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DEPARTMENT OF TRANSPORTATION

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RESEARCH REPORT
SEVENTH YEAR REPORT

THE PENNSYLVANIA STATE UNIVERSITY
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The seventh 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 basal bark herbicide applications, fall foliar herbicide applications, comparison of aqueous and invert emulsion applications of herbicides, and evaluation of closed-system herbicide injection techniques.
Evaluation of low maintenance grasses emphasizing species and cultivars, mixtures, and maintenance practices.
Plant growth regulator use on turf, evaluating sethoxydim as an alternative to mefluidide, trinexapac-ethyl combinations, and mefluidide combined with flurprimidol and paclabutrazol.
Herbaceous weed control research evaluating the tolerance of tall fescue and fine fescues to metsulfuron methyl and chlorsulfuron, and the tolerance of fine fescues to postemergence grass herbicides.
A total vegetation control study comparing fall and spring herbicide applications.
Wildflower research evaluating the effect of planting date on establishment of 18 species.

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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

This report includes information from studies relating to roadside brush control, evaluation of low maintenance grasses, herbaceous weed control, plant growth regulator applications to roadside turf, total vegetation control for guiderails and signposts, wildflower evaluation. Project activities intended for demonstration purposes only are not reported.

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

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

Trade Name	Active Ingredients	Formulation	Manufacturer
Access	picloram, triclopyr	3 OS (1.0, 2.0)	DowElanco
Arsenal	imazapyr	2 S	American Cyanamid Co.
Assure II	quizalofop-p-ethyl	0.88 EC	E.I. DuPont de Nemours & Co.
Banvel 520	2,4-D, dicamba	2.9 OS (1.9, 1.0)	Sandoz Crop Protection Co.
Banvel	dicamba	4 S	Sandoz Crop Protection Co.
Chopper	imazapyr	2 S	American Cyanamid Co.
CideKick II	adjuvant	- - -	JLB International Chemical Co.
Clean Cut	adjuvant	- - -	Arborchem Products, Inc.
Cutless	flurprimidol	50 W	DowElanco
Embark	mefluidide	2 S	PBI/Gordon Corporation
Escort	metsulfuron methyl	60 DG	E.I. DuPont de Nemours & Co.
Event	imazethapyr, imazapyr	1.46 S (1.43, 0.03)	American Cyanamid Company
Fusilade 2000	fluazifop-p-butyl	1 EC	ICI Americas
EXP-4167	2,4-D, 2,4-DP	RTU	Rhone Poulenc Ag Company
Garlon 3A	triclopyr	3 S	DowElanco
Garlon 4	triclopyr	4 EC	DowElanco

continued

(continued) 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
Horizon	fenoxaprop-ethyl	1EC	Hoechst-Roussel
Horizon 2000	fenoxaprop-ethyl, fluazifop-p-butyl	2.56 EC	Hoechst-Roussel
Hy-Grade	adjuvant	- - -	CWC Chemical Company
Hyvar X	bromacil	80 DF	E.I. du Pont de Nemours & Co.
Karmex	diuron	80 DF	E.I. du Pont de Nemours & Co.
Krenite S	fosamine ammonium	4 S	E.I. DuPont de Nemours & Co.
Oust	sulfometuron methyl	75 DF	E.I. du Pont de Nemours & Co.
- - -	paclabutrazol	50 W	ICI Americas
Penetrator	adjuvant	- - -	Helena Chemical
Primo	trinexapac-ethyl	1EC	CIBA Corporation
RiteWay	adjuvant	- - -	N.G. Gilbert Company
Spike	tebuthiuron	80 W	DowElanco
Telar	chlorsulfuron	75 DG	E.I. DuPont de Nemours & Co.
Vantage	sethoxydim	1 EC	BASF
Verdict	haloxyfop-methyl	2 EC	DowElanco
Visko-Rhap RTU	adjuvant	- - -	Agro-Linz
Weedone 170	2,4-D, 2,4-DP	3.7 EC (1.85, 1.85)	Rhone Poulenc Ag Company
Weedone CB	2,4-D, 2,4-DP	RTU	Rhone Poulenc Ag Company

Use of Statistics in This Report

Many of the individual reports in this document make use of statistics, particularly techniques involved in the analysis of variance. The use of these techniques allows for the establishment of a criteria for significance, or, when the differences between numbers are most likely due to the different treatments, rather than due to chance. We have relied almost exclusively on the commonly used probability level of 0.05. When two values are significantly different 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 results tables where analysis of variance has been employed, there is a value for significance level and LSD. The significance level is the probability that the variation between the different treatments is due to chance. Therefore, the lower the significance level, or p-value, the less likely the differences are due to chance. When the p-value is equal or less than 0.05, Fisher's Least Significant Difference (LSD) means separation test is used. This procedure produces a value that represents the least difference between two treatments that is significant when p=0.05. When the difference between two treatment means is equal or greater than the LSD value, these two values are significantly different.

When the p-value is greater than 0.05, the LSD procedure is not used. What is being demanded with this criteria is that the variation among 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.

BASAL BARK HERBICIDE APPLICATIONS TO FOUR BRUSH SPECIES ALONG ROADSIDES

INTRODUCTION

Basal bark herbicide applications provide an extremely flexible and selective method to control brush in roadside settings. This experiment compared Banvel 520 and Weedone 170 in various combinations; and ready-to-use formulations of 2,4-D plus 2,4-DP; to Garlon 4 and Access.

MATERIALS AND METHODS

Eleven herbicide combinations (Table 1) were applied April 10-12, 1991, to the basal bark of 10 stems each of red maple (*Acer rubrum*), black birch (*Betula lenta*), and quaking aspen (*Populus tremuloides*); and 8 stems of Virginia pine (*Pinus virginiana*). The treatments were applied with a syringe with a 14 ga pipetting needle, at the rate of 2.0 ml solution/inch of stem circumference measured at a height of 6 in. Stem diameters for all species ranged from 1 to 4 in, with most in the 1.5 to 2.5 in range. Eight of the herbicide treatments were diluted in HyGrade, and one in RiteWay. The remaining two treatments were ready-to-use formulations. In 1991, injury ratings were taken for birch and aspen on August 19, and maple and pine on September 9. In 1992, all species were rated July 1. Each stem was rated on a 1 to 5 scale, with 1=no injury, and 5=dead stem.

RESULTS

Quaking aspen was totally controlled by all treatments in 1991, and no suckering was observed in 1992.

At least seven of the eight treated stems of Virginia pine were killed by all treatments except EXP 4167 and Weedone CB, which controlled six and five stems, respectively. All treatments containing Banvel 520 provided complete control of all pine stems. Weedone 170 plus Access diluted in RiteWay killed pines sooner than when diluted in HyGrade, but both treatments provided complete control when rated in 1992.

All treatments containing Garlon 4 or Access provided quick, complete control of red maple. Banvel 520 alone provided poor control of maples, but provided almost complete control when combined with Chopper. EXP 4167 provide 70 percent control of maples, while Weedone CB provided only 30 percent.

All treatments provided at least 80 percent control of birch, except for EXP 4167, which controlled half of the treated stems and moderately injured the remainder.

CONCLUSIONS

Garlon 4 and Access alone provided complete control of all but one and two stems, respectively, in the entire test. Combining these materials with other products in this test provided no benefit. Banvel 520 alone at 50 percent solution was effective on aspen, birch, and pine; but only killed one stem of red maple. Combining Banvel 520 with Chopper improved control of maple to 90 percent. The effectiveness of Weedone 170 when combined with Access could not be determined because Access alone at the same rate provided similar control.

The use of a syringe to apply treatments in this experiment removed application variability, and provided excellent results using lower rates of Garlon 4 and Access than are used operationally. The rates of Banvel 520 and the RTU products were operational, however, and did not provide control equal to Garlon 4 or Access.

TABLE 1: The number of stems of four brush species in each injury rating category the year of application, and the season following application with basal bark herbicide treatments. Injury was rated on a 1 to 5 scale, with 1=no injury, and 5=dead stem. Applications were made April 10-12, 1991, to 10 stems each of red maple, black birch, quaking aspen; and eight stems each of Virginia Pine. Stems falling into rating categories '1' and '2' are not shown.

		red maple						black birch						quaking aspen						Virginia pine					
		1991			1992			1991			1992			1991			1992			1991			1992		
Product	% v/v	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
		(stems/category)						(stems/category)						(stems/category)						(stems/category)					
Garlon 4	10			10			10		1	9			10			10			10	1	1	5	1		7
HyGrade	90																								
Access	6			10			10	1	2	7		1	9			10			10	1	1	6			7
HyGrade	94																								
Banvel 520	30	1	1	2			2	3	4	2		2	8			10			10	1	1	6			8
HyGrade	70																								
Banvel 520	50	4	3				1		3	7			10			10			10	1	1	6			8
HyGrade	50																								
Banvel 520	30		1	9			10		1	9			10			10			10			8			8
Garlon 4	10																								
HyGrade	60																								
Banvel 520	30			10			10		1	9		1	9			10			10			8			8
Access	10																								
HyGrade	60																								
Banvel 520	40	2	2	6		1	9	1	3	6	1		9			10			10		1	7			8
Chopper	4																								
HyGrade	66																								
Weedone 170	14			10			10	1	1	8	1		9			10			10	3	1	4		1	7
Access	6																								
HyGrade	80																								
Weedone 170	14			10			10	1	1	8	1	1	8			10			10		1	7			8
Access	6																								
RiteWay	80																								
EXP 4167	100	1		7			7	6	3	1	4	1	5			10			10		2	6	2		6
Weedone CB	100	2		2			3	3	2	5			10			10			10	3	1	4	2	1	5

STUDIES OF FALL FOLIAR HERBICIDE APPLICATIONS FOR CONTROLLING ROADSIDE BRUSH

INTRODUCTION

The Department of Transportation relies on late season, foliar applied herbicides to provide effective brush control with a low visual impact, as the herbicides used and the timing of application allows the injury symptoms to blend somewhat with natural fall coloration. The effect of these treatments must be confined to the treated branches of the brush, due to the potential of off-site damage if the herbicides translocate widely through the brush, and damage portions of the plant that may be off the right-of-way. Two studies were initiated in 1991 to continue evaluations of the ability of different herbicide combinations to provide confined brush control. A study near New Stanton, PA, evaluated previously considered herbicides at lower application volumes and revised combinations. A study conducted at University Park compared applications of Garlon and Krenite S alone and in combination.

MATERIALS AND METHODS

A study comparing four different herbicide combinations including Krenite S was established near New Stanton, PA, on August 27, 1991. The treatments included Krenite S at 6 qt/ac in combination with either Arsenal at 4 oz/ac, Roundup at 1.5 qt/ac, Garlon 4 at 1.5 qt/ac, or Escort at 1 oz/ac. Krenite S plus Arsenal was applied at two spray volumes, 9 gal/ac and 30 gal/ac. All other treatments were applied in 30 gal/ac. The treatments were applied to plots 175 ft long using a CO_2-powered sprayer and a Radiarc. The 30 gal/ac treatments were applied to a 13 ft vertical pattern at 30 psi, and the 9 gal/ac treatment was applied to a 15 ft vertical pattern at 30 psi. All treatments included Clean Cut at 0.25% v/v. The most common species were red maple (*Acer rubrum*), red oak (*Quercus rubra*), black cherry (*Prunus serotina*), green ash (*Fraxinus pennsylvanica*), staghorn sumac (*Rhus typhina*), sassafras (*Sassafras albidum*), flowering dogwood (*Cornus florida*), and multiflora rose (*Rosa multiflora*).

A second study, evaluating Krenite S and Garlon formulations, alone and in combination, was established September 14, 1991, at the Pennsylvania State University, near the University Park Airport. The treatments included Garlon 4 alone at 2 and 4 qt/ac; Krenite S alone at 6 qt/ac; Krenite S plus Garlon 4 at three rates, 2 plus 1, 3 plus 1, and 3 plus 2 qt/ac; and Krenite S plus Garlon 3A at 2 plus 1.3 qt/ac. These treatments were applied to 150 ft plots with a 13 ft vertical pattern at 30 gal/ac at 30 psi using a CO_2-powered sprayer and a Radiarc. The most common species in this study were black cherry and red maple, with smaller amounts of red oak, sassafras, and green ash.

A visual rating of foliar injury was taken at University Park on October 4, 1991, 20 days after treatment (DAT). Brush control was visually rated at New Stanton on July 13, and University Park on August 31, 1992, with each stem rated on a scale of 1 to 7, where '1'= no injury, '5'=complete control of treated branches, '6'=control beyond the treated branches, and '7'=complete control of the plant.

RESULTS

At New Stanton, Krenite S plus Arsenal provided excellent control of all species at both 9 and 30 gal/ac (Table 1). This combination was particularly active on green ash, red maple, red oak, and American elm (*Ulmus americana*), with several 30 ft red maples completely controlled. Moderate understory injury was observed in both of these treatments as a thinning of the original herbaceous cover. Krenite S plus Roundup was very active on sassafras, and controlled treated stems of staghorn sumac, red maple, black locust, and multiflora rose. Single stems of tuliptree (*Liriodendron tulipifera*) and flowering dogwood showed only slight injury, and apple (*Malus* spp) showed severe thinning on treated branches. Branches of sassafras, staghorn sumac,black cherry, American elder (*Sambucus canadensis*), and shingle oak (*Quercus imbricaria*) treated with Krenite S plus Garlon 4 were completely controlled. Red maple and red oak showed severe thinning of branch tips, but treated branches were not completely controlled, and treated branches of green ash were only moderately injured. Krenite S plus Escort was extremely active on multiflora rose, completely controlling all treated plants; and black cherry was controlled well above the treated branches. Sassafras was only slightly injured.

When rated 20 DAT, all treatments caused foliar injury to all species at University Park. Red maple foliage showed necrosis from all treatments. Black cherry was strongly discolored by all treatments, but displayed more necrosis when treated with Garlon 4 alone than with Krenite S or combination treatments. On August 31, 1992, Garlon 4 alone at 2 qt/ac completely controlled treated branches of black cherry, and caused severe injury to treated branches of red maple, but only slightly injured sassafras (Table 2). Increasing the Garlon 4 rate to 4 qt/ac improved control of red maple and sassafras, and completely controlled the single red oak present Krenite S alone at 6 qt/ac provided only moderate control of treated branches of black cherry, red maple, and flowering dogwood. The best activity was seen on red oak, green ash, and mockernut hickory (*Carya tomentosa*) which showed severe injury to treated branches, while only slight injury to sassafras was noted. When either Garlon formulation at 1 lb ai/ac was combined with 2 qt/ac of Krenite S, Garlon 4 was more effective than Garlon 3A in the control of black cherry, red maple, red oak, and green ash. Krenite S plus Garlon 4 at 3 plus 1 qt/ac, respectively, effectively controlled treated branches of black cherry, and moderately injured treated branches of red maple and green ash. Increasing the Garlon 4 rate to 2 qt/ac improved control of red maple considerably.

CONCLUSIONS

The combination of Krenite S plus Arsenal was very active on all species treated, perhaps too active. The degree of translocation shown by this treatments at the rates used could lead to off right-of-way damage. This is of particular concern in Pennsylvania, where many of the secondary road right-of-ways are only 33 ft wide, and much of the brush encroaching on the roadway originates from off the right-of-way. Efforts to refine the rates used in this combination are warranted, as each of the other combinations evaluated exhibited weakness on at least one brush species. Additional studies have been initiated to evaluate this combination at lower rates to try to maintain the excellent control of treated branches while limiting translocation beyond the treated area.

At University Park, Garlon 4 alone was more effective on the species present than Krenite S alone, and the combination of these two herbicides at 2 plus 3 lb ai/a, respectively, provided control similar to triclopyr alone at 4 lb ai/ac. The combination of these two herbicides does not seem to provide the increase in the control spectrum seen with the combination of Krenite S plus Arsenal. Under the conditions of this study, all treatments caused noticeable foliage discoloration 20 DAT, so Krenite S alone or in combination with Garlon 4 did not provide any advantage over Garlon 4 alone.

TABLE 1: Average injury rating and number of stems, by species, for foliar herbicide treatments applied August 27, 1991, at New Stanton, PA. Injury was rated July 13, 1992, on a scale of 1 to 7, where '1'=no injury, '5'=complete control of treated branches, '6'=control beyond treated branches, and '7'=complete control of the tree.

	Herbicides (product/acre)									
	Krenite S (6 qt) Arsenal (4 oz)		Krenite S (6 qt) Arsenal (4 oz)		Krenite S (6 qt) Roundup (1.5 qt)		Krenite S (6 qt) Garlon 4 (1.5 qt)		Krenite S (6 qt) Escort (1 oz)	
Species	[9 gal/ac]		[------30 gal/ac						------]	
	(------average injury rating (number of stems)------)									
red maple	6.0	(7)	5.9	(24)	5.0	(1)	4.1	(9)	- -	
staghorn sumac	5.0	(1)	5.0	(8)	4.9	(11)	5.0	(6)	- -	
black cherry	5.0	(1)	7.0	(2)	- -		5.0	(1)	6.0	(4)
sassafras	- -		5.2	(8)	5.9	(8)	5.0	(10)	2.0	(2)
red oak	5.9	(18)	7.0	(3)	- -		4.5	(4)	- -	
green ash	6.2	(11)	6.0	(3)	- -		3.0	(1)	- -	
flowering dogwood	6.0	(3)	5.5	(4)	2.0	(1)	- -		- -	
multiflora rose	- -		- -		5.0	(1)	5.0	(3)	7.0	(10)
American elder	5.0	(1)	- -		- -		5.0	(1)	- -	
shingle oak	- -		- -		- -		5.0	(1)	5.0	(1)
American elm	6.0	(4)	- -		- -		- -		- -	
hawthorn	5.2	(9)	- -		- -		- -		- -	
hickory	5.0	(1)	- -		- -		- -		- -	
black locust	- -		- -		5.0	(1)	- -		- -	
apple	- -		- -		4.0	(1)	- -		- -	
tuliptree	- -		- -		2.0	(1)	- -		- -	

TABLE 2: Foliar discoloration, or 'brownout' ratings by species for foliar herbicide treatments applied September 14, 1991, at University Park, PA. Discoloration was rated October 4, 1991, on a scale of 1 to 3, where '1'=slight discoloration, '2'=strong discoloration, and '3'=necrosis. Hyphenated values indicate a range of discoloration response, and '- -' indicates that the species was not rated.

	Herbicides (product/ac)						
Species	Garlon 4 (2 qt)	Garlon 4 (4 qt)	Krenite S (6 qt)	Krenite S (2 qt) Garlon 4 (1 qt)	Krenite S (2 qt) Garlon 3A (1.3 qt)	Krenite S (3 qt) Garlon 4 (1 qt)	Krenite S (3 qt) Garlon 4 (2 qt)
	(------discoloration ------)						
black cherry	2-3	2-3	2	2	2	2	2
red maple	3	3	3	3	3	3	3
red oak	- -	- -	2	2	2	- -	- -
sassafras	2	3	2	- -	- -	- -	- -
green ash	- -	- -	1-2	3	1-3	2	- -
mockernut hickory	- -	- -	2	2-3	2-3	- -	- -
white oak	- -	- -	- -	3	- -	- -	- -

TABLE 3: Average injury rating and number of stems by species for foliar herbicide treatments applied September 14, 1991, at University Park, PA. Injury was rated August 31, 1992, on a scale of 1 to 7, where '1'=no injury, '5'=complete control of treated branches, '6'=control beyond treated branches, and '7'=complete of control of the tree.

