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DEPARTMENT OF TRANSPORTATION

ROADSIDE VEGETATION MANAGEMENT RESEARCH REPORT
TENTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY
RESEARCH PROJECT # 85-08
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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
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Monsanto
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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

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

This report includes information from studies relating to roadside brush control, 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 on the following page by product name, active ingredients, formulation, and manufacturer.

Product name, active ingredients, formulation, and manufacturer information for products referred to in this report. 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.
Break-Thru	adjuvant	- - -	
Cide-Kick	adjuvant	- - -	JLB International
Cide-Kick II	adjuvant	- - -	JLB International
Clean Cut	adjuvant	- - -	Arborchem Products, Inc.
Clean Cut plus Pine	adjuvant	- - -	Arborchem Products, Inc.
Clean Cut plus Citrus	adjuvant	- - -	Arborchem Products, Inc.
Dyne-Amic	adjuvant	- - -	
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
Gallery	isoxaben	75 DF	Dow Elanco
Garlon 3A	triclopyr	3 S	DowElanco
Garlon 4	triclopyr	4 EC	DowElanco
HyGrade	diluent	- - -	CWC Chemical Company
JLB Oil Plus	diluent	- - -	Brewer International
Karmex	diuron	80 DF	E.I. DuPont de Nemours & Co.
Kinetic	adjuvant	- - -	
Krenite S	fosamine ammonium	4 S	E.I. DuPont de Nemours & Co.
L-77	diluent	- - -	
MON 65005	glyphosate	4 S	Monsanto
NAF-6	triclopyr, picloram	RTU	DowElanco
Nu-Film-IR	adjuvant	- - -	Miller Chemical
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
Predict	norflurazon	80 DF	Sandoz Agro, Inc.
QwikWet 357	adjuvant	- - -	Exacto Chemical Company
Reward	diquat dibromide		Zeneca Professional Products
RoundUp	glyphosate	4 S	Monsanto
Scythe	pelargonic acid		Mycogen Corp.
Sta-Put	drift retardent	- - -	Nalco Chemical Company
Transline	clopyralid	3 S	DowElanco
Vanquish	dicamba-glycolamine	4 S	Sandoz Agro, Inc.
Velpar L	hexazinone	2 S	E.I. DuPont de Nemours & Co.
X-77	adjuvant		

COMPARISON OF MECHANICAL, CONVENTIONAL, AND INTEGRATED BRUSH CONTROL PROGRAMS ON A FORESTED, LIMITED ACCESS HIGHWAY

INTRODUCTION

Controlling brush is the most difficult and expensive part of a roadside vegetation management program in Pennsylvania. The standard methods of brush control currently used by PennDOT include broadcast or spot applications of herbicides applied from moving trucks. These methods often result in the elimination of the vegetative groundcover surrounding the target brush. The treated brush species are often the first plants to regrow in the treated areas, resulting in a vicious cycle of treat and retreat. Because of the frequency of application needed, and the dramatic effect these applications have on the target and surrounding vegetation, some people are opposed to the use of herbicides in roadside rights-of-way (ROW).

These people favor controlling brush with mechanical means. However, mechanical removal through brush mowers, or chainsaws and chippers; is time consuming, equipment maintenance intensive, and can be hazardous to operators.

There are alternative systems that overcome the problems associated with current practices and mechanical removal. Selective brush control application techniques are available that result in the control of the brush with little effect on the groundcover under it. The competitive effects of the groundcover minimize the establishment and growth of additional brush in the treated area. This results in a longer period between treatments, and reduces the time required to complete subsequent treatments. The objective of this project is to demonstrate the long-term cost and effectiveness of several brush control techniques that could be used along Pennsylvania highways.

Basal bark treatments involve the application of a herbicide to the lower 12 to 18 inches of each individual stem of the brush and are conducted in the dormant season. Low volume spot foliar sprays are done with backpack sprayers and are directed to the foliage of the specific plant to be controlled. Because the application is made by a person standing close to the brush, and low volumes are used, very little herbicide drops to the ground and injures understory plants. Spot concentrate applications involve the application of measured volumes of concentrated herbicide to the soil beneath brush to be killed. The herbicides must be soil active and root absorbed. The negative aspect of this application is desirable trees with roots growing in the treated area may be severely injured or killed. Cut stump treatments are made after trees are cut. A spray application of a translocated herbicide is made to the freshly cut stumps. This prevents the resprouting which occurs with many species of trees.

Prior to initiating treatments, a clearance standard was developed to provide guidelines for treatment. The clearance standard divides the ROW into two zones, a clear zone and a selective zone. The clear zone extends from the pavement edge for a distance of 30 ft. All woody stems within the clear zone are to be treated. Stems that are four inches or more in diameter are to be cut. The selective zone extends from the 30 ft boundary to a distance of 60 ft from the road, the original tree clearance distance, or the ROW fence; whichever is closest to the roadway. In the selective zone, only tall growing species that could potentially fall on to the roadway are to be treated. The most commonly treated species in the plot areas were red maple (*Acer rubrum*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*), and quaking aspen (*Populus tremuloides*). The most common low growing species that were left untreated in the selective zone included common witchhazel (*Hammemelis virginiana*), bear oak (*Quercus ilicifolia*), and serviceberry (*Amelanchier* spp.). Any existing stems in herbicide treated areas should be cut when they exceed 25 ft in height.

MATERIALS AND METHODS

A long-term study comparing the cost and effectiveness of mechanical-only, truck-based herbicide applications relying on broadcast or high-volume spot treatments (conventional), and integrated methods for brush control was initiated along SR 80, in western Centre County. The mechanical and integrated treatment areas were established in the shoulder and median areas of SR 80, in Rush Township.

Two plots each of the four treatment types were established between mile markers 139 and 141. The entire study area was divided into native and cut slope areas, and each treatment was randomly assigned to one plot within each area. Each plot was approximately 0.5 mile long. The four treatments included mechanical, low-volume basal bark/cut and stump treat (basal bark/cut stump), low-volume foliar/cut stump (foliar/cut stump), and spot concentrate/cut stump. Cut stump, basal bark, and foliar treatments are highly selective because the treatment is applied directly to the target brush. The spot concentrate soil treatment is less selective, as non-target plants can be injured if their roots extend into the treatment area and take up the herbicide. The conventional treatments were foliar applied during the 1994 season by contracted crews.

Basal Bark/Cut Stump

This treatment consisted of treating the lower 12 to 15 inches of target brush stems with a solution of Garlon 4 and oil diluent[1/] , in a ratio of 15/85 percent. This treatment was applied to the two plots with a piston pump backpack sprayer equipped with a B&G Extenda-Ban low volume basal wand equipped with a Spraying Systems #5500 adjustable ConeJet tip, size Y-2. The applications were made May 27 and June 1, 1993 A total of 2,980 stems were treated in 15.25 person-hours (hours), using 8 gallons of solution.

The cut and stump treatment portion of these plots was applied May 27, June 9, June 11, and July 9, 1993. The herbicide solution used for the stump treatment was the same as the basal bark solution. The solution was applied immediately after cutting with a household spray bottle to the cut surface of the stump. The two plots were completed in a total of 36.75 hours, treating 761 stumps with slightly over one gallon of solution. After cutting, the brush was either cut to smaller pieces and left in place, or drug into the forest or the top of the cut slope (which was very time consuming). None of the brush cut in any treatment plot was chipped.

Ratings were made on August 16 and 22, 1994, to estimate the number of stems that had less than 90% canopy reduction (uncontrolled) and the number of cut stumps that had resprouted within each plot.

Foliar/Cut Stump

The treatments were applied to the two plots on September 24 and 29, 1993, using piston pump backpack sprayers equipped with handguns configured with a two position swivel valve using a Spraying Systems 1502 flat fan and a Y-2 adjustable Cone Jet. The application of the herbicide involved light, uniform coverage of the leaf surfaces on the entire tree. The herbicide mixture used consisted of, on a volume basis, 5% Krenite S, 0.25% Arsenal, 0.5% Clean Cut and 0.25% StaPut (a drift control agent). A total of 5,326 stems were treated in 18.5 hours with 19 gallons of solution. Larger trees growing towards the roadway may have only been sprayed from one side, while smaller brush was completely covered.

The cut stump treatments in these plots were applied November 22, 1993. The two plots were completed in a total of 5.5 hours treating 72 stems with about 1 pint of solution.

Ratings were made on August 22, 1994, to estimate the number of uncontrolled stems and the number of cut stumps that had resprouted within each plot.

[1/] The diluents used were Arborchem Basal Oil, or CWC HyGrade.

Spot Concentrate /Cut Stump

This treatment consisted of applying precise amounts of undiluted Velpar L near the base of target brush. Dosage was based on the stem or canopy diameter. The application rate used was 4 mL per inch of stem diameter, or per 3 ft of canopy diameter. The treatment in the cut slope plot was applied November 18, 1993, using a piston-pump backpack sprayer equipped with a Spraying Systems MeterJet with a D2 straight stream spray tip. One applicator treated 1,244 stems in 2 hours using 0.9 gallons of solution. The native terrain plots were treated with identical equipment on April 15 and May 3, 1994, and required 4.3 hours to treat 2,878 stems, using 1.1 gallons of solution.

The cut and stump treatment portion of these plots was conducted on November 22, 1993. The stems cut were generally greater than 20 ft in height, or were located adjacent to a water source. A total of 14 stems were treated in 2 hours, using 2 oz solution. This seems like a lot of time to treat so few stems, but this primarily reflects the amount of time required for two operators to walk through both plots and cut the few stems that were there. No stems were cut within the cut slope treatment area.

Counts were taken of the number of stems with greater than 90% canopy reduction (controlled) in the cut slope plot on September 28, 1994. Counts were also taken of the number of stems with less than 90% canopy reduction (uncontrolled) in the native plot on September 16, 1994. The method of counting was dictated by convenience. The cut slope plot had very few controlled stems and the native plot had a large percentage of stems controlled. The cut stumps within the native terrain plot were not evaluated in 1994.

Mechanical Only

This technique consisted of hand cutting all stems above a height of 2 ft, without any stump treatment, on July 9, July 12-16, and November 18, 1993. The cut brush was either left where cut, or dragged out of the clear zone. No brush was chipped. Between the two plots, a total of 5,633 stems were cut in 67 hours. A count of stumps which resprouted within each plot was made on November 8, 1994.

Conventional

Two half mile plots were selected in close proximity to the study area. A count of all stems was taken within sixty feet of the road shoulder to determine the total number of possible target stems in each plot. This distance of sixty feet was chosen because it represents the selective zone area, according to the zone concept, where undesirable stems should be eliminated.

This treatment was applied on June 15, 1994 by contracted crews. The herbicide mixture contained Garlon 3A at 3 qts/ac and Escort at 0.33 oz/ac applied in 50 gal/ac of water. The application was made by a spray truck selectively treating brush up to thirty feet from the shoulder of the road. The day of the application the temperatures were approximately 90 degrees Fahrenheit with sunny skies. The operation was stopped later that day due to high temperatures and wind.

A count of treated stems, both controlled and uncontrolled, was taken on September 26 and 28, 1994.

RESULTS

Initial

Tables 1 and 2 summarize the results gathered from the initial herbicide and cut/stump treatment. The material costs reported include only the cost of herbicides, fuels, and lubricants used for the treatments. No equipment costs are included. Values are reported for both plots, native and cut slope, for each treatment and an average total for both plots is also reported. The conventional plots were located only on cut slope areas. The values reported show variability which can be associated with several factors, including; but not limited to, the terrain, stem density, plot size, and application method. Basal bark and foliar treatments had similar average total costs per acre. Spot concentrate treatments resulted in the lowest total cost per acre, while mechanical had the highest cost. There was a broad range in cost figures for the cut and stump treatment portions, due to the varying number of stems cut.

1994

Table 3 and 4 provide values from control data collected in 1994 for the herbicide applications and cut and stump treatment operations. The Cost Effectiveness Quotient (CEQ)[1/] is probably the most critical value represented on this table. The CEQ was developed to measure the cost effectiveness of all treatments. A low CEQ value suggests that the treatment is more cost effective than those with higher values. This CEQ formula takes into account the cost of the treatment per 1000 stems and the overall percent control of the treated stems.

It is obvious from the data presented that there were significant differences in values between plots, even for the same treatment. The treatment method had the most significant impact on the differences between values. However, several other variables including stem density, terrain, tree species present, and percent control all impacted the final outcome.

Basal bark treatments provided CEQ values of 190 in the native terrain and 462 in the cut slope terrain, showing the extent of variability among plots. Even though the CEQ was higher in the cut slope, the total cost per acre was substantially lower. This high CEQ value resulted from only 43 percent control of the treated stems in the cut slope plot, which was primarily due to poor control in a dense stand of quaking aspen. There was minimal damage to the existing groundcover.

