UNIVERSITY OF GEORGIA

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

1993 Research Grant: $6,000
(Final year of support)

Dr. Robert N. Carrow
Principal Investigator

Creeping bentgrass (Agrostis palustris Huds.) is the preferred species for golf greens in the upper South. The hot, humid environment of the Southeast, however, results in substantial high temperature and disease stress on this cool-season species. Dr. Milt Engelke, Texas A&M University, has an extensive bentgrass breeding program to develop 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 1) root growth and water extraction patterns in the summer months, 2) shoot growth, and 3) disease and insect tolerances. The five bentgrasses included Penncross, Pennlinks, SYN-1-88, SYN-3-88 (Crenshaw), and SYN-4-88 (Cato).

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. 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. The mowing height was 5/32 inch with clippings removed. The site was a 5-year old USGA specification golf green at Griffin, GA. Conclusions to date are:

1. SYN-3 and SYN-4 exhibited significantly better visual quality and shoot density than Penncross. As the summer progressed, both cultivars maintained better density and quality. Turf color of all cultivars were, in general, similar.

2. SYN-4 was the only cultivar that did not exhibit a greater deterioration in quality/shoot density in late summer at high N versus low N. This indicates that SYN-4 could withstand higher N when needed without adversely affecting late summer performance.

3. Relative to Penncross: SYN-1 was much more susceptible to brown patch; SYN-3 was very susceptible to dollar spot; all cultivars were more susceptible to the "Curvularia" yellow spot symptoms.

4. At the higher N regime, SYN-3 and SYN-4 tended to exhibit less root decline (based on percent changes in RLD) than Penncross within the 10 to 20 cm zone. This was a trend and not a strong treatment effect.

5. SYN-4 often extracted more soil moisture than Penncross during the summer months, which would lessen the effects of indirect high temperature stress over the summer.

6. All bentgrasses were found by Dr. Kris Braman to be equally susceptible to black cutworm induced feeding injury. All grasses were equally suitable for larval survival and growth as measured in these short-term, no-choice field studies. This will be repeated in 1994.

Data that was obtained in 1993, but still under preparation/analysis includes AUDPC by Dr. Lee Burpee for brown patch and dollar spot, thatch buildup over 3 yrs, and rooting. These results may alter the above conclusions to some extent.

October 1993

Annual Progress Report

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

UNIVERSITY OF GEORGIA
Griffin, GA
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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 (SYN-1-88, SYN-3-88 or Crenshaw, and SYN-4-88 or Cato) with two industry standards (Penncross and Pennlinks) for a) performance during the summer months, b) disease and insect tolerances, c) root growth and water extraction patterns in the summer months, and d) to investigate cultural requirements.

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 1-2 and Tables 3-5, 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 and Curvularia bears additional explanation. Plots were visually assessed for the severity of disease (% necrotic area per plot) by Dr. Lee Burpee over several weeks while the disease developed. 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. This rating is useful in assessing the rate of infection of a disease.

The analysis of variance (ANOVA) for each data set is included in the table with the data. The experimental design was a randomized complete block with treatments in a 5 (Cultivar) x 2(N-Programs) x 2(Fungicide Programs) factorial arrangement. Single degree of freedom contrasts were used to compare all cultivars versus Penncross as a standard. Since main effect interactions were rare, contrasts were normally made across N levels within a fungicide program. When important interactions did occur, the full data set is presented. Results are discussed below:

Visual Quality. Comparison of the grasses under a preventative fungicide program is the most related to current golf course situations, while comparison at the curative fungicide program would reflect a situation with minimal disease control. Over the 3-year period, 26 visual quality measurements were conducted during April through October. Substantial cultivar differences were observed when grasses were compared to Penncross:

Cultivar	Quality Rating† > Penncross	Quality Rating† < Penncross
	%	
Curative Fungicide Program		
Pennlinks	11.5	11.5
SYN-1	7.7	30.8
SYN-3	26.9	23.1
SYN-4	19.2	11.5
Preventative Fungicide Program		
Pennlinks	15.4	0
SYN-1	11.5	3.8
SYN-3	50.0	0
SYN-4	38.5	0

†Averaged across N treatments as in Tables 6,7,9.

Under a preventative fungicide regime, SYN-3 and SYN-4 exhibited higher visual quality than Penncross 50.0 and 38.5 percent of the time, respectively. All other quality ratings for these grasses were equal to Penncross. However, with a curative fungicide program, SYN-3 and SYN-4 had greater visual quality than Penncross 26.9 and 19.2 percent of the time, respectively; but, Penncross demonstrated higher ratings on 23.1 and 11.5 percent of the ratings for SYN-3 and SYN-4, respectively. The periods of higher quality for Penncross were related to differences in brown patch and dollar spot infection (discussed in disease section).

During the critical late summer months of August and September, visual quality averages for the grasses were:

	Preventative			Curative		
Cultivar	1991	1992	1993	1991	1992	1993
Penncross	7.5†	6.6	7.4	6.6	6.2	6.9
Pennlinks	7.5	6.7	7.3	6.2	6.3	7.1
SYN-1	7.2	6.7	7.3	5.8	6.5	7.0
SYN-3	7.7	7.2	7.4	6.2	6.5	6.6
SYN-4	7.8	7.1	7.4	6.4	6.5	6.9

†Visual quality: 9 = ideal density, color, uniformity; 1 = no live turf. Ratings are averaged for August and September.

Greatest differences for SYN-3 and SYN-4 versus Penncross were noted in 1992, which was a year of higher than normal summer rainfall. The summers of 1991 and 1993 were hot, but drier than normal. During the late summer period, SYN-3 and SYN-4 performed better than Penncross on 2 out of 3 years, with the preventative fungicide program; and were equal in the third year. However, for the curative program, in only 1992 did SYN-3 and SYN-4 exhibit better late summer quality.

As anticipated, the preventative fungicide program often resulted in higher quality ratings than the curative program, regardless of cultivar or N-program (Tables 6,7,9). Only when disease pressure was very low were no differences between fungicide programs apparent. The significant CxF interaction that occasionally occurred was a magnitude response (i.e., cultivars responding differently in magnitude or strength of a response) and not a trend response (where cultivars exhibit different trends with fungicide (Tables 8,10). FxN interactions were also magnitude in nature (Tables 8,10).

The CxN interactions of $P < 0.20$ all occurred in the July to September period, especially in the wet year of 1992, and were trend responses (Tables 8,10). Penncross and Pennlinks exhibited several instances within this period of higher visual quality at low N than at high N. In a previous study at this location using Penncross creeping bentgrass, we found increasing quality up to 6.0 lb N/1000 ft^2/yr but a decline in late summer quality at above 6.0 lb N. This would suggest that high N enhances the indirect high temperature stress these grasses are exposed to in the summer months. SYN-3 exhibited a similar CxN interaction in late summer of 1992, and SYN-1 a minor instance on 9 July 1992, and 24 September 1993. SYN-4, however, did not show a CxN interaction which suggests a) SYN-4 has an inherently greater high N tolerance, and/or b) it has a greater indirect high temperature tolerance.

It should be noted that differences between low and high N on all cultivars were less prevalent and less in magnitude in the late July through September period (Tables 6,7,9). Thus, with continued high temperature stress, application of high N did not compensate, and as discussed in the previous paragraph, actually increased stress in some cases.

Shoot Density. Shoot density is a very important component of overall visual quality, especially on putting green turf. Nineteen shoot density evaluations were conducted over the 3-year study, with all ratings made between April and October. Relative to Penncross shoot density differences were:

Cultivar	Shoot Density > Penncross	Shoot Density < Penncross
	------ % ------	
Curative Fungicide Program		
Pennlinks	21.1	10.5
SYN-1	5.3	21.1
SYN-3	68.4	0
SYN-4	63.2	0
Preventative Fungicide Program		
Pennlinks	26.3	0
SYN-1	15.8	5.3
SYN-3	89.5	0
SYN-4	84.2	0

†Averaged across N treatments as in Tables 11,12,13.

SYN-3 and SYN-4 consistently exhibited greater shoot density than Penncross regardless of fungicide program. When a preventative fungicide program was followed, SYN-3 and SYN-4 demonstrated higher shoot density than Penncross on over 85% of the ratings.

Shoot density comparisons in the August and September period are summarized below:

	Preventative			Curative		
Cultivar	1991	1992	1993	1991	1992	1993
	---------9=ideal shoot density; 1=no live turf---------					
Penncross	7.9†	7.5	7.3	7.8	7.2	7.1
Pennlinks	7.8	7.4	7.4	7.6	7.2	7.3
SYN-1	7.8	7.5	7.4	7.5	7.4	7.2
SYN-3	8.2	7.8	7.6	7.8	7.5	7.4
SYN-4	8.3	7.7	7.6	8.0	7.4	7.4

†Ratings are averaged for August and September

With a preventative fungicide regime, SYN-3 and SYN-4 consistently had better shoot density than Penncross in late summer. Similar trends, but lesser in magnitude, occurred under the curative treatments.

Significant interactions of treatments on shoot density are presented in Table 14. All CxF and FxN interactions were due to magnitude differences. CxN interactions revealed trend differences where all cultivars except SYN-4 exhibited similar or lower shoot density at high N as at low N during certain ratings in the July to October period of 1992 and 1993. This was similar to the visual quality results and indicates that shoot density changes were the primary factor in visual quality differences.

