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DEPARTMENT OF TRANSPORTATION

ROADSIDE VEGETATION MANAGEMENT RESEARCH REPORT THIRTEENTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY

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The thirteenth year report on a cooperative research project between the Pennsylvania Department of Transportation, Bureau of Maintenance and Operations; and the Pennsylvania State University, College of Agricultural Sciences; including:
Brush control research evaluating basal bark and low volume foliar herbicide applications.
Herbaceous weed control research evaluating the effect of herbicides on the control of Canada thistle.
Evaluation of Giant knotweed control and conversion into low maintenance grasses.
Comparing various herbicides and methods of vegetation control for use under guiderails.
Evaluating the use of herbicides for the establishment of native grasses.
Review of demonstrations evaluating both the control of Ailanthus using low volume backpack applications and converting an Ailanthus infestation into fine fesues.

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Exacto Chemical Company
Monsanto
Novartis Crop Protection, Inc.
PBI / Gordon Corporation
Spraying Systems, Inc.
Waldrum Specialties, Inc.

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INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

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

Use of Statistics in This Report

Many of the individual reports in this document make use of statistics, particularly techniques involved in the analysis of variance. The use of these techniques allows for the establishment of a criteria for significance, or, when the differences between numbers are most likely due to the different treatments, rather than due to chance. We have relied almost exclusively on the commonly used probability level of 0.05. When a treatment effect is significant at the 0.05 level, this indicates that there is only a five percent chance that the differences are due to chance alone. At the bottom of the results tables where analysis of variance has been employed, there is a value for significance level and least significant difference (LSD). The significance level is the probability that the variation between the different treatments is due to chance. Therefore, the lower the significance level, or p-value, the less likely the differences are due to chance. When the p-value 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 p-value is greater than 0.05, the LSD procedure is not used. What is being demanded with this criteria is that the variation due to the treatments be significant before we determine significant differences between individual treatments. Using the p-value as a criteria for the LSD test is called a 'Protected LSD test'. This provides a more conservative estimate of the LSD, as there are often significant differences within a large set of treatments, regardless of the p-value.

This report includes information from studies relating to roadside brush control, herbaceous weed control, roadside vegetation management demonstrations, and total vegetation control under guiderails.

Herbicides are referred to as product names for ease of reading. The herbicides used in each research area are listed by product name, active ingredients, formulation, and manufacturer.

Product name, active ingredients, formulation, and manufacturer information for products referred to in this report. Numbers in parentheses after formulations indicate amount of active ingredients in combination products in same order listed in 'Active Ingredients' column.

Trade Name	Active Ingredients	Formulation	Manufacturer
Accord	glyphosate	4 S	Monsanto
Arborchem Basal Oil	diluent	- - -	Arborchem Products, Inc.
Arsenal	imazapyr	2 S	American Cyanamid Co.
Dyne-amic	adjuvant	- - -	Setre Chemical Company
Endurance	prodiamine	65 WG	Novartis Crop Protection, Inc.
Escort	metsulfuron methyl	60 DF	E.I. DuPont de Nemours & Co.
Finale	glufosinate-ammonium	1 S	AgrEvo USA Company
Formula 358	drift retardent	- - -	Exacto Chemical Company
Garlon 3A	triclopyr	3 S	DowAgroSciences Ltd.
Garlon 4	triclopyr	4 EC	DowAgroSciences Ltd.
Karmex	diuron	80 DF	E.I. DuPont de Nemours & Co.
Krenite S	fosamine ammonium	4 S	E.I. DuPont de Nemours & Co.
MON 59120	adjuvant	- - -	Monsanto
Oust	sulfometuron methyl	75 DF	E.I. DuPont de Nemours & Co.
Pathfinder II	triclopyr	RTU	DowAgroSciences Ltd.
Pathway	picloram + 2,4-D	RTU	DowAgroSciences Ltd.
Pendulum	pendimethalin	3.3 EC	American Cyanamid Co.
Penevator Basal Oil	diluent	- - -	Exacto Chemical Company
Plateau	imazameth	2 S	American Cyanamid Co.
Polytex A1001	drift retardent	- - -	Exacto Chemical Company
Predict	norflurazon	80 DF	Novartis Crop Protection, Inc.
Premier	ametryn	76 WDG	Novartis Crop Protection, Inc.
QwikWet 357	adjuvant	- - -	Exacto Chemical Company
Roundup Pro	glyphosate	4 S	Monsanto
Sahara	diuron + imazapyr	DG	American Cyanamid Co.
Stalker	imazapyr	2 EC	American Cyanamid Co.
Telar	chlorsulfuron	75 DF	E.I DuPont de Nemours & Co.
Thinvert RTU	invert emulsion	- - -	Waldrum Specialties, Inc.
Tordon 101M	picloram + 2,4-D	2.5 S (0.5+2)	DowAgroSciences Ltd.
Tordon K	picloram	2 S	DowAgroSciences Ltd.
Transline	clopyralid	3 S	DowAgroSciences Ltd.
Vanquish	dicamba-glycolamine	4 S	Novartis Crop Protection, Inc.

BRUSH CONTROL PROVIDED BY LOW VOLUME FOLIAR APPLICATIONS USING FINALE WITH TRANSLOCATED HERBICIDES

INTRODUCTION

A study was conducted to evaluate the brush control provided by low volume foliar applications of Finale alone and in combination with other herbicides.

MATERIALS AND METHODS

Treatments were applied to pin cherry (*Prunus pensylvanica* L.), red maple (*Acer rubrum* L.) and black locust (*Robinia pseudoacacia* L.). Each species was located at a separate location. The pin cherry trial was established at the SR 219 off ramp to SR 22 east near Ebensurg, PA. The red maple was located at the SR 53/SR 22 interchange near Cresson, PA. The black locust site was near the Bellwood exit of I-99. The pin cherry was treated on September 4, 1997 and both the red maple and black locust were treated on September 5, 1997. The pin cherry were second year resprouts up to 6 feet in height, averaging 4 feet. This species was set up in a randomized complete block design with two replications and 12-30 x 30 foot plots. Both the black locust and red maple averaged 7-8 feet in height and were arranged in a completely randomized design with 10 stems receiving each treatment. All treatments were applied with a CO_2-powered backpack sprayer equipped with a SS #5500 adjustable conejet and Y-2 tip. The pressure was approximately 30 psi. Targeted output was 20 gal/ac. All treatments contained 0.125% (v/v) QwikWet 357 and 0.25% (v/v) Formula 358 drift control. Brown-out ratings were taken on September 17, 1997 for all three species (results not reported). Injury ratings were taken on 9/12/98 (red maple), 9/15/98 (pin cherry), and 9/16/98 (black locust). The injury ratings were on a scale from 1 to 4 with '1'= no symptoms, healthy; '2' = moderate injury, recovery likely; '3' = severe injury, death likely; and '4' = dead. From these data, a value for percent control was generated by dividing the number of stems rated '3' and '4' by the total number of stems. It was a mistake to use this 1 to 4 scale on the locust and maple because each stem was a single replicate, and we are then unable to generate a percent control value for each replicate. The 1 to 4 scale is categorical, and averaging these numbers in not meaningful. Therefore, the percent control ratings for maple and locust are unreplicated.

RESULTS

Results are shown in Table 1. Red maple injury increased with increasing rates of Finale alone. Adding Garlon 3A to the lower rate of Finale provided moderate control but, decreased when higher rates of Finale were used. Finale plus Arsenal provided complete control of red maple regardless of rates. Almost complete control of pin cherry was achieved with all herbicide treatments. Drift occurred to some of the trees in the untreated check plot within rep 2. The untreated check was not included in the statistical analysis for this species. Black locust also demonstrated increased injury with increasing rates of this product used alone. Both Finale plus Garlon 3A and the Finale/Garlon 3A/Escort combination provided excellent control with average injury ratings 90% and above. The results for Finale plus Arsenal are confusing, as increasing the Arsenal rate from 0.5 to 1.0 percent v/v decreased control, particularly with Finale at 3.0 percent v/v. This is contrary to what we would expect, which is that as Arsenal is held at a given concentration, the increase in Finale rate would reduce control due to the increased rapidity of injury from Finale. Due to the slow activity of Arsenal, we cannot readily understand why increasing the Arsenal rate at a given Finale rate would cause this apparent antagonism. The Roundup plus Arsenal and Krenite S plus Arsenal provided complete control of all three species.

CONCLUSIONS

Finale used alone or in the combinations tested in this study did not provide satisfactory control of all three tree species with the possible exception of 6% Finale plus 0.5% v/v Arsenal. However, with the mixed results of the Finale/Arsenal combinations it is difficult to suggest that this mixture would repeatedly provide acceptable control. Low volume foliar applications of Roundup Pro plus Arsenal and Krenite S plus Arsenal provided excellent control of the tree species investigated in this study.

Table 1: Treatments were applied September 4 and 5, 1997. All treatments contained 0.125% (v/v) QwikWet 357 and 0.25% (v/v) Formula 358 drift control. Ratings of percent injury were taken September 12 through 16, 1998. The injury ratings were taken on a scale from 1 to 4 with '1' = no symptoms, healthy ; '2' = moderate injury/defoliation; '3' = severe injury/defoliation; and '4' = dead. The average injury values shown in the table represent the percentage of trees given a rating of '3' or '4' for that treatment. The number in parenthesis indicate the total number of treated stems. Data for pin cherry (without untreated check) were subjected to AOV, and were not significant for treatment (p=0.5).

Treatment	Application Rate	Average Injury		
		red maple	pin cherry	black locust
	% (v/v)	(%)	(%)	(%)
Untreated	---	0 (10)	0 (32)	0 (9)
Finale	3.0	0 (9)	100 (32)	40 (10)
Finale	6.0	67 (9)	100 (79)	71 (7)
Finale Garlon 3A	3.0 2.5	75 (8)	98 (67)	90 (10)
Finale Garlon 3A	6.0 2.5	22 (9)	94 (45)	90 (10)
Finale Garlon 3A Escort	6.0 2.5 0.5 oz/ac	25 (8)	100 (86)	100 (10)
Finale Arsenal	3.0 0.5	100 (9)	100 (26)	78 (9)
Finale Arsenal	6.0 0.5	100 (8)	100 (27)	90 (10)
Finale Arsenal	3.0 1.0	100 (9)	100 (49)	22 (9)
Finale Arsenal	6.0 1.0	100 (8)	100 (32)	67 (9)
Roundup Pro Arsenal	4.0 0.5	100 (9)	100 (37)	100 (10)
Krenite S Arsenal	5.0 0.5	100 (9)	100 (39)	100 (10)

EVALUATION OF HERBICIDES FOR BRUSH CONTROL WITH BASAL BARK APPLICATIONS

INTRODUCTION

This study was initiated to evaluate several herbicide combinations for controlling brush using the basal bark application.

MATERIALS AND METHODS

Treatments included an untreated check; Pathfinder II (0.75 lb ae/gal triclopyr) alone; both Garlon 4 and Stalker alone, or in combination at various rates; Garlon 4 plus Tordon K; Accord plus MON 59120 and water at various rates; and Stalker plus either Accord or Krenite S in MON 59120 and water. Control of three separate tree species was evaluated. Treatments were applied to green ash (*Fraxinus pennsylvanica* Marsh.), black locust (*Robinia pseudoacacia* L.), and red maple (*Acer rubrum* L.). The green ash was located along SR 322 east near Port Matilda, PA. The black locust was located along I-99 near Duncansville, PA; and the red maple was in the SR 22/SR219 interchange. The green ash and red maple were arranged in a completely randomized design with each treatment applied to ten stems and each stem serving as an experimental unit or replicate. The black locust was arranged in a randomized complete block design with two replications. The black locust plots were approximately 15 by 50 ft in size. Green ash was treated March 26; red maple March 27; and black locust April 3, 1997. The treatments were applied to the lower 12 to 18 in of the stem with a CO_2-powered backpack sprayer equipped with a Spraying Systems #5500 adjustable cone jet with a Y-2 tip, operating at 30 psi. Prior to treatment, the diameter of each stem of the green ash and red maple was measured and recorded for use in determining if the size of the stem would directly affect overall control. Trees ranged in diameter from 0.75 to 3.25 in for green ash, 0.5 to 3.0 in for black locust, and 0.75 to 2.75 in for red maple. The red maple was rated August 12, green ash August 14, and black locust September 10, 1997. First year injury ratings were taken using a scale of 1 to 10 with, '1' denoting no injury; '5' indicating moderate defoliation including the terminal; and '10' indicating complete control of the tree. Second year ratings were taken in September 1998. Green ash was rated September 4, red maple September 12, and black locust September 17, 1998. Second year injury ratings were taken using a scale of 1 to 4 with '1' indicating no effect; '2' indicating injury, but the plant would recover; '3' indicating that the plant was judged to be mortally wounded; and '4' indicated plants were dead. A percent mortality was calculated by dividing the number of stems rated '3' and '4' by the total number of treated stems. Resprout information was gathered during both ratings for black locust.

RESULTS

First year results are presented in Table 1. All treatments containing Garlon 4 or Pathfinder II provided excellent control of all three species. The Accord plus MON 59120 provided acceptable control of green ash at rates of 25/25/50; 50/10/40; and 50/25/25; Accord, MON 59120, and water, respectively. These, and other combinations of Accord plus MON 59120 did not provide acceptable control of red maple or black locust in this study but, have performed well in other trials. Keeping a constant rate of Accord while increasing the rate of MON 59120 did not demonstrate a significant increase in control.

The Stalker plus Arborchem Basal Oil combination resulted in excellent control of green ash but, provided moderate control of red maple and black locust. Both the Accord or Krenite S plus Stalker, MON 59120, and water provided good control of green ash but, limited control of black locust and red maple.

Second year findings were similar to first year results (Table 2). The treatments containing Garlon 4 or Pathfinder II provided almost complete control of all three species. Green ash was completely controlled by all treatments except Accord, MON 59120 and water at 50/1/49, respectively. Two combinations including Accord, MON 59120 and water at rates of 25/10/65 and 50/5/45 provided complete control of green ash by the second year even though they were not among the best performers in year one. Accord, MON 59120, and water at 50/10/40, respectively; Accord plus Stalker; and Krenite S plus Stalker all provided 90 percent or greater mortality of green ash and red maple. These combinations provided greater control on red maple in the second year compared to first year results. The treated stems of black locust were only controlled well by treatments containing triclopyr. However, the control of the treated stems resulted in increased resprouting.

CONCLUSIONS

The Pathfinder II and Garlon 4 combinations tested in this study are all excellent choices for controlling trees using basal bark applications. Root suckering species, like black locust, will resprout and followup treatments should be anticipated. Where high stem densities exist the Tordon K or Stalker component at rates of 5% may result in excessive soil activity. Caution and discretion on the part of the applicator should be used. None of the Accord, MON 59120, and water treatments provided excellent control of all three species.

TABLE 1: Treatments were applied to green ash, red maple, and black locust on March 26, March 27, and April 3, 1997, respectively. Injury ratings were taken for green ash on August 14, black locust September 10, and red maple August 12, 1997. These first year injury ratings were taken using a scale of 1 to 10 with, '1' denoting no injury; '5' indicating moderate defoliation including the terminal; and '10' indicating complete control of the tree. Treatment means followed by the same letter within a given column are not significantly different according to Fisher's LSD. A single LSD value is not reported due to unequal replication.