The foliar/cut stump treatment provided the lowest CEQ value of 52 in the native terrain and had a total average CEQ value of 87. Minimal damage was observed to the groundcover.

The spot concentrate treatment provided one of the lowest CEQ values. However, several problems were associated with this treatment. The data reported represents only the native terrain plot, where all other treatments report the average of two plots (the native and cut slope terrains). The plot located on the cut slope resulted in such poor control that it was abandoned from the study. This poor control resulted from a terrain that was extremely difficult to negotiate for the applicator and the timing of the application (November) was late for this method. The cut slope plots for the basal bark, foliar, and mechanical treatments created higher CEQ values than those for the native plots for each given treatment. These results would suggest that a proper spot concentrate treatment applied to a more manageable cut slope, would result in a higher CEQ value than the native terrain's value. Some problems associated with the native terrain treated area included moderate damage to the groundcover and some off-target damage to several large red oaks which were severely injured when smaller stems located within their drip line were treated.

The mechanical treatment provided a total average CEQ of 508. One problem in collecting data for this mechanical treatment was locating the cut stumps, which was difficult due to large amounts of fallen brush and tall growing vegetative groundcover (goldenrod and brambles). It is possible that future ratings will reveal a larger percentage of uncontrolled stems as the sprouts originating from the untreated stumps become larger and more visible.

The conventional treatment was made by PennDOT contracted crews during a standard, selective brush control application. Although this application resulted in a high percentage of control for the actual treated stems, the reported overall percent control was low, only 10 or 11 percent. This low control value resulted because their application treated very few of the possible target stems located throughout the designated plot area (up to 60 ft from the road edge). The majority of these target stems could have been treated with the non-truck-based basal bark, foliar,

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[1/] Bramble W. C., W. R. Byrnes, and R. J. Hutnik (1987) Development of Plant Cover Diversity On An Electric Transmission Right-Of -Way. Proceedings of the Fourth Symposium on Environmental Concerns in Rights-of-Way Management, 4: 89-92.

and spot concentrate treatments used throughout the study. Due to this low percent control, an extremely high CEQ value is reported.

Table 4 reports the data for the cut and stump treatments conducted within each plot. This information was separated from the other treatment data to allow for valid comparisons among the standard treatments (Table 3). The average total CEQ values shown for the cut and stump treatments ranged from 1383 in the basal bark plots to 2128 in the foliar plots. The variation in CEQ values was associated with the difficult terrain, stem density, and tree species present within the plots. These cut stump CEQ values were very high in all plots, which suggests that this operation is more time consuming and expensive than the backpack-based herbicide applications.

1995

On August 25, 1995, treatment effects were observed for all plots.

The basal treatment showed approximately 90 percent control overall, with a lack of control on quaking aspen. Small quaking aspen sprouts were beginning to appear from both roots and some stumps. No groundcover damage was noted.

The foliar treatment provided some variability in effectiveness between the native and cut slope plots. The native plot, which had easily negotiated terrain, had excellent control. The smaller stem size encountered during the original treatment also allowed for better coverage of the treated stems. The cut slope plot had approximately 70 percent control overall. It was noted that some of the stems were treated only from one side because of the difficult terrain. Resprouting from some of these stems was due in part to the inadequate coverage. Canopy reduction still accounted for a 20-50 percent loss of leaves from these stems. There was no understory damage in either plot.

The spot treatment showed signs of fairly good control for the native plot. As previously discussed in the '1994 Results', the cut slope plot had been abandoned from the study as a result of poor control. There were some red maple and green ash (*Fraxinus pennsylvanica*) stems still surviving in the native plot. Only 25 percent control was achieved for species such as red oak, black cherry, and red maple towards the western end of the native plot. There were still signs of understory damage.

The mechanical treatment was beginning to show significant signs of resprouting for species such as black cherry, red maple, red oak, quaking aspen and staghorn sumac (*Rhus typhina*). Sprouts ranged in size from 2 feet to greater than 10 feet in height.

The conventional treatment showed good control of the treated stems. However, as previously noted, very few of the potential target stems were ever treated. Significant understory damage was still noticeable within these plots.

CONCLUSIONS

The initial treatment and control data established a baseline for future comparisons and any initial differences should not be overemphasized. The comparison between treatments becomes important in subsequent seasons as the amount of follow-up effort required to maintain the clearance standards is measured.

TABLE 1: Areas and stems treated, man-hours required, and treatment costs of the herbicide and mechanical brush control operations established near Snow Shoe. Cut and stump treatment operations conducted are not included in this table. Material costs include herbicides, and fuel and oil for the chainsaws. No equipment costs are included.

Treatment[1/]	Treated Acres	Stems per Acre	Man Hours per Acre	Material Cost per Acre ($)	Total Cost[2/] per Acre ($)
Basal Bark (n)	3.39	658	3.10	26.10	103.60
Basal Bark (c)	4.38	171	1.08	6.78	33.78
Basal Bark (t)	7.77	384	1.96	15.21	64.21
Foliar (n)	3.91	765	1.27	5.03	36.78
Foliar (c)	3.21	727	2.96	9.39	83.39
Foliar (t)	7.12	748	2.04	6.99	57.99
Spot Concentrate (n)	3.88	742	1.10	14.97	42.47
Spot Concentrate (c)	2.99	416	0.67	14.07	30.82
Spot Concentrate (t)	6.87	600	0.91	14.58	37.33
Mechanical (n)	2.13	910	4.23	3.27	109.02
Mechanical (c)	4.44	832	13.06	7.42	333.92
Mechanical (t)	6.57	857	10.20	6.07	261.07
Conventional (c)	3.64	202	---	---	164.00
Conventional (c)	3.64	201	---	---	164.00
Conventional (t)	7.28	202	---	---	164.00

[1/] (n) = native terrain, (c) = cut slope terrain, and (t) = average total of both treatment areas

[2/] Total Cost per Acre values are based upon labor rates of $25.00 per hour.

TABLE 2: Areas and stems treated, man-hours required, and treatment costs of the cut and stump treatment operations in the different brush control treatment areas established along Interstate 80 near Snow Shoe. Material costs include herbicides, and fuel and oil for the chainsaws. No equipment costs are included.

Treatment[1/]	Treated Acres	Stems per Acre	Man Hours per Acre	Material Cost per Acre	Total Cost[2/] per Acre
				($)	($)
Basal Bark					
Cut/Stump Trt (n)	3.39	192	8.19	6.90	211.65
Cut/Stump Trt (c)	4.38	25	2.05	0.80	52.05
Cut/Stump Trt (t)	7.77	98	4.73	3.54	121.79
Foliar					
Cut/Stump Trt (n)	3.91	0	0.26	0	6.50
Cut/Stump Trt (c)	3.21	22	1.40	0.83	35.83
Cut/Stump Trt (t)	7.12	10	0.77	0.38	19.63
Spot Concentrate					
Cut/Stump Trt (n)	3.88	4	0.34	0.22	8.72
Cut/Stump Trt (c)	2.99	0	0.22	0	5.50
Cut/Stump Trt (t)	6.87	2	0.29	0.12	7.37

[1/] (n) = native terrain, (c) = cut slope terrain, and (t) = average total of both treatment areas

[2/] Total Cost per Acre values are based upon labor rates of $25.00 per hour.

Table 3: Treatment results from 1994 and overall cost effectiveness of each treatment. A spot concentrate treatment was applied to a cut slope area but is not reported due to poor control resulting from an improper application timing and difficult terrain. The cut and stump treatment operations conducted are not included in this table, but are presented in table 4.

		Number of Targets[2/]			Total	
Treatment[1/]	Stems/ac	Treated or Cut	Controlled[3/]	% Control[4/]	$/ac	CEQ[5/]
Basal Bark (n)	658	2230	1856	83	104	190
Basal Bark (c)	171	750	324	43	34	462
Basal Bark (t)	384	1490	1090	73	64	228
Foliar (n)	765	2991	2776	93	37	52
Foliar (c)	727	2335	1972	84	83	136
Foliar (t)	748	2663	2374	89	58	87
Spot Concentrate (n)	742	2878	2299	80	42	71
Mechanical (n)	910	1939	1372	71	109	169
Mechanical (c)	832	3694	1999	54	334	743
Mechanical (t)	857	2817	1686	60	261	508
Conventional (c)	202	734	73	10	164	8119
Conventional (c)	201	732	82	11	164	7417
Conventional (t)	201	733	78	11	164	7417

1/ (n) = native terrain, (c) = cut slope terrain, and (t) = average total of both treatment areas.

2/ Number of targets refers to the stems treated with either basal bark, foliar, or spot concentrate applications. The treated target stems reported for the conventional treatment refers to the number of possible target stems present within the plot (according to the zone concept), not necessarily the actual number which were treated.

3/ A controlled stem refers to stems with more than 90% in canopy reduction or stumps with no resprouts.

4/ % Control was calculated by the number of controlled target stems or stumps divided by the total number of treated targets or cut stumps.

5/ CEQ is also referred to as the 'Cost Effectiveness Quotient' Brambles & Byrnes, 1985.

$$CEQ = \frac{\$ \text{ per 1000 stems}}{\% \text{ Control}} \times 100$$

Table 4: Cut and stump treatment results from 1994 and overall cost effectiveness of each operation. The spot concentrate treatment applied to the cut slope area is not included in the results due to poor control resulting from an improper application timing and difficult terrain. Therefore, results from the cut stump portion of that same area are not included.

Treatment[1/]	Stems/ac	Number of Stumps Cut/Treated	Number of Stumps Controlled[2/]	% Control[3/]	Total $/ac	CEQ[4/]
Basal Bark						
C&ST (n)	192	652	607	93	212	1187
C&ST (c)	25	109	80	73	52	2849
C&ST (t)	98	381	344	90	122	1383
Foliar						
C&ST (n)	0	0	0	- -	7	- -
C&ST (c)	22	72	67	93	36	1760
C&ST (t)	10	36	34	94	20	2128
Spot Concentrate						
C&ST (n)	4	14	- -[5/]	- -	9	- -

[1/] (n) = native terrain, (c) = cut slope terrain, and (t) = average total of both treatment areas. 'C&ST' refers to Cut and Stump Treatment.
[2/] A controlled stump refers to stumps with no resprouts.
[3/] % Control was calculated by the number of controlled stumps divided by the total number of cut and treated stumps.
[4/] CEQ is also referred to as the 'Cost Effectiveness Quotient' Brambles & Byrnes, 1985.

$$CEQ = \frac{\$ \text{ per } 1000 \text{ stems}}{\% \text{ Control}} \times 100$$

[5/] The cut stumps within this plot were not evalutated in 1994.

EFFECT OF HERBICIDE DILUENT ON CONTROL OF GREEN ASH, BLACK BIRCH, AND PIN CHERRY WITH BASAL BARK APPLICATIONS

INTRODUCTION

A trial was established near Port Matilda, PA, to compare the effect of diluents on the control of green ash (*Fraxinus pennsylvanica* Marsh.), black birch (*Betula lenta* L.), and pin cherry (*Prunus pensylvanica* L.) treated with basal bark herbicide applications. These diluents, utilized as the carrier in basal bark applications, assist the chemical in penetrating the bark of the tree.

MATERIALS AND METHODS

The six diluents evaluated included three petroleum-based products; Arborchem Basal Oil, HyGrade I Basal Oil, and Penevator Basal Oil; two vegetable-based products, JLB Oil Plus and Penevator Vegetable Oil; and Dyne-Amic, an organosilicone/methylated seed oil blend. Dyne-Amic is not currently labeled for basal bark applications, but it has proven to be an effective spray adjuvant on turf applications. Stems of birch and ash were treated February 14 and 20, 1995, respectively, with a solution containing 95 percent diluent and 5 percent Garlon 4 (v/v). Pin cherry was treated February 13, 1995, with a solution containing 95 percent diluent and 5 percent Access (v/v). The concentration of Garlon 4 and Access applied were below label rates, but were used to isolate any differences in control provided by the various diluents. Each treatment was applied to ten stems of each species at a rate of 1.0 mL/inch of stem circumference at a height of six inches, using a syringe and 14 gauge pipetting needle. The diameters for all three species ranged from 0.75 inches to 4 inches, with an average of 2 inches. The experimental layout for each species was a completely randomized design, with each stem being an experimental unit. Visual ratings of percent canopy reduction were taken August 9, 1995; where '0' indicates full leaf canopy and '100' indicates no leaves remaining. Canopy reduction values for the checks were reported 'as seen', rather than given zero values. The data were subjected to an analysis of variance. Analysis of covariance was used to adjust canopy reduction according to stem caliper in birch.

