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Bentgrass Performance in California's Central Coast

Ali Harivandi and William Hagan[1]

ABSTRACT

It is apparent that significant advances have been made regarding bentgrass breeding in the U.S. within the past several years. Now, a golf course and/or lawn bowling manager has several improved creeping bentgrass varieties available. Under the conditions of this study, varieties 'SR1020', 'Cobra', and 'Pro/Cup' all rated high for overall quality and least *Poa annua* invasion when grown in either sand or soil. Varieties TAMU 88-1, MSCB-8, 'Putter' and 'Regent' grown in sand, and varieties 'Pennlinks', 88.CBL, 'Carmen', and 'Providence' grown in soil, and maintained as golf greens, also ranked high for overall quality and least *P. annua* invasion.

In general, *P. annua* invaded creeping bentgrass less than other bentgrass species when grown in either sand or soil and maintained as golf green or tee/fairway. *P. annua* invasion was more severe in plots maintained as golf green (mowed at 5/32 inch), grown on either sand or soil, than in plots maintained as golf tee/fairway (mowed at 5/8 inch).

Although no significant differences were observed, thatch tended to accumulate more in creeping bentgrass than in other bentgrass species when grown in soil and maintained as either golf green or tee/fairway. This trend was not observed under sand green management.

The results of this study should assist golf course superintendents and managers of lawn bowling greens and tennis and croquet courts in selecting the most suitable creeping bentgrass variety for their specific needs.

On any golf course, the demand for quality turf is greatest on putting greens, and throughout temperate and transitional zone regions of the world, the finest quality greens are seeded with varieties of creeping bentgrass *(Agrostis palustris).* Creeping bentgrass is also the choice for bowling greens and lawn tennis and croquet courts. Creeping bentgrass, and colonial bentgrass *(Agrostis tenuis)* have, at times, been used for home lawns; however, due to their low tolerance of drought, heat, and wear, as well as high susceptibility to diseases, high rate of thatch buildup, and high nitrogen requirements, none of the bentgrasses are a good choice for a home lawn.

Creeping bentgrass is native to Eurasia, while colonial bentgrass is a native of Europe. Stolons of the former develop roots and shoots at their nodes, giving rise to the nickname "creeping." Colonial bentgrass, by contrast, has minimal creeping tendencies since stolons or runners growing from the crown of the plant are reduced or absent.

Under close mowing, creeping bentgrass tends to form a fine-textured, dense, and low-growing turf, while colonial bentgrass maintained similarly, forms an upright turf. Various bentgrass varieties produce a broad range of colors, from greenish-yellow to dark green and dark blue.

In transitional zones such as the San Francisco Bay area, moderately high summer temperatures, especially when coupled with lack of moisture, is a serious threat to bentgrasses.

Bentgrasses have medium tolerance to shade and salt, and they do best in well-drained, moist, medium-textured, noncompacted soils with a pH range of 5.5 to 6.5.

Golf greens and bowling greens planted with creeping bentgrass are mostly cut to a height of less than 0.25 inch. Heavy thatch, scalping, and overall quality decline are problems related to cutting bentgrass to a height greater than 0.5 inch. In general, the lower the bentgrass is cut, the greater its need for water and nutrients.

1 Area Environmental Horticulture Advisor and Research Assistant, respectively; Cooperative Extension, San Francisco Bay Area.

Bentgrasses are susceptible to most diseases such as Phythium blight, Fusarium patch, brown patch, Helmenthosporium spp. diseases, and dollar spot. Bentgrass greens are often invaded by weeds, especially annual bluegrass (Poa annua). Some bentgrass varieties are more competitive against annual bluegrass, therefore, invasion by the annual bluegrass is minimal. In the past, 'Penncross', 'Seaside', and 'Emerald' have been the most common creeping bentgrass varieties used on golf and bowling greens in California.

