THE INFLUENCE OF PLANT GROWTH REGULATORS ON WARM AND COOL-SEASON GRASS SPECIES

By

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INTRODUCTION

Each of the chapters of this thesis is a separate manuscript to be submitted for publication in Agronomy Journal (Chapter I) and HortScience (Chapter II).

CHAPTER I

SELECTIVE INHIBITION OF RYEGRASS OVER KENTUCKY BLUEGRASS USING MEFLUIDIDE AND PACLOBUTRAZOL

Selective Inhibition of Ryegrass Over Kentucky Bluegrass Using Mefluidide and Paclobutrazol[1]

D.P. Montgomery and A.D. Brede[2]

ABSTRACT

Cool-season grass species mixtures have many advantages, but a balanced mixture can be difficult to achieve. With ryegrass/Ky. bluegrass mixtures, the difficulty is due mainly to the vigorous seedling growth of the ryegrass. The purpose of this study was to determine whether annual ryegrass (*Lolium multiflorum* L.) or perennial ryegrass (*Lolium perenne* L., cv. 'Pennfine') seedlings could be selectively inhibited in a mixture with Kentucky bluegrass (*Poa pratensis* L., cv. 'Baron') by applying plant growth regulators (PGR) soon after ryegrass seedling emergence. Preliminary screening work in the greenhouse determined effective PGR rates and timings of application to achieve maximum growth inhibition and minimum injury from paclobutrazol (no chemical name to date) and mefluidide (N-(2,4-dimethyl-5-(((trifluoromethyl) sulfonyl)amino)phenyl)acetamide). Results from the screening experiments were used in field experiments in Stillwater, Oklahoma and Wichita, Kansas. Monocultures

and seed mixtures of 1:1 and 1:3 (ryegrass:bluegrass) pure-live-seed were tested in conjunction with a 1.12 kg ha^{-1} rate of paclobutrazol and a 0.28 kg ha^{-1} rate of mefluidide, applied at two different application dates prior to bluegrass emergence. Both PGR's significantly rediced ground coverage of all perennial ryegrass/Ky. bluegrass mixtures when compared to the untreated check. Paclobutrazol treatments on mixtures produced significant increases in turf color. Both PGR's reduced seedling heights of both ryegrass species and reduced initial clipping weights of annual ryegrass/Ky. bluegrass mixtures. Root dry weights were unaffected by both chemicals. Ryegrass (annual and perennial) shoot densities were also unaffected by both both chemicals, however paclobutrazol treatments on perennial ryegrass/Ky. bluegrass mixtures significantly decreased Kentucky bluegrass shoot density. In Kentucky bluegrass monocultures, paclobutrazol induced a greater than two-fold increase in shoot density during establishment. No detrimental effects were noticed on any of the seedling grasses as a result of selected rates of the chemicals.

Additional Index Words: Selectively, Lolium multiflorum, Lolium perenne, Poa pratensis, Seed Mixtures, Seedlings, Turf.

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INTRODUCTION

Mixtures of cool-season grasses have become common in fine turf areas. Using species mixtures has been shown to enhance genetic diversity and adaptability of the newly established turf (1,6, 9). One common mixture is perennial ryegrass (*Lolium perenne* L.) with Kentucky bluegrass (*Poa pratensis* L.). In other mixtures, such as ones containing annual ryegrass (*Lolium multiflorum* L.), the ryegrass is primarily used as a soil stabilizer, due to its seedling vigor (1). Seed Mixtures which contain only 10% ryegrass and 90%bluegrass often yield predominantly a ryegrass turf (2). It is this overly competitive growth of the ryegrass which can pose a problem in successfully establishing an even percentage of both species.

It has been shown that initial mowing of a perennial ryegrass/Kentucky bluegrass mixture effects the percentage of each turf species in the sward (3). Therefore, competition from the overly vigorous ryegrass seedlings can be somewhat overcome by initial cultural practices. The objective of the present study was to determine if plant growth regulators (PGR) could be used to selectively inhibit the growth of annual or perennial ryegrass seedlings when in a mixture with Kentucky bluegrass. Both annual and perennial ryegrass seedlings emerge from the soil several days before the Kentucky bluegrass seedlings (1). Our hypothesis involved applying a PGR during this time between the emergence of ryegrass and the later emergence of the bluegrass to possibly inhibit the ryegrass with little or no effect on the bluegrass. The desired results of these treatments would be a more balanced mixture, while preserving the initial soil stabilizing qualities of the ryegrass.

Researchers have shown that growth inhibition differs between species with respect to the PGR chemical application (5,10). This species differential suggested the possibility of influencing one species' growth more than another.

Mefluidide (N-(2,4-dimethyl-5-(((trifluoromethyl) sulfonyl)amino)phenyl)acetamide) and paclobutrazol (no chemical name to date) were chosen mainly due to their proven activity in inhibiting growth of mature turf (4,7, 10,11). Also these chemicals represent two different sites of activity and modes of uptake in the plant. Mefluidide, a growth inhibitor, acts at the apex of growing points, inhibiting the movement of indole acetic acid (IAA) which means loss of apical dominance. Mefluidide is predominantly a foliarly absorbed chemical. Paclobutrazol, a true growth regulator, inhibits formation of gibberillic acid, which is used in plant cell elongation. Paclobutrazol is absorbed predominantly through the roots.

MATERIALS & METHODS

Greenhouse Screenings

Three initial screening experiments were conducted in the USDA greenhouses in Stillwater, Oklahoma. The purpose of these studies were to determine the most effective rates and timing of applications of mefluidide and paclobutrazol.

The first screning experiment was initiated to determine the rate of mefluidide and paclobutrazol which would supply the greatest amount of growth inhibition and the least amount of injury to perennial ryegrass (Lolium perenne L., cv. 'Pennfine') and annual ryegrass (Lolium multiflorum L.) monocultures. The rates of both chemicals used were 0.14, 0.28, 0.56, 0.84, and 1.12 kg ha^{-1}.

The second screening experiment was designed to determine the proper timing of applications relative to ryegrass seedling emergence. Chemical rates determined from the first screening experiment were used. Annual and perennial ryegrass seed was sown in pots each day for eleven consecutive days, thereby establishing a range of seedling ages, from day-of-emergence to 10 days-after-emergence. Treatments were applied to all pots on 28 Dec., 1984 using the same method as before and were visually rated as before.

The final screening experiment was to study the effect of the selected chemical rates (determined from first screening experiment) on the growth of Kentucky bluegrass (Poa pratensis L., cv. 'Baron') seedlings. Arange of seedling ages were established similar to the second screening experiment. Seedling age ranged from 5 days-before-emergence to 5 days-after-emergence. Treatments were applied on 4 Jan., 1985 using the same method as before and was visually rated as before.

