'Tifway' Bermudagrass Responses to Plant Growth Regulator Application Dates

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Abstract. A field experiment was conducted over 2 years to determine the effects of treatment dates with plant growth regulators (PGRs) on performance of 'Tifway' bermudagrass [*Cynodon transvaalensis* Burt-Davy] × [*C. dactylon* (L.) Pers.]. For flurprimidol at 0.84 kg·ha⁻¹, the highest injury occurred from 16 or 28 June application in 1987 and from 17 May or June application in 1988. The injury was similar from treatment dates with flurprimidol + mefluidide or paclobutrazol + mefluidide. The PGRs were applied over a longer period in 1987 than 1988 without affecting vegetative suppression of 'Tifway' bermudagrass. However, in 1988, the suppression from the 17 May treatment was equal to or better than that obtained when treatment dates were delayed until 1 June or later. Chemical names: α-(1-methylethyl)-α-[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol (flurprimidol); N-[2,4-dimethyl-5-[(trifluoromethyl)sulfonyl]amino]phenylacetamide (mefluidide); (±)-(R,R')β-[(4-chlorophenyl)methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol (paclobutrazol).

Plant growth regulators (PGRs) are of interest for their potential to reduce the cost of turf maintenance. Batten (1983) reported as much as 50% reduction in mowing during 5 to 8 weeks. However, the use of PGRs on turfgrasses has two potential problems—they can cause severe injury to the turfgrass or fail to perform consistently (Christians, 1985).

Plant growth regulators are used to reduce vegetative growth and suppress seedheads, thereby reducing the number of mowings. Reducing frequency of mowing may be important on hazardous slopes (Batten, 1983) or during periods of rapid growth (Kaufmann, 1985). Although vegetative growth of bermudagrass has been reduced by PGRs (DiPaola et al., 1985; Johnson, 1988, 1989a; Rogers et al., 1987), it is important to apply the chemicals at a time that will provide the longest retardation without undesirable turfgrass injury. Kaufmann (1985) reported that the preferred time to apply a PGR to a turfgrass is just before the peak growth period. For cool-season grass, this is in the spring just before 50% of total annual growth can occur during six weeks (Kaufmann, 1985). In Georgia (Johnson, 1989b), PGRs applied 1 Mar. suppressed vegetative growth of tall fescue (*Festuca arundinacea* Schreb. 'Ky 31') for 6 weeks as well as or better than when PGRs were applied in mid-March or April.

Plant growth regulators applied in late May to common bermudagrass in Arkansas (Rog-

ers et al., 1987) had more dramatic effect on the grass than when applied in July. Similar results were also obtained from flurprimidol on 'Tifway' bermudagrass in Georgia (Johnson, 1988). Improved bermudagrasses exhibit a much different seasonal growth cycle than cool-season grasses, and much less has been published on warm-season grass responses to PGRs applied for maximum vegetation suppression. Therefore, an experiment was initiated on 'Tifway' bermudagrass to determine the effects of PGR treatment date on injury, turf density, and vegetative growth of turfgrass maintained for a high quality level.

The experiment was conducted on mature 'Tifway' bermudagrass at Griffin, Ga. The PGRs were flurprimidol at 0.84 kg·ha⁻¹, flurprimidol + mefluidide at 0.84 + 0.14 kg·ha⁻¹, and paclobutrazol + mefluidide at 1.1 + 0.14 kg·ha⁻¹. An untreated control was included. Treatment dates were 17 May, and 1, 16, and 28 June ± 1 day in 1987 and 1988. All PGRs were applied to different plots each year as a broadcast spray in 375 liters of water/ha.

'Tifway' bermudagrass was fertilized uniformly (kg·ha⁻¹) with 50N-22P-42K in mid-April. Additional N was applied at 50 kg·ha⁻¹ on the day of each PGR treatment and 25 kg·ha⁻¹ were applied to the same plots 4 weeks later.

The soil type was an Appling loamy sand (clayey, kaolinitic, Thermic Typic Hapludult) with 2.2% organic matter, 79% sand, 14% silt, and 7% clay. Soil pH was 5.7. A soil test indicated that P was high (48 mg·kg⁻¹) and K was low (59 mg·kg⁻¹).

'Tifway' bermudagrass was irrigated as needed to maintain optimum growth conditions before and after PGR treatments. Mowing was with a reel mower and clippings were removed before PGR treatments

were applied. One half of each plot was mowed weekly at 4 cm throughout the study.

Bermudagrass injury and turf density were estimated visually, while heights were measured from the soil surface to tip of the newest leaf. Turf injury symptoms from PGR treatments ranged from light green to leaf tip necrosis. The ratings were based on 0% = no injury to 100% = completely brown. Rating were weekly for 8 weeks beginning 1 week after PGR treatment. Turf injury ≥30% was considered to be commercially unacceptable. Turf density was based on 1 = no grass to 10 = complete, uniform cover. Plant heights were measured from 2 to 8 weeks in mowed plots and in unmowed plots at 4, 6, and 8 weeks after PGR treatments. Five foliar height measurements were made per replicated plot and reported as percent suppression.