Turfgrass Color. Color differences were not great in magnitude among the cultivars (Tables 11,15,16). Considering both fungicide programs, out of 28 ratings SYN-3 had 6 better and 2 lower than Penncross, while SYN-4 had 4 better and 3 lower. SYN-1 showed 6 lower color ratings than Penncross and none better. Higher N resulted in better color, especially in cooler periods. Color differences by late summer between N-programs were minimal. In general, the preventative fungicide program resulted in somewhat better color; however, after a curative fungicide application in late August 1991 and early October 1992 the reverse trend was noted. Apparently, residual N not used by the grass under stress was available on curative plots once a fungicide was applied.

Growth. Periodic clipping yields were collected and late August verdure to access relative growth responses under the preventative fungicide program. Some cultivar differences were observed but the only consistent response was reduced clipping yield for SYN-4 versus Penncross in late summer at the low N level. There was a similar numerical, but nonsignificant, trend at higher N (Table 17). Since SYN-4 maintained a consistently higher shoot density than Penncross during the same period, SYN-4 may be adapted to maintenance of a better carbohydrate balance during this period. SYN-3 exhibited a similar trend, but to a lesser magnitude. Verdure differences among cultivars were not apparent.

Interestingly, Penncross often produced fewer clippings at high N versus low N in the July to September period. SYN-3 and SYN-4 had similar or slightly higher clipping yields at high N versus low N. This would suggest that these cultivars may have a better tolerance to higher N levels than Penncross.

Disease. Climatic conditions were conducive in all three years for disease development. Concerning dollar spot (Sclerotina homoecarpa), SYN-3 demonstrated significantly greater infection than Penncross on all ratings under the curative fungicide program (Table 18). Use of a preventative fungicide regime controlled dollar spot on SYN-3 to the same degree of infection as Penncross on all dates except 7 June 1991. Preventative treatment disease ratings were consistently lower for all cultivars than curative. Except for 30 August 1993, no significant differences in infection between N treatments were noted.

The high degree of dollar spot susceptibility of SYN-3 would suggest a) greens established to SYN-3 will require a rigorous preventative fungicide program during dollar spot infection periods, b) this cultivar should not be used on fairways in areas of consistent dollar spot pressure unless a fairway preventative fungicide regime is planned, and c) as with the other cultivars, increasing N within the range of this study had little impact on reducing infection.

Brown patch (Rhizoctonia solani) infection was greatest under the curative fungicide program in terms of percent plot infected and in disease progress (Table 19). SYN-1 and Pennlinks were not susceptible to brown patch, while SYN-3 had less brown patch than Penncross on 2 out of 6 rating dates (curative program). The AUDPC data (1993 data not analyzed to date) suggests that with a preventative fungicide program SYN-1 was less responsive to fungicides, while Penncross was most responsive. AUDPC value under a preventative program for SYN-1 was 74 to 78% of curative and for Penncross it was 23 to 30% of curative. Brown patch infection was not significantly influenced by N-programs.

Symptoms occurred in both years of yellow to yellow-green, round spots of 3 to 6-inch diameter. These areas did not enlarge nor did stand thinning occur. With advent of cooler weather, the symptoms faded. Dr. Lee Burpee was able to find very high levels of Curvularia associated with these areas within the study, as well as on local golf courses. Thus, this has been termed "Curvularia" awaiting further clarification of the problem. All cultivars exhibited these symptoms, but based on the AUDPC data of Dr. Burpee in 1992, Penncross appears to be least susceptible, while SYN-4 was most (Table 20). Since all cultivars exhibited higher AUDPC values than Penncross even under a preventative fungicide program, this suggests that this problem may increase as other bentgrasses are used in place of Penncross. Symptoms were reduced under the preventative program (indicating fungicide control may be possible) and with higher N.

Other Pests. Purple cudweed (Gnaphalium purpureum L.) occurred on the research area and the degree of invasion was rated in April 1992 (Table 21). While high N tended to reduce infestation, the preventative fungicide plots also had less cudweed either due to competition and/or a herbicidal action on the cudweed from one or more of the fungicides. SYN-1 had the highest quantity of cudweed of the bentgrasses.

Sod webworm counts in October 1992 are listed in Table 21. Webworms were higher in the preventative fungicide plots. All cultivars exhibited more sod webworms than Penncross.

Dr. Kris Braman initiated a black cutworm (Agrostis ipsilon) susceptibility study on these grasses and results are reported in the summary "USGA Bentgrass Cultivars and Management", Appendix A.

Rooting. Under the low N regime, few cultivar differences were observed with respect to RLD (Tables 22,23) and these were not consistent over the two years. In 1991, SYN-1 had higher RLD within the surface 3 to 10 cm zone than Penncross in early July but not late summer. SYN-3 in 1992 exhibited lower RLD than Penncross at 10 to 20 cm (11 Jun) and 3 to 10 cm (26 Aug).

At the high N regime, RLD differences among cultivars were more frequent than under low N but differences were generally not consistent between years (Table 22, 23). On 12 July 1991, all cultivars had lower surface RLD values than Penncross but no differences were noted on 27 August within the 3 to 10 cm zone. Surface RLD (i.e., 3 to 10 cm) in June 92 were similar except for SYN-3 with a higher RLD than Penncross. By late summer, only Pennfine had a higher RLD than Penncross within this zone.

RLD differences among cultivars in the 10 to 20 cm soil zone were observed at the high N program in 1991 but not 1992. In 1991, all SYN materials had lower RLD than Penncross in early July, but by late August SYN and Pennlinks exhibited significantly greater RLD. Nitrogen rates significantly affected RLD values on July 1991 and had a weak influence ($P < 0.20$) in several instances (Table 22,23). The primary overall influence of increasing N within the range of this study was to slightly increase RLD. In terms of percent changes in RLD from early summer to late summer, the least decrease in RLD occurred at the higher N rate for RLD's within the 10 to 20 cm zone. It is often believed that higher N decreases deep rooting. This has been observed by this author in other studies on bentgrass on the same site but not until N reached 9.0 lb N per 1000 ft^2 per year.

In addition to absolute RLD values, a second means of evaluating rooting responses is to look at <u>percent changes in RLD</u> by depth over the summer (Tables 22,23). Within 1991, two instances of increased RLD from early July to late August were noted; namely, a 83% increase for Pennlinks at 3 to 10 cm depth and 286% increase for SYN-3 at the 10 to 20 cm depth. For SYN-3 and SYN-4, a decline in depth rooting over the summer appeared to be less pronounced for these cultivars than for Penncross.

A third means of observing root changes is by looking at <u>total root length</u> (Table 24) per cm^2 of surface area. Of particular interest would be the percent change from early summer to late summer. Only one positive (i.e., increase in rooting) was observed and that was for Pennlinks in 1991 (due to an increase in surface, 3 to 10 cm, RLD, Table 22). Cultivar responses were not consistent between the two years; perhaps reflecting the rooting differences apparent between 1991 and 1992. In 1991, lower total root lengths occurred in earlier summer compared to 1992 (possibly reflecting a loss in June, since sampling was not until 12 July vs 11 Jun for 1992). Overall losses of 53 (1991) to 84 (1992) percent of the total root system occurred by late summer on the bentgrasses. Due to the year to year differences in rooting, a third year of data may clarify the results, but 1993 roots are currently being analyzed.

<u>Water Extraction/Evapotranspiration</u>. Evapotranspiration (ET) data are in Tables 25 and 26. <u>Greater</u> ET would be viewed as beneficial on bentgrass grown on a sand media where unsaturated flow is very low, since it would reflect the ability of the grass to extract soil moisture. In 1991, ET data were collected over a 48-hour period (Table 25), but this resulted in the expression of localized dry spots on the plots within a couple of days after measurement. This was also noted on routine irrigation if a 2-day schedule was used. Measurement of water extraction patterns (data not presented) revealed that most water extracted on day 1 was from the surface 0 to 10 cm, which resulted in substantial drying of this zone over a 2-day period. Thus, in 1992 and 1993, the dry-down period was reduced to 30 hr. Data for 0 to 24 hr would be representative of a turf manager irrigating every day.

At the low N level for the duration of the 6 dry-down periods (i.e., 0 to 48 or 0 to 30 hrs), greater ET than Penncross was observed 2, 2, and 3 times for SYN-1, SYN-3, and SYN-4, respectively; while, SYN-4 exhibited 1 period of lower ET than Penncross. Under high N, higher ET than Penncross was noted for 3, 1, and 3, respectively, for SYN-1, SYN-3, and SYN-4; with SYN-1 and SYN-3 resulting in 1 period of lower ET. Overall, SYN-4 appeared to be the most efficient in extracting water.

ET data from the 0 to 24 hr period would be most reflective of normal irrigation. At low N, ET rates greater than Penncross were observed 3, 2, and 1 times, respectively, for SYN-1, SYN-3, and SYN-4; while at high N, 1, 0, and 3 times, respectively.

Stimpmeter. Two stimpmeter readings were obtained in 1992 with ball roll up a 2% slope (Table 27). In general, most significantly different values were for less stimpmeter values.