	Herbicides (product/ac)						
Species	Garlon 4 (2 qt)	Garlon 4 (4 qt)	Krenite S (6 qt)	Krenite S (2 qt) Garlon 4 (1 qt)	Krenite S (2 qt) Garlon 3A (1.3 qt)	Krenite S (3 qt) Garlon 4 (1 qt)	Krenite S (3 qt) Garlon 4 (2 qt)
	(-----------------------------average injury rating (number of stems) ----------------------------)						
black cherry	5.0 (9)	5.0 (9)	3.2 (11)	4.8 (9)	3.4 (9)	4.8 (13)	4.9 (21)
red maple	4.0 (2)	5.0 (5)	3.0 (4)	3.7 (3)	3.2 (4)	3.3 (3)	4.7 (16)
red oak	- -	7.0 (1)	4.5 (4)	4.5 (4)	1.0 (1)	- -	- -
sassafras	2.0 (1)	3.8 (4)	2.0 (1)	- -	- -	- -	- -
green ash	- -	- -	4.0 (2)	2.6 (17)	2.3 (6)	3.0 (1)	- -
flowering dogwood	- -	- -	3.5 (2)	- -	- -	- -	- -
mockernut hickory	- -	- -	4.0 (1)	- -	4.0 (1)	- -	- -
white oak	- -	- -	- -	4.8 (4)	- -	- -	- -
American elder	- -	- -	- -	- -	- -	- -	5.0 (1)

A COMPARISON OF AQUEOUS AND INVERT EMULSION APPLICATIONS FOR BRUSH CONTROL

INTRODUCTION

Invert emulsions provide a viscous spray carrier that when compared to aqueous solutions, reduce drift, increase throw distance, provide pattern indication, improve rain-fastness, and reduce drip from sprayed foliage. Drawbacks of invert emulsions are the increased complexity of spray equipment, and the lack of improved, easy to use equipment. There have been few modifications of invert emulsion sprayers since the 1960's. The objective of the trials reported here were to evaluate the invert emulsion technique compared to aqueous applications, to determine if the increased complexity of the invert system was outweighed by improved efficacy. Invert and aqueous applications were compared for foliar and dormant brush control applications.

MATERIALS AND METHODS

The foliar applications were made July 8, 1991, near the University Park airport. Tordon K plus Garlon 3A, at 20 plus 51 oz/ac; and Escort plus the Garlon 4 at 0.83 oz plus 38 oz/ac were applied using a Minnesota-Wanner sprayer equipped with a handgun, delivering approximately 33 gal/ac, covering a 10 ft vertical pattern. Aqueous treatments CideKick II at 0.25% v/v. Both invert emulsion treatments included a defoamer (Antifoam 1430) at 0.02% v/v. The Tordon K plus Garlon 3A invert emulsion treatment included an inverting oil, Visko-Rhap RTU, at 4.9% v/v, and the Escort plus Garlon 4 treatment included Visko-Rhap RTU at 3.1% v/v. Dormant applications were made April 9, 1992, near the University Park airport. Garlon 4 plus Weedone 170 at 3.0 plus 3.0 qt/ac, respectively, was applied as an aqueous treatment at 25 gal/ac, and as an invert emulsion treatment at 38 gal/ac. The aqueous treatment included HyGrade at 2 gal/ac, and a drift control agent (Sta-Put) at 0.75% v/v. The invert treatment included inverting oil at 5.0% v/v. The aqueous treatments were applied with CO_2-powered sprayer mounted on a utility vehicle, using a single Spraying Systems OC-40 spray tip treating a 10 ft vertical pattern. The invert treatments were applied with a modified Weed Systems sprayer with a Minnesota-Wanner flash-inverter, mounted on a utility vehicle, using a single Spraying Systems OC-40 spray tip treating a 9 ft vertical pattern. The predominant species in both test areas were black cherry (*Prunus serotina*), red maple (*Acer rubrum*), red oak (*Quercus rubra*), mockernut hickory (*Carya tomentosa*), sassafras (*Sassafras albidum*), and *Populus* spp. Brush control was rated in the foliar study on August 31, and in the dormant study on August 28, 1992, using a scale of 1 to 7, where '1'=no injury, '5'=complete control of treated branches, '6'=control beyond the treated branches, and '7'=complete control of the plant.

RESULTS

The invert emulsion application of Tordon K plus Garlon 3A completely controlled treated branches of black cherry and hickory, and gave control beyond the treated branches on red maple, red oak, flowering dogwood (*Cornus florida),* and American elm (*Ulmus americana*) (Table 1). The aqueous treatment provided similar control of black cherry, but did not demonstrate as much activity on red maple, as there was no control beyond the treated branches. The aqueous and invert applications of Escort plus Garlon 4 completely controlled treated branches of red maple, and provided some control beyond treated branches in black cherry. The invert application of this treatment completely controlled red oak.

The dormant applications of Garlon 4 plus Weedone 170 caused only a slight thinning of treated branches of black cherry, red maple, and hickory; whether applied as an invert emulsion or aqueous (Table 2). Both methods of application were effective in controlling treated branches of *Populus* and sassafras. The aqueous treatment was more effective than the invert on red oak. The invert treatment completely controlled grey dogwood (*Cornus racemosa*), and provided partial control of staghorn sumac (*Rhus typhina*).

CONCLUSIONS

In these studies, invert emulsion applications were as effective as aqueous applications, but were more difficult to apply, particularly when considering set-up and calibration that took place before going to the field. Although this increased effort was intensified by the research, rather than operational nature of the application, it must be emphasized that invert emulsions are more difficult to work with. Except in unique situations, particularly in reduced access situations where the low drift, increased throw capacity of invert emulsions would be advantageous, aqueous applications provide an easier to use and equally effective method to apply herbicides.

TABLE 1: Average injury ratings and number of stems for herbicide treatments applied as invert emulsion or aqueous treatments on July 8, 1991. Injury ratings were taken August 31, 1992, using a scale of 1 to 7, where '1'=no injury, '5'=complete control of treated branches, '6'=control beyond the treated branches, and '7'=complete control of the plant. '- -' indicates the species was not present.

	Tordon K + Garlon 3A 20 oz + 51 oz/acre				Escort + Garlon 4 0.83 oz + 38 oz/acre			
Species	invert		aqueous		invert		aqueous	
	(------------------------average injury rating (number of stems) -----------------------)							
black cherry	5.0	(9)	5.1	(19)	5.3	(11)	5.6	(10)
red maple	5.6	(7)	5.0	(16)	5.0	(2)	5.0	(1)
red oak	6.0	(1)	- -		- -		7.0	(1)
flowering dogwood	6.0	(1)	- -		- -		- -	
American elm	6.0	(1)						
hickory	5.0	(1)						

TABLE 2: Average injury ratings and number of stems for broadcast dormant stem applications made as aqueous and invert emulsion treatments on April 9, 1992. Injury ratings were taken August 28, using a scale of 1 to 7, where '1'=no injury, '5'=complete control of treated branches, '6'=control beyond the treated branches, and '7'=complete control of the plant. '- -' indicates the species was not present.

	Garlon 4 + Weedone 170 3 qt + 3 qt/acre			
Species	invert emulsion		aqueous	
	(--------------average injury ratings (number of stems)--------------)			
black cherry	2.5	(43)	2.1	(33)
red oak	2.0	(11)	3.7	(9)
red maple	2.8	(10)	2.0	(3)
<u>Populus</u> spp.	4.8	(5)	5.0	2)
mockernut hickory	1.8	(5)	2.5	(2)
staghorn sumac	3.0	(4)	- -	
sassafras	5.0	(2)	4.5	(2)
grey dogwood	5.0	(2)	- -	

CONTROL OF ROADSIDE BRUSH USING HERBICIDE INJECTION TREATMENTS

INTRODUCTION

Three methods of closed system injection were evaluated as brush control methods. Each of these methods relied on a ready to use injection unit which contained the herbicide. With these methods, the applicator is not exposed to the herbicide. These methods also reduce environmental exposure to the herbicides, and have use potential in wetland and aquatic settings. In this experiment, three brush species were treated with three injection methods, using two different herbicides.

MATERIALS AND METHODS

Five stems each of green ash (*Fraxinus pennsylvanica*), red oak (*Quercus rubra*), and red maple (*Acer rubrum*), were treated with each herbicide and injection method combination on September 11 and 12, 1991, along Interstate 80, near Bellefonte, PA. Stem diameters ranged from 2 to 10 in, with most in the 4 to 6 in range. Each injection method consisted of an injection unit containing 0.16 g ae of a dry formulation of either picloram or triclopyr, which was applied around the stem at a rate of 1 unit per 4 in of stem circumference, measured at 4 ft. The injections were made at a height of 1.5 to 3 ft on the stem. The three injection methods were the 'Wee-Do', which used an impact lance to drive a .22 caliber cartridge containing the herbicide through the bark; 'Gel Cap', which was a plastic cap mounted on a screw, and is driven into the outer bark using an electric drill; and 'F.I.C.', which consists of a hammer-like tool used to remove a plug approximately 0.4 in wide by 1.0 in deep from the tree, and a collapsible plastic capsule which is driven into the hole. Each species was treated as separate experiment site, each with a completely randomized design with a factorial treatment arrangement. Injury ratings were taken July 1, 1992, on a scale of 1 to 5, where '1'=no injury, and '5'=dead stem. 'Gel Cap' was the easiest treatment to apply, but did not seem to penetrate bark well, particularly green ash. The 'Wee-Do' provided the most consistent bark penetration, but the 4 ft lance was cumbersome to use in thick underbrush. The 'F.I.C.' was difficult to use on smaller stems, particularly on the hard-wooded species, and nearby objects interfered with the arm swing necessary to remove the plugs.

RESULTS

No red oaks, regardless of injection method, were injured by triclopyr (Table 1). Triclopyr caused only slight injury in red maple, and only moderately injured a few stems of green ash when applied with the 'Wee-Do'.

The 'Wee-Do' provided the most consistent control among the picloram treatments, causing moderate to severe injury in all species. When picloram was applied with the 'Gel-Cap', green ash was not injured, red oak ranged from no injury to severe injury, and red maple was severely injured with this method. Applied with the 'F.I.C.', picloram caused injury which ranged from slight to severe in oak and maple, but most treated stems of green ash were not injured.

Several of the treated red maples had codominant stems. When the union of the stems was below the injection site, no injury was observed in the untreated stem, even when the treated stem was killed. There were two observed instances of plants near picloram-treated green ash showing foliar injury, apparently from the herbicide being exchanged through a root graft or exuded by the roots of the treated plants.

CONCLUSIONS

The Wee-Do and F.I.C. injection methods used in this study do hold some promise as future brush control methods. Equipment very similar to the Wee-Do is being used in Canada to apply glyphosate, and the F.I.C. method is being used in Sweden with hexazinone. These methods should currently be regarded as appropriate for unique situations, such as wetlands or aquatic settings, as they are easier to use on larger brush, and would be difficult to use on brush with stem diameters less than three to four inches. Future development of quicker and easier to use injection devices would greatly enhance the usefulness of these applications for roadside brush control.

TABLE 1: Visual injury ratings for green ash, red maple, and red oak treated with picloram or triclopyr, each at 0.16 g ae per 4 in of stem circumference, using three different injection methods. Applications were made September 11 and 12, 1991; and injury ratings taken July 1, 1992, using a scale of 1 to 5, where '1'=no injury, and '5'=dead stem.

Injection	Injury Rating (1 - 5)		Method
Method	picloram	triclopyr	Mean
	Green Ash		
Wee-Do	3.2	2.0	2.6
Gel Cap	1.0	1.3	1.1
F.I.C.	1.6	1.2	1.4
Significance Level	0.0002	0.1909	0.0001
LSD (p=0.05)	0.8	n.s.	0.8
Herbicide Mean	1.9	1.5	p=0.0834
	Red Maple		
Wee-Do	4.2	1.6	2.9
Gel Cap	4.6	1.2	2.9
F.I.C	3.4	1.4	2.4
Significance Level	0.0816	0.4933	0.1680
LSD (p=0.05)	n.s.	n.s.	n.s.
Herbicide Mean	4.1	1.4	p=0.0001
	Red Oak		
Wee-Do	3.2	1.0	2.2
Gel Cap	2.4	1.0	1.7
F.I.C.	3.8	1.0	2.4
Significance Level	0.1046	- -	0.0813
LSD (p=0.05)	0.8	- -	n.s.
Herbicide Mean	3.1	1.0	p=0.0001

EVALUATION OF TURF SPECIES AND MIXTURES FOR ROADSIDE CONDITIONS

INTRODUCTION

The objective of this trial was to compare the performance of 'Kentucky 31' tall fescue to turf-type tall fescue, creeping red fescue, hard fescue, Canada bluegrass, perennial ryegrass, and deertongue grass planted alone and in combinations, under roadside maintenance conditions. The primary criteria for evaluation are cover provided by the planted species and amount of weed invasion.

MATERIALS AND METHODS

Seven single species treatments and five turf mixtures (Table 1) were established in September, 1987, at the interchange of SR 283 and SR 230, near Salunga, PA. Prior to establishment, the vegetation at the site was primarily tall fescue, and bordered a bank established to crownvetch (*Coronilla varia*). Prior to seeding, the site was treated with 3.0 lb ae/acre glyphosate, mowed, and the seedbed was prepared with an Olathe 83 overseeder, producing 0.5 in deep slits on 3 in centers. The treatments were drop seeded at 100 lb seed/acre on 12 by 30 ft plots. The experimental design was a randomized complete block with three replications. The area has not been fertilized. Herbicide treatments to control broadleaf weeds were applied July 5, 1988 (2,4-D, MCPP, and dicamba at 1.22, 0.65, and 0.11 lb ai/acre, respectively); and October 19, 1991 (triclopyr, clopyralid, and chlorsulfuron at 0.38, 0.09, and 0.012 lb ai/acre, respectively). The trial area was mowed once in 1989 and 1990. Beginning in 1991, the area was included in the PennDOT maintenance program, and was mowed four times per season; in mid-May, mid-June, early August, and early September, using a flail mower with a cutting height of approximately 2.5 in. A grid sampling with a soil auger revealed the site has a shallow soil, with an average depth of 20 in to an impenetrable layer. The 1988 and 1991 growing seasons were very dry. There were no significant periods of moisture stress during the 1989, 1990, and 1992 growing seasons. Visual ratings of percent turf cover (Table 1), and percent weed cover (Table 2) were taken April 22, May 28, July 28, September 9, and November 10, 1992. The predominant weeds were tall fescue, Kentucky bluegrass (*Poa pratensis*), quackgrass (*Elytrigia repens*), crownvetch, Canada thistle (*Cirsium arvense*), and creeping red fescue. Annual weed species were less common, and were typically found in plots that were thinned during the 1991 drought, or where sizable patches of crownvetch were killed by weed control applications in the fall of 1991.

RESULTS

The combination of hard fescue and creeping red fescue was rated highest for turf cover throughout the season, and was rated among the lowest for weed cover. The performance of this combination is notably better than either species seeded alone. Turf cover ratings for hard fescue or creeping red fescue seeded alone were significantly lower, or nearly so, than the the combination of the two species throughout the season. The individual plants in the hard fescue plots were easily distinguished, and provided little cover, particularly at the April and May ratings. As the season progressed, these plots filled in, and only the combination of hard fescue and creeping red fescue provided significantly more cover. The reasons for the performance difference between the hard and creeping red fescue alone and in combination is not clear. A contributing factor may have been the arrangement of the plots in the experimental area. By chance, the plots of hard and creeping red fescue seeded alone were clustered to one side of the experiment. This area of the study came under heavy invasion pressure from crownvetch, and had an area, extending through two experimental blocks, of very shallow soil. Plots in this area of the experiment were noticeably affected by the drought in 1991.

No perennial ryegrass was observed in any of the plots where it had been seeded. 'Tioga' deertongue grass was detectable, but was insignificant as a groundcover. There were no significant differences between 'Kentucky 31' and turf type tall fescue, but 'Kentucky 31' was consistently rated higher for turf cover and lower for weed cover. Canada bluegrass has persisted, but the stand is being reduced. Canada bluegrass is prone to weed invasion due to its upright growth habit and thin stand, and due to its drastically reduced growth during the summer months.

Plots seeded to combinations of fine fescues and tall fescue have not shown any advantage over seeding fine fescues alone. Tall fescue and fine fescues seem to co-exist well, but do not mix well visually due to great differences in leaf texture. The mixture plots do seem to have been invaded by additional tall fescue plants, but still contain more fine fescue than tall fescue.

Under low maintenance conditions, perennial ryegrass does not persist alone or in a mix, and to date has not been shown to provide better stand establishment than seeding fine fescue or tall fescue alone.

CONCLUSIONS

Five years after establishment, the combination of hard and creeping red fescue, which is very similar to the current Formula L (hard fescue 60%/creeping red fescue 40%), provided the best performance in terms of high turf cover and low weed cover. It has persisted well on a poor site through two severe droughts (1988, 1991), and tolerated a mowing regime the authors consider to be too frequent and too short for these conditions. This combination performed significantly better than either species alone. Tall fescue has also persisted well, and is one of the most common weeds in non-tall fescue plots. Under these conditions, Canada bluegrass, perennial ryegrass, and deertongue grass have not provided satisfactory groundcover. Mixing the fine fescue combination or tall fescue with other species did not provide any advantages in establishment or persistence in this study.

TABLE 1: Visual ratings of percent turf cover taken April 22, May 28, July 29, September 9, and November 10, 1992, for plots established September, 1987, near Salunga, PA. Each value is the mean of three replications.

Varieties	April 22	May 28	July 28	Sept 9	Nov 10
	(------------------------percent turf cover-------------------------)				
1. 'Kentucky-31' tall fescue	43	42	48	52	50
2. turf-type tall fescue[1/] (TTTF)	27	38	30	37	35
3. 'Ensylva' creeping red fescue(CRF)	15	23	38	42	40
4. 'Aurora' hard fescue (HF)	7	15	27	35	40
5. 'Reubens' Canada bluegrass	38	28	22	20	28
6. 'Tioga' deertongue grass	0	3	3	3	0
7. perennial ryegrass[2/] (PRG)	0	0	0	0	0
8. HF/CRF (70/30)	58	60	72	72	72
9. HF/TTTF (90/10)	27	42	43	52	45
10. HF/PRG (90/10)	38	40	53	58	52
11. HF/CRF/TTTF (80/10/10)	37	43	53	55	50
12. TTTF/PRG (90/10)	32	43	48	53	47
Significance Level (p)	0.0120	0.0107	0.0095	0.0035	0.0026
L.S.D. (p=0.05)	30	30	35	33	30

1/ 'Transition Blend', a blend of 'Cimmaron', 'Bonanza', and 'Olympia' tall fescues.
2/ 'Double Eagle Blend', a blend of 'Birdie II', 'Citation II', and 'Omega II' perennial ryegrasses.

TABLE 2: Visual ratings of percent weed cover taken April 22, May 28, July 29, September 9, and November 10, 1992, for plots established September, 1987, near Salunga, PA. Each value is the mean of three replications.

Varieties	April 22	May 28	July 28	Sept 9	Nov 10
	(------------------------percent weed cover------------------------)				
1. 'Kentucky-31' tall fescue	22	23	37	40	42
2. turf-type tall fescue[1/] (TTTF)	48	37	63	60	58
3. 'Ensylva' creeping red fescue(CRF)	38	57	52	57	52
4. 'Aurora' hard fescue (HF)	22	50	64	60	53
5. 'Reubens' Canada bluegrass	33	47	68	68	62
6. 'Tioga' deertongue grass	62	77	91	88	80
7. perennial ryegrass[2/] (PRG)	70	80	95	92	87
8. HF/CRF (70/30)	18	27	22	25	18
9. HF/TTTF (90/10)	19	30	50	43	43
10. HF/PRG (90/10)	23	45	42	38	40
11. HF/CRF/TTTF (80/10/10)	8	27	42	40	43
12. TTTF/PRG (90/10)	35	30	43	40	43
Significance Level (p)	0.0047	0.0287	0.0149	0.0099	0.0184
L.S.D. (p=0.05)	29	35	37	34	32

1/ 'Transition Blend', a blend of 'Cimmaron', 'Bonanza', and 'Olympia' tall fescues.
2/ 'Double Eagle Blend', a blend of 'Birdie II', 'Citation II', and 'Omega II' perennial ryegrasses.