The experimental design was a split-plot with four replications. Treatments dates were randomized within blocks as whole plots and PGR treatments were randomized as split-plots. Individual plots were 1.5 × 1.5 m. Analysis of variance using the statistical analysis system (General Linear Model procedure of SAS) was conducted within and across years (SAS Institute, 1982). The data was presented by year because of significant year × PGR × date interactions. When PGR × treatment date interaction occurred, treatment date comparisons were made within each PGR treatment.

The injury of 'Tifway' bermudagrass to PGRs varied between years and was influenced, in part, by treatment date (Table 1). In 1987, 3 weeks after flurprimidol was applied alone on 16 or 28 June, 'Tifway' bermudagrass was injured more than when applied 17 May or 1 June. By 5 weeks, the turfgrass treated with flurprimidol on 16 June had recovered slower than when treated 28 June. There were no differences due to treatment date when ratings were made 7 or 8 weeks after PGR treatment.

In 1988, flurprimidol applied 17 May or 1 June injured 'Tifway' bermudagrass more than when applied 16 June or later when ratings were made 5 weeks after treatment (Table 1). The grass treated 17 May with the PGR did not fully recover when final ratings were made 8 weeks after treatment.

There was little difference in turfgrass injury from treatment date of flurprimidol + mefluidide or paclobutrazol + mefluidide in 1987 (Table 1). However, in 1988, both tank-mixed treatments injured bermudagrass most when applied before 28 June, as indicated by ratings made 3 weeks after treatment. Turf treated with paclobutrazol + mefluidide on 17 May did not recover until 8 weeks after treatment, while turf treated with flurprimidol + mefluidide at the same date had not fully recovered at that time. Recovery was more rapid for later treatments.

The basis for the difference in response between years to treatment date is not known. During May, June, and July, the rainfall in 1987 was 150 mm more than in 1988, but the turfgrass was irrigated as needed to maintain growing conditions. Although there

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Table 1. Influence of plant growth regulator application dates on 'Tifway' bermudagrass injury following various periods of growth.^a

Application dates	Turfgrass injury (%) ^y					
	1987			1988		
	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide
<i>3 weeks</i>						
17 May	16	16	14	18	17	19
1 June	12	6	7	27	27	23
16 June	23	19	19	18	22	20
28 June	24	24	17	10	5	8
LSD 0.05	6	6	NS	10	11	9
<i>5 weeks</i>						
17 May	17	16	8	30	25	25
1 June	7	6	7	33	23	16
16 June	28	18	23	12	13	17
28 June	14	15	13	12	9	5
LSD 0.05	10	NS	NS	8	12	10
<i>7 weeks</i>						
17 May	12	11	0	23	20	12
1 June	8	0	0	8	0	0
16 June	14	10	13	0	0	4
28 June	5	9	9	0	0	0
LSD 0.05	NS	NS	NS	5	8	7
<i>8 weeks</i>						
17 May	2	4	0	13	10	3
1 June	8	3	5	0	0	0
16 June	11	3	9	0	0	5
28 June	5	8	8	0	0	0
LSD 0.05	NS	NS	NS	7	3	NS

^aPlant growth regulator rates (kg·ha⁻¹) were: flurprimidol, 0.84; flurprimidol + mefluidide, 0.84 + 0.14; and paclobutrazol + mefluidide, 1.1 + 0.14.^yTurf injury ratings are means from four replications and based on 0% = no injury and 100% = complete kill. Injury ≥30% was considered unacceptable.Table 2. Influence of plant growth regulator treatment application dates on turf density of 'Tifway' bermudagrass.^a

Application dates	Turf density (1 to 10) ^y					
	1987			1988		
	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide
17 May	8.9	9.3	9.6	8.5	8.2	9.2
1 June	8.9	9.4	9.4	8.8	9.5	9.3
16 June	7.9	8.5	7.8	9.4	9.5	9.1
28 June	9.1	8.8	8.9	9.5	9.8	9.8
LSD 0.05	NS	NS	1.4	0.5	0.3	0.4

^aPlant growth regulator rates (kg·ha⁻¹) were: flurprimidol, 0.84; flurprimidol + mefluidide, 0.84 + 0.14; and paclobutrazol + mefluidide, 1.1 + 0.14.^yTurf density ratings are means from four replications, were made 7 weeks after treatment, and are based on 1 = no turf and 10 = complete, uniform turf cover.

was some difference in temperature for 2 weeks after PGR treatment, it was not consistent.

The density of 'Tifway' bermudagrass was influenced by PGR treatment date at 7 weeks after treatment (Table 2). Turf density following paclobutrazol + mefluidide treatment on 16 June 1987 was lower than when the same treatment was applied 17 May or 1 June. At the same time in 1988, turf density following treatment with flurprimidol on 17 May or 1 June, flurprimidol + mefluidide on 17 May, or paclobutrazol + mefluidide on 17 May, 1, or 16 June was lower than when each respective PGR treatment was applied at other dates. However, the lower density of turf treated with PGRs was temporary, as the turf recovered when final ratings were made 8 weeks after treatment (data not presented).