Treatment	Application Rate	Average Tree Injury Rating Green Ash	Red Maple[1/]	Black Locust
	(% v/v)	(average injury rating (no. stems) T-Grouping)		
Check	----	1.1 e	1.2 h	2.0(47)f
Pathfinder II	RTU	10 a	10 a	10(22)a
Garlon 4 Arborchem Basal Oil	20 80	10 a	10 a	10(69)a
Garlon 4 Tordon K Arborchem Basal Oil	20 5 75	9.8 ab	10 a	10(53)a
Garlon 4 Stalker Arborchem Basal Oil	20 1 79	9.9 a	10 a	9.9(50)a
Garlon 4 Stalker Arborchem Basal Oil	15 3 82	10 a	9.9 ab	9.9(77)a
Garlon 4 Stalker Arborchem Basal Oil	10 5 85	9.9 a	9.7 ab	9.6(78)a
Stalker Arborchem Basal Oil	5 95	9.8 ab	8.0 bc	8.2(66)ab
Accord MON 59120 Water	25 10 65	8.9 c	2.2 h	2.4(59)f
Accord MON 59120 Water	25 25 50	9.4 abc	2.8 gh	3.4(29)def
Accord MON 59120 Water	50 1 49	6.7 d	4.3 fg	3.0(34)ef
Accord MON 59120 Water	50 5 45	9.0 bc	4.5 efg	3.3(56)ef
Accord MON 59120 Water	50 10 40	9.8 ab	6.6 cd	5.5(46)cde
Accord MON 59120 Water	50 25 25	9.8 ab	4.9 def	5.2(38)cde
Accord Stalker MON 59120 Water	50 5 22.5 22.5	10 a	6.4 cde	6.6(60)bc
Krenite S Stalker MON 59120 Water	50 5 22.5 22.5	9.9 a	7.7 c	5.6(65)cd

[1/] Means adjusted by analysis of covariance according to stem caliper.

TABLE 2: Treatments were applied to green ash, red maple, and black locust on March 26, March 27, and April 3, 1997, respectively. Injury ratings were taken for green ash on September 4, black locust September 17, and red maple September 12, 1998. Second year injury ratings were taken using a scale of 1 to 4, with '1' indicating no effect, '2' observable injury but the plant would live, '3' indicated mortal injury, and '4' was a dead plant. Percent mortality was calculated by dividing the total number of stems rated '3' and '4', divided by total number of stems.

Treatment	Application Rate	Mortality Green Ash	Mortality Red Maple	Mortality Black Locust	Black Locust Resprouts
	(% v/v)	(-------------------------%------------------------)			(No.)
Check	----	30	0	15	0
Pathfinder II	RTU	100	100	100	30
Garlon 4 Arborchem Basal Oil	20 80	100	100	100	20
Garlon 4 Tordon K Arborchem Basal Oil	20 5 75	100	100	100	9
Garlon 4 Stalker Arborchem Basal Oil	20 1 79	100	100	96	20
Garlon 4 Stalker Arborchem Basal Oil	15 3 82	100	100	97	30
Garlon 4 Stalker Arborchem Basal Oil	10 5 85	100	100	90	22
Stalker Arborchem Basal Oil	5 95	100	70	68	17
Accord MON 59120 Water	25 10 65	100	60	5	0
Accord MON 59120 Water	25 25 50	100	56	18	0
Accord MON 59120 Water	50 1 49	60	30	11	0
Accord MON 59120 Water	50 5 45	100	50	0	0
Accord MON 59120 Water	50 10 40	100	90	44	3
Accord MON 59120 Water	50 25 25	100	60	16	0
Accord Stalker MON 59120 Water	50 5 22.5 22.5	100	100	46	0
Krenite S Stalker MON 59120 Water	50 5 22.5 22.5	100	100	36	2
Significance Level				0.0001	0.4282
LSD (p=0.05)				28	n.s.

BRUSH CONTROL PROVIDED BY LOW VOLUME FOLIAR APPLICATIONS OF GARLON IN AQUEOUS SOLUTION

INTRODUCTION

A study was established to evaluate brush control provided by low volume foliar applications of Garlon 3A and 4 alone and in combination with other herbicides.

MATERIALS AND METHODS

Treatments included an untreated check; Garlon 4 alone and in combination with Tordon K or Arsenal; Garlon 3A alone and in combination with Tordon K, Vanquish, Arsenal or Roundup Pro; and Krenite S plus Arsenal. The study was established at two separate locations using three replications. The first two replications were located at Penn State's Research Forest near Masseyburg, PA. The third replication was located at the intersection of SR 53 and SR 22 near Cresson, PA. The treatments were applied on August 21, 1997, to either 10 ft by 150 ft or 35 ft by 90 ft plots, depending on the site, and arranged in a randomized complete block design. A CO_2-powered backpack sprayer equipped with a handgun and a Spraying Systems #5500 Adjustable ConeJet with Y-2 tip, operating at 30 psi was used to approximate an application volume of 20 gal/ac. All treatments included 0.125% (v/v) QwikWet 357 surfactant and 0.25% (v/v) Polytex A1001 drift control agent. Each plot contained several tree species in the 2 to 20 ft height range. The first two replications contained trees predominately at the higher end of this height range. The lower 15 ft of these trees got thorough coverage from the road at the front border of the plots. The predominant species were red maple (*Acer rubrum* L.), quaking aspen (*Populus tremuloides* Michx.), black birch (*Betula lenta* L.), red oak (*Quercus rubra* L.), witch-hazel (*Hamamelis virginiana* L.), black cherry (*Prunus serotina* Ehrh.), hickory (*Carya* spp.), white oak (*Quercus alba* L.), and green ash (*Fraxinus pennsylvania* Marsh.). Percent control was evaluated on September 10, 1998, 385 days after treatment, DAT.

RESULTS

The percent control rating on the far right side of table 1 includes all tree species in the statistical analysis. The treatments providing the highest average control ratings for all tree species 385 DAT were Garlon 3A or 4 in combination with either Tordon K or Arsenal; Garlon 3A plus Roundup Pro; and Krenite S plus Arsenal. There was increased control for all tree species when Tordon K was added to either Garlon 3A or 4 compared to Garlon alone, with the exception of black birch. Garlon 3A at 77 oz/ac resulted in 65 percent control and dropped to 39 percent when Tordon K was added. Arsenal served as an even better tank mix partner with Garlon. Poplar (not shown) and some miscellaneous species that were a part of the 'other' category were the only target species not to show improved efficacy with the Garlon plus Arsenal combinations compared to Garlon alone or Garlon plus Tordon K. The Garlon 4 plus Tordon K treatment resulted in 94 percent control and decreased to 88 percent when Arsenal was substituted for Tordon K. Similarly, the Garlon 3A plus Tordon K treatment provided 100 percent control and decreased to 50 percent when Arsenal replaced the Tordon K. Garlon 3A or 4 alone and Garlon 3A combined with Vanquish did not provide acceptable results.

CONCLUSIONS

Garlon 3A and 4 applied at equivalent rates of active ingredient (102 oz versus 77 oz, respectively) provide statistically similar control. Neither product applied alone resulted in acceptable levels of control. Adding Vanquish to the Garlon 3A still did not provide acceptable control at the rates tested in this study. Adding Tordon K, Arsenal or Roundup Pro improved efficacy. Although the average total control was statistically similar, Arsenal appears to be a better tank mix partner for Garlon than Tordon K or Roundup Pro based on the increased control observed in this study for most species.

TABLE 1: Treatments were applied on August 21, 1997. All treatments contained 0.125% (v/v) QwikWet 357 and 0.25% (v/v) Polytex A1001 drift control. Ratings of percent control were taken September 10, 1998 for the various brush species. A '---' indicates that the species was not present in the treatment area. Number in parentheses are number of stems treated. Each value is the mean of three replications. Poplar is not included on Table 1 due to lack of space. However, the average total control includes this species in the statistical analysis.

Treatment	Application Rate	Percent Control					
		Maple	Birch	Red Oak	Witch-hazel	Other	Total
	(oz product/ac)	(-------------------------------------% (no. of stems)					---)
Garlon 4	77	60(94)	79(14)	91(21)	97(33)	37(13)	64(224)
Garlon 4 Tordon K	51 19	80(66)	83(12)	96(14)	97(17)	88(19)	80(208)
Garlon 4 Arsenal	51 13	96(113)	89(22)	100(43)	100(17)	68(26)	90(262)
Garlon 3A	77	53(51)	65(51)	84(25)	72(30)	54(16)	53(216)
Garlon 3A	102	64(70)	67 (6)	92(23)	74(21)	100(17)	59(186)
Garlon 3A Tordon K	77 19	76(101)	39(10)	94(20)	72(14)	69(10)	69(188)
Garlon 3A Vanquish	77 26	55(78)	77(22)	96(15)	100(46)	18(72)	58(277)
Garlon 3A Arsenal	77 13	77(68)	75(12)	100(26)	89(19)	95(14)	81(189)
Garlon 3A Roundup Pro	77 38	42(93)	44(23)	80(23)	87(26)	63(16)	67(237)
Krenite S Arsenal	128 13	93(72)	98(23)	100(38)	99(50)	63(19)	92(237)
Significance Level (p)							0.0001
LSD (p=0.05)							25

BRUSH CONTROL PROVIDED BY LOW VOLUME FOLIAR APPLICATIONS OF GARLON ALONE OR IN COMBINATION WITH OTHER HERBICIDES IN THINVERT RTU

INTRODUCTION

This study was initiated to evaluate the control of various brush species using two formulations of Garlon in combination with other herbicides and Thinvert RTU. Thinvert RTU is a ready-to-use invert emulsion that is used as the carrier instead of water.

MATERIALS AND METHODS

Treatments were applied using Thinvert RTU as a carrier and included an untreated check; Garlon 3A alone and in combination with Tordon K, Arsenal or Vanquish; Garlon 3A and Vanquish with water as a carrier; Garlon 4 in combination with Tordon K; and Krenite S plus Arsenal. The study was established at two separate locations with two replications at each site. The first site was a stand of oak (*Quercus* spp.) at Penn State's Research Forest near Masseyburg, PA. The second site was a mixed stand of tree species located at the intersection of SR 53 and SR 22 near Cresson, PA. The oak was treated on August 19 and the mixed stand on August 21, 1997. Plots were 10 ft by 20 ft for the oak and 25 ft by 45 ft for the mixed stand. Both sites were arranged in a randomized complete block design. A CO_2-powered backpack sprayer equipped with a handgun and Thinvert 71510 tip, operating at 30 psi was used to approximate an application volume of 5 gal/ac. The aqueous treatment included 0.125% (v/v) QwikWet 357 surfactant and 0.25% (v/v) Formula 358 drift control agent. Trees ranged in size from 2 to 10 ft in height. The species present were red oak (*Quercus rubra* L.), white oak (*Quercus alba* L.), red maple (*Acer rubrum* L.), quaking aspen (*Populus tremuloides* Michx.), black birch (*Betula lenta* L.), and black cherry (*Prunus serotina* Ehrh.). Percent control was evaluated on September 22 (oak) and September 18, 1998 (mixed stand), 1 year after treatment, YAT.

RESULTS

The total mortality rating near the far right side of table 1 includes all tree species in the statistical analysis except oak. The treatments providing the highest total percent mortality and the only treatments with acceptable control were Krenite S plus Arsenal and 7.5% v/v Garlon 4 plus 2% v/v Tordon K. All treatments performed statistically similar on oak with the exception of Garlon 3A alone and in combination with Arsenal. These two treatments were similar to the untreated check. The percent mortality on oak ranged from 50% to 88% for the most effective treatments with Krenite S plus Arsenal and 7.5% v/v Garlon 4 plus 2% v/v Tordon K again yielding the highest mortality ratings of the treatments tested.

CONCLUSIONS

Krenite S plus Arsenal in Thinvert RTU is effective at controlling a wide range of tree species. 7.5% v/v Garlon 4 plus 2% v/v Tordon K in Thinvert RTU is also an effective combination but, is weak at controlling maple.

TABLE 1: Birch, cherry, maple, populus and other species were treated on August 21, 1997 and control ratings taken September 18, 1998. The 'Total" column represents the average control rating for these species. Oak was located at a separate study site and analyzed independently. It is not included in the 'Total' column shown below. Oak was treated on August 19, 1997 and rated for control on September 22, 1998. Ratings of brush control are reported as percent mortality. Each target stem was rated on a 1 to 4 scale, where '1' = no effect; '2'=visible effect, recovery likely; '3'=significant effect, mortality likely; and '4'= dead plant. Percent mortality was calculated as the sum of plants rated a '3' and '4', divided by total plants, multiplied by 100. A '---' indicates the species was not present in any of the treated plots. The results are the mean of two replications and the number in parentheses indicate the total treated stems for both replications, though each species may not have occurred in each replicate.

Treatment	Application Rate	Mortality											
		Birch		Cherry		Maple		Populus		**Total**		**Oak**	
	(% solution)	(------percent (no. of stems) ------)											
Untreated	---	0	(44)	0	(3)	0	(108)	0	(15)	0	(170)	0	(22)
Garlon 3A	10.00	33	(27)	---	(0)	6	(123)	21	(19)	12	(170)	29	(21)
Garlon 3A Tordon K	10.00 2.00	59	(31)	50	(2)	34	(97)	50	(8)	42	(138)	50	(6)
Garlon 3A Arsenal	10.00 1.00	17	(105)	21	(19)	51	(96)	53	(33)	35	(253)	25	(11)
Garlon 3A Vanquish	10.00 5.00	40	(126)	0	(1)	28	(105)	55	(47)	39	(279)	74	(17)
Garlon 3A[1/] Vanquish (Water carrier)	10.00 5.00	24	(52)	0	(4)	17	(210)	53	(43)	22	(310)	51	(22)
Garlon 4 Tordon K	7.50 2.00	84	(103)	---	(0)	55	(146)	99	(42)	73	(294)	77	(13)
Krenite S Arsenal	20.00 1.25	87	(62)	75	(3)	99	(101)	76	(78)	89	(246)	88	(23)
Significance Level (p)										0.0004		0.0122	
LSD (p=0.05)										22		38	

[1/] This treatment used water as a carrier and included the surfactant QwikWet 357 at 0.125 percent, v/v, and Formula 358 drift control at 0.25 percent, v/v.

BRUSH CONTROL PROVIDED BY LOW VOLUME FOLIAR APPLICATIONS

INTRODUCTION

A study evaluating brush control provided by tank mixes including Vanquish, compared to two standards - Krenite S plus Arsenal, and Roundup Pro plus Arsenal, was established in Penn State's Stone Valley Experimental Forest near Masseyburg, PA.

MATERIALS AND METHODS

Treatments included an untreated check; Vanquish alone; Vanquish in combination with either Garlon 4, Arsenal, or Roundup Pro; Roundup Pro, Arsenal, and Garlon 4 alone; and two standard treatments, Krenite plus Arsenal, and Roundup Pro plus Arsenal (Table 1). Treatments were applied on August 19, 1997, to approximately 15 by 50 ft plots which were arranged in a randomized complete block design with three replications. A CO_2-powered backpack sprayer equipped with a handgun and a Spraying Systems #5500 Adjustable ConeJet with Y-2 tip, operating at 30 psi was used to approximate an application volume of 20 gal/ac. All treatments included 0.125% (v/v) QwikWet 357 surfactant and 0.25% (v/v) Polytex A1001 drift control agent. Each plot contained several tree species in the 2 to 15 ft height range. The predominant species were black cherry (*Prunus serotina* Ehrh.), hickory (*Carya* spp.), red maple (*Acer rubrum* L.), red oak (*Quercus rubra* L.), white oak (*Quercus alba* L.), quaking aspen (*Populus tremuloides* Michx.), green ash (*Fraxinus pennsylvanica* Marsh.), and black birch (*Betula lenta* L.). Visual ratings of foliar necrosis, or 'brown-out', were taken September 16, 1997, 28 days after treatment (DAT). Visual ratings of tree injury were taken September 22, 1998 (399 DAT), using a 1 to 4 scale, where '1'=no injury, '2'=moderate injury, survival likely, '3'=severe injury, death likely, and '4'=dead plant. Percent mortality for each treatment was calculated by dividing the number of plants rated '3' or '4' by the total number plants. Percent mortality ratings are reported in Table 1.