Recently, several new bentgrass varieties have become available from private seed companies and the universities. Some of the new varieties exhibit enhanced agronomic characteristics compared to the old varieties. To evaluate the suitability and performance of many of the newly developed bentgrass varieties, and in cooperation with the Golf Course Superintendents Association of Northern California and the Sunnyvale Municipal Golf Course, the University of California Cooperative Extension conducted a 3-year bentgrass variety evaluation at Sunnyvale Municipal Golf Course. This location was one of 16 locations in the U.S. for the National Turfgrass Evaluation Program under the auspices of the United States Department of Agriculture.

Preparation of the site at the Sunnyvale Golf Course began in 1989. Two of the three sites were prepared by mixing 2 inches of organic matter into 6 inches of native soil with a rototiller. One of these sites was managed as a golf tee/fairway and the other site was managed as a golf green. The third site was prepared by replacing the native soil with one foot of pure sand. The sand was low in calcium and phosphorus. This was corrected by adding the appropriate amounts of gypsum and single superphosphate. The sand-base site was also managed as a golf green.

Table 1. Average Monthly Air and Soil Temperatures in Santa Clara, CA (1991-1993).

Month	Air Temperature °F			Soil Temperature °F		
	Average Max.	Average Min.	Mean	Max.	Min.	Mean
Jan.	56.9	40.3	46.6	51.0	42.7	46.8
Feb.	62.4	45.6	54.0	55.0	47.3	51.2
March	80.4	44.3	52.3	59.0	51.3	55.2
April	68.4	45.9	57.2	63.0	56.3	59.7
May	73.6	51.3	62.5	68.0	61.7	64.8
June	77.2	53.6	65.4	70.7	65.0	67.8
July	80.6	56.4	68.5	73.3	69.3	71.3
Aug.	80.6	58.8	68.7	73.6	69.0	71.3
Sept.	79.0	52.3	65.6	71.6	67.7	69.7
Oct.	76.6	51.2	63.9	69.3	61.7	66.5
Nov.	64.3	40.4	52.4	62.3	50.7	56.6
Dec.	54.8	36.9	45.9	53.3	40.0	49.7

+ Soil temperature measured 4 inches below surface. Maximums are highest and lowest for the months.

Table 2. Mean Turfgrass Quality and Other Ratings of Bentgrass Varieties in National Bentgrass (Greens-Sand) Test in Sunnyvale, CA (1991-1993).*

NAME	Quality	%POA	Thatch (inches)	Color	Leaf Texture	Density
Cobra	6.3	11.8	1.37	7.0	6.0	6.7
SRIO20	6.1	10.7	1.24	7.3	7.0	6.6
TAMU 88-1	6.0	12.0	1.40	7.3	6.0	6.7
MSCB8	5.9	20.2	1.19	6.7	6.3	7.0
Pro/Cup	5.9	27.1	1.29	1.3	6.3	6.1
Putter	5.9	11.1	1.22	7.0	6.3	6.9
Regent	5.9	15.7	1.26	7.1	5.7	6.8
Penncross	5.7	14.9	1.36	7.0	6.0	6.7
Pennlinks	5.7	16.0	1.21	6.7	6.7	6.7
Lopez	5.5	21.0	1.12	6.3	6.7	6.7
Carmen	5.4	22.8	1.18	6.3	6.3	6.8
Emerald	5.4	20.8	1.32	5.7	5.7	6.4
88.CBE	5.2	34.7	1.37	6.7	6.3	6.6
Biska	5.2	37.1	1.46	6.7	6.3	6.7
Egmont	5.1	26.8	1.05	4.7	8.0	6.5
National	4.9	42.8	1.12	5.3	5.3	6.4
Tracenta	4.4	46.2	1.23	4.3	5.7	5.7
Bardot	4.3	42.1	1.23	3.3	7.3	5.9
Allure	4.2	48.6	1.15	4.7	6.3	5.6
BR 1518	4.0	53.3	1.10	5.0	6.3	5.3
LSD Value (0.005)**	0.5	16.3	NS	1.7	1.2	0.7

* The values are averages of monthly and quarterly ratings from 1991 through 1993. The rating scales are: Quality (turfscore): 1-9; 9=ideal turf. % Poa: % Poa annua invasion. Thatch: thatch accumulation at the end of the study (inches). Color: 1-9; 9=darkest color. Leaf texture: 1-9; 9=finest leaf texture (most narrow). Density: 1-9; 9=densest stand of turf in various seasons.

