FERTILITY EFFECTS ON CREEPING BENTGRASS PEST, WATER, AND ROOT RELATIONSHIPS

UNIVERSITY OF GEORGIA
Griffin, GA

Dr. Robert N. Carrow
Principal Investigator

1991 Research Grant: $5,679
(Second Year of support)

Creeping bentgrass (Agrostis palustris Huds.) is the preferred species for golf greens in the upper South. However, the hot, humid environment of the Southeast results in substantial high temperature and disease stress on this cool-season species. Dr. Milt Engelke, Texas A&M, has an extensive bentgrass breeding program targeted to developing bentgrass cultivars that will exhibit improved adaptation to summer stresses. The objectives of this project were to compare three of Dr. Engelke's experimentals with two industry standards for a) root growth and water extraction patterns in the summer months, b) shoot growth, and c) disease and insect tolerances as pest stresses were observed. The five bentgrasses were: Penncross, Pennlinks, SYN-1-88, SYN-3-88 and SYN-4-88.

To define appropriate cultural regimes, two nitrogen fertility programs and two fungicide programs were included for each species. The annual fertility programs were 3.5 lb N and 7.0 lb N per 1000 ft^2, while the two fungicide programs were preventative and curative. The preventative program was based on use of a number of fungicides applied on a preventative (to prevent disease appearance) schedule. For the curative program, substantial disease development was allowed before curative rates of a fungicide were applied. This allowed disease infection and recovery from disease to be monitored. Mowing height was 5/32 inch with clippings removed. The site was a 5 year old USGA specification golf green at Griffin, GA. Establishment of the bentgrasses was in September 1990.

During the August-September period when continuous summer stresses often cause bentgrasses to deteriorate, SYN-4-88 demonstrated the highest visual quality, color, and shoot density of all cultivars under the high N-preventative fungicide regime. SYN-3-88 also preformed very well under these conditions. At the low N-preventative fungicide treatments, best visual quality was noted for SYN-3-88 followed by SYN-4-88.

Very severe brown patch and dollar spot disease pressures were apparent in 1991. Under a preventative fungicide program, least brown patch infection occurred on SYN-4-88 and Penncross, while SYN-1-88 was most susceptible. With the curative program, SYN-3-88 and Penncross demonstrated least infection. For dollar spot, SYN-3-88 was most susceptible.

Root samples by depth and water extraction by depth data were obtained in early July and late August. Samples and data are under preparation.

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Annual Progress Report

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To define appropriate cultural regimes, two nitrogen fertility programs and two fungicide programs were included for each species. The annual fertility programs were 3.5 lb N and 7.0 lb N per 1000 ft^2; while the two fungicide programs were preventative and curative. The preventative program was based on use of a number of fungicides applied on a preventative (to prevent disease appearance) schedule. For the curative program substantial disease development was allowed before curative rates of a fungicide were applied. This allowed disease infection and recovery from disease to be monitored. Treatment schedules for fertility and fungicide programs are in Tables 1 and 2, respectively.

Mowing height was 5/32 inch with clippings removed. The site was a 5-year old USGA specification golf green at Griffin, GA. Establishment of the bentgrasses was in September 1990. Ratings reported are visual quality, color, shoot density, clipping yield, verdure, brown patch incidence, and dollar spot incidence. Rating dates and scales are presented in the tables. The AUDPC rating for brown patch bears additional explanation. Plots were visually assessed for the severity of brown patch (% necrotic area per plot) on 5, 9, 15, 19, 23, and 30 July, and 8 and 13 August. Values were used to calculate an area under the disease progress curve (AUDPC) for each plot using the formula:
$\Sigma[(Y_i+Y_{i+1})(t_{i+1}-t_i)/2]$ for $i=1,2,3,...,n-1$, where y_i is the amount of disease and t_i the time at the ith rating.

Results to-date are:

Shoot Responses. For many high maintenance golf greens, the 7.0 lb N/1000 ft^2 and preventative fungicide programs would be most representative of actual use conditions. Using this set of treatments for comparison, SYN-4-88 exhibited the highest overall visual quality on four-out-of-six dates (Table 3). During the August-September period when continuous summer stresses often cause bentgrasses to deteriorate in quality, SYN-4-88 demonstrated the highest visual quality of all grasses, followed by SYN-3-88. Under the low N-preventative fungicide treatment, the best quality was apparent for SYN-3-88, SYN-4-88, and Penncross.