Conclusions.

1. SYN-3 and SYN-4 exhibited significantly better visual quality and shoot density than Penncross. As the summer progressed, both cultivars maintained better density and quality. Turf color of all cultivars were, in general, similar.

2. SYN-4 was the only cultivar that did not exhibit a greater deterioration in quality/shoot density in late summer at high N versus low N. This indicates that SYN-4 could withstand higher N when needed without adversely affecting late summer performance.

3. Relative to Penncross: SYN-1 was much more susceptible to brown patch; SYN-3 was very susceptible to dollar spot; all cultivars were more susceptible to the "Curvularia" yellow spot symptoms.

4. At the higher N regime, SYN-3 and SYN-4 tended to exhibit less root decline (based on percent changes in RLD) than Penncross within the 10 to 20 cm zone. This was a trend and not a strong treatment effect.

5. SYN-4 often extracted more soil moisture than Penncross during the summer months, which would lessen the effects of indirect high temperature stress over the summer.

Data that was obtained in 1993, but still under preparation/analysis includes AUDPC for brown patch and dollar spot, thatch buildup over 3 yrs, and rooting. These results may alter the above conclusions to some extent.

Appendix A

Annual Progress Report
USGA BENTGRASS CULTIVARS AND MANAGEMENT

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1993 Research Grant Extension (First year of support)

Kris Braman
Insect susceptibility

Experimental design and methods:

Five bentgrasses: Penncross, Pennlinks, SYN-1-88, SYN-3-88 and SYN-4-88 under two nitrogen fertility programs were examined for susceptibility to feeding injury by the black cutworm, *Agrotis ipsilon*. The site of initial establishment was a five year old USGA specification golf green; bentgrasses were established in September 1990. Annual fertility programs were 3.5 lb N and 7.0 lb N per 1000 ft^2. Mowing height was 5/32 inch with clippings removed.

Bentgrass selections were evaluated for susceptibility to injury by the black cutworm in no- choice tests in experimental plots twice during 1993. PVC pipe enclosures (15cm diam) served as confinement areas for second instar larvae. Larvae were introduced into each treatment enclosure on May 15. Plots were destructively sampled on June 11. Uninfested enclosures were used to compare relative growth of grasses. Larval survival, larval growth, and growth of grasses were compared among cultivars and fertility programs. The study was repeated during June, except that larvae were removed after 10 days.

Larval survival and larval weights were subjected to analysis of variance. Clipping dry weights, taken during trial 1, were recorded as a percentage of the uninfested control and subjected to analysis of variance after arcsine transformation.

Results:

1. Black cutworms in trial 1 reduced the growth of bentgrass 81-100% Differences in percent reduction in plant growth among cultivars and nitrogen fertility programs were not significant.

2. Larval survival ranged from 51-80% during trial 1 and from 22-67% during trial 2. In both trials larvae feeding on Syn-4, high N, experienced the lowest survival. An apparent, though non-significant, trend toward greater survival on high nitrogen plots was suggested when data from both trials were combined (Figure 1).

3. Larval weights were not affected by cultivar ($P>0.05$). A trend toward an increase in larval weight on high nitrogen plots is apparent (Figure 1).

Conclusions:

All bentgrasses were equally susceptible to black cutworm induced feeding injury. All grasses were equally suitable for larval survival and growth as measured in these short-term, no-choice field studies.

Table 1. Relative effect of black cutworm feeding on bentgrass cultivars

Treatment		May 28, 1993			June 25, 1993	
Cultivar	Annual Fertility*	% reduction in growth	% larval survival	larval weight(mg)	% larval survival	larval weight(mg)
Penncross	171	81.3	51.1	256	66.7	102
Penncross	342	96.8	57.8	274	66.7	113
Pennlinks	171	97.6	62.2	218	22.2	98
Pennlinks	342	100.0	62.2	273	55.6	97
SYN-1-88	171	97.8	64.4	257	22.2	109
SYN-1-88	342	98.6	80.0	236	66.7	97
SYN-3-88	171	98.2	73.3	265	44.4	103
SYN-3-88	342	100.0	64.4	333	55.6	88
SYN-4-88	171	100.0	62.2	294	33.3	100
SYN-4-88	342	91.4	51.1	390	22.2	96

* Kg ha-1

Figure 1

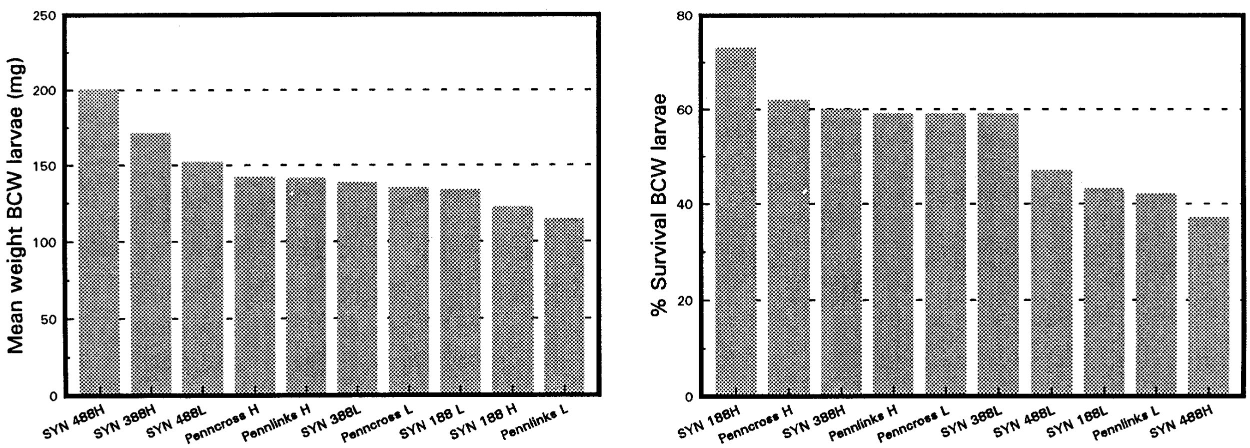

Table 1. Annual fertility programs (low, high) on five creeping bentgrasses in 1991.

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. Annual fertility programs (low, high) on five creeping bentgrasses in 1992 and 1993.

Date†	Low N lbs N/1000 ft^2	Low N Carrier	High N lbs N/1000 ft^2	High N Carrier
Jan.	0.25	31-3-10	0.50	31-3-10
Feb.	0.33	20-0-15	0.66	20-0-15
March	0.33	12-24-14	0.66	12-24-14
April	0.33	12-24-14	0.66	29-0-0
May	0.33	22-0-16	0.66	22-0-16
June	0.33	6-2-0	0.66	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	18-4-10	0.50	18-4-10
Oct.	0.33	22-0-16	0.66	29-0-0
Nov.	0.33	22-0-16	0.66	22-0-16
Dec.	0.33	22-0-16	0.66	22-0-16
Total N =	3.64		7.28	
P_2O_5 =	1.51		1.70	
K_2O =	1.56		3.88	

†Fertilizer was applied between day 1 to 10 of each month.

Table 3. Fungicide programs for five creeping bentgrasses in 1991.

Date of Application	Preventative Fung.	Preventative oz/1000 ft^2	Curative Fung.	Curative 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	-	
Dec. 6	Bayleton 25W	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 4. Fungicide programs for five creeping bentgrasses in 1992.

Date of Application	Preventative Fung.	Preventative oz/1000 ft^2	Curative Fung.	Curative oz/1000 ft^2
Feb 5[a]	Bayleton 25WP	2	Bayleton 25WP	2
Feb 28	Bayleton 25WP	2	Bayleton 25WP	2
Apr 9	Bayleton 25WP	2	-	
Apr 28	Banner	4	Banner	4
	Banol 6S	3	-	
May 13	Subdue	1.5	-	
	Rubigan 1EC	1.5	-	
May 27	Bayleton 25WP	1	-	
	Banol 6S	2	-	
Jun 10	Chipco 26019	1.5	-	
	Aliette 80WP	4	-	
Jun 23	Rubigan 1EC	1.5	Rubigan 1EC	1.5
July 8	Banner	4	-	
	Subdue 2EC	2	-	
July 22	Banol 6S	3.0	-	
	Rubigan 1EC	1	-	
July 30	Chipco 26019	2	Chipco 26019	2
Aug 14	Banol 6S	3	-	
	Formec 80WP	3	-	
Aug 18	Subdue 2EC	2	-	
	Chipco 26019	2	-	
Aug 31	Formec 80WP	3	Formec 80WP	3
Sept 11	Daconil 2787	6	Daconil 2787	6
Oct. 1	Bayleton 25W	2		

[a]All fungicides applied at 1.9 gal/1000 ft^2

Table 5. Fungicide programs for five creeping bentgrasses in 1993.