EVALUATION OF TURF SPECIES AND MIXTURES UNDER MOWED AND UNMOWED CONDITIONS

INTRODUCTION

The objective of this trial was to compare tall fescue, creeping red fescue, hard fescue, Kentucky bluegrass, Canada bluegrass, perennial ryegrass, sweet vernalgrass, and several species mixtures under roadside maintenance conditions. Mowing treatments were introduced during the second growing season, to evaluate the effects of mowing on stand persistence.

MATERIALS AND METHODS

Eleven single species treatments, four species mixtures, and an unseeded check (Table 1) were established at the Landscape Management Research Center, University Park, PA, on September 14, 1988. Each treatment was drop seeded to 12 by 30 ft plots, replicated three times in a randomized complete block design. Site preparation consisted of a broadcast application of glyphosate at 3.0 lb ae/ac, mowing the killed vegetation, and preparing the seedbed with an Olathe 83 turf overseeder, which produced 0.5 in deep slits on 3 in centers. The entire study was mowed once in 1989, and in 1990 mowing treatments were added to the experiment. Half of each plot was left unmowed during the season, and the other half was mowed three times with a flail mower set at a cutting height of 3.5 in. The mowing dates for 1992 were June 11, July 30, and December 9. On September 24, 1991, a broadcast application of 2,4-D plus clopyralid at 1.0 plus 0.19 lb ae/ac was made to control broadleaf weeds. These plots have not received supplemental irrigation, or fertilizer since establishment. Visual ratings of percent turf cover on a green tissue basis (Table 2), and percent weed cover (Table 3) were taken April 23, June 10, July 29, and November 13, 1992. Rating turf cover on a green tissue basis gave values that suggest less turf cover than was actually present. All plots were well vegetated, but much of the cover provided by the turf species was a mat of leaf tissue from previous seasons. Lack of turf cover is best approximated by the weed cover ratings, but even these values can be misleading, as the more upright morphology of some of the weed species created two vegetative canopies. The ratings taken April 23 provided an indication of spring 'green-up'. These ratings were low overall, as most species had not yet produced sufficient new growth to cover the previous seasons growth. The June 10 and July 29 ratings provide an indication of vigor during the growing season, and the November 13 ratings gave an indication of color retention into the fall.

RESULTS

The unseeded plots were deleted from the statistical analysis of the cover ratings. The presence of treatments receiving turf cover ratings of zero percent biases the analysis towards a significant treatment effect. The most common species in the unseeded checks were quackgrass (*Elytrigia repens*), and wirestem muhly (*Muhlenbergia frondosa*). The most common weeds in the seeded plots were quackgrass and dandelion (*Taraxacum officinale*).

In this fourth full growing season for these plots, the treatments fell fairly neatly into three performance categories, poor, fair, and acceptable. Both perennial ryegrass treatments, and the sweet vernalgrass provided poor cover. The 'Barclay' perennial ryegrass was mostly winterkilled during 1989. The 'Double Eagle' perennial ryegrass blend is persisting at low levels where seeded alone, but is completely gone where seeded with tall fescue. The sweet vernalgrass plots are also poor, and have been thinned to scattered plants, and have been overrun by quackgrass and other perennial grasses.

Canada bluegrass is the 'fair' species in this trial. It was rated best for cover on April 23, as it grows quickly in the early spring, but provides little green cover in the summer months. Due to its upright growth habit, Canada bluegrass also provides a thin stand.

Plots seeded to tall fescue, fine fescue (including 'D.O.T.' mixture), and Kentucky bluegrass all provided acceptable performance during 1992, and through the entire course of this study. 'Kentucky 31' tall fescue was rated highest for turf cover on June 10, which was significantly better than all treatments not seeded to tall fescue except Kentucky bluegrass. The fine fescue plots had been thinned during the drought of 1991, and started the 1992 season with lower ratings than tall fescue and Kentucky bluegrass. There was an interaction between species and mowing treatments for the July 29 turf cover ratings, as the unmowed tall fescue plots were rated high for cover relative to mowed tall fescue plots and to the other species, due largely to prolific seedhead production, and lodging of these seedheads. In the mowed plots, there was little difference between turf cover for tall fescue, the fine fescues, and Kentucky bluegrass. Also, in other species the degree of difference between cover in unmowed and mowed plots was less, or the relationship was reversed, as in the case of 'Aurora' hard fescue, which received a higher turf cover rating for unmowed plots. The weed cover ratings were not significantly different between any plots seeded to tall fescue, fine fescues, or Kentucky bluegrass.

CONCLUSIONS

'Kentucky 31' and 'Transition Blend' tall fescues have performed well at this site, but produce tall seedheads, and would require mowing at least once under roadside conditions. There is little difference between these two treatments under mowed conditions. The fine fescue treatments and the Kentucky bluegrass blend have also performed well, but because of little or no seedhead production, do not have the mowing requirements of the tall fescues evaluated. The colonial bentgrass and 'Barclay' perennial ryegrass components of 'D.O.T.' mixture have been absent from the plots for several seasons, and appear to have contributed little to this mixture. Perennial ryegrass alone does not persist under these conditions, and when combined with tall fescue at varying rates, did not persist or improve establishment. Under these conditions, sweet vernalgrass does not seem to offer any promise as an alternative species due to its invasion by other species and lack of persistence.

TABLE 1: Varieties seeded to low maintenance turf plots in September, 1988.

	Treatment	Seeding Rate (lbs/acre)
1.	‘Kentucky 31’ tall fescue	100
2.	‘Transition Blend’ turf-type tall fescue	100
	(a blend of ‘Cimmaron’, ‘Bonanza’, and ‘Olympic’ turf-type tall fescues)	
3.	‘Ensylva’ creeping red fescue	100
4.	‘Pennlawn’ creeping red fescue	100
5.	‘Aurora’ hard fescue	100
6.	‘SR 3000’ hard fescue	100
7.	Kentucky bluegrass	75
	(a blend of 'Georgetown', 'Merit', 'Nassau', and 'Ram I' Kentucky bluegrasses)	
8.	‘Reubens’ Canada bluegrass	75
9.	‘Double Eagle Blend’ perennial ryegrass	100
	(a blend of ‘Citation II’, ‘Birdie II’, and ‘Omega II’ perennial ryegrasses)	
10.	sweet vernal grass	80
11.	‘Barclay’ perennial ryegrass	40
12.	‘D.O.T.’ mixture	100
	(A mixture of 30% ‘Barclay’ perennial ryegrass, 25% creeping red fescue, 25% chewings fescue, and 20% ‘Highland’ colonial bentgrass.)	
13.	perennial ryegrass/turf-type tall fescue (70/30)	100
14.	perennial ryegrass/turf-type tall fescue (50/50)	100
15.	perennial ryegrass/turf-type tall fescue (30/70)	100
16.	unseeded check	- - -

TABLE 2: Visual ratings of percent turf cover on a green tissue basis, taken April 23, June 10, July 29, and November 13, 1992, for plots established September, 1988. There was a significant interaction between species and mowing treatments for the July rating, and a L.S.D. value is reported for both mowed and unmowed values. Values for the April, June, and November ratings are the mean of six observations (three replications, two mowing treatments). The July values are the mean of three replications.

			July 29		
Species	April 23	June 10	unmowed	mowed	November 13
	(----------------------------------percent turf cover----------------------------------)				
'Kentucky 31' tall fescue	9	61	90	63	32
Turf-type tall fescue (TTTF)	9	50	83	60	28
'Ensylva' creeping red fescue	5	28	53	53	45
'Pennlawn' creeping red fescue	7	35	72	47	44
'Aurora' hard fescue	5	41	62	72	55
'SR 3000' hard fescue	5	38	57	62	46
Kentucky bluegrass	12	52	78	68	38
'Reubens' Canada bluegrass	18	30	12	15	15
Perennial ryegrass (PRG)	9	19	23	17	7
Sweet vernalgrass	2	11	2	12	0
'Barclay' perennial ryegrass	0	0	0	0	0
'D.O.T.' mixture	8	38	70	52	38
TTTF/PRG (30/70)	8	54	85	48	22
TTTF/PRG (50/50)	8	57	88	58	28
TTTF/PRG (70/30)	7	47	70	50	22
Significance Level (p)	0.0019	0.0001	0.0001	0.0001	0.0001
L.S.D. (p=0.05)	6	18	26	21	12

TABLE 3: Visual ratings of percent weed cover on a green tissue basis, taken April 23, June 10, July 29, and November 13, 1992, for plots established September, 1988.. There was a significant interaction between species and mowing treatments for the June rating, and a single L.S.D. value is reported for both mowed and unmowed values. Values for the April, July, and November ratings are the mean of six observations (three replications, two mowing treatments). The June values are the mean of three replications.

		June 10			
Species	April 23	unmowed	mowed	July 29	November 13
	(----------------------------------percent weed cover----------------------------------)				
'Kentucky 31' tall fescue	1	2	3	0	0
Turf-type tall fescue (TTTF)	1	5	1	2	2
'Ensylva' creeping red fescue	2	5	8	11	13
'Pennlawn' creeping red fescue	2	10	8	11	15
'Aurora' hard fescue	2	9	5	9	11
'SR 3000' hard fescue	3	8	9	11	10
Kentucky bluegrass	2	12	7	8	14
'Reubens' Canada bluegrass	4	27	19	27	33
Perennial ryegrass (PRG)	20	72	32	58	26
Sweet vernalgrass	14	53	42	73	28
'Barclay' perennial ryegrass	19	60	62	72	26
'D.O.T.' mixture	1	7	3	6	8
TTTF/PRG (30/70)	1	1	14	9	6
TTTF/PRG (50/50)	1	2	1	0	0
TTTF/PRG (70/30)	1	2	14	12	2
Significance Level (p)	0.0001	0.0001	0.0007	0.0001	0.0001
L.S.D. (p=0.05)	6	18	25	21	11

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

INTRODUCTION

The objective of this trial is to evaluate the performance of fine fescue and perennial ryegrass cultivars under low maintenance conditions, with and without supplemental nitrogen application.

MATERIALS AND METHODS

Twenty-four fine fescue and two low-growing perennial ryegrass cultivars (Table 1) were planted May 8, 1990, at the Larson Agricultural Research Center, Rock Springs, PA. Prior to seeding, the site was plowed, disked, and harrowed. The seed was dropped on 7.5 by 30 ft plots, and the area was cultipacked. The experimental design is a randomized complete block design with a split-block treatment arrangement and three replications. An application of 2,4-D at 0.75 lb ae/ac was made July 16, 1990, to control common lambsquarters (*Chenopodium album*) and wild buckwheat (*Polygonum convolvulus*). The study was mowed in August, 1990; September, 1991; and July and September, 1992. In 1992, a rotary mower with a cutting height of 6 in was used, and very little tissue removal occurred. An application of 44 lb urea N/ac was made to half of each cultivar plot on October 18, 1990; October 8, 1991; and October 19, 1992. The entire study was treated with dicamba plus chlorsulfuron at 1.0 plus 0.023 lb ai/ac, on November 10, 1992, to control broadleaf weeds, which included dandelion (*Taraxacum officinale*), black medic (*Medicago lupulina*), Canada thistle (*Cirsium arvense*), and red clover (*Trifolium pratense*). Data collected in 1992 included percent turf cover and canopy height on May 12; and percent turf cover, canopy height, and percent weed cover on June 15, August 14, and November 13. Percent turf cover and percent weed cover were rated visually. Turf cover was rated on a green tissue basis, rather than total groundcover. Canopy height was measured by estimating an average canopy height with a ruler for the May, June, and August ratings. Canopy height measurements in November were taken using a graduated dowel to measure the height at which a 12 in diameter by 0.25 in thick wooden disk was suspended when dropped from a height of 3 ft.

RESULTS AND DISCUSSION

Data were analyzed by cultivars (Tables 2-5), and by species (Table 6, 7). When individual cultivars were evaluated, there was a significant interaction between turf cover and maintenance for turf cover ratings taken in May, June, and August; and for vegetative canopy height taken in November. When the analysis was done by species, there was significant interaction between species and maintenance level for turf cover ratings taken in May, June, and August; and for canopy height measurements taken in June. Where interactions occur, means separations are reported for cultivars or species for each maintenance level.

All fine fescue varieties established well and provided essentially 100 percent groundcover. Differences between the fine fescue cultivars are primarily the amount of green tissue present at a given time, as there is little difference in canopy height and weed cover among the cultivars. 'Durar' hard fescue and 'Covar' sheep fescue are notable for their longer leaf blades, less dense growth habit, and prolific seedhead production. Cover ratings for 'Durar' and 'Covar' were the highest for the trial for the May ratings (Table 2). These higher cover ratings were due to the weeping, or lodging, of the very long leaf blades. 'Durar' also rated the highest for turf cover in June due to lodging of seedheads. The two perennial ryegrass cultivars have declined in vigor and stand density since establishment, when they provided about 90 percent groundcover. They have since declined to levels of 30 to 50 percent groundcover, and have significantly more weeds than the fine fescue cultivars (Table 3).

The application of 44 lb N/ac provided significantly higher cover ratings and canopy heights for May, June, and August, and significantly reduced weed cover in August (Table 5). It did not account for significant differences for any variables at the November rating.

When cultivar performance was averaged for each species, hard fescue provided the best overall performance (Table 6). Hard fescue was rated highest for turf cover in June and August, at both maintenance levels; and second highest in May, behind sheep fescue. Perennial ryegrass was rated significantly higher for turf cover (55 percent) than the fine fescue species in November, apparently a response to the fertilizer application in October. Perennial ryegrass was rated significantly higher for percent weed cover and was significantly shorter than the fine fescue species at all rating dates (Table 7).

CONCLUSIONS

All fine fescue cultivars planted in this trial have established well, and are providing excellent low maintenance groundcover. Even 'old' cultivars such as 'Durar' and 'Covar' are proving effective, although their taller growth habit and lower stand densities provide a less desirable turf than the other fine fescue cultivars in this test. Except for 'Durar' and 'Covar', the fine fescues produce few seedheads, and have proven to be very competitive with weeds, even with no fertilization. The results after three growing seasons indicate that properly mowed, unfertilized fine fescue turf is an excellent low maintenance groundcover, though an annual application of nitrogen fertilizer increases green turf cover and competitiveness with weeds, without causing a great increase in canopy height. The two low-growing perennial ryegrass cultivars in this test established quickly, but have declined notably in three seasons, and are no longer competitive with weeds.

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

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

TABLE 2: Visual ratings of percent turf cover, taken on a green tissue basis. Ratings were taken May 12, June 15, August 14, and November 13. There was a significant interaction between cultivar and maintenance level treatments for the May, June, and August ratings, and a LSD value is reported for both the 0 and 44 lb N/ac applications at each date. The values for May, June, and August are the mean of three replications; and the November values are the mean of six observations (three replications, two maintenance levels).

		May 12		June 15		August 14		
	Varieties	0 lb N/ac	44 lb N/ac	0 lb N/ac	44 lb N/ac	0 lb N/ac	44 lb N/ac	November 13
		(---percent turf cover---)						
1.	Dover	13	37	17	53	35	57	36
2.	Jamestown	15	37	20	63	37	55	28
3.	Shadow	13	38	15	60	38	67	34
4.	SHE	13	33	17	63	42	67	33
5.	SR 5000	12	30	13	60	35	58	32
6.	Victory	13	30	13	63	32	67	30
7.	Wilma	12	30	15	53	33	58	34
8.	AUE	17	33	18	70	43	83	38
9.	Biljart	13	43	18	65	52	82	38
10.	Crystal	15	48	22	72	43	82	45
11.	Durar	28	63	57	88	30	38	34
12.	HF 8250	15	35	18	65	45	83	42
13.	Reliant	18	30	23	60	47	83	43
14.	Spartan	17	33	25	60	42	87	41
15.	SR 3000	17	37	20	57	45	87	42
16.	SR 3100	13	50	20	73	48	83	36
17.	Dawson	10	22	12	43	32	70	47
18.	Bargena	8	17	13	37	33	50	40
19.	Ensylva	7	23	13	40	30	52	37
20.	Jasper	10	25	17	42	33	57	39
21.	Pennlawn	8	23	12	38	33	53	37
22.	Bighorn	10	37	20	75	43	63	28
23.	Covar	32	67	23	65	20	20	31
24.	MX-86	13	32	23	63	35	62	34
25.	Lex86	15	35	15	30	35	32	60
26.	Barclay	8	28	10	30	28	37	50
Significance Level (p)		0.0001	0.0001	0.0001	0.0001	0.0004	0.0001	0.0001
L.S.D. (p=0.05)		5	11	7	10	12	12	7

TABLE 3: Visual ratings of percent weed cover taken June 15, August 14, and November 13. Each value is the mean of six observations (three replications, two maintenance levels).

Varieties	June 15	August 14	November 13
	(-----------------------	percent weed cover	------------------------)
1. Dover	3	10	6
2. Jamestown	4	6	4
3. Shadow	3	7	5
4. SHE	4	5	2
5. SR 5000	3	7	5
6. Victory	3	6	4
7. Wilma	3	6	4
8. AUE	3	3	2
9. Biljart	7	3	5
10. Crystal	5	6	6
11. Durar	2	2	1
12. HF 8250	3	4	4
13. Reliant	3	3	3
14. Spartan	2	2	1
15. SR 3000	3	3	2
16. SR 3100	4	4	3
17. Dawson	3	11	8
18. Bargena	1	2	1
19. Ensylva	3	5	4
20. Jasper	4	6	5
21. Pennlawn	2	2	2
22. Bighorn	4	3	4
23. Covar	4	3	5
24. MX-86	3	4	3
25. Lex86	32	51	18
26. Barclay	28	43	13
Significance Level (p)	0.0001	0.0001	0.0001
L.S.D. (p-0.05)	12	12	7

TABLE 4: Measurements of vegetative canopy height taken May 12, June 15, August 14, and November 13. There was a significant interaction between variety and maintenance level treatments for the November 13 measurements, and a LSD value is reported for the 0 and 44 lb N/ac treatments. Values for May, June, and August measurements are the mean of six observations (three replications, two maintenance levels), and the November values are the mean of three replications.

				November 13	
Varieties	May 12	June 15	August 14	0 lb N/ac	44 lb N/ac
	(---------------------------vegetative canopy height, inches------------------------)				
1. Dover	6.4	7.1	7.6	4.7	7.7
2. Jamestown	7.7	8.2	6.9	5.1	5.6
3. Shadow	7.3	8.1	7.6	4.9	6.5
4. SHE	8.1	8.2	7.8	5.8	7.6
5. SR 5000	7.2	7.7	7.4	4.8	7.6
6. Victory	7.1	8.4	7.3	5.0	6.8
7. Wilma	7.7	8.0	7.1	5.2	6.8
8. AUE	6.8	7.9	8.3	6.6	7.4
9. Biljart	7.0	7.9	8.3	6.1	7.4
10. Crystal	5.8	6.4	6.7	4.5	6.2
11. Durar	10.8	11.2	8.0	4.3	4.9
12. HF 8250	6.4	7.8	7.9	5.1	7.0
13. Reliant	7.0	7.4	8.0	5.8	7.3
14. Spartan	7.4	8.0	8.5	5.8	7.4
15. SR 3000	6.7	7.4	8.2	6.3	7.4
16. SR 3100	6.8	7.9	7.3	5.8	6.8
17. Dawson	6.3	6.4	7.4	4.8	5.9
18. Bargena	9.4	8.8	8.3	5.1	5.4
19. Ensylva	7.5	7.8	7.0	4.6	5.5
20. Jasper	8.3	8.0	8.4	6.1	6.2
21. Pennlawn	9.4	9.3	8.4	5.2	5.8
22. Bighorn	6.7	7.8	8.0	5.8	6.2
23. Covar	7.4	7.7	7.6	4.6	7.2
24. MX-86	7.4	8.2	9.4	7.3	6.2
25. Lex86	3.3	3.3	3.8	2.5	2.8
26. Barclay	3.9	3.8	4.6	2.8	3.3
Significance Level (p)	0.0001	0.0001	0.0001	0.0001	0.0002
L.S.D. (p=0.05)	1.1	1.8	1.0	1.3	2.0

TABLE 5: Effect of maintenance level on turf cover, weed cover, and vegetative canopy height, measured May 12, June 15, August 14, and November 13. Each value is the mean of 78 observations (three replications, 26 cultivars).

