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DEPARTMENT OF TRANSPORTATION

ROADSIDE VEGETATION MANAGEMENT
RESEARCH REPORT
NINTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY
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The tenth year report on a cooperative research project between the Department of Transportation, Bureau of Maintenance and Operations; and the Pennsylvania State University, College of Agricultural Sciences; including:
Brush control research evaluating implementation of integrated brush control methods, basal bark herbicide applications, low volume foliar applications, and selective control demonstrations.
Herbaceous weed control research evaluating the effect of spray adjuvants on the control of tall fescue and the control of giant knotweed with spring-applied herbicides.
Comparing RoundUp and MON 65005 for the control of tall fescue.
Evaluating Endurance and Predict for total vegetation control under guiderails.
Wildflower research evaluating the establishment of annual wildflowers in tall fescue suppressed with herbicides.

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Arthur E. Gover	former Project Associate
Jon M. Johnson	Project Assistant
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Robert W. Parks, III	former Research Technician
Chad W. Spackman	Research Technologist
Thomas L. Watschke	Professor of Turfgrass Science

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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 can be obtained from The National Technical Information Service, Springfield, VA, and 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

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, however a level of 0.10 is utilized in some circumstances. 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; or we are 95 percent sure that the differences are due to the treatments. 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 (or 0.10), 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 (or 0.10), 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. There are instances in this report where an LSD value is reported without a p-value. This unprotected test is used when the protected test obscures readily apparent differences, particularly in situations where the best performing treatments in a test are significantly different than the check plots, but due to variability in the test area, the treatment differences are not significant according to the p-value criterion.

This report includes information from studies relating to roadside brush control, evaluation of low maintenance grasses, herbaceous weed control, total vegetation control under guiderails, and wildflower evaluation.

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

Product name, active ingredients, formulation, and manufacturer information for products referred to in this report. 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
Access	picloram, triclopyr	3 OS (1+2)	DowElanco
Arborchem Basal Oil	diluent	- - -	Arborchem Products, Inc.
Arsenal	imazapyr	2 S	American Cyanamid Co.
Assure II	quizalofop-p-ethyl	0.88 EC	E.I. DuPont de Nemours & Co.
Basamid	dazomet	99 G	BASF Corporation
Clean Cut	adjuvant	- - -	Arborchem Products, Inc.
Emerest 2301	adjuvant	- - -	Henkle Company
Endurance	prodiamine	65 WG	Sandoz Agro, Inc.
Escort	metsulfuron methyl	60 DF	E.I. DuPont de Nemours & Co.
Finale	glufosinate-ammonium	1 S	Hoeschst-Roussel
Formula 358	drift retardent	- - -	Exacto Chemical Co.
Fusilade 2000	fluazifop-p-butyl	1 EC	ICI Americas
Garlon 3A	triclopyr	3 S	DowElanco
Garlon 4	triclopyr	4 EC	DowElanco
HyGrade	diluent	- - -	CWC Chemical Company
Karmex	diuron	80 DF	E.I. DuPont de Nemours & Co.
Krenite S	fosamine ammonium	4 S	E.I. DuPont de Nemours & Co.
Krovar I	bromacil + diuron	80 DF (40 + 40)	E.I. DuPont de Nemours & Co.
NAF-5	triclopyr	RTU	DowElanco
NAF-6	triclopyr, picloram	RTU	DowElanco
NAF-8	picloram, 2,4-D	60 WDG (15+45)	DowElanco
Oust	sulfometuron methyl	75 DF	E.I. DuPont de Nemours & Co.
Pathfinder II	triclopyr	RTU	DowElanco
Penevator 9	adjuvant	- - -	Exacto Chemical Company
Penevator Basal Oil	diluent	- - -	Exacto Chemical Company
Penevator Veg. Oil	diluent	- - -	Exacto Chemical Company
Poast	sethoxydim	1.5 EC	BASF Corporation
Predict	norflurazon	80 DF	Sandoz Agro, Inc.
QwikWet 357	adjuvant	- - -	Exacto Chemical Company
Rodeo	glyphosate	5.4 S	Monsanto
RoundUp	glyphosate	4 S	Monsanto
San-Ag 41A	drift retardent	- - -	Arborchem Products, Inc.
Spike	tebuthiuron	20P, 80W	DowElanco
Sta-Put	drift retardent	- - -	Nalco Chemical Company
Tordon 101M	picloram, 2,4-D	2.5 S (0.5+2)	DowElanco
Transline	clopyralid	3 S	DowElanco
Vanquish	dicamba-glycolamine	4 S	Sandoz Agro, Inc.
Velpar L	hexazinone	2 S	E.I. DuPont de Nemours & Co.
Weedone 170	2,4-D, 2,4-DP	3.7 EC (1.85, 1.85)	Rhone Poulenc Ag Company

EVALUATION OF KRENITE S FOR CONTROL OF PIN CHERRY, BLACK LOCUST, AND RED MAPLE WITH BASAL BARK APPLICATIONS

INTRODUCTION

Low volume basal bark applications provide a flexible, selective method for the control of roadside brush. This study was established in Centre and Clinton Counties to evaluate a commonly utilized foliar herbicide, Krenite S, for the control of pin cherry (*Prunus pensylvanica* L.), black locust (*Robinia pseudoacacia* L.), and red maple (*Acer rubrum* L.) stems with a basal bark application.

MATERIALS AND METHODS

Treatments (Table 1) included an untreated check, Krenite S alone and in combination with Penevator 9 (which includes emulsifiers) and/or water, and Garlon 4 plus Penevator Basal Oil. The treatments were applied to ten stems each of red maple on December 9, 1993, and pin cherry and black locust on February 7, 1994. The experimental design was completely randomized, with each stem used as an experimental unit or replication. The treatments were applied to the lower 12 to 15 in of the stem with a CO_2 powered, hand held sprayer equipped with a Spraying Systems #5500 adjustable cone jet with a Y2 tip. The applications were made in an operational type application which simulates the application method and equipment utilized in the field. Prior to treatment, the diameter of each stem was measured and recorded for use in determining if the size of the stem would directly affect the overall control. A continuous snow cover from mid-December 1993 to the beginning of April 1994, made timing of the basal bark applications difficult. One week prior to the applications in February, snow was manually cleared from the stems to allow for clear access and to allow any ice or snow on the stem to melt. A visual rating of canopy reduction was taken July 8 and 11, 1994, where '0' indicates no change to the leaf canopy and '100' indicates no leaves remaining. Results are reported in Table 1.

RESULTS

No values are reported for red maple stems because 25 percent of the research plot was disturbed during a construction project along SR 80. Some of these stems were totally uprooted and others had bark damage. There was a significant difference in treatments observed for both cherry and locust. Garlon plus Penevator Basal Oil provided significantly better control than the other treatments on cherry with a canopy reduction rating of 100 percent. Undiluted Krenite S (100 percent), the 50/50 blend, and the 50/25/25 blend provided the most significant canopy reduction ratings of the Krenite treatments on the cherry stems; and all treatments, except the 25/25/50 blend, reduced the canopy to a level lower than the untreated check. The Garlon 4 treatment, undiluted Krenite, and the 50/25/25 blend provided statistically similar results on black locust with 97, 91, and 79 percent canopy reduction, respectively. All treatments except the 25/75 blend provided significantly better results than the untreated check for the black locust. It was observed during application that the undiluted Krenite treatment was more viscous than the other treatments and was therefore more difficult to apply in a fan type spray pattern.

CONCLUSIONS

Based on results from the cherry and locust stems, Krenite S when applied in a basal bark application does provide partial control of the treated stems. However, a second year rating will be taken to determine if the treatments will provide increased control of the treated stems. Other research studies have suggested that because of the girdling affects of the basal bark treatments, final control results may not be evident until several years after treatment.

TABLE 1: Treatments applied to ten stems each of pin cherry, black locust, and red maple. Treatments were applied to maple December 9, 1993, and cherry and locust on February 7, 1994. Canopy reduction ratings were visually rated July 8 and 11, 1994, where '0' indicates no change in leaf canopy and '100' indicates no leaves remaining. No values are reported for red maple stems because 25 percent of the plot was disturbed during a construction project along SR 80. Each value is the mean of ten replications.

		Canopy Reduction	
Treatment	Ratio	Pin Cherry	Black Locust
	(%)	(%)	(%)
Krenite S	100	72	91
Krenite S + Water	50/50	57	60
Krenite S + Water	25/75	47	46
Krenite S + Penevator 9 + Water	50/25/25	58	79
Krenite S + Penevator 9 + Water	25/25/50	41	72
Garlon 4 + Penevator Basal Oil	25/75	100	97
Untreated Check	- - -	26	27
Significance Level (p)		0.0001	0.0001
LSD (p=0.05)		19	19

COMPARISON OF TWO READY-TO-USE BASAL BARK HERBICIDE FORMULATIONS FOR CONTROL OF BLACK BIRCH, PIN CHERRY, AND BLACK LOCUST - SECOND YEAR RESULTS

INTRODUCTION

A study evaluating the effect of picloram:triclopyr ratios, and two different application dates, on brush control with basal bark applications was established January 1993 along SR 80 in Clinton County. To accurately compare the two chemicals, a controlled application was established with a set dosage rate to be applied to each stem based upon its size. Without an exact dosage amount, excess material could be applied to the stem, run off the treated surface, and come into contact with the ground surface. Picloram has soil activity and triclopyr does not; therefore, any excess picloram on the ground could be absorbed by the tree's root system and the picloram:triclopyr ratio could be changed and vary from stem to stem. Basal bark treatments produce a girdling effect on trees, therefore more than one season may be required to gain full control of the stem. The intent of this current rating was to establish second season results and to determine if treatment affects differed from first year results.

MATERIALS AND METHODS

The treatments applied were NAF-6, a formulation of picloram plus triclopyr containing 0.25 plus 0.50 lb ae/gal, respectively; and NAF-6 plus NAF-5, a 0.125 plus 0.625 lb ae/gal picloram:triclopyr formulation. The treatments were applied on January 14 and April 13, 1993, to ten stems each of black locust (*Robinia pseudoacacia* L.), pin cherry (*Prunus pensylvanica* L.), and black birch (*Betula lenta* L.). The application was made with a syringe and a 14 gauge pipetting needle at a rate of 0.5 mL/in of stem circumference, based on caliper measurements to the nearest 0.25 in. The measurements were taken at a height of 6 in on each stem. The study was a randomized complete block design where each plant was used as an experimental unit. Treatments were applied at 6 in on black locust, and covered a 2 to 4 in band, dependent upon the bark texture; and pin cherry which provided coverage from 6 in to the soil. Coverage on black birch stems was from the soil line to a height of 8 in. The rates of application in this study were lower than would be applied in the field. The use of actual field rates could result in total control of all stems, masking subtle differences that may exist between treatments. Canopy reduction ratings were visually taken September 28 and 29, 1993, and July 8 and 22, 1994; where '0' indicates no change in leaf canopy and '100' indicates no leaves remaining. At the 1993 ratings, untreated cherry stems were showing fall coloration and some leaf drop accounted for the canopy reduction ratings for the check. No checks were rated during the 1994 season. Results are reported in Table 1.

RESULTS

An increase in canopy reduction, compared to the first year results, was observed at the 1994 rating for both the locust and birch. Birch stems treated in January reached 100 percent canopy reduction at the 1994 rating, and stems treated in April approached 98 percent canopy reduction, which was an increase of 18 to 24 percent. The canopies of the locust stems were reduced by 6 or 7 percent at the 1994 rating, with the best rating of 95 percent reduction for the January applied NAF-6 + NAF-5. All applications on pin cherry, provided 100 percent canopy reduction both the first and second season ratings. Neither the first nor second year ratings showed any statistical differences for the level of control between either picloram:triclopyr formulation or the application timing for any species, with the exception of the 1993 rating of the April applied NAF-6 + NAF-5 on black birch.

CONCLUSIONS

Based upon the first and second year results of this study, it may require two growing seasons before gaining full control or an increase in control of treated stems when the herbicides are applied at the low rates used in this study.

No statistical differences were observed for either of the two picloram:triclopyr formulations or the application timings by the second year. It may be possible to obtain total control of the treated stems beyond two years after treatment, if the stems are unable to properly nourish the plant with its remaining leaf canopy.

Table 1: Visual ratings of percent canopy reduction of black birch, pin cherry, and black locust resulting from the application of two herbicide formulations at two dates, January 14 and April 13, 1993. All herbicides were applied with a syringe at the rate of 0.5 mL/inch of circumference measured at 6 in. Ratings were taken September 28 and 29, 1993, and July 8 and 22, 1994; where '0' indicates no change in leaf canopy and '100' indicates no leaves remaining. Each value is the mean of 10 replications.

			Canopy Reduction					
		Application	Black Birch		Pin Cherry		Black Locust	
Herbicide	Picloram:Triclopyr	Date	1993	1994	1993	1994	1993	1994
	(lb ae/gal)		(--------%	-------)	(--------%	-------)	(--------%	-------)
NAF-6	0.25:0.50	Jan 14	97	100	100	100	80	87
NAF-6 + NAF-5	0.125:0.625	Jan 14	99	100	100	100	87	95
NAF-6	0.25:0.50	Apr 13	80	98	100	100	66	69
NAF-6 + NAF-5	0.125:0.625	Apr 13	74	98	100	100	62	68
Untreated Check	- - -	- - -	2	- -	30	- -	5	- -
Significance Level (p)			0.001	0.3	0.0001	- -	0.0001	0.1
LSD (p=0.05)			19	n.s.	4	- -	26	n.s.