Date of Application	Preventative Fung.	Preventative oz/1000 ft^2	Curative Fung.	Curative oz/1000 ft^2
May 14[a]	Fore	3[b]	-	
May 27	Fore	3	Fore	3
June 8	Chipco 26019	2	Chipco 26019	2
June 23	Rubigan 1EC	1.5	-	
	Subdue 2E	2	-	
July 2	Chipco 26019	2	-	
	Subdue 2E	2	-	
July 23	Chipco 26019	2	-	
	Aliette 80W	8	-	
Aug 4	Chipco 26019	2	-	
	Subdue 2E	2	-	
Aug 27	Rubigan 1EC	1.5	-	
	Subdue 2E	2	-	
Sept. 9	Chipco 26019	2	-	
	Subdue 2E	2	-	
Sept. 21	Rubigan 1EC	1.5	-	
Oct. 4	Bayleton 25W	2	-	

[a]Prior to May 14, a preventative program was applied to all plots.

[b]All fungicides applied at 1.9 gal water/1000 ft^2.

Table 6. Turfgrass visual quality main treatment effects in 1991.

Contrast or Main Effect	Turf Quality 16 May	7 Jun	15 Jul	9 Aug	29 Aug	17 Sep	24 Oct
	——9 = ideal density, color, uniformity; 1 = no live turf——						
Contrast at Cur. Fung.‡							
Penncross versus	6.9	7.3	6.0	5.6	7.5	6.6	7.4
Pennlinks	7.1	7.3	6.0	5.2	7.3	6.0*	6.9**
SYN-1-88	6.7	6.7*	6.7	4.6**	7.0†	5.8**	6.9**
SYN-3-88	7.4**	5.9**	4.5**	4.6**	7.5	6.4	7.5
SYN-4-88	7.2*	6.7*	4.8**	4.9*	7.6	6.6	7.2
Contrast at Prev. Fung.‡							
Penncross versus	7.2	7.2	7.5	7.6	7.4	7.6	7.5
Pennlinks	7.4	7.2	7.1	7.4	7.4	7.6	7.4
SYN-1-88	7.0	6.8	7.1	7.0†	7.2	7.5	7.4
SYN-3-88	7.6**	6.8	7.3	7.6	7.5	8.0†	7.8†
SYN-4-88	7.6**	7.2	7.1	7.9	7.5	8.0†	7.8†
Fungicide							
Curative	7.1	6.8	5.5	5.0	7.4	6.3	7.2
Preventative	7.4**	7.0*	7.2**	7.5**	7.4	7.8**	7.6**
Annual N							
171 kg ha^{-1}	7.2	6.8	6.2	6.2	7.3	7.0	7.0
342 kg ha^{-1}	7.3	7.0*	6.5*	6.3	7.5	7.1	7.8**
CV(%)	4	8	11	9	6	7	5
ANOVA							
Cultivar (C)	**	**	**	**	†	**	**
Fungicide (F)	**	*	**	**	.90	**	**
Nitrogen (N)	.19	*	*	.47	.63	.75	**
C x F	.98	.16	*	†	.99	.43	.36
C x N	.98	.79	.96	.20	.55	.91	.94
F x N	.25	.81	.43	.41	.63	.31	.78

†,*, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.
‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 7. Turfgrass visual quality main treatment effects in 1992.

Contrast or Main effect	Turf Quality 9 Apr	29 Apr	25 May	16 Jun	26 Jun	9 Jul	1 Aug	24 Aug	3 Sep	6 Oct
	9 = ideal density, color, uniformity; 1 = no live turf									
Contrast at Cur. Fung.‡										
Penncross versus	7.3	8.2	7.0	7.2	7.1	6.8	6.0	6.1	6.6	7.3
Pennlinks	6.9*	7.2	7.0	7.0	7.1	6.8	6.3	6.2	6.4	7.5
SYN-1-88	7.3	6.7†	6.8	6.7*	6.9	6.9	6.1	6.7†	6.8	7.5
SYN-3-88	7.5*	6.6†	7.3†	7.5	7.7**	7.5**	6.5	6.4	6.6	6.5*
SYN-4-88	7.4	7.3	7.3†	7.1	7.5*	7.3**	5.8	6.8*	6.9	7.6
Contrast at Prev. Fung.‡										
Penncross versus	7.6	7.4	7.0	7.3	7.0	6.9	6.8	6.7	6.2	7.1
Pennlinks	7.7	8.0†	7.4†	7.8*	7.5*	7.0	6.9	6.8	6.3	7.3
SYN-1-88	7.6	7.6	7.5*	7.6†	7.5*	6.9	6.7	6.9	6.6	7.3
SYN-3-88	7.9**	7.9	8.0**	8.0**	8.0**	7.6**	7.4†	7.2†	7.0*	7.4
SYN-4-88	7.8*	7.9	7.5*	7.8**	7.7**	7.7**	7.2	7.2†	6.9*	7.4
Fungicide										
Curative	7.3	7.0	7.1	7.1	7.2	7.0	6.2	6.5	6.7	7.3
Preventative	7.7**	7.8**	7.5**	7.7**	7.6**	7.3**	7.0**	7.0**	6.6	7.3
Annual N										
171 kg ha^{-1}	7.1	7.0	6.7	7.1	7.1	7.0	6.6	6.6	6.6	7.3
342 kg ha^{-1}	7.9**	7.8**	7.9**	7.8**	7.7**	7.3**	6.6	6.9*	6.6	7.3
CV(%)	2	8	5	6	5	4	10	8	8	8
ANOVA										
Cultivar (C)	**	.15	**	*	**	**	.24	†	*	.24
Fungicide (F)	**	**	**	**	**	**	**	**	.67	.74
Nitrogen (N)	**	**	**	**	**	**	.90	*	.92	.87
C x F	.48	.25	†	†	.28	.56	.62	.78	.61	†
C x N	.50	.88	.79	.89	.64	.21	.43	*	†	.96
F x N	.66	.42	†	†	*	†	.41	.70	.96	.61

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.
‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 8. Data for turfgrass visual quality on dates where significant treatment interactions occurred in 1991 and 1992.

			Turf Quality								
			1991		1992						
Cultivar	Fung.	Annual Fertility	15 Jul	29 Aug	25 May	16 Jun	26 Jun	9 Jul	24 Aug	3 Sep	6 Oct
		kg ha^{-1}	9 = ideal density, color, uniformity; 1 = no live turf								
Penncross	Cur.	171	5.7	5.9	6.2	6.8	6.5	6.4	6.3	6.7	7.3
Penncross	Cur.	342	6.2	5.4	7.7	7.6	7.6	7.1	6.0	6.5	7.2
Penncross	Pre.	171	7.2	7.5	6.3	6.9	6.7	6.7	6.9	6.4	7.2
Penncross	Pre.	342	7.7	7.6	7.7	7.6	7.4	7.1	6.5	6.1	7.1
Pennlinks	Cur.	171	6.1	5.5	6.4	6.4	6.6	6.6	6.2	6.6	7.5
Pennlinks	Cur.	342	5.9	4.9	7.7	7.6	7.5	6.9	6.2	6.1	7.5
Pennlinks	Pre.	171	6.7	7.3	7.0	7.7	7.4	7.0	6.7	6.6	7.4
Pennlinks	Pre.	342	7.5	7.6	7.8	7.9	7.7	7.0	6.9	6.1	7.3
SYN-1-88	Cur.	171	6.1	4.2	6.0	6.3	6.3	6.5	6.4	6.5	7.4
SYN-1-88	Cur.	342	6.3	5.1	7.5	7.2	7.5	7.3	6.9	7.0	7.6
SYN-1-88	Pre.	171	6.8	6.7	7.1	7.4	7.4	7.0	6.7	6.5	7.3
SYN-1-88	Pre.	342	7.5	7.4	8.0	7.9	7.6	6.9	7.1	6.7	7.3
SYN-3-88	Cur.	171	4.5	4.6	6.6	7.3	7.4	7.5	6.5	6.8	6.3
SYN-3-88	Cur.	342	4.7	4.7	8.0	7.8	8.0	7.5	6.3	6.4	6.8
SYN-3-88	Pre.	171	7.2	7.3	7.5	7.8	7.8	7.7	6.9	6.9	7.4
SYN-3-88	Pre.	342	7.4	7.6	8.5	8.2	8.2	7.6	7.4	7.0	7.4
SYN-4-88	Cur.	171	4.6	4.8	6.7	6.7	7.2	7.1	6.3	6.6	7.6
SYN-4-88	Cur.	342	4.9	5.0	7.9	7.6	7.8	7.5	7.4	7.3	7.5
SYN-4-88	Pre.	171	7.0	7.7	6.7	7.4	7.4	7.5	6.7	6.6	7.4
SYN-4-88	Pre.	342	7.2	8.0	8.2	8.2	8.0	8.0	7.7	7.2	7.3
CV (%)			11	9	5	6	5	4	8	8	8
ANOVA											
Cultivar			**	**	**	*	**	**	†	*	.24
Fungicide (F)			**	**	**	**	**	**	**	.67	.74
Nitrogen (N)			*	.47	**	**	**	**	*	.92	.87
CxF			*	†	†	†	.28	.56	.78	.61	†
CxN			.96	.20	.79	.89	.64	.21	*	†	.96
Fx N			.43	.41	†	†	*	†	.70	.96	.61

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

Table 9. Turfgrass visual quality main treatment effects in 1993.