	May 12	June 15	August 14	November 13
		Percent Turf Cover		
0 lb N/acre	14	19	37	36
44 lb N/acre	35	57	62	40
Significance Level (p)	0.0046	0.0020	0.0005	0.1201
L.S.D. (p=0.05)	6	7	2	n.s.
		Vegetative Canopy Height, inches		
0 lb N/acre	6.4	6.5	6.8	5.2
44 lb N/acre	7.9	8.7	8.3	6.3
Significance Level (p)	0.0026	- - 1/	0.0264	0.2437
L.S.D. (p=0.05)	0.3	- -	1.1	n.s.

1/ Invalid *F*-test, SSE=0.

	May 12	June 15	August 14	November 13
		Percent Weed Cover		
0 lb N/acre		6	10	6
44 lb N/acre		5	6	3
Significance Level (p)		0.1000	0.0262	0.0838
L.S.D. (p=0.05)		n.s.	3	n.s.

TABLE 6: Visual ratings of percent turf cover, on a green tissue basis, for turf species under low maintenance conditions. There was a significant interaction between species and maintenance level treatments for the May, June, and August ratings, and a LSD value is reported for both the 0 and 44 lb N/ac applications at each date. The number in parentheses after each species indicates the number of cultivars evaluated.

	May 12		Jun 15		Aug 8		
Species	0 lb N/ac	44 lb N/ac	0 lb N/ac	44 lb N/ac	0 lb N/ac	44 lb N/ac	Nov 11
	(---%---)						
chewings fescue (7)	13	34	16	60	36	61	32
creeping red fescue (4)	9	25	15	46	35	55	36
hard fescue (9)	17	42	25	69	44	78	39
sheep fescue (3)	23	49	23	64	28	41	33
slender creeping fescue (1)	10	22	12	43	32	70	47
perennial ryegrass (2)	12	32	13	30	32	34	55
Significance Level (p)	0.0001	0.0001	0.0003	0.0001	0.0328	0.0001	0.0001
LSD (p=0.05)	3	4	5	7	9	8	6

TABLE 7: Visual ratings of percent weed cover and measurements of vegetative canopy height. There was a significant interaction between species and maintenance level treatments for the June canopy height measurements, and a LSD value is reported for both the 0 and 44 lb N/ac applications. Number in parentheses after species indicates number of cultivars in trial.

	Weed Cover			Canopy Height				
					Jun 15			
Species	Jun 15	Aug 8	Nov 13	May 12	0 lb N/ac	44 lb N/ac	Aug 8	Nov 13
	(-------------%--------------)			(----------------------------in----------------------------)				
chewings fescue (7)	3	7	4	7.3	6.6	9.1	7.4	6.0
creeping red fescue (4)	3	4	3	8.3	7.3	9.3	8.0	5.6
hard fescue (9)	3	3	3	7.2	6.9	9.2	7.9	6.2
sheep fescue (3)	4	3	4	7.4	6.7	9.2	8.5	6.3
slender creeping fescue (1)	3	11	8	6.3	5.3	7.5	7.4	5.3
perennial ryegrass (2)	30	47	15	3.6	3.1	4.1	4.2	2.8
Significance Level (p)	0.0009	0.0035	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
LSD (p=0.05)	11	20	2	0.7	0.7	0.9	0.6	1.0

EVALUATION OF FINE FESCUE AND TALL FESCUE CULTIVARS UNDER LOW MAINTENANCE CONDITIONS AT THREE MOWING FREQUENCIES

INTRODUCTION

The objective of this trial is to evaluate the response of fine fescue and tall fescue cultivars to different mowing frequencies, when established to simulate roadside conditions.

MATERIALS AND METHODS

Cultivars of chewings, hard, slender creeping, creeping red, sheep, and tall fescue (Table 1) were seeded at 100 lb/ac on June 1, 1990, to 5 by 30 ft plots at the Penn State Landscape Management Research Center, University Park, PA. Prior to seeding, the area had been sprayed with 3 lb ae/ac of glyphosate, mowed, and the seedbed was prepared with a flail mower equipped with dethatching blades. The experimental design is a randomized complete block with a split block treatment arrangement, and three replications. The area was treated with 2,4-D at 0.5 lb ae/ac on July 16, and was mowed July 25 and October 16, 1990. Mowing frequency treatments of once (spring), twice (spring, fall), and three times (spring, summer, fall) per season were initiated in 1991, using a flail mower set at a cutting height of 3.75 inches. In 1992, mowing dates were June 11, July 31, and December 9. Visual ratings of percent living cover and measurements of vegetative canopy height were taken April 29, June 10, July 29, and November 5. Canopy height was estimated with a ruler for the April, June, and July measurements. For the November rating, a graduated dowel was used to measure the height at which a 12 in wide by 0.25 in thick wooden disk was suspended when dropped on the canopy from 3 ft. Visual ratings of percent weed cover were taken June 10, July 29, and November 5.

RESULTS

All cultivars in the test established well and provided excellent groundcover. Except for 'Durar' and 'Covar', seedhead production among the cultivars was very light. Turf cover ratings evaluating green tissue did not always reflect this, as much of the groundcover was provided by a mat of senesced leaf tissue. The best rated cultivars for ground cover in April were 'Durar', 'Covar', and the tall fescues (Table 2). 'Durar' and 'Covar' are taller growing fine fescue cultivars with lower tiller density than more recently released fineleaf fescue varieties. The higher groundcover ratings relative to the other fineleaf fescues were primarily due to longer leaf blade length and resultant weeping habit. There was a significant interaction between cultivar and mowing frequency for turf cover rated June 10, one day before the first 1992 mowing. Cultivar effects were non-significant for plots mowed once (p=0.0590), but were highly significant for plots mowed two or three times per season. The tall fescue cultivars provided very similar turf cover ratings regardless of mowing frequency. There was a considerable range in turf cover provided by the fineleaf fescue cultivars, ranging from values near 35 percent from 'Dawson', 'Jasper', and 'SHAE'; to ratings over 60 percent for 'Durar' and 'Bighorn'. Turf cover ratings taken July 29, two days prior to the second mowing of the 3X treatment, were notable for the poor performance of 'Covar' (25 percent), and the reduced performance of 'Durar' relative to the earlier ratings. Groundcover for both of these cultivars was considerably reduced by the first mowing due to their more upright, less dense growth habit and relatively high seedhead production, which had contributed to the groundcover ratings taken June 10. All fineleaf fescue cultivars were rated significantly higher for turf cover than the tall fescues on November 13. The tall fescues were very tightly grouped, below 30 percent; while the fine fescues ranged from 39 percent for 'Jamestown', to over 60 percent for 'Aurora', 'SR 3000', and 'AUE'.

The effect of cultivar was highly significant for vegetative canopy height measurements taken April 29 (Table 3). 'Durar' was significantly taller than any other cultivar at 8.6 inches. 'SR 3000' and 'SR 3100' were significantly shorter than all other cultivars at 4.7 and 4.9 inches, respectively. Canopy heights were significantly different between cultivars on June 10, but there was a smaller range of heights than at the April rating, as early spring growth rate differences were no longer present and the plants were probably approaching terminal height. Cultivar effects were not significant for canopy heights taken July 29, 48 days after the first mowing. Measurements taken

November 5 provided different results than earlier measurements as the suspended disk method provided more of an indication of biomass under the disk, rather than height. Taller species with thin stands, such as 'Durar', were measured lower than cultivars with denser stands that may actually have been shorter. The hard fescues (except 'Durar'), 'Bighorn' sheep fescue, and the tall fescues had the highest measurements at this date.

The most common weed species in the plots were dandelion (*Taraxacum officinale*), orchardgrass (*Dactylis glomerata*), and wirestem muhly (*Muhlenbergia frondosa*). Weed cover in all the plots was low, but there were significant differences at all three rating dates (Table 3). At each date, 'Covar' had significantly higher weed cover than all other cultivars. The differences between the other cultivars were small, and though significant differences exist, they are not functional as all other cultivars had weed cover ratings less than 10 percent.

Turf cover differences between the different mowing frequencies averaged over all cultivars were not significant at any rating date (Table 4). Canopy height differences were significant on April 29 and June 10, with the plots mowed once in 1991 being significantly taller than the plots mowed two or three times. At those dates, the plots had not yet been mowed in 1992, and the plots mowed two or three times per season had been mowed the previous fall. The once-mowed plots were taller than the other plots on July 29 and November 5 also, but the differences were not significant. Weed cover differences for the mowing frequency treatments were not significantly different at any rating date.

CONCLUSIONS

At this stage of this experiment, cultivar effects have more influence on the quality of the groundcover provided than the mowing frequency treatments. Mowing frequency treatments have only been imposed for two seasons, and the relatively high cutting height used may further minimize the stress of additional mowings. None of the cultivars in the test are performing poorly, but 'Durar' and 'Covar' are inferior to improved cultivars of hard fescue and sheep fescue, respectively. The hard fescues performed well in the summer, and maintained color into the fall better than the other species. The tall fescue cultivars in the test are smaller stature 'turf-type' varieties, and to date have performed well. They grow lower and produce fewer seedheads than 'Kentucky 31' tall fescue, but it is not known yet if these more recently released cultivars are as durable.

The vegetative canopy heights measured in this test never exceeded 11 inches, even just prior to the first mowing of the season on June 10. The measurements taken at this date represent the plants at their most vigorous, and most likely their maximum vegetative height. If roadside turf is not going to exceed 11 inches, the only reasons to mow are to remove tall seedheads and control weeds and brush. Seedhead control can be accomplished with a single mowing in the spring at a height of 4 to 6 inches.

TABLE 1: Cultivar names and species evaluated at three mowing frequencies

Cultivar	Species	Cultivar	Species
1. Jamestown	chewings fescue	12. SHAE	creeping red fescue
2. Victory	chewings fescue	13. Shademaster	creeping red fescue
3. AUE	hard fescue	14. Bighorn	sheep fescue
4. Aurora	hard fescue	15. Covar	sheep fescue
5. Durar	hard fescue	16. MX 86	sheep fescue
6. Reliant	hard fescue	17. Murietta	tall fescue
7. Spartan	hard fescue	18. Rebel II	tall fescue
8. SR 3000	hard fescue	19. Rebel Jr.	tall fescue
9. SR 3100	hard fescue	20. Shortstop	tall fescue
10. Dawson	slender creeping fescue	21. Silverado	tall fescue
11. Jasper	creeping red fescue		

TABLE 2: Visual ratings of percent turf cover, taken on a green tissue basis. Ratings were taken April 29, June 10, July 29, and November 5, 1992. Due to a significant interaction between cultivar and mowing frequency treatments for the June 10 rating, cover ratings for each cultivar for each mowing treatments are reported. Values for April, July, and November are the mean of 9 observations (three replications, three mowing treatments), and values for June are the mean of three replications.

		Jun 10				
Cultivar	Apr 29	Mow 1X	Mow 2X	Mow 3X	Jul 29	Nov 5
	(-----------------------------------percent turf cover -----------------------------------)					
1. Jamestown	6	68	45	42	69	39
2. Victory	5	50	43	38	71	48
3. AUE	5	55	40	42	71	62
4. Aurora	6	55	55	48	72	61
5. Durar	14	57	62	65	57	41
6. Reliant	7	53	43	38	68	57
7. Spartan	5	45	40	45	68	57
8. SR 3000	7	53	52	52	76	61
9. SR 3100	5	53	47	48	79	55
10. Dawson	2	43	32	37	58	54
11. Jasper	4	45	36	33	66	56
12. SHAE	4	43	33	35	60	49
13. Shademaster	6	62	45	43	58	57
14. Bighorn	3	62	63	60	74	47
15. Covar	18	50	50	53	25	44
16. MX 86	6	48	47	52	52	56
17. Murietta	11	55	52	48	64	26
18. Rebel II	8	53	50	48	66	27
19. Rebel Jr.	11	53	50	45	66	28
20. Shortstop	9	50	53	55	67	26
21. Silverado	8	52	52	48	69	26
Significance Level (p)	0.0001	0.0590	0.0001	0.0008	0.0001	0.0001
L.S.D. (p=0.05)	4	n.s.	10	13	10	10

TABLE 3: Measurements of vegetative canopy height, and visual ratings of percent weed cover taken April 29 (canopy height only), June 10, July 29, and November 5, 1992. Each value is the mean of 9 observations (3 replications, 3 mowing treatments).

	Weed Cover			Vegetative Canopy Height			
Cultivar	Jun 10	Jul 29	Nov 5	Apr 29	Jun 10	Jul 29	Nov 5
	(-------------%-------------)			(------------------inches -------------------)			
1. Jamestown	4	6	2	6.3	8.6	6.4	4.8
2. Victory	4	3	1	6.4	8.6	6.8	4.4
3. AUE	8	8	4	5.7	8.6	8.2	5.5
4. Aurora	5	4	2	5.8	8.6	7.9	6.1
5. Durar	5	9	4	8.6	10.2	8.9	4.3
6. Reliant	6	7	3	6.9	9.4	9.0	5.7
7. Spartan	4	5	4	6.8	10.1	8.9	5.3
8. SR 3000	6	5	2	4.7	8.0	7.4	5.4
9. SR 3100	6	5	1	4.9	7.9	7.9	5.6
10. Dawson	4	7	2	6.2	8.2	7.9	4.5
11. Jasper	4	7	2	6.5	8.8	7.9	4.5
12. SHAE	4	7	2	7.2	9.6	8.9	4.3
13. Shademaster	4	6	1	7.7	10.8	9.1	4.8
14. Bighorn	7	6	2	5.7	9.7	8.8	5.9
15. Covar	13	12	9	5.7	7.9	7.1	4.8
16. MX 86	6	7	2	6.4	9.3	9.5	5.3
17. Murietta	3	2	1	6.0	9.1	7.9	5.5
18. Rebel II	4	4	2	7.1	10.2	8.4	5.7
19. Rebel Jr.	4	3	1	6.5	9.6	7.8	6.0
20. Shortstop	4	3	1	6.1	8.9	7.3	5.3
21. Silverado	4	3	1	6.3	9.1	7.7	6.0
Significance Level (p)	0.0216	0.0006	0.0004	0.0001	0.0414	0.7962	0.0004
L.S.D. (p=0.05)	4	4	3	0.8	1.7	n.s.	0.9

TABLE 4: Results of percent turf cover, vegetative canopy height, and percent weed cover ratings taken April 29, June 10, July 29, and November 5, 1992. Each value is the mean of 63 observations (three replications, 21 cultivars).

Mowing Frequency	Apr 29	Jun 10	Jul 29	Nov 13
		Percent Turf Cover		
Mow 1X	6	53	64	46
Mow 2X	8	47	65	46
Mow 3X	7	47	65	47
Significance Level (p)	0.1826	0.1604	0.9367	0.4998
L.S.D. (p=0.05)	n.s.	n.s.	n.s.	n.s.
		Vegetative Canopy Height (in)		
Mow 1X	7.0	10.1	8.7	5.6
Mow 2X	6.2	8.9	8.0	5.3
Mow 3X	5.9	8.3	7.6	4.8
Significance Level (p)	0.0183	0.0242	0.1170	0.1075
L.S.D. (p=0.05)	0.6	1.1	n.s.	n.s.
		Percent Weed Cover		
Mow 1X	--	5	6	2
Mow 2X	--	6	7	3
Mow 3X	--	4	5	2
Significance Level (p)		0.2476	0.0934	0.6173
L.S.D. (p=0.05)		n.s.	n.s.	n.s.

TABLE 5: Visual ratings of percent turf cover for turf species, taken on a green tissue basis. Ratings were taken April 29, June 10, July 29, and November 5, 1992. There was a significant interaction between species and mowing treatments for ratings taken June 10, therefore ratings on this date are reported for each mowing treatment. Values for April, July, and November are the mean of nine observations (three replications, 3 mowing treatments), and the June values are the mean of three replications. The number in parentheses after each species indicates the number of values (cultivars) used to derive the species average.

		Jun 10				
Species	Apr 29	Mow 1X	Mow 2X	Mow 3X	Jul 29	Nov 5
	(---%---)					
chewings fescue (2)	5	59	44	40	70	43
creeping red fescue (3)	4	50	38	37	61	54
hard fescue (7)	7	53	48	48	70	56
sheep fescue (3)	9	53	53	55	50	49
slender creeping fescue (1)	2	43	32	37	58	54
tall fescue (5)	9	53	51	49	66	27
Significance level (p)	0.0001	0.2509	0.0028	0.0277	0.0030	0.0003
LSD (p=0.05)	2	n.s.	9	12	9	10

TABLE 5: Visual ratings of percent weed cover and measurements of vegetative canopy height taken April 29 (canopy height only), June 10, July 29, November 5, 1992. Each value is the mean of nine observations (three replications, three mowing treatments).

	Weed Cover			Vegetative Canopy Height			
Species	Jun 10	Jul 29	Nov 11	Apr 29	Jun 10	Jul 29	Nov 5
	(-------------%--------------)			(-------------------inches --------------------)			
chewings fescue (2)	4	4	2	6.4	8.6	6.6	4.6
creeping red fescue (3)	4	7	1	7.1	9.7	8.6	4.5
hard fescue (7)	5	6	3	6.2	9.0	8.3	5.4
sheep fescue (3)	8	8	4	5.9	9.0	8.4	5.3
slender creeping fescue (1)	4	7	2	6.2	8.2	7.9	4.5
tall fescue (5)	4	3	1	6.4	9.4	7.8	5.7
Significance level (p)	0.0183	0.0036	0.0020	0.0347	0.1074	0.0547	0.0054
LSD (p=0.05)	3	2	1	0.6	n.s.	1.3	0.6

PERFORMANCE OF FINE FESCUE CULTIVARS UNDER LOW MAINTENANCE CONDITIONS

INTRODUCTION

As part of the National Turfgrass Evaluation Program 1989 Fineleaf Fescue test, 93 cultivars of fine fescue were seeded to be evaluated under low maintenance conditions. The maintenance level of this test could be described as a low maintenance turf, in contrast to a conservation planting, which would be a more appropriate description of a roadside. Still, we feel information from this test will be useful to the Department to evaluate cultivars for use in seed mixes such as Formula L.

MATERIALS AND METHODS

Cultivars of chewings, creeping red, hard, sheep, and slender creeping fescue were drop seeded to 4 by 6 plots arranged in a randomized complete block design with three replications on October 5, 1990. Starter fertilizer was applied at 30, 44, and 9 lbs/ac of N, P_2O_5, and K_2O, respectively. Urea was applied at 22 lb N/ac on May 23 and October 23, 1991, and 44 lb N/ac on October 19, 1992. A treatment of 2,4-D plus dicamba at 0.48 plus 0.25 lb/acre was applied on May 29, 1991, to control broadleaf weeds. The area is maintained with a rotary mower with a cutting height of 3.75 in. The test was only mowed four times in 1991, due to the drought conditions during the growing season. Mowing was more frequent in 1992, with mowing frequencies of two to three weeks, depending on growing conditions. Data collected in 1992 included spring greenup and canopy height on May 1, genetic color and turf quality on June 2, and turf quality on June 25 and August 10. Spring greenup was rated as percent cover by green tissue; and genetic color and turf quality were rated on a 1 to 9 scale, with 1=brown or dead turf and 9=ideal. These results, as well as the mean quality for the three ratings are reported in Table 1.