EVALUATION OF PATHFINDER II AND NAF-6 EXPERIMENTAL BASAL BARK HERBICIDES FOR CONTROL OF BLACK BIRCH, PIN CHERRY, AND BLACK LOCUST

INTRODUCTION

A study comparing the application date and efficacy of two ready-to-use basal bark herbicide formulations was established December 1993 in Centre and Clinton Counties, PA. A similar study was established in January 1993; however, it utilized a controlled application, with a syringe delivering 0.5 mL/in of stem circumference. In this study, application was made with a more operational type system that simulates the application method and equipment utilized in the field.

MATERIALS AND METHODS

The treatments included an untreated check, Pathfinder II (0.75 lb ae/gal triclopyr), and NAF-6 (0.50 lb ae/gal triclopyr plus 0.25 lb ae/gal picloram). These treatments were applied to the lower 12 to 15 in of ten stems each of black birch (*Betula lenta* L.), pin cherry (*Prunus pensylvanica* L.), and black locust (*Robinia pseudoacacia* L.). The low volume application was made with a CO_2 powered, hand held sprayer equipped with a Spraying Systems #5500 adjustable Cone Jet nozzle with a Y-2 tip. The experimental design was completely randomized, with each stem used as an experimental unit or replication. A continuous snow cover from mid-December 1993 to the beginning of April 1994, made basal bark applications difficult. The first application was made to black birch on December 9, 1993, and to pin cherry and black locust on February 7, 1994. One week prior to the February applications, snow was manually cleared from the stems to allow for clear access and to allow any ice or snow on the stem to melt. The applications were also made to all three species on April 27, 1994, shortly after bud break. A visual rating of canopy reduction was taken July 11, 1994, where '0' indicates no change in leaf canopy and '100' indicates no leaves remaining. Results are reported in Table 1.

RESULTS

NAF-5 applied on December 9, 1993, provided a significantly higher canopy reduction rating than any of the other treatments for black birch. All treatments to black birch provided statistically more control than the untreated check except for the April 27 application of NAF-6. Treatments applied to pin cherry were significantly better than the untreated check with either total or almost total defoliation of the treated stem. February treatments to black locust provided 100 percent canopy reduction and were statistically better than the April applied NAF-5 treatment. Each treatment provided significantly better control than the untreated check which had a canopy reduction of 23 percent.

CONCLUSIONS

These first year results should not be used to determine the level of long term control these treatments can produce, but rather the initial quickness of the treatments. With the first year results of this study, there appears to be no notable difference between any treatment or timing application that is the same for all three species. Second year results will determine if April treated cherry and locust stems will approach 100 percent canopy reduction, and if birch stems will show an increase in control.

Table 1: Visual ratings of percent canopy reduction of black birch, pin cherry, and black locust resulting from application of two herbicide formulations at two dates, February 7[1/] and April 27, 1994. All herbicides were applied to the lower 12 - 15 inches of the stem with an operational type application utilizing a Y-2 tip. Ratings were taken July 11, 1994, where '0' indicates no change in leaf canopy and '100' indicates no leaves remaining. Each value is the mean of 10 replications.

		Canopy Reduction		
Herbicide	Application Date	Black Birch	Pin Cherry	Black Locust
		(%)	(%)	(%)
Untreated Check	- - -	4	45	23
NAF-5	Feb 7[1/]	78	100	100
NAF-6	Feb 7[1/]	39	100	100
NAF-5	Apr 27	44	100	81
NAF-6	Apr 27	23	99	89
Significance Level (p)		0.0001	0.0001	0.0001
LSD (p=0.05)		22	10	14

[1/] Black birch stems were treated December 9, 1993. Black locust and pin cherry stems were treated February 7, 1994.

EFFECTS OF SPRAY VOLUME, HERBICIDE CONCENTRATION, AND ADJUVANTS ON CONTROL OF BLACK CHERRY AND RED MAPLE WITH DORMANT STEM APPLICATIONS OF GARLON 4

INTRODUCTION

Observations and research studies conducted in the past suggest that dormant stem applications can be a means of controlling roadside brush. Dormant stem applications are treatments made to the bare stems and trunks of target trees when the foliage is not present. This provides a selective application technique that also allows flexibility of scheduling work crews. It was believed that an advantage of dormant stem treatments is that control can be obtained in dense stands of brush where only one side of the brush can be treated. However, it has been found that for best results with a dormant stem application, the entire circumference of the tree stem and branches should be treated. This study was established to evaluate seven treatments to compare the effects of application volume, herbicide concentration, and adjuvant type on control provided by dormant stem applications with Garlon 4.

MATERIALS AND METHODS

The treatments consisted of three low volume applications of Garlon 4, methyl oleate spray adjuvant (Emerest 2301), and water at percentages of 12.5/37.5/50, 6.25/18.75/75, and 2.5/7.5/90 (v/v), respectively. High volume treatments consisted of Garlon 4 at 1.5 percent (v/v), with either Emerest 2301 or Clean Cut at 3 percent (v/v); and Garlon 4 plus Weedone 170 at 1.5 plus 1.0 percent (v/v), respectively, with either Emerest 2301 or Clean Cut at 3 percent (v/v). All treatments were applied with a CO_2-powered, single nozzle sprayer equipped with a Spraying Systems #5500 adjustable Cone Jet, at 30 psi. Low volume treatments were applied with a Y-2 tip, and high volume treatments were applied with an X-12 tip. Treatments were applied April 28 and May 2, 1994, to ten stems each of red maple (*Acer rubrum* L.) and 50 stems each of black cherry (*Prunus serotina* Ehrh.). Phenology for both species ranged from bud swell to approximately 25 percent leaf out. The experimental layout was a completely randomized design, with ten replications. Each plot consisted of one red maple and five black cherry plants. Visual ratings of percent canopy reduction were taken between September 8 and 29, 1994. Results are reported in Table 1.

RESULTS

The data were subjected to an analysis of variance, and orthogonal contrasts were run on the high volume treatments to compare Emerest 2301 and Clean Cut, and presence or absence of Weedone 170 in the treatment. Canopy reduction ranged from 35 to 89 percent in red maple, and 44 to 72 percent in black cherry. The low values for each species were for the low volume application of Garlon 4/Emerest 2301 at 6.25/18.75 percent (v/v), respectively. The accuracy of this treatment is suspect, as the 2.5/7.5 percent (v/v) treatment of Garlon 4/Emerest 2301 performed better on each species.

Among the high volume treatments, the effect of spray adjuvant was significant for red maple (p=0.008), as mixtures with Clean Cut averaged 85 percent canopy reduction, compared to 68 percent for Emerest 2301 treatments. The effect of spray adjuvant type was not significant for black cherry. The effect of adding Weedone 170 to each mix was significant in black cherry, and nearly significant (p=0.09) in red maple.

During the application, it was noted that the Emerest solution separated more quickly from the other herbicides, thus additional emulsifiers need to be added.

CONCLUSIONS

The results of this study suggest that these herbicide combinations can provide partial control of treated stems when applied with a dormant stem application. However, no treatments provided greater than 90 percent canopy reduction, which is the threshold level for acceptable control of the brush.

Adjuvant comparisons show treatments with Clean Cut provided more control of red maple than treatments with Emerest 2301; however, there was no significant difference between the two for the control of black cherry. Also, the addition of Weedone 170 provided significant differences on the control of black cherry but not red maple.

Future studies utilizing these same chemical combinations will require a variation in the rates to try and achieve a more acceptable level of control. Also, these combinations should be evaluated for their control of other tree species.

TABLE 1: Visual rating of canopy reduction of red maple and black cherry resulting from treatments applied April 28 and May 2, 1994. Ratings were taken between September 8 and 29, 1994. Each value is the mean of 10 replications.

Treatment	Application Rate	Application Volume[1/]	Red Maple Canopy Reduction	Black Cherry Canopy Reduction
	(%v/v)		(%)	(%)
Garlon 4 Emerest 2301	12.50 37.50	Low	80	67
Garlon 4 Emerest 2301	6.25 18.75	Low	35	44
Garlon 4 Emerest 2301	2.50 7.50	Low	67	54
Garlon 4 Emerest 2301	1.50 3.00	High	75	57
Garlon 4 Clean Cut	1.50 3.00	High	89	58
Garlon 4 Weedone 170 Emerest 2301	1.50 1.00 3.00	High	60	65
Garlon 4 Weedone 170 Clean Cut	1.50 1.00 3.00	High	81	72
Significance Level (p)			0.0001	0.0007
LSD (p=0.05)			18	12
Contrasts - High Volume Applications:				
'adjuvant: Emerest 2301 vs Clean Cut'			0.008	0.4
'Weedone 170: with vs without'			0.09	0.005

[1/] All applications were made with a handgun containing a Spraying Systems #5500 Adjustable Cone Jet nozzle. Low volume applications were made with a Y-2 tip, high volume applications were made with an X-12 tip.

EVALUATION OF BRUSH CONTROL PROVIDED BY FOLIAR APPLICATIONS OF TWO FORMULATIONS OF PICLORAM PLUS 2,4-D

INTRODUCTION

An experiment was established near State College, PA, to compare brush control provided by the currently labeled picloram:2,4-D amine salt formulation with an experimental dry formulation with the same 1:4, picloram:2,4-D ratio. The amine formulation (Tordon 101M) contains the triisopropanolamine salts of picloram and 2,4-D, for a total of 49.8 percent active ingredient. The experimental water dispersable granule formulation (NAF-8) contains 75 percent active ingredient.

MATERIALS AND METHODS

Both herbicides were tested at 0.625 and 1.25 lb ai/ac. Equivalent rates would be 32 and 64 oz/ac Tordon 101M and 13.33 and 26.67 oz/ac NAF-8. Treatments were applied to ten stems each of black locust (*Robinia pseudoacacia* L.), black cherry (*Prunus serotina* Ehrh.), and a mixed stand of red oak (*Quercus rubra* L.) and blackjack oak (*Q. marilandica* Muench.). The study was arranged in a completely randomized design, with each stem serving as an experimental unit or replicate. Prior to treatment, the canopy width and height were measured for each stem. The treatment dosage was then administered based on the canopy index (canopy width x canopy height). Black locust were treated with a carrier of 10 gal/ac, on August 24, 1993. At this dilution, the NAF-8 treatments required repeated agitation to keep the herbicide in suspension during the application. Cherry and oak were treated on September 8, at 15 gal/ac, which resolved the suspension problems encountered with the 10 gal/ac rate. Treatments were applied at 30 psi with a CO_2-powered backpack sprayer equipped with a Spraying Systems MeterJet and a rollover-valve nozzle with 1502 and 4002 flat fan spray tips. All treatments included a surfactant (Penevator 9) and a drift control agent (Sta-Put), each at 0.25% (v/v).

Black locust was visually rated for percent defoliation October 6, 1993. On October 8, the oak were rated for percent defoliation and percent fall coloration of the remaining foliage, and cherry was rated for percent leaf drop and percent necrosis of remaining foliage. The leaf drop rating refers to the amount of leaves which had fallen at the time of rating due to natural senescence. All species were visually rated for percent canopy reduction on July 5, 1994. Results are reported in Table 1.

RESULTS

Locust response to the treatments was the most dramatic, as the checks were not yet showing fall color, and severely injured plants were defoliated or had hanging necrotic leaves, and were showing bark cracking on the main stem 6 weeks after treatment. Initial oak symptoms were not as clear, and had to be rated as a function of defoliation and coloration of remaining leaves. At the first rating, the cherry had dropped most of their leaves, but there were differences in the amount of necrosis in the remaining leaves. Data were subjected to analysis of variance, and orthogonal contrasts were used to evaluate the effect of formulation, rate, and to compare the treatments with the untreated check. In these orthogonal contrasts, a value equal to or greater than 0.10 (the 'p' value), indicates no significant differences between the two items being compared.

The treatments were significantly different than the check for all ratings except for initial leaf drop in cherry. Tordon 101M provided more initial defoliation of locust, but there were no significant differences due to formulation or rate on final canopy reduction, which ranged from 77 to 95 percent. The effect of rate was significant on canopy reduction in oak, as the 1.25 lb ai/ac rate averaged 94 percent, compared to 80 for 0.625 lb ai/ac. The effects of formulation and rate were not significant on the canopy reduction of cherry, as all treatments provided excellent control, ranging from 93 to 98 percent.

CONCLUSIONS

Except for the initial defoliation of the black locust, NAF-8 provided the same efficacy as Tordon 101M, though the dry formulation does not mix as readily as the liquid formulation at volumes less than 15 gal/ac. Also, applying the low rate of each product (0.625 vs 1.25 lb ai/ac) did not provide significant differences in efficacy.

TABLE 1: Injury ratings from foliar herbicide treatments applied to black locust on August 24, 1993; black cherry, and red and blackjack oak on September 8, 1993, near State College, PA. Black locust were treated at 10 gal/ac, and oak and cherry were treated at 15 gal/ac, based upon the canopy index (height x width). Defoliation, fall coloration, and foliar necrosis were rated October 6 and 8, 1993. The leaf drop rating on black cherry was taken October 8 and refers to the amount of leaves that had fallen due to the natural senescence. Final canopy reduction was rated July 5, 1994. Each value is the mean of 10 replications.

