Progress Report: The Effect of Seven Management Factors and their Interaction on the Competitive Ability of Annual Bluegrass and Creeping Bentgrass.

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INTRODUCTION

The purpose of this report is to update the USGA research committee on the progress of the sponsored research on competition between annual bluegrass (Poa annua L var reptans) and creeping bentgrass (agrostis palustris Huds. var Penncross).

The purpose of the research is to examine the effects of seven different cultural factors on the competitive interaction of annual bluegrass and creeping bentgrass maintained as a fairway turf. The seven factors are irrigation rate and frequency, clipping removal, nitrogen fertility level, plant growth regulator treatment, bentgrass overseeding, compaction, and core cultivation.

The intent of the research is to outline which combinations of the above practices favor annual bluegrass or creeping bentgrass. Ideally, this research would allow a superintendent to decide which practices he can employ, in a cost effective manner, to achieve his desired results.

A second goal of the research is to generate data for practices, such as lowered nitrogen fertility, which have been observed to favor bentgrass, but for which quantitative data does not exist.

EXPERIMENTS IN PROGRESS

Three field studies have been initiated to examine the above mentioned practices. The first study was initiated on May 15, 1984 at the Hancock Turfgrass Research Center. The experimented design is a five factor factorial arranged as a split-split plot with 72 treatment combinations. The five factors are irrigation (daily at 75% of open pan evaporation (OPE), 3x per week at 110% of OPE, and irrigation at wilt); clipping removal or return; nitrogen fertility (2 lbs N/M/YR or 6 lbs N/M/YR); plant growth regulator treatment (mefluidide at 1/8 lbAI/A, EL-500 at 1.0 lb/AI/A, or a check); and overseeding with bentgrass or no overseeding.

A second study was initiated in July of 1984 to study the effects of compaction and coring on the competition between annual bluegrass and creeping bentgrass. A four factor factorial consisting of irrigation (same treatments as above), clippings removed or returned, compaction (compaction or no compaction), and coring (1x/yr,3x/yr, or check) treatments. Compaction was applied 3 times per week with a vibrating, water-filled roller.

For both of the studies described above, data was taken as species counts. The relative percentage of annual bluegrass in a mixed stand of predominantly annual bluegrass and creeping bentgrass was determined using a grid consisting of 112 individual points. A plot was evaluated by determining the number of points on the grid which overlay annual bluegrass. The result is an estimate of the percentage annual bluegrass in the plot.

A third field study was designed to measure the effect of flurprimidol on the competitive balance between annual bluegrass and creeping bentgrass. Flurprimidol has been observed to yield a more phytotoxic effect on annual bluegrass than creeping bentgrass. The hypothesis is that creeping bentgrass can take advantage of the weakened condition of the annual bluegrass and become the primary species. To test this hypothesis, ten treatments of differing rates and timing of flurprimidol were applied to an essentially pure stand of annual bluegrass into which three 4" diameter plugs of 'Penncross' creeping bentgrass had been transplanted. The area of each bentgrass plug is determined periodically by tracing the diameter of the plug and measuring the area of trace with a planimeter.

Laboratory Research

The visual observations of annual bluegrass and creeping bentgrass treated with growth regulators led us to investigate their effects on photosynthesis and transpiration. PGR's have been observed to decrease water use in the field and change the photosynthetic pigmentation of the treated plants (Gaussoin, unpublished data). Several experiments have been conducted to determine the effect of various rates of flurprimidol and mefluidide on net photosynthesis, transpiration, leaf conductance, and several other physiological parameters.

Results and Discussion

The results of species counts of the five factor study are shown in tables 1 and 2. The species counts are presented for each growing season individually and as the total population shift from the spring of 1984 to the fall of 1985.

Two of the five main effects were significant at the 1% level. Clipping removal was significant during 1984 and over both seasons but was not significant during 1985. Fertility level was not significant in 1984 but highly significant in 1985 and over both years. In 1984 there was a significant ($P = 0.05$) interaction between irrigation and overseeding. The means of the interactions are shown in table 2. A significant three way interaction occurred over combined years for irrigation, clipping removal, and fertility. In 1985 a significant four way interaction between all factors except plant growth regulators occurred.