RESULTS

Compared to the untreated check, all treatments provided significant canopy reduction on all species, except Dyne-Amic on black birch (Table 1). Black birch treated with Garlon in Dyne-Amic were no different from the controls.

Arborchem Basal Oil, HyGrade I Basal Oil, Penevator Basal Oil, and Penevator Vegetable Oil treatments provided canopy reduction values from 88 to 95 percent on green ash and provided complete control of the pin cherry stems. Black birch was more difficult to control, with adjusted canopy reduction ratings for these four diluents ranging from 41 to 54 percent.

JLB Oil Plus was statistically similar to Arborchem Basal Oil, HyGrade I Basal Oil, Penevator Basal Oil, and Penevator Vegetable Oil on green ash and pin cherry, but did not provide as good control of black birch.

Dyne-Amic provided the lowest canopy reduction ratings of all the diluents on all three species.

During the ratings that there were no visible signs of resprouting on the cherry stems. Also, the untreated checks for both green ash and pin cherry had canopy reduction values of 24 and 31 percent, respectively. These canopy reduction values for the checks were due to the high stem density and full canopy, which shaded the lower branches and reduced their foliage density.

CONCLUSIONS

Arborchem Basal Oil, HyGrade I Basal Oil, Penevator Basal Oil, and Penevator Vegetable Oil all worked equally well on all species tested. JLB Oil Plus did provide similar results to these diluents on ash and cherry, but did not provide as good control of birch. These five diluents are similarly priced, therefore a purchase decision is a matter of personal preference and product availability. Industry representatives have suggested using Dyne-Amic in a diluted form for basal bark applications tested in the future. Also, by diluting the product, its pricing will be more competitive with the other diluents evaluated in this study.

TABLE 1: Control provided by various basal bark treatments based on visual ratings of percent canopy reduction taken August 9, 1995. Treatments of 5 percent Garlon 4 and 95 percent (v/v) diluent were applied to black birch and green ash stems on February 14 and 20, 1995, respectively. Treatments of 5 percent Access and 95 percent (v/v) diluent were applied to pin cherry stems February 13, 1995. A rating of '0' indicates full leaf canopy and '100' indicates no leaves remaining. Each value is the mean of ten replications.

	Canopy Reduction		
Diluent	Green Ash	Pin Cherry	Black Birch[1/]
	(%)	(%)	(%)
Arborchem Basal Oil	95	100	41 ab
HyGrade I Basal Oil	91	100	54 a
JLB Oil Plus	83	94	23 bc
Penevator Basal Oil	88	100	49 a
Penevator Vegetable Oil	94	100	49 a
Dyne-Amic	72	81	12 c
Untreated Check	24	31	5
Significance Level (p)	0.0001	0.0001	0.0002
LSD (p=0.05)	21	12	-

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

EFFECT OF HERBICIDE DILUENT ON CONTROL OF TREE-OF-HEAVEN WITH BASAL BARK APPLICATIONS

INTRODUCTION

Tree-of-heaven is a fast growing, weak wooded, root-suckering tree that is rapidly colonizing roadside right-of-ways in Pennsylvania, and spreading into adjacent properties. A trial was initiated to evaluate the effect of five herbicide diluents on the control of tree-of-heaven (*Ailanthus altissima* Mill.) with basal bark applications.

MATERIALS AND METHODS

The study area was located along SR 322, near Newport, PA, on a south-facing cut slope. The site featured a well developed canopy, and a sparse understory including crownvetch (*Coronilla varia* L.), blackberry (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica* Thunb.), and black cherry (*Prunus serotina* Ehrh.). The diluents tested included three petroleum-based products, Arborchem Basal Oil, HyGrade I Basal Oil, and Penevator Basal Oil; and two vegetable-based products, JLB Oil Plus and Penevator Vegetable Oil. Each treatment consisted of 95 percent (v/v) diluent, and 5 percent (v/v) Access. The rate of Access applied is below labeled rate, but was selected with an attempt to isolate any differences in control provided by the various diluents. The experimental design was a randomized complete block, with two replications. Each plot consisted of 20 stems, greater than 1 inch diameter. Each stem was treated with a syringe with a 14 gauge pipetting needle at a rate of 1 mL/inch circumference, on February 3, 1995. The base of the stems were covered to a height of 3 to 8 inches, depending on bark texture and amount of exposed roots. Stems between plots, and the few stems less than 1 inch diameter within plots were treated with the same concentration of herbicide, in HyGrade I Basal Oil. This treatment was applied using a CO_2-powered sprayer equipped with a handgun with a Spraying Systems #5500 Adjustable ConeJet nozzle and a Y-2 tip. Percent canopy reduction for each treated stem; and the number, stem diameter, and height of each root sprout within each plot was recorded September 5, 1995. The data was subjected to an analysis of variance, and an analysis of covariance was used to evaluate the effect of stem basal area on canopy reduction, and plot basal area on root sprout variables.

RESULTS

Effect of diluent treatments on canopy reduction were not significant (Table 1). Percent canopy reduction ranged from 89 to 100 percent. There was variability in the speed of control, as stems treated with Arborchem Basal Oil and HyGrade Basal Oil had less leaf-out than the other treatments. Root sprouts were observed in all plots. The effect of the diluent on root sprout number, basal area, and height was not significant, and plot basal area was not a significant covariate for any root sprout characteristic. The majority of the root sprouts displayed leaf curling and other symptoms that could be attributed to the picloram contained in Access.

CONCLUSIONS

Under the conditions of this study, all treated stems were effectively controlled; and there were no differences in amount of root sprouts observed, regardless of diluent. The diluents utilized are comparably priced, therefore a purchase decision is a matter of personal preference and product availability.

Table 1: Percent canopy reduction; and root sprout number, basal area, and height from tree-of-heaven treated with a basal bark solution containing 5% v/v Access, using five different diluents. Treatments were applied February 3, 1995, and data was collected September 5, 1995. Each value is the mean of two replications.

Diluent	Canopy Reduction	Root Sprout Number	Root Sprout Basal Area	Root Sprout Height
	(%)	(plants/plot)	(in^2/plot)	(ft)
Arborchem Basal Oil	100	17	0.43	0.9
HyGrade	100	33	1.67	1.0
JLB Oil Plus	89	18	0.56	1.3
Penevator	96	28	0.94	0.8
Penevator Vegetable Oil	95	17	0.98	1.4
Significance Level (p)	0.45	0.56	0.60	0.53
LSD (p=0.05)	n.s.	n.s.	n.s.	n.s.

EFFECT OF BASAL BARK APPLICATION TIMINGS ON THE CONTROL OF TREE-OF-HEAVEN AND SUMAC

INTRODUCTION

Previous basal bark applications conducted in April on tree-of-heaven (*Ailanthus altissima* Mill.) and sumac (*Rhus* spp.), have produced significant amounts of root sprouting. Therefore, this study was established to evaluate the effect of different application timings on the control of the treated stems and on the control of root sprouts. This study compared two basal bark herbicide treatments, applied at three times, for the control of tree-of-heaven and sumac, including smooth sumac (*Rhus glabra* L.) and staghorn sumac (*Rhus typhina* L.).

MATERIALS AND METHODS

The two herbicide treatments were 20% (v/v) Garlon 4; and 20% (v/v) Access, each diluted in HyGrade Basal Oil. A total of six colonies were chosen for each species. Two colonies, or replications, were treated at each timing, with each herbicide treatment applied to half of each colony. The treatments were applied at a rate of 1.0 mL/inch of stem circumference at a height of six inches, using a syringe and a 14 gauge pipetting needle. Tree-of-heaven stems were treated near Lewistown, PA, on December 22, 1994; February 1, 1995; and April 6, 1995. Applications were made to sumac on December 21, 1994; January 30, 1995; and April 26, 1995; near State College, PA. The diameters of the treated tree-of-heaven and sumac stems ranged in size from less than 0.25 inches up to 9 inches, with most below 1 inch. Visual ratings of percent canopy reduction of the treated stems were taken for tree-of-heaven on July 21, 1995, and the sumac plots on September 18, 1995. Also, the number of tree-of-heaven root sprouts were counted within each treated area and visual estimates were taken of percent groundcover by sumac root sprouts.

RESULTS

Both herbicides applied at all three timings provided almost 100 percent control of the treated tree-of-heaven and sumac stems. These values were not statistically different and are not reported.

There was no difference among treatment timings for Garlon 4 on tree-of-heaven root sprouts. There were differences among timings when Access was used. The number of tree-of-heaven root sprouts in the area treated in February was significantly lower than in the areas treated at the other two times. Also, there were significantly fewer root sprouts in the Access treated plots than in the Garlon treated plots at the February timing. The April application resulted in the lowest number of root sprouts of sumac for both herbicides. Areas treated with Access in December and January had less root sprouting than areas treated with Garlon 4.

CONCLUSIONS

All treatments were effective in controlling the treated stems regardless of timing, material, or species treated. Access performed better in controlling root sprouts for tree-of-heaven in the February treatment. Both herbicides provided superior results in the sumac plots when applied in April. However, this April treatment has not been effective in other demonstration areas in Pennsylvania. Perhaps the location of these two plots on a cut slope, a lower density of treated stems, or other environmental factors led to the significant difference found in this April timing. Further work needs to be done to evaluate the validity of this timing difference.

The difficulty in controlling these brush sprecies with one treatment, mechanical or chemical, is also well documented. Killing the 'mother' trees as was done in this study or as is done with mechanical removal results in a flush of root sprouts. To eliminate these species from an area, a foliar spray should be applied to the resprouts before they become too well established.

Table 1: Number of root sprouts/plot counted July 21, 1995, for tree-of-heaven treated with basal bark herbicide applications on December 22, 1994; February 1, 1995; and April 6, 1995. Each value is the mean of two replications.

		Application Timing		
Herbicide	Concentration	December	February	April
Garlon 4	20% (v/v)	354 a[1/]	251 a	377 a
Access	20% (v/v)	334 a	96 b	230 a
Significance Level (p)		0.84	0.007	0.35

1/ Means in a row followed by the same letter are not significantly different (p=0.10) according to Fisher's protected LSD.

Table 2: Percent cover from root sprouts on September 18, 1995, for sumac treated with basal bark herbicide applications on December 21, 1994; January 30, 1995; and April 26, 1995. Each value is the mean of two replications.

		Application Timing		
Herbicide	Concentration	December	January	April
Garlon 4	20% (v/v)	85 a[1/]	90 a	8 b
Access	20% (v/v)	52 a	48 ab	4 b
Significance Level (p)		0.09	0.14	0.62

1/ Means in a row followed by the same letter are not significantly different (p=0.10) according to Fisher's protected LSD.

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

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. Basal bark treatments often produce a girdling effect on the tree, and often more than one growing season is required to thoroughly evaluate the success of the application. Therefore, the intent of this current rating was to establish second season results and to determine if treatment affects differed from first year evaluations.

MATERIALS AND METHODS

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 conejet 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, with stems between bud break and early leaf out. A visual rating of canopy reduction was taken July 11, 1994, and August 9, 1995; where '0' indicates full leaf canopy and '100' indicates no leaves remaining.

RESULTS

Compared to the first year results, there was a greater canopy reduction in 1996 compared to 1995 (Table 1). Treated stems for all species provided significantly more canopy reduction than the untreated checks at the 1995 rating. In 1995, birch stems treated in December had 100 percent canopy reduction. The April applied Pathfinder II increased from 44 percent to 97 percent reduction. These treatments were significantly better than the April applied NAF-6 although it increased from 23 to 72 percent reduction. No statistical differences were observed between treatments on the cherry stems, as all reached 100 percent canopy reduction in 1995. Also in 1995, the locust stems treated in February had 100 percent canopy reduction and were significantly better than the April applied Pathfinder II which increased from 81 to 88 percent. The April applied NAF-6 treatment increased from 89 to 92 percent reduction.

Canopy reduction values for the checks were reported 'as seen', rather than given zero values. Pin cherry had the highest canopy reduction values for the untreated check, 45 and 32 percent in 1994 and 1995, respectively. Black locust stems also had high canopy reduction ratings. It is believed that these high canopy reduction values reported for the untreated checks were due to the high stem density and full canopy surrounding the treated stems, which caused shading of the lower branches.

CONCLUSIONS

All treatments showed an increase in control from the first year's rating, therefore it is necessary to evaluate the application two years after treatment to determine its success. All treatments applied in December or February provided 100 percent control of the treated stems on all three species two growing seasons after application.