		Black Locust		Red and Blackjack Oak			Black Cherry		
Treatment	Application Rate	Defoliation	Canopy Reduction	Defoliation	Fall Coloration	Canopy Reduction	Leaf Drop	Foliar Necrosis	Canopy Reduction
	(lb ai/ac)	(-----------%------------)		(---------------------% -------------------)			(----------------%------------)		
Tordon 101M	0.625	93	95	14	80	80	74	67	96
Tordon 101M	1.25	95	87	45	86	90	57	92	99
NAF-8	0.625	84	81	24	91	80	73	67	93
NAF-8	1.25	75	77	25	96	97	70	70	98
Untreated Check	- - -	2	1	0	69	5	69	0	10
LSD (p=0.10)		10	19	22	17	16	n.s.	24	6
Contrasts:									
'101M vs NAF-8'		0.002	0.2	0.5	0.2	0.6	0.4	0.3	0.4
'0.625 vs 1.25'		0.4	0.4	0.09	0.4	0.05	0.2	0.2	0.09
'Treated vs Check'		0.0001	0.0001	0.01	0.02	0.0001	0.9	0.0001	0.0001

EFFECT OF SPRAY ADJUVANTS ON BRUSH CONTROL PROVIDED BY LOW VOLUME FOLIAR APPLICATIONS OF KRENITE S PLUS ARSENAL

INTRODUCTION

Today's chemical marketplace has been flooded with numerous types of spray adjuvants. Adjuvants can improve the wetting and spreading of the spray solution over the entire leaf surface, improve the penetrating ability of the herbicides into the leaf tissue, and help the herbicide remain on the leaf tissue, even during a rain storm, for longer periods of time to improve the overall absorption of the chemical into the leaf. This study was established to determine the effects, if any, of three different surfactants on the control of roadside brush with a low volume foliar application. The three adjuvants included Clean Cut, Penevator 9, and QwikWet 357. Both Clean Cut and Penevator 9 are categorized as 83/17 surfactants, in which 83% of the formulation consists of oil (aliphatic based petroleum oil for Clean Cut and refined paraffinic oil for Penevator). The remaining 17% contains a mixture of surfactants, emulsifiers, and other inert ingredients. QwikWet 357 is a non-ionic organosilicone wetting agent. All claim to improve wetting and spreading of the spray solution and to enhance the penetrating characteristics of the herbicides. QwikWet 357 also promotes increased rain fastness.

MATERIALS AND METHODS

The experimental site was located along the east and west bound lanes of Interstate 80 near Snow Shoe, PA. Treatments (Table 1) included a combination of 3 percent (v/v) Krenite S and 0.125 percent (v/v) Arsenal; with either no adjuvant, Clean Cut, Penevator 9, or QwikWet 357. The concentration of Krenite S and Arsenal applied are below labeled rates, but were selected with an attempt to isolate any differences in control provided by the adjuvants. All treatments contained 0.25 percent (v/v) of Formula 358 drift control. The experimental design was a randomized complete block with two replications. Applications were made with a backpack sprayer equipped with a Spraying Systems #5500 Adjustable Cone Jet nozzle with a Y2 tip. The targeted application rate was a light, uniform coverage of the entire leaf surface of the plant. Each plot was treated with approximately 0.5 gal of spray solution, which treated an average of 149 stems. The plot size ranged from 0.1 to 0.2 acres. The most common species were red maple (*Acer rubrum* L.), black cherry (*Prunus serotina* Ehrh.), and red and white oak (*Quercus rubra* L. and *Q. alba* L.). Other species included quaking aspen (*Populus tremuloides* L.), green ash (*Fraxinus pennsylvanica* Marsh.) and hawthorn (*Cretageus* spp.). Applications were made to one replication on September 16 and 17; and to a second replication on September 29, 1993. An intermittent drizzle fell during the applications on September 16 and 17, but the conditions were dry for the application on September 29. All treated stems were visually rated for percent canopy reduction on July 7 and 15, 1994, using four species groups (maple, cherry, oak, other), and four height classes (0-5, 5-10, 10-15, and greater than 15 ft). Results are reported in Table 1.

RESULTS

The combined species data were subjected to analysis of variance. Analysis of covariance evaluating effect of target height on control was not significant. Replication was not a significant source of variation, suggesting that light rainfall is not detrimental to low volume foliar applications of Krenite S plus Arsenal. The effect of spray adjuvant was not significant for any individual species, groups, or for the combined data.

CONCLUSIONS

Based on the results of this study, the addition of a surfactant to the herbicides provided no significant increase in control. The formulation of Krenite used in this study includes a surfactant. The additional surfactants did not enhance the control it provided.

Table 1: Effect of spray adjuvants on percent canopy reduction due to low volume applications of a solution containing 3% (v/v) Krenite S and 0.125% (v/v) Arsenal. Applications were made September 16, 17, and 29, 1993. Visual ratings of canopy reduction were taken July 7 and 15, 1994. 'Other' includes green ash, quaking aspen, and hawthorn. Numbers in parentheses are number of stems treated. Values reported are the means of two replications.

Adjuvant	Application Rate	All Species	Red Maple	Black Cherry	Red and White Oak	Other
	(% v/v)	(--------------------------percent canopy reduction				-----------------------------)
none	- - -	84	84 (147)	98 (21)	87 (44)	81 (124)
Clean Cut	0.5	83	90 (89)	94 (116)	84 (54)	60 (67)
Penevator 9	0.25	88	90 (103)	95 (128)	77 (39)	72 (31)
Penevator 9	0.5	88	78 (72)	94 (64)	87 (38)	93 (60)
Penevator 9	1.0	89	96 (152)	100 (4)	79 (61)	77 (30)
QwikWet 357	0.125	84	86 (260)	90 (12)	80 (45)	72 (29)
QwikWet 357	0.25	80	84 (207)	20 (1)	90 (30)	59 (59)
Significance Level (p)		0.85	0.20	0.62	0.69	0.60
LSD (p=0.05)		n.s.	n.s.	n.s.	n.s.	n.s.

BRUSH CONTROL DEMONSTRATION - DISTRICT 1-0

INTRODUCTION

Low volume foliar applications are effective techniques for controlling roadside brush up to 20 ft in height. This method does not require the applicator to refill as often and provides a selective application which minimizes the damage to the surrounding groundcover. Two low volume foliar techniques were used in District 1-0 during the 1993 season. The applications included treatment with backpack sprayers or a truck-based handgun.

MATERIALS AND METHODS

A low volume foliar demonstration with backpack sprayers was established August 31, 1993, along SR 79 South beginning at segment 1150 and continuing south for approximately 1.5 miles. The treatment area included the median; and the shoulder, which had been hand cut during the winter of 1992-1993. The species treated consisted of red maple (*Acer rubrum* L.), ash (*Fraxinus* spp.), Populus spp., hawthorn (*Crataegus* spp.), and oak (*Quercus* spp.), ranging in size from 1 to 16 ft. The applicators used two Birchmeier backpack sprayers equipped with a rollover-nozzle handgun containing Spraying Systems 1502 and 4002 tips. Another applicator utilized a motorized backpack equipped with the 'Philly Foamer' handgun. The 'Philly Foamer' system consists of special handgun nozzles and a special foaming agent (LVF 100) which serves as a deposition aid and pattern marker for applicators. The motorized backpack delivered a higher volume than the other backpack sprayers. The treatment solution applied consisted of 5% (v/v) Krenite S, 0.25% (v/v) Arsenal, 0.25% (v/v) Clean Cut, and 0.25% (v/v) Sta-put (a drift retarding agent). Arborchem's LVF 100 was added to the motorized backpack at a rate of 2 oz/gal of solution. Three applicators treated the resprouts for 1 hour and 50 minutes using approximately 8 gallons of solution. A steady rain fell one hour after treatment.

A low volume foliar demonstration with a truck-based application was made September 1, 1993, along SR 258, beginning at the Mercer County PennDOT Maintenance Shed and continuing west along SR 258 to the intersection of SR 18. The total distance treated, including both sides, was approximately 19 miles, and the target area on each side of the right-of-way was approximately 12 feet wide and 20 ft high. The spray unit consisted of a gasoline powered engine, a centrifugal pump, and an 80 gallon mix tank, all mounted to a skid in the back of a pickup truck. The custom made handguns utilized consisted of five 0.045 Radiarc tips arranged in either a triangular or semi-circular configuration. These handguns were operated at 25 psi which produced an output of approximately 1.5 gal/min. The solution applied consisted of 5% (v/v) Krenite S, 0.25% (v/v) Arsenal, 0.25% (v/v) Clean Cut, and approximately 1 oz/18 gallons of solution of San-Ag 41A drift control agent. The treatment required two hours to complete and the total volume sprayed was 80 gallons over an area of approximately 28 acres, with an average spray volume of 2.85 gal/ac. The species, size, and density of the vegetation treated varied throughout the treatment area.

RESULTS

The backpack application site was not reviewed by the research team during the 1994 season.

The truck-based handgun demonstration was quite effective on maples and sassafras (*Sassafras albidum*). In fact, several maples forty feet in height, were entirely defoliated when only the lower 20 ft had been treated. Large elms and oak trees were effectively side trimmed, and some of the smaller stems (up to 12 ft) were completely controlled. Mixed results were observed for stems of ash and populus. Very little damage to the understory was observed.

CONCLUSIONS

The truck-based handgun application was very effective in controlling the target species with very little damage to the understory. This application method permits the applicator to treat an area in less time than backpack applications. This method is useful for controlling brush close to roads with wide rights-of-way. On roads with narrow rights-of-way it can only be used where total control of some treated trees is acceptable.

BRUSH CONTROL DEMONSTRATION - DISTRICT 4-0

INTRODUCTION

Where right-of-ways are wide enough, all brush should be cleared to 30 ft from the pavement edge, and all tall growing tree species should be cleared to a distance from which they can no longer fall onto the road surface. However, many truck-based herbicide applications are made utilizing equipment that provides a fixed spray pattern, and only the brush that falls within this fairly narrow pattern is treated. Therefore, to thoroughly control roadside brush to the proper distances (where right-of-way widths permit), herbicide applications with backpack sprayers should be utilized. Backpack applications allow for a more precise application which prevents excessive application of chemical and minimizes damage to the desirable groundcover.

Demonstrations utilizing selective low volume foliar and basal bark applications with backpacks were established in District 4-0 to evaluate the effectiveness of these methods for the control of roadside brush.

MATERIALS AND METHODS

A low volume foliar herbicide demonstration was established along SR 1030 in Luzerne County, on August 25, 1993. The application was made to both sides of the roadway for a distance of 1.3 miles (from SR 1055 to SR 29). The targets included all woody plants within a 10 ft distance of the road shoulder. Species treated included red maple (*Acer rubrum* L.), sugar maple (*Acer saccharum* Marsh.), black locust (*Robinia pseudoacacia* L.), green ash (*Fraxinus pennsylvanica* Marsh.), red oak (*Quercus rubra* L.), white oak (*Quercus alba* L.), sassafras (*Sassafras albidum* Nees.), black cherry (*Prunus serotina* Ehrh.), birch (*Betula* spp.), witch-hazel (*Hamamelis virginiana* L.), staghorn sumac (*Rhus typhina* L.), multiflora rose (*Rosa multiflora* Thunb.), and striped maple (*Acer pensylvanicum* L.). The equipment utilized for the application consisted of two Birchmeier backpacks with a rollover-nozzle handgun with 1502 and 4002 tips, and a Solo backpack with a single 6502 tip. The solution was applied at a rate of approximately 15 gal/ac and contained 4% (v/v) RoundUp, 0.25% (v/v) Arsenal, and 0.25% (v/v) Clean-Cut in an aqueous solution. On a per acre basis, the chemical combination was 2.5 qts RoundUp and 4 oz Arsenal. The application was completed with 4.75 manhours and a total of 5.5 gallons of spray solution.

A low volume foliar herbicide demonstration was also applied along SR 4001 in Luzerne County on August 26, 1993. This treatment covered 2 miles of roadway treating both shoulders from segments 140-120 and 100-80. The targets again included all woody plants within a distance of 10 ft of the road shoulder. Species treated included green ash, red oak, red maple, white oak, sassafras, witch-hazel, and birch. The same solution and equipment as the application to SR 1030 was utilized, except the Solo backpack contained a Spraying Systems #5500 Adjustable Cone Jet nozzle with a Y-2 tip. A total of 7.25 man hours and 7.25 gallons of solution were utilized to complete the application.

A basal bark application was made April 20 and 21, 1994, from SR 115 (Exit 47 A) along the median and southbound shoulder of Interstate 81 to segment 1671, approximately 3.5 miles. The timing of the application was later than normal for a basal bark application due to the continuous snow cover from December to April. All undesirable species were treated from the road edge to the right-of-way fence, including black locust, birch, cherry, ailanthus (*Ailanthus altissima* Mill.), sumac, populus (*Populus* spp.), and oak. The median contained very few treatable stems due to its mowing in 1993, however the stems present were treated. The treatment contained 15% Garlon 4 and 85% of various diluents (HyGrade, Penevator Basal Oil, Penevator Vegetable Oil, Penetrator, or Soydex), or Pathfinder II (a ready-to-use basal solution). The application was made using Birchmeier and Solo backpacks equipped with hand-held basal wands containing a Spraying Systems # 5500 Adjustable Cone Jet with a Y-2 tip. Application required a total of 30.67 man hours and 16.8 gallons of solution.

A portion of the section treated with the basal bark application in April 1994, was treated with a low volume foliar follow-up to control resprouts. The shoulder and median between segments 1691 and 1681 were treated on

September 14, 1994, with a solution of 5% (v/v) Krenite S, 0.5% (v/v) Arsenal, 0.125% (v/v) QwikWet 357, and 0.5% (v/v) Formula 358 (a drift control agent). The application was made with backpacks equipped with hand held spray guns containing a Spraying Systems #5500 Adjustable Cone Jet with a Y-2 tip. The application required a total of 11 man hours and 18.8 gallons of solution. Due to its mowing in 1993, the median contained the most resprouts and required the most time and material to complete.

RESULTS

The low volume foliar sites on SR 1030 and SR 4001 (both in Luzerne County) were reviewed on September 13, 1994. Control in both areas was good. The target species were controlled with very little damage to the ground cover. On average, the applicators treated a 10 ft wide area at a rate of approximately 0.55 lineal miles per hour.