Field Studies

Results from greenhouse screening studies established effective rates and timing of applications and these results were used to design two field experiments which were initiated in Stillwater, Oklahoma and Wichita, Kansas in Apr., 1985. Monocultures and seed mixtures of 1:1 and 1:3 (ryegrass:bluegrass) pure-live-seed were used at the Oklahoma location, whereas only a 1:1 ratio was used at the Kansas location due to limited space. The seeding rate used at both locations was 14 PLS/64.5 cm^2. The chemical treatments used were paclobutrazol at 1.12 kg ha^{-1} and mefluidide at 0.28 kg ha^{-1}. These treatments were applied to monocultures and mixtures of the three species. Treaments were also applied at two different timings relative to ryegrass emergence. A randomized complete block design was used with four replications in Oklahoma and three replications in Kansas. All data were subjected to analysis of variance, when appropriate means were separated using the Waller-Duncan K-ratio t-test at the K=100 level.

Soil at the Oklahoma location was a Kirkland silt loam while at Kansas it was a Canadian walldeck sandy loam (thermic, udic Haplustoll). After tillage and site preparation, 1.2 by 1.8 m^2 plots were seeded using wind boxes and shaker jars to apply appropriate seeds or seed mixtures. Starter fertilizer (17-10.1-4.9) was applied at planting at both locations at 98 kg N ha^{-1}. After seeding, the research area was hydromulched with a mixture of Soil-Gard mulch and a 12 kg ha^{-1} rate of siduron (1-(2-methylcyclohexyl)-3-phenyl urea). Both locations were supplied an additional 98 kg N ha^{-1} using a slow-release (32-1.3-8.3) fertilizer 6 to 7 weeks after experiment initiation.

The Oklahoma location was planted on 8 Apr., 1985 and treatments were applied on 18 Apr. and 21 Apr. At the 18 Apr. application the annual ryegrass and perennial ryegrass seedlings were 3 to 5 and 2 to 3 cm tall, respectively, and the 21 Apr. application 5 to 7 and 3 to 5 cm tall, respectively. No Kentucky bluegrass seedlings had emerged at either location when PGR applications were made. Kentucky bluegrass emergence, in untreated check plots, occured approximately one week after the last application date at both locations.

Chemical treatments were walked on using a CO_2-powered sprayer at an output of 468 L ha^{-1}. Treatments were applied over the right 3/4 of the plot, the remainder serving as an untreated area to aid in visual ratings.

At the Oklahoma location seedling heights were measured on 2 May, 1985. Three seedling heights were measured for each plot. Plots were visually rated for percent ground cover on 2 May and 23 May. Color was also visually rated on 23 May, on a scale of 1 to 9 with 9=most green, 1=less green and the untreated check would=5.

The research areas were maintained at a cutting height of 5 cm throughout their establishment. Fresh clipping weights were taken off the treated portion of the plots on 20 May and 18 June. Weights were taken by mowing and catching the clippings, which were weighted immediately. The plots were mowed approximately one week prior to harvesting clipping weights. Shoot counts and root dry weights were taken on 28 June. Shoots counts were collected using a 10 cm cup cutter on annual ryegrass mixtures and monocultures, and a Noer soil profile sampler on perennial ryegrass and Ky. bluegrass mixtures and monocultures. The two sampling techniques were equilibrated and counts were converted to shoots dm^{-2}. The same equilibration and conversions were used on root weights.

At the Kansas location seedling heights were measured on 2 May, percent ground cover on 8 May and 23 May, and color on 23 May. Fresh clipping weights were taken on 31 May and 25 June. Shoot counts and root dry weights were taken on 11 July. Shoot counts were taken again on 30 July. All ratings, measurements, and counts at the Kansas location were taken in the same manner as described previously for the Oklahoma location.

RESULTS

Greenhouse Screenings

The first greenhouse screening determined the most effective rates of both chemicals on the two ryegrass species. The 1.12 kg ha^{-1} rate of paclobutrazol was shown to have the best inhibition of growth on both ryegrass species with no injury to the seedlings (data not presented). Mefluidide at 0.28 kg ha^{-1} was the only rate that inhibited the ryegrass seedlings but did not cause an unacceptable amount of injury.

The second greenhouse screening has shown the older ryegrass seedlings were less effected by the chemical treatments than older ones (Figure 1).

The third greenhouse screening determined the effect of the predetermined chemical rates on Kentucky bluegrass seedlings of different ages. With respect to growth inhibition, mefluidide and paclobutrazol had opposite results (Figure 2). Mefluidide showed very little growth inhibition when applied to seedlings which were 3 to 5 days-from-emergence and showed only slight injury to the bluegrass seedlings (Figure 2). However, paclobutrazol was showing high levels of growth inhibition when applied to seedlings which were 3 to 5 days-from-emergence.

Field Studies

Analysis of data from field investigations (Oklahoma & Kansas) indicated no significant location x treatment interaction for several data. Therefore these data were pooled and presented in Table 1.

Seedling heights were measured approximately 20 days-after-treatment (DAT). All mixtures showed an initial reduction in seedling height as compared to the untreated check. The paclobutrazol treatments inhibited seedlings in mixtures significantly more than the mefluidide treatments. Paclobutrazol has been noticed to generally reduce growth of cool-season species more than mefluidide (4).

Clipping fresh weights were taken per plot approximately 50 DAT. Clipping weights on the annual ryegrass/Ky. bluegrass were significantly reduced by both chemicals when compared to the untreated check. Paclobutrazol again was significantly better than mefluidide in reducing clipping fresh weights. The perennial ryegrass/Ky. bluegrass mixtures showed a trend toward reduction in clipping weight, but the reduction was not significant.

Approximately 90 DAT shoot counts and root dry weights were taken. Root dry weights of mixtures and monocultures containing annual and perennial ryegrass were not significantly affected by either chemical as compared to the untreated check. Neither chemical significantly affected the shoot densities of annual or perennial ryegrass, but the trend was towards decreased ryegrass density when in mixtures (Table 1). Paclobutrazol-treated Kentucky bluegrass monocultures, however, showed a better than two-fold increase in shoot density as compared to the untreated check. Shoot samples taken from the Oklahoma location showed no bluegrass had survived more than 2 months in any of the treatments due to the onset of summer.

Data variables with a significant location x treatment interaction were analyzed by location and presented in Table 2. The two seed ratios (1:1 and 1:3) used in the Oklahoma study were similar in response to species and chemical treatment. Also the two treatment dates were essentially the same in activity at both locations. Therefore Table 1 and 2 describe only the 1:1 ratio and only the first treatment date data.