** LSD Value: To determine statistical differences among varieties, subtract one variety's mean from another variety's mean. Statistical differences occur when the value is larger than the corresponding LSD value. If the difference between the mean value for two varieties within the same columns not greater than the corresponding LSD, then the two varieties are statistically the same for that specific quality component.

NS No significant difference.

Varieties were planted (l/2 lb/l,000 ft^2) in March 1990, in a randomized, complete-block design, in 10ft x 10-ft plots with three replications. Fertilization, irrigation, aeration, and sand topdressing were done as needed, similar to what was practiced on other greens at the golf course. The tee site on the soil was mowed at 5/8 inch 2 days a week. Greens were mowed at 5/32 inch 3 days a week. Several fungicide applications were made on all plots during the trial period to prevent disease infestation. Twenty varieties were entered in each replication for each soil. Three of the varieties were colonial bentgrass ('Bardot', 'Allure', and 'Tracenta'), one dryland bentgrass (*Agrostis castellana)* (BR 1518), one browntop bentgrass *(Agrostis cappillaris)* ('Egmont'), and the rest were creeping bentgrasses. Not all of the same varieties were used on each of the soils. The trial was completed in December 1993 after 3 years of evaluations. Table 1 summarizes air and soil temperatures during the trial period (1991-93), measured at

U.C. Santa Clara Research and Extension Center, a few miles from the trial site.

Starting in January 1991, various data were taken on each plot. Overall quality on a scale of 1 to 9 (9 best) was taken on a monthly basis. Color ratings were taken one time per year during October or November when the least amount of environmental stress was present and the full genetic potential for any given variety could be expressed. The first color rating was taken when the plantings were more than 1 year old in order to eliminate false color expression of juvenile plants. Noncompressed thatch thickness was measured one time per year during July or August. The zone between the original seedbed and just beneath the green tissue was measured as thatch, which also included the topdressing sand. Annual bluegrass invasion visual estimates (percent present in each plot) were taken on a quarterly basis. The accompanying tables (2-4) summarize the final results of these evaluations.

DISCUSSION

Green (sand-based): Data for parameters measured are given in Table 2. Variety 'Cobra' received the highest quality rating (6.3) and the third lowest percent *P. anma* invasion (11.8 %) over the 3-year period for the 20 varieties grown in sand. However, the quality rating for 'Cobra' was statistically similar to the ratings for 'SR1020' (6.1), TAMU 88-1 (6.0), MSCB-8 (5.9), 'Pro/Cup' (5.9), 'Putter' (5.9), and 'Regent' (5.9). Among the above varieties with low percent *P. annua* invasion, were 'SR1020' (10.7%), TAMU 88-l (12.0%), and 'Putter' (11.1%). For significant difference in percent *P. anma* invasion, a LSD (least significant difference) of 16.3 was required. Therefore, the top 12 varieties in Table 2 are not different in their competitiveness :against *P. annua*. The colonial, browntop, and dryland species, along with the creeping varieties 'Biska', 'National', and 88.CBE had the least desirable quality and the most *P. annua* invasion. These varieties also received low ratings for the other components that contribute to overall quality (i.e., genetic color, leaf texture, and density). Thatch accumulation was statistically similar for all varieties and varied from 1.1 to 1.4 inches. However, the trend is for more thatch development in creeping species than other species.

Table 3. Mean Turfgrass Quality Ratings of Bentgrass Varieties in National Bentgrass (Greens-Native Soil) Test in Sunnyvale, CA (1991-1993).*