One year after treatment, results of the basal bark application along SR 81 south were not very favorable. The treated stems were controlled fairly well but a significant number of resprouts occurred. The most significant resprouting occurred in the median area, but it was most likely due to the mowing operation performed in 1993. The most prolific resprouting species were sumac and ailanthus. Because of this resprouting, a low volume foliar follow-up treatment was made to control the existing resprouts along a one mile section of the original treatment area. The results of this foliar treatment will not be known until the summer of 1995.

CONCLUSIONS

Based upon the observations of these demonstrations, low volume foliar applications made with backpacks can be an effective means of controlling roadside brush. The backpack application is slower than a truck based application, but it reduces the overall spray volume and provides a more selective treatment, which in turn minimizes the environmental impact by reducing off-target damage.

Basal bark treatments have proven to be effective in the past, but the results of the treatment along SR 81 were not favorable. The late application timing may have had a limiting effect on the control received. Results from other demonstrations with basal bark treatments applied in April, have shown similar effects with prolific resprouting of ailanthus and sumac. A possible study is being planned for 1995 to investigate the effect of application timing on these two species. The other problem area was the resprouting which occurred from the mowing operation conducted in 1993 to the median area. At the time of the basal application, very few stems were present to treat. Based on the observation of this median area, it is evident that mowing of brush will not provide long term control without a herbicide treatment.

The results of the low volume foliar treatment applied to a section of the basal bark area are unknown and will be reviewed during the 1995 season.

BRUSH CONTROL DEMONSTRATION - DISTRICT 5-0

INTRODUCTION

The ideal time to initiate a brush control program for a right-of-way is when it is relatively young. At this point, any brush present is small and sparse in density. It is much more economical to control brush at this stage, and it will also disturb the desired groundcover less, which will limit the future encroachment of woody plants. Also, at this stage of brush development, it is important to treat all brush within 30 ft of the roadway and all tall growing species which could potentially reach the road surface if it fell in the future. If the brush is not controlled at this point, in several years there will be an established stand of brush which will pose a threat to passing motorists and be much more costly to control.

A demonstration of brush control was established along SR 78 in Northampton County, which is a portion of roadway only a few years old. The demonstration included low volume foliar, basal bark, spot concentrate, and Spike pellet applications and was intended to provide the opportunity to compare the efficacy, as well as the application time and selectivity of these methods under operational conditions.

MATERIALS AND METHODS

Low Volume Foliar - On October 7 and 8, 1993, a low volume foliar application was made to the median and westbound shoulder, for approximately 10 miles. The application was made utilizing Birchmeier backpack sprayers equipped with handguns containing a rollover-nozzle with a SS 1502 and a Spraying Systems #5500 Adjustable Cone Jet with a Y-2 tip. The treatment solution contained 5% (v/v) Krenite S, 0.5% (v/v) Arsenal, 0.125% (v/v) QwikWet 357 (a wetting agent), and 0.25% (v/v) Sta-put (a drift control agent). The application of the herbicide involved a light, uniform coverage of the leaf surface over the entire target plant. The application was completed in a total of 12.5 hours using 9.75 gallons of solution. Species treated included black locust (*Robinia pseudoacacia* L.), boxelder (*Acer negundo* L.), sumac (*Rhus typhina* L.), ash (*Fraxinus* spp.), autumn olive (*Eleafnus angustifolia*), willow (*Salix* spp.), Populus spp, birch (*Betula* spp.), cherry (*Prunus* spp.), and maple (*Acer* spp.).

Spot Concentrate - This application was applied October 7, 1993, and involved applying precise amounts of undiluted Velpar L herbicide directly to the soil near the base of the tree stem. Over approximately 100 black locust stems were treated along the westbound shoulder and required 30 minutes and 0.25 gallons of solution to complete. The application was made with a backpack sprayer equipped with a Spraying Systems MeterJet, delivering 4 mL herbicide/inch of stem diameter, or 4 mL herbicide/3 ft of canopy diameter for multi-stemmed plants.

Spike - The 20 P (20% active ingredient pellet) formulation of Spike was utilized to treat over one hundred black locust stems along the westbound shoulder on October 7, 1993. The pellets were applied using an automatic dispensing unit which delivered the same amount of pellets each time it was activated. For every 1-2" of stem diameter, one unit of pellets were applied to the ground at the base of the tree. The application was completed in 25 minutes and required the use of approximately 2.5 lbs of the pellets.

Low Volume Basal Bark - On April 7 and 8, 1994, a low volume basal bark application was made to a 12 mile portion of the eastbound shoulder and 2 mile portion of the westbound shoulder. The herbicide solution utilized contained 15% (v/v) Garlon 4 and 85% (v/v) of various diluents (HyGrade, Arborchem Basal Oil, Penevator Basal Oil, or Penevator Vegetable Oil) and was applied to the lower 12 to 18 inches of the bark. The intent of the low volume application is to apply a minimum amount of solution to the bark, preventing runoff and puddling at the base of the plant. The application was made with backpack sprayers and hand held basal wands containing a Spraying Systems #5500 Adjustable Cone Jet nozzle with a Y-2 tip. Tree species with a diameter up to 6 in were treated, including black locust, boxelder, sumac, cottonwood (*Populus* spp.), black cherry (*Prunus serotina* Ehrh.), and maple. A total of 17.6 gallons of solution was used and was applied in 28.1 total manhours.

A low volume foliar application was made on August 29 and 30, 1994, to the entire median and shoulders of SR 78 in Northampton County to control brush that resprouted following the other treatments. Backpack sprayers equipped with Spraying Systems #5500 Adjustable Cone Jet nozzles and Y-2 tips were utilized. The herbicide solution contained 5% (v/v) Krenite S, 0.5% (v/v) Arsenal, 0.5% (v/v) Formula 358 (drift control agent), and 0.125% (v/v) QwikWet 357 (a wetting agent). A total of 80.8 gallons of solution was applied in a total of 61.5 manhours.

RESULTS AND DISCUSSION

Low Volume Foliar - The initial low volume foliar application provided mixed results. It was perhaps applied a few weeks too late as most of the boxelder were losing their leaves and many other species were experiencing fall coloration. This may have prevented enough herbicide from entering the plant system to gain full control. This type of foliar application is fairly quick and easy to apply; permits an easier approach to treating targets within dense stands of brush; utilizes small amounts of chemical solution; and is fairly selective with regard to the desirable groundcover. Some disadvantages however, include the need to stop and mix the solution being applied, a high drift potential on windy days, and the application must be conducted during the growing season.

Spot Concentrate - This treatment provided good control on most of the treated stems, but also provided some short term damage to the surrounding groundcover. Stems with only fair control were most likely missed during the application or an under application of herbicide was made. Some advantages to this type of treatment include no need to mix the treatment solution (undiluted Velpar L was utilized), it is not necessary to treat the entire circumference of the tree (as with foliar and basal bark applications), and the application can be made throughout the entire year, as long as the soil is not frozen or the plant is in standing water. Disadvantages include the difficulty in accessing all of the stems in a dense stand of trees; the chemical is applied to the soil, is non-selective, and may injure any desirable surrounding vegetation with roots in the treated area; and requires more time to apply because the applicator must calculate the dosage based upon the tree size and must get quite close to the stem to deliver the material.

Spike - There was good control of the brush in the area treated with the Spike pellets. As expected, the groundcover was injured, but the injury only lasted a few months before the crownvetch began filling in. This treatment shares many of the advantages and disadvantages of the spot concentrate treatment. However, the pellet container is more lightweight than a backpack sprayer needed for the spot concentrate treatment. Clearly, one of the largest disadvantages with this treatment is the potential for off-site damage.

Low Volume Basal Bark - This treatment controlled treated stems, but a substantial amount of resprouts occurred from the sumac plants treated. This method of basal bark application is normally effective during the winter months, which provides an opportunity to expand the window of brush control applications. It is a very selective technique which usually results in little damage to the groundcover. However, it is best suited to areas with a low to moderate density of brush.

The low volume foliar treatment applied in August 1994 will be evaluated during the 1995 season to determine its effectiveness.

CONCLUSIONS

This demonstration project has provided an opportunity to evaluate several different application methods on a large scale basis. As a result of this project, the selectiveness, overall control, application time, and volume of material can be compared for each treatment. For roadways with young, sparse stands of brush, low volume foliar, spot concentrate, Spike pellets, and basal bark applications can effectively be utilized to control brush with wide rights-of-way. This cannot be accomplished with the current method of chemical brush control provided by a truck-based, fixed pattern application. However, applicators should consider that the Spike and spot concentrate treatments have a greater potential for understory and off-site damage. The applicators in this demonstration favored the low volume foliar application technique compared to the others. However, each technique does have its own unique area of application. This demonstration project will continue to be evaluated in future years.

BRUSH CONTROL DEMONSTRATION - DISTRICT 8-0

INTRODUCTION

Ailanthus (*Ailanthus altissima*) is a tree species that is becoming more common along Pennsylvania's roadsides. Due to its aggressive growth habit and prolific root-suckering, typical maintenance practices of cutting or fixed patterns of herbicide application, make it difficult if not impossible to totally control established colonies. It is a weak-wooded species and the stems and root-suckers grow vigorously. These characteristics make this tree a hazard to motorists.

A demonstration area was established along SR 322 near Newport, PA, to evaluate some selective brush control techniques for the control of this tree species.

MATERIALS AND METHODS

On April 27, 1994, a basal bark application was made to a two mile stretch of roadside between the Newport and Millerstown exits along SR 322. The eastbound shoulder, median, and the Newport interchange was treated. The primary target species was ailanthus. A total of 9.8 gallons of solution was applied. Of this total, 5.8 gallons were a tank mix of 15% (v/v) Garlon 4 and 85% (v/v) Penevator Basal Oil; 2 gallons of 15% (v/v) Garlon 4 and 85% (v/v) Arborchem Basal Oil; and 2 gallons of 0.37% (v/v) Arsenal, 15% (v/v) Garlon 4, and 84.63% (v/v) Arborchem Basal Oil. The application was made in a total of 15 man hours by personnel equipped with backpack sprayers containing Spraying Systems #5500 adjustable cone jets with a Y-2 tip.

On August 19 and 23, 1994, a low volume foliar treatment was made to this same site to control any missed targets or resprouts from the basal bark application in April. In addition, approximately two miles of the eastbound shoulder of SR 322 was treated prior to the Newport exit. A total of 29 gallons of spray solution was applied to the entire area. Of this total, 22.7 gallons was 5% (v/v) Krenite S, 0.5% (v/v) Arsenal, 0.25% (v/v) QwikWet 357, and 0.5% (v/v) Formula 358. Another 3.2 gallons each of 2% (v/v) Garlon 4 or 1% (v/v) Arsenal were applied in combination with 0.25% (v/v) QwikWet and 0.25% (v/v) Formula 358 to compare their effectiveness. The application was made in a total of 29 man hours by personnel utilizing the same equipment as that used for the basal bark application.

RESULTS

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

The low volume foliar treatment was applied to resprouts and missed stems in August and the site was visited September 2, 1994 (2 WAT). At this time, the 2% Garlon 4 treatment was causing necrosis of many of the treated leaves and a fair amount of understory damage. The foliage in the area treated with the Krenite and Arsenal combination was beginning to discolor. The 1% Arsenal treatment caused some leaf curling similar to the Krenite plus Arsenal treatment. These last two treatments were expected to show less symptoms than the Garlon treatments because of the slower acting mode-of-action.

CONCLUSIONS

The basal bark application in April controlled most of the target stems of ailanthus and sumac, but did not prevent those species from resprouting in large quantities. Previous studies have indicated that Garlon 4 does not translocate into the root system of the plants with this type of application, but rather controls the stem above the treatment band with a girdling affect. The degree of resprouting that occurred was never before noticed by the project personnel. Therefore the question arose as to whether the later than normal application timing caused the resprouting. To evaluate this problem, a study will need to be established to compare the application timing of basal bark applications on both the ailanthus and sumac.

The efficacy by the low volume foliar treatment applied in August will be determined in 1995. Because of the large amount of resprouting from the basal bark treatment, the stem density of the foliar treated area was high and therefore damage to the existing groundcover is expected.

EVALUATION OF FINE FESCUE AND PERENNIAL RYEGRASS CULTIVARS UNDER LOW MAINTENANCE CONDITIONS WITH AND WITHOUT NITROGEN FERTILIZATION

INTRODUCTION

The objective of this trial was to evaluate the long-term performance of fine fescue and perennial ryegrass cultivars under low maintenance conditions, with and without supplemental nitrogen fertilization.

MATERIALS AND METHODS

Twenty-four fine fescue and two low-growing perennial ryegrass cultivars (Table 1) were planted May 8, 1990, at the Russell E. Larson Agricultural Research Center located in Rock Springs, PA. Prior to seeding, the site was plowed, disked, and harrowed. The seed was dropped on 7.5 by 30 ft plots, and the area was cultipacked. The experimental design is a randomized complete block design with a split-block treatment arrangement and three replications. An application of 2,4-D at 0.75 lb ai/ac was made July 16, 1990, to control annual broadleaf weeds, including common lambsquarters (*Chenopodium album* L.) and wild buckwheat (*Polygonum convolvulus* L.). The entire study area was treated with dicamba plus chlorsulfuron at 1.0 plus 0.023 lb ai/ac, on November 10, 1992, to control perennial broadleaf weeds such as Canada thistle (*Cirsium arvense* L.), black medic (*Medicago lupulina* L.), red clover (*Trifolium pratense*), and common dandelion (*Taraxacum officinale* Weber.). The study area was mowed at a height of 6 inches, removing very little leaf tissue, in August, 1990; September, 1991; July and September, 1992; June, 1993; and July, 1994. An application of urea (46-0-0) at 44 lb N/ac was made to half of each cultivar plot on October 18, 1990; October 8, 1991; and October 19, 1992. On October 4, 1993, an application of sulfur-coated urea (39-0-0) was applied to half of each cultivar plot at 44 lb N/ac. Data collected in 1994 included visual ratings of percent green turf cover and percent weed cover on June 2, June 30, August 18, and October 5. The most prevalent weed species were common dandelion, black medic, Canada thistle, and red clover.