The initial ground cover rating in Oklahoma showed most chemical treatments tended to reduce ground cover, but only the mefluidide-treated annual ryegrass/Ky. bluegrass mixtures were significantly reduced. At the Kansas location, annual ryegrass/Ky. bluegrass mixtures were not significantly reduced by chemical treatments. However, the perennial ryegrass/Ky. bluegrass mixtures were significantly reduced in ground cover by both chemicals. A second ground cover rating was taken, at both locations, approximately 45 DAT and at this time all mixtures and monocultures were equal in ground cover to the untreated checks. Averaged over species (Sept. 1985), at the Oklahoma location, mefluidide treatments were showing a 6% reduction in ground cover, whereas, paclobutrazol treatments were showing a 35% decrease (this decrease was significant at the 0.05 level).

A visual rating of color was taken at 45 and 40 DAT in Oklahoma and Kansas, respectively. Paclobutrazol-treated mixtures and monocultures of annual and perennial ryegrass were significantly deeper green than untreated check plots. Increased color of turfgrasses has been previously noticed with both chemicals by many researchers (4). Mefluidide applications in the present study, increased green color by an insignificant amount.

Shoot densities were counted again at 100 DAT at the Kansas location. Ryegrass shoot densities were unaffected by chemical treatments (Table 2). However the bluegrass shoot density was reduced significantly by paclobutrazol treatments when the bluegrass was in a mixture with the two ryegrasses. Again bluegrass monocultures showed better than a two-fold increase in shoot density when paclobutrazol had been applied, as well as a significant increase in shoot density from the mefluidide treatment. These results of increased bluegrass shoot densities do not coroborate with those of other researchers who have noticed decreased shoot densities with paclobutrazol and mefluidide (8). The percentage of bluegrass shoots in both ryegrass/Ky. bluegrass mixtures were unaffected by the mefluidide treatments but were significantly reduced by paclobutrazol treatments.

The present study has determined that a mixture of grass species can be affected by the applications of PGR's during establishment. However, the use of these two chemicals did not seem to inhibit the ryegrass seedlings enough to prevent their vigorous competition with the Kentucky bluegrass. The answer to why paclobutrazol would increase bluegrass shoot density in monocultures and decrease it in mixtures, remains a mystery. Brede and Duich (3) noticed a similar unexplained event with perennial ryegrass. Perennial ryegrass monocultures responded to close mowing during establishment with an increase in shoot density, but with a corresponding decrease in density when in mixtures. Applications of PGR chemicals used in conjunction with lower percentages of ryegrass (10-20%) in the mixtures may show more promising results.

LITERATURE CITED

1. Blazer, R.E., T. Taylor, W. Griffeth, and W. Skrdla. 1956. Seedling competition in establishing forage plants. Agron. J. 48:1-6.

2. Brede, A.D. 1982. Interaction of three turfgrasses species. Ph.D. thesis. Penn. State Univ. microfilms. Ann Arbor, Mich. (Diss Abstr. 43: 2070B).

3. __________, and J.M. Duich. 1984. Initial mowing of Kentucky Bluegrass - Perennial Ryegrass seedling turf mixtures. Agron. J. 76:711-714.

4. Campbell, R.W. 1984. Turfgrass Growth Retardants. Kansas State Univ. Progress Report.

5. Christians, N.E., and J. Nau. 1984. Growth retardant effects on three turf species. J. Amer. Soc. Hort. Sci. 109(1):45-47.

6. Daniel, W.H., and R.P. Freeborg. 1980. Turf Managers Handbook. Harvest Pub. Co. pg. 92.

7. Dernoeden, P.H. 1984. Four-year response of a Kentucky Bluegrass - Red Fescue turf to plant growth regulators. Agron. J. 76:807-813.

8. Elkins, D.M., J.W. Vandeventer, and M.A. Briskovich. 1979. Effect of chemical growth retardants on turfgrass morphology. Agron. J. 69:458-461.

9. Gibeault, V.A., R. Autio, S. Spaulding, and V.B. Youngner. 1980. Mixed turfgrasses controls Fusarium blight. Calif. Turfgrass Culture 30(2-4):9-11.

10. Schmidt, R.E., and S.W. Bingham. 1979. Chemical growth regulation of "Baron" kentucky bluegrass. Agron. J. 69:995-1000.

11. Watschke, T.L. 1976. Growth regulation of Kentucky Bluegrass with several growth retardants. Agron. J. 68:787-791.

APPENDIX

Selective Inhibition of Ryegrass Over Kentucky Bluegrass Using Mefluidide and Paclobutrazol

Greenhouse Screenings

Annual and perennial ryegrass seed were planted in 15 by 20 by 5 cm pots filled with sterilized Kirkland silt loam (thermic, udertic Paleustoll). Soil was sterilized to eliminate soil pathogens which can be detrimental to young seedlings. Pots filled with soil were treated with methyl bromide for twenty-fours and then allowed to air-out for fourty-eight hours. During all screening experiments, irrigation and fertilization were supplied to prevent any nutrient deficiencies or water stress to the seedlings.

The chemical treatments were walked-on using a CO_2-powered sprayer with an output of 468 L ha^{-1}. The treatments were applied on 6 Nov, 1984 to seedlings which ranged from 3 to 5 cm in height. Seedlings were visually rated for injury on a scale of 9=no necrosis and 0=complete necrosis, each week for six consecutive weeks. Growth of seedlings was also visually rated on a scale of 9=complete growth and 0=no growth, each week for six consecutive weeks. All screening experiments were arranged in a randomized complete block design with two replications. All data were analyzed using regression analysis.

Figure 1. Fitted regression curves of growth inhibition and injury from paclobutrazol and mefluidide applications on seedling annual and perennial ryegrass.