Contrast or Main Effect	Turf quality 27 May	23 Jun	12 Jul	5 Aug	30 Aug	24 Sept	4 Oct
	9 = ideal density, color, uniformity; 1 = no live turf						
Contrast at Cur. Fung.‡							
Penncross versus	7.5	7.5	7.4	6.2	7.0	7.4	6.9
Pennlinks	7.5	7.5	7.2	6.7*	7.3**	7.4	7.4†
SYN-1-88	7.4	7.3	7.1†	6.5	7.3*	7.3	7.4
SYN-3-88	6.4**	7.2*	7.6†	6.8*	7.2	5.7**	6.2**
SYN-4-88	7.2	7.5	7.3	6.5	7.0	7.2	7.4
Contrast at Prev. Fung.‡							
Penncross versus	7.5	7.4	7.5	7.0	7.3	7.5	7.1
Pennlinks	7.6	7.3	7.6	7.1	7.4	7.4	7.4
SYN-1-88	7.5	7.2	7.5	7.1	7.3	7.4	7.4
SYN-3-88	7.7	7.4	7.7†	7.1	7.5	7.6	7.6†
SYN-4-88	7.8	7.5	7.7	7.3	7.3	7.6	7.5
Fungicide							
Curative	7.2	7.4	7.3	6.5	7.1	7.0	7.1
Preventative	7.6**	7.4	7.6**	7.1**	7.4**	7.5**	7.4**
Annual N							
171 kg ha^{-1}	7.3	7.3	7.4	6.8	7.2	7.1	7.1
342 kg ha^{-1}	7.6*	7.4*	7.5	6.9	7.3**	7.4*	7.4**
CV(%)	8	3	3	7	3	8	7
ANOVA							
Cultivar (C)	.13	.16	**	.27	†	**	*
Fungicide (F)	**	.62	**	**	**	**	**
Nitrogen (N)	*	*	.21	.42	**	*	**
C x F	*	.36	.26	.75	.34	**	**
C x N	.66	.42	.17	.81	.44	.57	.69
F x N	.47	.62	.35	.20	*	.22	.32

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.
‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 10. Data for turfgrass visual quality on dates where significant interactions occurred in 1993.

			Turf quality‡			
Cultivar	Fung.	Annual N	27 May	30 Aug	24 Sept	4 Oct
		kg ha^{-1}				
Penncross	Cur.	171	7.4	6.8	7.1	6.7
Penncross	Cur.	342	7.5	7.1	7.7	7.2
Penncross	Pre.	171	7.5	7.3	7.4	6.9
Penncross	Pre.	342	7.6	7.2	7.6	7.3
Pennlinks	Cur.	171	7.4	7.2	7.2	7.4
Pennlinks	Cur.	342	7.6	7.4	7.6	7.5
Pennlinks	Pre.	171	7.5	7.4	7.3	7.4
Pennlinks	Pre.	342	7.6	7.3	7.6	7.5
SYN-1-88	Cur.	171	7.4	7.2	7.3	7.2
SYN-1-88	Cur.	342	7.6	7.4	7.4	7.5
SYN-1-88	Pre.	171	7.4	7.3	7.5	7.4
SYN-1-88	Pre.	342	7.6	7.4	7.4	7.5
SYN-3-88	Cur.	171	5.9	6.9	5.0	5.6
SYN-3-88	Cur.	342	6.9	7.5	6.5	6.8
SYN-3-88	Pre.	171	7.4	7.4	7.6	7.5
SYN-3-88	Pre.	342	7.9	7.5	7.6	7.6
SYN-4-88	Cur.	171	7.0	6.7	7.2	7.3
SYN-4-88	Cur.	342	7.5	7.2	7.2	7.4
SYN-4-88	Pre.	171	7.8	7.2	7.5	7.4
SYN-4-88	Pre.	342	7.9	7.4	7.7	7.6
CV(%)			8	3	8	7
ANOVA						
Cultivar (C)			.13	†	**	*
Fungicide (F)			**	**	**	**
Nitrogen (N)			*	**	*	**
CxF			*	.34	**	**
CxN			.66	.44	.57	.69
FxN			.47	*	.22	.32

**, *, † Significantly different F-test at 1, 5, and 10% levels, respectively.
‡ Turf quality: 9 = ideal density, color, uniformity; 1 = no live turf.

Table 11. Turfgrass shoot density and color main treatment effect responses in 1991.

Contrast or Main Effect	Shoot Density[§] 29 Aug	17 Sep	24 Oct	Turf Color 16 May	9 Aug	29 Aug	24 Oct
	---9 = dark green; 1 = no green turf---						
-							
Contrast at Cur. Fung.[‡]							
Penncross versus	7.9	7.7	7.6	6.5	7.7	8.2	7.8
Pennlinks	7.8	7.4*	7.4*	7.2†	7.6	8.1*	7.5*
SYN-1-88	7.7†	7.2**	7.3*	6.8	7.3**	8.0**	7.4**
SYN-3-88	8.0	7.6	7.8	7.3*	7.6	8.1†	7.6†
SYN-4-88	8.2*	7.8	7.5	7.4*	7.5*	8.2	7.5*
Contrast at Prev. Fung.[‡]							
Penncross versus	7.8	7.9	7.8	7.4	7.5	7.9	7.9
Pennlinks	7.8	7.8	7.7	7.2	7.6	7.8	7.5**
SYN-1-88	7.8	7.7	7.7	6.7†	7.5	7.7*	7.5**
SYN-3-88	8.0*	8.3**	8.0*	7.3	7.8**	7.9	7.8
SYN-4-88	8.2**	8.3**	7.9	7.5	7.8**	7.8†	7.8
Fungicide							
Curative	7.9	7.5	7.5	7.0	7.5	8.2	7.6
Preventative	7.9	8.0**	7.8**	7.2	7.7*	7.9**	7.7**
Annual N							
171 kg ha^{-1}	7.8	7.7	7.5	7.0	7.6	7.9	7.4
342 kg ha^{-1}	8.0*	7.8	7.9**	7.2	7.6	8.0**	7.9**
CV(%)	3	3	3	9	3	2	3
ANOVA							
Cultivar (C)	**	**	**	†	*	**	**
Fungicide (F)	.76	**	**	.23	*	**	**
Nitrogen (N)	*	.14	**	.19	.21	**	**
C x F	.83	.17	.69	.34	*	.95	.78
C x N	.37	.74	.88	.32	.38	.68	.94
F x N	.31	.31	.74	.30	.67	.92	.56

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.
‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.
§ Shoot Density: 9 = ideal, 1 = no live turf.

Table 12. Turfgrass shoot density main treatment effect responses in 1992.

Contrast or Main Effect	Shoot density								
	9 Apr	29 Apr	25 May	16 Jun	26 Jun	9 Jul	1 Aug	24 Aug	6 Oct
	9 = ideal, 1 = no live turf								
Contrast at Cur. Fung.‡									
Penncross versus	8.0	8.0	7.7	7.6	7.3	7.2	7.0	7.3	7.7
Pennlinks	7.9	8.1	7.8	7.5	7.5	7.2	7.0	7.3	7.9†
SYN-1-88	7.9	7.9	7.7	7.4	7.3	7.3	7.2	7.5	7.8
SYN-3-88	8.0	8.3*	8.1**	7.9†	7.9**	7.8**	7.3†	7.7**	8.2**
SYN-4-88	8.0	8.4*	8.0*	7.6	7.6**	7.7**	7.0	7.7**	8.3**
Contrast at Prev. Fung.‡									
Pencross versus	8.2	8.2	7.8	7.5	7.3	7.3	7.4	7.5	7.6
Pennlinks	8.3	8.4*	7.8	8.0**	7.6*	7.5	7.3	7.4	7.4
SYN-1-88	8.2	8.2	7.8	7.8*	7.6*	7.3	7.4	7.6	7.6
SYN-3-88	8.4*	8.5*	8.2**	8.2**	8.0**	7.8**	7.7†	7.8**	7.9*
SYN-4-88	8.4*	8.5*	8.1**	7.9**	7.9**	8.0**	7.6	7.8**	7.8
Fungicide									
Curative	8.0	8.1	7.9	7.6	7.5	7.5	7.1	7.5	8.0
Preventative	8.3**	8.4**	8.0*	7.9**	7.7**	7.6*	7.5**	7.6*	7.8**
Annual N									
171 kg ha^{-1}	7.8	7.9	7.6	7.5	7.4	7.4	7.3	7.5	7.8
342 kg ha^{-1}	8.4**	8.6**	8.2**	8.0**	7.8**	7.6**	7.3	7.6	7.9
CV (%)	2	2	3	4	3	3	4	2	3
ANOVA									
Cultivar (C)	.13	**	**	**	**	**	*	**	**
Fungicide (F)	**	**	*	**	**	*	**	*	**
Nitrogen (N)	**	**	**	**	**	**	.69	.40	.46
CxF	.34	.36	.93	.14	.45	.45	.49	.97	.35
CxN	.34	.62	.28	.74	.38	†	.23	*	.71
FxN	.41	.37	.20	.71	.17	*	.76	.89	.64

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.
‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 13. Turfgrass shoot density main treatment effect responses in 1993.