RESULTS

The data for turf and weed cover were analyzed by cultivar (Tables 2 and 4), by species (Tables 3 and 5), and by fertility or maintenance level (Table 6).

Analyzing turf cover by cultivar (Table 2), the initial green cover rating taken on June 2 showed no significant differences between cultivars for chewings, hard, slender creeping, creeping red and sheep fescue. These fine fescue cultivars ranged from 18 to 33 percent green cover, with 'Durar' providing the highest rating. There was a significant difference between the ryegrass cultivars, with 'Lex86' providing more green cover than 'Barclay'. A significant interaction between cultivar and nitrogen rate for the rating on June 30 was observed, therefore the ratings were analyzed by cultivar for each nitrogen rate. Turf cover ratings at this rating on June 30 were higher in plots to which nitrogen was applied, but the amount of response varied. Unfertilized fine fescue plots ranged from 15 to 28 percent, and the fertilized plots ranged from 20 to 35 percent cover. Among the fine fescue cultivars, 'Jasper' showed the greatest variation between unfertilized and fertilized plots with 23 and 32 percent, respectively. 'Durar' showed the least amount of difference with 20 and 23 percent cover, respectively. The ryegrass plots showed little or no difference between the fertilized and unfertilized plots.

The ratings on August 18 showed no difference between fertility levels, and fine fescue plots ranged from 13 percent for 'Covar' to 34 percent cover for 'HF 8250'. 'Covar' was significantly less than all other fine fescue and ryegrass cultivars. On August 18 and October 5, the perennial ryegrass cultivars provided the highest levels of green turf cover, statistically higher than any of the fine fescues. Also at the October 5 rating, 'Bargena' was significantly better than all other fine fescue cultivars with 38 percent cover. Other fine fescue cultivars providing good results at the October rating included 'Dawson', 'Ensylva', 'Jasper', and 'Pennlawn'. Of all fine fescue cultivars, 'Bargena', 'Jasper', and 'Ensylva' had the lowest ratings of green cover at the June 2 rating but were among the highest ratings by October 5.

When turf cover was evaluated by species (Table 3), no significant difference was observed between species at the rating on June 2. A significant interaction between species and fertility level occurred for the rating on June 30; however, no significant differences were observed between the species for either fertility level. At both the August 18 and October 5 ratings, the perennial ryegrasses had significantly higher ratings than the other species. The fine fescue species providing the highest ratings in August were creeping red, hard, and slender creeping with 28, 31, and 30 percent cover, respectively. In October, slender creeping, with 38 percent cover, was significantly better than all the other fine fescues.

The two perennial ryegrass culitvars have shown more green color throughout the growing season than the fine fescues, however they currently only provide 60-80 percent of the groundcover within the plots. Fine fescues however, have consistently provided almost 100 percent of the groundcover within the plots. These groundcover ratings were determined by the amount of coverage in each plot provided by the turf species being evaluated. The groundcover ratings for each species was similar, therefore this data is not presented in the tables.

Compared to previous year results, there was a significant increase in the amount of weed pressure in the plots. The highest weed cover rating for a fine fescue plot in 1994 was 80 percent, compared to the highest rating of 5 percent in 1993. Significant interactions occurred between cultivar and fertility level for all ratings of percent weed cover. Of the fine fescue plots, there was little significant difference at the initial rating on June 2, with marginally more weed cover in 'Bargena' at the 0 lb N/ac fertility rate. However, at the October 5 rating, with the most weed cover present, the highest weed cover rating in a fine fescue plot, in either fertility level, was 'Bargena' with 80 and 70 percent in the 0 and 44 lb N/ac plots, respectively. The lowest rated fine fescue plot in October at 0 lb N/ac was MX-86 with 6 percent weed cover, and the lowest at 44 lb N/ac was 'Spartan' with 2 percent cover. 'Lex86' had significantly less weed cover than 'Barclay' at all ratings except August at 0 lb N/ac fertility rate and both October fertility rates. The perennial ryegrass plots had significantly higher weed cover ratings than all fine fescue plots except for the unfertilized plots of 'Bargena' at both the June 30 and October 5 ratings and the unfertilized plots of 'Ensylva' at the October 5 rating. Overall, little difference was observed between cultivars within each species of fine fescue or perennial ryegrass.

When weed cover was evaluated by species, there was a significant interaction between species and fertility level for all ratings except June 2, at which no statistical difference was observed among the fine fescues. By the June 30 rating, differences were noticed among the fine fescue species as both fertility levels. At both fertility levels for the August and October ratings, the slender creeping had higher ratings of weeds than the other fine fescues. Fertilized plots of hard and sheep fescue had the least amount of weeds at the October rating with 11 and 5 percent cover, respectively. In general, all fine fescues started the growing season with similar weed pressure but during the rest of the season, the sheep and hard fescues provided the most weed suppression and the slender creeping provided the least. The perennial ryegrass plots had significantly more weeds than all fine fescue plots at the August and October ratings.

When the data was analyzed by fertility level, there were significant differences for both turf cover and weed cover (Table 6). The application of 44 lb N/ac provided significantly higher turf cover ratings on June 2, June 30, and August 18; and significantly lower ratings in weed cover on August 18 and October 5. No significant differences were observed at all other rating periods.

CONCLUSIONS

Very little, if any, difference was observed for color or weed prevention between cultivars for each species of fine fescue and perennial ryegrass. It appears that applications of 44 lb N/ac are beneficial in providing improved turf cover which in turn reduces weed cover or competition. The two perennial ryegrass cultivars are providing more late season green turf cover, but less total groundcover, and contain significantly more weeds than most of the fine fescue plots. At the last rating, the ryegrass plots actually approached total weed cover. They grow well in the fall, and respond rapidly to fertilizer applications, but because of the low amount of groundcover and high weed invasion, they are not providing reliable low maintenance groundcovers.

From a maintenance perspective, one of the best qualities of the turf species evaluated in this study, is their ability to prevent weed and brush invasion along the roadways. Results of this study have shown that hard and sheep fescue have provided nearly 100 percent groundcover and the best weed prevention, although they may not have exhibited the highest ratings for green cover.

After four years of observation, it was decided that 1994 would be the last year annual data will be collected from this area. The area will be mowed once or twice per year and observed for major changes in the covers.

TABLE 1: Cultivars and species evaluated under low maintenance conditions with and without application of nitrogen fertilizer

Cultivar	Species	Cultivar	Species
1. Dover	chewings fescue	14. Spartan	hard fescue
2. Jamestown	chewings fescue	15. SR 3000	hard fescue
3. Shadow	chewings fescue	16. SR 3100	hard fescue
4. SHE	chewings fescue	17. Dawson	slender creeping fescue
5. SR 5000	chewings fescue	18. Bargena	creeping red fescue
6. Victory	chewings fescue	19. Ensylva	creeping red fescue
7. Wilma	chewings fescue	20. Jasper	creeping red fescue
8. AUE	hard fescue	21. Pennlawn	creeping red fescue
9. Biljart	hard fescue	22. Bighorn	sheep fescue
10. Crystal	hard fescue	23. Covar	sheep fescue
11. Durar	hard fescue	24. MX-86	sheep fescue
12. HF 8250	hard fescue	25. Lex86	perennial ryegrass
13. Reliant	hard fescue	26. Barclay	perennial ryegrass

TABLE 2: Visual ratings of percent turf cover, taken on a green tissue basis. Ratings were taken June 2, June 30, August 18, and October 5, 1994. There was a significant interaction between cultivar and fertility treatments for the June 30 rating, and a LSD value is reported for both the 0 and 44 lb N/ac applications at each date. The values for June 30 are the mean of three replications; and the June 2, August, and October values are the mean of six observations (three replications, two maintenance levels).

		Jun 30 (lb N/ac)			
Cultivar	Jun 2	0	44	Aug 18	Oct 5
	(----------------------percent green turf cover				----------------------------)
1. Dover	28	23	30	23	25
2. Jamestown	25	20	27	19	21
3. Shadow	24	20	27	24	25
4. SHE	23	18	25	23	26
5. SR 5000	24	23	27	23	23
6. Victory	23	18	23	26	28
7. Wilma	23	17	22	24	27
8. AUE	25	27	32	33	25
9. Biljart	26	18	25	31	24
10. Crystal	31	22	30	33	23
11. Durar	33	20	23	23	27
12. HF 8250	29	27	33	34	26
13. Reliant	28	28	35	33	23
14. Spartan	30	28	33	29	23
15. SR 3000	29	25	33	33	27
16. SR 3100	27	27	32	31	24
17. Dawson	23	22	28	31	33
18. Bargena	18	22	30	30	38
19. Ensylva	21	22	27	26	33
20. Jasper	21	23	32	28	32
21. Pennlawn	25	27	32	27	29
22. Bighorn	26	23	28	29	21
23. Covar	28	15	20	13	23
24. MX-86	26	23	28	28	21
25. Lex86	29	28	28	46	58
26. Barclay	14	20	23	38	60
Significance Level (p)	0.01	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)	8	5	6	4	4

TABLE 3: Visual ratings of percent turf cover in 1994, on a green tissue basis, for turf species under low maintenance conditions. There was a significant interaction between species and fertility treatment for the June 30 rating. The values for June 30 are the mean of three replications; and the June 2, August, and October values are the mean of six observations (three replications, two maintenance levels). The number in parentheses after each species indicates the number of cultivars evaluated.

Species	Jun 2	Jun 30 (lb N/ac) 0	Jun 30 (lb N/ac) 44	Aug 18	Oct 5
	(-----------------------percent green turf cover------------------------)				
chewings fescue (7)	24	20	26	23	25
creeping red fescue (4)	23	23	30	28	31
hard fescue (9)	29	25	31	31	25
sheep fescue (3)	27	21	26	23	22
slender creeping fescue (1)	18	22	30	30	38
perennial ryegrass (2)	22	24	26	42	58
Significance Level (p)	0.2	0.1	0.4	0.0001	0.05
LSD (p=0.05)	n.s.	n.s.	n.s.	4	4

TABLE 4: Visual ratings of percent weed cover taken June 2, June 30, August 18, and October 5, 1994. There was a significant interaction between cultivar and fertility treatments for all ratings, and a LSD value is reported for both the 0 and 44 lb N/ac applications at each date. The values for are the mean of three replications.

Cultivar	Jun 2 (lb N/ac) 0	Jun 2 (lb N/ac) 44	Jun 30 (lb N/ac) 0	Jun 30 (lb N/ac) 44	Aug 18 (lb N/ac) 0	Aug 18 (lb N/ac) 44	Oct 5 (lb N/ac) 0	Oct 5 (lb N/ac) 44
	(--percent weed cover --)							
1. Dover	3	4	3	4	10	7	20	10
2. Jamestown	4	2	6	2	15	4	38	9
3. Shadow	2	2	4	2	15	4	48	5
4. SHE	3	2	5	3	15	5	38	11
5. SR 5000	2	3	5	5	15	6	45	11
6. Victory	3	3	7	6	23	11	58	24
7. Wilma	3	2	5	5	21	10	53	22
8. AUE	1	1	2	2	4	3	11	15
9. Biljart	2	3	3	3	8	7	30	25
10. Crystal	3	2	3	2	6	3	21	8
11. Durar	2	2	2	2	5	6	9	12
12. HF 8250	2	2	2	2	5	4	11	9
13. Reliant	2	3	2	3	7	5	13	11
14. Spartan	1	1	2	1	6	2	13	2
15. SR 3000	1	2	1	1	5	2	16	3
16. SR 3100	2	2	2	3	7	4	18	12
17. Dawson	4	2	9	2	17	5	33	9
18. Bargena	10	7	49	10	65	32	80	70
19. Ensylva	6	3	29	5	47	11	78	27
20. Jasper	4	2	11	3	31	11	67	30
21. Pennlawn	4	1	12	1	20	6	53	14
22. Bighorn	1	2	2	1	7	3	25	8
23. Covar	1	1	2	1	5	2	21	3
24. MX-86	1	1	2	2	3	2	6	4
25. Lex86	40	45	58	57	83	78	95	92
26. Barclay	53	57	77	78	92	96	96	96
Significance Level (p)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)	8	9	14	7	13	10	24	20

TABLE 5: Visual ratings of percent weed cover for turf species under low maintenance conditions. There was a significant interaction between species and fertility treatment for the June 30, August 18, and October 5, 1994, ratings, and a LSD value is reported for the 0 and 44 lb N/ac applications at each date. The values for June 30, August 18, and October 5, are the mean of three replications; and the June 2 values are the mean of six observations (three replications, two maintenance levels). The number in parentheses after each species indicates the number of cultivars in trial.

		Jun 30 (lb N/ac)		Aug 18 (lb N/ac)		Oct 5 (lb N/ac)	
Species	Jun 2	0	44	0	44	0	44
	(------------------------------------percent weed cover						-------------------------------------)
chewings fescue (7)	3	5	4	16	7	43	13
creeping red fescue (4)	3	15	3	29	8	58	20
hard fescue (9)	2	2	2	6	4	16	11
sheep fescue (3)	1	2	1	5	2	17	5
slender creeping fescue (1)	8	49	10	65	32	80	70
perennial ryegrass (2)	49	68	68	87	87	96	94
Significance Level (p)	0.0001	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)	12	25	7	12	15	15	15

TABLE 6: Effect of fertility treatments on turf cover and weed cover, measured June 2, June 30, August 18, and October 5, 1994. Each value is the mean of 78 observations (three replications, 26 cultivars).