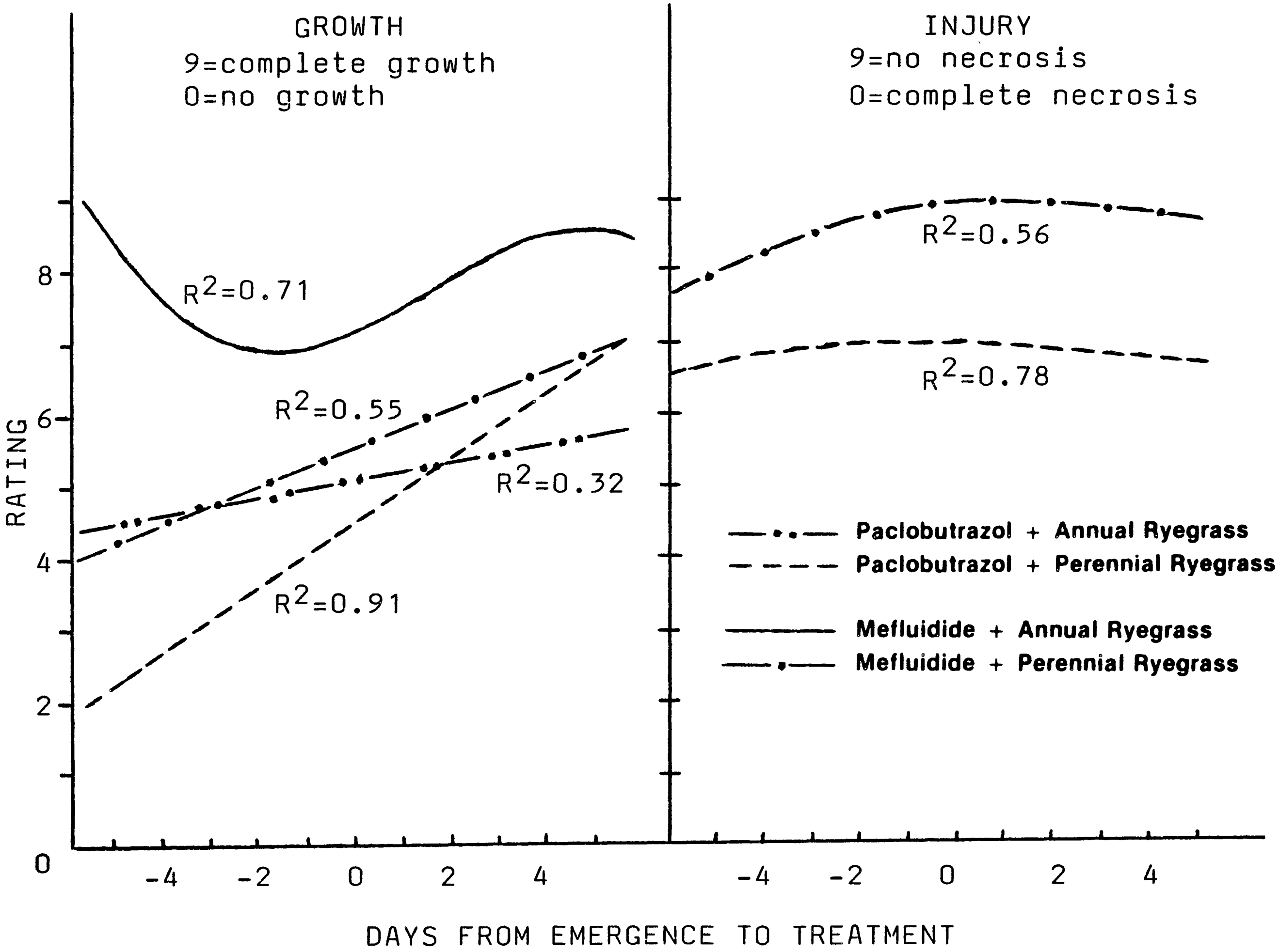

Figure 2. Fitted regression curves of growth inhibition and injury from paclobutrazol and mefluidide applications on Kentucky bluegrass seedlings.

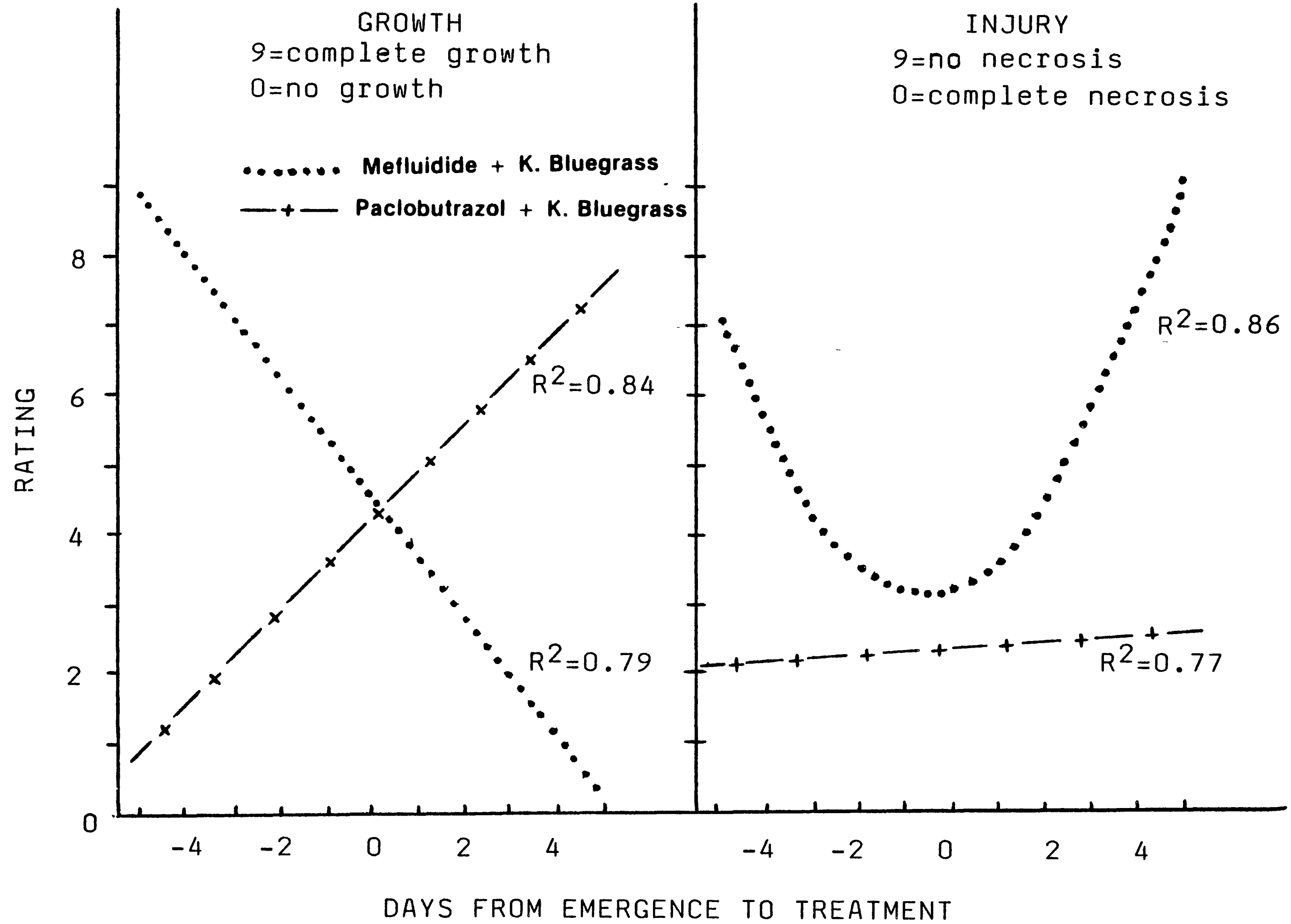

Table 1. Pooled effects of mefluidide and paclobutrazol on cool-season seedling grass mixtures in Stillwater, Oklahoma and Wichita, Kansas.