Contrast or Main Effect	Shoot density 27 May	23 Jun	12 Jul	5 Aug	30 Aug	24 Sep	4 Oct
	9 = ideal shoot density; 1 = no live turf						
Contrast at Cur. Fung.‡							
Penncross versus	7.5	7.5	7.5	6.4	7.2	7.6	7.3
Pennlinks	7.6	7.5	7.6*	6.9*	7.4	7.7	7.6**
SYN-1-88	7.5	7.4*	7.5	6.7	7.3	7.5	7.5**
SYN-3-88	7.3	7.6	7.8**	7.0**	7.6**	7.7*	7.6**
SYN-4-88	7.6	7.7†	7.7*	7.0**	7.3	7.8**	7.6**
Contrast at Prev. Fung.‡							
Penncross versus	7.5	7.4	7.6	7.0	7.4	7.6	7.4
Pennlinks	7.6	7.4	7.7*	7.2	7.4	7.6	7.5**
SYN-1-88	7.6	7.3*	7.6	7.2	7.4	7.6	7.5**
SYN-3-88	7.8	7.7**	7.9**	7.2	7.7**	7.9**	7.7**
SYN-4-88	7.9*	7.6*	7.8**	7.4*	7.6**	7.8**	7.6**
Fungicide							
Curative	7.5	7.5	7.6	6.8	7.4	7.6	7.5
Preventative	7.7*	7.5	7.7**	7.2**	7.5**	7.7†	7.5
Annual N							
171 kg ha^{-1}	7.5	7.4	7.6	6.9	7.4	7.6	7.4
342 kg ha^{-1}	7.7**	7.6**	7.8**	7.1†	7.5**	7.8**	7.6**
CV(%)	4	2	1	5	3	2	2
ANOVA							
Cultivar (C)	.22	**	**	**	**	**	**
Fungicide (F)	*	.14	**	**	**	†	.43
Nitrogen (N)	**	**	**	†	**	**	**
C x F	.23	.52	.62	.72	.28	.49	†
C x N	.28	.39	.28	.83	.38	*	*
F x N	.13	.54	.82	.48	.22	**	.19

†,*, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 14. Turfgrass shoot density on dates where significant treatment interactions occurred in 1992 and 1993.

Treatment			Shoot Density			
			1992		1993	
Cultivar	Fung.	Annual N	9 July	24 August	24 Sept	4 Oct
		kg ha^{-1}	--------9=ideal density; 1=no live turf---------			
Penncross	Cur.	171	7.0	7.4	7.4	7.1
Penncross	Cur.	342	7.4	7.3	7.8	7.5
Penncross	Pre.	171	7.2	7.6	7.6	7.3
Penncross	Pre.	342	7.5	7.4	7.7	7.5
Pennlinks	Cur.	171	7.1	7.3	7.5	7.6
Pennlinks	Cur.	342	7.4	7.3	7.8	7.6
Pennlinks	Pre.	171	7.5	7.5	7.6	7.5
Pennlinks	Pre.	342	7.5	7.4	7.7	7.6
SYN-1-88	Cur.	171	7.1	7.4	7.4	7.3
SYN-1-88	Cur.	342	7.6	7.5	7.6	7.6
SYN-1-88	Pre.	171	7.5	7.6	7.6	7.5
SYN-1-88	Pre.	342	7.2	7.6	7.5	7.6
SYN-3-88	Cur.	171	7.8	7.7	7.7	7.5
SYN-3-88	Cur.	342	7.3	7.7	7.8	7.7
SYN-3-88	Pre.	171	7.9	7.8	7.9	7.6
SYN-3-88	Pre.	342	7.8	7.8	7.9	7.7
SYN-4-88	Cur.	171	7.6	7.5	7.6	7.5
SYN-4-88	Cur.	342	7.9	7.8	7.9	7.7
SYN-4-88	Pre.	171	7.8	7.6	7.7	7.5
SYN-4-88	Pre.	342	8.2	8.0	8.0	7.7
CV (%)			3	2	2	2
ANOVA						
Cultivar (C)			**	**	**	**
Fungicide (F)			*	*	†	.43
Nitrogen (N)			**	.40	**	**
CxF			.45	.97	49	†
CxN			†	*	*	*
FxN			*	.89	**	.19

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

Table 15. Turfgrass color main treatment effect responses in 1992.

Contrast or Main Effect	Turf Color 9 Apr	25 May	1 Aug	24 Aug	3 Sep	6 Oct
	——9 = dark green; 1 = no green——					
Contrast at Cur. Fung.‡						
Penncross versus	7.7	7.7	7.4	7.5	7.4	7.5
Pennlinks	7.7	7.5	7.4	7.3	7.4	7.5
SYN-1-88	7.6	7.5	7.4	7.4	7.4	7.5
SYN-3-88	7.8	7.9*	7.5	7.4	7.4	7.6
SYN-4-88	7.9*	7.6	7.2	7.5	7.4	7.5
Contrast at Prev. Fung.‡						
Penncross versus	7.8	7.6	7.7	7.7	7.3	7.5
Pennlinks	8.0*	7.7	7.6	7.5	7.4	7.5
SYN-1-88	7.8	7.7	7.6	7.5	7.3	7.4
SYN-3-88	8.0*	7.9*	7.7	7.5	7.4	7.5
SYN-4-88	8.1*	7.8	7.6	7.6	7.4	7.5
Fungicide						
Curative	7.8	7.6	7.4	7.4	7.4	7.54
Preventative	7.9**	7.7†	7.6**	7.6**	7.3	7.47**
Annual N						
171 kg ha^{-1}	7.4	7.4	7.5	7.5	7.4	7.47
342 kg ha^{-1}	8.3**	8.0**	7.5	7.5	7.4	7.54**
CV(%)	2	3	2	2	1	1
ANOVA						
Cultivar (C)	**	**	*	**	.31	.39
Fungicide (F)	**	†	**	**	.19	**
Nitrogen (N)	**	**	.17	.15	.99	**
CxF	.72	.395	†	.68	.67	.45
CxN	.75	.80	.97	.75	.74	.96
FxN	.23	*	**	.99	.19	.27

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 16. Turfgrass color main treatment effect responses in 1993.

Contrast or Main Effect	Turf Color 27 May	5 Aug	24 Sept	4 Oct
	9 = dark green; 1 = no green			
Contrast at Cur. Fung.‡				
Penncross versus	7.6	7.4	7.6	7.4
Pennlinks	7.4	7.4	7.6	7.6**
SYN-1-88	7.5	7.4	7.5	7.4
SYN-3-88	7.8	7.5	7.6	7.5
SYN-4-88	7.7	7.5	7.6	7.5
Contrast at Prev. Fung.‡				
Penncross versus	7.7	7.5	7.6	7.5
Pennlinks	7.6	7.5	7.6	7.6*
SYN-1-88	7.7	7.5	7.6	7.5
SYN-3-88	7.9	7.5	7.7	7.6*
SYN-4-88	7.8	7.6	7.6	7.5
Fungicide				
Curative	7.6	7.4	7.6	7.5
Preventative	7.7**	7.5**	7.6	7.6**
Annual N				
171 kg ha^{-1}	7.6	7.4	7.5	7.4
342 kg ha^{-1}	7.8**	7.5**	7.7**	7.6**
CV(%)	2	1	1	1
ANOVA				
Cultivar (C)	**	**	.23	**
Fungicide (F)	**	**	.26	**
Nitrogen (N)	**	**	**	**
C x F	.87	.80	.58	.60
C x N	.88	.14	.57	.76
F x N	.66	.53	†	.24

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 17. Relative clipping yield and verdure data in 1991 to 1993.

Contrast or Main Effect	Relative Clipping Yield[§] 1991 5 Jun	1991 15 Jul	1991 21 Aug	1991 24 Sep	1992 1 Jun	1992 24 Jul	1992 19 Aug	1993 16 Jun	1993 29 Jul	1993 22 Sep	Verdure 1991 29 Aug	Verdure 1992 26 Aug
	% control										g m^{-2}	
Contrast at Low N[‡]												
Penncross versus	100	100	100	100	100	100	100	100	100	100	37.2	37.4
Pennlinks	110	135[†]	75*	87	104	89	89	111	113	84	30.3	34.9
SYN-1-88	124	43[†]*	72*	111	127[†]	109	97	111	96	87	36.7	33.0
SYN-3-88	123	132[†]	92	122	91	97	93	92	79	76[†]	32.5	42.6
SYN-4-88	117	73	71*	102	78	103	79*	110	87	63*	32.9	38.1
Contrast at High N[‡]												
Pencross versus	163	53	93	115	170	119	93	121	93	93	40.0	37.2
Pennlinks	147	59	89	114	173	93*	100	109	97	100	39.5	38.9
SYN-1-88	189	65	106	126	200[†]	108	89	133	88	115	35.6	32.1
SYN-3-88	159	60	89	147*	155	110	79[†]	116	83	81	39.2	39.9
SYN-4-88	103	84	81	115	185	105[†]	86	105	93	81	28.7	42.6
Annual N												
171 kg ha^{-1}	115	97	82	104	100	100	92	105	95	82	33.9	37.2
342 kg ha^{-1}	152	64*	92	123[†]	177**	107	89	117[†]	91	94	36.6	38.1
CV (%)	63	46	22	24	22	14	17	17	33	23	21	25
ANOVA												
Cultivar (C)	.90	.30	.43	.29	.27	.26	.46	.42	.97	.19	.51	.56
Nitrogen (N)	.23	*	.20	†	**	.20	.70	†	.69	.12	.35	.79
C x N	.92	†	.39	.98	.77	.79	.58	.78	.70	.40	.55	.96

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡ Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

§ Relative to Penncross at the low N rate.