However, these December or February treatments were only statistically better than the April applied NAF-6 on black birch, and the April applied Pathfinder II on black locust. Therefore, based on the results of this study, it appears that both treatments provide similar results and performing the application in the dormant season (December - February) can only provide slightly better control than when applied in late April.

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, and August 9, 1995; where '0' indicates full 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	Date	1994	1995	1994	1995	1994	1995
		(--------%--------)		(--------%--------)		(--------%--------)	
Untreated Check	- - -	4	1	45	32	23	12
Pathfinder II	Feb 7[1/]	78	100	100	100	100	100
NAF-6	Feb 7[1/]	39	100	100	100	100	100
Pathfinder II	Apr 27	44	97	100	100	81	88
NAF-6	Apr 27	23	72	99	100	89	92
Significance Level (p)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)		22	16	10	10	14	11

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

CONTROL OF RED MAPLE, PIN CHERRY, AND BLACK LOCUST PROVIDED BY BASAL BARK APPLICATIONS OF KRENITE S

INTRODUCTION

A study was established in 1993-94 to compare five Krenite S treatments, and Garlon 4 in oil for control of pin cherry (*Prunus pensylvanica* L.), black locust (*Robinia pseudoacacia* L.), and red maple (*Acer rubrum* L.) with a basal bark application. Krenite S is not currently labeled for basal bark applications and is still under experimentation for this use.

MATERIALS AND METHODS

The treatments included Krenite S at 100, 50, and 25 percent in water; and Krenite S/oil/water at 50/25/25 and 25/25/50 (v/v), using a crop oil concentrate (Penevator 9) for the oil component. The experimental design for all three species was a completely randomized design, with 10 replications. Each replication consisted of a single plant. Stem diameters were measured for all treated stems at a height of six inches. Visual ratings of percent canopy reduction were taken for all three species on July 8, 1994, and August 9, 1995; where '0' indicates full leaf canopy and '100' indicates no leaves remaining.

The red maple site was located along eastbound I-80, on a north-facing cut slope, near Loganton, PA. The treatments were applied December 9, 1993, using a piston-pump backpack equipped with a Spraying Systems #5500 conejet nozzle with a Y-2 tip. The treatment covered the lower 15 inches of the stem. Stem diameters ranged from 1.75 to 4.5 inches, measured at a height of six inches. Prior to the first rating, this section of roadway was closed for resurfacing, and the site was impacted by earth moving equipment. Seven stems were destroyed, and 23 appeared to be suffering from mechanical injury. These stems were omitted from the analysis of variance.

The pin cherry site was located along westbound I-80, on a south facing cut slope, near Loganton, PA. Treatments were applied February 7, 1994. Both the pin cherry and locust treatments were scheduled to be treated in December, but shortly after the maple treatments were applied, central Pennsylvania was blanketed with continuous snow cover until the first week of April. Five days prior to the application to pin cherry and locust, approximately 12 inches of snow was removed from around the base of the stems. Treated stem sizes ranged from 1.5 to 3.25 inches. The treatments were applied with a CO_2-powered, hand held sprayer equipped with a Spraying Systems #5500 conejet nozzle with a Y-2 tip.

The black locust stems were located along US Route 322, near Port Matilda, PA, on a north facing cut slope. Treatments were applied February 7, 1994, to stems ranging from 2 to 5 inches in diameter. The stems were numbered after leaf drop in 1993, and it was apparent at the first rating in 1994 that the lower branches of some of the plants were treated during a PennDOT Garlon plus Escort spray application during late summer 1993. A total of 15 stems were identified as possibly having been treated by PennDOT. The analysis of variance was performed with and without these treated stems and are reported as either a full or partial data set, respectively.

RESULTS

Stem diameter was not a significant covariate for either rating for any of the species. Treatment effect was highly significant for all three species at both ratings. In red maple and black locust, where replications were unequal, a single LSD value is not reported. The number of remaining or uninjured stems used for the analysis of variance on red maple and black locust is reported in Tables 1 and 3, respectively.

Garlon 4 plus oil provided complete control of red maple (Table 1), while none of the Krenite S treatments were significantly different than the check. The range of canopy reduction for Krenite S treatments was only 13 to 23 percent , so no trends among the different mixtures was apparent.

Garlon 4 provided 100 percent canopy reduction of pin cherry (Table 2). The Krenite S treatments provided significant canopy reduction compared to the check (23 percent), and ranged from 47 to 78 percent in 1995. Canopy reduction by Krenite S treatments appeared to be a function of mixture concentration, while carrier did not impact control. There was minimal root sprouting.

Krenite S was much more active on black locust than maple or cherry. The undiluted treatment and the Krenite S/oil/water at 50/25/25 provided 100 percent canopy reduction in 1995, compared to 95 percent for Garlon 4. Carrier had a significant impact on canopy reduction, as the 50 and 25 percent Krenite S treatments with oil provided equal control to the 100 and 50 percent treatments in water-only, respectively. The 25 percent Krenite S in water-only was not significantly different than the check. There was no indication of root sprouting from controlled stems treated with Krenite S.

Canopy reduction values for the checks were reported 'as seen', rather than given zero values. Pin cherry had the highest canopy reduction values for the check, 23 percent in 1995. It is believed this was due to the high stem density and full canopy, which caused shading of the lower branches.

The undiluted Krenite S and Krenite S/oil/water at 50/25/25 did not disperse out of the nozzle as readily as the other treatments during the applications.

CONCLUSIONS

In this test, control of red maple was poor regardless of the rate of application of the Krenite S. The canopy of pin cherry was significantly reduced by the treatments, but the level of control was generally unacceptable. Only the Krenite S at 100 percent provided control that was not significantly different from the Garlon 4 standard in 1995. The control of black locust was significantly affected by concentration and carrier type. The effectiveness of Krenite S basal bark treatments is species dependent, but from the results of this study, there is hope for control of root spouting species with basal applications, if a suitable tank mix partner can be identified.

Table 1: Visual ratings of canopy reduction of red maple treated December 9, 1993. Ratings were taken July 8, 1994, and August 9, 1995. The treated stand was damaged by road construction during the summer of 1994 and injured stems were omitted from the analysis. The number of remaining stems used for the analysis is indicated for each treatment and represents the number of replications.

Treatment	Mixture Rate	Remaining Stems	Canopy Reduction July 1994	Canopy Reduction August 1995
	(%)		(%)	(%)
Krenite S	100	7	12 b	13 b
Krenite S/Water	50/50	7	24 b	20 b
Krenite S/Water	25/75	9	24 b	21 b
Krenite S/Oil/Water	50/25/25	8	25 b	17 b
Krenite S/Oil/Water	25/25/50	6	34 b	23 b
Garlon 4/Oil	25/75	7	100 a	100 a
Untreated Check	- - -	3	8 b	3 b
Significance Level (p)			0.0001	0.0001

Table 2: Visual ratings of canopy reduction of pin cherry treated February 7, 1994. Ratings were taken July 8, 1994, and August 9, 1995. Each value is the mean of ten replications.

Treatment	Mixture Rate	July 1994 Canopy Reduction	August 1995 Canopy Reduction
	(%)	(%)	(%)
Krenite S	100	72	78
Krenite S/Water	50/50	57	65
Krenite S/Water	25/75	47	47
Krenite S/Oil/Water	50/25/25	58	65
Krenite S/Oil/Water	25/25/50	41	55
Garlon 4/Oil	25/75	100	100
Untreated Check	- - -	26	23
Significance Level (p)		0.0001	0.0001
LSD (p=0.05)		20	23

Table 3: Visual ratings of canopy reduction of black locust treated February 7, 1994. Ratings were taken July 11, 1994, and August 4, 1995. Each value reported in the full data set is the mean of ten replications. For the values reported in the partial data set, the number of stems used for the analysis is reported and represents the number of replications.

		Full Data Set		Partial Data Set[1/]		
Treatment	Mixture Rate	Jul 94	Aug 95	no. stems	Jul 94	Aug 95
	(%)	(%)	(%)		(%)	(%)
Krenite S	100	91	100	9	91 a[2/]	100 a[2/]
Krenite S/Water	50/50	60	75	9	57 b	72 c
Krenite S/Water	25/75	46	40	5	24 c	17 d
Krenite S/Oil/Water	50/25/25	79	100	9	79 ab	100 a
Krenite S/Oil/Water	25/25/50	72	81	8	67 b	78 bc
Garlon 4/Oil	25/75	97	95	9	96 a	94 ab
Untreated Check	- - -	27	10	6	20 c	8 d
Significance Level (p)		0.0001	0.0001		0.0001	0.0001
LSD (p=0.05)		19	23			

1/ Stems that appeared to have been treated during summer of 1993 by PennDOT were omitted from the analysis of variance.

2/ Means followed by the same letter are not significantly different according to a protected Fisher's LSD test (p=0.05).

CONTROL OF RESPROUTS OF PIN CHERRY, BLACK LOCUST, AND RED MAPLE WITH CUT SURFACE APPLICATIONS OF KRENITE S

INTRODUCTION

A study was established to evaluate the effect, if any, Krenite S had on the control of resprouts of pin cherry (*Prunus pensylvanica* L.), black locust (*Robinia pseudoacacia* L.), and red maple (*Acer rubrum* L.) when applied to a stump surface following cutting.

MATERIALS AND METHODS

Five Krenite S treatments were compared against a standard, Garlon 4 in oil, and an untreated check. The treatments included Krenite S at 100, 50, and 25 percent in water: and Krenite S/oil/water at 50/25/25 and 25/25/50 percent, using a crop oil concentrate (Penvevator 9) for the oil component. All stems were cut by chain saw and the interval between cutting and treatment did not exceed 20 minutes. The experimental design for all three species was a completely randomized design, with ten replications. Each replication consisted of a single stem.

The red maple site was located along eastbound I-80, near Bellefonte, PA, beneath a full canopy of a mixed stand of trees including black birch (*Betula lenta* L.), red oak (*Quercus rubra* L.), and white pine (*Pinus strobus* L.). The treated stem diameters ranged from 3.5 to 7 inches at a height of six inches from the base. The treatments were applied November 10, 1993, using a CO2-powered sprayer equipped with a Spraying Systems #5500 adjustable conejet nozzle, with a Y-2 tip.

The pin cherry site was located along westbound I-80, near Loganton, PA, on a south facing, shaley cut slope originally seeded to crownvetch. The treatment area consisted almost solely of pin cherry. The treatments were applied November 10, 1993, using a CO2-powered sprayer equipped with a Spraying Systems #5500 adjustable ConeJet nozzle, with a Y-2 tip. Stem diameters, measured at a height of six inches, ranged from 2 to 5.5 inches.

The black locust site was located north of State College, PA, near the western junction of US and Business Routes 322. The locust stems were on the edge of a relatively undisturbed, mixed stand of oak and red maple. Stem diameters, measured at six inches, ranged from 3 to 7.5 inches. The treatments were applied November 12, 1993, using hand-held squirt bottles.

For all species, each treated stem was evaluated for number of resprouts, and sprout clump width and average height on July 11, 1994, and December 4, 1995. Resprout canopy volumes were calculated using a cylinder as an approximation. Data for sprout canopy volume and sprout number were subjected to an analysis of variance, with treated stem diameter used as a covariate.

RESULTS

All treatments were active on pin cherry (Table 1), as all treated stumps were essentially clear of sprouts. Sprouts were often observed on exposed roots eminating from the treated stump. These sprouts, and occasionally adjacent uncut stems, were stunted and chlorotic. At the December 1995 rating, the distance from the cut stumps to the nearest root sprouts were measured and subjected to an analysis of variance, but there was no treatment effect.

All treatments were effective on black locust (Table 2). The Krenite S/water, 25/75, and Garlon 4 treatments had minor sprouting, but the resprout canopy volume of the untreated stumps was greater than 100 times larger. As with the pin cherry, there were root sprouts observed away from the stump on many treated plants.

In red maple (Table 3), the herbicide treatments effectively reduced the resprout canopy volume, but only the Garlon 4 treatments, undiluted Krenite S and Krenite S/oil/water at a percent solution of 50/25/25, significantly reduced the resprout number compared to the untreated check. Foliar symptoms were not observed in 1995, but the resprout stems were severely stunted compared to the sprouts arising from untreated stumps.

The only instance of stem diameter providing a significant effect on the canopy volume was on pin cherry in December, 1995, but the only treatment producing sprouts was the untreated check.

CONCLUSIONS

Krenite S applications clearly reduce stump resprouts of pin cherry, black locust, and red maple. Pin cherry and black locust were adequately controlled by all rates of Krenite S tested, but control of red maple resprouts was rate depentdent. Based on observations of symptoms on root sprouts and adjacent uncut stems of pin cherry, it is apparent that Krenite S is translocating through the root system. If this is the case, this may serve as a useful tool in the management of large-growing, root suckering species, possibly tree-of-heaven (*Ailanthus altissima*).