Treatment[††]	Rate	Species[†]	20 DAT Seedling Height	50 DAT Fresh Clipping Weight	90 DAT Ryegrass Shoot Count	90 DAT Root Dry Weight
	kg/ha		cm	g $2.2m^2$	dm^{-2}	g dm^{-2}
Mefluidide	0.28	A+B	10.5 b[+]	105 bc	195 d	4.2 a-c
Mefluidide	0.28	P+B	5.7 de	38 d-g	302 b-d	3.3 bc
Paclobutrazol	1.12	A+B	4.4 e-g	52 de	193 d	5.1 ab
Paclobutrazol	1.12	P+B	3.5 f-h	14 e-g	363 a-c	4.2 a-c
Mefluidide	0.28	A	12.3 a	172 a	208 d	4.3 a-c
Mefluidide	0.28	P	7.1 cd	51 de	437 a	3.2 b-c
Paclobutrazol	1.12	A	4.6 ef	69 cd	216 d	6.1 a
Paclobutrazol	1.12	P	3.3 f-h	11 eg	360 a-c	4.2 a-c
Mefluidide	0.28	B	1.4 i	o g	267 cd	2.7 c
Paclobutrazol	1.12	B	1.0 i	6 fg	430 a	2.6 c
Check	----	A+B	13.1 a	215 a	229 d	4.2 a-c
Check	----	P+B	7.4 c	47 d-f	319 a-d	3.9 bc
Check	----	B	2.1 hi	12 e-g	202 d	2.6 c

[+]Means followed by the same letter are not significantly different at the 5% level as determined by the Waller-Duncan K-ratio t-test.

[†]A=Annual ryegrass, P=Perennial ryegrass (cv., 'Pennfine'), B=Kentucky bluegrass (cv., 'Baron'); all mixtures seeded at 50:50 pure-live seed count ratio.

[††]Stillwater, Oklahoma treatments were applie on 8 Apr., 1985; Wichita, Kansas treatments were applied on 12 Apr., 1985.

Table 2. Effects of mefluidide and paclobutrazol on cool-season seedling grass mixtures in Stillwater, Oklahoma and Wichita, Kansas.

			Oklahoma			Kansas					
Treatment[††]	Rate	Species[†]	20 DAT Ground Cover	45 DAT Green Color rating[¶]	70 DAT Fresh Clipping weight	30 DAT Ground cover	40 DAT Green Color rating[¶]	70 DAT Fresh Clipping weight	100 DAT Bluegrass shoots	100 DAT Bluegrass shoot density	100 DAT Ryegrass Shoot density
	kg/ha		%		g 2.2m^2	%		g 2.2m^2	% of total	dm $^{-2}$	dm $^{-2}$
Mefluidide	0.28	A+B	41 hi	4.0 h	127 a-d	92 ab	3.0 g	72 de	9 bc	9 ef	85 d
Mefluidide	0.28	P+B	50 e-h	6.3 d-f	172 ab	73 d	6.7 c-e	25 ef	13 ab	27 de	174 ab
Paclobutrazol	1.12	A+B	74 bc	8.3 a-c	146 a-d	85 a-c	6.0 d-f	137 bc	1 d	1 f	80 d
Paclobutrazol	1.12	P+B	65 cd	8.3 gh	78 b-d	77 cd	7.0 b-e	27 ef	3 cd	6 ef	181 ab
Mefluidide	0.28	A	92 a	4.5 gh	149 a-d	95 a	3.0 g	53 d-f	---	---	101 d
Mefluidide	0.28	P	72 bc	7.3 b-d	143 a-d	92 ab	5.7 ef	30 ef	---	---	199 ab
Paclobutrazol	1.12	A	84 ab	7.5 a-d	150 a-d	90 ab	6.7 c-e	147 ab	---	---	123 cd
Paclobutrazol	1.12	P	66 cd	8.8 a	116 a-d	83 b-d	7.3 a-b	33 ef	---	---	177 ab
Mefluidide	0.28	B	10 j	6.0 ef	56 cd	18 ef	8.3 ab	23 ef	---	195 b	---
Paclobutrazol	1.12	B	10 j	7.0 c-f	53 d	13 f	8.7 a	15 f	---	270 a	---
Check	----	A+B	84 ab	4.0 h	149 a-d	95 a	3.0 g	72 de	9 bc	8 ef	89 d
Check	----	P+B	83 c-e	6.5 d-f	179 ab	88 ab	5.0 f	22 ef	18 a	37 d	165 ab
Check	----	B	11 j	7.3 b-e	96 a-d	27 e	7.7 a-c	28 ef	---	116 c	---
Check	----	A	95 a	3.3 h	85 a-d	---	---	---	---	---	---
Check	----	P	84 ab	6.5 d-f	112 a-d	---	---	---	---	---	---

* Means followed by the same letter are not significantly different at the 5% level as determined by the Waller-Duncan K-ratio t-test.
† A=Annual ryegrass; P=Perennial ryegrass (cv., 'Pennfine'); B=Kentucky bluegrass (cv., 'Baron'); all mixtures seeded at 50-50 pure-live-seed count ratio.
†† Stillwater, Oklahoma treatments were applied on 8 Apr., 1985;
Wichita, Kansas treatments were applied on 12 Apr., 1985.
¶ Green color was visually rated on a 1 to 9 scale, 9=most green.

CHAPTER II

INFLUENCE OF SULFOMETURON METHYL AND FLURPRIMIDOL TREATMENTS ON DORMANT AND ACTIVELY GROWING BERMUDAGRASS

Influence of Sulfometuron methyl and Flurprimidol Treatments on Dormant and Actively Growing Bermudagrass[1]

D.P. Montgomery and A.D. Brede[2]

ABSTRACT

The purpose of this study was to determine if the activity of growth regulating chemicals on bermudagrass (Cynodon dactylon L. Pers., cv. 'U-3') could be enhanced by making applications on winter dormant versus actively growing turf. A dormant application would hypothetically limit bermudagrass growth from dormancy break and produce a dwarfed plant form as the grass emerges in the spring. Sulfometuron methyl (methyl 2 (((((4,6 dimethyl-2-pyrimidyl) amino)carbonyl)amino)sulfonyl)bensoate) at 0.07, 0.14, 0.21, and 0.28 kg ha^{-1} and flurprimidol (α-(1-methylethyl)-α-(4-(trifluroro-methoxy)phenyl-5-pyrimidine methanol) at 0.84, 1.12, 2.24, and 3.36 kg ha^{-1} were tested in field experiments in 1984 and 1985.

