EFFECTS OF VARIOUS GROWTH REGULANTS ON THE GROWTH AND QUALITY OF THREE TURF-TYPE BERMUDAGRASSES

By

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INTRODUCTION

The production of high quality turf requires the proper grass and its proper maintenance. Frequent mowing is one requirement for the production of valuable turf. Frequent mowing is both laborious and expensive. It was the purpose of this study to evaluate various chemical growth regulators as tools to reduce the required frequency of mowing of certain turf-type bermudagrasses. A chemical that would suppress growth without causing the grass to be discolored or severely injured would be ideal.

REVIEW OF LITERATURE

There is considerable literature pertaining to chemical regulation of higher plant growth. Little work has concerned warm-season turf grasses. Schriener and Reed (1908) reported the early use of trimethyl ammonium compounds on plants. Heatherbell, Howard, and Wicken (1966) proposed the mode of action of two chemicals, Cycocel and B-nine, to be an uncoupling of oxidative phosphorylation. Humphries, Welbank, and Witts (1965) showed the effects of Cycocel on wheat to be increased tillering, increased grain yield, delayed ear emergence, reduced leaf area index, and a reduced dry matter content. Gordon, McKell, and Webb (1966) reported the action of Cycocel on barley plants to interrupt water relations. Phosfon, B-nine, and Cycocel were shown to suppress the growth of ornamental plants by Rothemberger (1965). This action was related to the environment. Greulach and Haesloop (1954) found maleic hydrazide to inhibit primarily cell division. Folkner (1955) applied MH-30T to bermudagrass and reported vegetative and reproductive growth of the grass to be retarded. He reported no phytotoxicity to the turf. Moore (1950) reported the root tips of certain species of plants killed by maleic hydrazide. The growth of four bermudagrass varieties was suppressed by four chemicals: CCC, AMAB, maleic hydrazide, and AMO-1618 as shown by Elmore (1962). He reported discoloration of the grasses by maleic hydrazide.

MATERIALS AND METHODS

The research program included three experiments to evaluate various growth regulants as possible means to suppress the growth of certain turf-type bermudagrasses. The experiments were: a greenhouse study, a field treatment of the most promising rates as determined in the greenhouse study, and a field rate-of-application experiment to pinpoint further chemical effect.

The chemicals included in the program were: B-nine (N-dimethylamino succinimic acid), Cycocel (2-chloroethyltrimethyl ammonium chloride), MH-30T, a formulation of maleic hydrazide (1,2 dihydropyridazine 3-6 dione), and Phosfon (2,4 dichlorobenzyltributyl phosphonium chloride). The varieties of bermudagrass were 'Sunturf' (*Cynodon magennissii* Hur.), 'Tifgreen' (x *C. dactylon* L. x *C. transvaalensis* Burtt-Davy), and 'U-3' (*C. dactylon* L.).

Greenhouse Study: The chemical treatments in this investigation were B-nine, Cycocel, and Phosfon each at three logarithmic rates plus a control treatment which received no chemicals. The rates of application in kilograms of active ingredients per hectare were: 0.966, 9.66, and 96.6 of B-nine; 0.118, 1.18, and 11.8 of Cycocel and 0.198, 1.98, and 19.8 of Phosfon (1 lb/acre = approx. 1.1 kg/ha). These were applied to sod of the three varieties of bermudagrass which was established in 10 inch glazed pots three months prior to the treatment date of January 9, 1967. Cycocel and B-nine were applied as foliar sprays with 7.8 hl/ha (hectoliters/hectare) total volume including water as a carrier (1 hl/ha = approx. 10.5 gal/acre). Phosfon was drenched into the soil with 173 hl/ha total solution applied. A completely randomized design was used. There were four pots for each chemical-rate-variety combination. The grass was clipped to one inch height just prior to treatment.

The grasses were allowed to grow 80 days then harvested by again clipping to a one inch height and collecting the vegetation. The variables measured as indications of growth suppression were: stolon growth in centimeters, grams fresh weight, grams dry matter and the percent dry matter. Dry matter was determined by drying the clippings at 70° C. for 72 hours.

Field Study: Four chemicals and a control treatment were included in the field study. The four chemicals each at one rate were applied to three varieties of bermudagrass, Sunturf, Tifgreen, and U-3, on July 19, 1967. The rate of application for each chemical in kilograms of active ingredient per hectare was 96.6 of B-nine, 11.8 of Cycocel, 4.4 of MH-30T and 19.8 of Phosfon. B-nine, Cycocel, and MH-30T were sprayed on the foliage using a total volume of 7.8 hl/ha. Phosfon was applied with 173 hl/ha total aqueous solution to drench it into the root zone. The treatments were made in a randomized block design within a variety of grass. There were three blocks for each variety using plots of 30 square feet.