In retrospect, the design of the pin cherry and locust experiments were flawed, as the root suckering nature of these species often made it difficult to determine the 'parent' stem of the root sprouts occurring near treated stems. The pin cherry site would have lent itself to blocking the treatments, due to the discrete clump form of the clone. The locust was much less dense, and was most likely a congregation of several clones. By not treating sizable blocks of stems in the root suckering species plots, we failed to get an indication of how effective the Krenite S treatments would be on controlling the entire root system of a suckering species. This will be done in future studies.

Table 1: Measurements of canopy volume and sprout number, taken July 1994, and December 1995, from pin cherry stumps treated November 10, 1993. Each value is the mean of 10 replications.

		July 1994		December 1995	
Treatment	Mixture Rate	Canopy Volume	Sprout Number	Canopy Volume	Sprout Number
	(%)	(ft^3)	(#/stump)	(ft^3)	(#/stump)
1. Krenite S	100	0.0	0.0	0	0.1
2. Krenite S/Water	50/50	0.03	0.5	0	0.0
3. Krenite S/Water	25/75	0.07	5.3	0	0.3
4. Krenite S/Oil/Water	50/25/25	0.01	1.5	0	0.0
5. Krenite S/Oil/Water	25/25/50	0.01	0.7	0	0.1
6. Garlon 4/Oil	25/75	0.64	0.4	0	0.0
7. Untreated Check	- - -	5.4	29.0	40	14.9
Significance Level (p)		0.0001	0.0001	0.003	0.0001
LSD (p=0.05)		1.8	6.4	23	3.4

Table 2: Measurements of canopy volume and sprout number, taken July 1994, and December 1995, from black locust stumps treated November 11, 1993. Each value is the mean of 10 replications.

Treatment	Mixture Rate	July 1994 Canopy Volume	July 1994 Sprout Number	December 1995 Canopy Volume	December 1995 Sprout Number
	(%)	(ft^3)	(#/stump)	(ft^3)	(#/stump)
1. Krenite S	100	0.0	0.0	0.0	0.0
2. Krenite S/Water	50/50	0.03	0.3	0.0	0.0
3. Krenite S/Water	25/75	0.2	1.4	4.0	0.5
4. Krenite S/Oil/Water	50/25/25	0.0	0.0	0.0	0.0
5. Krenite S/Oil/Water	25/25/50	0.0	0.0	0.0	0.0
6. Garlon 4/Oil	25/75	0.0	0.0	4.4	0.5
7. Untreated Check	- - -	32.6	10.0	525.9	5.4
Significance Level (p)		0.0007	0.0001	0.0001	0.0001
LSD (p=0.05)		15	2.8	233	1.6

Table 3: Measurements of canopy volume and sprout number, taken July 1994, and December 1995, from red maple stumps treated November 10, 1993. Each value is the mean of 10 replications.

Treatment	Mixture Rate	July 1994 Canopy Volume	July 1994 Sprout Number	December 1995 Canopy Volume	December 1995 Sprout Number
	(%)	(ft^3)	(#/stump)	(ft^3)	(#/stump)
1. Krenite S	100	0.0	0.9	0.2	5.7
2. Krenite S/Water	50/50	0.04	8.5	0.8	15.8
3. Krenite S/Water	25/75	0.07	7.6	1.3	26.6
4. Krenite S/Oil/Water	50/25/25	0.04	3.3	0.9	13.2
5. Krenite S/Oil/Water	25/25/50	0.45	23.7	6.9	31.9
6. Garlon 4/Oil	25/75	0.0	0.0	0.02	1.5
7. Untreated Check	- - -	7.2	27.3	67.2	27.6
Significance Level (p)		0.0001	0.0001	0.02	0.0001
LSD (p=0.05)		2.9	11.7	43.0	14

EVALUATION OF BRUSH CONTROL PROVIDED BY VANQUISH WITH LOW VOLUME APPLICATIONS

INTRODUCTION

A study was established near State College, PA, to evaluate brush control provided by a low volume foliar application of the diglycol amine salt of dicamba, or the product Vanquish, alone and in combination with other herbicides.

MATERIALS AND METHODS

Treatments were applied to a recently clear cut area on September 8, 1994. Vanquish was applied alone at rates of 1.0, 1.25, 1.5, and 2.0 qts/ac; in combination with Garlon 3A, Arsenal, and RoundUp; and compared to RoundUp plus Arsenal and Krenite S plus Arsenal (Table 1). The plots were 20 by 100 ft, arranged in a randomized complete block design with two replications. Applications were made with a CO_2-powered backpack sprayer operating at 20 psi and equipped with a handgun containing a Spraying Systems #5500 adjustable conejet nozzle with a Y-2 tip. An application volume of approximately 15 gal/ac was targeted. All spray treatments included a surfactant, QwikWet 357, and a drift control agent, Formula 358, at 0.125 and 0.5 percent v/v, respectively. Each plot contained several tree species ranging from 3 to 10 ft in height. The predominant species were red maple (*Acer rubrum* L.), black cherry (*Prunus serotina* Ehrh.), quaking aspen (*Populus tremuloides* Michx.), mockernut hickory (*Carya tomentosa* L.), white oak (*Quercus alba* L.), red oak (*Quercus rubra* L.), and green ash (*Fraxinus pennsylvanica* Marsh.). Visual ratings of foliar necrosis, or 'brown-out', were taken September 22, 14 days after treatment (DAT), where '1' indicates 0-20 percent discoloration of the leaves and '5' indicates 80-100 percent discoloration of the leaves. Visual ratings of percent canopy reduction were taken August 24, 1995 (350 DAT), where '0' indicates full leaf canopy and '100' indicates no leaves remaining or complete control.

RESULTS

The treatments causing the most overall foliar necrosis 14 DAT (Table 1) were 1.5 qts/ac Vanquish plus 0.75 qts/ac Arsenal; both Vanquish plus RoundUp treatments; and RoundUp plus Arsenal. Untreated check values represent the amount of natural fall coloration at the time of rating.

The treatments providing the best canopy reduction 350 DAT (Table 2) were RoundUp plus Arsenal and 1.5 qts/ac Vanquish plus 0.75 qts/ac Arsenal, both with 97 percent reduction; and 2 qts/ac Vanquish plus 0.5 qts/ac Arsenal with 89 percent reduction. Krenite S plus Arsenal provided an average of only 79 percent canopy reduction, due primarily to poor control of populus or quaking aspen. The 1.5 qts/ac rate of Vanquish plus RoundUp provided an average of 82 percent canopy reduction, including total control of cherry but poor control of ash. Vanquish alone did not provide satisfactory results at any rate.

CONCLUSIONS

The two Vanquish plus Arsenal combinations evaluated in this trial provided control similar to RoundUp plus Arsenal, but used higher rates of Arsenal. Due to the soil activity of Arsenal, combinations with Vanquish using lower rates of Arsenal may need to be evaluated if this combination is to be regularly used on rights-of-way. However, a loss in control of treated stems may be encountered. The treatments providing the greatest amount of foliar necrosis or 'brown-out' also provided the best control 350 DAT. Therefore, if 'brown-out' is not an important concern, these treatments appear to provide effective brush control with a low volume foliar application.

TABLE 1: Treatments were applied September 8, 1994. All treatments contained 0.125% (v/v) QwikWet 357 and 0.5% (v/v) Formula 358 drift control. Ratings of foliar necrosis or 'brown-out' were taken September 22 and 23, 1994, on various brush species where '1' denotes 0-20% discoloration of leaves and '5' denotes 80-100% discoloration of leaves. Each rating value is the mean of two replications and numbers in parentheses indicate the total treated stems for both replications. A '- -' indicates the species was not present in the treatment area.

	Application	Brown-out Ratings						
Treatment	Rate	Maple	Cherry	Populus	Hickory	Oak	Ash	Other
	(qts/ac)	(1-5)	(1-5)	(1-5)	(1-5)	(1-5)	(1-5)	(1-5)
Vanquish	2	1.2 (10)	2.7 (17)	1.3 (8)	- - - -	2.0 (2)	2.4 (14)	- - - -
Vanquish	1.5	1.8 (5)	1.5 (11)	1.8 (27)	1.0 (3)	1.0 (10)	2.3 (13)	4.0 (1)
Vanquish	1.25	1.6 (15)	2.6 (8)	1.2 (21)	1.0 (2)	1.2 (19)	3.0 (12)	1.0 (1)
Vanquish	1	1.6 (11)	2.4 (10)	1.8 (8)	1.5 (2)	1.5 (9)	2.5 (21)	2.0 (1)
Vanquish Garlon 3A	2 1	2.3 (7)	3.5 (18)	3.5 (18)	1.8 (5)	1.8 (4)	2.1 (13)	- - - -
Vanquish Arsenal	2 0.5	2.2 (10)	3.6 (12)	1.8 (20)	1.0 (2)	1.0 (3)	2.4 (33)	3.0 (1)
Vanquish Arsenal	1.5 0.75	3.3 (6)	3.6 (16)	2.3 (12)	2.0 (1)	2.0 (1)	3.4 (24)	- - - -
Vanquish RoundUp	2 1.5	3.1 (10)	3.5 (10)	2.6 (11)	1.0 (2)	2.0 (3)	3.6 (22)	5.0 (3)
Vanquish RoundUp	1.5 1.5	3.3 (5)	4.7 (8)	3.2 (40)	- - - -	3.5 (2)	3.7 (18)	- - - -
Krenite S Arsenal	3 0.3	2.4 (10)	2.6 (19)	1.4 (20)	- - - -	- - - -	2.6 (32)	- - - -
RoundUp Arsenal	3 0.3	3.6 (8)	3.4 (6)	3.5 (38)	2.0 (2)	1.5 (4)	3.7 (19)	- - - -
Untreated	- - -	1.5 (16)	1.2 (20)	1.2 (23)	1.5 (5)	1.2 (10)	1.9 (33)	- - - -
Significance Level (p)		0.009	0.007	0.08	0.7	0.05	0.09	- -
LSD (p=0.10)		0.9	1.1	1.4	n.s.	1.0	1.0	- -

TABLE 2: Treatments were applied September 8, 1994. All treatments contained 0.125% (v/v) QwikWet 357 and 0.5% (v/v) Formula 358 drift control. Ratings of percent canopy reduction were taken August 23 and 24, 1995, on various brush species where '0' denotes full canopy and no discoloration of leaves and '100' denotes no leaves remaining on tree. Each rating value is the mean of two replications and the number in parentheses indicate the total treated stems evaluated for both replications. A '- -' indicates the species was not present in the treatment area.

Treatment	Application Rate	Canopy Reduction Ratings							
		Maple	Cherry	Populus	Hickory	Oak	Ash	Other	Total
	(qts/ac)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Vanquish	2	86 (9)	39 (17)	40 (5)	- -	40 (2)	52 (16)	- -	53 (49)
Vanquish	1.5	30 (4)	13 (9)	49 (29)	8 (2)	76(10)	72 (11)	5 (1)	36 (66)
Vanquish	1.25	63(16)	44 (8)	39 (21)	5 (2)	63(17)	55 (13)	10(1)	41 (78)
Vanquish	1	49 (9)	33 (8)	46 (6)	25 (2)	72 (9)	44 (20)	5 (1)	42 (55)
Vanquish Garlon 3A	2 1	83 (7)	57 (17)	50 (19)	38 (5)	100(4)	89 (12)	- -	68 (64)
Vanquish Arsenal	2 0.5	100(10)	89 (12)	71 (19)	60 (2)	98 (3)	97 (31)	100(1)	89 (78)
Vanquish Arsenal	1.5 0.75	100(6)	94 (16)	94 (12)	100 (1)	100(1)	97 (24)	- -	97 (60)
Vanquish RoundUp	2 1.5	57(10)	88 (11)	72 (9)	90 (2)	83 (3)	70 (21)	- -	75 (56)
Vanquish RoundUp	1.5 1.5	82 (5)	100 (8)	85 (39)	- -	78 (2)	66 (16)	- -	82 (70)
Krenite S Arsenal	3 0.3	100(10)	71 (19)	47 (20)	- -	- -	100 (33)	- -	79 (82)
RoundUp Arsenal	3 0.3	100(8)	100 (7)	100 (37)	98 (2)	87 (4)	98 (20)	- -	97 (78)
Untreated	- - -	23(16)	6 (22)	7 (24)	6 (4)	5 (10)	15 (33)	- -	11(109)
Significance Level (p)		0.003	0.0008	0.0003	0.0009	0.001	0.0005	- -	0.0001
LSD (p=0.05)		34	37	25	18	30	25	- -	12

EVALUATION OF SPRING-APPLIED HERBICIDE TREATMENTS FOR THE CONTROL OF GIANT KNOTWEED - SECOND YEAR RESULTS

INTRODUCTION

Giant knotweed (*Polygonum sachalinense* F.Schmidt ex Maxim) and Japanese knotweed (*Polygonum cuspidatum* Sieb & Zucc.) are becoming an increasing problem along Pennsylvania's roadways. These very similar species are characterized by few-branched stems with hollow internodes, growing in dense colonies to heights of 10 feet. A trial was established in 1994 to evaluate the effectiveness of a variety of herbicide combinations on the control of giant knotweed. Most of the herbicides used have little soil activity and would allow the seeding of a cover crop shortly after treatment. An evaluation was made over a two year period to determine the extent of regrowth within the treated areas.