	Jun 2	Jun 30	Aug 18	Oct 5
		percent green turf cover		
0 lb N/acre	19	22	28	32
44 lb N/acre	28	28	31	32
Significance Level (p)	0.003	0.008	0.002	0.4
LSD (p=0.05)	3	3	1	n.s.

	Jun 2	Jun 30	Aug 18	Oct 5
		percent weed cover		
0 lb N/acre	11	23	35	52
44 lb N/acre	11	15	23	35
Significance Level (p)	0.8	0.07	0.03	0.01
LSD (p=0.05)	n.s.	n.s.	8	12

CROWNVETCH TO FORMULA L CONVERSIONS
DISTRICTS 8-0 AND 2-0

INTRODUCTION

Canada thistle (*Cirsium arvense*) is found throughout Pennsylvania's roadside areas and is an extremely difficult noxious weed to control. Much of the difficulty in controlling this perennial weed is its tenacious rhizomatous growth habit. Research has shown some herbicides will control the thistle well, however control along the roadsides is complex because the thistle has developed well as a companion plant with the desirable crownvetch (*Coronilla varia*) groundcover planted along many of the highways. Considerable effort has gone into trying to find a herbicide that will selectively control the Canada thistle in the established crownvetch groundcover, but little success has been achieved. Since it is not yet possible to selectively remove Canada thistle from crownvetch, the alternative is to eliminate both the crownvetch and Canada thistle and establish a grass, from which the thistle could be selectively removed. The PennDOT specified seed mix 'Formula L' was selected for these conversion demonstrations. The new Formula L seed mix contains approximately 35% creeping red fescue (*Festuca rubra*), 55% hard fescue (*Festuca longifolia*), and 10% annual ryegrass (*Lolium multiflorum*) by weight. At the time these plots were seeded, the old Formula L mix (40% creeping red fescue, 60% hard fescue blend) was utilized. Formula L has proven to be a very effective low maintenance turfgrass mixture once established. It survives well under low fertility and has good drought tolerance. These finely bladed grasses also will not reach more than eight inches in height before falling over. Because of this growth characteristic, it forms a very dense mat of grass that is very competitive against weed encroachment. It also requires little or no mowing of the leaf tissue. By having an established stand of turfgrass in an area that was previously Canada thistle and crownvetch, it would be possible to selectively control the Canada thistle in the desired groundcover without eliminating it.

MATERIALS AND METHODS

Two areas in the state were used as demonstration sites to look at the practicality of this approach. In District 8-0 near Ephrata, a several acre site was chosen to compare the difference between fall and spring seedings of Formula L. Another one acre site along SR 322 near Old Fort, PA, was converted to Formula L in the fall of 1993. Two fertilizer rates were applied to this area once the Formula L was established to determine any potential benefits of applying nitrogen.

District 8-0

On September 24, 1992, an area of approximately 1.25 acres along SR 222 was treated to control the existing vegetation. Three different herbicide combinations were evaluated and included broadcast applications of RoundUp plus Garlon 3A at 2 qt/ac and 1 qts/ac, respectively; RoundUp plus Transline at 2 qts/ac and 4 oz/ac, respectively; and Garlon 3A plus Transline at 1 qt/ac and 6 oz/ac, respectively. The application was made with a backpack sprayer and two OC-02 spray tips, delivering 13 GPA at 13 psi.

On April 29, 1993, the broadcast treated areas were mowed, fertilized with 40 lb/ac urea nitrogen, disked, seeded with Formula L at 50 lb/ac, disked, and seeded again at 50 lb/ac. Spot treated areas were disked, then seeded at 100 lbs/ac, with no urea application. On June 24, 1993, the one acre broadcast treated area was treated with 2 qts/ac Garlon 3A, 8 oz/ac Transline, 48 oz/ac Fusilade 2000, 0.25% (v/v) Clean Cut, and 0.75% (v/v) Sta-Put. The application was made with a Radiarc containing nine 0.045 tips and one 0.070 tip. The spray unit operated at 20 psi and delivered 25 GPA over a 22 ft horizontal pattern. The 0.25 acre spot treatment area was treated with the same herbicide combination but was applied with a backpack sprayer containing an OC-08 nozzle and delivering approximately 10 GPA at 20 psi.

On September 9, 1993, the broadcast treated area was divided and treated with 3% (v/v) Fusilade 2000 plus 1% (v/v) Clean Cut or 2% (v/v) Assure II plus 1% (v/v) Clean Cut. The Assure II treatment was further divided into two areas. One of these areas was treated using OC-08 nozzle tips and the other using OC-04 nozzle tips. These applications were made in an attempt to remove reed canarygrass (*Phalaris arundinacea*) from the stand of Formula L. The entire area was spot-treated for weed control again on May 20, 1994, using backpack sprayers. The treatment included 2 qts/ac Vanquish, 8 oz/ac Transline, 10 oz/ac Assure II, 0.25% (v/v) Sil-Wet, and 1 oz/20 gal solution of Get-Down drift retardant.

The fall seeding conversion area was first treated with a combination of RoundUp at 2 qts/ac, Transline at 8 oz/ac, 0.25% (v/v) Clean Cut, and 0.03% (v/v) San Ag 41A drift control on August 23, 1993. The treatment was applied with a Radiarc equipped with the same nozzle arrangement as used for the spring seeded plots plus a 0.030 tip at each end. The spray unit operated at approximately 25 psi and delivered 16.7 GPA.

On September 9 and 10, 1993, the fall seeding area, which was sprayed in August, was mowed with a flail mower. A 10-20-20 fertilizer was then applied to the entire 3 acre area with a rotary spreader at a rate of 345 lbs/ac. The area was disked and seeded to Formula L with a rotary spreader at an average of 92 lbs/ac. On November 11, 1993, this area received an application of 39-0-0 sulphur-coated urea at 44 lbs of nitrogen/ac.

On May 20, 1994, a broadcast application for weed control was made to the fall seeded area with a Radiarc delivering 18 GPA at 25 psi. The treatment included 2 qts/ac Vanquish, 8 oz/ac Transline, 10 oz/ac Assure II, 0.25% (v/v) Sil-Wet, and 1 oz/20 gal solution of Get-Down drift retardant. A spot-treatment was also made to the spring seeded area using the same mixture and Birchmeier backpacks with adjustable cone jet nozzles and X-6 tips.

District 2-0

On September 7, 1993, a one acre area was treated with 2 qts/ac RoundUp, 8 oz/ac Transline, 0.25% (v/v) Clean Cut, and 5 oz/100 gal solution of San Ag 41A drift control to control the existing vegetation. Canada thistle and crownvetch were the primary targets. The application was made with a Radiarc delivering 17.5 GPA at 20 psi. To avoid an over application onto the neighboring properties, a Birchmeier backpack equipped with an OC-08 nozzle was used to apply the material along the right-of-way fence.

The area was mowed with a flail mower and fertilized with 10-20-20 at a rate of 400 lbs/acre on September 20, 1993. On September 21, 1993, the area was disked twice, an application of sulphur-coated urea (39-0-0) was made at a rate of 39 lb N/ac, and the area was then seeded to Formula L at 100 lbs/ac. On May 16, 1994, an application of 46-0-0 fertilizer was spread at a rate of 44 lb N/ac to half of the study area. The site was treated for broadleaf weeds on May 18, 1994, with 2 qts/ac Garlon 4, 8 oz/ac Transline, 0.25% (v/v) Sil-Wet, and 0.5% (v/v) StaPut at a rate of 10 GPA.

RESULTS

District 8-0 (Spring Seeded Area)

The spring seeded area was reviewed May 17, 1993, approximately four weeks after seeding. The seed had germinated and grown to a height of two inches, however no tillering was evident yet. Some weeds were present throughout the study area, including reed canarygrass, Canada thistle, wild garlic (*Allium vineale*), yellow rocket (*Barbarea vulgaris*), ragweed (*Ambrosia artemisiifolia*), and common milkweed (*Asclepias syriaca*).

By June 24, 1993, the fine fescue seedlings were two to four inches in height. Some areas had thin stands of the Formula L and other areas were filling in completely. The various weeds present throughout the site were reaching mature heights. The Canada thistle plants were up to eighteen inches and beginning to bloom, crownvetch was up to twelve inches and in bloom, and the reed canarygrass was up to fifteen inches in height. There was a significant flush of yellow rocket and some common ragweed. Due to this weed pressure, a selective weed control application was made on this date (refer to above methods and materials).

The same weed species were still present on September 9, 1993. At this time an application, as mentioned previously in the materials and methods, was made to control the reed canarygrass with treatments of Fusilade 2000 and Assure II. The area was rated on November 11, 1993, and the control appeared to vary. The area in which

Fusilade 2000 was applied provided the best control. There was not much difference between the two rates of Assure II. No injury to the fine fescue stand was observed for either treatment. Overall, the Formula L stand was 8 to 12 inches tall and approximately one-third of the area was densely covered by the Formula L, with very little weed pressure. The other two-thirds of the area still had a prevalent reed canarygrass problem. Canada thistle was also actively growing throughout the area.

An observation on May 20, 1994, showed Canada thistle, crownvetch, reed canarygrass, prickly lettuce (*Lactuca serriola*), bull thistle (*Cirsium vulgare*), goldenrod (*Solidago nemoralis*), mullein (*Verbascum thapsus*), and yellow rocket actively growing in the study area. A spot treatment was made at this time to control those existing weeds (refer to the methods and materials section).

On August 3, 1994, the overall appearance was approximately forty percent green and the rest brown thatch. The fine fescue blades were nearly 24 inches in length, but the actual vertical canopy height was around eight inches tall because the blades were bent over. Overall, the appearance of the site looked good except where reed canarygrass had taken over. Other weed species found throughout the site included Canada thistle, pokeweed (*Phytolacca americana*), ailanthus (*Ailanthus altissima*), crownvetch, milkweed, and goldenrod.

District 8-0 (Fall Seeded Area)

The area seeded to Formula L on September 9th and 10th, 1993, was reviewed on November 11, 1993. Overall, the stand appeared satisfactory. The Formula L ranged from one-half to four inches in height, and density varied. In areas that were primarily tall fescue (*Festuca arundinacea*) before the conversion, it was regrowing strongly and it appeared that very little Formula L would establish in those areas. The primary weeds present were yellow rocket, wild garlic, Canada thistle, and a few spots of reed canarygrass. The selective herbicide application on May 20 was made to control the weeds present.

District 2-0

The area seeded on September 21, 1993, was first reviewed on November 3, 1993. The Formula L had germinated to a height of approximately two inches and its density varied. A few weeds were sprouting including Canada thistle and wild garlic.

On July 20, 1994, the Formula L had a blade length of approximately nine inches and seedheads to thirteen inches. Most of the turf had a good, dark green color but there was some browning in a few areas. The overall density was good, however there were still a few large bare spots. Some weed pressure was noticed in the study area, with weed species including Canada thistle, crownvetch, foxtail (*Setaria* spp), hemp dogbane (*Apocynum cannabinum*), quackgrass (*Elytrigia repens*), timothy (*Phleum pratense*), and wirestem muhly (*Muhlenbergia frondosa*). No significant differences were noted between the portions that did or did not receive the fertilizer application of 46-0-0 on May 16, 1994.

By October 13, 1994, the entire area had filled in and appeared healthy. The section which had received the 46-0-0 application on May 16, 1994, appeared slightly greener and taller than the unfertilized section. The average length of the fine fescue blades were fifteen to sixteen inches. A few weeds were present with species including Canada thistle, crownvetch, and pokeweed.

CONCLUSIONS

Converting crownvetch areas to stands of Formula L, is an excellent first step towards controlling Canada thistle along roadsides. The Formula L groundcover not only helps eliminate thistle, but due to its competitive nature it can help reduce the infestation of other noxious weeds or woody plants. Therefore this established groundcover can help reduce maintenance costs in the future.

Based on observations from these demonstrations, fall seedings provided better stands of Formula L and had less weed invasion. However, it is perhaps too early to accurately conclude a better seeding date with only two demonstration plots to evaluate. The Formula L required about one full growing season to obtain a dense stand. The plots did require some weed control maintenance after establishment but it is anticipated that this need will diminish in the future as the turf becomes more established and more competitive against invading weeds.

The seeded area at Old Fort received an additional application of nitrogen to half of the plot once it was actively growing; however, no significant difference was observed compared to the unfertilized portion. These fine fescues are well known for their tolerance to low fertility.

The continued benefits and problems associated with this type of renovation or conversion need to be further investigated in the future.

MOWING DEMONSTRATION - DISTRICT 2-0

INTRODUCTION

Tall fescue (*Festuca arundinacea*) is the most common type of turfgrass planted along the roadsides throughout the state of Pennsylvania. It is a cool season grass which has an initial growth flush of leaf tissue and seedheads in the spring, and a growth flush of only leaf tissue in the fall. Therefore, if the first mowing of the season is conducted after the tall fescue has sprouted all of its seedheads, little plant growth will occur until the fall, at which time another mowing should be performed. Mowing at any other time period is not necessary and will only harm the tall fescue. Mowing stresses turf, and the more often and shorter it is mowed, the more the turf is stressed. By mowing at a height above six inches, less stress is placed on the plant and the stand of turf will remain healthier and more vigorous.

To demonstrate the mowing practices recommended by the project, a mowing demonstration was conducted during the 1994 growing season in the median area of the Mount Nittany Expressway (SR 322 bypass) near State College, PA. This demonstration was established to allow PennDOT personnel and passing motorists to view an area that was mowed according to the research project's specifications - with a higher cutting height and at a reduced mowing frequency.