Table 18. Dollar spot ratings in 1991 to 1993.

Contrast or Main Effect	Dollar spot 1991 16 May	1991 7 Jun	1991 15 Jul	1992 29 Apr	1992 6 Oct	1993 27 May	1993 30 Aug	1993 1 Oct
	% plot							
Contrast at Cur. Fung.‡								
Penncross versus	0.3	0.5	3.9	0.3	0	0.5	0	1.0
Pennlinks	0.2	0.5	2.2	0	0	0.3	0	0
SYN-1-88	1.8	1.9	5.5	0	0.2	0.2	0	1.6
SYN-3-88	6.5**	7.8**	23.9**	5.2**	5.2**	6.5**	4.2**	9.8**
SYN-4-88	1.8	2.4	13.9**	0.5	0.7	1.7	0	2.3
Contrast at Prev. Fung.‡								
Pencross versus	0.1	0.2	0	0	0.2	0	0	0
Pennlinks	0	0.2	0	0	0	0	0	0.4
SYN-1-88	0	1.7	0.5	0	0	0	0	0
SYN-3-88	0.7	2.9*	0.5	0	0.2	1.7	0	0
SYN-4-88	0	0.3	0.2	0	0	0	0	0
Fungicide Curative	4.3	2.7	9.8	1.2	1.2	1.8	0.8	3.0
Preventative	0.3**	1.0**	0.2**	0*	0.1*	0.3†	0**	0.1**
Annual N								
171 kg ha^{-1}	2.5	2.1	5.3	0.6	0.6	1.0	.7	1.8
342 kg ha^{-1}	2.1	1.6	4.8	0.6	0.7	1.2	.1†	1.2
CV (%)	164	117	111	99	98	303	295	217
ANOVA								
Cultivar (C)	**	**	**	*	*	*	**	**
Fungicide (F)	**	**	**	*	*	†	**	**
Nitrogen (N)	.65	.41	.75	.91	.92	.78	†	.52
CxF	**	*	**	*	*	.39	**	**
CxN	.68	.33	.99	.99	.99	.99	*	.50
FxN	.81	.99	.65	.91	.93	.78	†	.65

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 19. Brown patch infection in 1991 to 1992.

Contrast or Main Effect	Brown Patch Infection						Brown Patch AUDPC§	
	1991			1992	1993			
	15 Jul	9 Aug	17 Sep	16 Jun	31 Aug	17 Sep	1991	1992
	% plot							
Contrast at Cur. Fung.‡								
Penncross versus	17.6	22.7	32.5	22.5	11.3	8.6	734	499
Pennlinks	16.7	44.2**	56.5*	35.0	5.5†	1.6	409**	459
SYN-1-88	9.7*	51.7**	71.7**	40.0†	6.6	2.7	423**	473
SYN-3-88	9.3*	27.5	36.7	30.0	4.3*	2.0	482*	377
SYN-4-88	15.3	30.3	36.7	35.0	7.1	8.6	622	557
Contrast at Prev. Fung.‡								
Pencross versus	4.2	1.5	0.8	0	6.7	4.7	220	114
Pennlinks	7.0	7.7	4.7	0	4.7	2.3	187	179
SYN-1-88	3.5	20.5*	7.0	4.5	3.5	.8	332	350*
SYN-3-88	3.2	4.7	1.7	0	2.7	.8	151	145
SYN-4-88	6.4	1.7	0	0	3.9	2.3	225	224
Fungicide								
Curative	13.7	35.2	46.8	32.5	6.9	4.7	535	474
Preventative	4.8**	7.2**	2.8**	0.9**	4.3†	2.6	224**	202*
Annual N								
171 kg ha^{-1}	8.6	22.3	24.4	18.9	6.7	5.5	395	313
342 kg ha^{-1}	9.9	20.1	25.1	14.5	4.5	1.8*	362	363
CV (%)	77	66	71	99	109	181	57	68
ANOVA								
Cultivar (C)	.18	**	**	.59	.28	†	.24	.49
Fungicide (F)	**	**	**	**	†	.24	**	**
Nitrogen (N)	.48	.53	.87	.31	.17	*	.56	.41
CxF	.70	.66	.13	.85	.94	.76	.17	.68
CxN	.23	.29	.69	.99	.94	.26	.96	.98
FxN	.87	.97	.70	.22	†	.15	.92	.88

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

§ AUDPC = area under the disease progress curve. Higher values reflect a more rapid rate of infection by the disease.

Table 20. Curvularia infection in 1991 to 1993.

Contrast or Main Effect	Curvularia 1991 15 Jul	1993 12 Jul	1993 30 Aug	AUDPC[§] 1992
	% plot			
Contrast at Cur. Fung.[‡]				
Penncross versus	17.3	5.3	3.3	51
Pennlinks	21.5	10.6†	2.5	340**
SYN-1-88	14.6	8.8	0.3†	411**
SYN-3-88	14.7	4.7	1.5	238*
SYN-4-88	17.5	9.5	2.3	429**
Contrast at Prev. Fung.[‡]				
Penncross versus	6.1	2.8	2.3	7
Pennlinks	7.8	2.8	2.0	94
SYN-1-88	5.0	1.8	0.1	94
SYN-3-88	9.2	3.3	4.0	127
SYN-4-88	7.8	2.0	3.8	140†
Fungicide				
Curative	17.1	7.8	2.0	294
Preventative	7.1**	2.6**	2.5	80*
Annual N				
171 kg ha^{-1}	12.5	5.2	1.8	223
342 kg ha^{-1}	11.7	5.2	2.7	152†
CV(%)	70	101	139	84
ANOVA				
Cultivar (C)	.77	.67	.18	**
Fungicide (F)	**	**	.56	**
Nitrogen (N)	.73	.98	.25	†
C x F	.80	.41	.61	.24
C x N	.78	.46	*	.32
F x N	.98	.82	*	.76

†, *, ** Significant at the 0.10, 0.05, 0.01 probability levels, respectively.
‡ Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.
§AUDPC = area under the disease progress curve. Higher values reflect a more rapid rate of infection by the disease.

Table 21. Weed and insect data on bentgrasses in 1992.

Contrast or Main Effect	Cudweed 29 Apr	Sod webworm Counts 10 Oct
	-% plot-	-------m^2------
Contrast at Cur. Fung.‡		
Penncross versus	2.5	0.17
Pennlinks	2.8	0.33
SYN-1-88	5.0**	0.33
SYN-3-88	1.8	0.67
SYN-4-88	3.2	0.67
Contrast at Prev. Fung.‡		
Penncross versus	0.8	0.67
Pennlinks	0.5	3.17**
SYN-1-88	1.2	3.15**
SYN-3-88	0.3	2.50*
SYN-4-88	0.7	1.50*
Fungicide		
Curative	3.1	.43
Preventative	0.7**	2.43**
Annual N		
171 kg ha^{-1}	2.5	1.57
342 kg ha^{-1}	1.2**	1.30
CV (%)	80	91
ANOVA		
Cultivar (C)	*	†
Fungicide (F)	**	**
Nitrogen (N)	**	.43
CxF	.36	.19
CxN	.58	*
FxN	†	.84

†, *,**Significant at the 0.10, 0.05, 0.01 probability levels, respectively.

‡Contrasts are across N levels. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 22. Influence of fungicide and N-Program treatments on rooting of five bentgrass cultivars in 1991.

Contrast or Main Effect	Root Length Density				Percent Change in RLD From 12 Jul to 27 Aug	
	12 Jul		27 Aug			
	3 to 10 cm	10 to 20 cm	3 to 10 cm	10 to 20 cm	3 to 10 cm	10 to 20 cm
	$cm \cdot cm^{-3}$				%	
Contrast at Low N‡						
Penncross versus	.99	.11	.82	.03	-17	-73
Pennlinks	.63	.12	1.15	.12	+83	0
SYN-1-88	1.99*	.16	.59	.06	-70	-63
SYN-3-88	.90	.14	.69	.09	-23	-36
SYN-4-88	1.64	.13	.50	.03	-70	-77
Contrast at High N‡						
Penncross versus	4.58	.21	.58	.04	-87	-81
Pennlinks	1.30*	.17	.58	.15*	-55	-12
SYN-1-88	1.08*	.07*	.98	.07	-9	- 0
SYN-3-88	2.56*	.07*	.67	.27*	-71	+286
SYN-4-88	1.32*	.10*	.36	.06	-73	-40
Annual N						
171 kg ha^{-1}	1.23	.13	.75	.07	-39	-46
342 kg ha^{-1}	2.17**	.13	.64	.12	-71	- 7
CV (%)	34	65	75	106	-	-
ANOVA						
Cultivar	**	.76	.68	†	-	-
Nitrogen	**	.83	.55	.16	-	-
CxN	**	.27	.61	.52	-	-

†, *, **Significant at the 0.10, 0.05, and 0.01 probability levels, respectively.

‡Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †,*,** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 23. Influence of N-Program treatments on rooting of five bentgrass cultivars in 1992.