RESULTS

SR 3100 hard fescue was rated best for mean quality, and was rated significantly higher than all but four cultivars. When the cultivars are arranged by mean quality, 20 of the top 25 entries are hard fescue. When the performance of cultivars within a species are averaged, and the species compared, hard and sheep fescues are significantly better than the other species for mean quality (Table 2), and creeping red fescue is rated significantly lower than all other species. Hard and sheep fescue were also rated highest for spring greenup and had the shortest canopies. Sheep fescue was rated significantly higher for genetic color than all other species. The characteristic that most sets the hard and sheep fescues apart from the other species are their density. The other species tend to produce a taller stand of fewer tillers compared to hard and sheep fescue. All of the cultivars have become quite thatchy, but under low maintenance conditions, particularly under roadside conditions, this is not undesirable. The thatch layer of the fine fescues under these conditions is an effective groundcover and weed barrier.

CONCLUSIONS

After only two full growing seasons, it is too soon to discuss the long term durability of the species and cultivars in this test. The hard fescues have been the best species to date, and provide the lowest growing and densest turf. These results confirm the utility of including hard fescue as the major component of the Formula L seeding specification.

TABLE 1: Spring greenup, canopy height, genetic color, and turf quality evaluations of fine fescue cultivars during 1992. Genetic color and turf quality were visually rated on a scale of 1 to 9, where 1=dead turf and 9=ideal. Each value is the mean of three replications.

Entry	Species	Spring Greenup May 1	Canopy Height May 1	Genetic Color Jun 2	Turf Quality Jun 2	Turf Quality Jun 25	Turf Quality Aug 10	Turf Quality Mean
		(%)	(in)	(1-9)	(-----------------1-9----------------)			
SR 3100	Hard	42	6.3	6.7	7.0	6.0	5.7	6.2
PST-4HD	Hard	28	6.5	6.0	7.3	6.0	5.0	6.1
BAR Fo 9A2	Hard	47	7.7	6.0	6.7	5.3	5.3	5.8
Bighorn	Sheep	47	6.8	7.0	6.7	5.3	5.3	5.8
ERG 1143	Chewings	38	6.8	6.3	7.0	5.3	5.0	5.8
Scaldis	Hard	32	7.2	6.0	6.7	5.0	5.3	5.7
Barcrown	Slender Creeping	27	7.3	6.0	6.0	5.0	6.0	5.7
PST-4AG	Hard	27	7.7	5.7	7.0	5.0	5.0	5.7
Biljart	Hard	48	7.0	5.7	7.0	5.0	5.0	5.7
HF 9032	Hard	37	6.2	6.0	7.0	5.0	5.0	5.7
Melody	Hard	37	7.5	6.0	7.0	4.7	5.0	5.6
Attila	Hard	60	6.5	6.0	7.0	4.3	5.3	5.6
Bar Fr 9F	Chewings	38	6.8	6.7	6.3	5.0	5.3	5.6
SR 3000	Hard	47	8.0	5.3	6.3	5.0	5.3	5.6
Aurora	Hard	40	7.5	5.3	6.7	5.0	5.0	5.6
Reliant E	Hard	40	7.7	5.7	6.7	5.0	5.0	5.6
Valda	Hard	30	6.8	6.0	7.0	4.7	5.0	5.6
PST-AUE	Hard	33	7.7	6.0	6.3	5.0	5.0	5.4
Reliant	Hard	38	7.8	5.7	6.7	4.7	5.0	5.4
Silvana	Hard	37	7.2	6.0	7.0	4.3	5.0	5.4
Waldorf	Chewings	33	7.5	6.0	6.7	5.0	4.7	5.4
Eureka	Hard	43	7.3	5.3	6.7	4.7	5.0	5.4
Spartan	Hard	35	7.3	5.7	7.0	4.7	4.7	5.4
HF 8250*	Hard	43	7.8	5.7	6.7	4.7	4.7	5.3
Barreppo	Hard	60	7.0	7.0	5.7	4.7	5.3	5.2
Rainbow	Chewings	27	7.2	6.0	6.0	4.7	5.0	5.2
LD 3485	Chewings	27	7.3	6.0	6.0	4.7	5.0	5.2
Ensylva	Creeping Red	28	8.2	6.0	6.0	4.7	4.7	5.1
Enjoy	Chewings	40	7.3	6.0	5.7	4.7	5.0	5.1
MX 86	Sheep	27	6.8	6.7	5.7	4.3	5.0	5.0
Bargreen	Chewings	35	7.7	6.0	5.3	4.7	5.0	5.0
Mary	Chewings	30	7.8	6.0	5.7	4.7	4.7	5.0
Raymond	Chewings	28	6.8	6.0	5.7	5.0	4.3	5.0
Trophy*	Chewings	23	7.8	6.0	6.3	4.0	4.7	5.0
Capitol	Chewings	33	7.7	6.0	6.0	4.7	4.3	5.0
Marker	Slender Creeping	25	6.7	6.7	5.7	4.3	5.0	5.0
Serra	Hard	30	7.8	5.7	6.0	4.3	4.3	4.9
BAR Fr 9P	Slender Creeping	27	7.8	6.0	5.3	4.0	5.3	4.9
Frt-30149	Slender Creeping	27	7.8	6.0	5.3	4.3	5.0	4.9
PST-4CD	Chewings	15	8.5	6.0	5.3	4.7	4.7	4.9
Scarlet	Chewings	42	7.8	6.3	5.7	4.7	4.3	4.9
Belmont	Chewings	27	8.7	5.7	6.0	4.0	4.7	4.9
Longfellow	Chewings	22	8.5	5.7	6.0	4.0	4.7	4.9
JMB-89	Chewings	25	9.0	6.0	5.3	4.0	5.0	4.8
PST-SHE	Chewings	28	8.0	6.0	5.3	4.3	4.7	4.8
Atlanta	Chewings	35	8.0	5.7	5.7	4.3	4.3	4.8
HF 112	Chewings	23	7.7	5.7	5.3	4.3	4.7	4.8
LD 3488	Slender Creeping	27	7.3	6.0	5.7	4.0	4.7	4.8
Puma	Chewings	22	7.3	6.0	5.3	4.3	4.7	4.8

continued

TABLE 1: (cont) Spring greenup, canopy height, genetic color, and turf quality evaluations of fine fescue cultivars during 1992. Genetic color and turf quality were visually rated on a scale of 1 to 9, where 1=dead turf and 9=ideal. Each value is the mean of three replications.

Entry	Species	Spring Greenup May 1	Canopy Height May 1	Genetic Color Jun 2	Turf Quality Jun 2	Turf Quality Jun 25	Turf Quality Aug 10	Turf Quality Mean
		(%)	(in)	(1-9)	(-----------------1-9			----------------)
Barlotte	Slender Creeping	20	8.7	5.7	4.7	4.0	5.3	4.7
SR 5000	Chewings	20	8.2	5.3	5.3	4.0	4.7	4.7
Jamestown II	Chewings	20	8.3	5.7	5.3	4.0	4.7	4.7
Wilma	Chewings	28	8.5	6.0	5.7	3.7	4.7	4.7
OFI 89-200	Chewings	20	7.7	6.0	5.3	4.3	4.3	4.7
LD 3438	Creeping Red	18	7.3	6.3	5.3	4.0	4.7	4.7
89.LKR	Chewings	30	8.7	6.0	5.3	4.3	4.3	4.7
Molinda	Chewings	28	8.8	6.0	5.3	4.0	4.3	4.6
PST-4FE	Chewings	27	7.8	6.0	5.0	4.3	4.3	4.6
HF 138	Hard	28	8.5	5.7	4.7	4.0	5.0	4.6
Southport	Chewings	17	8.7	5.7	5.3	4.0	4.3	4.6
Cindy	Creeping Red	20	9.7	6.0	5.0	4.0	4.7	4.6
Barnica	Chewings	23	7.7	5.3	4.7	4.0	4.7	4.4
Shadow	Chewings	30	8.3	6.0	5.0	4.0	4.3	4.4
Flyer	Creeping Red	22	9.3	6.0	4.7	4.0	4.7	4.4
Jamestown	Chewings	22	8.7	6.0	5.0	4.0	4.3	4.4
NK 82492	Chewings	22	8.5	6.0	4.7	4.0	4.3	4.3
HF 102	Slender Creeping	18	7.8	6.0	4.7	3.7	4.7	4.3
Herald	Creeping Red	18	8.8	6.0	4.7	3.3	5.0	4.3
Jasper	Creeping Red	23	8.3	6.7	4.7	4.0	4.3	4.3
Banner	Chewings	25	8.5	6.0	5.3	3.7	4.0	4.3
LD 3414	Creeping Red	15	7.0	6.0	4.7	4.0	4.3	4.3
Camaro	Chewings	23	8.7	5.7	4.7	4.0	4.0	4.2
PST-4C8	Creeping Red	17	8.5	6.3	4.3	4.0	4.3	4.2
Koket	Chewings	33	8.3	5.3	5.0	3.7	4.0	4.2
PST-43F	Creeping Red	22	8.0	6.0	4.3	3.3	4.7	4.1
PST-4NI	Creeping Red	28	8.3	6.3	4.3	3.7	4.3	4.1
Belvedere	Creeping Red	23	8.7	6.0	4.3	3.7	4.3	4.1
Salem	Creeping Red	20	9.2	6.0	4.7	3.3	4.3	4.1
ZW 42-148	Creeping Red	25	8.5	5.7	4.7	3.3	4.0	4.0
PST-4R3	Creeping Red	20	9.3	6.0	3.7	4.0	4.3	4.0
Dawson	Slender Creeping	22	8.5	5.7	4.7	3.3	4.0	4.0
Elanor	Creeping Red	18	8.2	6.0	4.0	3.3	4.3	3.9
WW Rs 138	Creeping Red	18	8.3	6.0	4.0	3.0	4.7	3.9
Shademaster	Creeping Red	18	8.2	6.0	4.0	3.3	4.3	3.9
Vista	Creeping Red	28	9.5	6.0	4.7	3.0	4.0	3.9
WW Rs 143	Creeping Red	18	9.0	5.3	4.0	3.7	3.7	3.8
Bargena	Creeping Red	18	9.3	5.3	4.0	3.3	4.0	3.8
BAR Fr8RC3	Creeping Red	25	9.2	6.0	4.3	3.0	4.0	3.8
Boreal	Creeping Red	23	9.2	6.3	4.3	3.0	3.7	3.7
Franklin	Creeping Red	25	8.7	6.0	3.7	3.0	4.0	3.6
Claudia	Creeping Red	18	9.3	6.0	3.7	3.0	4.0	3.6
Sylvester	Creeping Red	20	9.5	6.0	3.7	3.0	3.7	3.4
WW Rs 130	Creeping Red	22	8.7	5.7	3.7	3.0	3.7	3.4
Significance Level (p)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)		12	1.0	0.6	0.8	0.8	0.7	0.5

TABLE 2: Spring greenup, canopy height, genetic color, and turf quality evaluations of fine fescue averaged by species during 1992. Genetic color and turf quality were visually rated on a scale of 1 to 9, where 1=dead turf and 9=ideal. Each value is the mean of three replications. The number of cultivars evaluated for each species is indicated in parentheses.

Fine Fescue Species	Spring Greenup May 1	Canopy Height May 1	Genetic Color Jun 2	Turf Quality Jun 2	Jun 25	Aug 10	Mean
	(%)	(in)	(1-9)	(-----------------1-9----------------)			
hard (22)	39	7.3	5.9	6.6	4.9	5.0	5.5
sheep (2)	37	6.8	6.8	6.2	4.8	5.2	5.4
chewings (35)	27	8.0	5.9	5.5	4.3	4.6	4.8
slender creeping (8)	24	7.8	6.0	5.3	4.1	5.0	4.8
creeping red (26)	21	8.7	6.0	4.4	3.5	4.3	4.0
Significance Level (p)	0.0023	0.0116	0.0004	0.0001	0.0001	0.0002	0.0001
LSD (p=0.05)	8	0.9	0.3	0.3	0.3	0.3	0.2

PERFORMANCE OF KENTUCKY BLUEGRASS CULTIVARS UNDER LOW MAINTENANCE CONDITIONS

INTRODUCTION

As part of the National Turfgrass Evaluation Program 1990 Low Maintenance Kentucky Bluegrass test, 63 cultivars of Kentucky bluegrass were seeded to be evaluated under low maintenance conditions. The maintenance level of this test could be described as a low maintenance turf, in contrast to a conservation planting, which would be a more appropriate description of a roadside. Kentucky bluegrass is not often considered a suitable species for low maintenance conditions, but positive performance of this species in other trials conducted by this project warranted the initiation of this test.

MATERIALS AND METHODS

Cultivars of Kentucky bluegrass were drop seeded to 4 by 6 plots arranged in a randomized complete block design with three replications on October 5, 1990. Starter fertilizer was applied at 30, 44, and 9 lbs/ac of N, P_2O_5, and K_2O, respectively. Urea was applied at 22 lb N/ac on May 23 and October 23, 1991, and 44 lb N/ac on October 19, 1992. A treatment of 2,4-D plus dicamba at 0.48 plus 0.25 lb/acre was applied on May 29, 1991, to control broadleaf weeds. The area is maintained with a rotary mower with a cutting height of 3.75 in. The test was only mowed four times in 1991 due to the drought conditions during the growing season. Mowing was more frequent in 1992, with mowing intervals of two to three weeks, depending on growth rate. Data collected in 1992 included spring greenup and canopy height on May 1, genetic color and turf quality on June 2, and turf quality on June 25 and August 10. Spring greenup was rated as percent cover by green tissue; and genetic color and turf quality were rated on a 1 to 9 scale, with 1=brown or dead turf and 9=ideal. These results, as well as the mean quality for the three ratings are reported in Table 1.

RESULTS

The cultivars Barmax and EVB 13.703 were rated highest for mean quality, and were rated significantly better than all but six other cultivars. Barmax received the highest August quality rating, and maintained its quality from the June to August ratings, while most other cultivars with high mean quality ratings declined in quality from June to August. The mean quality ratings ranged from 5.7 to 2.7, and 38 cultivars had mean quality ratings between 4.0 and 5.0. All the cultivars have developed a significant thatch layer, and are providing excellent groundcover regardless of amount of cover provided by green tissue. Weed pressure is fairly light to date, and consists almost entirely of common dandelion (*Taraxacum officinale*). This test is directly adjacent to the NTEP 1989 fineleaf fescue test, and the Kentucky bluegrasses grow less between mowings than fine fescues, and lose color much earlier in the fall.

CONCLUSIONS

Although Kentucky bluegrasses do not perform under the conditions of this experiment as well as fine fescues, they are persisting, and some cultivars seem promising at this stage for use in reduced maintenance settings. However, this is only the second full growing season, and any conclusions about the fitness of these cultivars under these conditions should be viewed with, at best, suspicion.

TABLE 1: Spring greenup, canopy height, genetic color, and turf quality evaluations for Kentucky bluegrass cultivars during 1992. Genetic color and turf quality were visually rated on a scale of 1 to 9 where 1=dead turf and 9=ideal. Each value is the mean of three replications.

Entry	Greenup Apr 29	Height May 1	Color May 29	Turf Quality May 29	Turf Quality Jun 25	Turf Quality Aug 10	Turf Quality Mean
	(%)	(in)	(1-9)	(------------------------1-9------------------------)			
Barmax	38	5.3	3.7	6.3	5.3	5.3	5.7
EVB 13.703	35	4.3	6.3	6.7	6.0	4.3	5.7
NE 80-47	38	4.7	6.0	7.0	5.3	4.0	5.4
Amazon	33	3.8	7.3	6.0	6.0	4.3	5.4
Midnight	40	3.2	8.7	6.7	5.7	3.7	5.3
BAR VB 1169	27	4.7	6.3	6.0	5.3	4.7	5.3
Barsweet	32	4.8	6.3	5.7	5.7	4.3	5.2
798	38	5.0	6.0	6.7	5.0	4.0	5.2
Bartitia	32	4.2	6.7	5.7	5.0	4.7	5.1
Fortuna	32	4.7	5.7	6.0	5.0	4.3	5.1
EVB 13.863	38	5.3	5.0	6.0	5.0	4.3	5.1
PST-C-76	45	3.5	7.3	6.0	5.3	4.0	5.1
Merit	35	4.0	5.7	6.3	4.7	4.0	5.0
Cynthia	37	5.2	5.7	6.0	5.3	3.7	5.0
Opal	23	4.3	6.3	5.7	5.0	4.3	5.0
ISI-21	43	6.8	4.3	5.3	5.0	4.3	4.9
BAR VB 13-2	28	5.3	4.7	5.7	5.0	4.0	4.9
PST-C-391	33	6.0	4.3	5.7	5.0	3.7	4.8
PST-C-303	30	5.3	4.0	6.0	4.7	3.7	4.8
PST-YQ	27	5.5	4.0	5.7	4.7	4.0	4.8
Liberty	28	3.7	5.0	5.3	5.0	4.0	4.8
Suffolk	27	5.7	4.0	5.3	5.0	4.0	4.8
Haga	37	5.3	4.7	5.7	4.7	4.0	4.8
Cobalt	27	4.3	6.0	5.3	5.0	4.0	4.8
Kyosti	33	6.5	5.3	5.3	4.7	4.0	4.7
Baron	35	4.5	5.3	5.3	4.7	4.0	4.7
Ba 74-017	33	4.8	5.7	5.3	4.3	4.3	4.7
Ram-1	32	4.5	5.0	5.0	4.3	4.7	4.7
J-229	25	4.2	4.3	5.3	4.7	4.0	4.7
SR 2000	38	5.5	6.7	5.7	4.7	3.7	4.7
Crest	30	6.0	5.0	5.0	4.3	4.3	4.6
Livingston	28	4.8	5.0	5.3	4.7	3.7	4.6
Destiny	37	4.5	6.3	5.0	5.0	3.7	4.6
Freedom	23	4.7	4.3	5.3	4.7	3.7	4.6
J-335	23	5.0	5.0	4.7	5.0	4.0	4.6
BAR VB 895	15	4.3	4.7	4.7	4.3	4.3	4.4
GEN-RSP	40	8.3	4.0	5.3	4.0	4.0	4.4
NuStar	22	7.0	4.7	5.0	4.3	4.0	4.4
BAR VB 7037	35	6.0	4.3	5.0	4.3	4.0	4.4
NJIC	38	8.3	3.7	5.0	4.0	4.0	4.3
Gnome	27	5.2	5.7	5.0	4.0	4.0	4.3
Monopoly	18	7.2	3.3	5.0	4.0	3.7	4.2
Bronco	27	6.7	3.7	5.0	3.7	4.0	4.2
Miracle	37	5.0	5.3	4.3	4.3	4.0	4.2
Sophia	25	5.8	5.0	4.7	4.0	4.0	4.2
Unknown	23	4.3	5.0	5.3	3.7	3.7	4.2
J-386	23	7.2	5.3	5.0	3.7	4.0	4.2
Victa	32	5.3	5.0	5.0	4.0	3.7	4.2
Merion	32	4.8	5.0	5.0	4.3	3.0	4.1
ZPS-84-749	25	8.3	5.3	4.3	4.0	3.7	4.0

continued

TABLE 1: Spring greenup, canopy height, genetic color, and turf quality evaluations for Kentucky bluegrass cultivars during 1992. Genetic color and turf quality were visually rated on a scale of 1 to 9 where 1=dead turf and 9=ideal. Each value is the mean of three replications.