RESULTS AND DISCUSSION

The percent mortality rating for the 'Total' column in Table 1 is the average over all species. Foliar necrosis data is not reported, however, the treatments including Roundup Pro or Garlon 4 caused the most foliar necrosis 28 DAT.

The standard treatments, Krenite S plus Arsenal, and Roundup Pro plus Arsenal, provided 96 and 81 percent mortality, respectively. Though effective on most species in the trial, Roundup Pro plus Arsenal was ineffective on hemlock, which brought the mortality ratings down.

Vanquish alone provided poor control of all species evaluated, and averaged 22 percent mortality. The most effective tank mix partner for Vanquish was Garlon 4. Together they provided 81 percent mortality, which was also an improvement over Garlon 4 alone, which provided 60 percent average mortality. Vanquish combined with either Roundup Pro at 64 oz/ac, or Arsenal at 12 oz/ac, did not provide an increase in brush mortality compared to either herbicide alone. The addition of Vanquish actually decreased average mortality from Roundup Pro alone, from 73 to 62 and 52 percent, for Vanquish at 64 and 48 oz/ac, respectively. Arsenal at 24 oz/ac alone provided 73 percent average mortality compared to 46 percent for 12 oz/ac alone. The difference was due to increased activity on oak and hickory.

CONCLUSIONS

None of the treatments evaluated provide the level of control available with Krenite S plus Arsenal. Although applications of Arsenal, Garlon 4, Roundup Pro, and Vanquish alone were made in this trial, single herbicide applications for brush control would never be recommended. As the results show, individual herbicides are ineffective on certain species. Single material applications were made to evaluate the performance of tank mix partners alone and together, to determine if the combinations were antagonistic, additive, or synergistic. Vanquish when applied alone at 64 oz/ac is not an effective brush control agent on any species in this trial. When tank mixed, it does not increase the activity of Arsenal applied at 12 oz/ac, or Roundup Pro applied at 64 oz/ac. Vanquish does form an effective combination when tank-mixed with Garlon 4. Further work on this combination could provide an alternative to the Garlon/Escort combination that is commonly used in weed/brush programs, so that managers have an option for tolerance/resistance management.

TABLE 1: Ratings of brush control, reported as percent mortality, taken September 22, 1998, for treatments applied August 19, 1997. Each target stem was rated on a 1 to 4 scale, where '1' = no effect, '2'=visible effect, recovery likely, '3'=significant effect, mortality likely, and '4'= dead plant. Percent mortality was calculated as the sum of plants rated '3' or '4', divided by total plants. A '---' indicates the species was not present in any of the treated plots. The 'Total' results are the mean of three replications, though each species may not have occurred in each replicate.

Treatment[1/]	Application Rate	Mortality										
		Total	Oak		Maple		Cherry		Hickory		Other	
	(oz product/ac)	(-----percent (no. of stems) -----)										
Vanquish	64	22	23	(56)	5	(50	47	(9)	0	(5)	18	(39)
Vanquish Garlon 4	64 32	81	94	(53)	26	(31)	100	(3)	25	(3)	91	(89)
Vanquish Arsenal	64 4	36	45	(42)	6	(23)	14	(9)	50	(5)	33	(48)
Vanquish Arsenal	64 8	48	60	(37)	67	(17)	67	(3)	0	(5)	43	(78)
Vanquish Arsenal	64 12	48	72	(62)	49	(29)	100	(2)	48	(10)	38	(67)
Vanquish Roundup Pro	48 64	52	58	(71)	24	(33)	- -		0	(9)	70	(64)
Vanquish Roundup Pro	64 64	62	52	(48)	26	(34)	100	(4)	52	(11)	82	(98)
Roundup Pro	64	73	73	(72)	54	(61)	100	(2)	33	(9)	80	(101)
Arsenal	12	46	57	(45)	93	(16)	39	(7)	0	(1)	34	(106)
Arsenal	24	73	94	(35)	93	(29)	67	(4)	100	(6)	46	(68)
Garlon 4	64	60	58	(30)	27	(30)	40	(7)	90	(6)	46	(104)
Krenite S Arsenal	128 8	96	100	(37)	100	(36)	100	(4)	100	(9)	91	(96)
Roundup Pro Arsenal	128 8	92	95	(18)	100	(26)	100	(8)	- -		76	(148)
Significance Level (p)		0.0001										
LSD (p=0.05)		28										

[1/] All treatments included the surfactant QuikWet 357 at 0.125 percent, v/v, and Polytex A1001 drift control at 0.25 percent, v/v.

EVALUATION OF BRUSH CONTROL PROVIDED BY BASAL BARK APPLICATIONS OF ACCORD SECOND YEAR RESULTS

INTRODUCTION

A study was established to evaluate the control of green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), and tree-of-heaven, AKA Ailanthus (*Ailanthus altissima*) treated with basal bark applications of Accord and MON 59120 in February, 1997. MON 59120 is an experimental adjuvant. Preliminary data was collected in August and September, 1997. However, basal bark treatments produce a girdling effect on the tree, and more than one growing season is often required to determine the success of the application. The intent of this current rating was to determine the long term results of the treatments.

MATERIALS AND METHODS

Treatments included an untreated check; Accord in MON 59120 and water; Garlon 4 in Penevator Basal Oil; and a combination of either Accord or Krenite S, plus Stalker in MON 59120 and water. Treatments were applied on February 12 and 13, 1997 to three separate colonies (replications) of Ailanthus divided into equal portions. The study area was located near State College and Bellefonte, PA. Treatments were applied to ten stems each of green ash and eleven stems each of red maple near Port Matilda, PA on February 10. The experimental design for Ailanthus was a randomized complete block design with three replications; and the design for ash and maple was completely randomized, with each stem being an experimental unit. Treatments of Accord in combination with MON 59120 and water were applied to cover the lower 24 inches of the base of each stem. All other treatments were applied to the lower 12 inches. Application equipment included a CO_2-powered backpack sprayer equipped with a Spraying Systems #5500 Adjustable ConeJet nozzle with a Y-2 tip, operating at 30 psi. Stem diameters ranged from 1 to 4 inches for Ailanthus, 0.75 to 3.25 inches for red maple, and 0.5 to 3 for green ash. Ratings of tree injury were taken August 14, 1997 for ash and maple; while tree injury and percent groundcover of resprouts was rated for Ailanthus on September 13, 1997. Injury was rated on a scale of 1 to 10; in which '1' indicates no injury, '5' indicates moderate defoliation including the terminal, and '10' indicates complete control of the treated stem. The data was subjected to an analysis of variance. Second year ratings were taken September 4, 1998 for green ash and red maple; and September 15 for Ailanthus. Second year injury ratings were taken for ash and maple using a scale of 1 to 4 where '1' was no effect, '2' was observable injury but the plant would live, '3' indicated mortal injury, and '4' was a dead plant. Percent mortality was calculated by dividing the number of stems rated '3' and '4' by total number of stems. Only two of the three replications were rated to provide second year results for Ailanthus. Injury ratings were taken using a scale of 1 to 10, in which '1' indicates no injury, '5' indicates moderate defoliation including the terminal, and '10' indicates complete control of the treated stem. The percent groundcover of Ailanthus resprouts was also recorded. The percent of soil surface within the plot covered by the resprout canopy was used to determine this value.

RESULTS

First year results showed that stem caliper had a significant effect on control of maple. Maple data were subject to analysis of covariance, and reported means were adjusted according to stem caliper (Table 1). Accord, when used without MON 59120 resulted in poor control of all three species. All treatments including Accord at 25 percent, v/v, provided very good control of green ash and Ailanthus, but only moderate control of red maple. All treatments including Accord at 50 percent, v/v, with MON 59120 provided excellent control of all three species. Garlon 4 in oil, the current industry standard, provided excellent control of all species. Accord plus Stalker and Krenite S plus Stalker provided very good to excellent control of all three species. None the of the treatments provided acceptable suppression of Ailanthus resprouts.

By the second year after application there was complete control of all three species with Accord at 50 percent, v/v, plus MON 59120; Garlon 4 in oil; and Accord plus Stalker. Nearly complete control of all three species was achieved with Krenite S plus Stalker. Accord at 25 percent, v/v provided complete control of green ash and

Ailanthus, and moderate to good control of red maple. Accord at 50 percent, v/v, without MON 59120 did not provide acceptable results.

Although the treated Ailanthus stems were completely controlled by all treatments, with the exception of 50 percent Accord alone in water, the percent groundcover of Ailanthus resprouts was unacceptable for most treatments. Because of an unusually high coefficient of variation (58.9) the percent groundcover of resprouts was not significantly different among treatments. However, the untreated check, Accord alone in water, and Accord plus Stalker treatments averaged 8 percent or less groundcover by resprouts. All other treatments ranged from 35 to 85 percent.

CONCLUSIONS

Second year results were similar to first year results, leading to the following conclusions: Accord, when applied at 50% with MON 59120 and water provided excellent control in both this and previous work with the exception of an unexplained weakness on Ailanthus in a study established in 1996. MON 59120 is necessary in the mix to obtain control, and rates of Accord at 25% or less have shown reduced control of some species. Garlon 4 and the Accord or Krenite S plus Stalker treatments all provided excellent control. However, there is a higher cost and risk to adjacent desirable vegetation when Stalker is added to the mix.

Typically, when Ailanthus is controlled by a chemical treatment tremendous resprouting follows. The Accord plus Stalker treatment was unique in this test because it provided complete control of the Ailanthus and minimal resprouting was observed at the end of the second season. It is important to keep in mind that the means recorded for percent groundcover of Ailanthus resprouts did not statistically separate as a result of unexplained variation within the test. Further investigation into this combination should be made to see if these results can be duplicated. At this point, any of the treatments that provided complete control of the treated stems of Ailanthus could be used, but treatment of the resprouts is inevitable.

TABLE 1: Tree injury provided by various basal bark treatments applied to green ash and red maple plots February 10, and Ailanthus February 12 and 13, 1997. Treatments were rated August 14, 1997, for maple and ash, respectively; and September 13 for Ailanthus. Average injury was visually rated on a scale of 1 to 10, in which '1' indicates no injury, '5' indicates moderate defoliation including the terminal, and '10' indicates complete control of the treated stem. Each value is the mean of three replications for Ailanthus, ten replications for green ash and eleven replications for red maple.

Herbicide	Application Rate	Average Tree Injury Rating: Green Ash	Red Maple[1/]	Ailanthus	Groundcover of Ailanthus Resprouts
	(% v/v)	(-----------------average injury rating	----------------	-)	(%)
Untreated Check	- -	---	---	1.0	27
Accord	25	9.4	7.5 bc	9.3	65
MON 59120	10				
Water	65				
Accord	25	9.6	8.2 abc	10.0	62
MON 59120	25				
Water	50				
Accord	25	8.9	6.8 c	10.0	54
MON 59120	37.5				
Water	37.5				
Accord	50	6.8	3.3 d	2.7	22
Water	50				
Accord	50	9.2	9.4 ab	10.0	42
MON 59120	5				
Water	45				
Accord	50	9.5	9.8 a	9.7	56
MON 59120	10				
Water	40				
Accord	50	9.5	9.5 ab	10.0	62
MON 59120	25				
Water	25				
Garlon 4	20	10.0	9.8 a	10.0	47
Penevator Basal Oil	80				
Accord	50	9.5	8.4 abc	9.7	30
Stalker	5				
MON 59120	22.5				
Water	22.5				
Krenite S	50	9.9	9.0 abc	8.0	23
Stalker	5				
MON 59120	22.5				
Water	22.5				
Significance Level (p)		0.0001	0.0001	0.0001	0.0746
LSD (p=0.05)		1.0	----	1.9	n.s.

[1/] Means adjusted by analysis of covariance according to stem caliper.

TABLE 2: Tree injury provided by various basal bark treatments applied to green ash and red maple plots February 10, and Ailanthus February 12 and 13, 1997. Treatments were rated September 4, 1998, for ash and maple; and September 15 for Ailanthus. Second year injury ratings were taken for ash and maple using a scale of 1 to 4 where '1' was no effect, '2' was observable injury but the plant would live, '3' indicated mortal injury, and '4' was a dead plant. Percent mortality was calculated by dividing the number of stems rated '3' and '4' by the total number of stems. Second year injury ratings for Ailanthus were taken using a scale of 1 to 10, in which '1' indicates no injury, '5' indicates moderate defoliation including the terminal, and '10' indicates complete control of the treated stem. Each value is the mean of two replications for Ailanthus, ten for green ash and eleven for red maple. Treatment means followed by the same letter within a given column are not significantly different according to Fisher's LSD.

		Mortality		Average Tree Injury	Groundcover of Ailanthus
Herbicide	Application Rate	Green Ash	Red Maple	Ailanthus	Resprouts
	(% v/v)	(---------------%	----------------)	(average injury)	(%)
Untreated Check	- -	0 c	----	----	----
Accord	25	100 a	82 ab	10	85
MON 59120	10				
Water	65				
Accord	25	100 a	73 b	10	60
MON 59120	25				
Water	50				
Accord	25	100 a	82 ab	10	85
MON 59120	37.5				
Water	37.5				
Accord	50	80 b	45 c	5	8
Water	50				
Accord	50	100 a	100 a	10	35
MON 59120	5				
Water	45				
Accord	50	100 a	100 a	10	65
MON 59120	10				
Water	40				
Accord	50	100 a	100 a	10	75
MON 59120	25				
Water	25				
Garlon 4	20	100 a	100 a	10	40
Penevator Basal Oil	80				
Accord	50	100 a	100 a	10	8
Stalker	5				
MON 59120	22.5				
Water	22.5				
Krenite S	50	100 a	91 ab	10	43
Stalker	5				
MON 59120	22.5				
Water	22.5				
Significance Level (p)		0.0001	0.0004	0.1368	0.1814
LSD (p=0.05)		----	----	n.s.	n.s.

EVALUATION OF GIANT KNOTWEED CONTROL AND CONVERSION INTO FINE FESCUES

INTRODUCTION

Giant knotweed (*Polygonum sachalinense*) and Japanese knotweed (*Polygonum cuspidatum*) are becoming an increasing problem along Pennsylvania's roadways. Complete control of a knotweed stand along the road is difficult since much of a population may exist outside the right-of-way. A combination of chemical and cultural practices may help to improve the long-term goal of managing these knotweed stands. The cultural practice of planting grasses in these areas would provide the benefit of forming a competitive groundcover where selective materials can later be applied to control any knotweed resprouts. A study was established to determine the effectiveness of converting a stand of giant knotweed to 'Formula L'[1/]. The results of this study can be referenced in The Roadside Vegetation Management Research Twelfth Year Report. Since the study ended in July 1997, the area has been converted to a demonstration. The demonstration was established in an attempt to continue control measures at the site and monitor long-term results. This report summarizes the findings of the initial study and details the events and findings that have occurred from July 1997 to August 1999.