The grasses were harvested September 19, 1967, by mowing to one inch and collecting the clippings. Only 25 square feet in each plot was harvested for evaluation. The measure of suppression in this study was dry weight. The clippings were dried for 72 hours at 70° C. before the weights were taken. The data was analyzed as a split plot experiment. The main plots were the varieties which were completely randomized.

Field Rate-of-Application Study: In this investigation the chemicals B-nine, Cycocel, and MH-30T each at three rates were applied along with a control treatment to U-3 bermudagrass turf on August 18, 1967. The active ingredient of B-nine applied was 96.6, 193.2, and 286.4 kg/ha. The Cycocel treatments were 11.8, 23.6, and 47.2 kg/ha. MH-30T was applied at 1.1, 2.2, and 4.4 kg/ha. Each treatment was applied with 7.8 hl/ha total volume sprayed on the foliage of the turf using water as a carrier. The treatments were made in a randomized block design with three replications. The plots were 30 square feet. As in the field study, 25 square feet was harvested by clipping the grass to the original height and collecting the clippings on October 13, 1967. The total dry matter yeild was analyzed as an indication of growth suppression.

RESULTS AND DISCUSSION

Greenhouse Study: In evaluating growth suppression in this study, the analyses of variance showed similar patterns of significance for stolon growth, fresh weight, and dry weight as shown in Table I. There was a significant difference in varietal growth and a difference in treatments applied to the grasses. Further analysis of the treatments showed the check treatment when compared to the chemical treatments to be significantly different. There was no difference among the chemicals. A significant difference among levels was detected. The comparison of check to the chemical-rate combinations interacted with the varieties.

The average dry matter yield illustrated the comparison of the check to the chemical treatments (Figure 1). Stolon length and fresh weight exhibited responses similar to the dry weight. The dry weight showed a log-linear suppression pattern for Cycocel and Phosfon. The growth allowed by B-nine at the medium rate was greater than at the low rate as indicated by dry weight, fresh weight, and stolon length.

The analysis of variance for percent dry matter indicated a significant varietal difference (Table I). The average percentages of dry matter were: 46.9 for U-3, 44.2 for Sunturf, and 50.8 for Tifgreen. The chemical treatments were shown to influence the amount of dry matter produced per pot. This effect was primarily attributed to the comparison of the check to the chemical treatments. There was

TABLE I

THE ANALYSES OF VARIANCE FOR FOUR GROWTH RESPONSE VARIABLES OF THREE TURF-TYPE BERMUDAGRASSES AS INFLUENCED BY THREE LOGARITHMIC RATES OF THREE GROWTH REGULANTS

		Mean Squares			
Source	df	Stolon Growth	Dry Wt.	Fresh Wt.	% Dry Wt.
Total	119	—	—	—	—
Variety	2	687,661**	375.6**	2,359.7**	445.9**
Treatment	9	102,428**	58.1**	346.7**	46.4*
Check vs others	1	542,035**	235.0**	1,635.6**	168.3**
Chemical	2	26.456	36.8	166.1	30.4
Level	2	87.467*	60.1*	272.1*	23.8
Chemical x level	4	37,995	23.4	152.1	35.2
Variety x Treatment	18	29.885	21.7	112.4	29.8
Var. x (check vs others)	2	97,584*	68.6*	404.6*	63.1*
Var. x chemical	4	8,942	33.2	124.4	17.9
Var. x level	4	20,936	8.9	53.2	7.6
Var. x chem. x level	8	27,906	10.7	63.1	38.5
Error	90	22,823	18.9	90.1	19.8
Coefficient of variability		68.68%	54.54%	54.66%	9.42%

*Significant difference at .05 level
**Significant difference at .01 level

	Application Rates (Kg ai/ha)		
	Low	Med.	High
B-nine	0.966	9.66	96.6
Cycocel	0.118	1.18	11.8
Phosfon	0.198	1.98	19.8