The results from removing clippings are quite interesting. In 1984 plots where clippings were removed showed a 5.7% decrease in annual bluegrass whereas plots with clippings returned showed a 1% increase in annual bluegrass. In 1985, however, plots where clippings were removed showed a 8.8% decrease in annual bluegrass compared to a 7.1% decrease where clippings were returned. Over the two year period, clipping removal resulted in a 14.2% decrease in annual bluegrass compared to a 6.5% decrease with clippings returned. Why a larger shift in population difference was not observed in 1985 is not understood.

Clipping removal seems to be effective in reducing the annual bluegrass population. The question is which year, 1984 or 1985, should receive the most scrutiny. In 1984 a large population shift was observed that showed clipping removal to favor creeping bentgrass. In 1985 the population shift was smaller, not significant but still in favor of creeping bentgrass. Next years data should be helpful in determining the magnitude of this effect. At this point, a few reasons for the effect of clipping removal can be discussed. One reason commonly given is a reduction in compaction due to lighter weight mowing equipment. In this study the same triplex greensmower is used to mow both clipping removed and returned areas and therefore differences in compaction are not factors in this study. The two most plausible explanations, in our opinion, are a reduction in viable seed population from clipping removal or a weak form of alleopathy from decomposing annual bluegrass leaves and seeds. These two possibilities will be examined during the coming year.

The other main effect that was significant was fertility level. As seen in table 2, the effect of fertility was not significant in 1984 but significant ($P = 0.01$) in 1985 and over the two year period. The author believes that the lack of differences in the first year reflected the residual fertility from past management of the area. Once the fertility level was reduced, the competitive balance was shifted towards creeping bentgrass. Notice that difference in populations means was greater for clipping removal than for fertility. Thus, after two years of treatments, plots fertilized at 2 lbsN/M/YR had 3.8% less annual bluegrass than plots fertilized at 6 lbsN/M/YR while plots where clippings were removed had 7.7% less annual bluegrass than plots where clippings were returned.

In 1984 only, a significant two way interaction was observed between overseeding and irrigation. By examining table 2, it is apparent that the significant interaction was caused by the larger differential seen in the wilt irrigation treatment. The wilt treatments suffered some turf thinning due to the dryness of the plots. The overseeding treatment had an enhanced effect because there were open areas in which the bentgrass seed could germinate.

Other irrigation treatments, because of their better density, did not have as much bentgrass germination.

A significant three way interaction occurred over combined years between irrigation, clipping removal, and fertility. This interaction contains some interesting and valuable information. The plots watered at wilt had the lowest amount of annual bluegrass, and clipping removal combined with low fertility, caused a significantly lower amount of annual bluegrass in the wilt plots. The plots watered 3x/week, our estimation of the average superintendent's practice, had more annual bluegrass than the other two irrigation treatments. The most important information in this table is the effect of daily watering and low fertility. Under these two management factors, clipping removal did not cause a decline in the annual bluegrass population compared to the clipping return treatment. Thus, there exists the possibility of achieving substantial declines in annual bluegrass populations without the expense of clipping removal. The basis for this phenomenon is not understood.

COMPACTION STUDY

Compaction treatments were initiated in the summer of 1984 and coring treatments (once in the spring; once in the spring, summer, and fall, or no coring) were initiated in 1985. Compaction was significant ($P = 0.001$, table 3) with compacted plots having a 9.6% increase in annual bluegrass compared to a -5.4% decrease where no compaction was applied. Unfortunately, it is not possible to separate the effects of compaction from wear, because the roller used in this study clearly applies a significant amount of wear to the plots as well. Thus while the intended measurement is the effect of compaction, wear stress also must be considered as a contributory factor.