MATERIALS AND METHODS

The 0.65 ac study area was located in an established giant knotweed stand along SR 2019 near Luciusboro, PA. The entire study area was seeded with 100 lb/ac of 'Formula L' on March 22, 1996, with hand-held rotary spreaders. Approximately 2-4 inches of snow was present at the time of seeding. The area was divided into plots and five separate herbicide treatments were applied on July 17, 1996, as part of the initial study to evaluate the effectiveness of the treatments and the amount of turf that established. On July 2, 1997, at the conclusion of the study, the treated plots were sprayed with 0.75% (v/v) Vanquish and 0.0625% (v/v) Transline. Previously untreated areas were sprayed with 1% (v/v) Roundup Pro and 0.0625% (v/v) Arsenal. The treatments were applied using a truck mounted sprayer equipped with a hose reel and GunJet handgun with a D6 spray tip, at 60 psi and approximately 100 gpa. All treatments included 0.125% (v/v) QwikWet 357 surfactant and 0.25% (v/v) Polytex A1001 drift control agent. Fifty gallons of solution was applied to approximatley 0.5 ac. On September 18, 1997 all areas devoid of turf were seeded with Formula L. This mix was hand seeded with approximately 75 lbs of seed using hand-held rotary spreaders. Touchup sprays were made on September 15, 1998 and August 10, 1999 to control any remaining knotweed plants. Both treatments were low volume backpack applications targeting 20 gal/ac. Approximately 5 gal was sprayed on September, 1998 and 4.5 gal on August, 1999 to cover 0.25 and 0.22 acres, respectively. On September, 1998 a mixture containing 2.5% (v/v) Vanquish, 0.31% (v/v) Transline, 0.1% (v/v) QwikWet 357 surfactant, and 0.25% (v/v) Polytex A1001 drift control agent was applied. An additional 45 lbs of Formula L was seeded to areas sprayed on this date. On August, 1999 the spray mixture contained 4 qts/ac Garlon 4, 8 oz/ac Transline and 0.125% (v/v) QwikWet 357.

RESULTS

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

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

across the demonstration site. During the September, 1998 visit the area was approximately 30% knotweed with the remaining area predominately covered with Formula L.

CONCLUSIONS

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

EFFECT OF HERBICIDE AND PRE-PLANT APPLICATION TIMING ON ESTABLISHMENT OF FINE FESCUES

ABSTRACT

The herbicides Arsenal, Escort, Garlon 3A, Telar, Tordon K, Transline, and Vanquish were evaluated as pre-plant tank mix partners with Roundup Pro for their effect on the establishment of fine fescues. In the course of two trials, with application times ranging from 72 to 7 days before seeding, Garlon 3A, Tordon K, Transline, and Vanquish were found to have no inhibitory effect on fine fescue establishment. Escort was intermediate in its inhibition of fescue establishment, and Arsenal and Telar were most inhibitory.

INTRODUCTION

In situations where undesirable roadside plant communities are going to be replaced with a desirable groundcover, such as the Department's Formula L, an opportunity for the new seeding to become established must be created. This seeding opportunity can either come about through timing, where seeding occurs prior to spring regrowth of the undesirable plant material, or by suppressing existing undesirable vegetation with an herbicide application. When the seeding opportunity is going to be created with an herbicide application, the herbicide mixture should be as lethal as possible to the target vegetation without causing inhibition of the fine fescue seeding due to herbicide residues in the soil. The herbicide glyphosate, the active ingredient in Roundup Pro, is arguably the standard material for this situation because it has no soil activity. When applied alone, Roundup Pro is effective on the above ground vegetation, and provides a degree of suppression of regrowth from underground propagules. In past efforts to rehabilitate Canada thistle-infested crownvetch to Formula L, the Research Project's experience has been that the addition of an herbicide active on broadleaf species will improve the control of the root system of Canada thistle, and provide a longer window of opportunity for the new seeding to establish.

The objective of this research was to evaluate the effects of application rate, and the interval between herbicide application and seeding, on the establishment of hard and creeping red fescues, the primary components of seeding specification 'Formula L' (hard fescue/creeping red fescue/annual ryegrass at 55/35/10 percent respectively). The combination of different rates, and intervals before seeding would provide an indication of when potentially useful herbicides with residual soil activity could potentially be used, expanding the choices available to vegetation managers.

MATERIALS AND METHODS

Two trials were conducted at the Landscape Management Research Center of the Pennsylvania State University, on soil mapped as a Opequon-Hagerstown complex (Lithic hapludalf), which is a shallow, fertile, limestone-derived soil. Each trial included four herbicide application dates. The first trial was initiated June 1997, to accommodate a late August seeding. The second trial was established in April of 1998 so that establishment effects could be viewed during the Roadside Vegetation Management Conference in late July 1998.

1997 Trial

The study area was a Roundup Pro-killed stand of Kentucky bluegrass, shredded to a depth of 2 inches with a Lely Roterra to expose the soil. The trial was seeded to Formula L at 100 lb/acre on August 19. Herbicide treatments were applied June 7, July 14, July 25, and August 12, providing treatment intervals of 72, 36, 25, and 7 days before seeding (DBS), respectively. The herbicide treatments were Roundup Pro at 128 oz/ac, Transline at 8 or 16 oz/ac, Tordon K at 32 or 64 oz/ac, Telar at 0.5 or 1.0 oz/ac, Escort at 0.5 or 1.0 oz/ac, and Arsenal at 8 or 16 oz/ac. These treatments were applied to 3 by 18 ft plots, arranged as a randomized complete block with a split-plot treatment arrangement with three replications. Prior to the 36 and 7 DBS treatments, the entire study area was treated with Finale at 192 oz/ac to eliminate the weed canopy so that each herbicide timing was applied to the soil.

The Formula L was seeded with a PTO-powered slice seeder, which dropped seed over slits about 0.5 inch deep on 3 inch centers. The seedbed was irrigated as needed to optimize establishment and eliminate potential moisture stress as a variable. The first data collected was initial cover relative to the Roundup Pro plots, taken September 9, 21 days after seeding (DAS), on a 0 to 5 scale, where '0' indicated no establishment, and '5' indicated establishment at least equal to that in the Roundup Pro plots. Additional ratings included percent Formula L cover on October 9, 51 DAS; Formula L canopy height on October 13, 55 DAS; percent cover from annual ryegrass on October 13, 55 DAS; biomass fresh weight, collected with a rear bag rotary mower at a cutting height of 3.0 inches, on October 14, 56 DAS; and percent total cover, and cover from fine fescue, annual ryegrass, and weeds, on October 23, 64 DAS.

The canopy height, annual ryegrass cover, and biomass data were collected to separate the behavior of annual ryegrass and fine fescues in response to the herbicide treatments. Because of the relatively high quality of the site, the annual ryegrass growth was greater than anticipated, and would have obscured effects on the fine fescues if the ryegrass had not been characterized separately, and the canopy removed during the biomass measurements to characterize the fine fescue 'understory'.

1998 Trial

The 1998 trial was established immediately adjacent to the 1997 trial, using identical site preparation, spraying, and seeding techniques. The herbicide treatments were applied April 25, May 22, June 5, and June 12, and the plots were seeded June 19, 1998. The herbicide treatments were changed from 1997 in that each material was tank mixed with Roundup Pro, rather than applied alone. The treatments included Roundup Pro at 128 oz/ac alone, and in combination with Transline at 8 or 16 oz/ac, Tordon K at 32 or 64 oz/ac, Vanquish at 32 oz/ac, Garlon 3A at 48 oz/ac, Escort at 0.5 or 1.0 oz/ac, Telar at 0.5 or 1.0 oz/ac, and Arsenal at 8 oz/ac. The seed mixture was a 60/40 combination of hard fescue/creeping red fescue, seeded at 100 lb/ac. The annual ryegrass component was deleted to prevent the difficulties caused by its rank growth during the 1997 trial. The seedbed was irrigated as needed to provide optimum establishment. The entire study area was treated with Tordon 101M on September 3 to remove broadleaf weeds to facilitate a fine fescue-only rating. Data collected in 1998 included percent total, fine fescue, and weed cover on September 3, 76 DAS, and percent fine fescue cover on October 22, 125 DAS.

RESULTS

1997 Trial

Results for Formula L cover 21 DAS, percent total cover 51 DAS, fresh weight biomass 56 DAS, and fine fescue cover 64 DAS, are reported in Tables 1 through 4, respectively. There was a significant interaction between the effects of herbicide treatments, and application timing, therefore results are reported for each herbicide application date. Due to an application error, there is no data for Telar treatments applied 7 DBS.

When rated 21 DAS, Formula L cover (Table 1) was approximately 20 percent in the best established plots. Ratings in the 0 to 5 scale were a function of both plant number and development. There was no difference in Formula L cover for the treatments applied 72 DBS. Herbicide differences became apparent when applied 36 DBS, as only the Transline and Tordon K treated plots provided the same level of cover as Roundup Pro. The low rates of Escort and Arsenal provided an intermediate level of cover, significantly less than Roundup Pro, Transline, or Tordon K treated plots; but significantly more than plots treated with the high rate of Escort or Arsenal, and either rate of Telar. This grouping of treatments, with Transline and Tordon K treated plots providing similar cover to Roundup Pro treated plots; and Escort, Telar, and Arsenal plots having significantly less than Roundup Pro treated plots continued through the 25 and 7 DBS applications.

Percent total cover ratings taken 51 DAS (Table 2) reflected herbicide effects more dramatically than the 21 DAS ratings. Annual ryegrass was providing up to 95 percent of the cover in plots, and was 8 to 9 inches tall. Roundup Pro treated plots averaged 97, 90, 98, and 99 percent cover for the 72, 36, 25, and 7 DBS applications, respectively. As with the earlier rating, there was no herbicide effect on cover when treatments were applied 72 DBS. When applied 36 DBS, plots treated with either rate of Telar, and the high rates of Escort or Arsenal had significantly less cover than those treated with Roundup Pro. When applied 25 DBS, only Transline and Tordon K treated plots had the same level of cover as the Roundup Pro plots, ranging from 86 to 98 percent. Cover in plots treated with the low rates of Escort and Arsenal was intermediate, rated at 67 and 72 percent respectively. Cover in plots treated with the high rates of Escort or Arsenal, or Telar ranged from 32 to 8 percent.

Measurements of biomass fresh weight were taken on October 14, 56 DAS, to further characterize establishment, as there were visibly noticeable differences in the amount of vegetation present in plots that were given similar cover ratings. Removing the annual ryegrass canopy also provided an opportunity to better characterize the fine fescue growing underneath. The plot harvest were done by taking a single pass in the middle of the plot with a 20 inch rear-bag rotary mower, with a cutting height of 3.0 inches. At this cutting height, the fine fescues were largely uncut, which allowed for a more representative characterization of fine fescue establishment. Unlike the cover ratings at 21 and 51 DAS, there was a significant effect from herbicide treatment from the 72 DBS application. The biomass in the plots treated with the high rate of Telar was significantly lower than all other treatments, at 2.5 tons/ac, compared to a range of 3.8 to 5.3 tons/ac for the other treatments. As the interval between herbicide treatment and seeding decreased from 72 to 7 DBS, the degree of inhibition became greater for the Telar, Escort, and high rate of Arsenal treatments. Application time had no effect on yields in plots treated with Roundup Pro, Transline, and the low rate of Tordon K.

Results from the fine fescue ratings taken on October 23, 64 DAS paralleled the earlier cover ratings in that treatment effect was not significant for the 72 DBS applications. Cover ratings for the Roundup Pro, Transline, and Tordon K treatments ranged from 32 to 47 percent over all four application timings. The low rate treatments of Escort and Arsenal were similar, ranging from 30 to 41 percent. Telar was the most inhibitory, with the high rate plots rated at only 12 percent cover for the 25 DBS application.

When fine fescue cover was rated October 1998, 429 DAS, all treatments averaged between 94 and 97 percent cover.

1998 Trial

The results for ratings of total cover taken 76 DAS, proportion of total cover from fine fescue and weeds taken 76 DAS, and fine fescue cover taken 125 DAS are reported in Tables 5 through 8, respectively. When the data were subjected to analysis of variance, there was a significant interaction between application timing and herbicide treatment for total cover and fine fescue cover 76 DAS, and fine fescue cover 125 DAS.

Total cover ratings from 76 DAS paralleled results from the 1997 trial in that at the earliest herbicide application, 56 DBS, the effect of herbicide treatment on cover was not significant. At 28 DBS, the Roundup Pro, Transline, Tordon K, Garlon 3A, and Vanquish treatments had 99 to 100 percent cover. Both rates of Telar and the high rate of Escort had significantly less cover, 69, 47, and 30 percent respectively. The low rate of Escort, and Arsenal were rated at 76 and 86 percent, respectively, and were not significantly different from the highest rated grouping. When applied 7 DBS, all Telar, Escort, and Arsenal treatments had significantly less cover than the Roundup Pro, Transline, Tordon K, Vanquish, and Garlon 3A plots.

The results for the fine fescue cover taken 76 DAS did not reflect the trends apparent in the total cover ratings. Treatment effect was not significant for the 56 or 14 DBS applications. Fine fescue cover was not proportional to total cover across the treatments. To better illustrate the herbicide effects on the fine fescue and weed components of cover, each was analyzed as a proportion of the total, rather than as actual percent cover (Table 7). The high rate of Tordon K provided a significantly higher proportion of fine fescue cover than all other treatments, at 47 percent. The remainder of the treatments provided between 34 and 13 percent of total cover from fine fescue, with the Tordon K, Escort, Telar, and Arsenal treatments comprising the upper half of this grouping; and the Roundup Pro, Transline, Vanquish, and Garlon 3A providing the lowest proportion of total cover from fine fescue. The results for proportion of total cover from weeds were exactly opposite the fine fescue results.

Fine fescue cover ratings taken October 22, 125 DAS, reflected response to the preplant herbicide treatments, as well as compensatory growth after being released from broadleaf weed competition with the Tordon 101M application to the entire study on September 3. There was no significant herbicide treatment effect in plots treated 56 DBS. At 28 DBS, the highest rated treatments were the low and high rates of Tordon K at 93 and 92 percent, respectively. There was a low-rated cluster of the high rates of Telar and Escort, and Arsenal at 42, 48, and 55 percent cover, respectively. All other treatments were grouped in the 68 to 83 percent cover range. The 14 DBS applications were more tightly grouped ranging from 47 percent (high rate Telar) to 83 percent (high rate Tordon K).

Roundup Pro was rated at 63 percent fine fescue cover. The 7 DBS treatments ranged from 94 to 10 percent fine fescue cover. The best rated treatment was the low rate of Tordon K, which was not significantly different from the high rate of Tordon K, or the Transline, Vanquish, and Garlon 3A treatments, which ranged from 86 to 78 percent fine fescue cover. Roundup Pro, and low rates of Telar and Escort provided 73 to 57 percent cover; and the high rate of Escort, Arsenal, and the high rate of Telar were rated at 42, 30, and 10 percent fine fescue cover, respectively.