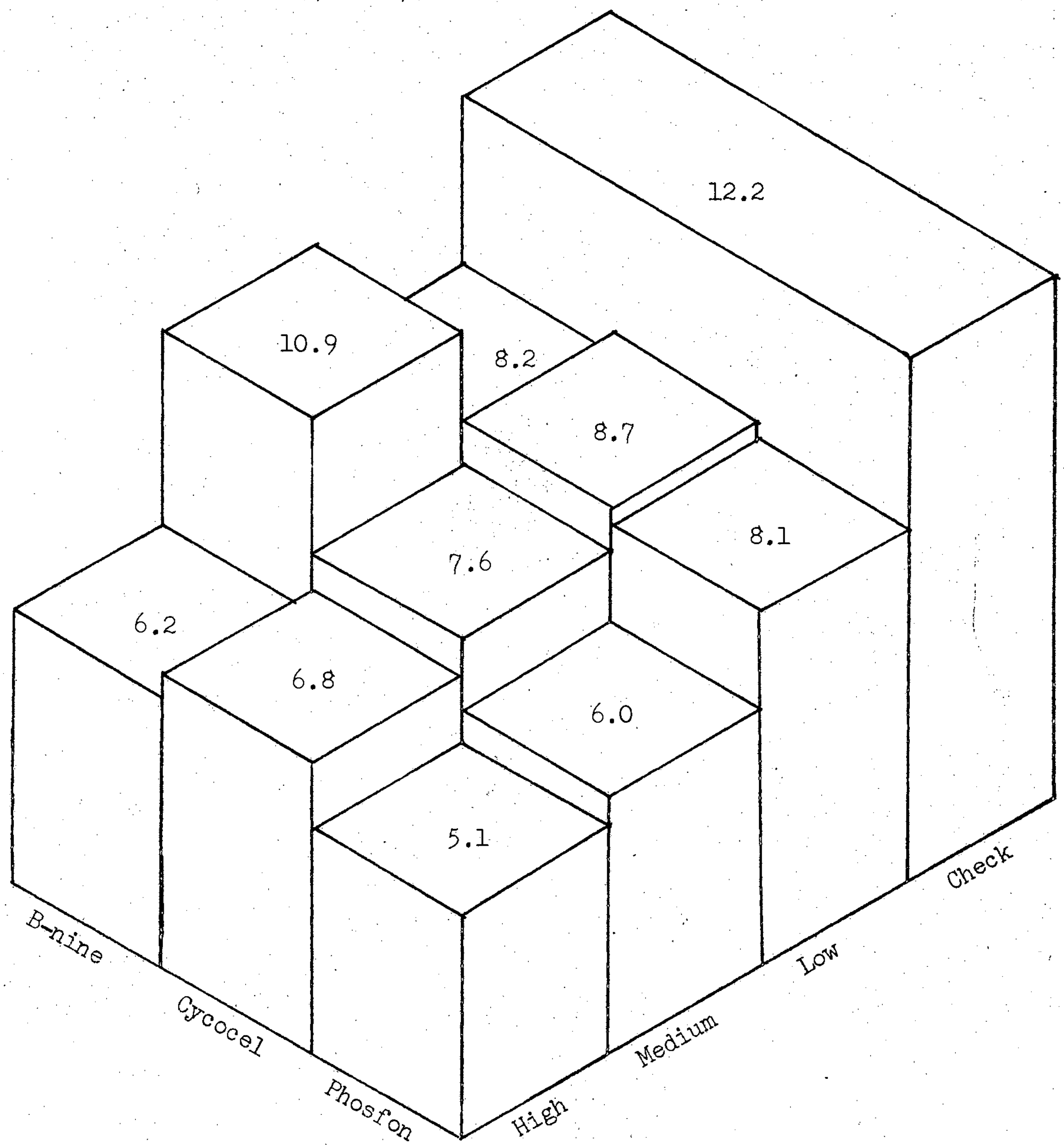

Figure 1. The Average Dry Matter Yield in Grams of Three Turf-type Bermudagrasses as Influenced by Three Logarithmic Rates of Three Growth Regulants Applied in the Greenhouse.

an interaction between this comparison and the varieties which rendered less confidence in that observation. The coefficient of variability was 9.42%.

The average of the check plots contained 43.74% dry matter. The chemical treatment averages ranged from 45.82% to 49.48% dry matter (Figure 2). However, there was no pattern to these ranges within a chemical or among chemicals. Statistically, as shown by the analysis of variance, there was no significant difference among chemicals or levels. These observations would not support the idea that the suppression was an interference of water relations in the test plants. Yet, they would not disprove it because the grass receiving no chemical contained less dry matter than the grass receiving chemical treatments.

Field Study: The data for the dry matter harvested from 25 square feet per plot indicated a difference among varieties. There was a chemical effect but an interaction among varieties and chemicals yielded less confidence on that effect (Table II).

The average grams of dry matter produced illustrated the areas of difference (Figure 3). Cycocel and MH-30T were the only two chemicals allowing less growth than the control plots. MH-30T had the least clipping yield. However, visual observation indicated severe damage to the turf which was noticeable 100 days after treatment. Phosfon at 19.8 kg/ha under these conditions induced slight discoloration but the turf recovered within two weeks.