Dormant applications of sulfometuron methyl in 1984 and 1985 and flurprimidol in 1985 produced significantly greater growth reductions with dormant applications than when applied to actively growing turf. Spring green-up was delayed 4 to 6 weeks from applications in 1984 and by 2 to 3 weeks in

1985. Turf injury was negligible.

Additional Index Words: Cynodon dactylon, Green-up, Weed Control, PGR, Turfgrass, Stolon.

[1]Contribution from the Okla. Agr. Exp. Stn., Journal Series No. ____________; received ____________.

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INTRODUCTION

Application of plant growth regulators (PGR) to turf can save considerable amounts of money in reducing mowing costs (7). Increasing fuel, machinery, and labor costs, and the danger of mowing sloped areas are but a few of the reasons why PGR's are in demand. Advantages from a PGR application range from reducing mowing frequency to reducing the water requirements of the turf (6).

PGR's have been widely used to successfully inhibit the growth of cool-season grass species. Some PGR's have been shown to retard bermudagrass (Cynodon dactylon L. Pers.) growth, but with poor success when compared to inhibition of cool-season species (5).

The present study examined two chemicals, sulfometuron methyl (methyl 2 (((((4,6 dimethyl-2-pyrimidyl)amino)carbonyl) amino)sulfonyl)bensoate) which inhibits plant growth through mitotic inhibition and flurprimidol (α-(1-methylethyl)-α -(4-(trifluroro-methoxy)phenyl)-5-pyrimidine methanol) which retards plant growth by inhibiting formation of gibberillic acid, thus suppressing cell elongation. Both sulfometuron methyl (SMM) and flurprimidol (FLUR) have been shown to have limited yet significant activity on warm-season grass species (1,3, 9).

Our hypothesis involved applying PGR materials to dormant bermudagrass to produce a dwarfed plant as dormancy begins to break in the spring. Rate and timing of this dormant application seem to be the keys to successfully inhibiting the growth of warm-season turf species.

The objective of this study was to determine the effects of two PGR chemicals applied to dormant and actively growing bermudagrass. The desired results from a PGR application on dormant bermudagrass would be a dwarfing effect as the turf breaks dormancy with little or no injury from the dormant application.

MATERIALS & METHODS

A field study was conducted at the Oklahoma Turfgrass Research Center in Stillwater during 1984 to determine the growth retarding properties of sulfometuron methyl and flurprimidol applied to bermudagrass (_Cynodon_ _dactylon_ L. Pers. cv. 'U-3') before, during, and after spring green-up. A 5 by 3 factorial design was used with five chemical treatments (Table 1) and three application dates (Table 2). Treatments were arranged in a randomized complete block design with three replications.

Chemical treatments, in 1984 experiment, were applied on 15 Mar., 17 Apr., and 15 May to 1.2 by 1.8 m^2 plots. Treatments were walked-on using a CO_2-powered sprayer with an output of 280 L ha^{-1} and a pressure of 207 k Pa. Bermudagrass green-up, in 1984, in the untreated check plot occurred on approximately 14 Apr.

The soil at this site was a Kirkland silt loam. During the 1984 experiment, irrigation was supplied to prevent any moisture stress to the turf. Fertilizer was applied at 49 kg N ha^{-1}, using a 18-2.2-7.4 (N-P-K) formulation on 27 Apr.

Plots were visually rated in 1984 for percent weed control as compared to the untreated check on 17 Apr. and 17 May. Weeds present were downy brome (<u>Bromus tectorum</u> L.), henbit (<u>Lamium amplexicaule</u> L.), and horseweed (<u>Erigeron canadensis</u> L. Crong.). Discoloration from the chemical treatments was visually rated on 15 June on a scale of 0 to 9, with 9=brown turf, and 0=green turf. Green-up delay was rated on 17 Apr. on a scale of 0 to 9 with 9=brown turf, 0=green turf. Growth was visually rated on 17 May and 15 June on a scale of 0 to 9 with 9=no regrowth, and 0=complete regrowth. Plots were left unmowed until clipping weights were taken on 23 Aug. at a cutting height of 2.5 cm. Clipping weights were taken using a Jari-mower to harvest the entire plot. Internode lengths were measured on 15 June by randomly selecting three stolons in each plot and measuring the first three internodes on each stolon starting at the end of the stolon, for a total of nine internode measurements per plot.

Field studies in 1985 were conducted at an adjacent site of U-3 bermudagrass. Treatments of SMM and FLUR were made to dormant and actively growing bermudagrass (Table 3). A split-plot design was used with fertility levels as whole plots and chemical treatments as sub plots. The experiment was replicated in two blocks. Three fertility were used (0, 88, and 263 kg N ha^{-1} yr^{-1} supplied by a 20-1.3-6.6 fertilizer) to establish low, medium, and high fertility regimes. The 263 kg N ha^{-1} yr^{-1} level involved a split application with 176 kg N ha^{-1} applied on 1 Apr. and an additional 88 kg N ha^{-1} application on 15 May. Chemical applications were made on 25 Feb. and 15 May to 0.9 by 1.5 m^2 plots using the same method as in 1984. Bermudagrass green-up in the untreated check plot occurred on approximately 1 Apr. Discoloration was visually rated on 14 June and green-up delay on 15 Apr. as before. Growth was visually rated on 15 May, 14 June, and 8 July as before. Clipping fresh weights were taken on 15 May at a 2.5 cm cutting height using the same procedure as in 1984. Internode lengths were measured on 18 June as before.

Data for both 1984 and 1985 studies were subjected to analysis of variance and the Waller-Duncan K-ratio t-test at the 0.05 level (K=100).

RESULTS & DISCUSSION

Both PGR's showed significant control of weeds which lasted into mid-summer (Table 1). SMM treatments have been shown by other researchers to produce excellant weed control on several annual weed species (3, 9).

Growth ratings taken 60 days-after-treatment (DAT) showed that all treatments, except the low rate of FLUR significantly reduced topgrowth. By the 90 DAT rating only the two highest rates of SMM were still showing significant topgrowth reduction (Table 1).

A visual rating of green-up delay taken 30 DAT has shown that all treatments of SMM were increasing green-up delay (Table 1). Visual ratings of discoloration taken 90 DAT has shown significant discoloration from the higher rates of SMM (Table 1). Internode lengths taken 90 DAT showed a trend towards reduction from all treatments, excluding the low rate of FLUR, however there were no significant reductions (Table 1).

Weed control was essentially the same with respect to application date (Table 2). Applications made to dormant bermudagrass produced significantly greater topgrowth reductions than the applications on actively growing bermudagrass at both of the visual growth ratings (Table 2). Clipping fresh weights taken 125 DAT have shown that both PGR's applied as dormant applications reduced topgrowth, but only the 15 Apr. application date showed a significant reduction when compared to the actively growing application date (Table 2). Suppression of topgrowth from SMM applications on warm-season grasses has been noted by several researchers (2, 6, 9).