Some people feel that flail mowers, which are the most common type of mower used by department personnel, do not effectively cut tall fescue at heights above four inches. Therefore, this demonstration area was mowed with both a flail and rotary mower to allow comparison between the two types.

MATERIALS AND METHODS

The median between SR 26 and the Oak Hall interchange was comprised predominately of K-31 tall fescue. The turf was mowed at a height of six inches on June 8 and 9, 1994, with either a flail or rotary mower. The demonstration area was mowed again in the fall of 1994. The portion of the median closest to the SR 322 eastbound lanes was cut with a flail mower and the portion of the median closest to SR 322 westbound lanes was cut with the rotary mower.

Both the flail mower and the rotary were attached to a Ford 1710 tractor. The rotary was set at a height of six inches from the ground. The flail mower was set at a height of four inches from the ground which actually provided a six inch height of cut. The areas beyond either end of the demonstration area were under the regularly scheduled maintenance program for this limited access highway, which included four mowings at a two to four inch height of cut.

RESULTS

By the beginning of June the tall fescue was in full seedhead which, in the opinion of the authors, did not create an unsightly appearance for this right-of-way setting. The height of the seedheads were approximately twenty-four inches but the leaf blades were only ten inches in height. These heights did not pose any visibility concerns for passing motorists. Both the flail and rotary mower performed well and provided a six inch height of cut. The only differences observed between the two were that the flail mower left more grass clippings than the rotary; however, neither produced enough grass clippings to smother the existing turf.

The demonstration area had better turf color during the summer months than the portion maintained by the department, because it was not mowed as often or as short, which caused less stress to the turf.

CONCLUSIONS

This demonstration shows that the cutting height can be increased and the number of mowing cycles can be reduced to two times per season without greatly sacrificing aesthetics along many of limited access highways. These adjustments will also benefit the established turf by causing less stress on the plants, especially during the dry, hot months of July and August. Either type of mower will produce an adequate cut at a height of six inches. Each type of mower has some advantages and disadvantages, so it would be a matter of personal preference on selecting the best type for the job. Department equipment is of better quality than the equipment used by the project for this demonstration, so the quality of the mowing could be increased by utilizing their equipment.

These recommended mowing procedures can be adapted with only slight modification to the existing equipment and methods of the department. However, the greatest advantage to reducing the number of mowing cycles performed each year, would be the substantial cost savings that would be incurred. Not only would there be a cost savings from reduced mowing, but because of the healthier turf stands less money would need to be spent on broadleaf weed control applications in these areas.

FIRST-YEAR EVALUATION OF SPRING-APPLIED HERBICIDES FOR CONTROL OF GIANT KNOTWEED

INTRODUCTION

Giant knotweed (*Polygonum sachalinense*) and Japanese knotweed (*Polygonum cuspidatum*) are becoming an increasing problem along Pennsylvania's roadways. These very similar species in the buckwheat family (*Polygonaceae*) are characterized by their broad leaves and large panicled inflorescences. They also have hollow stems and grow in dense colonies to heights of 10 feet. There have been anecdotal reports of single application control with products such as Spike or Arsenal, which have lengthy soil residual activity at the rates used; and products containing picloram, such as Tordon K and Tordon 101M, which are Restricted Use Products. Some contractors have reported successful control with three applications of RoundUp, usually on a spring-fall-spring cycle, using high-volume applications of a 1 percent solution. The objective of this study was to screen a variety of herbicide combinations with limited soil residual activity; and to apply them early enough in the spring so that the knotweed would not be at full height and would be easier to treat. The latter objective was only partially fulfilled, as the stand in the experimental area was much taller than anticipated; and in terms of application timing, the stand was essentially full grown.

MATERIALS AND METHODS

The study area was located near Doylestown, PA, on the shoulder of SR 611. Treatments were applied May 10, 1994, to 6 by 40 ft plots with a CO_2-powered, hand held sprayer delivering approximately 20 gal/ac at 30 psi, using Spraying Systems 8002 flat fan spray nozzles. The experimental design was a randomized complete block with three replications. Treatments (Table 1) included an untreated check and combinations of Arsenal, Escort, Garlon 3A, RoundUp, Transline, and Vanquish. All herbicide treatments contained 0.125% (v/v) organosilicone spray adjuvant (QuikWet 357) and 0.25% (v/v) drift control agent (Sta-Put). At the time of application, the knotweed ranged in size from 4 to 6.5 ft. The application was made holding the sprayer boom over the applicator's shoulder to provide an adequate height for proper coverage of the plot. Percent defoliation was rated June 10, and percent control of the treated stems was rated August 3 and October 11. The number of resprouts within each plot were counted August 3, and percent groundcover from resprouts was rated October 11. Results are reported in Table 1.

RESULTS

All herbicide treatments provided greater than 90 percent defoliation at the June 10 rating, except for Transline plus Arsenal, Transline plus Escort, and Arsenal plus Escort This was not considered to be an indication of ineffectiveness, as these three herbicides (Arsenal, Escort, and Transline) are known to be slow-acting.

August 3 control ratings were lower for some treatments than the June 10 defoliation ratings because many of the treated stems resprouted from lower leaf axils. Five treatments were rated at greater than 90 percent control: Vanquish/Transline, Vanquish/Arsenal, RoundUp/Escort, RoundUp/Arsenal, and Transline/Escort.

At the October 11 rating, all treatments except RoundUp alone provided 90 percent or greater control of the treated stems. Treatments of RoundUp/Arsenal, RoundUp/Escort, RoundUp/Transline, Vanquish/Arsenal, Vanquish/Transline, Transline/Arsenal, Transline/Escort, and Arsenal/Escort showed no significant differences in the amount of groundcover from resprouts, with ratings from 4 to 20 percent. Resprouts varied in size from 1 to 4 ft.

No values are reported for resprouts in the untreated check plots at the August and October ratings because little resprouting occurred in these undisturbed areas.

CONCLUSIONS

An evaluation will be necessary during the growing season of 1995 to determine how quickly the resprouts recolonize the area. Additional studies will have to be done in the future to determine the reproducibility of these results, and to evaluate the effects of the timing of application.

TABLE 1: Summary of treated-stem control and resprout growth of giant knotweed treated May 10, 1994. Visual ratings of percent defoliation were taken June 10, 1994. Visual ratings of percent control of the treated stems were taken August 3 and October 11, 1994. Number of resprouts were counted in each plot August 3, 1994, and percent cover of the resprouts was visually rated October 11, 1994. Each value is the mean of three replications.

		June 10, 1994	August 3, 1994		October 11, 1994	
Treatment	Application Rate	Defoliation	Control of Treated Stems	Number of Resprouts	Control of Treated Stems	Resprout Ground Cover
	(oz product/ac)	(%)	(%)	(#/plot)	(%)	(%)
RoundUp	128	90	63	20	82	38
RoundUp + Arsenal	128 8	94	97	24	100	10
RoundUp + Escort	128 1	96	99	10	98	5
RoundUp + Transline	128 8	95	81	16	95	13
Garlon 3A + Escort	96 1	96	77	15	90	75
Garlon 3A + Arsenal	96 8	92	79	22	93	58
Vanquish + Arsenal	96 8	99	100	10	100	20
Garlon 3A + Transline	96 8	94	63	19	93	47
Vanquish + Transline	96 8	99	100	6	100	4
Transline + Arsenal	8 8	40	88	16	95	5
Transline + Escort	8 1	43	94	12	98	5
Arsenal + Escort	8 1	37	85	12	93	9
Untreated Check	- -	0	0	-	0	-
LSD (p=0.10)		11	26	7	5	23

TOLERANCE OF FINE FESCUE AND CONTROL OF CANADA THISTLE WITH BROADLEAF HERBICIDES

INTRODUCTION

The use of fineleaf fescues is increasing along Pennsylvania roadsides and the presence of Canada thistle (*Cirsium arvense*), a noxious weed in Pennsylvania, is also increasing. Some advantages of the fineleaf fescue groundcover are reduced mowing needs and broadleaf weeds can be selectively removed from it with herbicides. The intent of this study was to evaluate the new herbicide Vanquish, a new formulation of dicamba, alone and in combination with other commonly used broadleaf weed control herbicides for their selective control of Canada thistle in a stand of fine fescue.

MATERIALS AND METHODS

The study area was a stand of 60% hard fescue and 40% creeping red fescue (a combination specified as Formula L by the Pennsylvania Department of Transportation) established September 1993 along SR 222 near Ephrata, PA. Treatments were applied May 20, 1994, to 6 by 15 ft plots using a CO_2-powered, hand held sprayer delivering 20 gal/ac at 30 psi. The experimental design was a randomized complete block with three replications. Treatments (Table 1) included an untreated check; Vanquish alone and in combination with Garlon 3A, 2,4-D, or Transline; Garlon 3A plus Escort; and Garlon 3A plus Transline. All treatments included 0.25% (v/v) drift control agent (Sta-Put) and 0.25% (v/v) non-ionic spray adjuvant (Silwet). The turf was approximately 9 in tall and the Canada thistle plants ranged from 3 - 24 in tall at the time of treatment application. A turf injury rating was taken June 13; and a count of Canada thistle resprouts and turf injury were taken August 3 and November 11, 1994. Results are reported in Table 1.

RESULTS

There was no difference in appearance or reduction in the stand of fine fescue for any treatments at all rating periods. Also, all treatments were statistically similar and provided a significant reduction of Canada thistle resprouts within the plot compared to the untreated check, at both ratings. Plots treated with 32 oz/ac Vanquish and 8 oz/ac Transline contained no resprouts in either rating period. The untreated plots had 35 and 25 resprouts present at the August 3 and November 11 ratings, respectively. No initial count was taken of thistle plants in the plots at the time of treatment application; however, it was observed that all plots did contain thistle plants.

CONCLUSIONS

The results of this study suggest that all of these treatments can effectively reduce the amount of Canada thistle without harming the fineleaf fescues.

TABLE 1: Canada thistle resprouts located in a seeding of creeping red and hard fescue near Ephrata, PA. Treatments were applied May 20, 1994. Turf injury ratings were taken June 13, August 3, and November 11, 1994 with no injury recorded for any treatments. Thistle resprout counts were taken August 3 and November 11, 1994, and are the mean of 3 replications.

Treatment	Application Rate (oz/ac)	Number of Canada Thistle Resprouts August 3	November 11
Untreated Check	- - -	35	25
Vanquish	16	11	7
Vanquish	32	8	1
Vanquish Garlon 3A	32 21.3	9	6
Vanquish Garlon 3A	16 10.7	4	4
Vanquish 2,4-D	16 32	3	2
Vanquish Transline	16 6	2	3
Vanquish Transline	32 8	0	0
Garlon 3A Escort	48 0.5	6	2
Garlon 3A Transline	48 6	4	5
LSD (p=0.10)		24	17

COMPARISON OF FALL AND SPRING HERBICIDE APPLICATIONS FOR TOTAL VEGETATION CONTROL UNDER GUIDERAILS

INTRODUCTION

In Pennsylvania, ideal applications for total vegetation control are made in early to mid April before plants begin germination. However, the applications are often not completed until May or June. Therefore, treatments are applied to established vegetation which causes an undesirable brownout effect when treated. If fall applications were as effective as spring treatments, this would widen the application window, and provide more flexibility in scheduling such treatments thus making it easier to complete spray operations early in the season. This study evaluated three herbicide combinations to determine if they could provide acceptable season-long control when applied in the fall.

MATERIALS AND METHODS

Treatments were applied under a section of guiderail along Park Avenue, near State College, PA. The treatments included an untreated check; and the broad spectrum herbicides Oust at 0.1875 lb product/ac, Krovar I at 10 lb product/ac, and Spike 80W at 4 lb product/ac. Herbicide treatments of Oust and Spike included Karmex at 8 lb product/ac and the treatment with Krovar I included Karmex at 3 lb product/ac. All spray treatments included a drift control agent (Sta-Put) at 0.25% v/v. Fall treatments were applied November 19, 1993; and spring applications were made April 4, 1994. The treatments were applied with a CO_2-powered, hand-held sprayer equipped with a single Spraying Systems OC-08 spray tip, delivering 36 gal/ac at 25 psi. The experimental plots were 3 by 50 ft, arranged in a randomized complete block design with three replications. Visual ratings of green vegetative cover were taken November 24, 1993, to determine initial vegetation levels; and May 17, 1994. Visual ratings of total vegetative cover were taken July 1, August 5, and September 29, 1994. Results from all ratings are reported in Table 1. At the November 24 rating, the most common weed species in the treatment areas were spotted knapweed (*Centaurea maculosa* Lam.), white sweetclover (*Melilotus alba* Medik.), wild parsnip (*Pastinaca sativa* L.), wild carrot (*Daucus carota* L.), and tall fesuce (*Festuca arundinacea* Schreb.).

RESULTS

Initial vegetation levels were not significantly different, and ranged from 27 to 40 percent green cover. Cover ratings for the untreated check were 27, 53, 90, 91, and 85 percent; on November 24, May 17, July 1, August 5, and September 29, respectively. The fall treatments did not provide acceptable control at any post-treatment rating. The ratings for fall-applied Oust plus Karmex and Krovar I plus Karmex were not significantly different from the check at any rating date. Of the fall-applied treatments, only Spike plus Karmex plots had significantly less cover than the untreated check for ratings taken July 1, August 5, and September 29; but had significantly more cover than the spring-applied Spike plus Karmex and Krovar I plus Karmex. The most common species in the fall treated plots were common ragweed (*Ambrosia artemisiifolia* L.), wild parsnip, wild carrot, spotted knapweed, and chicory (*Cichorium intybus* L.). No statistical difference was observed between any of the spring-applied treatments at all ratings. Spike plus Karmex vegetative cover ratings never exceeded four percent and vegetative cover ratings increased in the Krovar I and Oust treatments as the growing season progressed, peaking at 15 and 25 percent, respectively, on August 5. The species most common in the spring treated plots were common ragweed, white sweetclover, wild parsnip, wild carrot, and spotted knapweed.