In 1987, vegetative suppression of mowed 'Tifway' bermudagrass 2 weeks after the 28

June treatment with flurprimidol + mefluidide was higher than when treated 17 May (Table 3). Although there was no difference in vegetation suppression 2 and 3 weeks after the 16 and 29 June treatments, at 5 weeks, turf treated 16 June was suppressed more than turf treated 28 June. During 1987, paclobutrazol + mefluidide was only slightly influenced by treatment date (evaluated after 5 weeks), while vegetative suppression with flurprimidol was not influenced by treatment date.

The vegetative suppression of mowed 'Tifway' bermudagrass in 1988 was as high or higher and over a longer period from the 17 May treatment with flurprimidol than with later treatment dates. Although there was no difference in suppression of turfgrass from treatment dates with tank mixes of mefluidide with flurprimidol or paclobutrazol at 2 or 3 weeks after treatments, bermudagrass was suppressed longer when treated 17 May

than when treated anytime in June.

These results show that PGRs could have been applied over a longer period in 1987 than 1988 without affecting the suppression of vegetative growth of mowed 'Tifway' bermudagrass. However, in 1988, turfgrass suppression was as good or better from the 17 May treatment as from delayed treatments in June.

Flurprimidol applied alone resulted in vegetative growth only 1.2 to 2.9 cm high in unmowed 'Tifway' bermudagrass in 1987. In 1988, the height ranged from 4 cm when flurprimidol was applied 17 May to 8.4 cm when applied 16 June. Treatment date did not influence the performance of flurprimidol in 1987 as it did in 1988 when final ratings were made 8 weeks after treatment (Table 4). There was no advantage with tank mixes of flurprimidol + mefluidide or paclobutrazol + mefluidide in suppressing the vegetative height of unmowed 'Tifway' ber-

Table 3. Influence of plant growth regulator treatment application dates on vegetative height of mowed 'Tifway' bermudagrass following various periods of growth.^a

Application dates	Suppression of vegetative height (%) ^y					
	1987			1988		
	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide
			2 weeks			
17 May	4	+1	3	19	3	13
1 June	12	9	12	22	10	13
16 June	15	9	8	4	3	8
28 June	14	16	6	+2	1	15
LSD 0.05	NS	10	NS	19	NS	NS
			3 weeks			
17 May	19	11	12	23	15	19
1 June	9	0	+6	3	20	2
16 June	13	11	13	7	5	15
28 June	16	17	12	5	14	1
LSD 0.05	NS	NS	NS	19	NS	NS
			5 weeks			
17 May	14	11	+8	29	32	13
1 June	4	2	5	17	6	4
16 June	16	15	20	11	5	5
28 June	20	+1	3	5	0	+4
LSD 0.05	NS	11	18	15	11	12
			7 weeks			
17 May	+5	+7	+7	17	6	4
1 June	2	+3	4	+16	+13	+13
16 June	9	2	3	+1	+9	4
28 June	+1	+2	+10	+4	+7	+2
LSD 0.05	NS	NS	NS	20	13	8

^aPlant growth regulator rates (kg·ha⁻¹) were: flurprimidol, 0.84; flurprimidol + mefluidide, 0.84 + 0.14; and paclobutrazol + mefluidide, 1.1 + 0.14.

^yVegetative height ratings are means from four replications and based on percent suppression. Values preceded by + are taller than untreated plants.

Table 4. Influence of plant growth regulator treatment application dates on vegetative height of unmowed 'Tifway' bermudagrass 8 weeks after treatment.^a

Application dates	Suppression of vegetative height (%) ^y					
	1987			1988		
	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide	Flurprimidol	Flurprimidol + mefluidide	Paclobutrazol + mefluidide
17 May	47	43	34	51	49	33
1 June	48	41	43	65	53	44
16 June	30	32	19	43	47	46
28 June	29	38	38	41	35	34
LSD 0.05	NS	NS	NS	16	NS	NS

^aPlant growth regulator rates (kg·ha⁻¹) were: flurprimidol, 0.84; flurprimidol + mefluidide, 0.84 + 0.14; and paclobutrazol + mefluidide, 1.1 + 0.14.

^yVegetative height ratings were made 8 weeks after treatment, are means from four replications, and are based on percent suppression.

mudagrass compared with flurprimidol applied alone.

These results show that either flurprimidol, flurprimidol + mefluidide, or paclobutrazol + mefluidide will cause slight to severe injury to 'Tifway' bermudagrass, but that the turfgrass recovered to an acceptable level on or before 7 weeks after treatment. There was either little or no difference in vegetative growth of mowed bermudagrass due to PGR treatment dates in 1987. However, in 1988, the suppression of growth was as good or better when PGRs were applied mid-May than when delayed until 1 June or later.

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