Turf Color. Color ratings were obtained in late spring and mid- to late summer (Table 4). Best color ratings were noted on all dates by SYN-4-88 at the high N-preventative fungicide treatment. At low N-preventative treatment, SYN-1-88 tended to be lowest in color ratings, while all other grasses were similar. Color of all five turfgrasses was very good, even at low N.

Shoot Density and Growth. By late summer, the best shoot density was exhibited by SYN-4-88 followed by SYN-3-88, at both N levels with a preventative fungicide program (Table 4). Relative clipping yield throughout the summer months and verdure in late August did not reveal any significant cultivar differences (Table 5).

Disease. Disease pressure was very severe in 1991 for brown patch (Rhizoctonia solani) from July to September and dollar spot (Sclerotinia homoecarpa) from May to July. When a preventative fungicide program was followed, least brown patch infection occurred in SYN-4-88 and Penncross plots, while SYN-1-88 had the most (Table 6). All grasses demonstrated considerable brown patch infection on a curative program, but least infection was observed for SYN-3-88 and Penncross and most for SYN-1-88 and Pennlinks. AUDPC data did not reveal a significant difference among cultivars in disease progression (Table 6).

In terms of dollar spot, the most evident result was for SYN-3-88 to be most susceptible on all dates (Table 7). SYN-4-88 was the next most susceptible cultivar but to a much lesser extent than SYN-3-88.

No cultivar differences were apparent for yellow spot (Table 7). Yellow spot occurs in July and August as round yellow to yellow-green spots of 3 to 6-inch diameter. These areas do not enlarge nor does stand thinning occur. With advent of cooler weather, they fade away. Numerous theories have been proposed for the cause of these spots on bentgrass, but to-date, none have been proven.

Rooting/Water Use. On 10 July and 27 August, root samples were obtained from the 0 to 4 and 4 to 8-inch zones. Just prior to sampling roots, water extraction by depth (0 to 4, 4 to 8 inch) and total water use (evapotranspiration) were obtained on a daily basis for the periods 22-24 June and 28-30 August. These data are in preparation.

Implications. The results from this study have several potential implications:

a). to define the relative performance of these five bentgrasses under the severe environmental and disease stresses of the Southeast at a location currently considered the southern limit for bentgrass greens

b). to define appropriate N fertility regimes for each grass

c). to relate rooting and water extraction by depth to summer performance. Continuous high temperature stress resulting from limited rooting is considered a major contributor to decline of bentgrasses as the summer progresses.

d). to demonstrate relative disease resistance of each cultivar. Disease resistance on creeping bentgrasses is anticipated to play a much larger role in cultivar selection in the future as Integrated Pest Management practices are implemented to a greater degree on golf greens. Cultivars with high resistance will require fewer fungicide applications.

Table 1. Annual fertility program on five creeping bentgrasses

Date	Low N lbs N/1000 ft^2	Low N Carrier	High N lbs N/1000 ft^2	High N Carrier
Jan.	-		-	
Feb.	0.30	22-0-16	0.61	22-0-16
March	0.12	22-0-16	0.50	22-0-16
March	0.33	12-24-14	0.33	12-24-14
April	0.30	22-0-16	0.60	22-0-16
May	0.30	12-24-14	0.60	12-24-14
June	0.25	6-2-0	0.50	6-2-0
July	0.25	22-0-16	0.50	22-0-16
Aug.	0.25	22-0-16	0.50	22-0-16
Sept.	0.25	22-0-16	0.50	22-0-16
Oct.	0.40	12-24-14	0.80	12-24-14
Nov.	0.40	12-24-14	0.80	22-0-16
Dec.	0.40	22-0-16	0.80	22-0-16
Total N =	3.51		7.04	
P_2O_5 =	2.28		3.63	
K_2O =	2.64		5.32	

Table 2. Fungicide programs for five creeping bentgrasses in 1991. (as of Nov. 1, 1991).