MATERIALS AND METHODS

The study area was located near Doylestown, PA, on the shoulder of SR 611, in a patch of giant knotweed approximately 0.5 acre in size. Treatments were applied May 10, 1994, to 6 by 40 ft plots with a CO_2-powered, hand-held sprayer delivering 20 gal/ac at 29 psi, using Spraying Systems 8002 flat fan spray tips. The experimental design was a randomized complete block with three replications. Treatments (Table 1) included an untreated check, and combinations of Transline, Vanquish, RoundUp, Arsenal, Escort, and Garlon 3A. All herbicide treatments contained QwikWet 357 surfactant at 0.125% (v/v) and StaPut drift retardent at 0.25% (v/v). At the time of application, the knotweed ranged in size from 4 to 6.5 feet. Percent defoliation was rated June 10, and percent control of the treated stems was rated August 3 and October 11, 1994. The number of resprouts within each plot was counted August 3, and percent ground cover from resprouts was rated October 11, 1994; and May 26, 1995.

RESULTS

All herbicide treatments provided at least 90 percent defoliation at the June 10 rating, except for Transline plus Arsenal, Transline plus Escort, and Arsenal plus Escort (Table 1). 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. At this rating, five treatments were rated at greater than 90 percent control: RoundUp plus Arsenal, RoundUp plus Escort, Vanquish plus Arsenal, Vanquish plus Transline, and Transline plus Escort. Of these five, only RoundUp plus Arsenal had significantly more resprouts than the untreated check. On October 11, the best rated treatment was Vanquish plus Transline, which provided complete control of treated stems and 4 percent ground cover from resprouts. Other treatments that provided at least 90 percent control of treated stems and less than 10 percent ground cover from resprouts included RoundUp plus Arsenal, RoundUp plus Escort, Transline plus Arsenal, Transline plus Escort, and Arsenal plus Escort. The untreated check plots contained 4 percent groundcover from resprouts. Resprouts ranged in height from 1 to 4 ft at this rating period. On the final rating of resprout cover, taken May 26, 1995, the only treatment not significantly different from the untreated check was Garlon 3A plus Arsenal, at 80 percent cover. The best rated treatment was Vanquish plus Transline, at 8 percent. Treatments that were not significantly different from the best treatment contained up to 25 percent resprout cover, and included RoundUp plus Arsenal, RoundUp plus Escort, RoundUp plus Transline, Vanquish plus Arsenal, and Transline plus Arsenal.

CONCLUSIONS

Giant knotweed is an extremely hard to control weed. Çurrently, it does not appear that it is possible to control it with one application of an herbicide or combination of herbicides. The best treatment scenario would involve severely injuring the stand of knotweed with an herbicide application that had little soil residue and seeding a grass cover crop. Vanquish plus Transline and RoundUp plus Transline provided good control of the giant knotweed and have little soil residue. Regrowth of the knotweed could be spot treated with an herbicide that would selectivly kill knotweed but not the grass. Vanquish and transline are two herbicides that could be used for this purpose.

An alternative would be to use RoundUp plus Arsenal, RoundUp plus Escort, RoundUp plus Transline, Vanquish plus Arsenal, or Transline plus Arsenal to provide initial kill of the knotweed. Vanquish plus Transline and RoundUp plus Transline could then be used for a follow-up treatment of the resprouts prior to seeding the grass.

Future research will focus on the establishment of grass in areas treated for giant knotweed control.

TABLE 1: Summary of treated-stem control and resprout growth of giant knotweed treated May 10, 1994. A visual rating of percent defoliation was 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 rated October 11, 1994, and May 26, 1995. Each value is the mean of three replications.

		Jun 10, 1994	Aug 3, 1994		Oct 11, 1994		May 26, 1995
Treatment	Application Rate	Defoliation	Control	Resprouts	Control	Resprout Cover	Resprout Cover
	(oz/ac)	(%)	(%)	(#/240 ft^2)	(%)	(%)	(%)
RoundUp	128	90	63	20	82	38	40
RoundUp + Arsenal	128 8	94	97	24	100	10	17
RoundUp + Escort	128 1	96	99	10	98	5	18
RoundUp + Transline	128 8	95	81	16	95	13	23
Garlon 3A + Escort	96 1	96	77	15	90	75	70
Garlon 3A + Arsenal	96 8	92	79	22	93	58	80
Vanquish + Arsenal	96 8	99	100	10	100	20	21
Garlon 3A + Transline	96 8	94	63	19	93	47	72
Vanquish + Transline	96 8	99	100	6	100	4	8
Transline + Arsenal	8 8	40	88	16	95	5	25
Transline + Escort	8 1	43	94	12	98	5	43
Arsenal + Escort	8 1	37	85	12	93	9	58
Untreated Check	- -	0	0	9	0	4	100
Significance Level (p)		0.0001	0.0001	0.0045	0.0001	0.0001	0.0001
LSD (p=0.05)		13	31	8	6	28	24

EFFECT OF SPRAY ADJUVANTS ON THE CONTROL OF TALL FESCUE

INTRODUCTION

Spray adjuvants can improve the wetting and spreading of a spray solution over an entire leaf surface, improve the penetration of the herbicides into the leaf tissue, and help hold the herbicide on the leaf longer to improve the overall absorption into the leaf. This study was established to determine which surfactants, if any, may provide increased control of tall fescue (*Festuca arundinacea* L.) with an application of Rodeo herbicide (5.4 lbs ai/gal glyphosate with no surfactant).

MATERIALS AND METHODS

Most of the 'families' or types of surfactants available were tested within the study, with at least one representative from each. The families and products tested were as follows: organosilicone blend (Kinetic and QwikWet), 100% organosilicone (L-77 and Break-Thru), methylated seed oil and organosilicone blend (Dyne-Amic), crop oil concentrate (Clean Cut), crop oil concentrate and Dypentine blend (Clean Cut plus Pine and Cide-Kick II), crop oil concentrate and d'Limonene blend (Clean Cut plus Citrus and Cide-Kick), 90/10 (X-77) with 90% surfactant and 10% inert ingredients, and pinolene (Nu-Film-IR). Two experimental products were also tested and no product from an 80/20 category was tested.

The study area was located at Penn State's Landscape Management Research Center in an established stand of turf-type tall fescue. The arrangement was a randomized complete block design with three replications. The entire area received an application of 44 lbs N/ac of 46-0-0 fertilizer on May 23, 1995, with a broadcast rotary spreader. At the time of treatment on June 1, 1995, the tall fescue had a vegetative canopy height of 4-5 in with seedheads from 6-8 in. Each surfactant was applied in combination with either 0.75 or 1.5 lbs ai/ac Rodeo to 3 by 15 ft plots. The rates of Rodeo applied were below labeled rates, but were selected with an attempt to isolate any differences in control provided by the surfactants. Application was made using a CO_2 powered sprayer equipped with Spraying Systems XR 8004 VS nozzles, delivering 25 GPA at 18 psi. All treatments contained 0.25% (v/v) Formula 358 drift control. A light drizzle fell one hour after application. A rating of percent green cover was taken June 9, 8 days after treatment (DAT), June 19, 18 DAT, and July 21, 1995, 50 DAT.

RESULTS

Green cover ratings on June 9 showed minimal differences among treatments; therefore, the values are not reported. All treated areas had green cover ratings from 48 to 75 percent on June 19 and had significantly less green than the untreated check (Table 1). Experimental #1, Kinetic, L-77, and Dyne-Amic applied with 1.5 lbs ai/ac Rodeo and Break-Thru at either Rodeo rate provided the least amount of green cover. Ratings on July 21 showed statistically similar results for the untreated check, Dyne-Amic, Clean Cut plus Citrus, Clean Cut plus Pine, and Cide-Kick II applied with 0.75 lbs ai/ac Rodeo. Kinetic, QwikWet, L-77, Dyne-Amic, and Cide-Kick applied with 1.5 lbs ai/ac Rodeo, and Break-Thru applied at either Rodeo rate, provided among the lowest ratings overall and significantly less green cover than treatments containing no surfactant. Break-Thru with 1.5 lbs ai/ac Rodeo actually provided statistically less green cover than all other treatments. Treatments without surfactant showed no difference between the Rodeo rates and the only surfactants to show a statistical increase in control between the low and high Rodeo rates were Nu-Film-IR, Kinetic, QwikWet, L-77, Break-Thru, Dyne-Amic, Cide-Kick, and Cide-Kick II.

The authors suspect that the light drizzle which fell one hour after application may have affected the results of the treatments.

CONCLUSIONS

Under the conditions of this study, increased control of the tall fescue was obtained with only a few surfactants, predominantly those containing organosilicones (blends, 100%, or with methylated seed oils). Further investigation should be continued evaluating surfactants for their ability to increase control on various target species (turf, weeds, and brush).

Table 1: Treatments were applied June 1, 1995. Ratings of green cover were taken June 9, 8 DAT, June 19, 18 DAT, and July 21, 50 DAT. Minimal differences were observed between the ratings on June 9 and the data is not reported. Each value is the mean of 3 replications.

Surfactant	Surfactant Rate	Rodeo Rate	Green Cover June 19	Green Cover July 21
	(oz/ac or % v/v)	(lb ai/ac)	(%)	(%)
Untreated Check	- -	- -	95	100
None (Treated Check)	- -	0.75	70	88
		1.5	63	87
Nu-Film-IR	12	0.75	70	89
		1.5	63	78
Experimental #1	12	0.75	67	87
		1.5	57	80
Kinetic (%)	0.1	0.75	70	89
		1.5	55	73
QwikWet (%)	0.1	0.75	65	88
		1.5	60	73
L-77 (%)	0.1	0.75	60	78
		1.5	55	67
Break-Thru (%)	0.1	0.75	57	75
		1.5	48	57
Dyne-Amic (%)	0.38	0.75	67	91
		1.5	55	77
Clean Cut	16	0.75	70	86
		1.5	62	78
Clean Cut plus Citrus	16	0.75	73	91
		1.5	63	82
Cide-Kick	16	0.75	68	85
		1.5	58	74
Clean Cut plus Pine	16	0.75	75	92
		1.5	63	83
Cide-Kick II	16	0.75	68	92
		1.5	63	82
X-77	16	0.75	62	87
		1.5	62	80
Experimental #2	12	0.75	67	86
		1.5	62	88
Significance Level (p)			0.0001	0.0001
LSD (p=0.05)			9	9

COMPARISON OF ROUNDUP AND MON 65005

INTRODUCTION

A study was established at Penn State's Landscape Management Research Center to compare RoundUp and an experimental glyphosate product (MON 65005). MON 65005 contains the same amount of active ingredient as RoundUp but contains an improved surfactant, thus eliminating the need for additional surfactants to be added into the tank mixture.

MATERIALS AND METHODS

Treatments included an untreated check, 2 and 4 qts/ac of RoundUp, and 2 and 4 qts/ac of MON 65005. An additional surfactant, Clean Cut at 0.5 qts/ac, was added to the RoundUp treatments. All treatments contained 0.25% v/v Formula 358 drift control. Treatments were applied to a 3 in high stand of tall fescue (*Festuca arundinacea* L.) on July 13, 1995; using a CO_2-powered hand held sprayer equipped with Spraying Systems XR 8002 VS spray tips, delivering 20 GPA at 30 psi. The experimental plots were 6 by 15 ft with a randomized complete block design and three replications. A solid stand of tall fescue was present in all plots at the time of treatment with very little weed pressure. Visual ratings of percent green cover were taken July 17, 1995, 4 days after treatment (DAT); a rating of '1' indicates 0-20% green cover in the plot, '3' indicates 40-60% green cover, and '5' indicates 80-100% green cover. Ratings of percent green cover were taken July 24, 11 DAT, and August 8, 26 DAT;'0' indicates no green cover remaining and '100' indicates total green cover remaining in the plot. Other observations were planned to evaluate the long term control of both products on the tall fescue, but a severe drought was experienced throughout August and September which caused all of the turf to turn brown and show signs of necrosis.