DISCUSSION

Both trials demonstrated that applying any of the herbicide treatments tested at least 56 days prior to seeding would not inhibit a fine fescue seeding. Both trials also clearly demonstrated the inhibitory effects of Escort, Arsenal, and particularly Telar, when applied pre-plant, close to the seeding dates. The 1997 trial included annual ryegrass in the seed mix, and was fall-seeded. Annual ryegrass established better than anticipated, and without mowing probably would have acted more as a weed than a nurse crop. The relative amount of annual ryegrass in the mixture only seemed to be strongly influenced by the Telar treatments, which at the 25 DBS timing (no data for 7 DBS) significantly reduced the proportion of annual ryegrass in the plot. The 1998 trial was a spring seeding without annual ryegrass in the seed mix. Weed pressure was substantial, and fine fescue establishment was affected both by herbicide residue as well as weed competition, particularly at the 76 DAS evaluation. Tordon K apparently combined low levels of fine fescue inhibition with selective activity on broadleaf weeds, as the high rate had significantly higher proportion of fine fescue than all other treatments. The treatments with the least residual activity (Roundup Pro, Transline, Garlon 3A, Vanquish) had the lowest proportion of fine fescue cover, but had more total cover than the residual treatments (Telar, Escort, Arsenal), which provided more actual fine fescue cover. The application of Tordon 101M to the 1998 study at 76 DAS to control broadleaf weeds dramatically improved the fine fescue cover between 76 and 125 DAS. By that time, only the plots treated with the high rate of Telar applied 14 or 7 DBS, and Arsenal applied 7 DBS had cover ratings low enough to be considered operationally unsatisfactory. As the October 1998 ratings of the 1997 trial suggest, the presence of enough fine fescue plants after seeding, despite their stage of establishment, will probably result in a full stand.

MANAGEMENT IMPLICATIONS

The intended use of the information generated by these experiments is optimizing the establishment of Formula L during rehabilitation efforts. The target weed for these trials was Canada thistle growing in crownvetch. These experiments clearly demonstrate that Garlon 3A, Tordon K, Transline, or Vanquish, materials commonly referred to as 'broadleaf herbicides', can be combined with Roundup Pro in an effort to increase suppression of Canada thistle, and be applied seven days before seeding without reducing the establishment of Formula L. Based on these results, as well as those from rehabilitation work with Sakhalin knotweed detailed in this report, we would be comfortable with using these materials in a combined operation where seeding and herbicide treatment occur during the same site visit.

Table 1: Visual ratings of Formula L groundcover taken September 9, 1997, 21 DAS, after pre-plant herbicide applications at four intervals before seeding. Ratings were taken on a 0 to 5 scale, where '0' = no cover, and '5' = cover equal to that in the Roundup Pro plot in a given replication. The Roundup Pro plots were not included in the statistical analysis because they were all rated a '5'. Each value is the mean of three replications.

		------------------------------Interval Before Seeding---------------------------------			
Treatment	Application Rate	72 DBS	36 DBS	25 DBS	7 DBS
	(oz product/ac)				
Roundup Pro	128	5.0	5.0	5.0	5.0
Transline	8	5.0	4.7	4.7	4.7
Transline	16	5.0	5.0	4.7	5.0
Tordon K	32	5.0	5.0	4.3	5.0
Tordon K	64	5.0	4.7	4.7	4.0
Telar	0.5	5.0	3.0	2.7	.
Telar	1	4.7	2.3	2.0	.
Escort	0.5	4.7	3.7	3.7	2.7
Escort	1	5.0	3.0	2.0	2.0
Arsenal	8	4.7	3.7	3.3	3.0
Arsenal	16	4.7	2.7	2.7	2.3
Significance Level (p)		0.48	0.0001	0.0001	0.0001
LSD (p=0.05)		NS	0.7	1	1.1

Table 2: Visual ratings of percent groundcover taken October 9, 1997, 51 DAS, after pre-plant herbicide applications at four intervals before seeding. Each value is the mean of three replications.

		------------------------------Interval Before Seeding---------------------------------			
Treatment	Application Rate	72 DBS	36 DBS	25 DBS	7 DBS
	(oz product/ac)	(---------------------------------- percent------------------------------------)			
Roundup Pro	128	97	90	98	99
Transline	8	97	91	98	99
Transline	16	98	88	96	96
Tordon K	32	98	85	95	96
Tordon K	64	98	80	86	88
Telar	0.5	95	43	25	.
Telar	1	89	18	8	.
Escort	0.5	98	78	67	53
Escort	1	95	60	32	15
Arsenal	8	94	70	72	65
Arsenal	16	93	20	23	18
Significance Level (p)		0.1	0.0001	0.0001	0.0001
LSD (p=0.05)		NS	24	15	17

Table 3: Fresh weight biomass yields in tons/acre, taken October 14, 1997, 56 DAS, after pre-plant herbicide applications at four intervals before seeding. Each value is the mean of three replications.

		------------------------------Interval Before Seeding---------------------------------			
Treatment	Application Rate	72 DBS	36 DBS	25 DBS	7 DBS
	(oz product/ac)	(------------------------- Tons/acre, fresh weight-------------------------)			
Roundup Pro	128	4.3	3.7	3.3	4.6
Transline	8	4.5	3.2	3.9	4.5
Transline	16	4.9	4.3	4.4	3.9
Tordon K	32	4.9	4.1	4.1	4.8
Tordon K	64	5.3	3.2	3.6	3.0
Telar	0.5	4.1	1.0	0.2	.
Telar	1	2.5	0.3	0.04	.
Escort	0.5	4.8	2.9	1.6	1.1
Escort	1	4.5	3.3	0.4	0.2
Arsenal	8	3.7	2.1	2.1	1.9
Arsenal	16	4.0	0.5	0.5	0.4
Significance Level (p)		0.0002	0.0001	0.0001	0.0001
LSD (p=0.05)		0.9	2.0	0.9	1.5

Table 4: Visual rating of fine fescue cover, taken October 23, 1997, 64 DAS, after pre-plant herbicide applications at four intervals before seeding. Each value is the mean of three replications.

		------------------------------Interval Before Seeding---------------------------------			
Treatment	Application Rate	72 DBS	36 DBS	25 DBS	7 DBS
	(oz product/ac)	(----------------------------------- percent------------------------------------)			
Roundup Pro	128	36	36	37	34
Transline	8	35	32	41	33
Transline	16	32	41	38	46
Tordon K	32	35	43	41	36
Tordon K	64	40	39	43	40
Telar	0.5	35	28	24	.
Telar	1	37	18	12	.
Escort	0.5	37	40	36	35
Escort	1	41	36	24	24
Arsenal	8	41	30	36	30
Arsenal	16	34	15	20	14
Significance Level (p)		0.12	0.0001	0.0001	0.002
LSD (p=0.05)		NS	9	9	12

Table 5: Visual rating of percent vegetative cover, taken September 3, 1998, 76 DAS, after pre-plant herbicide applications at four intervals before seeding. Each value is the mean of three replications.

		Interval Before Seeding			
Treatment	Application Rate	56 DBS	28 DBS	14 DBS	7 DBS
	(oz product/ac)	percent			
Roundup Pro	128	98	100	100	100
+ Transline	8	98	100	97	100
+ Transline	16	100	100	99	100
+ Tordon K	32	100	99	100	100
+ Tordon K	64	100	100	97	99
+ Vanquish	32	100	100	100	100
+ Garlon 3A	48	88	100	97	100
+ Telar	0.5	95	69	50	50
+ Telar	1	84	47	28	25
+ Escort	0.5	99	76	68	60
+ Escort	1	98	30	57	37
+ Arsenal	8	100	86	100	41
Significance Level (p)		0.24	0.0002	0.0005	0.0001
LSD (p=0.05)		NS	29	32	28

Table 6: Visual rating of percent fine fescue cover, taken September 3, 1998, 76 DAS, after pre-plant herbicide applications at four intervals before seeding. Each value is the mean of three replications.

		Interval Before Seeding			
Treatment	Application Rate	56 DBS	28 DBS	14 DBS	7 DBS
	(oz product/ac)	percent			
Roundup Pro	128	14	8	15	27
+ Transline	8	8	20	20	24
+ Transline	16	8	12	12	21
+ Tordon K	32	10	50	27	48
+ Tordon K	64	17	58	47	63
+ Vanquish	32	8	23	22	15
+ Garlon 3A	48	5	32	20	22
+ Telar	0.5	22	13	18	15
+ Telar	1	13	7	10	2
+ Escort	0.5	8	32	22	24
+ Escort	1	26	4	24	4
+ Arsenal	8	22	26	32	8
Significance Level (p)		0.07	0.002	0.6	0.001
LSD (p=0.05)		NS	25	NS	23

Table 7: Proportion of vegetative cover provided by fine fescue or weeds, visually rated September 3, 1998, 76 DAS, after treatment with pre-plant herbicides. Each value is the mean of four application dates and three replications (n=12).

		Proportion of Total Vegetative Cover	
Treatment	Application Rate	Fine Fescue	Weeds
	(product oz/ac)	(---------------------percent-----------------------	)
Roundup Pro	128	16	84
+ Transline	8	18	82
+ Transline	16	13	87
+ Tordon K	32	34	66
+ Tordon K	64	47	53
+ Vanquish	32	17	83
+ Garlon 3A	48	21	79
+ Telar	0.5	27	73
+ Telar	1	22	78
+ Escort	0.5	32	68
+ Escort	1	26	74
+ Arsenal	8	25	75
Significance Level (p)		0.0001	0.0001
LSD (p=0.05)		12	12

Table 8: Visual rating of percent fine fescue cover, taken October 22, 1998, 125 DAS, after pre-plant herbicide applications at four intervals before seeding. Each value is the mean of three replications.

		------------------------------Interval Before Seeding--------------------------------			
Treatment	Application Rate	56 DBS	28 DBS	14 DBS	7 DBS
	(oz product/ac)	(---------------------------------- percent-----------------------------------			)
Roundup Pro	128	75	77	63	73
+ Transline	8	74	80	75	78
+ Transline	16	73	78	77	80
+ Tordon K	32	73	93	79	94
+ Tordon K	64	82	92	83	86
+ Vanquish	32	70	81	75	80
+ Garlon 3A	48	63	83	60	84
+ Telar	0.5	77	72	63	57
+ Telar	1	76	42	47	10
+ Escort	0.5	72	68	77	70
+ Escort	1	85	48	63	42
+ Arsenal	8	82	55	78	30
Significance Level (p)		0.15	0.003	0.02	0.0001
LSD (p=0.05)		NS	24	18	19

CONTROL OF CANADA THISTLE AND INJURY TO FALL SEEDED FORMULA L WITH SPRING-APPLIED BROADLEAF HERBICIDES

ABSTRACT

Eight herbicide combinations targeting Canada thistle were applied to a fall-seeded stand of Formula L the spring after seeding. The combinations were Transline alone, and in combination with Tordon K, Vanquish, Telar, or Escort. All of the treatments provided excellent control of Canada thistle, and no injury symptoms were observed on the Formula L from any treatment.

INTRODUCTION

During the process of rehabilitating a Canada thistle-infested site with Formula L, it is essential that a follow-up herbicide application be made to control the inevitable Canada thistle regrowth. This application should be as lethal as possible to the thistle without injuring the Formula L seeding. In a rehabilitation sequence where the primary herbicide treatment and the seeding take place in the fall, the follow-up application should be made the following spring. The objective of this trial was to evaluate the efficacy, and potential phytotoxicity of herbicide combinations targeting Canada thistle in fine fescue. The combinations were built around Transline, which has been repeatedly demonstrated to be very active on thistle species, and non-injurious to grasses.

MATERIALS AND METHODS

This experiment was conducted at the Park Avenue interchange of SR 322. A 0.5 acre area of Canada thistle-infested crownvetch in the infield of the on-ramp to SR 322 W was treated with Roundup Pro at 128 oz/ac in late August, 1996, and broadcast seeded to a 60/40 mixture of hard fescue/creeping red fescue (Formula L without annual ryegrass) at 100 lb/ac on September 16, 1996, after the treated vegetation was mowed. After seeding, a PTO-powered slit-seeder was run over the site to provide some loosening of the soil surface, and create slits for the seed to settle into. The seeding was successful, and Canada thistle regrowth was vigorous. On June 24, 1997, herbicide combinations were applied to bud- to early bloom stage Canada thistle that was 12 to 48 inches tall. The fine fescue was well established, at the anthesis stage of seedhead development, with an average canopy height of 5 inches. The eight herbicide treatments included Transline at 8 oz/ac, alone or in combination with Vanquish at 16 oz/ac, Tordon K at 32 or 64 oz/ac, Telar at 0.5 or 1.0 oz/ac, and Escort at 0.5 or 1.0 oz/ac. The treatments were applied to 6 by 15 ft plots, arranged in a randomized complete block with three replications, using a CO_2-powered, hand-held sprayer delivering 20 gal/ac.

Canada thistle stems were counted in each plot to establish an initial infestation level. Evaluations of fine fescue response to the herbicide treatments were made July 15 and 22, 1997. Follow-up thistle stem counts were taken early November, 1997, and October 4, 1998. Follow-up stem counts were divided by initial stem counts to calculate percent resprouting. These data were subjected to analysis of variance without the values from the untreated plots, although these values are presented for comparison in the results table.

RESULTS AND DISCUSSION

No herbicide injury to the fine fescue was observed at any time during the course of the experiment. The only type of injury observed was in the untreated plots where Canada thistle densities were high, there was considerable rodent activity observed, which included feeding and tunneling through the fescues. Canada thistle resprout percentages are reported in Table 1. The untreated plots averaged 78 and 126 percent of the original stem count for the 1997 and 1998 ratings, respectively. The 22 percent reduction from the original count in June reflects typical Canada thistle seasonal growth, where the spring shoots flower and set seed, then most of the stems die. There is a second flush of growth, consisting of new shoots and resprouting from the base and axils of surviving spring shoots. The 1997 treatments provided very effective suppression of Canada thistle, as resprout percentage ranged from 0 to 4 percent. The 1998 counts yielded 3 to 31 percent resprouting, compared to the original stem counts. There was no significant difference between any of the treatments for either rating.

These results demonstrate the absolute necessity of vigilant follow-up when rehabilitating Canada thistle infestations. This species has tremendous regenerative capacity from its root system, and it is very difficult to affect the majority of the root system with foliar herbicide applications. Establishing fine fescues as a groundcover provides more options in managing Canada thistle, but does not eliminate the need for ongoing management.

MANAGEMENT IMPLICATIONS

Once a seeding of Formula L is established, there is tremendous flexibility in developing herbicide mixtures to manage Canada thistle. Managers do not have to develop special mixes to treat fall-seeded Formula L, and can use the spring-applied weed/brush mix that they have programmed for the rest of their system. This makes it more likely that new seedings will receive the follow-up treatment that is necessary to ensure the success of rehabilitation efforts.

Table 1: Canada thistle resprouting after treatment with herbicide combinations the spring after a fall seeding of Formula L. Percentages were calculated from stems counts, compared to original counts when the herbicides were applied in June, 1997. Each value is the mean of three replications.