CONCLUSIONS

The results of this test suggest that even late fall applications of non-selective herbicides do not provide enough residual activity to provide acceptable weed control the following spring, at least when spring-applied rates are used. These treatments can not be applied much later in the fall, as the weather becomes much more uncertain. During the winter of 1993/1994, there was continuous snow cover from mid-December to late March. Also, using higher application rates could create a potential for off-site movement of these materials. It appears that different combinations and/or new products will have to be part of future investigation into late fall herbicide applications for total vegetation control.

TABLE 1: Control provided by spring or fall herbicides based on visual ratings of green vegetative cover taken November 24, 1993, and May 17, 1994; and total vegetative cover taken July 1, August 5, and September 29, 1994. Fall herbicide treatments were applied November 19,1993, and the spring application was made April 4, 1994. Each value is the mean of three replications.

			Green Cover		Total Vegetative Ground Cover - 1994		
Treatment	Application Rate	Application Timing	Nov 24, 1993	May 17, 1994	Jul 1	Aug 5	Sep 29
	(lb product/ac)		(--------%---------)		(-------------%------------------)		
Untreated Check	- - -	- - -	27	53	90	91	85
Oust	0.1875	Fall	37	32	70	82	80
Karmex	8						
Krovar I	10	Fall	28	35	70	79	68
Karmex	3						
Spike 80W	4	Fall	30	28	37	53	42
Karmex	8						
Oust	0.1875	Spring	32	10	17	25	21
Karmex	8						
Krovar I	10	Spring	40	4	9	15	15
Karmex	3						
Spike 80W	4	Spring	27	4	3	2	3
Karmex	8						
Significance Level (p)			0.37	0.01	0.0001	0.0001	0.0001
LSD (p=0.05)			n.s.	27	27	27	29

EVALUATION OF ENDURANCE AND PREDICT FOR VEGETATION CONTROL ON ROADSIDE AND AGRICULTURAL SITES

INTRODUCTION

A study was established to evaluate the preemergent herbicides Endurance and Predict for broad spectrum preemergence vegetation control along a roadside guiderail and on an agricultural site, both near State College, PA.

MATERIALS AND METHODS

The roadside experimental area was treated with 3% (v/v) RoundUp and 2.5% (v/v) dicamba on November 11, 1993; and 6 qts/ac Finale on May 9, 1994. These applications were utilized for controlling the existing vegetation in the plots since many of the preemergent herbicides used in this study have no postemergent activity. Treatments (Table 1) were applied to 3 by 25 ft plots located along a guiderail on November 16, 1993; using a CO_2-powered hand held sprayer equipped with a single Spraying Systems OC-08 spray tip, delivering 35 GPA at 25 psi, . Visual ground cover ratings of only annual weed species were taken June 28, 32 weeks after treatment (WAT); August 12, 38 WAT; and September 26, 1994, 45 WAT. Results are reported in Table 1.

The agricultural site trial was conducted at Penn State's Landscape Management Research Center. Seedbed preparation included an application of RoundUp at 4 qts/ac on April 28, 1994; and the soil was grooved with a slice seeder on May 11, 1994. Treatments (Table 2) were applied to 6 by 15 ft plots on May 13, 1994, with a CO_2-powered hand held sprayer delivering 33.3 GPA at 26 psi, using Spraying Systems XR 8004 VS spray tips. Visual ground cover ratings of only annual weed species were taken June 28, 7 WAT; and July 26, 11 WAT. The study area was treated with RoundUp at 4 qts/ac on July 27, 1994, to control existing vegetation; and mowed on August 8, 1994. To evaluate treatment persistence, annual ryegrass (*Lolium multiflorum* Lam.) was slice seeded to a depth of 0.5 inch at 25 lb/ac on August 15, 1994, 13 WAT. When the plots were evaluated in September, cover provided by annual ryegrass was complete in all plots. Results are reported in Table 2.

The statistical analysis for both sites was performed using an 'unprotected' LSD test, with p=0.10.

RESULTS

No statistical differences were observed between the roadside treatments and the untreated check at the rating on June 28, except 2 and 4 lbs/ac of Predict. With the exception of these same Predict treatments and the 1 lb/ac Endurance plus 5 lbs/ac Karmex treatment, no significant differences were observed between the other treatments and the untreated check at the August and September ratings. Predominant annual weed species were common ragweed (*Ambrosia artemisiifolia* L.), giant foxtail (*Setaria faberi* Herrm.), and prickly lettuce (*Lactuca serriola* L.).

The only treatments to provide acceptable control through 74 days in the agricultural site were Endurance plus Karmex at 1.5 plus 4 lb product/ac; Predict plus Karmex both at 3 lb product/ac, and the combination of Predict, Endurance, and Karmex. Predominant annual weed species were smooth pigweed (*Amaranthus hybridus* L.), common lambsquarters (*Chenopodium album* L.), and common yellow woodsorrel (*Oxalis stricta* L.).

CONCLUSIONS

Based on results from this and other studies under similar conditions using more persistent herbicides, it appears the application timing of the roadside treatments was not suitable. Despite the winter conditions that should have reduced herbicide degradation, the herbicides were applied too soon to be effective in the spring.

The process of seeding the annual ryegrass into the agricultural site may have provided enough soil disturbance to disrupt a persistent herbicide barrier; however, at the time of the slice seeding, treatments without Karmex showed little sign of residual control. Other studies suggest that annual ryegrass shows some tolerance to Endurance.

Under the conditions of this study, it appears that Endurance and Predict at these rates will not provide acceptable season-long control. Control was achieved at acceptable rates with the addition of Karmex and with a spring application. If these products are to be investigated further for their effectiveness on bare ground, higher rates with an application in the spring would have to be evaluated.

TABLE 1: Visual ground cover ratings of annual weed species taken June 28, August 12, and September 26, 1994. Herbicide treatments were applied to the roadside site on November 16, 1993. Each value is the mean of three replications.

Treatment	Application Rate	Ground Cover of Annual Weed Species June 28	August 12	September 26
	(lb product/ac)	(----------------------------%	------------------------------)	
Untreated Check	- - -	4	25	27
Endurance	1.0	5	27	33
Endurance	2.0	3	20	23
Endurance	3.0	3	18	20
Predict	2.0	29	37	47
Predict	4.0	31	42	51
Endurance + Predict	1.0 + 2.0	3	20	27
Endurance + Predict	2.0 + 2.0	4	18	19
Endurance + Predict	1.0 + 4.0	7	28	35
Endurance + Predict	2.0 + 4.0	6	25	38
Endurance + Karmex	1.0 + 5.0	10	37	45
Endurance + Karmex	2.0 + 5.0	4	12	15
Oust + Karmex	0.1875 + 5.0	2	13	17
LSD (p=0.10)		23	18	23

TABLE 2: Visual ground cover ratings of annual weed species taken June 28 and July 26, 1994. A visual rating was intended for September 1994, however no significant differences in the experimental plots were observed. Herbicide treatments were applied to the agricultural site on May 13, 1994. Each value is the mean of three replications.

Treatment	Application Rate	Ground Cover of Annual Species June 28	July 26
	(lb product/ac)	(%)	(%)
Untreated Check	- - -	84	96
Predict	5.0	25	77
Predict	2.0	57	95
Endurance	2.3	5	42
Endurance	1.5	6	43
Predict + Endurance	2.0 + 1.5	4	37
Predict + Karmex	3.0 + 3.0	1	8
Endurance + Karmex	1.5 + 4.0	0	4
Predict + Endurance + Karmex	2.0 + 1.0 + 2.0	2	17
LSD (p=0.10)		14	20

EFFECT OF SEEDBED PREPARATION ON THE ESTABLISHMENT OF ANNUAL WILDFLOWERS

INTRODUCTION

This study was conducted at a wildflower site previously established by PennDOT in the spring of 1991 near Oak Hall, PA. The purpose of the study was to evaluate the type and timing of seedbed preparation and to compare two different seeding dates on the establishment of annual wildflowers. With seedbed preparation performed during the fall, the spring work load could be reduced, which would permit the seeding of all wildflowers to be completed by April or early May.

MATERIALS AND METHODS

The experimental design was a randomized complete block with two replications. Seeding of the wildflower species (Table 1) was done with a hand held rotary broadcast seeder at a rate of 8 lb/ac on April 14 or May 3 (Table 2). The type and dates of the seedbed preparation (Table 2) included no-till, till, a RoundUp application, and/or an application of Basamid (a soil fumigant). Tilling was performed to a depth of 6 in with a tractor mounted Howard Rotovator. Applications of RoundUp on September 8, 1993, were applied by PennDOT personnel and the application on April 14, 1994, was made by Penn State personnel. The April 14 application was made at 10 GPA with 4 qts/ac RoundUp, 0.25% (v/v) QuikWet 357, and 0.25% (v/v) Sta-Put. Basamid was applied at 250 lbs/ac with the soil tilled prior to, immediately following, and 2 weeks after the application. The addition of compost was planned for two plots but was deleted due to a delay caused by a scheduling conflict. Ratings of percent groundcover of wildflowers and weeds were taken July 18, 1994, where '0' indicates no cover and '100' indicates total cover of the plot. Following a series of frosts, the site was mowed in October 1994. The study area was then rated for percent vegetative cover of all remaining green plant species on November 17, 1994, where a rating of '1' represents 0 - 20% groundcover, '3' represents 40 - 60% groundcover, and '5' indicates 80 - 100% groundcover. Results are reported in Table 2.

RESULTS

There was a significant interaction between the treatments and the amount of cover from the wildflowers and weeds. Plots with seedbed preparation in the spring showed similar results and produced more wildflower cover and less weed cover than plots prepared during the fall, with the plot containing an April 18 application of Basamid producing the most wildflowers. Only one significant difference was observed when comparing the fall seedbed preparation combinations - with no-till, till, RoundUp, and Basamid. The plots which received a Basamid application and were tilled on October 6, but where no RoundUp application was made, had significantly higher ratings for wildflower cover than the other fall treated plots. The most common wildflowers observed in all plots were cosmos, corn poppy, and rocket larkspur. Prevalent weed species were prickly lettuce (*Lactuca serriola* L.), black medic (*Medicago lupulina* L.), white clover (*Trifolium repens* L.), and common lambsquarters (*Chenopodium album* L.). Plots with seedbed preparation in the spring provided the least amount of green vegetative cover, or the least amount of weeds present, at the rating on November 17, 1994. The fall prepared plots showed no differences. Common weed species present during this rating were white clover, wild carrot (*Daucus carota* L.), and tall fescue (*Festuca arundinacea* Schreb.). Plots seeded May 3 produced more wildflowers than plots seeded April 14.

CONCLUSIONS

Seedbed preparation during the fall permits too much weed germination in the spring thus inhibiting the growth of the wildflowers, while seedbed preparation during the spring destroys more weeds as they are beginning to germinate and are less tolerant. Although plots seeded May 3 produced more wildflowers than plots seeded April 14, other studies suggest that an April seeding is usually more successful. Thus, any differences in the results of this study are most likely associated with the timing of the seedbed preparation. Based on the results of this study, the most economical and effective approach for establishing annual wildflowers would be an application of RoundUp and tilling in the spring.

A possible combination for seedbed preparation not evaluated in this study would be tilling the soil in the fall and applying RoundUp in the spring. This method should be evaluated in future research efforts.

TABLE 1: Annual wildflower species evaluated at two different seeding dates. Seeding rate was 8 lb/ac.

Common Name	Scientific Name	Mixture %
Cornflower	*Centaurea cyanus*	13.73
Corn Poppy	*Papaver rhoeas*	6.60
Cosmos	*Cosmos bipinnatus*	43.61
Rocket Larkspur	*Delphinium ajacis*	21.66
Sweet Alyssum	*Lobularia maritima*	7.15
Tall Plains Coreopsis	*Coreopsis tinctoria*	6.72

TABLE 2: Average groundcover ratings for study evaluating different seedbed preparations and two different seeding dates. Wildflower and weed groundcover ratings were taken July 18, 1994, where '0' indicates no cover and '100' indicates total cover of the plot. A rating of living vegetation was taken following a frost on November 17, 1994. A rating of '1' represents 0 - 20% groundcover, '2' represents 20-40% groundcover, '3' represents 40 - 60% groundcover, '4' represents 60-80% groundcover, and '5' indicates 80 - 100% groundcover. Each value is the mean of two replications.

1994 Seeding Date	Seedbed Preparation	RoundUp Application	Basamid Application	Wildflower Cover Jul 18	Weed Cover Jul 18	Vegetative Cover Nov 17
				(%)	(%)	(1-5)
Apr 14	No-Till	Sep 8, 1993	None	9	96	4
Apr 14	Till - Oct 6, 1993	Sep 8, 1993	None	6	88	4
Apr 14	Till - Oct 6, 1993	Sep 8, 1993	Oct 6, 1993	5	95	4
Apr 14[1/]	No-Till	Sep 8, 1993	None	5	93	4
Apr 14[1/]	Till - Oct 6, 1993	Sep 8, 1993	Oct 6, 1993	9	89	4
Apr 14	Till - Oct 6, 1993	None	Oct 6, 1993	23	89	3
May 3	Till - Apr 28, 1994	Apr 14, 1994	None	73	18	1
May 3	Till - Apr 28, 1994	None	Apr 18, 1994	85	18	1
Significance Level (p)				0.0001	0.0001	- -
LSD (p=0.05)				9	17	- -

[1/] Originally scheduled to receive compost.