	Greenup	Height	Color	Turf Quality			
Entry	Apr 29	May 1	May 29	May 29	Jun 25	Aug 10	Mean
	(%)	(in)	(1-9)	(-----------------------1-9------------------------)			
Voyager	25	8.2	4.3	4.0	3.7	4.0	3.9
Barzan	10	5.0	4.7	3.3	3.0	5.0	3.8
Washington	18	6.3	3.3	4.3	3.3	3.7	3.8
MN 2405	28	8.7	4.7	3.3	3.7	3.7	3.6
Park	35	7.8	3.3	3.7	3.0	3.7	3.4
Chelsea	20	6.3	5.3	3.3	3.3	3.7	3.4
KWS Pp 13-2	28	5.5	5.0	3.7	3.0	3.7	3.4
Ba 78-376	22	7.5	3.7	3.3	3.3	3.3	3.3
PST-A7-111	35	9.3	3.7	3.3	3.0	3.0	3.1
Kenblue	17	8.0	4.0	3.3	2.7	3.0	3.0
H76-1034	18	8.5	3.7	3.0	2.3	3.3	2.9
Alene	10	7.5	4.7	3.3	2.3	3.0	2.9
South Dakota Certified	3	5.8	5.0	3.0	2.0	3.0	2.7
Significance Level (p)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)	11	1.4	0.9	1.0	0.9	0.7	0.6

EFFECT OF APPLICATION DATE ON RESPONSE OF TALL FESCUE TO TELAR AND ESCORT

INTRODUCTION

The sulfonylurea herbicides Telar and Escort are common components in treatments used to control broadleaf weeds on Pennsylvania roadsides. Both of these herbicides are also used as growth regulators in combination with Embark on tall fescue, at rates much lower than those for broadleaf weed control. Overapplication of these herbicides in plant growth regulator treatment combinations has caused unacceptable injury to tall fescue, and there is concern that use of these materials in broadleaf weed control treatments may also cause unacceptable injury to tall fescue. This study was initiated to determine if the rates of these herbicides used for broadleaf weed control were injurious to tall fescue, and if time of application influenced the degree of injury.

MATERIALS AND METHODS

This test was conducted on a stand of 'Transition Blend' tall fescue established in 1987, and maintained at 3.5 in, at the Penn State Landscape Management Research Center. An untreated check; Escort alone at 0.5 and 1.0 oz product/ac, and 0.5 oz product/ac in combination with 3 pts/ac Garlon 3A; and Telar alone at 0.5 and 1.0 oz product/ac, and 0.5 oz product/ac in combination with 3 pts/ac Garlon 3A were applied May 4, June 1, June 30, August 7, and September 2, 1992. The treatments were applied with a CO_2-powered, hand-held sprayer delivering 15.8 gal/ac to 3 by 15 ft plots arranged in a randomized complete block design with a split-plot treatment arrangement and three replications. Application date was the whole plot treatment, and herbicide was the sub-plot treatment. Prior to each application, the entire study area was mowed at 3.0 in with a rotary mower collecting clippings. Clipping harvests were taken from all treated plots on May 29, June 30, July 31, September 1, and September 30, 1992; which provided clipping yield measurements at all five harvest dates for plots treated May 4, and a single yield measurement for plots treated September 2. A final harvest of all plots will be taken in the spring of 1993. Clippings were collected by mowing a single pass with a 20 in rotary mower with a cutting height of 3.0 in. Dry matter content was determined for the May 29 and June 30 harvests by measuring fresh and dry weights of sub-samples of each plot harvest, and multiplied by whole plot fresh weight to determine dry weight yields. The July, August, and September dry weight yields were determined by weighing the entire oven dried plot sample. Turf color was visually rated May 29, on a scale of 1 to 9, with 1=dead turf, 9=untreated check, and 5=lowest acceptable rating.

RESULTS

The untreated check was rated significantly better than all herbicide treatments for turf color, and there were no significant differences between the herbicide treatments, which ranged from 6.3 to 6.0. This pattern was apparent at all applications, with distinct, but acceptable discoloration with all herbicide treatments and no visual difference between them. After harvest, the herbicide treated plots were visually distinct from the untreated plots due to regrowth almost exclusively from tiller buds. There was no extension of previously cut leaf blades, and the plots had a distinct color and texture compared to the untreated plots.

The dry weight yields of each herbicide treatment at each application date for each harvest date are reported in Table 1. Average clipping yields of the untreated plots were highest in May, at 19.1 lb dry matter/1000 ft^2 (lb/M), dropped to 9.0 lb/M for June, and reached the lowest level in July at 6.1 lb/M. Growth increased in August to 10.0 lb/M, and decreased again in September to 7.6 lb/M. This trend follows the expected cool-season grass growth trend, with reduced growth after spring, a second increase in growth at the end of the summer, and decreasing growth with the onset of shorter daylengths and decreased temperatures. To make comparisons across application dates that were less influenced by seasonal growth trends, yields of the first harvest after each treatment date were expressed as percent of the untreated check (Table 2). To resolve a significant interaction between treatment date and herbicide treatment (p=0.006), the percent-of-check values for the treatments were analyzed for each treatment date, and are reported in Table 2. Clipping yields in lb/M for the first harvest after each treatment date are reported in Table 3.

Orthogonal contrasts were performed to test the variation due to differences between the untreated and treated plots, and plots treated with Telar and Escort for the first harvest for each treatment date (Table 2). The contrast between the untreated check and the herbicide treated plots was significant for all treatment dates. The contrast between Telar and Escort treatments was significant for the June 30 treatment, with Telar treatment yields averaging 62 percent of the untreated check, and Escort treatment yields averaging 91 percent of the untreated check. At this date, the yields of the Escort treatments were not significantly different than the check. There were no significant differences between percent-of-check yields for the six herbicide treatments when applied May 4 or August 7. The greatest suppression occurred with the May application, with the herbicide treatment yields averaging 24 percent of the untreated check. The growth of tall fescue decreased from May through July, and the amount of growth suppression from the herbicide treatments decreased also, with yields in the herbicide plots treated June 30 averaging 78 percent of the untreated check. This correlation between growth and suppression in the May through July treatments was reversed for the August and September treatments. Yields of the herbicide treated plots treated July 31 averaged 64 percent of the untreated check, and were the highest first harvest yields, on a dry weight basis, of any treatment date (Table 3). Tall fescue growth decreased during September, and suppression increased as herbicide treated plot yields averaged 48 percent of the untreated check.

Percent-of-check yields averaged over the five first harvest dates for each treatment, and averaged over the treatments (with and without the untreated check) are reported in Table 4. When treatments are averaged over time, percent-of-check yields for all herbicide treatments were significantly lower than the untreated check, and the 1.0 oz/acre rate of Telar was significantly lower than the three Escort treatments. When treatment averages for each harvest date were compared, percent-of-check yields for treatments applied May 4 were significantly lower than those for June 30 and August 7.

Despite significant growth reductions at the first harvest after treatment, yields of plots treated as late as August 7 rebounded by the second clippings harvest (Table 1). This yield rebound varied in intensity from levels not significantly different from the check to levels significantly greater than the untreated check. Observations of clipping yield increase could not be made on the plots treated September 2, due to a single harvest in 1992, and will be made the first time in spring of 1993.

CONCLUSIONS

Treating tall fescue with either Escort or Telar between the first week of May and the first week in September caused a reduction in growth, and discoloration. The degree of growth reduction varied with time of application. Growth reduction was greatest with the May treatment, when the growth rate was highest. The least growth reduction occurred when treatments were applied June 30. This correlation between potential growth and suppression was not observed during the August growth period. The untreated check yields were the second highest of the season, and first harvest yields of the herbicide treated plots were the highest recorded during the season. Average first harvest yields were lower for Telar treatments than Escort treatments, with the greatest differences occurring for the June 30 application. In the applications made up to August 7, where at least two clipping harvests were made, all treated plots rebounded to growth levels equalling or exceeding untreated plots.

These two herbicides had a negative impact on tall fescue throughout the growing season, but this impact was transient. With a single season's results, it is impossible to determine under what conditions these affects could be ameliorated, or when these affects may not be transient. Roadside managers should use these materials with caution, tempered with their previous experience, and the utility they perceive these two herbicides to have in their broadleaf weed control program.

TABLE 1: Dry weight yields of tall fescue treated with Telar or Escort on five different dates. Each value is the mean of three replications.

Application Date	Treatment	Application Rate	Harvest Date May 29	Jun 30	Jul 31	Sep 1	Sep 30
		(oz product/ac)	(---------------lb dry matter/1000 ft^2			----------------)	
May 4	Untreated Check	- - -	19.1	9.8	6.2	11.0	7.3
May 4	Escort	0.5	3.5	8.3	8.5	8.6	6.1
May 4	Escort	1.0	4.5	8.1	13.0	12.4	7.9
May 4	Escort + Garlon 3A	0.5 + 48	4.1	10.6	9.8	9.2	6.4
May 4	Telar	0.5	4.5	11.1	9.9	12.9	8.2
May 4	Telar	1.0	5.0	8.6	8.5	11.9	8.5
May 4	Telar + Garlon 3A	0.5 + 48	5.6	11.7	8.1	10.6	7.3
Significance Level (p)			0.0001	0.5054	0.1646	0.4615	0.1630
LSD (p=0.05)			3.3	n.s.	n.s.	n.s.	n.s.
Jun 1	Untreated Check	- - -		8.1	6.4	8.8	6.3
Jun 1	Escort	0.5		2.7	7.2	9.5	6.4
Jun 1	Escort	1.0		4.9	9.4	10.2	7.6
Jun 1	Escort + Garlon 3A	0.5 + 48		4.6	10.2	12.2	8.0
Jun 1	Telar	0.5		4.1	8.7	8.1	7.9
Jun 1	Telar	1.0		3.3	7.4	9.6	7.5
Jun 1	Telar + Garlon 3A	0.5 + 48		2.3	4.7	8.7	6.8
Significance Level (p)				0.0075	0.0094	0.3230	0.1252
LSD (p=0.05)				2.6	2.6	n.s.	n.s.
Jun 30	Untreated Check	- - -			5.8	8.2	6.4
Jun 30	Escort	0.5			5.3	11.7	7.3
Jun 30	Escort	1.0			4.7	11.1	7.4
Jun 30	Escort + Garlon 3A	0.5 + 48			5.3	12.6	7.9
Jun 30	Telar	0.5			4.0	9.8	7.9
Jun 30	Telar	1.0			2.2	8.9	8.2
Jun 30	Telar + Garlon 3A	0.5 + 48			3.4	8.9	8.0
Significance Level (p)					0.0468	0.1291	0.7101
LSD (p=0.05)					2.2	n.s.	n.s.
Aug 7	Untreated Check	- - -				12.2	8.7
Aug 7	Escort	0.5				7.9	10.4
Aug 7	Escort	1.0				6.2	8.0
Aug 7	Escort + Garlon 3A	0.5 + 48				6.9	9.1
Aug 7	Telar	0.5				6.7	8.7
Aug 7	Telar	1.0				6.3	7.1
Aug 7	Telar + Garlon 3A	0.5 + 48				6.5	7.1
Significance Level (p)						0.0751	0.1978
LSD (p=0.05)						n.s.	n.s.
Sep 2	Untreated Check	- - -					9.5
Sep 2	Escort	0.5					4.4
Sep 2	Escort	1.0					4.6
Sep 2	Escort + Garlon 3A	0.5 + 48					4.6
Sep 2	Telar	0.5					4.5
Sep 2	Telar	1.0					3.3
Sep 2	Telar + Garlon 3A	0.5 + 48					4.9
Significance Level (p)							0.0001
LSD (p=0.05)							1.3

TABLE 2: Tall fescue clipping yields for the first harvest after treatment, for five treatment dates. Yields are expressed as percent of the untreated check. First harvest dates were May 29, June 30, July 31, September 1, and September 30 for the treatments applied May 4, June 1, June 30, August 7, and September 30, respectively. Each value is the mean of three replications.

	Treatment	Application Rate	Treatment Date May 4	Jun 1	Jun 30	Aug 7	Sep 2
		(oz product/ac)	(------------------yield as percent of check				-----------------)
1.	Untreated Check	- - -	100	100	100	100	100
2.	Escort	0.5	19	33	96	75	46
3.	Escort	1.0	24	63	84	59	49
4.	Escort + Garlon 3A	0.5 + 48	22	58	94	66	49
5.	Telar	0.5	23	50	68	60	48
6.	Telar	1.0	26	39	48	62	36
7.	Telar + Garlon 3A	0.5 + 48	30	30	70	64	52
Significance Level (p)			0.0001	0.0053	0.0177	0.1266	0.0001
LSD (p=0.05)			15	31	29	n.s.	13
Contrasts:							
Untreated Check vs. Herbicides (p)			0.0001	0.0003	0.0392	0.0062	0.0001
Escort vs. Telar (p)			0.2660	0.1797	0.0022	0.5755	0.4006

TABLE 3: Tall fescue clipping yields for the first harvest after treatment, for five treatment dates. Yields are expressed in lbs dry matter/1000 ft^2. Harvest dates were May 29, June 30, July 31, September 1, and September 30 for the treatments applied May 4, June 1, June 30, August 7, and September 30, respectively. Each value is the mean of three replications.

	Treatment	Application Rate	Treatment Date May 4	Jun 1	Jun 30	Aug 7	Sep 2
		(oz product/ac)	(--------------------lbs dry matter/1000 ft^2				-------------------)
1.	Untreated Check	- - -	19.1	8.1	5.8	12.2	9.5
2.	Escort	0.5	3.5	2.7	5.3	7.9	4.4
3.	Escort	1.0	4.5	4.9	4.7	6.2	4.6
4.	Escort + Garlon 3A	0.5 + 48	4.1	4.6	5.3	6.9	4.6
5.	Telar	0.5	4.5	4.1	4.0	6.7	4.5
6.	Telar	1.0	5.0	3.3	2.2	6.3	3.3
7.	Telar + Garlon 3A	0.5 + 48	5.6	2.3	3.4	6.5	4.9
Significance Level (p)			0.0001	0.0075	0.0468	0.0751	0.0001
LSD (p=0.05)			3.3	2.6	2.2	n.s.	1.3

TABLE 4: Tall fescue clipping yields for the first harvest after treatment for five treatment dates, season averages for herbicide treatments averaged over application dates, and application date treatments averaged over treatments excluding the untreated check. Yields are expressed as percent of the untreated check. Herbicide treatment averages are the mean of 15 observations (5 dates, 3 replications); and application date averages are the mean of 18 observations (6 herbicide treatments, 3 replications).

	Treatment	Application Rate	Treatment Date					
			May 4	Jun 1	Jun 30	Aug 7	Sep 2	Average
		(oz product/ac)	(--------------------yield as percent of check--------------------)					
1.	Untreated Check	- - -	100	100	100	100	100	100
2.	Escort	0.5	19	33	96	75	46	54
3.	Escort	1.0	24	63	84	59	49	56
4.	Escort + Garlon 3A	0.5 + 48	22	58	94	66	49	58
5.	Telar	0.5	23	50	68	60	48	50
6.	Telar	1.0	26	39	48	62	36	42
7.	Telar + Garlon 3A	0.5 + 48	30	30	70	64	52	49
Significance Level (p)								0.0001
LSD (p=0.05)								10
Application Date Average (excluding check)			24	46	77	64	47	p=0.0529 LSD=29

EFFECT OF APPLICATION DATE ON RESPONSE OF FINE FESCUES TO TELAR AND ESCORT

INTRODUCTION

The sulfonylurea herbicides Telar and Escort are common components in treatments used to control broadleaf weeds on Pennsylvania roadsides. Both of these herbicides are also used as growth regulators in combination with Embark, at rates much lower than those for broadleaf weed control. Overapplication of these herbicides in plant growth regulator treatment combinations has caused unacceptable injury to tall fescue, the primary roadside turf species in Pennsylvania. There is concern that use of these materials in broadleaf weed control treatments may also cause unacceptable injury to roadside turf. Fine fescues are used in both 'Formula D' (70% tall fescue/30% creeping red fescue), and 'Formula L' (60% hard fescue/40% creeping red fescue). This study was initiated to determine if the rates of these herbicides used for broadleaf weed control were injurious to fine fescues, and if time of application influenced the degree of injury.

MATERIALS AND METHODS

This test was conducted on a mixed stand of chewings, creeping red, and hard fescues, established in 1990 and maintained at 2.5 in, at the Penn State Landscape Management Research Center. An untreated check; Escort alone at 0.5 and 1.0 oz product/ac, and 0.5 oz product/ac in combination with 3 pts/ac Garlon 3A; and Telar alone at 0.5 and 1.0 oz product/ac, and 0.5 oz product/ac in combination with 3 pts/ac Garlon 3A were applied May 4, June 1, June 30, August 7, and September 2, 1992. The treatments were applied with a CO_2-powered, hand-held sprayer delivering 15.8 gal/ac to 3 by 15 ft plots arranged in a randomized complete block design with a split-plot treatment arrangement and three replications. Application date was the whole plot treatment, and herbicide was the sub-plot treatment. Prior to each application, the entire study area was mowed at 3.0 in with a rotary mower collecting clippings. Clipping harvests were taken from all treated plots on May 29, June 30, July 31, September 1, and October 6, 1992; which provided clipping yield measurements at all five harvest dates for plots treated May 4, and a single yield measurement for plots treated September 2. A final harvest of all plots will be taken in the spring of 1993. Clippings were collected by mowing a single pass with a 20 in rotary mower with a cutting height of 3.0 in. Dry matter content was determined for the May 29 and June 30 harvests by measuring fresh and dry weights of sub-samples of each plot harvest, and multiplied by whole plot fresh weight to determine dry weight yields. The July, August, and September dry weight yields were determined by weighing the entire oven dried plot sample.

RESULTS

Dry weight clipping yields for each harvest of each treatment are reported in Table 1. Average yields of the untreated checks for each of the monthly growth periods were 16.6, 9.0, 5.7, 6.6, and 8.7 lb/1000 ft^2 (lb/M) for May, June, July, August, and September, respectively. To reduce the effect of seasonal growth patterns, clipping yields for the first harvest after treatment were converted to percent of the untreated check. There was an interaction ($p=0.089$) between the effects of herbicide treatment and application date when comparing the first harvest of each treatment. The percent-of-check yields were then analyzed for herbicide treatment effects at each date, and orthogonal contrasts evaluating the variation between the untreated check and the herbicide treatments, and the variation between Escort and Telar treatments (Table 2). The effects of the herbicide treatments were significant for the May and September growth periods. For both of these periods, the orthogonal contrast for untreated check vs herbicide treatments was significant, and the yield of all herbicide treatments was less than the untreated check. The contrast for Escort vs. Telar treatments was significant for the May growth period, with yields of Escort treated plots averaging 45 percent of the untreated check, and Telar treated plots averaging 63 percent of the untreated check. For the June, July, and August growth periods, there were herbicide treatments with yields greater than the untreated check.

When subsequent clipping harvests were taken for the May through August treatments, the yields of all the herbicide treatments exceeded the untreated check by the second or third harvest. The orthogonal contrast between the untreated check and the herbicide treatments was significant ($p \leq 0.05$) for the May 4 application for the July 31 harvest; the June 1 application for the July 31, September 1, and October 6 harvest; and the June 30 application for the October 6 harvest.