Contrast or Main Effect	Root Length Density 11 Jun 3 to 10 cm	Root Length Density 11 Jun 10 to 20 cm	Root Length Density 26 Aug 3 to 10 cm	Root Length Density 26 Aug 10 to 20 cm	Percent Change in RLD From 11 Jun to 26 Aug 3 to 10 cm	Percent Change in RLD From 11 Jun to 26 Aug 10 to 20 cm
	----cm•cm^{-3}----				----%----	
Contrast at Low N‡						
Penncross versus	2.71	.29	.73	.07	-73	-76
Pennlinks	5.33	.18	.54	.08	-90	-56
SYN-1-88	3.67	.16	.47	.06	-87	-63
SYN-3-88	4.90	.11*	.29*	.05	-94	-55
SYN-4-88	3.90	.18	.51	.07	-87	-61
Contrast at High N‡						
Penncross versus	4.26	.19	.62	.07	-79	-63
Pennlinks	4.89	.13	.97†	.06	-80	-54
SYN-1-88	3.63	.19	.47	.09	-87	-54
SYN-3-88	7.66†	.13	.45	.09	-94	-31
SYN-4-88	2.93	.14	.68	.11	-77	-21
Annual N						
171 kg ha^{-1}	4.10	.18	.51	.066	-88	-63
342 kg ha^{-1}	4.67	.16	.64	.084	-86	-47
CV (%)	53	62	42	53	-	-
ANOVA						
Cultivar	.50	.44	†	.86	-	-
Nitrogen	.17	.43	.16	.20	-	-
CxN	.65	.85	.39	.59	-	-

†, *, **Significant at the 0.10, 0.05, and 0.01 probability levels, respectively.

‡Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 24. Influence of fungicide and N-Program treatments on total root length of five bentgrass cultivars in 1991 and 1992.

Contrast or Main Effect	1991 Total Root Length 3 to 20 cm 12 Jul	1991 Total Root Length 3 to 20 cm 27 Aug	1991 Percent change in total root length 12 Jul to 27 Aug	1992 Total Root Length 3 to 20 cm 11 Jun	1992 Total Root Length 3 to 20 cm 28 Aug	1992 Percent change in total root length 11 Jun to 26 Aug
	------cm•cm^{-2}------		--------%--------	------cm•cm^{-2}------		--------%--------
Contrast at Low N‡						
Penncross versus	8.04	6.06	- 25	21.89	5.79	- 74
Pennlinks	5.54	9.26*	+ 67	39.22	4.63	- 88
SYN-1-88	15.61*	4.69	- 70	22.55	3.92	- 83
SYN-3-88	7.65	5.76	- 25	35.51	2.46	- 93
SYN-4-88	11.51	3.79*	- 67	29.10	4.29	- 85
Contrast at High N‡						
Penncross versus	34.25	4.50	- 87	31.81	5.05	- 84
Pennlinks	10.81*	5.52	- 49	35.63	7.45	- 81
SYN-1-88	8.28*	7.54*	- 9	27.30	4.21	- 85
SYN-3-88	18.67*	7.37*	- 61	55.03	4.03	- 93
SYN-4-88	10.28*	3.14	- 69	21.93	5.87	- 73
Annual N						
171 kg ha^{-1}	9.67	5.90	- 39	29.65	4.22	- 85
342 kg ha^{-1}	16.46*	5.61	- 66	34.34	5.32	- 83
CV (%)	79	87	-	126	93	-
ANOVA						
Cultivar	*	.39	-	.68	.56	-
Nitrogen	*	.82	-	.67	.34	-
CxN	**	.53	-	.93	.89	-

†, *,**Significant at the 0.10, 0.05, and 0.01 probability levels, respectively.

‡Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †,*,** for 0.10, 0.05, and 0.01 probability levels, respectively.

Table 25. Evapotranspiration in July and August 1991.

Contrast or Main Effect	Evapotranspiration§ 22 to 24 Jul 0 to 24 hr	24 to 48 hr	0 to 48 hr	28 to 30 Aug 0 to 24 hr	24 to 48 hr	0 to 48 hr
	mm					
Contrast as Low N‡						
Penncross versus	6.47	4.63	11.10	6.67	4.93	11.00
Pennlinks	8.30	5.30	13.60*	8.50†	3.70†	12.20
SYN-1-88	9.47**	4.30	13.76*	8.10	5.20	13.30
SYN-3-88	9.33*	2.97*	12.30	6.63	3.80	10.44
SYN-4-88	8.47	4.40	12.86†	6.27	6.33*	12.60
Contrast at High N‡						
Penncross versus	6.73	3.73	10.46	7.80	3.83	11.62
Pennlinks	6.67	4.97	11.64	7.60	5.97*	13.56
SYN-1-88	8.07	5.47*	13.54*	8.97	4.80	13.76†
SYN-3-88	7.23	6.07*	13.30*	7.53	4.93†	12.46
SYN-4-88	6.80	5.37*	12.16†	10.83**	3.47	14.30*
Annual N						
171 kg ha^{-1}	8.41	4.32	12.72	7.23	4.79	12.02
342 kg ha^{-1}	7.10	5.12	12.22	8.55†	4.60	13.14
CV (%)	30	34	17	26	27	19
ANOVA						
Cultivar	.57	.85	.24	.59	.85	.44
Nitrogen	.14	.19	.51	†	.68	.23
CxN	.92	.27	.81	.25	*	.94

†,*,**Significant at the 0.10, 0.05, and 0.01 probability levels, respectively.

‡Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †,*,** for 0.10, 0.05, and 0.01 probability levels, respectively.

§Readings were initiated at 8:00 hr (i.e., 0 hr) on 22 July and 28 August.

Table 26. Evapotranspiration data in 1992 and 1993.

Contrast or Main Effect	1992§ 23 to 24 Jun 0 to 24 hr	1992§ 23 to 24 Jun 0 to 30 hr	1992§ 9 to 10 Sep 0 to 24 hr	1992§ 9 to 10 Sep 0 to 30 hr	1993§ 12 to 13 Aug 0 to 24 hr	1993§ 12 to 13 Aug 0 to 30 hr	1993§ 29 to 30 Sep 0 to 24 hr	1993§ 29 to 30 Sep 0 to 30 hr
	mm							
Contrast at Low N‡								
Penncross versus	6.54	8.26	10.13	16.00	9.63	12.37	2.40	5.70
Pennlinks	9.20†	10.93	7.47†	13.13	7.20	10.80	5.03	7.27
SYN-1-88	9.53*	11.20†	10.93	14.80	7.70	10.30	12.07†	12.23
SYN-3-88	9.54*	11.60*	7.13*	13.93	8.63	11.53	7.47	16.50*
SYN-4-88	9.80*	11.67*	7.53†	12.73†	7.01	9.50	9.87	17.40*
Contrast at High N‡								
Penncross versus	7.54	10.60	7.87	15.33	10.50	15.70	10.40	15.73
Pennlinks	6.53	8.83	7.53	13.40	9.57	14.13	20.13*	22.33
SYN-1-88	11.53*	13.33†	7.20	15.50	12.87	18.87	5.47	6.33†
SYN-3-88	4.13*	5.80*	11.33*	13.93	8.77	11.00	9.80	10.43
SYN-4-88	10.00†	12.54	7.40	11.87†	9.10	11.43	17.60†	18.05
Annual N								
171 kg ha^{-1}	8.92	10.73	8.64	14.12	8.06	10.90	7.37	11.81
342 kg ha^{-1}	7.95	10.22	8.26	14.01	10.16	14.23	12.68	14.57
CV (%)	36	29	32	30	44	51	92	67
ANOVA								
Cultivar	†	†	.64	.64	.81	.77	.64	.53
Nitrogen	.29	.40	.71	.94	.17	.17	.13	.44
CxN	.15	*	.17	.99	.85	.76	.37	.17

†, *, **Significant at the 0.10, 0.05, and 0.01 probability levels, respectively.

‡Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †, *, ** for 0.10, 0.05, and 0.01 probability levels, respectively.

§Readings were initiated at 8:00 hr (i.e., 0 hr) for all time periods.

Table 27. Stimpmeter readings in 1992 rolling up a 2% slope.

Contrast or Main Effect	Stimpmeter 27 Mar	14 May
	------- m -------	
Contrast as Low N‡		
Penncross versus	2.12	1.70
Pennlinks	2.02	1.81
SYN-1-88	1.89†	1.76
SYN-3-88	1.96	1.71
SYN-4-88	2.12	1.88
Contrast at High N‡		
Penncross versus	2.02	1.63
Pennlinks	1.81†	1.72
SYN-1-88	1.74*	1.85†
SYN-3-88	1.76*	1.56
SYN-4-88	1.94	1.74
Annual N		
171 kg ha^{-1}	2.02	1.78
342 kg ha^{-1}	1.85*	1.70
CV (%)	10	12
ANOVA		
Cultivar	.18	.43
Nitrogen	.035	.31
CxN	.99	.90

†,*,**Significant at the 0.10, 0.05, and 0.01 probability levels, respectively.

‡Contrasts are in the Preventative Fungicide program. Cultivars significantly different from Penncross within a column are denoted by †,*,** for 0.10, 0.05, and 0.01 probability levels, respectively.