Field Rate-of-Application Study: The dry matter yield of U-3 bermudagrass was significantly influenced by the treatments in this study as shown by the analysis of variance (Table III). Further

	Application Rates (Kg ai/ha)		
	Low	Med.	High
B-nine	0.966	9.66	96.6
Cycocel	0.118	1.18	11.8
Phosfon	0.198	1.98	19.8

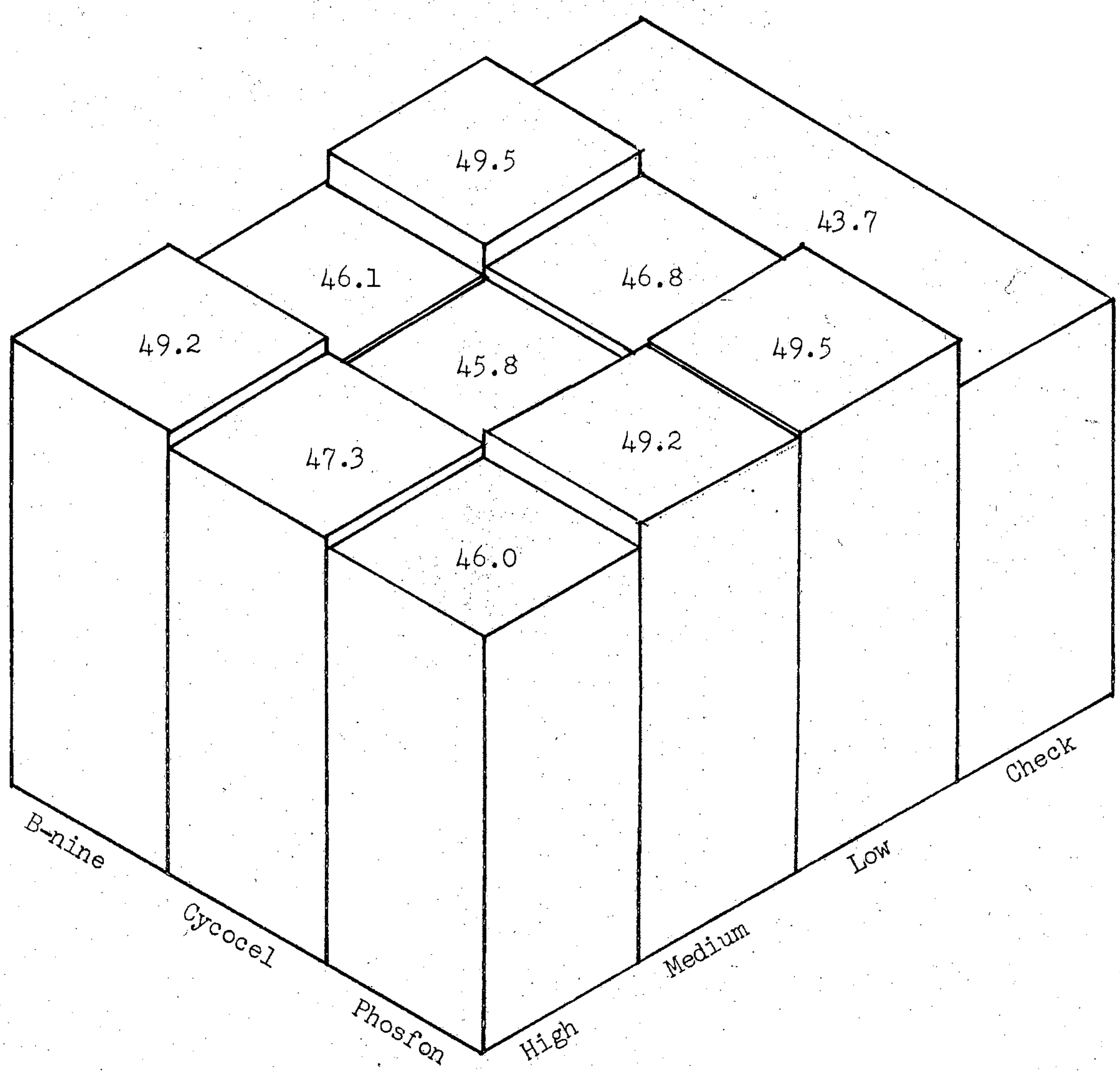

Figure 2. The Average Percent Dry Matter of Three Turf-type Bermudagrasses as Effected by Three Logarithmic Rates of Three Growth Regulants Applied in the Greenhouse.