Date of Application	Preventative Treatment		Creative Treatment	
	Fung.	oz/1000 ft^2	Fung.	oz/1000 ft^2
May 7[a]	Chip 26019	2[b]	-	
May 21	Banner	4	Banner	4
	Aliette	8	Aliette	8
June 3	Chipco 26019	2	-	
	Subdue	2	-	
June 17	Rubigan 1EC	1.5	-	
	Banol	3	-	
July 3	Subdue	2	-	
	Chipco 26019	2	-	
July 15	Rubigan 1EC	1.5	-	
	Aliette	8	-	
July 29	Chipco 26019	2	-	
	Pace	6.4	-	
Aug 8	Aliette	8	Aliette	8
	Chipco 26019	2	Chipco 26019	2
Aug 13	Tersan 1991	2	Tersan 1991	2
	Pace	6.4	Pace	6.4
Aug 26	Subdue	2	-	
	Rubigan 1EC	1.5	-	
Sept. 10	Chipco 26019	2	-	
	Pace	6.4	-	
Sept. 20	-		Chipco 26019	2
	-		Subdue	2
Sept. 26	Subdue	2	-	
	Rubigan 1EC	1.5	-	
Oct. 8	Chipco 26019	2	-	
Oct. 22	Bayleton	2	-	

[a]Prior to May 7, a preventative program was applied on all plots.

[b]All fungicides applied at 1.0 gal/1000 ft^2 until 1 July and then increased to 1.9 gal water/1000 ft^2.

Table 3. Visual quality of creeping bentgrasses in 1991.

Treatment			Visual Quality						
Cultivar	Fung.	Annual Fertility	16 May	7 Jun	15 Jul	9 Aug	29 Aug	17 Sept	Avg
		lb N/1000 ft^2	9 = ideal density,color,uniformity; 1 = no live turf						
Penncross	Cur.	3.5	6.8	7.0	5.7	5.9	7.4	6.5	6.6
Penncross	Cur.	7.0	7.1	7.5	6.2	5.4	7.6	6.8	6.8
Penncross	Pre.	3.5	7.2	7.1	7.2	7.5	7.4	7.7	7.4
Penncross	Pre.	7.0	7.1	7.3	7.7	7.6	7.4	7.5	7.4
Pennlinks	Cur.	3.5	6.9	7.0	6.1	5.5	7.6	6.2	6.6
Pennlinks	Cur.	7.0	7.4	7.6	5.9	4.9	7.1	5.9	6.5
Pennlinks	Pre.	3.5	7.4	7.2	6.7	7.3	7.2	7.6	7.2
Pennlinks	Pre.	7.0	7.3	7.3	7.5	7.6	7.5	7.7	7.5
SYN-1-88	Cur.	3.5	6.8	6.8	6.1	4.2	6.7	5.8	6.1
SYN-1-88	Cur.	7.0	6.7	6.7	6.3	5.1	7.3	5.8	6.3
SYN-1-88	Pre.	3.5	6.9	6.8	6.8	6.7	7.1	7.3	6.9
SYN-1-88	Pre.	7.0	7.1	6.9	7.5	7.4	7.3	7.7	7.3
SYN-3-88	Cur.	3.5	7.4	5.8	4.5	4.6	7.5	6.6	6.1
SYN-3-88	Cur.	7.0	7.5	6.0	4.7	4.7	7.5	6.3	6.1
SYN-3-88	Pre.	3.5	7.6	6.5	7.2	7.7	7.4	7.9	7.4
SYN-3-88	Pre.	7.0	7.7	7.0	7.4	7.6	7.7	8.1	7.6
SYN-4-88	Cur.	3.5	7.2	6.4	4.6	4.8	7.4	6.7	6.2
SYN-4-88	Cur.	7.0	7.3	6.9	4.9	5.0	7.8	6.6	6.4
SYN-4-88	Pre.	3.5	7.6	7.0	7.0	7.7	7.4	7.8	7.4
SYN-4-88	Pre.	7.0	7.6	7.4	7.2	8.0	7.7	8.2	7.7
CV (%)			4.0	7.6	11.1	8.6	6.5	7.1	-
ANOVA[a]									
Cultivar			**	**	**	*	NS	**	
Fung.			**	*	**	**	NS	**	
Fert.			NS	*	*	NS	NS	NS	
Cult. x Fung.			NS	NS	*	†	NS	NS	

a **,*,† Significantly different F-test at 1, 5, and 10% levels, respectively.