		----------Percent of Original Stem Number ---------	
Treatment	Application Rate	November 1997	October 1998
	(product oz/acre)	(----------------------- % ---------------------)	
Transline	8	1	12
+ Vanquish	16	3	31
+ Tordon K	32	1	14
+ Tordon K	64	0	11
+ Telar	0.5	4	13
+ Telar	1	2	3
+ Escort	0.5	1	4
+ Escort	1	0	15
Untreated Check[1]		*78*	*126*
Significance Level (p)		0.17	0.59
LSD (p=0.05)		NS	NS

[1] Data from the untreated checks was not included in the analysis of variance

COMPARISON OF SEEDING METHODS TO ESTABLISH FORMULA L DURING SITE REHABILITATION

ABSTRACT

During a rehabilitation project in Philadelphia County, Formula L was seeded hydraulically with and without wood fiber mulch, or drill seeded, in October, 1996. When evaluated in June, 1997, there was no significant difference between the treatments for percent total cover or percent fine fescue cover. Drill seeded areas did have a significantly higher proportion of fine fescue than either of the hydraulically seeded areas.

INTRODUCTION

Rehabilitation is the process of improving the vegetation on a disturbed site, typically by replacing the undesirable vegetation with desirable vegetation. *Restoration* differs from *rehabilitation* in that the premise of restoration is that site will be returned to its natural, or native condition. *Reclamation* is the initial stabilization of a disturbed site.

Seeding success is the primary objective during a rehabilitation operation. Establishment of an intact groundcover greatly eases the elimination of the remaining undesirable vegetation. Seeding success is a function of creating an opportunity - an opening in the existing vegetation - at the right time and getting the seed in contact with the soil. When the seeding is taking place in a short window of opportunity, the quicker that seed to soil contact takes place, the sooner germination occurs. This trial was established to compare three readily implemented seeding methods to determine if establishment differences were apparent. The method designated as 'conventional' was hydraulic seeding, using wood fiber as a mulch. The alternatives for comparison were hydraulic seeding without mulch, and drill seeding. These two seeding methods were chosen for evaluation because in many rehabilitation scenarios, there would be vegetative residue present, precluding the need for added mulch. Adding mulch and tackifier might actually inhibit the seed from reaching the soil surface where vegetative residue is present. Drill seeding, which provides immediate seed-to-soil contact would always be the theoretical ideal, but terrain is sometimes limiting. Comparing the methods on the same sites provides more information so that managers can weigh expected establishment results against availability of equipment or contractors.

METHODS AND MATERIALS

This trial was conducted along SR 63, Woodhaven Road, as part of a vegetation rehabilitation project in Philadelphia county. Approximately 20 acres of infested and degraded crownvetch at 25 locations throughout the corridor were treated between October 13-17, 1996 with a mixture of Roundup Pro, Garlon 3A, Transline, and Escort, at 128, 64, 8, and 1 oz/ac respectively by the Department's contractor, Weeds Inc. Prior to seeding, three areas at the interchange of SR 63/SR 1 were each divided into three plots to be seeded by each method. The 'no-mulch' plots were hydraulically seeded October 28, 1996. The mulch plots and the drilled plots were seeded October 30, 1996. Hydraulic seeding was done by Valley Seeding, Inc., and the drill seeding was done by All-Seasons Landscaping Co., Inc. The seed drill was a Truax Flex II 88, which provides sub-surface placement, 0.5 to 0.75 inches deep, on 8 inch centers. The fall of 1996 was relatively mild, and soil temperatures at the site were 60° and 55° F at the surface, and a depth of six inches, respectively, on October 28. The hydraulic seeding slurry was mixed on a 1000 gal/ac basis, and included the following materials on a per 1000 gallon basis: PRS wood fiber HydroMulch at 800 lb, pulverized agricultural lime at 3900 lb, 10-20-20 fertilizer at 680 lb, and Formula L at 125 lb. The drilled plots were not limed, and were fertilized with a 10-6-4 fertilizer at 680 lb/ac. Soil fertility status from soil tests taken October 28 are reported in Table 1. Particle size analysis of a composite sample placed the soil from the sites in the silt loam textural class, with a composition of sand, silt, and clay of 24, 62, 14 percent, respectively. Establishment was evaluated June 17, 1997. Visual observations of total cover, and cover from the Formula L and weed component of total cover were taken on a grid basis with observations taken in 10 by 10 ft squares on 15 ft centers.

RESULTS AND DISCUSSION

Plots in the third replication, in the infield of the ramp leading to SR 1 North, were nearly devoid of any vegetation. Visual analysis of the site did not provide a satisfactory reason for this occurrence. There was no pattern of occurrence of vegetation to suggest misapplication, or off-site movement of herbicide. Data from this replication was deleted from the analysis. The summary of total cover, cover from Formula L, and proportion of cover from Formula L are reported in Table 2. Weed species present were a mixture of perennial species that had been present at project initiation, as well annual and biennial species taking advantage of open soil during the rehabilitation process. Common species included Canada thistle (*Cirsium arvense*), goldenrod (*Solidago* spp), bull thistle (*Cirsium vulgare*), yellow rocket (*Barbarea vulgaris*), shepherdspurse (*Capsella bursa-pastoris*), giant foxtail (*Setaria faberi*), brambles (*Rubus* spp.), and Japanese honeysuckle (*Lonicera japonica*). On June 17, the vegetative canopy height of Formula L was 3 to 6 inches. Both the fine fescues and annual ryegrass were in seedhead. Annual ryegrass establishment was variable, ranging from about 5 to 15 percent of the total Formula L stands. Total cover was similar between plots, ranging from 49 to 60 percent. Percent cover from Formula L ranged was 19, 28, and 53 percent in the hydraulic no mulch, hydraulic mulch, and drill seeded plots, respectively. Despite the apparently obvious differences, these results were not statistically significant. It was only when Formula L was reported as a percentage of the total cover that the magnitude of difference between drill and hydraulically-seeded plots were statistically significant, with Formula L accounting for 85 percent of the total cover in drilled plots, but only 36 to 57 percent in the hydraulic plots.

The establishment success was quite variable, particularly within the hydraulically-seeded plots. A 2000 gallon hydroseeder is not a finesse tool. The spray gun is very high output, and considerable skill and effort is required by the operator to approximate uniform coverage, especially on narrow areas, close to, and sloping away from the truck. Conducting a trial with relatively small plots under operational conditions sacrifices much of the variability control that small-plot research supplies. Observing significant differences under these conditions strongly suggests that drill seeding be considered wherever practical.

MANAGEMENT IMPLICATIONS

The results of this trial reinforce long established observations on establishment, and confirm the value of quick seed to soil contact. The overall project that this trial was a part of was an excellent example of the value of flexibility within a contract. When the 25 different sites were identified for rehabilitation, it was also determined which would be drill seeded, and which would be hydraulically seeded. This is a practical means to optimize the establishment during rehabilitation projects. In this situation, it was more practical to determine seeding method on a site basis due to the large number of relatively small acreage sites. In other circumstances, large sites could be divided into seeding method areas based on readily-observed terrain features. A tangible improvement in establishment would justify the additional effort invested in writing such a contract, and overseeing its execution. Rapid establishment, and subsequent reduction of weed pressure through competition is one the most recognizable examples of 'Preventive Maintenance' that an IVM approach can provide the Department.

Table 1: Summary of soil test results from composite samples taken within the three different seeding treatments for one replication, and composite samples from each of the remaining two replications. Site codes mean the following: R1NMPre - replication one, hydraulic seeding, no mulch, sampled prior to seeding; R1NMPost - replication one, hydraulic seeding, no mulch, sampled after seeding; R1MD - replication one, composite sample from hydraulic w/mulch and drill plots; R2 - composite sample from replication 2; and R3 - composite sample from replication three.

Site	pH	Organic Matter	P	Acidity	K	Mg	Ca	CEC
		(%)	(lb/ac)	(------------------------meq/100 g)				-----------------------)
R1NMPre	6.0	3.8	74	2.0	0.43	1.2	4.3	7.9
R1NMPost	5.9	3.3	64	2.0	0.34	1.1	4.0	7.4
R1MD	6.0	2.6	60	2.0	0.34	1.1	4.0	7.5
R2	5.6	2.9	38	3.9	0.26	1.0	3.5	8.6
R3	6.1	2.2	44	2.5	0.30	1.0	3.8	7.5

Table 2: Establishment of Formula L seeded October 28, 1996, using three seeding methods. Evaluations were made June 17, 1997. Each value is the mean of two replications.

Treatment	Total Cover	Formula L Cover	Proportion of Cover from Formula L
	(---	%	--)
Hydraulic Seeding, No Mulch	50	19	36 b
Hydraulic Seeding, Mulch	49	28	57 b
Drill Seeding	60	53	85 a
LSD (p=0.05)	NS	NS	

COMPARING CHEMICAL VERSUS MECHANICAL METHODS OF VEGETATION CONTROL UNDER GUIDERAILS

INTRODUCTION

The standard practice used to control vegetation under a guiderail is to apply a mixture of pre and postemergence herbicides early in the growing season that will eliminate existing vegetation and provide long term residual control. Several alternatives to this practice were investigated in this long term study. Included in this study were two application timings of a standard herbicide mixture, two different mechanical control sequences, and a geotextile fabric impregnated with a herbicide installed just beneath the soil surface. These five treatments were evaluated for the control provided, cost, and long term effectiveness. The objective was to determine whether the standard practice of applying a herbicide mixture early in the season is the most acceptable and cost effective approach to managing vegetation in this area of the right-of-way.

MATERIALS AND METHODS

This study was initiated in 1996 and consisted of five treatments. The treatments included string trimming the guiderail either once/year in August or three times/year targeting June 1, August 1, and October 1; applying 2 qts/ac Roundup Pro plus 3 oz/ac Oust plus 6 lb/ac Karmex, either early or mid season; or installing Biobarrier II[1/] under a guiderail. The study was established along Park Avenue in State College, PA. The plot size was 3 ft by 25 ft arranged as a randomized complete block design with four replications. Predominant weed species present throughout the study included: spotted knapweed (*Centaurea maculosa* Lam.), wild parsnip (*Pastinaca sativa* L.), and chicory (*Cichorium intybus* L.).

Treatments were not always applied as originally targeted (Table 1). The early season chemical treatment was applied late in 1996 and 1999. The 3X/year mechanical treatments did not conform to the schedule in 1996 and 1998. The first cutting was missed in 1996, and the second cutting in 1998 was done late in the season and did not allow time for regrowth for the third cutting. All other application timings were fairly close to the target dates established at the onset of the study.

A commercial grade Stihl string trimmer was used to mechanically remove the top growth of unwanted vegetation. The chemical treatments were applied using a CO_2 powered backpack sprayer equipped with either two OC-04 or a single OC-12 spray tip, delivering 35 gal/ac at 28-34 psi. Biobarrier II is a geotextile fabric that has composite nodules impregnated with trifluralin[2/] . The fabric is installed 2 inches beneath the soil surface. For this study a two inch layer of gravel was removed within the Biobarrier II plots, the fabric laid down and the gravel was replaced on top of the fabric. The composite nodules slowly release the trifluralin to the soil where the chemical inhibits root development. The Biobarrier II used in this study came in a roll 39 inches by 100 ft. After being cut in four 25 ft lengths the fabric was installed on May 22, 1996.

Ratings of green cover and average height of weeds were recorded prior to each mechanical treatment and the day the early season chemical treatment was applied in 1996 and 1998. An additional rating occurred on October 14, 1998.

RESULTS

The initial rating in May, 1996 showed that there were no significant differences between treatments for green cover of weed species when the study began. The green cover by weeds ranged from 35 to 58 percent at this time. The chemical treatments of Roundup Pro, Oust and Karmex provided the best control over the entire four year study period. There was no difference in the control provided by early or mid-season treatments, except in 1997 when the mid-season treatment was applied late. Control provided by the Biobarrier II treatment was similar to the control

[1/] Biobarrier II, geotextile fabric containing nodules on 1.5 inch centers impregnated with 17.1% trifluralin, Reemay, Inc. Old Hickory, TN.
[2/] Treflan, 17.1% trifluralin, DowElanco, Indianapolis, IN.

provided by the early chemical treatment on only 3 of 12 rating dates (8/96, 4/98, 6/99) since the study was initiated. Neither mechanical treatment provided acceptable reduction in green cover of weeds. Ratings of green cover of weed species ranged from 41 to 91 percent for these treatments.

The average height of weeds was lowest for the early season chemical treatment throughout the study with the exception of the 3X/year mechanical treatment in September, 1998. The mid season chemical treatment was statistically similar to the early season chemical treatment on several occasions including 8/96, 6/97, 9/98 and 10/98. The 3X/year mechanical treatment was statistically similar on two rating dates including 4/98 and 9/98. There were no significant differences for average height of weeds among any of the treatments throughout 1999.

The time and cost involved for each treatment varies greatly. Assuming $20/hr for labor, the approximate cost for spraying one time per year for either chemical treatment was $703/ac (13 min/300 sq ft at $20/hr equals $629/ac labor plus $74/ac chemical). The mechanical treatments averaged 18 min/300 sq ft costing a total of $871/ac. The cost of the Biobarrier II treatment would be $46,464/ac (4 hrs/300 sq ft for installation at $20/hr equals $11,616/ac labor plus $34,848/ac material cost).

There were several useful observations made during the course of the study. Plants were able to grow in the gravel on top of the Biobarrier II. Although the roots were severely stunted by the trifluralin when they came close to the fabric, the above ground portion of the plants showed no evidence of control and appeared healthy and vigorous. Two of the plots had periodic washouts exposing areas of the fabric and the gravel needed to be replaced adding to the labor involved in maintaining this system of weed control.

The string trimmer used in this study was originally equipped with plastic string common to many homeowner applications. After the first few cuttings the switch was made to plastic blades. The plastic blades were discovered to be superior to plastic string for this application. The blades were better suited to cutting through some of the more resilient vegetation that persists in this setting and they held up longer.

All of the treatments required more time than if they had been performed on a large scale basis. This added to the labor costs associated with each treatment. This is especially true of the chemical and Biobarrier II treatments where more automated systems could be used to bring down the labor costs associated with each.

CONCLUSIONS

The chemical treatments offered the most cost effective approach to controlling vegetation under a guiderail. A single mechanical treatment costs more and adds a greater element of risk. The operator of the string trimmer is spending more time along the roadway, is virtually unprotected, and the equipment is continually throwing small stones and other debris at both the operator and oncoming traffic. Literature produced by the manufacturer of Biobarrier II guarantees the fabric will prevent weeds for a period of at least 10 years. Even if the product meets or exceeds this guarantee it is cost prohibitive for this application. It is also ineffective by allowing for the germination and growth of weeds in the soil layer above the fabric.

Table 1: Dates the treatments were applied.

Treatment	Application Rate (oz/ac)	Application Dates 1996	1997	1998	1999
Biobarrier II	---	5/22	---	---	
Roundup Pro Oust Karmex (Target: Early Season)	64 3 96	5/23	5/8	4/7	5/26
Roundup Pro Oust Karmex (Target: Mid Season)	64 3 96	5/23	8/7	6/25	5/26
Mechanical 1X/Year (Target Date: 8/1)	---	8/5	8/7	9/17	8/2
Mechanical 3X/Year (planned) (Target Date: 6/1, 8/1, & 10/1)	---	8/5, 10/3	6/26, 8/7, 10/15	6/25, 9/17	6/2, 8/2, 10/1

TABLE 2: Green cover ratings of weed species taken in 1996 and 1997. Ratings are the mean of four replications.