TABLE II

THE ANALYSIS OF VARIANCE FOR THE DRY MATTER HARVESTED FROM 25 SQUARE FEET OF FIELD-ESTABLISHED TURF OF THREE BERMUDAGRASS VARIETIES AS INFLUENCED BY FOUR GROWTH REGULANTS

Source	df	MS
Total	44	---
Variety	2	950,059**
Error A#	6	6,429
Chemicals	4	391,858**
Var. x Chem.	8	48,180**
Error B##	24	3,142

Coefficient of Variability (A) = 15.01%
Coefficient of Variability (B) = 12.74%
**Significantly different at .01 level

#Error A was found by pooling the SS for blocks and the SS for blocks x varieties.
##Error B was found by pooling the SS for blocks x chemicals and the SS for blocks x varieties x chemicals.

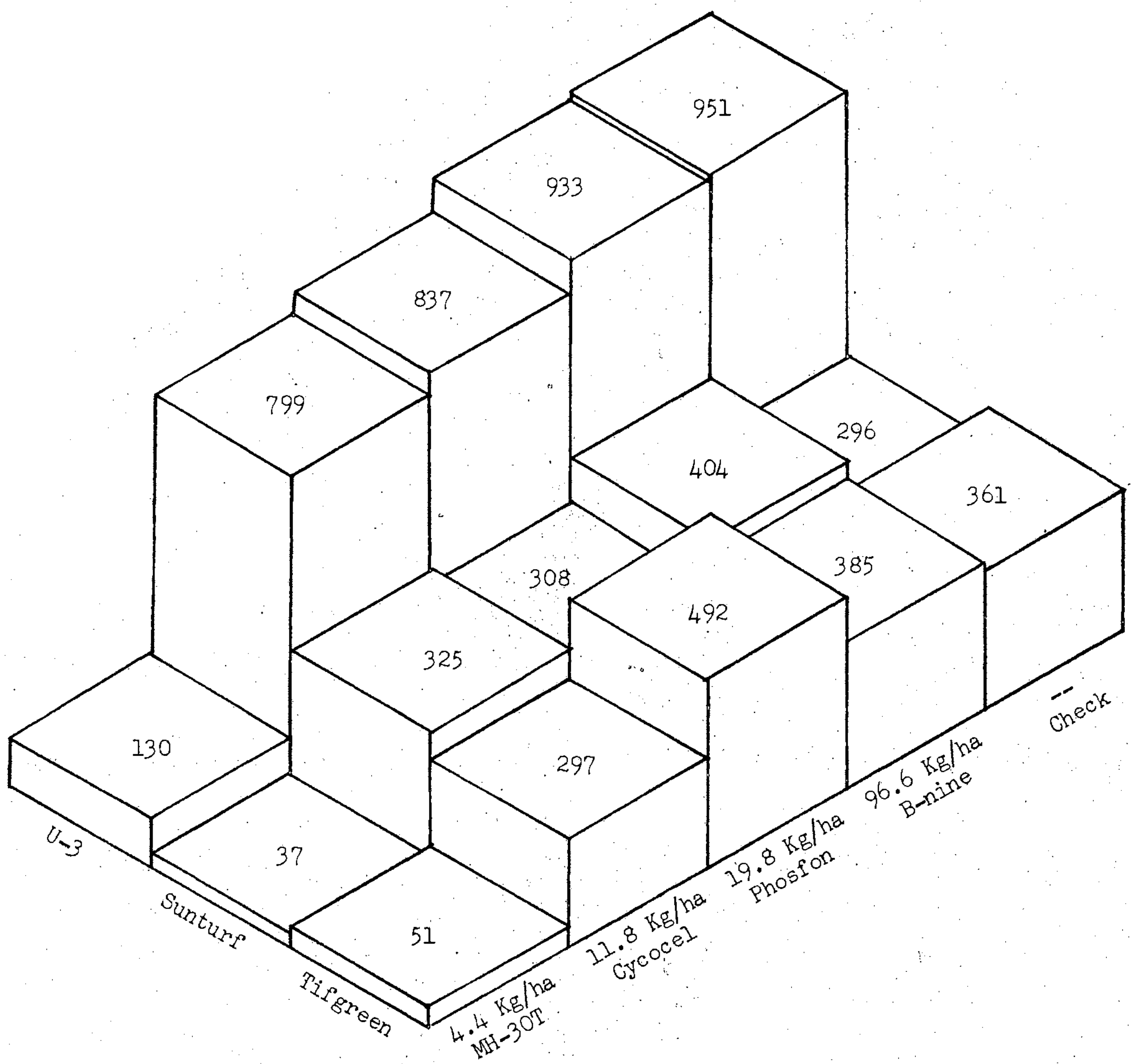

Figure 3. The Average Grams of Dry Matter Harvested from 25 Square Feet of Field-established Turf of Three Bermudagrass Varieties as Influenced by Four Growth Regulants.