When averaged over the five application dates, the percent-of-check yields for all Escort treatments were significantly less than the untreated check, as was the high rate of Telar (Table 3). The percent-of-check yields for the 0.5 and 1.0 oz product/acre rates of Escort alone were significantly lower than the corresponding rates of Telar alone. When combined with Garlon 3A, the percent-of-check yields of the 0.5 oz/acre rates of Escort and Telar were nearly identical, and were not significantly different than either product alone at 0.5 oz/acre.

The effect of application date was nearly significant ($p=0.0652$) when the percent-of-check yields herbicide treatments (excluding the untreated check) were averaged, as the percent-of-check yields for the June 1, June 30, and August 7 treatments ranged between 93 and 97 percent and were significantly higher than the 54 percent yield of the May 4 applications (LSD=33).

CONCLUSIONS

Escort and Telar treatments applied May 4 or September 2 had a significant effect on the first clipping yields taken after treatment, while applications made June 1, June 30, and August 7 did not. Yield reduction was greatest in May, when growth rate was highest. September was a period of increased growth compared to the previous month, but dry matter production was similar to June, a month of decreasing growth compared to May. The herbicides, then seemed to have the most effect when grass growth was increasing. Growth of herbicide treated fine fescue increased, and was greater than untreated fine fescue by the second or third monthly harvest after treatment, for all treatments applied May 4 through August 7. There was no second harvest of plots treated September, therefore observations of recovery cannot be made until spring of 1993. Yield rebound is a common observation when turf has been suppressed by growth regulator applications, and was also observed when the herbicide treatments used in this test were applied to tall fescue. However, in this trial, there was increased growth in later harvests from all treatments, regardless of initial yield suppression. Total cumulative dry matter yields for all herbicide treatments applied May 4 through June 30 were higher than the untreated checks. In the absence of detailed morphological observations during this trial, or similar data from other similar studies, we have no explanation for this occurrence.

On average, Escort caused more suppression at first harvest after treatment than did Telar at the same product rates. The addition of Garlon 3A to Escort or Telar at 0.5 oz/acre did not cause significantly different yields than either product alone at the same rate.

The final data from this study will not be collected until May, 1993, but it is apparent that fine fescues are impacted less by applications of Escort and Telar than tall fescue. The greatest impact occurs in May, however, when broadleaf weed control treatments are often applied. Under the conditions of this experiment, the effects of these herbicides were transient, but this does not rule out exercising caution, particularly if roadside turf is under additional stress, such as drought.

TABLE 1: Dry weight yields of a mixed stand of fine fescues treated with Telar or Escort on five different dates. Each value is the mean of three replications.

Application Date	Treatment	Application Rate	Harvest Date May 29	Jun 30	Jul 31	Sep 1	Sep 30
		(oz product/ac)	(---------------lb dry matter/1000 ft^2				----------------)
May 4	Untreated Check	- - -	16.6	9.1	5.0	5.9	7.6
May 4	Escort	0.5	7.7	7.5	6.1	6.2	8.1
May 4	Escort	1	6.2	7.7	6.2	6.7	8.5
May 4	Escort + Garlon 3A	0.5 + 48	9.1	7.0	6.6	6.8	9.1
May 4	Telar	0.5	11.8	6.0	6.6	7.2	9.0
May 4	Telar	1	10.0	7.1	6.8	7.4	8.8
May 4	Telar + Garlon 3A	0.5 + 48	10.4	7.7	5.6	7.1	9.9
Significance Level (p)			0.0001	0.5004	0.3365	0.4031	0.3705
LSD (p=0.05)			1.8	n.s.	n.s.	n.s.	n.s.
Jun 1	Untreated Check	- - -		8.8	5.2	6.1	8.4
Jun 1	Escort	0.5		7.0	5.0	7.0	10.1
Jun 1	Escort	1		7.6	6.6	7.3	10.7
Jun 1	Escort + Garlon 3A	0.5 + 48		8.6	6.4	7.3	9.4
Jun 1	Telar	0.5		9.7	6.9	8.4	10.0
Jun 1	Telar	1		7.4	6.4	8.2	11.4
Jun 1	Telar + Garlon 3A	0.5 + 48		7.6	6.2	7.9	9.6
Significance Level (p)				0.3060	0.0592	0.0572	0.1741
LSD (p=0.05)				n.s.	n.s.	n.s.	n.s.
Jun 30	Untreated Check	- - -			7.0	7.4	10.2
Jun 30	Escort	0.5			6.6	8.2	11.3
Jun 30	Escort	1			5.2	8.6	12.7
Jun 30	Escort + Garlon 3A	0.5 + 48			7.8	9.9	14.1
Jun 30	Telar	0.5			6.7	7.7	12.3
Jun 30	Telar	1			6.6	8.5	12.1
Jun 30	Telar + Garlon 3A	0.5 + 48			6.1	8.0	11.3
Significance Level (p)					0.0871	0.0975	0.0748
LSD (p=0.05)					n.s.	n.s.	n.s.
Aug 7	Untreated Check	- - -				7.1	9.0
Aug 7	Escort	0.5				5.4	10.0
Aug 7	Escort	1				6.1	12.6
Aug 7	Escort + Garlon 3A	0.5 + 48				5.8	11.4
Aug 7	Telar	0.5				7.2	10.5
Aug 7	Telar	1				6.4	9.4
Aug 7	Telar + Garlon 3A	0.5 + 48				9.1	10.4
Significance Level (p)						0.4189	0.1280
LSD (p=0.05)						n.s.	n.s.
Sep 2	Untreated Check	- - -					8.4
Sep 2	Escort	0.5					6.6
Sep 2	Escort	1					4.6
Sep 2	Escort + Garlon 3A	0.5 + 48					5.9
Sep 2	Telar	0.5					8.4
Sep 2	Telar	1					6.6
Sep 2	Telar + Garlon 3A	0.5 + 48					4.7
Significance Level (p)							0.0103
LSD (p=0.05)							2.2

TABLE 2: Tall fescue clipping yields for the first harvest after treatment, for five treatment dates. Yields are expressed as percent of the untreated check. First harvest dates were May 29, June 30, July 31, September 1, and September 30 for the treatments applied May 4, June 1, June 30, August 7, and September 30, respectively. Each value is the mean of three replications.

	Treatment	Application Rate	Treatment Date				
			May 4	Jun 1	Jun 30	Aug 7	Sep 2
		(oz product/ac)	(------------------yield as percent of check				-----------------)
1.	Untreated Check	- - -	100	100	100	100	100
2.	Escort	0.5	46	81	96	78	79
3.	Escort	1.0	37	91	74	88	54
4.	Escort + Garlon 3A	0.5 + 48	53	102	111	84	69
5.	Telar	0.5	70	116	95	104	98
6.	Telar	1.0	59	90	95	92	80
7.	Telar + Garlon 3A	0.5 + 48	61	89	88	136	58
Significance Level (p)			0.0001	0.2923	0.1004	0.4957	0.0123
LSD (p=0.05)			11	n.s.	n.s.	n.s.	26
Contrasts:							
Untreated Check vs. Herbicides (p)			0.0001	0.6292	0.4207	0.8949	0.0118
Escort vs. Telar (p)			0.0001	0.4009	0.8646	0.1127	0.1141

TABLE 3: Tall fescue clipping yields for the first harvest after treatment, for five treatment dates. Yields are expressed in lbs dry matter/1000 ft^2. Harvest dates were May 29, June 30, July 31, September 1, and September 30 for the treatments applied May 4, June 1, June 30, August 7, and September 30, respectively. Each value is the mean of three replications.

	Treatment	Application Rate	Treatment Date				
			May 4	Jun 1	Jun 30	Aug 7	Sep 2
		(oz product/ac)	(-------------------lbs dry matter/1000 ft^2				------------------)
1.	Untreated Check	- - -	16.6	8.8	7.0	7.1	8.4
2.	Escort	0.5	7.7	7.0	6.6	5.4	6.6
3.	Escort	1.0	6.2	7.6	5.2	6.1	4.6
4.	Escort + Garlon 3A	0.5 + 48	9.1	8.6	7.8	5.8	5.9
5.	Telar	0.5	11.8	9.7	6.7	7.2	8.4
6.	Telar	1.0	10.0	7.4	6.6	6.4	6.6
7.	Telar + Garlon 3A	0.5 + 48	10.4	7.6	6.1	9.1	4.7
Significance Level (p)			0.0001	0.3060	0.0871	0.4699	0.0103
LSD (p=0.05)			1.8	n.s.	n.s.	n.s.	2.2

TABLE 4: Fine fescue clipping yields for the first harvest after treatment for five treatment dates, season averages for herbicide treatments averaged over application dates, and application date treatments averaged over treatments excluding the untreated check. Yields are expressed as percent of the untreated check. Herbicide treatment averages are the mean of 15 observations (5 dates, 3 replications); and application date averages are the mean of 18 observations (6 herbicide treatments, 3 replications).

	Treatment	Application Rate	Treatment Date May 4	Jun 1	Jun 30	Aug 7	Sep 2	Average
		(oz product/ac)	(--------------------yield as percent of check--------------------)					
1.	Untreated Check	- - -	100	100	100	100	100	100
2.	Escort	0.5	46	81	96	78	79	76
3.	Escort	1.0	37	91	74	88	54	69
4.	Escort + Garlon 3A	0.5 + 48	53	102	111	84	69	84
5.	Telar	0.5	70	116	95	104	98	97
6.	Telar	1.0	59	90	95	92	80	84
7.	Telar + Garlon 3A	0.5 + 48	61	89	88	136	58	86
Significance Level (p)								0.0110
LSD (p=0.05)								15
Application Date Average (excluding check)			54	95	93	97	73	p=0.0652 n.s.

TOLERANCE OF ESTABLISHED FINE FESCUES TO GRASS HERBICIDES

INTRODUCTION

The fineleaf fescues are adapted to a wide range of roadside conditions, and the Department's use of Formula L (60% hard fescue, 40% creeping red fescue) is increasing. One advantage of using fine fescues is the ability to selectively remove non-desirable grasses, as well as broadleaf weeds with herbicides. Assure II, Fusilade 2000, Horizon, and Vantage are currently labelled for use in roadside settings; Horizon 2000 will be available shortly; and Verdict is still being evaluated for non-crop use. To evaluate the safety of these herbicides on fine fescues, these materials were applied at 1, 2, 4, and 8X the recommended rate for quackgrass control. The upper end rates used in this test were well in excess of maximum label rates, and were used to determine if overapplication would cause injury to fine fescues.

MATERIALS AND METHODS

The study area was a mixed stand of chewings, creeping red, and hard fescue established in July, 1990, at the Penn State Landscape Management Research Center. The treatments were applied May 12, 1992, to 3 by 15 ft plots using a CO_2-powered, hand held sprayer delivering 15.5 gal/ac at 20 psi. The experimental design was a randomized complete block design with a split-plot treatment arrangement and three replications. Herbicide application rate was the whole plot factor, and herbicide was the sub-plot factor. The following rates, in product/ac, were used for the 1X level for each herbicide: Assure II at 10 oz/ac, Fusilade 2000 at 24 oz/ac, Horizon at 32 oz/ac, Horizon 2000 at 8 oz/ac, Vantage at 60 oz/ac, and Verdict at 8 oz/ac. All herbicide treatments included a non-ionic spray adjuvant (CideKick II) at 0.25% v/v. An untreated check was included in all application rate whole plots, but was not included in the statistical analysis. The complete treatment list is reported in Table 1. A clippings harvest was taken July 3, 1992, with a single swath of a 20 in rotary mower with a 3 in cutting height. Fresh clippings weight was recorded for each plot, and a clippings sub-sample from each plot was weighed fresh and dry to determine dry matter content, and dry weight yields.

RESULTS

The only visual impact from the treatments was a distinct reduction in seedhead production, and a slight stand thinning in Verdict treated plots at the 4 and 8X rates. There was no appearance of discoloration or stand reduction from any of the other treatments. There was no significant interaction between the herbicide and application rate treatments ($p=0.54$). Table 2 reports dry weight yields for herbicides averaged over application rates, and for application rates averaged over herbicide treatments. Both application rate and herbicide treatment effects were significant. Dry weight yields of treatments applied at 8X were significantly lower than all other rates, and there were no differences between the other rates. Dry weight yields for Verdict treated plots were significantly lower than all other herbicide treatments, and there were no significant differences between the other herbicide treatments. When the untreated check was included in the analysis to compare herbicide treatments, dry weight yields of plots treated with Assure II, Vantage, and Horizon were not significantly different from the check.

CONCLUSIONS

All the products used in this test were safe on a mixed stand of established fine fescues. Verdict was the most active herbicide on the fine fescues, but even at the 8X rate, the effects were limited to seedhead reduction and slight thinning. The other herbicides had no effect on the fine fescues at the 4X application rate. It is clear these herbicides are a useful tool in managing undesirable grasses in fine fescue stands, and the flexibility in weed control they will provide make a strong argument for increased use of Formula L on Pennsylvania roadsides.

TABLE 1: Application rates in product/acre and active ingredient/acre (ai/ac) for six grass herbicides at 1, 2, 4, and 8X rates.

	1X		2X		4X		8X	
Product	product	ai	product	ai	product	ai	product	ai
	(oz/ac)	(lb/ac)	(oz/ac)	(lb/ac)	(oz/ac)	(lb/ac)	(oz/ac)	(lb/ac)
Assure II	10	0.069	20	0.14	40	0.28	80	0.55
Fusilade 2000	24	0.19	48	0.38	96	0.76	192	1.52
Horizon	32	0.25	64	0.50	128	1.0	256	2.0
Horizon 2000	8	0.17	16	0.33	32	0.66	64	1.33
Vantage	60	0.47	120	0.94	240	1.88	480	3.76
Verdict	8	0.12	16	0.25	32	0.50	64	1.0

TABLE 2: Dry weight yields on July 3 from a mixed stand of fine fescue treated May 12 with six grass herbicides applied at four rates each. LSD values (p=0.05) are reported for each treatment averaged over application rates (n=12), and for application rates averaged over treatments (n=18).

	Application Rate				
Product	1X	2X	4X	8X	Average
	(-----------------------------------lbs dry weight/M			-----------------------------------)	
Assure II	56	45	49	36	46
Fusilade 2000	46	44	48	30	42
Horizon	47	44	48	30	42
Horizon 2000	42	51	44	32	42
Vantage	55	49	41	36	45
Verdict	41	39	27	15	30
					LSD = 6
Average (excluding check)	48	45	43	30	LSD =11
Untreated Check	47	49	52	47	49

COMPARISON OF MEFLUIDIDE AND SETHOXYDIM AS PLANT GROWTH REGULATORS IN TALL FESCUE

INTRODUCTION

Vantage in combination with either Telar or Event was compared with recommended rates of Embark plus either Telar or Event. Vantage was applied at low rates with the intent of achieving suppression of tall fescue seedheads. At higher rates, Vantage will kill tall fescue, as well as many other perennial grasses.

MATERIALS AND METHODS

The study was established May 11, 1992, on a six year old stand of 'Bonanza', 'Cimmaron', and 'Olympia' tall fescues at the Penn State Landscape Management Research Center. The study included nine treatments arranged in a randomized complete block design, with three replications. The treatments were applied to 3 by 15 ft plots with a CO_2 pressurized backpack sprayer delivering 15.8 gal/ac at 24 psi using Spraying Systems 8002 flat fan spray tips. The treatments were Telar at 0.25 oz product/ac plus either Embark at 12 oz product/ac, or Vantage at 8, 12, or 16 oz product/ac; Event at 4 oz product/ac plus either Embark at 8 oz product/ac, or Vantage at 8, 12, or 16 oz product/ac; and an untreated check. A non-ionic spray adjuvant (CideKick II) was included in all plant growth regulator treatments at 0.25 % v/v.

On June 2, 22 days after treatment (DAT), visual ratings of turf color were taken on a 1 to 9 scale where '1' = dead turf, '9' = darkest green, and '5' being the lowest acceptable rating for low maintenance turf; and vegetative canopy height measurements were taken at two locations in each plot. On June 17, 37 DAT, fresh clipping weights were taken with a 20 in rotary mower with a cutting height of 3 in. A subsample was taken from each plot harvest, and weighed fresh and dry to determine dry matter content and dry weight clipping yields. Fresh plot weights were taken on July 24, 1992, 74 DAT, to determine recovery. Results are reported in Table 1.

RESULTS

The color rating for the untreated check was significantly better than all treated plots while the combinations of Embark plus Telar and Embark plus Event were significantly better than all treatments which included Vantage. All turf color ratings for Vantage treated plots were unacceptable. Vegetative canopy height, and fresh and dry weight clipping yields taken 37 DAT were similar among all treated plots, while the untreated checks were significantly greater. No differences in dry matter content were found among any of the treatments. Plot regrowth 74 DAT in the untreated check was significantly lower than for the treated plots. All treatments provided excellent seedhead control.

CONCLUSIONS

Vantage provided growth inhibition similar to Embark treatments, but the amount of discoloration of tall fescue was unacceptable. Lower rates of Vantage than used in this study may reduce the discoloration resulting from the treatment and still provide acceptable results. However, because of declining interest in the use of growth regulators on Pennsylvania roadsides and lack of sufficient interest from the manufacturer, no further action will be taken on this matter.

TABLE 1: Results for plant growth regulator treatments applied May 11, 1992, to tall fescue. Vegetative canopy measurements and visual color ratings were taken on June 2, 22 days after treatment (DAT). Turf color was rated on a scale of 1 to 9, where 1=dead turf, 9=untreated turf, and 5=lowest acceptable rating for roadside turf.. Fresh clipping weights were taken on June 17 and July 24, 37 DAT and 74 DAT, respectively. Clipping weights are reported in lbs/1000 ft^2. Each value is the mean of three replications.

Treatment	Application Rate	Turf Color 22 DAT	Vegetative Canopy Height 22 DAT	Fresh Weight 37 DAT	Fresh Weight 74 DAT
	(oz product/ac)	(1-9)	(in)	(lb/M)	(lb/M)
1. Embark + Telar	12 + 0.25	6.0	6.3	37	19
2. Vantage + Telar	8 + 0.25	4.7	5.8	38	17
3. Vantage + Telar	12 + 0.25	4.3	6.6	40	21
4. Vantage + Telar	16 + 0.25	4.0	6.3	38	18
5. Embark + Event	8 + 4	6.7	6.3	46	19
6. Vantage + Event	8 + 4	4.3	6.0	36	17
7. Vantage + Event	12 + 4	4.0	6.3	47	22
8. Vantage + Event	16 + 4	3.7	6.3	42	22
9. untreated check	- - -	9.0	8.3	95	10
Significance Level (p)		0.0001	0.0003	0.0018	0.0056
LSD (p=0.05)		0.8	0.8	24	5

EVALUATION OF PRIMO IN COMBINATION WITH SEVERAL PLANT GROWTH REGULATORS APPLIED TO TALL FESCUE

INTRODUCTION

Primo is a new growth regulator currently targeted for mowing reduction on improved turf. It acts in a manner similar to Type II growth regulators such as Cutless and paclabutrazol, by reducing plant size through inhibition of cell elongation, rather than cell division. It is not effective in suppressing seedheads, though it will make them shorter. This study was initiated to evaluate Primo in combination with other materials used as growth regulators for use on tall fescue prior to seedhead emergence, to evaluate foliage and seedhead inhibition, as well as injury to the treated turf.

MATERIALS AND METHODS

This study was established May 1, 1992, at the Landscape Management Research Center of the Pennsylvania State University. Primo at rates of 0, 16, and 32 oz product/ac was applied alone and in combination with Embark at 8 oz product/ac; Event at 4 oz product/ac; Telar at 0.25 oz product/ac; and Escort at 0.125 oz product/ac. These treatments were applied to a six year old stand of a blend of 'Cimmaron', 'Bonanza', and 'Olympia' turf-type tall fescues. The applications were made to 3 by 15 ft plots in a randomized complete block design with a factorial treatment arrangement and three replications, using a CO_2 powered, hand-held sprayer delivering 15.8 gal/ac at 20 psi using Spraying Systems 8002 flat fan spray tips. All plots except the untreated check were also treated with a commercial premix of 2,4-D, MCPP, and dicamba, at 1.0, 1.0, and 0.25 lb ae/ac, respectively, tank mixed with the growth regulator treatments.