There was a significant interation between irrigation and clipping removal for the 1985 results. As can be seen from table 3, the interaction occurred because the trend towards less annual bluegrass where clippings were removed was reversed in the irrigation at wilt plots. The authors believe that the reason for the reversal of the clipping removal effect in the irrigation at wilt treatments is because of the injury those plots received from the lack of water. The bare areas filled in with annual bluegrass regardless of the clipping treatments. Had these plots not been allowed to be stressed to the point of loss of turf, the reversal in the effect of clipping removal would not have been seen. A possible explantion for the reversal in clipping effect is that clipping removed plots, because of the depletion of nutrients, primarily N and K, that occurrs with clipping removal, were less able to respond to the water stress and suffered more turf loss and thus had larger bare areas for the annual bluegrass to fill in. An examination of the data supports this hypothesis.

EFFECT OF RATE AND TIMING OF CUTLESS ON THE SPREAD OF CREEPING BENTGRASS IN ANNUAL BLUEGRASS

A study was initiated in the spring of 1985 to determine the effects of differing rates and timing of Cutless on the spread of creeping bentgrass. Rates and timings of Cutless treatments are shown in table 4. Also shown in table 4 are the results of data taken on August 17, 1985 before the fall treatments were initiated. As can be seen from the data, Cutless treatments in

the spring had no effect on the spread of the creeping bentgrass plugs. This data combined with the data from the five factor field study leads to the conclusion that Cutless is ineffective in promoting the spread of creeping bentgrass.

Effects of Cutless and Embark on Photosynthesis of Annual Bluegrass and Creeping Bentgrass.

Data on the effect of Cutless on photosynthetic parameters are shown in table 4. Cutless at 2 and 4 lbsAI/A affected net photosynthesis; leaf, stomatal, and mesophyll conductance; and water use efficiency. However, no differential response by species was observed. We are currently conducting a study of the effects of Embark and Cutless over a 64 day period. This study should conclusively determine if the basis for the visually observed differences in species response to Cutless is due to alteration of the photosynthetic process. Our preliminary results suggest that Cutless is affecting photosynthesis of both species in a uniform manner, and thus may not be providing a competitive advantage to creeping bentgrass.

Planned Investigations for 1985-86.

Future plans for determining the significance of cultural factors on the competitive balance between annual bluegrass and creeping bentgrass include continued work on measuring photosynthetic parameters of the two species, initiating greenhouse competition studies to discover the reason why clipping removal favors creeping bentgrass, and examining the effect of clipping removal on the annual bluegrass seed reservoir in the soil. In addition, the three field studies described in this report will be continued for another year.

TABLE 1. Analysis of Variance of Five Factor Field Study

	df	SP84-FA84	FA84-FA85	SP84-FA85
Blocks (B)	2	NS	NS	NS
Irrigation (I)	2	NS	NS	NS
Error	4	-	-	-
Clipping Removal (CR)	1	**	NS	**
IxCR	2	NS	NS	NS
Error	6	-	-	-
Fertilizer (F)	1	NS	**	**
FxI	2	NS	NS	NS
FxCR	1	NS	NS	NS
IxCRxF	2	NS	NS	*
Growth Regulators (G)	2	NS	NS	NS
GxI	4	NS	NS	NS
GxCR	2	NS	NS	NS
GxIxCR	4	NS	NS	NS
GxF	2	NS	NS	NS
GxFxI	4	NS	NS	NS
GxFxCR	2	NS	NS	NS
GxIxCRxF	4	NS	NS	NS
Overseeding (O)	1	NS	NS	NS
OxI	2	*	NS	NS
OxCR	1	NS	NS	NS
OxIxCR	2	NS	NS	NS
OxF	1	NS	NS	NS
OxFxI	2	NS	NS	NS
OxFxCR	1	NS	NS	NS
OxIxCRxF	2	NS	*	NS
OxG	2	NS	NS	NS
OxGxI	4	NS	NS	NS
OxGxCR	2	NS	NS	NS
OxGxIxCR	4	NS	NS	NS
OxGxF	2	NS	NS	NS
OxGxFxI	4	NS	NS	NS
OxGxFxCR	2	NS	NS	NS
OxGxIxCRxF	4	NS	NS	NS
Error	132	-		

*,** Significant at the 5 and 1 percent levels, respectively.

