J Plant Growth Regul (1993) 12:91–93

Journal of
Plant Growth Regulation

A 10-Year Evaluation of Plant Growth Regulator Carryover in Roadside Test Plots in Indiana

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Received March 22, 1993; accepted May 27, 1993

Abstract. Three primary growth regulators/herbicides, mefluidide, chlorsulfuron and sulfometuron, alone and in combinations with and without surfactant or 2,4-dichlorophenoxyacetic acid (2,4-D), were applied annually eight to 10 times the cost-effective rates of application to roadside stands of mixed tall fescue (*Festuca arundinacea* Schreb.) and native bluegrass (*Poa pratensis* L). The plots were not mowed. Applications were during the first week of May prior to elongation of culms bearing seed heads. With all of the materials and at all rates of applications, the grass had recovered fully by the end of the growing season (August). Even in the final year of the trial, all plots still supported strong stands of perennial grasses. The results show that the growth retardant mefluidide alone or in combination with the sulfonylurea herbicides, chlorsulfuron or sulfometuron, can be applied to established turf at cost-effective rates on an annual basis without permanent damage to turf or detrimental carryover of materials.

A combination of a primary growth retardant, mefluidide, a synergistic additive, chlorsulfuron, a detergent to enhance penetration (X-77), and an herbicide, 2,4-D, has been reported to be effective for full-season suppression of seed head formation in bluegrass–tall fescue stands along roadsides at cost-effective rates of application (Morré and Tautvydas 1986). The treatments, if applied prior to seed head emergence, prevent the elongation of culms bearing seed heads and largely eliminate the need for early or mid-season mechanical mowing. However, to achieve the desired reductions in mechanical mowing on a recurring basis, annual applications of the retardant mixtures would be required.

A series of repeated applications of the retardant mixtures and some of their components were initiated in the spring of 1983 after an initial 2 years of field testing. After 10 years both in small plots and under actual roadside use, no permanent loss of turf viability was observed with any of the treatments.

Materials and Methods

Growth retardant and herbicide treatments were applied to established roadside turf both to small plots and to large-scale test areas under roadside-use conditions. Uniform stands of predominantly tall fescue (*Festuca arundinacea* Schreb.) and native perennial bluegrass (*Poa pratensis* L.) in roadside locations were selected for evaluation.

Small Plots

Small plots were in three different locations along a 3-mile segment of State Road 126 in Tippecanoe County, Indiana. Plots were triplicated, 1.8 × 5.4 m. The plots were along a fence line adjacent to a meadow at two locations and a tilled field at another. The plot borders were mowed two to three times each year (spring, mid-season, fall) as a part of normal roadside maintenance, but the plot areas were not mowed at any time during the trial.

Applications were with a hand-held compressed air sprayer, spraying systems 8004 nozzles, 40 psi, and 374 L/ha (40 gpa). The initial applications were on May 3–5, 1983. The annual repeat applications were all between May 3 and May 9 (average date of application: May 5). Foliage was dry at the time of application. The average extended blade height of the fescue was 7 (5–10) cm, that of the bluegrass was 5 (3–9) cm. Applications were prior to the elongation of fescue seed head-bearing culms. Plots were rated for grass kill or changes in species composition at the time of application and the following August. Detailed counts were made in August of 1987, 1990, and 1992.

Large-Scale Trials

Large-scale trials of the retardant combinations only were applied to a segment of highway I-70 between Indianapolis and the Illinois state line beginning in the spring of 1984. Applications by

Table 1. Tall fescue (*Festuca arundinacea* Schreb.) and native perennial bluegrass (*Poa pratensis* L.) composition of roadside plots after 10 years of annual treatment with growth retardant/herbicides singly and in combination, for 1.8 × 5.4 m triplicated plots.

Treatment		Culms/m^2	
		Fescue	Bluegrass
None		77 ± 18	4.0 ± 0.2
Schedule A		68 ± 16	5.2 ± 1.2
Schedule B		80 ± 8	4.7 ± 0.7
Mefluidide[a]	0.14 kg/ha	88 ± 36	6.9 ± 2.1
	0.28 kg/ha	98 ± 46	6.4 ± 1.6
	0.56 kg/ha	79 ± 38	4.8 ± 0.4
	0.84 kg/ha	76 ± 51	4.4 ± 0.4
	1.12 kg/ha	56 ± 5	3.5 ± 0.5
	2.24 kg/ha	58 ± 6	3.0 ± 0.5
Chlorsulfuron[a]	8.8 g/ha	68 ± 8	4.4 ± 1.2
	17.6 g/ha	68 ± 4	4.8 ± 1.2
	35.2 g/ha	72 ± 8	4.4 ± 0.4
	52.8 g/ha	64 ± 4	4.4 ± 0.4
	70.4 g/ha	49 ± 20	4.0 ± 1.7
	140.8 g/ha	50 ± 6	5.2 ± 0.6
	280.6 g/ha	56 ± 7	6.5 ± 1.8
Sulfometuron[a]	4.4 g/ha	73 ± 20	5.8 ± 0.8
	8.8 g/ha	72 ± 16	5.0 ± 0.3
	17.6 g/ha	77 ± 25	5.5 ± 0.8
	26.4 g/ha	70 ± 17	5.0 ± 0.25
	35.2 g/ha	60 ± 8	5.2 ± 1.0
	70.4 g/ha	58 ± 8	5.2 ± 0.8
	140.8 g/ha	58 ± 10	5.5 ± 1.1
	218.6 g/ha	48 ± 16	4.4 ± 1.6