Results from the 1984 study indicated that reduced rates of SMM should be used in 1985 in conjunction with earlier application dates to minimize injury. Gonzalez et. al. (3) and Rogers (8) have shown that SMM can reduce bermudagrass topgrowth but the rate and more importantly the timing of application will determine the amount of suppression and injury to the turf.

Analysis of data from the 1985 field study indicated no significant fertility x treatment interaction; therefore, these data were pooled (Table 3).

Green-up delay, visually rated 50 DAT, showed that the SMM and FLUR treatments caused significant delay in green-up of the turf (Table 3). February treatments were used in 1985 instead of March to hopefully reduce this delay in bermudagrass green-up which is a result of the chemical application. However, due to the early onset of spring in 1985 our attempts were essentially nullified. Visual growth ratings and clipping fresh weights taken 80 DAT have shown all FLUR and SMM treatments were reducing topgrowth significantly (Table 3). By 110 DAT, all SMM treatments, excluding the 0.14 Feb treatment, were still maintaining significant growth reduction.

Internode lengths at 110 DAT showed that all SMM treatments, excluding the 0.14 Feb. treatment, significantly reduced internode lenghts across all fertility levels, when compared to the untreated check plot (Table 4). An ideal characteristic of a successful bermudagrass growth regulator would be its ability to shorten internodes. The split applications of SMM showed the ability to reduce internode lengths and to produce dwarf plants and maintain this dwarfness with a second application.

Discoloration ratings at 100 DAT showed only four treatments exhibiting any significant effect (Figure 1). The discoloration at this rating was a yellowing of the turf. Treatments of SMM showed increasing amounts of discoloration with fertility levels. The amount of discoloration from the SMM treatments was considerably less in 1985 than was noticed from similar treatments in 1984 (at the 90 DAT discoloration rating). FLUR showed significant levels of discoloration in 1985 which decreased as fertility increased. This level of discoloration exhibited by both chemicals might be acceptable on low or medium maintenance turf areas (roadside, cemetary) but would probably be unacceptable on high maintenance areas (golf courses).

Results from 1984 and 1985 have shown that both SMM and FLUR can be used to suppress bermudagrass growth either before or after dormancy break. PGR treatments made during dormancy or at dormancy break were most successful in suppressing growth of the bermudagrass. The split applications in the 1985 study resulted in approximately the same amount of growth suppression as the single applications of similar rates in the 1984 study. The split applications, however, tended to reduce green-up delayment when compared to single applications of similar rates in 1984.

Literature Cited

1. Allen, T.J., J. Crosby, and R. Smith. 1983. Bermudagrass (*Cynodon dactylon* L. Pers.) release. *Proc. South. Weed Sci. Soc.* 36:294-299.

2. Deal, D.L., and J.M. Dipaola. 1983. Lateral and vertical growth of common bermudagrass following seasonal applications of GA_3, and growth retardants. Agron Abs. pg. 124.

3. Gonzalez, F.E., R.L. Atkins, and G.C. Brown. 1983. Sulfometuron methyl, rate and timing studies on bermudagrass and bahiagrass roadside turf. Proc. South. Weed Sci. Soc. 37:272-274.

4. Johns, D., and J.B. Beard. 1981. Reducing turfgrass transpiration using a growth inhibitor. Agron. Abs. pg. 126.

5. Kelly, C.A., K.L. Walker, J.R. Abernathy, and C.A. Wendf. 1983. The influence of growth regulators on common bermudagrass. Texas Turfgrass research-1983-. pg. 111-125.

6. Link, M.L., and R.L. Atkins. 1983. Control and suppression of warm-season grasses to reduce mowing highway rights-of-way. Proc. South. weed Sci. Soc. 36:310-312.

7. Miller, J.F. 1984. Weeds on roadsides-Weeds or Opportunities. Weeds Today 15(4):8.

8. Rogers, T. 1984. Influence of metsulfuron methyl and sulfometuron methyl on growth of bermudagrass. Masters Thesis. University of Arkansas.

9. Winthrow, K.D., and P.D. Middlebrooks. 1983. Control of roadside vegatation in Georgia with "Oust". Proc. South. Weed Sci. Soc. 36:293.

Table 1. Influence of growth regulating chemicals on growth and development of bermudagrass. 1984 .

Treatment	Rate	Weed Rating		Growth Rating[b]		Green-up Delay Ratings	Discoloration Rating[c]	Internode Lengths	Harvest fresh weights
		30 DAT	60 DAT	60 DAT	90 DAT	30 DAT	90 DAT	90 DAT	125 DAT
	kg ha^{-1}	% of control						cm	9 2.2m^2
Flurprimidol	.84	57 b*	61 b	2.7 cd	1.7 b	0.9 c	0.7 b	2.2 a	1160 b
Flurprimidol	1.12	46 b	65 bc	4.3 bc	2.6 b	1.3 c	2.1 b	1.8 ab	813 bc
Sulfometuron methyl	.07	61 b	87 c	5.0 ab	3.1 b	2.6 b	2.9 b	1.9 ab	1099 b
Sulfometuron methyl	.14	48 b	83 bc	6.9 a	6.7 a	3.4 a	6.2 a	1.7 ab	680 c
Sulfometuron methyl	.28	49 b	76 bc	6.4 ab	6.7 a	3.4 a	6.2 a	1.3 b	638 c
Check	---	0.0 a	0.0 a	1.7 d	3.0 b	1.0 c	2.3 b	2.0 ab	1562 a

* Means followed by the same letter are not significantly different at the 5% level as determined by the Waller-Duncan K-ratio t-test.

b Growth ratings were visually rated on a 0-9 scale, 9 = no regrowth.

c Discoloration and Green-up delay ratings were visually rated on a 0-9 scale, 9 = brown turf.

Table 2. Influence of timing of application of growth regulating chemicals applied to dormant and actively growing bermudagrass. 1984 .

Application Date	Weed Rating		Growth Rating[b]		Green-Up Rating	Discoloration Rating[c]	Internode Lengths	Harvest fresh weights
	30 DAT	60 DAT	60 DAT	90 DAT	30 DAT	90 DAT	90 DAT	125 DAT
	% of control							$g\ 2.2m^2$
(3-15-84) 4 weeks prior to greenup	72 b*	71 a	5.1 a	4.5 a	5.1 a	3.9 a	1.8 a	922 ab
(4-17-84) week of greenup	33 a	70 a	6.4 a	4.9 a	0.8 b	4.3 a	1.6 a	760 b
(4-15-84) 4 weeks after greenup	36 a	66 a	2.9 b	2.7 b	0.3 b	2.4 a	2.0 a	1082 a

* Means followed by the same letter are not significantly different at the 5% level as determined by the Waller-Duncan K-ratio t=test.

b Growth ratings were visually rated on a 0-9 scale, 9 = no regrowth.

c Discoloration and Green-up delay ratings were visually rated on a 0-9 scale, 9 = brown turf.