RESULTS

The rating on July 17 showed no variability between replications for each treatment and no LSD value is reported; however, all differences are significant (Table 1). All treatments showed significantly less green cover in the plots than the untreated check at all ratings. When comparing RoundUp and MON 65005, no significant differences were observed at any rating when applied at identical rates. The 2 qts/ac rate for both products showed more green cover than the 4 qts/ac rate at the July 17 and 24 ratings. On August 8, no statistical differences were observed between application rates.

CONCLUSIONS

At the time of this publication, Monsanto has discontinued the sale of RoundUp and has introduced MON 65005 under the trade name RoundUp PRO. Based on the results of this study, there was no observable differences in control between RoundUp plus Clean Cut and MON 65005.

Table 1: Treatments were applied July 13, 1995. Ratings of percent green cover on July 17, July 24, and August 8, 1995. Ratings on July 17 were made from 1-5, where '1' denotes 0-20% green cover and '5' denotes 80-100% green cover. Ratings on July 24 and August 8 were made from 0-100, where '0' indicates no green remaining and '100' indicates total green cover of plot. Each value is the mean of 3 replications.

Treatment	Application Rate	Green Cover July 17	July 24	August 8
	(qts/ac)	(1-5)	(%)	(%)
Untreated Check	- - -	5	98	73
RoundUp	2	3	15	1
Clean Cut	0.5			
MON 65005	2	3	15	2
RoundUp	4	2	1	0
Clean Cut	0.5			
MON 65005	4	2	1	0
Significance Level (p)		0.0001	0.0001	0.0001
LSD (p=0.05)		- -[1/]	9	6

[1/] No variability among ratings for each replication was observed (p=0). All differences are significant.

EVALUATION OF ENDURANCE AND PREDICT FOR PREEMERGENCE VEGETATION CONTROL

INTRODUCTION

A study was established to evaluate the preemergent herbicides Endurance and Predict for broad spectrum preemergence control under a guiderail.

MATERIALS AND METHODS

The study area was located along SR 150 near Bellefonte, PA, and was treated with 4 qts/ac RoundUp, 0.125% (v/v) QwikWet 357, and 0.375% (v/v) Formula 358, on April 28, 1995, to control the existing vegetation. The application was made with a piston-pump backpack sprayer equipped with a Spraying Systems OC-08 spray tip, delivering approximately 25 GPA. Treatments (Table 1) included Endurance and Predict alone, in combination, and with Gallery, Karmex, or Arsenal. A standard treatment of Oust plus Karmex and an untreated check were also included. All treatments contained 0.25% (v/v) Formula 358 drift control. Treatments were applied May 1, with a CO_2-powered hand held sprayer equipped with a single Spraying Systems OC-08 spray tip, delivering 35 GPA at 25 psi. The experimental plots were 3 by 25 ft, arranged in a randomized complete block design with three replications. Visual groundcover ratings of only annual weed species were taken June 30, July 27, and August 28, 1995.

The plots covered an area 1 ft wide in front and 2 ft behind the guiderail. The 1 ft area in front of the guiderail was accidentally mowed by PennDOT crews on June 5. It did not have a major impact on the study as the vegetation present continued to grow. Another accidental incident occurred in mid-July where a spray contractor treated the vegetation in front of and behind the guiderail with a treatment of Garlon/Escort. This treatment was not applied over the entire study area and only affected broadleaf weeds and brush within one replication. However, a rating was taken in July before any substantial control or browning of the treated vegetation in this replication occurred. The rating of this replication on August 28 was only slightly affected by this misapplication because most of the annual weeds present were grass species, which were not injured by the spray.

RESULTS

The ratings in June, July, and August, showed no significant difference across the treatments and all provided more control of annual species than the untreated check, except for Endurance alone at the August rating (Table 1). Predominant annual species were giant foxtail (*Setaria faberi* Herrm.), common ragweed (*Ambrosia artemisiifolia* L.), yellow foxtail (*Setaria glauca* (L.) Beauv.), and large crabgrass (*Digitaria sanguinalis* (L.) Scop.).

CONCLUSIONS

The mowing of the area in front of the guiderail in June and the misapplication of the Garlon/Escort in July appears to have had a minimal affect on the study. The results of the study showed that Endurance and Predict provided season long control of annual vegetation alone or in combination with other herbicides. However, combination treatments in this study provided higher ratings than single herbicide treatments and they can often control a broader spectrum of weed species.

TABLE 1: Treatments were applied May 1, 1995. All treatments contained 0.25% v/v Formula 358 drift control. Ratings of percent cover of annual species within the plot were taken June 30, July 27, and August 28, 1995. Each value is the mean of three replications.

Treatment	Application Rate	Cover of Annuals		
		June 30	July 27	August 28
	(oz/ac)	(%)	(%)	(%)
Untreated Check	- - -	23	38	41
Endurance	24.6	8	10	18
Predict	32	2	4	5
Predict	48	2	2	3
Endurance Predict	24.6 48	1	1	1
Endurance Predict Gallery	24.6 32 10.7	1	1	2
Endurance Predict Gallery	24.6 48 10.7	1	1	2
Endurance Karmex	24.6 80	1	1	1
Endurance Arsenal	24.6 16[1/]	1	1	2
Oust Karmex	3 80	1	1	1
Significance Level(p)		0.05	0.02	0.04
LSD (p=0.05)		13	20	24

[1/] Fluid ounces

DEMONSTRATION TREE AND SHRUB PLANTING

INTRODUCTION

Trees and shrubs are planted along roadsides to enhance the beauty and increase the safety of the highway system. Ornamental trees and shrubs make roads safer by breaking the monotony of highway travel and keeping drivers more alert. They also provide light and wind barriers, block drifting snow, and protect adjoining properties from the sights and sounds associated with the road.

However, trees along roadsides are subject to a number of stresses that can severely reduce their survival and growth. By understanding the stresses that affect trees along roadsides, and what causes them, tree plantings can be established that will survive and perform better than many of those done in the past. Also, since trees along roadsides can become hazards to users of the road, additional restrictions must be considered when selecting where and what to plant.

<u>Salt.</u> Deicing salts used on roads can injure trees through foliar or root contact. Vehicles can splash water containing salt or, at high speeds, create saltwater sprays that can be deposited on the foliage of evergreens. Melting snow and rains wash salt from the highways and carry it into the soil where it can concentrate until diluted by spring rains. Salt deposits on foliage or high salt concentrations around roots can lead to the desiccation and death of the affected tissues, injuring and disfiguring, or killing, the entire plant. No trees or shrubs should be planted in low areas which will receive a lot of runoff from highways that are salted heavily. Evergreen trees that are sensitive to salt sprays should not be planted close to highways. Currently, the single most overused salt sensitive tree is Eastern White Pine.

<u>Establishment and maintenance of groundcovers.</u> Most trees planted along roadsides are planted at the same time the groundcover is seeded, or worse, planted into an established groundcover. From the simple standpoint of competitiveness, the standard cool-season grasses such as tall and fine fescues and perennial ryegrass have the greatest negative impact on tree survival and growth. They produce both a dense root system and alleleopathic chemicals that inhibit the growth of tree roots. The roots of crownvetch are not as competitive with tree roots as the grasses, but dense stands of both crownvetch and grass present several other problems for trees. 'Varmints' (voles, rabbits, groundhogs) that make their homes in the cover provided often chew on the bark of trees, severely injuring or killing them. Other 'varmints' that operate mowers sometimes try to trim too close to trees and rip the bark off them near the soil line. These wounds reduce the movement of water and nutrients in the plant and open the trunk to decay organisms.

Planting trees in groups and surrounding them with shrubs will keep mowers and the worst of the competitive vegetation away from them. At the time of planting, a four inch layer of bark or wood chip mulch should be placed around the trees and shrubs, preferably covering the whole planted area. A layer of solid black plastic under the mulch would be useful in preventing weed growth for a year or more. A low-growing groundcover such as the PennDOT specified seed mix 'Formula L', should be seeded in the remaining area within the cluster because it would require little maintenance, no mowing, and reduce weed invasion.

<u>Size.</u> The primary objective of PennDOT's vegetation managers is to make the roads safe for users. Trees along roadsides that could pose a hazard to users are removed. Trees that could eventually pose a hazard to highway users should not be planted in the right-of-way. Though white pines can reach heights well in excess of 70 feet, they have been planted much closer than that to roads. Evergreen trees have been planted that shade road and bridge surfaces in the winter. The direct seeding of forest tree species is being done in areas that would normally be treated for brush control.

Trees, or seeds of trees, that grow tall should not be planted close to roads. Evergreen trees should not be planted where they can shade road surfaces, especially bridges. There are many small to medium sized evergreen and deciduous trees that would make excellent trees for roadside use.

Planting practices. The traditional planting practices for trees in PennDOT's rights-of-way have too often lead to the death of the trees. Guy wires or metal trunk guards that were not removed the year following planting have girdled and killed many trees that otherwise would have survived. Newly planted trees should not be staked unless the soil balls are damaged and the tree will not stand upright without support. Expandable plastic guards should be used to protect the trunks of trees rather than the heavy steel guards that have been used.

Species should be selected that are adapted to the zone and site conditions where they are being established. The trees and shrubs being planted should be tolerant to the harsh environment that exists along the roadside. Little care will be given to nurture these plants once established. The amount of sunlight the plant will receive, soil type, and surrounding vegetation should be considered when choosing the species and cultivar. The timing of the planting for trees, shrubs, or groundcovers should be done in the spring or fall of the year when natural rainfall and cooler temperatures help to ensure the success of the planting.

A planting that followed these guidelines was established for evaluation near State College, PA, in 1994.

MATERIALS AND METHODS

The planting site was located in an infield area along the interchange of Park Avenue and SR 322 West. The planting design placed several trees in a cluster surrounded by ornamental shrubs. The selected area was located on a fill slope and was placed at a safe distance from the road surface with an attempt to minimize the potential for salt damage to the plants. The design also incorporated existing white pines (*Pinus strobus*), a sweet gum (*Liquidambar styraciflua*), and two London plane trees (*Platanus acerifolia*).

The existing groundcover, comprised predominantly of crownvetch (*Coronilla varia*), was treated with an application of 4 qts/ac RoundUp, 15.5 oz/ac Weedone 170, 0.125% (v/v) SilWet, and 0.5% (v/v) Sta-Put on May 13, 1994. The application was made with a motorized backpack sprayer equipped with a hand-held spray boom containing Spraying Systems 8002 nozzles, delivering approximately 23 GPA at 50 psi.

On May 19, holes were excavated for the trees using a backhoe. The trees were delivered, planted, and watered on May 23. A layer of black plastic was placed around the trees to provide a weed barrier and several inches of wood chips were then placed upon the plastic to serve as a mulching material. The trees planted included five sweet crab apples (*Malus coronaria*), green ash (*Fraxinus pennsylvanica*), three northern red oak (*Quercus rubra*), two bradford pear (*Pyrus calleryana*), four white pines, and four Colorado spruce (*Picea pungens*). The white pines were planted to compare their survival and growth with the Colorado spruce, which in theory should be better adapted to the harsh roadside environment. All of the trees were field-grown and balled in burlap.

On May 25, a row of 25 forsythia (*Forsythia intermedia*) and 25 doublefile viburnum (*Viburnum* plicatum) were planted along the borders of the trees. All of the shrubs were container grown, in a soilless media. Several inches of wood chips were placed around the plants and they were watered.

The weather following planting was hot and dry. The viburnum began to wilt severely. To prevent losses, both the trees and shrubs were watered on June 1 and 3, with trees receiving a total of 35 gal water and shrubs 25 gal.

The infield area of the planting was mowed on August 19 with a small walk-behind rotary mower to reduce the canopy height of the weeds present. The area was then treated August 24 with 4 qts/ac RoundUp, 8 oz/ac Transline, 0.25% (v/v) QwikWet 357, and 0.5% (v/v) Formula 358 drift control to control the existing vegetation in preparation for groundcover establishment. The application was made with a motorized backpack sprayer equipped with a hand-held spray boom containing Spraying Systems 8002 nozzles, delivering approximately 23 GPA at 50 psi. A piston-type backpack sprayer equipped with a handgun containing a Spraying Systems #5500 adjustable conejet nozzle with a Y2 tip was used for treating the mulched areas near the shrubs and trees. The predominant vegetation included crownvetch, pokeweed (*Phytolacca americana*), velvetleaf (*Abutilon theophrasti*), plumeless thistle (*Carduus acanthoides*), and Canada thistle (*Cirsium arvense*).