TABLE III

THE ANALYSIS OF VARIANCE FOR THE DRY MATTER HARVESTED FROM 25 SQUARE FEET OF FIELD-ESTABLISHED SOD OF U-3 BERMUDAGRASS AS INFLUENCED BY THREE GROWTH REGULANTS EACH APPLIED AT THREE RATES

Source	df	MS
Total	29	---
Replications	2	22,484*
Treatments	9	35,947**
Check vs others	1	92,703**
Chemical	2	42,408**
Level	2	36,529**
Chemical x level	4	18,237*
Error	18	4,978

Coefficient of variability = 20.54%

*Significantly different at .05 level
**Significantly different at .01 level

investigation showed the check to be different from the chemical treatments. There were chemical effects and level differences. These factors interacted to some degree. This interaction can partially be explained by the difference in degree of suppression by the chemicals within each rate.

All chemical treatments suppressed growth of the turf as indicated by the check plot (Figure 4). MH-30T at 2.2 kg/ha visably injured the turf but not so extensively as twice that rate. Cycocel at 23.6 kg/ha gave the greatest suppression without phytotoxicity.

	Application Rates (Kg ai/ha)		
	Low	Med.	High
B-nine	96.6	193.2	286.4
Cycocel	11.8	23.6	47.2
MH-30T	1.1	2.2	4.4