Table 4. Creeping bentgrass color and shoot density in 1991.

Treatment			Turf Color[a]			Turf Density[b]	
Cultivar	Fung.	Annual Fertility	16 May	9 Aug	29 Aug	29 Aug	17 Sept
		lb N/1000 ft^2					
Penncross	Cur.	3.5	5.6	7.7	8.2	7.9	7.6
Penncross	Cur.	7.0	7.4	7.7	8.3	7.9	7.7
Penncross	Pre.	3.5	7.4	7.6	7.9	7.8	8.0
Penncross	Pre.	7.0	7.5	7.5	8.0	7.8	7.9
Pennlinks	Cur.	3.5	7.1	7.4	8.1	7.9	7.5
Pennlinks	Cur.	7.0	7.2	7.7	8.1	7.6	7.4
Pennlinks	Pre.	3.5	7.2	7.6	7.8	7.7	7.7
Pennlinks	Pre.	7.0	7.2	7.7	7.9	8.0	7.9
SYN-1-88	Cur.	3.5	6.7	7.2	8.0	7.5	7.2
SYN-1-88	Cur.	7.0	6.8	7.5	8.1	7.8	7.3
SYN-1-88	Pre.	3.5	6.7	7.5	7.7	7.7	7.6
SYN-1-88	Pre.	7.0	6.7	7.6	7.7	7.9	7.9
SYN-3-88	Cur.	3.5	7.3	7.6	8.1	7.9	7.6
SYN-3-88	Cur.	7.0	7.3	7.6	8.2	8.0	7.5
SYN-3-88	Pre.	3.5	7.3	7.9	7.8	7.9	8.2
SYN-3-88	Pre.	7.0	7.3	7.7	7.9	8.1	8.3
SYN-4-88	Cur.	3.5	7.4	7.5	8.1	8.1	7.7
SYN-4-88	Cur.	7.0	7.4	7.4	8.4	8.3	7.8
SYN-4-88	Pre.	3.5	7.5	7.7	7.8	8.1	8.2
SYN-4-88	Pre.	7.0	7.6	8.0	8.0	8.3	8.4
CV (%)			9.4	2.8	1.6	2.7	2.9
ANOVA[c]							
Cultivar			†	*	**	**	**
Fung.			NS	*	**	NS	**
Fert.			NS	NS	**	*	NS
Cult. x Fung.			NS	*	NS	NS	NS

[a]Turf color: 9 = dark green; 1 = no green

[b]Turf density: 9 = ideal shoot density; 1 = no live turf

[c] **,*,†Significantly different F-test at levels of 1, 5, and 10%, respectively.
NS = not significant.

Table 5. Relative clipping yield and verdure of creeping bentgrasses in 1991.

Treatment[c]		Relative Clipping Yield[a]				Verdure
Cultivar	Annual Fertility	5 Jun	15 Jul	21 Aug	24 Sep	29 Aug
	lb N/100 ft^2	%				mg m^{-2}
Penncross	3.5	100	100	100	100	372
Penncross	7.0	163	53	93	115	400
Pennlinks	3.5	110	135	75	87	303
Pennlinks	7.0	147	59	89	114	395
SYN-1-88	3.5	124	43	72	111	367
SYN-1-88	7.0	189	65	106	126	356
SYN-3-88	3.5	123	132	92	122	325
SYN-3-88	7.0	159	60	89	147	392
SYN-4-88	3.5	117	73	71	102	329
SYN-4-88	7.0	103	84	81	115	287
CV (%) =		62	47	22	24	21
ANOVA[b]						
Cultivar		NS	NS	NS	NS	NS
Fertility		NS	*	NS	†	NS
Cult. x Fert.		NS	†	NS	NS	NS

[a]Relative to Penncross at 3.5 lb N/1000 ft^2/year.

[b]*,†Significantly different F-test at 5 and 10% levels, respectively.

[c]At the preventative fungicide program.

Table 6. Brown patch infection on creeping bentgrasses in 1991.