Name	Quality	% POA	Thatch (inches)	Color	Leaf Texture	Density
SR1020	6.8	10.2	1.47	6.7	7.3	1.2
Pennlinks	6.1	18.2	1.50	6.1	6.7	6.8
88.CBL	6.6	16.0	1.46	1.7	7.0	6.9
Pro/Cup	6.4	17.9	1.53	1.3	7.0	7.1
Carmen	6.3	18.9	1.44	6.1	7.0	6.9
Cobra	6.2	16.9	1.29	6.7	6.7	6.8
Providence	6.2	15.7	1.38	7.0	7.0	7.1
88.CBE	6.0	21.7	1.44	6.7	6.7	6.8
Lopez	6.0	21.1	1.50	7.0	6.7	6.8
Putter	6.0	16.8	1.46	6.0	6.1	6.8
Regent	6.0	18.6	1.44	6.3	7.0	6.1
Penncross	5.7	30.8	1.39	6.0	6.3	6.1
Emerald	5.2	38.8	1.55	5.0	6.0	6.2
National	4.9	41.6	1.35	6.3	6.0	6.1
Egmont	4.1	44.7	1.37	4.3	7.7	6.2
Bardot	4.6	58.2	1.35	5.3	7.0	5.9
Allure	4.2	56.8	1.25	5.7	6.3	5.9
Seaside	4.2	59.2	1.31	6.0	7.0	5.5
Tracenta	4.0	63.1	1.30	5.1	6.3	5.7
BR 1518	3.6	70.5	0.83	5.7	6.3	5.3
LSD Value (0.005)**	0.5	20.1	NS	1.6	1.1	0.7

* The values are averages of monthly and quarterly ratings from 1991 through 1993. For rating scales, see legend in Table 2.
** LSD Value: see legend in Table 2.
NS No significant difference.

Table 4. Mean Turfgrass Quality and Other Ratings of Bentgrass Varieties in National Bentgrass (Tee-Fairway) Test in Sunnyvale, CA (1991-1993).

Name	Quality	% POA	Thatch (inches)	Color	Leaf Texture	Density
Putter	7.1	9.3	1.35	1.7	7.0	7.2
Cobra	6.7	13.1	1.37	7.3	6.7	7.0
Regent	6.7	11.6	1.37	7.7	1.0	7.1
Penncross	6.6	11.3	1.33	8.0	6.3	6.7
Penneagle	6.6	7.1	1.27	7.3	7.3	6.8
TAMU 88-l	6.5	12.6	1.11	8.0	7.0	6.1
Providence	6.4	13.3	1.17	7.0	6.3	6.7
Carmen	6.3	18.7	1.26	7.0	7.0	6.8
Pro/Cup	6.3	21.1	1.21	7.0	6.0	6.9
88.CBL	6.2	21.2	1.13	7.0	6.7	6.9
Lopez	6.2	18.2	1.23	7.3	6.7	6.8
SR1020	6.2	19.1	1.08	7.0	7.0	6.7
National	5.8	22.4	1.06	7.0	6.0	6.2
Emerald	5.6	23.1	1.12	7.0	7.0	6.7
Egmont	5.4	20.7	0.87	5.3	6.0	5.8
Allure	5.2	19.9	1.05	6.0	6.0	6.6
Seaside	5.1	28.3	1.00	6.7	5.3	5.9
Bardot	5.0	22.9	0.81	5.0	8.0	5.6
Tracenta	4.7	22.1	0.81	5.3	7.0	5.4
BR 1518	4.1	26.8	0.70	6.0	5.3	5.1
LSD Value (0.005)**	0.4	NS	NS	0.9	1.2	0.9

• The values are averages of monthly and quarterly ratings from 1991 through 1993. For rating scales, see legend in Table 2.
** LSD Value: see legend in Table 2.
NS No significant difference.

Green (soil-based): Data for parameters measured are given in Table 3. Variety 'SR 1020' received the highest quality rating (6.8) and had the least amount of *P. annua* invasion (10.2%) over the 3-year period for the 20 varieties grown in amended soil. However, the quality rating for 'SR 1020' was statistically similar to ratings for 'Pennlinks' (6.7), 88.CBL (6.6), Pro/Cup (6.4), and Carmen (6.3). A rating of 6.0 or above is generally considered acceptable. Therefore, 'Cobra' *(6.2),* 88.CBE (6.0), 'Lopez' (6.0), 'Putter' (6.0), and 'Regent' (6.0) all had acceptable quality. The aforementioned varieties, all creeping bentgrasses, were statistically similar for *P*. annua invasions with a low of 10.2% and a high of 27.7%. The colonial, browntop, and dryland species along with the creeping species 'Emerald', 'Seaside', 'National', and 'Penncross', have the least desirable quality and the most *P*. annua invasion. These varieties also received low ratings for the other components that contribute to overall quality (i.e., genetic color, leaf texture, and density). Thatch accumulation was statistically similar for all varieties and varied from 0.83 to 1.53 inches. However, the trend is for more thatch development in creeping species than the other species.