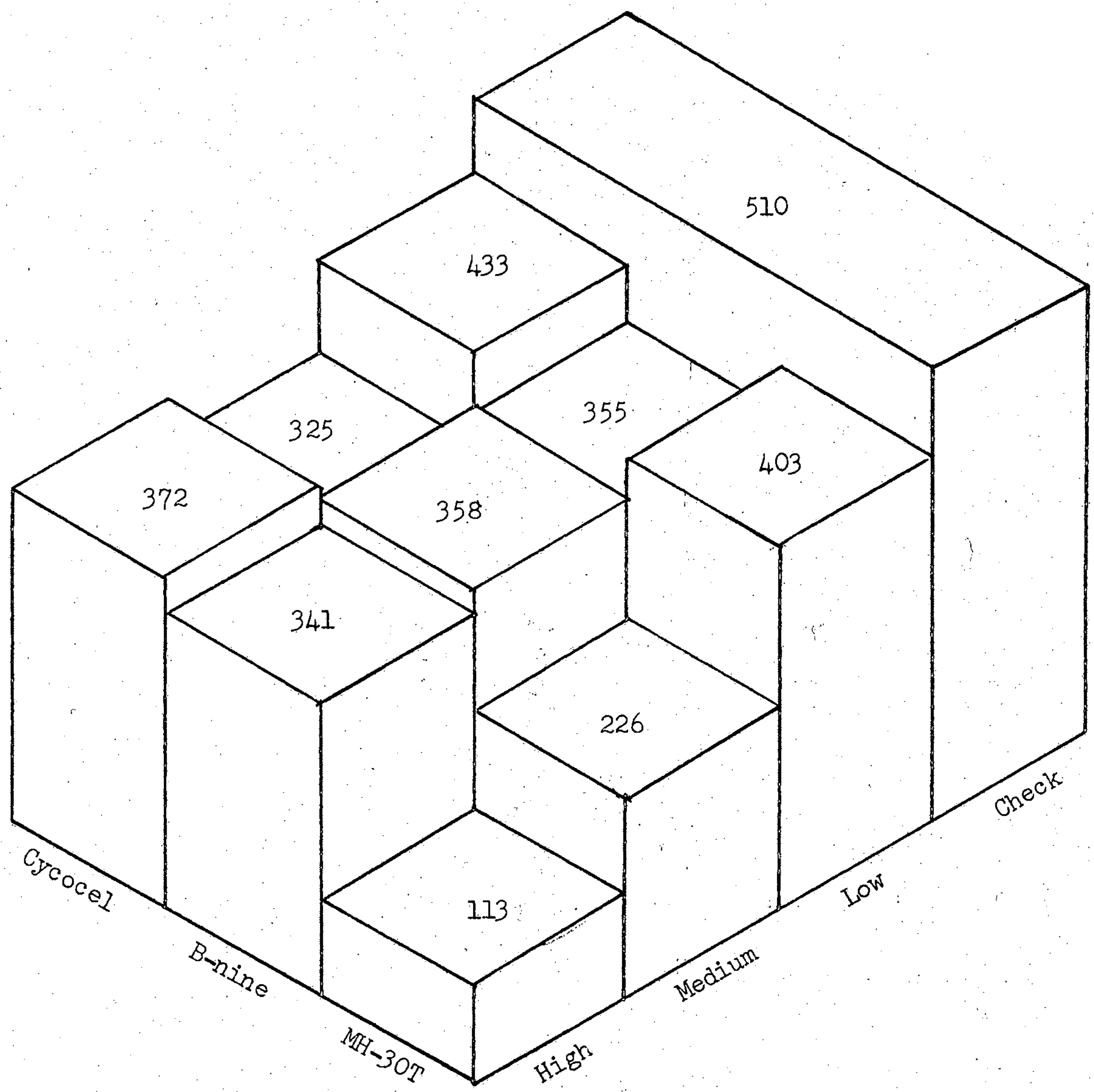

Figure 4. The Average Grams of Dry Matter Harvested from 25 Square Feet of Field-established Sod of U-3 Bermudagrass as Influenced by Three Growth Regulants Each Applied at Three Rates.

SUMMARY AND CONCLUSIONS

The effects of four chemicals were evaluated on the growth and quality of U-3, Sunturf, and Tifgreen bermudagrass turf. The research program included three experiments. Under greenhouse conditions Cycocel and Phosfon reduced growth in a linear trend when added in logarithmic rates. B-nine allowed more growth at 9.66 kg/ha than at .966 kg/ha. A field study included MH-30T at 4.4 kg/ha in addition to the highest rate of the three chemicals used in the greenhouse study. MH-30T most effectively reduced growth rate but severely injured the grass. Phosfon at 19.8 kg/ha temporarily discolored the turf. In the third experiment, a field rate-of-application study on U-3 bermudagrass, MH-30T was found to injure the turf at 4.4 kg/ha and at 2.2 kg/ha. Cycocel at 23.6 kg/ha gave the greatest suppression without phytotoxicity.

These studies indicate severe phytotoxicity from MH-30T on these varieties of bermudagrass. Therefore, it may be undesirable for use on certain areas.

Cycocel suppressed the turf in a linear fashion when added in logarithmic rates in the greenhouse and was the only chemical involved in these studies that consistently suppressed the turf without phytotoxicity. These studies tend to show Cycocel to be the most desirable chemical for growth suppression of U-3, Sunturf, and Tifgreen bermudagrass.

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A P P E N D I X

APPENDIX TABLE I

THE DATA OF FOUR GROWTH RESPONSE VARIABLES OF THREE TURF-TYPE BERMUDAGRASSES AS INFLUENCED BY THREE GROWTH REGULANTS EACH APPLIED AT THREE LOGARITHMIC RATES IN THE GREENHOUSE