Vegetative canopy height was estimated at two locations in each plot on May 29, 28 days after treatment (DAT). Seedhead height and density were measured June 12, 42 DAT. Seedhead density was measured by counting the number of seedheads in a single 0.25 m^2 quadrat placed in each plot. Clipping yields were taken June 18 and July 27, 47 and 87 DAT, respectively, using a 20 in rotary mower set at 3 in. A clippings subsample was taken from each plot at the 47 DAT harvest, and weighed fresh and dry to determine dry weight clippings yield.

RESULTS

There were no turf color differences observed during the course of the study. There was no significant interaction between Primo rate and plant growth regulator treatment for any dependent variable. Primo rate had a significant effect on vegetative canopy height and seedhead height. There was a significant decrease in vegetative canopy height and seedhead height with each increase in Primo application rate. Dry weight clipping yields of turf treated with Primo at 32 oz product/ac were significantly lower than when treated with 0 or 16 oz product/ac (Table 1).

Plant growth regulator treatment had a significant effect on all dependent variables (Table 2). Treatments including a growth regulator in addition to Primo provided a reduction in vegetative canopy height, seedhead height, seedhead density, and clipping yields and dry matter content 47 DAT; and a significant increase in clipping yields 87 DAT, compared to treatments of Primo alone.

CONCLUSIONS

The addition of Primo at increasing rates did increase the inhibition of turf growth without causing phytotoxicity, but the application rates used in this study were not sufficient to provide the degree of inhibition, particularly of seedhead production, that would be considered satisfactory. Future investigations of combination treatments should include increased application rates of the treatment components.

TABLE 1: Results from three rates of Primo applied to tall fescue on May 1, 1992, and averaged over five plant growth regulator treatments . Vegetative height was measured May 29 (28 DAT). Seedhead height and density were measured June 11 (42 DAT). Clipping weights were taken June 17 (47 DAT) at a height of 3 in using a rotary mower, and subsamples were taken dry weight yield. Fresh clipping weights were taken July 27 (87 DAT) to determine post-mow regrowth. Each value is the mean of 15 observations (five growth regulator treatments, three replications.

Treatment	Application Rate	Vegetative Height 28 DAT	Seedhead Height 42 DAT	Seedhead Density 42 DAT	Dry Weight 47 DAT	Fresh Weight 87 DAT
	(oz product/ac)	(in)	(in)	(seedhead/ft^2)	(lb/M)	(lb/M)
none	- - -	7.9	29.8	36	55	37
Primo	16	7.5	28.7	40	55	38
Primo	32	7.1	26.7	40	48	38
Probability Level (P)		0.0002	0.0001	0.2986	0.0368	0.8366
LSD (P=0.05)		0.4	1.1	n.s.	5	n.s.

TABLE 2: Results from five plant growth regulator treatments applied to tall fescue on May 1, 1992, averaged over three rates of Primo. Vegetative height was measured May 29 (28 DAT). Seedhead height and density were measured June 11 (42 DAT). Clipping weights were taken June 17 (47 DAT) at a height of 3 in using a rotary mower, and subsamples were taken to determine dry weight. Fresh clipping weights were taken July 27 (87 DAT) to determine post-mow regrowth. Each value is the mean of 9 observations (three Primo rates, three replications).

Treatment	Application Rate	Vegetative Height 28 DAT	Seedhead Height 42 DAT	Seedhead Density 42 DAT	Dry Weight 47 DAT	Fresh Weight 87 DAT
	(oz product/ac)	(in)	(in)	(seedhead/ft^2)	(lb/M)	(lb/M)
none	- - -	8.8	31.6	19	60	31
Embark	8	8.0	29.6	13	54	35
Event	4	6.9	24.0	10	51	39
Telar	0.25	6.6	27.3	14	47	41
Escort	0.125	7.0	29.7	16	50	42
Probability Level (P)		0.0001	0.0001	0.0001	0.0085	0.0001
LSD (P=0.05)		0.5	1.5	3	7	4

EVALUATION OF MEFLUIDIDE IN COMBINATION WITH TYPE II PLANT GROWTH REGULATORS APPLIED TO TALL FESCUE

INTRODUCTION

Cutless and paclabutrazol are plant growth regulators that inhibit cell elongation (Type II); in contrast to Embark, which inhibits cell division (Type I). These materials were combined with Embark and applied to tall fescue to evaluate their potential to reduce seedhead and foliage growth, while minimizing injury to the tall fescue.

MATERIALS AND METHODS

This study was established at the Landscape Management Research Center on a six-year old stand of a blend of 'Cimmaron', 'Bonanza', and 'Olympia' tall fescues. Embark at 0, 2, 4, 8, and 16 oz product/ac was applied alone and in combination with either Cutless at 0.25 or 0.50 lb ai/ac, or paclabutrazol at 0.25 or 0.50 lb ai/ac. The 25 treatment combinations were applied May 11, 1992, to 3 by 15 ft plots using a CO_2-powered, hand-held boom delivering 16 gal/ac at 20 psi using Spraying Systems 8002 flat fan spray tips. The experimental design was a randomized complete block design with a factorial treatment arrangement, with three replications. Measurements of vegetative canopy height, seedhead height, and seedhead density were taken June 11, 31 days after treatment (DAT). Clipping yields were taken June 18 and July 21, 38 and 71 DAT, respectively, using a 20 in rotary mower with a 3 in cutting height. Sub-samples were taken 38 DAT, and weighed fresh and dry to determine dry matter content and dry weight clipping yields.

RESULTS

There were no turf color differences observed during the experiment. There was a significant interaction between Embark rates and Type II treatments for seedhead height. Cutless at 0.25 lb ai/ac plus Embark at 0, 2, or 4 oz product/ac, provided less seedhead height reduction than the other Type II materials, but seedhead heights were not significantly different between the Type II materials at Embark rates of 8 and 16 oz product/ac. Dry matter content was not affected by any treatment 38 DAT, so only fresh clipping yields are reported. Type II treatments had no significant effect on seedhead density (Table 1). There was no significant difference in canopy height between any of the Cutless or paclabutrazol treatments, but both rates of each significantly reduced canopy height compared to Embark alone ('none' in Table 1). Cutless and paclabutrazol significantly reduced seedhead height compared to Embark alone, and the 0.50 lb ai/a rate of each significantly reduced seedhead height compared to the 0.25 lb ai/ac rate. Both Type II materials provided a significant decrease in fresh clipping weights 38 DAT compared to Embark alone, and clipping yields for Cutless at 0.25 lb ai/ac were significantly higher than the 0.50 lb ai/ac treatment and both rates of paclabutrazol. When clipping yields were taken 71 DAT, paclabutrazol treatments provided the lowest yields, and Cutless at 0.25 lb ai/ac was not significantly different than Embark alone. Embark treatments had no significant effect on fresh clipping yields taken 71 DAT (Table 2). Increasing Embark rates did increase the suppression of canopy height, seedhead height, seedhead density, and clipping yields 38 DAT.

CONCLUSIONS

At the rates applied, these combinations provided significant, but not functional suppression of tall fescue, particularly of seedheads; and there was no indication of a synergistic response between Embark and Cutless or paclabutrazol. Future research of these combinations should include higher rates of one or both of the components, or the addition of an additional plant growth regulator.

TABLE 1: Results from Type II plant growth regulator treatments, averaged over five Embark rates (n=15), applied to tall fescue May 11, 1992. Vegetative canopy height, seedhead height, and seedhead density were were measured June 11, 31 days after treatment (DAT). Fresh clipping weights were taken June 18 (38 DAT) and July 21 (71 DAT), using a rotary mower with a 3 in cutting height.

Treatment	Application Rate	Canopy Height 31 DAT	Seedhead Height 31 DAT	Seedhead Density 31 DAT	Fresh Clipping Yield 38 DAT	Fresh Clipping Yield 71 DAT
	(lb ai/ac)	(in)	(in)	(seedheads/ft^2)	(lb/M)	(lb/M)
none	- -	11.8	25.6	21.1	197	20
Cutless	0.25	11.0	21.1	19.8	177	22
paclabutrazol	0.25	10.6	18.0	19.4	153	16
Cutless	0.50	10.3	17.4	18.5	155	18
paclabutrazol	0.50	10.4	16.3	18.2	142	14
Significance Level (P)		0.0010	0.0001	0.3210	0.0001	0.0001
L.S.D. (p=0.05)		0.8	1.4	n.s.	18	3

TABLE 2: Results from increasing Embark rates, averaged over five Type II plant growth regulator treatments (n=15), applied to tall fescue May 11, 1992. Vegetative canopy height, seedhead height, and seedhead density were were measured June 11, 31 days after treatment (DAT). Fresh clipping weights were taken June 18 (38 DAT) and July 21 (71 DAT), using a rotary mower with a 3 in cutting height.

Treatment	Application Rate	Application Rate	Canopy Height 31 DAT	Seedhead Height 31 DAT	Seedhead Density 31 DAT	Fresh Clipping Yield 38 DAT	Fresh Clipping Yield 71 DAT
	(oz product/ac)	(lb ai/ac)	(in)	(in)	(seedheads/ft^2)	(lb/M)	(lb/M)
none		- -	11.9	27.0	23.7	206	18
Embark	2	0.031	11.1	22.5	21.7	171	17
Embark	4	0.062	10.9	19.1	18.8	163	17
Embark	8	0.12	10.1	16.3	17.6	147	18
Embark	16	0.25	10.2	13.7	15.2	135	20
Significance Level (P)			0.0001	0.0001	0.0001	0.0001	0.1230
L.S.D. (p=0.05)			0.8	1.4	3.0	18	n.s.

VEGETATION CONTROL PROVIDED BY FALL OR SPRING APPLICATIONS OF NON-SELECTIVE HERBICIDES

INTRODUCTION

Total vegetation control treatments are typically applied from early April to June, with an emphasis on earlier treatments to avoid treating taller vegetation and causing unfavorable public reaction to brownout. If effective, economical treatments could be applied in the previous fall, this would reduce the spring work load, and make it easier to complete spray operations early in the season. This study compared a September and April application of five herbicides, to determine if any of them have the potential to provide season-long bare ground when applied the previous fall.

MATERIALS AND METHODS

The experimental design was a randomized complete block with a factorial treatment arrangement and two replications. The herbicide treatments were Arsenal at 48 oz product/ac, Oust at 3 oz product/ac, Hyvar X at 5 lb product/ac, Spike 80W at 4 lb product/ac, and Karmex at 10 lb product/ac. Fall applications were made September 16, 1991, and spring applications were made April 15, 1992. The treatments were applied to 5 by 50 ft plots along a section of guiderail on Central Road, near New Stanton, PA. Fall treatments were applied with a CO_2 pressurized backpack sprayer delivering 11.5 gal/ac at 30 psi using two Spraying Systems OC-02 spray tips mounted in-line on a double swivel nozzle body. One spray tip was angled forward, the other to the rear, to provide coverage on both sides of the guiderail posts. Prior to the fall application the predominant species were tall fescue (*Festuca arundinacea*), orchardgrass (*Dactylis glomerata*), Kentucky bluegrass (*Poa pratensis*), quackgrass (*Elytrigia repens*), and crownvetch (*Coronilla varia*). The spring treatments were applied with a CO_2 pressurized backpack sprayer delivering 17.3 gal/ac at 24 psi using one Spraying Systems OC-08 spray tip. Visual ratings of percent vegetative cover were taken on April 15, 1992, 212 days after treatment (DAT), for fall treatments only; and June 9, 1992, 55 and 267 DAT for spring and fall treatments, respectively. A later season rating was not taken because the area was unfortunately excavated with a grader. Results are reported in Table 1.

RESULTS

At the April 15 rating, plots treated with Karmex had significantly more vegetation than plots treated with Arsenal, Oust, and Spike. Predominant species were the same as those recorded prior to treatment. On June 9 the predominant species in the test area were smooth brome (*Bromus inermis*), crownvetch, quackgrass, and tall fescue. There was no significant interaction between herbicide treatment and application timing for the June 9 rating. Spring treated plots had significantly less cover on June 9, averaging 20 percent compared to 31 percent for fall treated plots. Plots treated with Arsenal received significantly lower cover ratings than any treatment except for Oust. Plots treated with Karmex received significantly higher cover ratings than any other treatment. Off-site movement was not observed for any of the treatments. On July 16, a field day was held at the test site where it was observed that the residual control provided by the fall application of imazapyr was failing, and the fall treated imazapyr plots had noticeably more vegetative cover than the spring treated plots. All plots should have been rated again in late summer, but were destroyed by the grading operation before that could be done.

CONCLUSIONS

Under the conditions of this study, it appears that a September application of herbicides may be too early to provide control the following growing season, particularly if using Arsenal, as nearly seven months elapse between application and the onset of the growing season. Although the rate of herbicide degradation should be reduced during the winter, enough degradation or movement out of the surface layer of the soil occurs to limit the effectiveness of the treatments. If further investigation into fall treatments is undertaken, later applications should be evaluated, as many perennial herbaceous species are still green in November in this region, and may be susceptible to herbicide applications.

TABLE 1: Visual ratings of percent living vegetative cover taken on April 15, 1992 for fall applied treatments only, and on June 9, 1992 for both fall and spring applied treatments. Fall treatments were applied September 16, 1991, and spring treatments were applied April 15, 1992.

			Vegetative	Vegetative Cover June 9		
Treatment	Application Rate	Application Rate	Cover April 15 (n=2)	Mean (n=4)	Fall Applied (n=2)	Spring Applied (n=2)
	(product/ac)	(lb ai/ac)	(%)	(%)	(%)	(%)
Arsenal	48 oz	0.75	1	7	9	5
Oust	3 oz	0.14	3	12	18	5
Hyvar X	5 lb	4.0	13	30	33	28
Spike 80W	4 lb	3.2	8	22	25	18
Karmex	10 lb	8.0	35	58	70	45
Significance Level (p)			0.0615	0.0020		
LSD (p=0.10)			23	20		

EFFECT OF SEEDING DATE ON ESTABLISHMENT OF 18 WILDFLOWER SPECIES

INTRODUCTION

Success of wildflower plantings throughout the state has been variable since Operation Wildflower began in 1990. In an effort to address the effect of planting date on planting success, particularly dormant seeding compared with early spring plantings, a study evaluating 18 wildflower species planted at five times was established.

MATERIALS AND METHODS

Species and seeding rates are reported in Table 1. The seeding dates were November 27, 1991; and January 2, February 3, March 4, and April 2, 1992. Seed for each species was suspended in 30 g of sand, and individually seeded to 3 by 3 ft plots with 1 ft vegetation-free borders arranged in a randomized complete block design with a split-block treatment arrangement, with three replications. The study area is mapped as a Hagerstown silt loam. Prior to seeding, existing vegetation was killed with applications of glyphosate plus triclopyr at 2.65 plus 2.0 lb ai/ac on September 17, 1991; and spot treatments of a 5% solution of diquat on November 25, 1991. The seedbed was prepared with a turf overseeder, producing slits 0.5 in deep on 3 in centers. The plot borders were maintained with an application of diquat plus oryzalin at 0.5 plus 2.0 lb ai/ac on April 27, 1992. Wildflower counts within each plot were taken June 23-26, 1992.

RESULTS

There was a strong interaction between wildflower species and planting date ($p=0.0001$). When analysis was performed for each species, the effect of timing date was not significant for New England aster, purple coneflower, and blackeyed Susan. New England aster and blackeyed Susan performed poorly at all timings, while purple coneflower produced between 9 and 20 plants/plot at all timings, with no apparent trend due to planting date (Table 2). Cornflower, tall plains coreopsis, cosmos, Indian blanket, corn poppy, white yarrow, oxeye daisy, dames rocket, and prairie coneflower exhibited significantly better establishment at the April 2 seeding than all other dates. Rocket larkspur, Siberian Wallflower, sweet William, and blue flax, and evening primrose also provided better establishment at later seeding dates, but provided peak establishment at the March 4 seeding. Lance leaved coreopsis plant counts were highest for the February 3 and March 4 seedings, which were significantly higher than all other seeding dates.

CONCLUSIONS

On average, wildflower species established better when planted April 2. The only species that suffered from delaying planting to this date was lance-leaved coreopsis. Although fitting several wildflower plantings into this time period may not be easy to accomplish, the increased chance of good stand establishment warrant this effort.

TABLE 1: Wildflower species and planting rates evaluated at five planting dates.

	Common Name	Scientific Name	Seeding Rate (lb/ac)
1.	Dwarf Cornflower	*Centaurea cyanus dwf.*	5
2.	Tall Plains Coreopsis	*Coreopsis tinctoria*	2
3.	Cosmos	*Cosmos bipinnatus*	15
4.	Rocket Larkspur	*Delphinium ajacis*	10
5.	Indian Blanket	*Gaillardia pulchella*	10
6.	Corn Poppy	*Papaver rhoeas*	1
7.	White Yarrow	*Achillea millefolium*	0.5
8.	New England Aster	*Aster novae-angliae*	2
9.	Siberian Wallflower	*Cheiranthus allionii*	5
10.	Oxeye Daisy	*Chrysanthemum leucanthemum*	5
11.	Lance Leaved Coreopsis	*Coreopsis lanceolata*	10
12.	Sweet William	*Dianthus barbatus*	6
13.	Purple Coneflower	*Echinacea purpureum*	12
14.	Dames Rocket	*Hesperis matronalis*	8
15.	Blue Flax	*Linum perenne lewisii*	8
16.	Evening Primrose	*Oenethera lamarkiana*	2
17.	Prairie Coneflower	*Ratibida columnifera*	2
18.	Blackeyed Susan	*Rudbeckia hirta*	2

TABLE 2: Number of plants counted in 9 ft^2 plots June 23-26, for 18 wildflower species planted at five different dates. Each planting date value is the mean of three replications.

		Seeding Date					Significance Level	L.S.D.
	Wildflower Species	Nov 27	Jan 2	Feb 3	Mar 4	Apr 2	(p)	(p=0.05)
		(-------------------- plants/9 ft^2 --------------------)						
1.	Cornflower	0	0	5	5	11	0.0009	4
2.	Tall Plains Coreopsis	0	3	10	16	37	0.0004	11
3.	Cosmos	0	0	3	13	30	0.0025	13
4.	Rocket Larkspur	1	0	2	9	4	0.0379	6
5.	Indian Blanket	3	9	9	29	61	0.0005	19
6.	Corn Poppy	0	2	7	6	12	0.0005	4
7.	White Yarrow	4	4	4	13	29	0.0001	5
8.	New England Aster	1	0	0	0	0	0.4609	n.s.
9.	Siberian Wallflower	0	0	0	6	1	0.0004	2
10.	Oxeye Daisy	7	7	19	23	46	0.0006	13
11.	Lance Leaved Coreopsis	15	10	25	22	10	0.0392	11
12.	Sweet William	5	5	21	31	26	0.0045	13
13.	Purple Coneflower	13	9	12	20	11	0.3157	n.s.
14.	Dames Rocket	2	7	15	24	55	0.0010	18
15.	Blue Flax	1	0	3	11	8	0.0012	4
16.	Evening Primrose	1	4	9	13	13	0.0046	6
17.	Prairie Coneflower	0	3	2	6	10	0.0001	2
18.	Blackeyed Susan	1	1	1	1	3	0.3833	n.s.
	Timing Means (n=54)	3	4	8	14	20	0.0001	4