Treatment	Application Rate	Green Cover of Weed Species					
		5/96	8/96	10/96	6/97	8/97	10/97
	(oz/ac)	(-------------		%			-------------)
Biobarrier II	---	58	16	30	25	28	30
Roundup Pro	64	50	2	3	0	1	1
Oust	3						
Karmex	96						
(Early Season)							
Roundup Pro	32	35	4	7	26	25	11
Oust	3						
Karmex	96						
(Mid Season)							
Mechanical	---	41	66	88	86	91	84
1 time/year in August							
Mechanical	---	53	80	88	83	79	79
3X/year planned (6/1,8/1,10/1)							
Significance Level (p)	---	0.2547	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)	---	n.s.	18	12	19	14	13

TABLE 3: Green cover ratings of weed species taken in 1998 and 1999. Ratings are the mean of four replications.

Treatment	Application Rate	Green Cover of Weed Species						
		4/98	6/98	9/98	10/98	6/99	8/99	10/99
	(oz/ac)	(-------------			%			-------------)
Biobarrier II	---	16	18	39	18	8	19	19
Roundup Pro	64	1	0	6	2	2	1	3
Oust	3							
Karmex	96							
(Early Season)								
Roundup Pro	32	8	8	19	4	6	2	4
Oust	3							
Karmex	96							
(Mid Season)								
Mechanical	---	78	64	89	73	54	66	69
1 time/year in August								
Mechanical	---	58	54	83	55	49	61	66
3X/year planned (6/1,8/1,10/1)								
Significance Level (p)	---	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)	---	17	16	15	9	8	13	13

TABLE 4: Average height of weed species taken in 1996 and 1997. Ratings are the mean of four replications.

Treatment	Application Rate	Average Height of Weed Species (inches)				
		8/96	10/96	6/97	8/97	10/97
	(oz/ac)					
Biobarrier II	---	6	9	8	10	10
Roundup Pro	64	2	3	1	1	1
Oust	3					
Karmex	96					
(Early Season)						
Roundup Pro	32	3	6	5	11	5
Oust	3					
Karmex	96					
(Mid Season)						
Mechanical	---	9	7	12	14	7
1 time/year in August						
Mechanical	---	8	6	9	9	6
3X/year planned (6/1,8/1,10/1)						
Significance Level (p)	---	0.0001	0.0038	0.0004	0.0003	0.0008
LSD (p=0.05)	---	1	2	4	4	3

TABLE 5: Average height of weed species taken in 1998 and 1999. Ratings are the mean of four replications.

Treatment	Application Rate	Average Height of Weed Species (inches)						
		4/98	6/98	9/98	10/98	6/99	8/99	10/99
	(oz/ac)							
Biobarrier II	---	4	27	27	4	9	11	8
Roundup Pro	64	2	0	9	1	5	6	4
Oust	3							
Karmex	96							
(Early Season)								
Roundup Pro	32	4	24	17	2	10	13	6
Oust	3							
Karmex	96							
(Mid Season)								
Mechanical	---	4	26	20	5	10	19	7
1 time/year in August								
Mechanical	---	3	28	7	3	12	13	8
3X/year planned (6/1,8/1,10/1)								
Significance Level (p)	---	0.0001	0.0001	0.0117	0.0004	0.3153	0.1458	0.1136
LSD (p=0.05)	---	1	4	11	1	n.s.	n.s.	n.s.

EVALUATION OF PLATEAU AND SAHARA FOR TOTAL VEGETATION CONTROL UNDER GUIDERAILS

INTRODUCTION

Plateau, recently introduced into the roadside market, has a unique selectivity that gives it a variety of uses, including the establishment of native prairie grasses, release of wildflower and legume species from weed competition, turfgrass suppression, and bareground weed control. It has both pre- and postemergence activity on a broad range of plant species. One weakness of Plateau in a total vegetation control program is the tolerance of leguminous species to it. This is especially troublesome in Pennsylvania where legumes, mainly crownvetch (*Coronilla varia* L.), often comprise a large part of the plant community under the guiderails. Sahara is a commercially available, dispersible granular formulation of 7.8% imazapyr and 62.2% diuron. There were two different water dispersible granular formulations of Sahara tested in this study. The original formulation is on a "clay" base. A new experimental formulation is on a "starch" base. This study was established to evaluate Plateau alone, and in combination with other herbicides, and the two formulations of Sahara for total vegetation control along roadsides including a legume as a significant part of the vegetation to be controlled.

MATERIALS AND METHODS

Plateau was applied at 12 oz/ac alone, or in combination with Roundup Pro at 32, Pendulum 3.3EC at 155, or three rates of Karmex at 96, 128, or 160 oz/ac, respectively. Roundup Pro was applied alone at 32 oz/ac and Oust at 3 plus Karmex at 96, and Roundup Pro at 32 oz/ac were applied as controls. Sahara at 160 oz/ac was applied on clay and starch carriers. The treatments were applied to 6 by 25 ft plots located along a guiderail near State College, PA on May 19, 1998. The test area was heavily infested with birdsfoot trefoil (*Lotus corniculatus* L.). The study was arranged in a randomized complete block design with three replications. The treatments were applied using a CO_2-powered hand held sprayer equipped with two Spraying Systems OC-04 spray tips, delivering 20 GPA at 30 psi. Plateau and Sahara treatments contained 0.25 % (v/v) methylated seed oil[1/] and all contained 0.25% (v/v) Polytex A1001 drift control agent. Green cover ratings of weed species were taken May 19, the day of treatment; June 17, 29 days after treatment (DAT); August 26, 99 DAT; and October 13, 147 DAT. Predominant weed species were birdsfoot trefoil, crownvetch, spotted knapweed (*Centaurea maculosa* Lam.), and Canada thistle (*Cirsium arvense* (L.) Scop.).

RESULTS

The initial green cover rating on the day of treatment showed there were no significant differences in the test area, with average green cover ratings between 62 and 75 percent for all plots. Plateau alone did not reduce the green cover rating compared to the control at any of the evaluation dates. Roundup Pro alone, or in combination with Plateau, caused a slight reduction in green cover 29 DAT, but not later. All other treatments reduced green cover at all rating dates, compared to the untreated control. The standard roadside treatment, Oust plus Karmex plus Roundup Pro, consistently provided the lowest green cover ratings. However, at 29 DAT there was no difference between any of the treatments including Karmex or Sahara. At 99 DAT the Oust, Karmex, Roundup Pro treatment provided lower green cover ratings than the Plateau plus Karmex treatments. The Sahara treatments were between them. At 147 DAT the Oust, Karmex, Roundup Pro treatment; both Sahara treatments, and the Plateau plus Karmex at 160 oz/ac all provided similar green cover ratings.

There were no differences in any of the plots in the initial birdsfoot trefoil cover on the day of treatment, with average trefoil cover ratings between 51 and 69 percent for all plots.

The control ratings of the birdsfoot trefoil almost perfectly paralleled the green cover ratings. The Plateau or Roundup Pro alone did not provide reduced trefoil ratings at any rating date. The Plateau plus Roundup Pro and the Plateau plus Pendulum only reduced the cover at 29 DAT. All other treatments reduced the trefoil cover compared to the control at all rating dates. Although all three Plateau plus Karmex treatments provided good control at 29 and 99

[1/] Sun-It II, 100% methylated seed oil, American Cyanamid Company, Wayne, NJ.

DAT, only the combination with the highest rate of Karmex provided acceptable long term control. The standard Oust, Karmex and Roundup Pro combination, or either formulation of Sahara, also provided long term control of the birdsfoot trefoil. The percent cover by birdsfoot trefoil for these treatments ranged from 4 to 19 percent at 147 DAT. Both formulations of Sahara used in this study provided similar control at all rating periods.

CONCLUSIONS

The treatment containing Oust, Karmex, and Roundup Pro is considered to be the current industry standard for total vegetation control under guiderails in the northeast United States. This combination, either formulation of Sahara, and the 12 oz/ac Plateau plus 160 oz/ac Karmex provided statistically comparable control under the conditions of this study. However, only the Oust, Karmex, and Roundup Pro combination approached the 90 percent control threshold often stated as a performance standard. Although birdfoot trefoil is low-growing, and relatively unobstrusive, if bare ground is desired, tank mix partners need to be identified for Plateau or Sahara to be effective on this species.

TABLE 1: Green cover ratings of weed species located under a guiderail near University Park, PA. Treatments were applied May 19, 1998. Green cover ratings were taken 0, 29, 99, and 147 DAT. Ratings are the mean of three replications. Treatment means followed by the same letter within a given column are not significantly different according to Fisher's LSD. A single LSD value is not reported due to missing data.

	Application	Green Cover of Weed Species			
		19-May	17-Jun	26-Aug	13-Oct
Treatment	Rate	0 DAT	29 DAT	99 DAT	147 DAT
	(oz/ac)	(---------------------------------------	--%	--	---------------------------------------)
Untreated Check	---	72 a	88 a	95 a	90 a
Plateau	12	75 a	73 ab	94 a	82 a
Roundup Pro	32	75 a	68 b	92 a	80 a
Plateau Roundup Pro	12 32	75 a	57 b	88 a	85 a
Plateau Pendulum 3.3EC	12 155	62 a	55 b	83 a	71 ab
Plateau Karmex	12 96	75 a	12 c	42 bc	48 cd
Plateau Karmex	12 128	65 a	17 c	48 b	52 bc
Plateau Karmex	12 160	63 a	10 c	27 c	30 cde
Oust Karmex Roundup Pro	3 96 32	75 a	7 c	8 d	12 e
Sahara (clay)	160	68 a	10 c	35 bc	25 de
Sahara (starch)	160	70 a	11 c	25 cd	20 e

TABLE 2: The green cover of birdsfoot trefoil that comprised the total percentage of weeds. Treatments were applied May 19, 1998. Green cover ratings of birdsfoot trefoil were taken 0, 29, 99, and 147 DAT. Ratings are the mean of three replications. Treatment means followed by the same letter within a given column are not significantly different according to Fisher's LSD. A single LSD value is not reported due to missing data.

	Application	Green Cover of Birdsfoot Trefoil			
		19-May	17-Jun	26-Aug	13-Oct
Treatment	Rate	0 DAT	29 DAT	99 DAT	147 DAT
	(oz/ac)	(-------------------	------%------	-------------------	-------------------)
Untreated Check	---	61 a	75 a	82 a	72 a
Plateau	12	69 a	63 abc	88 a	66 a
Roundup Pro	32	68 a	64 ab	86 a	67 a
Plateau	12	59 a	44 c	84 a	71 a
Roundup Pro	32				
Plateau	12	55 a	51 bc	71 a	58 ab
Pendulum 3.3EC	155				
Plateau	12	60 a	7 d	24 bc	28 cd
Karmex	96				
Plateau	12	57 a	13 d	40 b	40 bc
Karmex	128				
Plateau	12	53 a	4 d	14 c	17 cde
Karmex	160				
Oust	3	69 a	4 d	5 c	4 e
Karmex	96				
Roundup Pro	32				
Sahara (clay)	160	51 a	9 d	29 bc	19 de
Sahara (starch)	160	55 a	6 d	21 bc	14 e

EVALUATION OF PREMIER AND ENDURANCE AS BAREGROUND HERBICIDES

ABSTRACT

The herbicides Premier and Endurance were evaluated for their suitability for applications to guiderail areas. Premier provided faster burn-down than Roundup Pro plus Arsenal, but less control of treated vegetation. Combinations including Endurance were effective if the burn-down component was Roundup Pro plus Arsenal, or if Karmex was included.

INTRODUCTION

The combination of Oust, Karmex, and Roundup Pro is one the most widely used treatments for maintaining bareground. This combination has proven to be effective, and is economical. However, to prevent selection of tolerant species, or herbicide-resistant biotypes of susceptible species, vegetation managers should vary herbicide mixtures. Endurance is a dinitroanaline herbicide, chemically similar to Surflan and Pendulum, and is a relatively recent addition to the industrial market. The objective of this trial was to continue to generate performance data for Endurance in combination with different tank-mix partners, both burn-down and residual. Residual herbicides included Karmex, Predict, Escort, and Oust. The burn-down materials were Roundup Pro plus Arsenal (R/A), and Premier, a triazine herbicide used for burn-down in row crop settings as the product Evik.

MATERIALS AND METHODS

The trial was located on the east-bound shoulder of SR 322, near State College, PA, on a fill-slope vegetated with crownvetch. Plots were 6 by 25 ft, arranged in a randomized complete block, with three replications. Treatments were applied May 15, 1998, using a CO_2-powered, hand-held sprayer equipped with two Spraying Systems OC-04 spray tips, delivering 20 gal/ac at 25 psi. Treatment combinations, and results from visual ratings taken May 15 (0 DAT), June 23 (39 DAT), August 26 (103 DAT), and October 14 (152 DAT) are reported in Table 1. Established vegetation included crownvetch (*Coronilla varia*), downy brome (*Bromus tectorum*), Virginia pepperweed (*Lepidium virginicus*), plumeless thistle (*Carduus acanthoides*), Canada thistle (*Cirsium arvense*), perennial ryegrass (*Lolium perenne*), Canada bluegrass (*Poa compressa*), and yellow nutsedge (*Cyperus esculentus*). Emerging species included giant foxtail (*Setaria faberi*), prostrate knotweed (*Polygonum aviculare*), common ragweed (*Ambrosia artemisiifolia*), prickly lettuce (*Lactuca serriola*), bull thistle (*Cirsium vulgare*), and wild buckwheat (*Polygonum convolvulus*). Species observed later in the season included yellow foxtail (*Setaria lutescens*), green foxtail (*Setaria viridis*), and barnyardgrass (*Echinochloa crusgalli*). The data for each rating was subjected to analysis of variance, and where treatment effects significant ($p \leq 0.05$), means were separated using Fisher's Protected LSD.

RESULTS AND DISCUSSION

Living vegetative cover in the untreated check plots increased from an initial level of 28 percent on May 15, to a peak of 57 percent on August 26. There was a decrease to 47 percent, observed on October 14, due to senescence of annual species. Endurance plus Oust plus R/A provided the least amount of vegetative cover at all post-treatment ratings.

Plots treated with Premier alone were rapidly burned down, and had significantly less cover than the check on June 23, 39 DAT; but there was no significant difference between Premier alone and the check for the subsequent ratings. R/A provided a slower, but more effective burn-down. At 39 DAT, this treatment had 3 percent cover, significantly lower than Premier alone. The R/A plots were reinfested with annual vegetation, and had 32 and 30 percent cover on August 26 and October 14, respectively.

The combination of Endurance plus Premier was no more effective than Premier alone. This treatment did not have a component to control existing biennial or perennial vegetation. Although Endurance would be effective against many of the weeds coming from seed, there was nothing to suppress the regrowth of the weeds not killed by Premier.

The addition of Karmex to the Endurance plus Premier combination reduced vegetative cover at all post-treatment rating dates, compared to Endurance plus Premier alone. Endurance plus Karmex provided the same results with Premier or R/A as the burn-down component, suggesting postemergence contribution by the Karmex.

The combination of Endurance plus Predict plus Premier was not as effective as Endurance plus Karmex plus Premier, but the Endurance/Predict combination with R/A as the burn-down component was not significantly different from the best rated treatment.

MANAGEMENT IMPLICATIONS

Endurance can be used as a preemergence component in a tank mix that includes ingredients that will control existing vegetation, particularly when annual grasses are a concern. It is a viable material to keep on the list of alternatives, or additions, to Karmex. Endurance is labeled for use in ornamental situations, and would be considered with materials such as Surflan, Pendulum, Gallery, and Snapshot, for use where bare ground is needed in sensitive settings. Premier provided fast contact activity on existing weeds, but unless the pricing is highly economical, it does not offer utility not already available with Roundup Pro, Finale, or Reward.