Tee/Fairway (soil-based): Data for parameters measured are given in Table 4. 'Putter' received the highest quality rating (7.1) and the second lowest *P. annua* invasion (9.3 %) for the 3-year period of the 20 varieties grown in amended soil. However, the quality rating for 'Putter' was statistically similar to the ratings for 'Cobra' (6.7) and 'Regent' (6.7). A rating of 6.0 or above is generally considered acceptable. Therefore, 'Penncross' *(6.6),* 'Penneagle' (6.6), TAMU 88-1 (6.5), 'Providence' (6.4), 'Carmen' *(6.3),* 'Pro/Cup' (6.3), 88.CBL (6.2), 'Lopez' (6.2), and 'SR1020' (6.2) all had acceptable quality. Varieties in this trial did not differ statistically for percent *P. annua* invasion; however, creeping species generally had lower *P*. annua invasion than the other species. The colonial, browntop, and dryland species along with creeping varieties 'Emerald', 'National', and 'Seaside' had the least desirable quality. These varieties also received low ratings for the other components that contribute to overall quality (i.e., genetic color, leaf texture, and density). Thatch accumulation was statistically similar for all varieties and varied from 0.7 to 1.37 inches. However, the trend is for more thatch development in creeping species than the other species.

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Leaf Firing and Greenup of 46 Tall Fescue Genotypes

V. A. Gibeault, Robert L. Green, S. T. Cockerham, and R. Autio

Tall Fescue *(Festuca arundinaceae)* is widely used in California for general and certain speciality turf sites. It is a well-adapted, cool season turfgrass with the newer cultivars having good color, texture, and density characteristics. Tall fescue is well recognized to have the best drought resistance, because of a deep root system, of any cool season turfgrass grown in California; it is also known to have among the highest water-use rates of the cool season grasses. What is not known is the variation within the species for leaf firing resistance (LFR), which is the ability of a plant to maintain green color during dry periods with minimal supplemental irrigation. Therefore, it was the objective of this study to evaluate the LFR of a large number of tall fescue genotypes when subjected to drought conditions.

The study site was on the Turfgrass Research Facility at the University of California at Riverside. A 6-year-old, tall fescue variety trial was subjected to drought conditions from September 7, 1993 through November 1, 1993. Prior to the initiation of drought, the turf had been mowed weekly at 2 inches, fertilized with 0.5 lb N per 1,000 sq ft in January, February, April, May, July, September, October, and November; and irrigated to prevent wilt based on 80% ET from an on-site California Irrigation Management Information System (CIMIS) station. Following cessation of irrigation, mowing was continued during the drought study. The turf remained without water until November 1, 1993, when irrigation was resumed in order to measure greenup. Greenup was observed for 17 days following the reinitiation of irrigation.

The 46 genotypes were arranged in a randomized, complete block with three replications. The turf was rated visually with 0 representing no leaf firing and 100 representing total leaf firing. The results of leaf firing through 56 days of drought are presented in Table 1 and the leaf firing following 17 days of rewetting in Table 2. Background environmental conditions at the test site are given in Table 3.