TABLE 3. Poa Bent Competition Study II. Compaction and Coring Effects

ANALYSIS OF VARIANCE

Source	df	1985
Blocks	2	NS
Irrigation (I)	2	NS
Error	4	-
Clippings (C)	1	NS
IxC	2	**
Error	6	-
Compaction (CM)	1	**
CMxI	2	NS
CMxC	1	NS
CMxCxI	2	NS
Coring (CO)	2	NS
COxI	4	NS
COxC	2	NS
COxCxI	4	NS
COxCM	2	NS
COxCMxI	4	NS
COxCMxC	2	NS
COxCMxCxI	4	NS
Error	60	-

% Shift in Poa

Compaction	+9.6
No Compaction	-5.4

	Irrigation Daily	Irrigation 3x/wk	Irrigation at wilt
Clippings removed	-0.4	-10.7	9.4
Clippings returned	3.3	5.3	5.8

** Significant at the 1% level.

TABLE 2. Summary of Significant Effects from Five Factor Field Study

Values shown represent change in annual bluegrass populations.

	1984	1985	84-85
Clippings removed	-5.7	NS	-14.2
Clippings returned	+1.0		- 6.5
2 lbs N/M/YR	NS	-10.1	-12.2
6 lbs N/M/YR		- 5.8	- 8.4

IRRIGATION

1984 only	daily	3x/week	wilt
Overseeding	-4.7	+ 1.5	- 5.5
No overseeding	-4.1	- 0.5	- 0.9

1984-1985 only

IRRIGATION

	daily		3x/week		wilt	
	C+	C-	C+	C-	C+	C-
2#N	-12.9	-13.5	-2.8	-11.4	-10.1	-22.8
6#N	- 1.9	-12.8	-1.4	-11.1	-10.0	-13.4

1985 only

IRRIGATION DAILY

		CR+		CR-	
		2#N	6#N	2#N	6#N
Overseeded.....	OS	-13	-0.9	- 8.7	-5.5
Not overseeded.....	NOS	-4.2	-0.4	-10.8	-2.8

IRRIGATION 3x/WEEK

	CR+		CR-	
	2#N	6#N	2#N	6#N
OS	-3.7	-2.8	-13	-10.1
NOS	-8.9	-6.7	-11.2	- 6.2

IRRIGATION AT WILT

	CR+		CR-	
	2#N	6#N	2#N	6#N
OS	- 9.6	-14.9	-12.2	- 4.8
NOS	-17.0	- 7.2	- 8.7	-11.4

TABLE 4. Change in area of "Penncross" creeping bentgrass plugs in annual bluegrass after treatment with Cutless at different rates and times. Measurement obtained on 12 August, 1985. Hancock Turfgrass Research Center, East Lansing, Michigan

TREATMENT	CUTLESS RATE AND TIMING	MEAN OF 3/PLUGS PLOT (CM^2)	% INCREASE/DECREASE FROM CHECK
1	1.5#/A Spring (May 15)	76.3	5.3
2	1.5#/A Fall (August 15)	84.3	14.7
3	1.0#/A Spring	77.1	6.7
4	1.0#/A Fall	77.9	5.3
5	0.5#/A + 0.25#/A + 0.25#/A Spring (May 15, June 1, June 15)	77.8	7.0
6	0.5#/A + 0.25#/A + 0.25#/A Fall (August 15, August 30, September 15)	68.0	-5.3
7	0.5#/A + 0.5#/A Spring (May 15, June 1)	77.3	6.3
8	0.5#/A + 0.5#/A Fall (August 15, September 1)	77.4	9.7
9	1.0#/A + 1.0#/A Spring, Fall	87.0	16.7
10	CHECK	71.7	0.0

NOTE: Based on the analysis of variance (AOV) no statistical differences were noted on this evaluation date.