			Centimeters Stolon Growth				Grams Fresh Weight				Grams Dry Weight				Percent Dry Matter			
			Replications				Replications				Replications				Replications			
Grass	Chemical	Kg Active/ha.	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
U-3	Control	---	144	190	140	219	18.4	20.8	13.0	15.7	7.7	9.4	6.2	7.2	41.8	45.2	47.7	45.9
	B-nine	0.966	130	220	45	128	16.0	19.0	14.9	15.1	7.4	8.7	7.0	6.7	46.3	45.8	47.0	44.4
	"	9.66	72	203	72	284	13.1	30.4	7.3	27.6	5.9	14.1	3.5	13.6	45.0	46.4	48.0	49.3
	"	96.6	34	19	117	10	8.7	7.8	15.9	13.8	3.3	3.9	8.2	6.2	38.0	50.0	51.6	44.9
	Cycocel	0.118	168	81	263	332	19.9	10.4	25.7	31.0	8.7	4.8	16.8	14.6	43.7	46.2	65.4	47.1
	"	1.18	151	262	413	73	15.6	26.0	48.2	16.5	6.5	11.7	23.1	7.6	41.7	45.0	47.9	46.1
	"	11.8	84	102	132	67	11.3	17.9	25.6	12.8	5.3	8.1	12.6	6.9	46.9	45.3	49.2	53.9
	Phosfon	0.198	280	251	68	37	20.2	23.0	11.5	9.6	9.1	10.9	5.3	5.3	45.0	47.4	46.1	55.2
	"	1.98	229	50	31	34	24.0	5.7	9.1	6.1	10.2	2.6	4.5	2.9	42.5	45.6	49.5	47.5
	"	19.8	124	28	67	75	16.3	6.6	7.2	16.2	6.3	3.1	3.9	7.8	38.7	47.0	54.2	48.1
Sunturf	Control	---	828	526	965	132	40.5	20.3	44.3	58.0	15.7	10.3	18.8	23.6	38.8	50.7	42.4	40.7
	B-nine	0.966	300	334	147	1428	13.4	25.8	17.0	64.5	5.8	11.9	8.1	30.7	43.3	46.1	47.6	47.6
	"	9.66	926	317	194	153	50.4	17.1	17.0	15.0	20.3	7.4	7.2	7.1	40.3	43.3	42.4	47.3
	"	96.6	202	148	676	588	13.6	12.5	38.9	45.0	5.4	5.7	16.5	19.8	39.7	45.6	42.4	44.0
	Cycocel	0.118	291	406	361	286	14.7	18.2	22.2	26.5	6.8	8.9	10.2	12.4	46.3	48.9	45.9	46.8
	"	1.18	739	465	644	429	44.2	26.2	34.9	35.9	17.1	10.2	15.5	16.1	38.7	38.9	44.4	44.8
	"	11.8	117	252	235	223	8.8	12.0	22.3	12.8	3.8	5.5	10.2	6.4	43.2	45.8	45.7	50.0
	Phosfon	0.198	316	261	517	728	24.8	13.7	32.8	38.4	10.0	6.2	13.6	17.1	40.3	45.3	41.5	44.5
	"	1.98	322	263	247	331	16.9	18.6	19.0	23.1	6.9	8.2	8.7	11.2	40.8	44.1	45.8	48.5
	"	19.8	131	120	120	173	10.9	12.1	12.6	16.8	4.4	5.2	5.5	7.9	40.4	43.0	43.7	47.0
Tifgreen	Control	---	296	107	624	888	13.0	15.4	36.9	45.0	5.5	6.9	14.9	19.9	42.3	44.8	40.4	44.2
	B-nine	0.966	317	101	93	184	8.6	7.4	9.6	12.8	4.1	3.7	4.7	6.0	47.7	50.0	49.0	46.9
	"	9.66	63	100	70	18	5.3	7.0	9.2	5.0	2.3	3.4	4.4	2.4	43.4	48.6	47.8	48.0
	"	96.6	30	143	52	42	3.2	10.4	5.9	5.8	1.7	4.7	3.7	2.9	53.0	45.2	62.7	50.0
	Cycocel	0.118	221	43	129	123	8.9	3.6	6.9	10.3	4.3	1.8	3.5	5.6	48.3	50.0	50.7	54.4
	"	1.18	242	102	188	150	11.1	7.8	11.7	12.2	5.5	4.3	6.9	5.8	49.5	55.1	59.0	47.5
	"	11.8	74	141	67	99	2.8	11.4	7.7	5.4	1.4	6.1	4.5	2.6	50.0	53.5	58.4	48.1
	Phosfon	0.198	122	154	95	122	6.7	6.6	6.9	12.8	3.8	3.3	3.5	9.1	56.7	50.0	50.7	71.1
	"	1.98	28	73	63	189	2.4	4.7	10.3	11.6	1.3	2.4	6.7	6.4	54.2	51.1	65.0	55.2
	"	19.8	85	57	40	390	4.7	1.8	4.3	25.2	2.2	0.9	1.9	12.3	46.8	50.0	44.2	48.8

APPENDIX TABLE II

THE DATA FOR GRAMS OF DRY MATTER HARVESTED FROM 25 SQUARE FEET OF FIELD-ESTABLISHED TURF OF THREE BERMUDAGRASS VARIETIES AS INFLUENCED BY FOUR GROWTH REGULANTS

	Grass								
Treatment	Tifgreen			Sunturf			U-3		
	Blk 1	Blk 2	Blk 3	Blk 1	Blk 2	Blk 3	Blk 1	Blk 2	Blk 3
Check	337	327	420	330	332	227	948	967	939
B-nine	302	425	428	501	334	377	918	896	984
Cycocel	223	335	333	362	259	353	777	775	843
MH-30T	61	26	66	19	37	56	137	148	106
Phosfon	441	428	605	314	252	357	967	752	791

APPENDIX TABLE III

THE DATA FOR GRAMS OF DRY MATTER HARVESTED FROM 25 SQUARE FEET OF FIELD-ESTABLISHED SOD OF U-3 BERMUDAGRASS AS INFLUENCED BY THREE GROWTH REGULANTS EACH APPLIED AT THREE RATES

	Block 1			Block 2			Block 3		
Treatment	Low	Med	High	Low	Med	High	Low	Med	High
B-nine	331	293	287	406	424	424	329	357	312
Cycocel	382	282	263	459	417	519	457	275	335
MH-30T	350	177	141	542	167	89	316	333	109
Check		463			470			598	

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