Table 1. Percent Leaf Firing of 46 Tall Fescue Genotypes Subject to 56 Days Drouaht Under Field Conditions.1

GENOTYPE	Days after drought began 10	19	26	39	45	56
Tribute	4.0	13.3	23.3	43.3	68.3	88.3
Fatima	6.7	15.0	15.0	48.3	15.0	90.0
Wrangler	6.3	10.0	13.3	46.1	68.3	90.0
Bel 86-2	4.7	12.7	23.3	48.3	70.0	91.3
Trident	5.3	18.3	25.0	50.0	78.3	93.0
PST-DCB	5.3	10.7	la.3	41.7	71.7	93.0
Pick 845 PN	4.3	14.0	20.0	63.3	83.3	93.3
Pick SLD	6.0	16.7	16.7	46.7	80.0	93.3
506	4.1	16.7	20.0	68.3	76.7	93.3
Pick TF9	5.1	13.3	23.3	61.7	86.7	94.3
Normare 25	6.0	11.7	20.0	50.0	16.1	94.7
Maverick II	3.1	11.7	11.7	51.7	80.0	94.1
Cihnmaron	6.3	13.3	21.7	70.0	90.0	94.1
Trailblazer	6.0	23.3	25.0	65.0	73.3	94.1
Apache	5.0	15.0	21.7	56.1	71.1	94.7
Normarc 99	6.0	12.0	31.7	63.3	80.0	94.1
Winchester	6.3	25.0	30.0	80.0	85.0	94.1
Rebel	7.0	16.7	16.7	56.1	83.3	94.7
Pick 151	6.0	16.7	21.7	51.7	78.3	94.1
Normarc 71	5.3	14.0	18.3	46.7	56.1	95.0
Wilhtmettc	6.3	23.3	35.0	65.0	18.3	95.0
Murietta	4.3	16.1	16.7	50.0	61.7	95.0
Olympic	1.3	20.0	25.0	66.1	16.1	95.0
Monarch	5.0	11.7	25.0	56.7	83.3	95.1
Twilight	6.0	40.0	40.0	75.0	83.3	96.0
Eldorado	4.3	14.0	21.7	55.0	75.0	96.0
BAR Fa 7851	4.3	9.0	26.7	48.7	71.7	9.3
Titan	5.3	18.3	25.0	50.0	83.3	9.3
Shortstop	5.7	16.0	40.0	68.3	88.3	9.3
Shenandoah E	6.7	13.3	28.3	56.7	18.3	96.3
Hubbard 87	5.0	15.0	23.3	55.0	81.7	96.3
Sundance	5.0	15.0	18.3	48.3	15.0	96.3
Anthem	5.0	11.7	23.3	58.3	76.1	96.3
Chicftao	4.0	15.0	26.1	48.3	16.7	96.3
PST-S AG	1.3	28.3	26.1	63.3	70.0	9.3
PST-5 DM	4.3	16.7	21.7	55.0	11.1	96.3
Richmond	7.3	18.3	21.7	58.3	75.0	96.3
517	5.0	10.7	31.7	58.3	78.3	96.3
Taurus	3.1	13.3	18.3	60.0	90.0	97.1
Aztec	4.3	15.0	23.3	56.7	83.3	97.1
Thoroughbred	6.0	13.3	23.3	58.3	83.3	97.1
Pick DM	5.0	16.0	25.0	60.0	86.1	97.1
Carefree	5.3	28.3	40.0	58.3	88.3	97.7
Tip	8.1	20.0	23.3	71.7	83.3	97.1
5 MI + endophyte	4.1	15.0	20.0	56.1	78.3	97.1
LSD p = 0.05	3.0	10.3	14.7	23.4	20.2	5.9

I Scale=0 to 100, with O=no leaf firing; lOO=total leaf firing.

Table 2. Percent Leaf Firing of 46 Tall Fescue Genotypes Subject to 56 Days Drought Followed by Rcwcttina for 17 Days.'