Any existing soil mounds were leveled on September 2 and the infield area was prepared for seeding with a tractor mounted Olathe slice seeder. The area was then broadcast seeded with 60% hard fescue (*Festuca longifolia*) and 40% creeping red fescue (*Festuca rubra*) at 100 lbs/ac.

The infield area was mowed with a flail mower to a height of 7 inches on August 2, 1995, to reduce the canopy height of invading weeds. Observations of the trees, shrubs, and Formula L growth were recorded.

RESULTS

Despite dry growing seasons in 1994 and 1995, the trees and shrubs grew well. In 1994, several crabapples had some bark injury due to rodents. The injured trees recovered in 1995. One pear and two oaks were completely girdled by the rodents and were totally defoliated in 1995, so they were cut and removed during the early summer. By the August 1995 observation, the two oak stumps were sprouting.

The Formula L filled in and had grown to heights of 7 or 8 inches by August 1995 and was providing almost total groundcover. However, a fair amount of weed invasion did occur, including plumeless thistle, Canada thistle, bull thistle (*Cirsium vulgare*), pokeweed, and crownvetch.

CONCLUSIONS

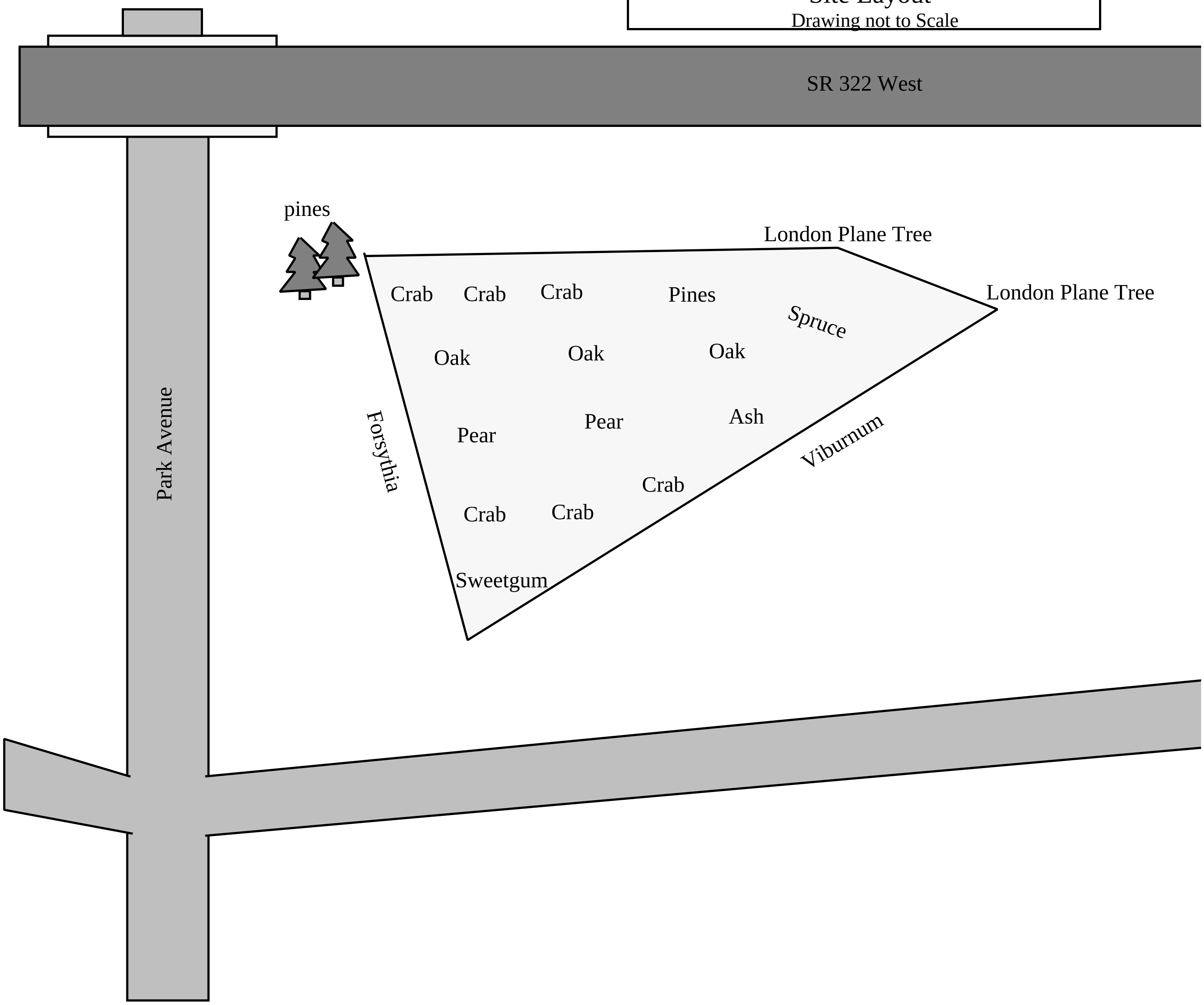
The planting has been fairly successful despite the loss of a few trees and invasion of weeds. The failure to use tree guards around the trunks of the trees was an oversight that proved costly. In low maintainence areas rodents can always be expected to be a problem. The survival of the trees and shrubs that were not injured by rodents was very high and can probably be attributed to the few applications of water they received. The weather was extremely hot and dry following planting, and the viburnums had begun to wilt prior to watering. Without the water, they may have died. The viburnum and the forsythia were container grown plants. Almost all container grown plants are grown in soilless media and are subject severe water stress if not watered several times after planting. As much as possible, balled in burlap plants should be used in roadside plantings.

A selective herbicide application is planned for the summer of 1996 to remove any existing weeds. Also, the planting will continue to be monitored to observe the growth of the trees, shrubs, Formula L, and weeds throughout the coming years.

Demonstration Tree and Shrub Planting

Site Layout

Drawing not to Scale



EVALUATION OF WILDFLOWER ESTABLISHMENT IN TALL FESCUE SUPPRESSED WITH HERBICIDES

INTRODUCTION

Research conducted by the project in the past has shown that in general, annual wildflower species have performed better than biennial or perennial species along Pennsylvania's roadways. Therefore, a current method of wildflower establishment is to control the existing vegetation within the plot with a herbicide application, prepare the seedbed (disking, tilling, etc.), seed the plot with annual species, and at the end of the growing season mow off the vegetation. This method of establishment has several disadvantages. After the wildflowers are mowed in the fall, a barren area remains. Then, a decline in the quality of wildflowers seems to occur in sites that are continually used year after year. Because there is no vegetative cover for much of the year, this area is not aesthetically pleasing to the public, and it provides an ideal location for weeds and brush to encroach onto the right-of-way. Finally, after a location is no longer to be utilized for wildflowers, the area must be reseeded to turf.

The search for a system which would solve the problem of site decline while preventing a barren area from existing within the right-of-way was initiated. Tall fescue (*Festuca arundinacea* Schreb.) is the predominant grass species found along Pennsylvania's roadsides. One concept involved the establishment of wildflowers into a stand of tall fescue. With this system a tall fescue groundcover would remain in the fall after the wildflowers had been mowed. No barren area would exist, so this location would not have to be used again the following year, thus solving the site decline issue. Also, no turf reseeding costs would have to be incurred. Broadleaf weeds have been a severe problem in established wildflower stands because they are virtually impossible to chemically remove, so with a competitive tall fescue groundcover in the wildflower stands, weed encroachment could be decreased. To permit the wildflower seedlings to germinate and grow to a height above the tall fescue canopy, the tall fescue would have to first be suppressed with a non-selective, postemergent herbicide. The objective of this study was to evaluate the development of a wildflower planting in a tall fescue turf suppressed with postemergence herbicides.

MATERIALS AND METHODS

Herbicide treatments included 3 and 6 qts/ac Finale, 16 qts/ac Scythe, 0.75 qts/ac RoundUp, 1.5 qts/ac Reward, and an untreated check. The treatments of RoundUp and Reward contained QwikWet 357 at 0.125% v/v and all treatments contained Formula 358 drift control at 0.25% v/v. Treatments were applied to 6 by 15 ft plots at Penn State's Landscape Management Research Center on April 18, 1995, using a CO_2-powered hand held sprayer equipped with Spraying Systems XR 8004 VS spray tips, delivering 40 GPA at 30 psi. On April 25, 1995, 7 days after treatment, the untreated check was mowed to 1.25 in, the entire study area was grooved two times to a depth of 0.25 in with a soil slicer, and all plots were seeded with wildflowers at 12 lbs/ac using a shaker jar. The annual wildflower mix contained cosmos (*Cosmos bipinnatus*), corn poppy (*Papaver rhoeas*), cornflower (*Centaurea cyanus*), tall plains coreopsis (*Coreopsis tinctoria*), sweet alyssum (*Dianthus barbatus*), and rocket larkspur (*Delphinium ajacis*). The wildflowers were mowed in October leaving a complete understory of tall fescue. Percent green cover ratings of tall fescue were taken April 19, April 25, May 19, July 12, and September 18. Visual ratings of groundcover and average canopy heights of the wildflowers were taken July 12 and September 18, 1995. Results of the tall fescue ratings are reported in Table 1 and wildflower ratings in Table 2.

RESULTS

All plots initially contained 100 percent tall fescue cover with little or no weed pressure. There was little change in the grass cover or weed pressure at the end of the study in September. The green cover rating taken April 25 showed little or no discoloration in the untreated check or RoundUp plots. The most discoloration was provided by Finale at 6 qts/ac with only 25 percent green cover remaining within the plot. The green cover rating on May 19 showed all of the treated plots were recovering, except RoundUp which had 53 percent green cover. The rating of wildflower cover on July 12 showed wildflowers germinating in all plots, with RoundUp-treated plots having 80 percent cover and the mowed check having 27 percent cover. The cover of wildflowers rated September 18 shows the RoundUp-treated plots with 63 percent cover and the mowed check with 25 percent. It is believed the decline in cover of wildflowers from July to September was due to a severe drought experienced during July, August, and September. A germination test of the wildflower seed mix was conducted in April and all species germinated. However, the only wildflowers which germinated within the plots were cosmos, cornflower, and tall plains coreopsis.

CONCLUSIONS

The only treatment to provide an acceptable stand of wildflowers within the tall fescue, was RoundUp at 0.75 qts/ac. This method of wildflower establishment could be very beneficial in reducing weed invasion into areas planted with wildflowers, solving the site decline problem, and reducing turf reseeding costs. A possible disadvantage to this treatment however, would be that an over application could permanently destroy the established turf.

TABLE 1: Herbicide treatments were applied on April 18, 1995. All treatments contained 0.25% (v/v) Formula 358 drift control. Percent green cover ratings of tall fescue were taken April 19, April 25, May 19, July 12, and September 18, 1995. Each value is the mean of three replications.

Herbicide	Application Rate	Green Cover Apr 19	Apr 25	May 19	Jul 12	Sep 18
	(qts/ac)	(------ %				------)
Finale	3	100	42	94	96	100
Finale	6	100	25	80	94	100
Scythe	16	100	42	94	95	100
RoundUp QwikWet 357	0.75 0.125% (v/v)	100	96	53	95	100
Reward QwikWet 357	1.5 0.125% (v/v)	100	37	93	93	100
mowed check	- -	100	99	97	97	100
Significance Level (p)		- -	0.0001	0.0001	0.7	0.5
LSD (p=0.05)		- -	15	7	n.s.	n.s.

TABLE 2: Herbicide treatments were applied on April 18, 1995, and the wildflowers were seeded at 12 lbs/ac on April 25, 1995. All treatments contained 0.25% (v/v) Formula 358 drift control. Visual ground cover ratings and average canopy heights of wildflowers taken July 12 and September 18, 1995. A ground cover rating of '0' indicates no cover of wildflowers and '100' indicates total coverage of the plot. Each value is the mean of three replications.

Herbicide	Application Rate	Ground Cover Jul 12	Ground Cover Sep 18	Avg. Height Jul 12	Avg. Height Sep 18
	(qts/ac)	(-------------%--------------)		(----------- in ------------)	
Finale	3	30	11	9	13
Finale	6	30	15	9	12
Scythe	16	33	16	9	11
RoundUp QwikWet 357	0.75 0.125% (v/v)	80	63	18	22
Reward QwikWet 357	1.5 0.125% (v/v)	53	46	10	16
mowed check	- -	27	25	8	15
Significance Level (p)		0.005	0.001	0.0002	0.01
LSD (p=0.05)		25	21	3	5