plot. Very few woody stems resprouted following the herbicide treatment. Herbaceous plants were affected as well. The herbicide treated plot contained a greater percentage of annuals, especially foxtails. The tank mix used for this demonstration, while effective, contained Tordon K. This presents two problems. First, Tordon K is soil active. It is difficult to say whether the herbicides are actually absorbed by the stump or taken up by the roots. Therefore, herbicides that are not soil active may be less effective. Secondly, the restrictive labeling of this particular product may present some problems for use within PENNDOT. It was clear though that simply cutting the brush without the use of herbicides resulted in sprouting.

The demonstration showed this unit has a potential fit in right-of-way vegetation management. The Brush Monitor could provide a role in reclaiming a moderately overgrown corridor, in conjunction with a chainsaw crew to get the stems that are too large. This could serve as a precursor to implementing a wide-area mowing program to prevent brush reinfestation of mowable terrain. Data reported from Georgia utility trials indicated 80 percent reduction of resprouting compared to mowing alone, and a 25 percent reduction in cost compared to mowing followed by a separate herbicide application.

Reconstruction Clearance and Establishment of Formula L

This site showed the success of clearing unwanted trees from the right-of-way and then broadcasting grass seed. A section of road from the SR 80/54 interchange west to the Northumberland County line (7.5 miles) was cleared as part of a construction project in 1998. The clearing operation included both east and westbound shoulders of I-80 to the right-of-way fence, plus the median was cleared 50 feet from white line on the passing lane shoulder. The total cost was $70,000. Formula L was broadcast over the site in the fall of 1999 following the clearing operation. The site viewed during the field day had a well-established stand of fine fescue, and was at the early stages of brush encroachment. At the current stage, the corridor could easily be treated to selectively remove the brush.

Kut Kwick Slope Mower

Severe slopes are commonplace along Pennsylvania's highways. These areas are planted to groundcovers during road construction to help slow the establishment of undesirable trees and brush. A mower was demonstrated that showed promise for getting into areas often overlooked with conventional mowing equipment. It was hoped that this mower would allow the operator to cut areas typically too steep for standard equipment. Mowing in these areas could take place infrequently, but often enough to allow the mowing operation to remove problem woody vegetation before it gets well established.

The SlopeMaster series is one of several mower types available from Kut-Kwick Corporation, Brunswick, GA. This mower is designed with a low center of gravity that makes it capable of cutting on slopes up to 40 degrees. The unit is powered with either a 24 HP Onan air-cooled gasoline or 24 HP water-cooled diesel engine. It is available with either a 60 or 72-inch cutting width. The mower is hydrostatically driven with a rear discharge. The main mowing deck is an out-front rotary mower. The operator is seated at the rear of the machine in a pivoting seat the keeps them level with the contour of the slope. Mowing heights are adjustable through 5 inches for the air-cooled engine unit and 1.5 to 6.5 inches for the diesel mower. A Super-Slopemaster mowing unit is also available with a 38 HP water-cooled diesel engine. This mower is similar to the other two mentioned, but comes with the wider 72 inch cutting width.

An additional rear towed cutting unit with two cutting decks can quickly and easily be attached to increase the overall cutting width to 15 feet 7 inches. These additional cutting decks can be independently and hydraulically controlled from the operator's seat. With the addition of the towed cutter the machine can operate effectively on up to 20 degree or 36 percent slopes.

The demonstration took place on a 50 percent slope, on dew-covered crownvetch. The mower was able to negotiate the slope effectively and provide a functional cut.

The issue with such a mower within the PENNDOT scheme is that not enough slope mowing is done to justify having a County purchase a unit and train operators, and the unit is too specialized to be practical for a Department mowing contractor, who needs to mow a lot of acres to justify equipment purchase.

TrucKat Demonstration

The TrucKat is manufactured by Tiger Corporation of Sioux Falls, SD. This unit is a boom arm mower mounted on an Isuzu flat bed truck. The truck has a cabover engine design. It is a 4 speed automatic equipped with a 4 cylinder, 175 horsepower, diesel engine. A 4 cylinder, 80.5hp, diesel auxiliary engine is used to power the mowing unit. A joystick controls the boom operation from inside the cab of the truck. An operator's seat on both the left and right side of the cab allow the driver to move to the right-hand side of the cab to both drive the truck while operating the boom arm mower simultaneously. While in transit from one location to another the boom mower can be stored on the flatbed and the driver resumes the left-hand seat within the cab.

This piece of equipment is referred to as the "fastest mower on earth". It travels at highway speeds of up to 75 miles per hour while in transit from one job site to another. The rapid movement across open roads allows the entire machine to more easily be stored in secured areas each night or returned to the shop for maintenance. The unique design makes transport simple. When the boom is stored on the bed the width of the unit is 8 feet. The overall length is 17 feet 5 inches and height is 12 feet.

The mower is capable of reaching heights of 19 feet 10 inches, reaching out 21 feet, and reaching down 12 feet 5 inches. The cutter head can rotate 180 degrees around the outer boom providing greater maneuverability. During the demonstration the mower was equipped with a 50 inch, carbide-tipped saw blade. Other heads are available including a 50-inch rotary, 60-inch rotary grass, 50-inch flail, and 63 inch flail grass head. The most effective cutting is done at speeds of 1 1/2 to 6 miles per hour. Trees and brush up to 6 inches in diameter can be cut using this machine.

The demonstration site chosen for this unit was far from ideal. The area had few target branches to demonstrate the capabilities of the carbide-tipped blade. This blade is suited specifically for trimming or mowing woody vegetation, and is ill suited to cut dense herbaceous vegetation. A different cutting head would have been more appropriate.

Being two-wheel drive also limits the usefulness of this machine. It is often necessary to get off the pavement to reach problem vegetation. A four-wheel drive mowing unit would provide greater flexibility. The truck-based scheme greatly reduces transport time, but does limit the reach of the unit compared to a tractor, which can get farther off the road.

FECON Bullhog Demonstration

The Bull Hog is a shredder manufactured by FECON Resource Recovery Equipment and Systems of Cincinnati, OH. There are both PTO and hydraulic drive units available. Cutting widths range from 32 to 88 inches. The Bull Hog can be matched to a variety of 70 to 500 HP tractors, excavators, track units, or skid steers. With anywhere from 18 to 48 double carbide cutting tips the Bull Hog cuts and shreds any size wood quickly and effectively. A push bar and drag teeth mounted on the front of the Bull Hog allows the operator to more effectively direct the brush away from or into the unit. The cutting tips have a 300-hour life expectancy before needing replacement.

The unit viewed during the field day was mounted on a skid steer equipped with rubber tracks, providing a very light footprint. The Bull Hog effectively cleared small brush down to the soil, and left behind a shredded material and soil that would serve as an ideal seedbed for a broadcast seeding. The operator has the flexibility to work the soil as much as desired, from no-contact to incorporation of debris and debris to a depth of several inches.

FECON's website address is www.fecon.com.