Table 3. Effects of timing and rate of growth regulating chemicals applied on dormant and actively growing bermudagrass. 1985 .

Treatment[a]	Rate	Application Date	Green-up Delay rating[b] 50 DAT	Clipping fresh weights 80 DAT	Growth rating[c] 80 DAT	Growth rating[c] 110 DAT	Growth rating[c] 135 DAT
	$kg\ ha^{-1}$			$g\ 1.4m^2$			
Sulfometuron methyl	0.07 + 0.07	Feb + May	6.5 ab*	118 d	3.2 e	6.0 d	0.7 a
Sulfometuron methyl	0.14	Feb	7.5 a	95 d	3.3 e	1.3 ab	1.2 a
Sulfometuron methyl	0.14 + 0.07	Feb + May	6.5 ab	133 cd	3.0 e	6.8 d	2.7 b
Sulfometuron methyl	0.21	May	---	---	---	6.3 d	5.3 cd
Flurprimidol	1.12	Feb	3.5 d	173 cd	1.3 bc	1.8 b	0.0 a
Flurprimidol	2.24	Feb	3.8 cd	146 cd	1.8 cd	0.2 a	0.2 a
Flurprimidol	3.36	Feb	5.3 bc	175 cd	1.5 de	0.7 ab	0.5 a
Flurprimidol	1.12	May	---	---	---	1.8 b	0.8 a
Flurprimidol	2.24	May	---	---	---	4.8 bc	3.3 bc
Flurprimidol	3.36	May	---	---	---	7.7 d	5.5 d
Check	---	---	0.0 e	318 ab	0.0 a	0.0 a	0.0 a

* Means followed by the same letter are not significantly different at the 5% level as determined by the Waller-Duncan K-ratio t-test.

a February treatmetns were applied on 25 Feb., 1985.
May treatments were applied on 15 may, 1985.
All DAT's refer to Feb. treatment date.

b Green-up delay rating was visually rated on a 0-9 scale, 9 = brown turf.

c Growth rating was visually rated on a 0-9 scale, 9 = no regrowth.

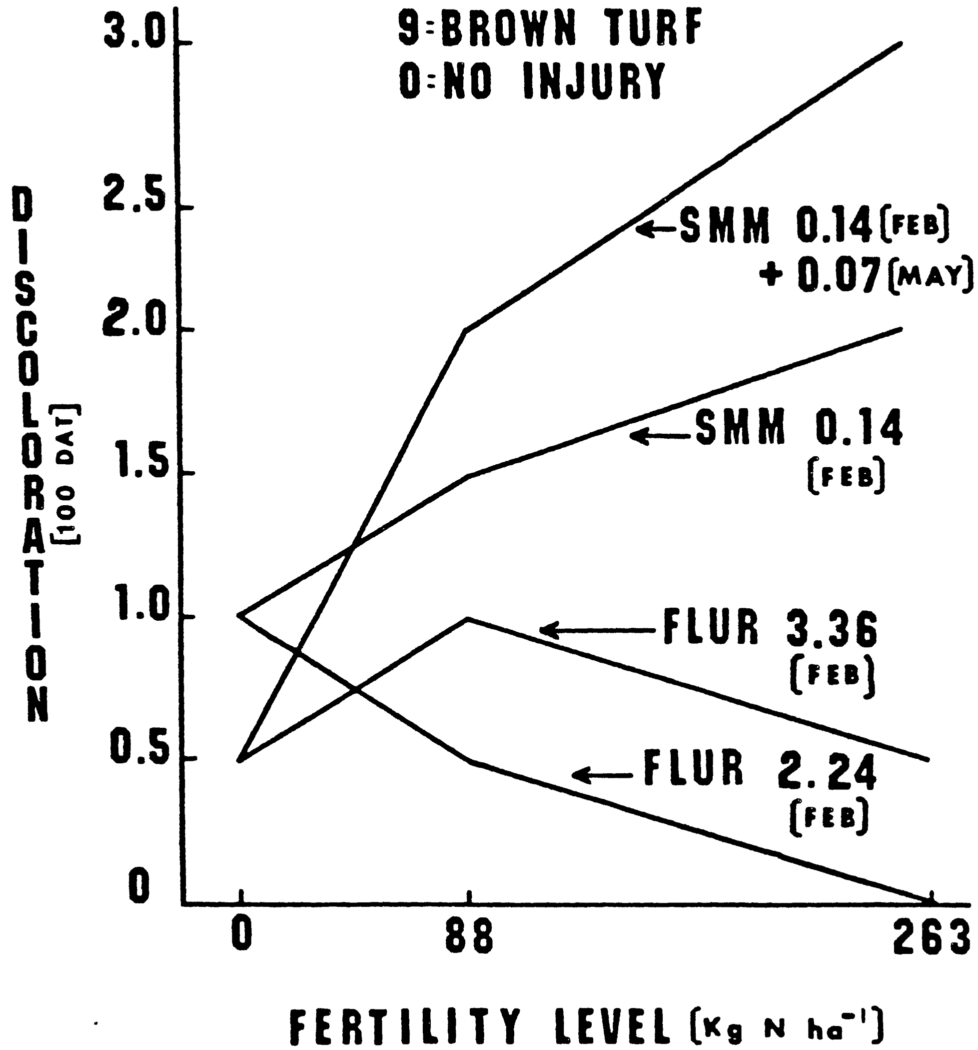
Table 4. Influence of fertility level, timing and rate of growth regulating chemical application on internode lengths of bermudagrass. 1985 .

Treatment[a]	Application Rate	Application Date	Internode lengths 100 DAT Fertility levels kg N ha^{-1}		
			0	88	263
	kg ha^{-1}		cm		
Sulfometuron methyl	0.07 + 0.07	Feb + May	1.07*	0.96	1.15
Sulfometuron methyl	0.14	Feb	1.58	1.97	2.72
Sulfometuron methyl	0.14 + 0.07	Feb + May	0.85	0.88	1.11
Sulfometuron methyl	0.21	May	0.82	1.10	1.40
Flurprimidol	1.12	May	1.94	1.67	3.19
Flurprimidol	2.24	May	1.69	1.89	2 52
Flurprimidol	3.36	May	0.93	1.52	1.58
Check	---	---	2.11	2.08	2.67

* LSD 0 05 within columns = 0 98, within rows = 4.12

a February treatments were applied on 25 Feb., 1985.
May treatments were applied on 15 May, 1985.
All DAT's refer to Feb. treatment date.

Figure 1. Discoloration influenced by fertility level, timing, and rate of growth regulating chemical application to bermudagrass (LSD 0.05 within fertility level=89, within chemical treatment= 0.91). 1985.



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