TABLE 5. Effect of 4 rates of Cutless on photosynthetic parameters of annual bluegrass and creeping bentgrass.

Variable	Rep	Species	PGR	Interaction
Dry weight (mg cm^{-2})	*	*	NS	NS
Chlorphyll (ug cm^{-2})	*	NS	NS	NS
PNET ($mgco_2$ dm^{-2} hr^{-1})	NS	NS	*	NS
LEAF cond (cm s^{-1})	NS	NS	*	NS
STOM cond (cm s^{-1})	NS	NS	*	NS
MES cond (cm s^{-1})	NS	NS	*	NS
TRANS (mg H_2O cm^{-2} s^{-1})	NS	NS	NS	NS
TRANS RATIO (mol H_2O mol CO_2^{-1})	NS	NS	NS	NS
WUE (mol CO_2 mol H_2O^{-1})	NS	NS	*	NS

Means: Dry Weight (mg cm^{-2})

Annual Bluegrass	2.13
Creeping Bentgrass	2.54

Rate	PNET	LEAF COND	STOM COND	WUE	MES COND
CK	12.17	0.7881	0.4928	3.23×10^{-3}	0.0702
1 lb EL-500/A	10.16	0.8104	0.5069	2.07×10^{-3}	0.0565
2 lb EL-500/A	8.43	0.5726	0.3582	2.34×10^{-3}	0.0478
4 lb EL-500/A	8.04	0.6626	0.4144	2.09×10^{-3}	0.044
LSD P = 0.05	2.7	0.0179	0.1112	0.8×10^{3}	0.0162

* Significant at the 5% level.

Executive Summary: The Effect of Seven Management Factors and their Interaction on the Competitive Ability of Annual Bluegrass and Creeping Bentgrass.

Annual bluegrass is the predominant turfgrass found on golf courses in the Northeastern region of the United States. Annual bluegrass is not planted intentionally but is a weed that is very competitive under golf course management. The preferred species for golf course greens and fairway is creeping bentgrass. These studies were designed to measure the influence of seven management factors and their interactions on the competitive balance between the two species. Two main field studies are being conducted to examine these seven factors. One study contains five factors of irrigation (daily, 3 times per week, or irrigation at wilt); fertility (2 lbs N/M/YR or 6 lbs N/M/YR); clipping removal or return; plant growth regulator (flurprimidol at 1 lb AI/A, mefluidide at 0.125 lb AI/A, or a check); and overseeding with bentgrass or no overseeding. This five factor study has been conducted for two years at the Hancock Turfgrass Research Center in East Lansing, MI. The results indicate that removing clippings causes the greatest reduction in annual bluegrass population with a 14.2% decrease. The only other factor that caused a significant decrease in annual bluegrass populations was low nitrogen fertility, 2 lbs N/M/YR, which caused a 12.2% decrease in annual bluegrass. There was, however, a significant three interaction between clipping removal, irrigation, and fertility. Plots where clippings were removed, fertility was at 2 lbs N/M/YR and irrigation occurred at wilt had a significantly lower amount of annual bluegrass with a 22.8% decline. The other interesting aspect of this three way interaction was that where irrigation was applied daily and fertility was low, the clipping treatment was not significant. Whether clippings are removed or returned, significant reductions in the annual bluegrass population can be achieved with low fertility and daily irrigation. A second study examining the same irrigation and clipping treatments along with compaction and coring treatments found only compaction to be significant. Compacted plots had a 9.6% increase in annual bluegrass while noncompacted plots had a 5.4% decrease. A final field study was designed to determine the effects of flurprimidol, a plant growth regulator which is claimed to give a competitive advantage to creeping bentgrass, on the rate of spread of creeping bentgrass. Results are preliminary but seem to indicate that flurprimidol does not encourage the spread of creeping bentgrass in an annual bluegrass turf.