Table 1: Visual cover ratings from a guiderail site treated May 15, 1998 to evaluate total vegetation control. May 15 data indicate conditions at treatment. Subsequent ratings include total living vegetative cover, and cover from crownvetch, the predominant species. Each value is the mean of three replications.

	Application	---------------Total Cover -------------				-----------Crownvetch Cover ----------			
Product	Rate	15-May	23-Jun	26-Aug	14-Oct	15-May	23-Jun	26-Aug	14-Oct
	(oz product/ac)	(-----------percent cover				----------)			
untreated check	- - -	28	48	57	47	8	13	20	26
(R/A) Roundup Pro Arsenal	64 4	23	3	32	30	7	2	1	2
Premier	40	33	22	42	48	8	8	18	30
Endurance Premier	24 40	28	20	38	45	6	4	22	33
Endurance Karmex R/A	24 80 64 + 4	28	1	6	23	6	0	3	15
Endurance Karmex Premier	24 80 40	25	4	15	25	8	2	11	15
Endurance Predict R/A	24 48 64 + 4	22	1	7	18	4	1	2	8
Endurance Predict Premier	24 48 40	25	18	27	33	5	3	8	22
Endurance Escort R/A	24 0.5 64 + 4	23	2	11	12	8	2	0	1
Endurance Oust R/A	24 3 64 + 4	25	1	1	4	8	1	0	0
LSD (p=0.05)		NS	11	24	19	NS	NS	NS	15

USE OF PLATEAU FOR ESTABLISHMENT OF NATIVE GRASSES

INTRODUCTION

With the advent of federal regulations requiring the use of native species along roadsides following construction, a great deal of attention has been given to developing effective means of establishment them. In the northeastern United States weed competition is the greatest impediment to establishment. A trial was initiated to investigate weed control and tolerance of selected native grasses to Plateau.

MATERIALS AND METHODS

The study, established in 1996, compared Plateau used preemergence versus postemergence at rates of 4 and 8 oz/ac, and Garlon 3A plus Transline at 24 and 8 oz/ac, respectively. These materials were tested during the establishment of six different native warm season grasses including: 'Bison' big bluestem (*Andropogon gerardii* Vitman), 'Camper' little bluestem (*Schizachyrium scoparium* (Michx.) Nash), 'Cave-In-Rock' switchgrass (*Panicum virgatum* L.), 'Holt' Indiangrass (*Sorghastrum nutans* L. Nash), 'Pierre' sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) and Canada wildrye (*Elymus canadensis* L.). The area was first sprayed with glyphosate and rototilled. On May 31, 1996 the plots were seeded and cultipacked. The native grasses were seeded at rates of 20 lbs/ac for big bluestem and Canada wildrye; 12 lbs/ac little bluestem; and 10 lbs/ac for switchgrass, Indiangrass, and sideoats grama. Preemergence treatments were applied on June 3, 1996 and the postemergence treatments on June 28. The plot size was six by ten feet arranged in a split-block treatment design with three replications. The herbicide treatments were applied using a CO_2-powered backpack sprayer equipped with a six foot boom and XR 8004 VS tips delivering 40 gallons per acre (GPA) at 38 psi. All treatments included 0.25% v/v Formula 358 drift control agent. Postemergence treatments included 0.38% v/v Dynamic (surfactant). Ratings of percent total vegetative cover, and cover by the desirable native grasses was taken on October 22, 1998. Results are shown on Tables 1, 2 and 3.

RESULTS

By October 1998, many of the native grasses were well established. Four of the species, including little bluestem, big bluestem, sideoats grama and Canada wildrye showed no statistical benefit from using Plateau. The vegetative cover of big bluestem averaged from 42% to 78% for each of the treatments including the untreated check, which averaged 65%. Little bluestem ranged from 11% to 59% . Sideoats grama and Canada wildrye averaged below 18% cover for all treatments, with no treatments providing significantly better cover than the untreated check. Switchgrass responded best to 4 oz/ac Plateau applied preemergence (averaging 52% cover for this treatment). Indiangrass responded well to both rates of Plateau applied postemergencewith percent cover ranging from 32% to 40% but, appeared to be negatively impacted by the high rate applied preemergence.

CONCLUSIONS

First year observations of this study did show that Plateau provides excellent control of selected weed species. None of the treatments significantly reduced establishment of the native grass species with the exception of 8 oz/ac Plateau postemergenceapplication to switchgrass. The use of Plateau on switchgrass is not recommended. According to the label severe injury can result to switchgrass from using this product. Although some native species may be negatively impacted by Plateau, the weed control it provides gives the natives a distinct advantage in the establishment process. Further research needs to be done to isolate a seed mix that is adapted to a wide range of environmental conditions and tolerant to Plateau both pre- and postemergence.

Table 1: Preemergence treatments were applied on June 3, 1996 and the postemergence treatments on June 28. Ratings of percent total vegetative cover and percent cover by the desirable native grasses indicated below was taken on October 22, 1998. Each value is the mean of three replications.

Herbicide	Application Rate	'Bison' Big Bluestem		'Camper' Little Bluestem	
		Total Cover	'Bison' Cover	Total Cover	'Camper' Cover
	(oz/ac)	(----------------------	%	----------------------	)
Untreated	----	97	65	88	28
Plateau (PRE)	4	100	58	93	54
Plateau (PRE)	8	95	43	97	33
Plateau (POST)	4	97	65	95	52
Plateau (POST)	8	98	78	97	59
Garlon 3A (POST) Transline	24 8	97	42	95	11
Significance Level (p)		0.5859	0.0574	0.0857	0.2731
LSD (p=0.05)		n.s.	n.s.	n.s.	n.s.

Table 2: Preemergence treatments were applied on June 3, 1996 and the postemergence treatments on June 28. Ratings of percent total vegetative cover and percent cover by the desirable native grasses indicated below was taken on October 22, 1998. Each value is the mean of three replications.

Herbicide	Application Rate	'Cave-In-Rock' Switchgrass		'Holt' Indiangrass	
		Total Cover	'C-I-R' Cover	Total Cover	'Holt' Cover
	(oz/ac)	(----------------------	%	----------------------	)
Untreated	----	92	30	85	4
Plateau (PRE)	4	83	52	83	21
Plateau (PRE)	8	88	15	77	9
Plateau (POST)	4	91	19	90	32
Plateau (POST)	8	92	3	82	40
Garlon 3A (POST) Transline	24 8	92	19	95	5
Significance Level (p)		0.3927	0.0015	0.1378	0.0425
LSD (p=0.05)		n.s.	17	n.s.	25

Table 3: Preemergence treatments were applied on June 3, 1996 and the postemergence treatments on June 28. Ratings of percent total vegetative cover and percent cover by the desirable native grasses indicated below was taken on October 22, 1998. Each value is the mean of three replications.

Herbicide	Application Rate	Canada Wildrye Total Cover	Canada Wildrye Wildrye Cover	'Pierre' Sideoats Grama Total Cover	'Pierre' Sideoats Grama 'Pierre' Cover
	(oz/ac)	(--	%		--)
Untreated	----	90	12	92	0
Plateau (PRE)	4	92	6	93	0
Plateau (PRE)	8	92	3	83	1
Plateau (POST)	4	95	13	85	1
Plateau (POST)	8	88	7	80	2
Garlon 3A (POST) Transline	24 8	95	18	93	0
Significance Level (p)		0.2366	0.3480	0.1337	0.1990
LSD (p=0.05)		n.s.	n.s.	n.s.	n.s.

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

INTRODUCTION

Within a limited access right-of-way, at least three vegetation management zones should be designated. These management zones include a non-selective zone addressing the shoulders and guiderails; a safety clear zone extending at least 30 feet from the road edge that is kept free of all woody vegetation; and a selective zone extending to 80 feet from road edge, where tall growing woody species, as well as any other undesirable species would be suppressed. With this zone concept in mind the Penn State Roadside Research Project, a cooperative project between The Pennsylvania State University and The Pennsylvania Department of Transportation, set out to establish a large scale demonstration of selective brush control techniques. In particular, to demonstrate the effectiveness of backpack-based applications on managing vegetation in the selective zone.

MATERIALS AND METHODS

A 14 mile stretch of I-78 in Northampton County was chosen for the demonstration. This section of I-78 was first opened to traffic in November, 1987. The initial applications were made in October, 1993. At that time, the most common brush species were staghorn sumac (*Rhus typhina* L.) and black locust (*Robinia pseudoacacia* L.). Other species included: boxelder maple (*Acer negundo* L.), shrub-type willows (*Salix* spp.), black birch (*Betula lenta* L.), yellow-poplar (*Liliodendron tulipifera* L.), sycamore (*Platanus occidentalis* L.), Ailanthus (*Ailanthus altissima* Mill.), and Paulownia (*Paulownia tomentosa* Thunb.).

Table 1 lists the vegetation efforts that were undertaken by the research project, as well as time, materials and comments. The Penn State/PennDOT Roadside Vegetation Management project has spent nearly 300 hours actually treating brush in this corridor, in addition to other projects and follow-up evaluations.

RESULTS AND DISCUSSION

Vegetation management in the selective zone is crucial to maintaining a safe corridor, but is often neglected. The hazards associated with tall growing trees falling onto the roadway and limited sight distance are the primary concerns associated with vegetation in this zone.

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

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

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

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

14 miles long, two 80 ft shoulders, a 50 ft median = 356 acres

$24/hour x 77 hours = $1848

Herbicide cost = $436

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

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

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

INTRODUCTION

Tree-of-Heaven or Ailanthus (*Ailanthus altissima* L.) is a problematic tree species that continues to invade roadway corridors throughout the northeastern United States. It is a root-suckering species that forms large colonies where it exists. This tree, capable of growing to heights of 80 ft, is weak wooded and spreads readily. It is capable of spreading not only by the abundant seed it produces but, also through the distribution of root fragments. This tree has no significant insect or disease pests in the U.S. and has the ability to grow in poor soils and under stressful environmental conditions. Because it grows in full sun and thrives in poor growing conditions the roadside environment provides a tremendous opportunity for the establishment, growth, and spread of this tree. The physical characteristics including fast growth, maximum height, and structural weakness, in combination with it's difficulty to control, make this a truly problematic species. Mechanical and chemical control options have not provided complete control of this invasive plant. This demonstration investigated the addition of using cultural controls by converting an area infested with tree-of-heaven to fine fescue.

MATERIALS AND METHODS

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

RESULTS

By September 18, 1997 the trees treated during 1996 were completely controlled and the fine fescue stand had become well established. The honeysuckle that dominated the other half of the demonstration area was also thriving. Ailanthus repsrouts were evident throughout both areas but were later controlled with the selective application made on September 22. The costs associated with this conversion are outlined on Table 1.

CONCLUSIONS

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

Table 1: Cost figures for converting the Ailanthus stand to fine fescue. The treatments outlined are the four visits made during 1996 and 1997. Labor costs are based on $20.00/hour.

Treatment	Material Cost	Manhours	Labor Costs
Basal Bark	$76.18	4	$80.00
Low Volume Foliar	$37.80	2	$40.00
Seeding	$79.90	2	$40.00
Low Volume Foliar	$7.64	1.5	$30.00

Total Cost = $391.52 for treating 0.75 ac and seeding 0.40 ac.

Based on these figures, it would cost $661.91/ac to similarly treat and seed an Ailanthus infestation.

ONGOING AILANTHUS MANAGEMENT DEMONSTRATION - DISTRICT 8-0

INTRODUCTION

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

MATERIALS AND METHODS

On April 27, 1994, a basal bark application was made to Ailanthus growing in a two mile stretch of median of SR 22 between Millerstown and Newport (SR 34 interchange), plus the Newport entrance and exit ramps. In addition, a few stems of red maple (*Acer rubrum* L.), black locust (*Robinia pseudoacacia* L.), and staghorn sumac (*Rhus typhina* L.) were also treated. On August 19 and 23, 1994, a low volume foliar treatment was made to this same site, as well as the eastbound shoulder, to control all resprouts and uncontrolled stems from the basal bark application. Another low volume foliar application was made to the median area on October 1, 1996, to control any root sprouts or uncontrolled stems from the previous applications made in 1994. The eastbound shoulder area treated in August 1994 was not retreated. Treatments made in 1994 and 1996 are described in The Roadside Vegetation Management Eleventh Year Research Report. Observations of the area were made August 19 and September 2, 1994; May 23 and October 3, 1995; and October 9, 1997.

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

RESULTS AND DISCUSSION

Table 1 illustrates the reduction in Ailanthus in this area since 1994, but also illustrates the absolute necessity of vigilant follow-up. The 1994 basal bark application very effectively controlled the original stems on the site, many of which were 30 ft tall. The subsequent resprouts were very vigorous, and by time of treatment were up to 8 ft tall. The size and density of the vegetation was such that the follow-up took longer than the original basal treatment. Although the low volume backpack treatment was largely effective, a high volume hose and handgun application would arguably have been more appropriate. The October, 1996 treatment required 32 percent less material and 22 percent less time. The Ailanthus was a combination of small sprouts reestablishing from the remnant root systems surviving the previous treatments, and larger stems up to 15 ft tall that had been in the center of some of the larger clumps in 1994 and were under- or untreated. The 1996 treatment was very effective, and substantially reduced the number of stems were terrain allowed. There were locations where Ailanthus has established on the steep cut slope (cliff) above the eastbound lanes and is untreatable with backpack sprayers. The September, 1998 treatment saw a notable reduction in target number as well as size. Most treated stems were 5 ft tall, or less. Although the timing of the 1998 treatment was ideal, conditions were very dry, and foliar symptom development was less than expected.

CONCLUSIONS

The change in the Ailanthus population in the demonstration area has been dramatic. If the area had not been treated, most of the trees would be 10 to 15 ft taller, and would pose substantially more risk to motorists. However, the population has been very tenacious, and will continue to persist. The goal of an Ailanthus management plan should be to eliminate large, higher-risk colonies and engage in annual or biannual operations to incrementally reduce populations in size and number. As the population is reduced, treatments become more selective, and desirable vegetation steadily increases. However, as Table 1 graphically demonstrates, the program cannot be discontinued, or else the Ailanthus population will flare up again, and the cycle will be repeated. The root system of Ailanthus is extensive, and only through persistence can it be eliminated.

Date	Treatment (% solution, v/v)[1]	Solution	Man-hours	Results
4/27/94	basal bark Garlon 4/oil (85/15) Garlon 4/Arsenal/oil (84/1/15)	 10 gal 2 gal	15 total	Excellent control of treated stems. Profuse resprouting, beginning in June. Note increase in hours to treat resprouts, listed below.
8/19/94	low volume foliar Krenite S/Arsenal (5/0.25) Garlon 4 (2) Arsenal (1)	 19.5 gal 3 gal 3 gal	23 total	High stem density, height from 3 to 8 ft. Resprouting: 10% in Krenite/Arsenal, 25 % in both Garlon and Arsenal areas.
10/1/96	low volume foliar Krenite/Arsenal (5/0.5) Garlon 4/Roundup Pro (4/1)	 13 gal 5 gal	18 total	Combination of young, small sprouts, 3 ft high, and escapes from 1994 up to 15 ft.
9/9/98	low volume foliar Garlon 4/Tordon K (2.25/1)	 4.5 gal	3.5 total	Predominately small plants, 1 to 5 ft. Few scattered larger plants in 'cliff' area.

[1] For low volume foliar applications, water comprise the balance of the percentage