Treatment			Brown Patch			
Cultivar	Fung.	Annual Fertility	15 Jul	9 Aug	17 Sep	AUDPC[b]
		lb N/1000 ft^2		% plot		
Penncross	Cur.	3.5	10.3	26.0	36.7	753
Penncross	Cur.	7.0	25.0	19.3	28.3	715
Penncross	Pre.	3.5	4.0	1.3	1.6	241
Penncross	Pre.	7.0	4.3	1.7	0	198
Pennlinks	Cur.	3.5	15.0	38.3	43.0	414
Pennlinks	Cur.	7.0	18.3	50.0	70.0	403
Pennlinks	Pre.	3.5	4.3	6.3	4.7	206
Pennlinks	Pre.	7.0	9.7	9.0	4.7	169
SYN-1-88	Cur.	3.5	9.7	58.3	73.3	468
SYN-1-88	Cur.	7.0	9.7	45.0	70.0	379
SYN-1-88	Pre.	3.5	3.0	30.7	8.3	391
SYN-1-88	Pre.	7.0	4.0	10.3	5.7	273
SYN-3-88	Cur.	3.5	11.3	26.7	40.0	491
SYN-3-88	Cur.	7.0	7.3	28.3	33.3	474
SYN-3-88	Pre.	3.5	1.3	2.7	2.0	119
SYN-3-88	Pre.	7.0	5.0	6.7	1.3	183
SYN-4-88	Cur.	3.5	18.3	32.3	35.0	639
SYN-4-88	Cur.	7.0	12.3	28.3	38.3	606
SYN-4-88	Pre.	3.5	9.0	1.0	0	227
SYN-4-88	Pre.	7.0	3.7	2.3	0	224
CV (%)			77	66	71	57
ANOVA[a]						
Cultivar			NS	**	**	NS
Fung.			**	**	**	**
Fert.			NS	NS	NS	NS
Cult. x Fung.			NS	NS	NS	NS

[a]**Represents 1% level of significance for F-test. NS = not significant.

[b]AUDPC = area under the disease progress curve. Higher values reflect a more rapid infection of the disease; brown patch in this case. Based on disease progression from 5 to 30 July and 8 to 13 August 1991.

Table 7. Dollar spot and yellow patch of creeping bentgrasses in 1991.

Treatment			Dollar Spot			Yellow[a] Spot
Cultivar	Fung.	Annual Fertility	16 May	7 Jun	15 Jul	15 Jun
		lb N/1000 ft^2	% plot			
Penncross	Cur.	3.5	0.5	0.7	3.7	13.7
Penncross	Cur.	7.0	0.1	0.3	4.0	21.0
Penncross	Pre.	3.5	0	0.3	0	6.7
Penncross	Pre.	7.0	0.1	0	0	5.7
Pennlinks	Cur.	3.5	0.1	1.0	1.3	20.7
Pennlinks	Cur.	7.0	0.3	1.0	3.0	22.3
Pennlinks	Pre.	3.5	0	0.3	0	8.7
Pennlinks	Pre.	7.0	0	0	0	6.0
SYN-1-88	Cur.	3.5	1.0	1.0	4.0	17.7
SYN-1-88	Cur.	7.0	2.5	2.7	7.0	11.7
SYN-1-88	Pre.	3.5	0	1.3	1.0	6.3
SYN-1-88	Pre.	7.0	0	2.0	0	3.7
SYN-3-88	Cur.	3.5	7.6	9.3	23.7	13.0
SYN-3-88	Cur.	7.0	5.3	6.3	24.0	16.3
SYN-3-88	Pre.	3.5	1.0	4.0	0.7	9.3
SYN-3-88	Pre.	7.0	0.3	1.7	0.3	9.0
SYN-4-88	Cur.	3.5	2.1	2.7	13.7	22.3
SYN-4-88	Cur.	7.0	1.5	2.0	14.0	12.7
SYN-4-88	Pre.	3.5	0	0.3	0	6.7
SYN-4-88	Pre.	7.0	0	0.3	0.3	9.0
CV (%)			164	117	111	70
ANOVA[b]						
Cultivar			**	**	**	NS
Fung.			**	**	**	**
Fert.			NS	NS	NS	NS
Cult. x Fung.			**	*	**	NS

[a]Yellow spot. Unknown organism or cause.

[b]**,*Significantly different F-test at 1 and 5% levels, respectively. NS = not significant.