Schedule A = Mefluidide 0.56 kg/ha plus 2,4-D amine 2.24 kg/ha plus 0.5% X-77 (as percent of the total spray mixture).
Schedule B = Mefluidide 0.28 kg/ha plus chlorsulfuron 17.5 g/ha plus, 2,4-D amine 2.24 kg/ha plus 0.5% X-77.
Amounts of materials are of active materials. X-77 is as percent of the total spray mixture. Differences were not significant for any of the treatments ($p < 0.05$) as determined by analysis of variance.
Replicates from each location were averaged. Results are means from the three different locations ± standard deviations among locations. All single materials were compared with and without surfactant included in the spray mixture. There were no observable effects of surfactant on grass survival and the values with and without surfactant were pooled for analysis.
[a] Cost-effective rates are represented by the second and third lowest rates for each compound.

licensed Department of Highway applicators were made at 234 L/ha (25 gpa) using a commercial (Swinglok) applicator system. During much of the trial, the treated areas were unmowed but were included in a full-width mowing cycle beginning in 1989.

Results

After 10 years of annual applications of growth retardant at eight to 10 times the rates required for suppression of seed head formation, treated areas still supported normal stands of perennial grasses (Table 1).The very high rates of the two sulfonylureas, chlorsulfuron and sulfometuron, and all but the lowest rates of mefluidide inhibited early vegetative growth, as well as seed head formation (>80%). Yet, both fescue and bluegrass survived.

Although not statistically significant, some trends were noted. At cost-effective rates (0.16–0.28 kg/ha) of mefluidide, bluegrass appeared to increase in density as fescue seed heads were reduced. However, at very high concentrations of mefluidide (1.12 and 2.24 kg/ha), this effect was not seen. At high rates of mefluidide, bluegrass appeared to be killed, but then regrew from newly sprouted rhizomes.

Neither chlorsulfuron nor sulfometuron appeared to exert any detrimental effects on bluegrass. In fact, the ratio of bluegrass to fescue in the plots appeared to approximately double over the 10-year period. In contrast, fescue densities exhibited a significant numerical decrease with increasing concentrations of both sulfonylureas when compared on a logarithmic scale ($r = -0.83$, $p < 0.003$, beginning at 35.2 g/ha for chlorsulfuron and at 17.6 g/ha sulfometuron). In no instance did any of the treatments appear to be toxic. Results obtained in 1988 and 1990 were similar to those summarized in Table 1.

In large-scale trials with schedule A, stand composition also did not change appreciably since 1984. In the sprayed areas, both the bluegrass and fescue were shorter in the spring after green up (0.9 dm for sprayed bluegrass compared to 1.2 dm for unsprayed bluegrass and 1.8 dm for sprayed fescue compared to 2.4 dm for unsprayed fescue), but both bluegrass and fescue were still present and healthy.

Discussion

A major concern with the annual use of growth retardant mixtures along roadsides was the possibility that the turf would be weakened and deteriorate progressively. The mixture of materials (schedule B) will continue to be evaluated with repeated applications in two of the original locations. However, it seems highly unlikely that problems would ever arise with any of the materials in the mixture as a result of repeated applications if applied as single agents at cost-effective rates (≤0.56 g/ha for mefluidide and ≤17.5 g/ha for the sulfonylureas).

Date of application was important both with mefluidide and with the mefluidide–sulfonylurea mixtures. Both were observed to kill fescue and bluegrass applied as either schedule A or schedule B (Table 1) in very early spring. Toxicity correlated with application during a period of extreme cold where growth was slowed following an extended period of warm weather and rapid growth. Our applications were well after such critical periods. The critical periods when mefluidide or mefluidide plus chlorsulfuron toxicity would have been encountered were approximately 4 to 6 weeks earlier in late March or early April. The growth- and weather-related toxicity was observed to the same extent in areas sprayed for the first time as in plots after seven annual sprays in early to mid-April.

Not ruled out by the study are opportunities for long-term or accelerated changes in species composition due to reduced competition from the existing fescue or bluegrass plants in the sprayed areas. In one location, there was significant encroachment of quackgrass (*Agropyron repens* L.) from adjacent cropland in one entire replicate of plots sprayed with sulfonylurea alone. However, to what extent the progress of encroachment was accelerated or retarded by the annual application of sulfonylureas could not be evaluated in the present study. This was, however, the only change in species composition observed in any of the plots. Scattered clumps of smooth brome (*Bromus inermis Leyss*) or orchard grass (*Dachtylis glomerata* L.) remained scattered throughout the period of study with no apparent change in relative numbers.

The materials investigated have been studied widely as components of growth retardant mixtures (Freeborg et al. 1985). However, except for the 4-year trial reported by Dernoeden (1984), most evaluations in the same location have been based on one or more applications within a single season (Diesburg and Christians 1989, Walker and Welch 1989). While chlorsulfuron does appear to carry over from one season to the next (Walker and Welch 1989), this carryover appears to be insufficient to be detrimental to fescue or bluegrass at rates required for seasonal applications (e.g., 17.5 g/ha) in combination with mefluidide.

Acknowledgment. This work was supported in part by the Joint Highway Research Project, Purdue University, West Lafayette, IN.

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