GENOTYPE	Days after rewetting 6	13	17
Wrangler	71 .7	48.3	21.1
Bel 86-2	75.0	56.1	22.3
Nomarc 77	16.7	53.3	23.3
Tribute	13.3	53.3	25.0
Sundance	83.3	66.1	26.1
Fattima	16.7	56.7	26.1
Maverick II	85.0	68.3	30.0
Chieftan	80.0	65.0	31.7
Murrieta	83.3	63.3	31.7
Apache	83.3	66.7	31.7
Emperor	at.7	66.1	31.7
Adventure	85.0	68.3	33.3
Shenandoah	81.7	65.0	33.3
Olympic	83.3	70.0	33.3
Monarch	85.0	70.0	33.3
Arriba	83.3	68.3	33.3
Rebel II	83.3	66.7	33.3
Pick 15 I	85.0	71.1	33.3
Pick 845 PN	83.3	70.0	35.0
Taurus	86.1	13.3	35.0
Trailblazer	85.0	71.7	35.0
Normarc 99	86.7	11.1	35.0
Richmond	83.3	68.3	35.0
Hubbard 87	90.0	16.7	36.7
Ciiion	88.3	13.3	36.7
Eldorado	83.3	63.3	36.1
Tip	88.3	63.3	36.7
5 MI + cndophyte	86.1	13.3	36.1
Normarc 25	85.0	13.3	36.1
Anthem	86.1	73.3	38.3
Crossfire	85.6	71.7	38.3
PST 5 AG	83.3	71.7	38.3
517	85.0	13.3	38.3
Trident	83.3	68.3	40.0
Shortstop	88.3	68.3	40.0
Tradition	90.0	18.3	40.0
Avanti	88.3	76.7	40.0
Carefree	90.0	80.0	40.0
man	91 .7	81.1	41.7
Aztec	88.3	16.1	41.7
Williamcttc	88.3	75.0	41 .7
506	88.3	80.0	43.3
Twilight	93.3	85.0	45.0
Thoroughbred	83.3	10.0	45.0
Winchester	90.0	83.3	45.0
PST-SHF	90.0	80.0	47.5
LSD P = 0.05	11.8	20.8	15.0

t Scale =0 to 100, with O=no leaf firing; lOO=total leaf firing.

Table 3. Environmental Conditions During the 1993 Leaf-Firing Evaluation at UCR Turfgrass Research Project, Riverside, California.

Date	Accumulative Weekly ETO (in/wk)	Avenge daily air temperature ('F)	Average' daily soil temperature ('F)
9/5 -9/1 1	1.52	78.8	15.2
6/12 - 9/18	0.96	66.2	71.6
9/19 - 9/25	1.01	68.0	69.8
9/26 - 10/2	1.34	78.8	69.8
10/3 - 10/9	0.69	66.2	69.8
10/10 - 10/+16	0.59	66.2	69.8
10/17 - 10/23	0.89	66.2	66.2
10/24 - 10/30	1.12	68.0	62.6
10131 - 11/6	0.93	66.2	60.8
11/7 - 11/13	0.47	57.2	60.8
11114 - 11/20	0.79	57.2	57.2
11/21 - 11/27	0.66	57.2	55.4

1 Soil temperature at 4-inch depth.

It was found that 'Tribute', 'Fatima', 'Wrangler', Bel 86-2, 'Trident', and PST-DBC were the most resistant to leaf firing. 'Normac 77', BAR Fa 781, 'Sundance', and 'Chieftan' were fairly resistant through 39 days of drought. 'Wrangler', Be1 86-2, 'Normac 77', 'Sundance', and 'Fatima' had the quickest recovery, with 'Marverick II', 'Chiefian', 'Murrieta', 'Apache', and 'Emperor' also having good recovery rates. All genotypes had exhibited better than 50% recovery after 17 days when the study was terminated.

In general, turfgrasses differ in their water-use rates, drought resistance characteristics, and leaf-firing resistance. Grasses that have a high degree of leaf firing resistance could provide an irrigation management advantage by staying green longer following the curtailment of supplemental irrigation for water conservation purposes or during drought periods. This study has shown that genotypes of tall fescue do differ in their leaf firing resistance.

UC TURF CORNER

UC Turf Corner contains summaries of recently reported research results, abstracts of certain conference presentations and announcements of new turf management publications.

Role of Horticulture in Human Well-Being

A symposium was held in April 1990 in Arlington, Virginia, for the horticulture community to join with psychologists and sociologists to gain a view of the role played by ornamental horticultural plants to people. The symposium focused on objective studies, whenever possible, that examined people and plant interactions; the presentations were organized into a recently released text, *The Role of Horticulture in Human Well-Being and Social Development*. In introductory comments, Diane Relf, Editor-in-Chief, indicated that it is "only by going beyond questions of commercial crop production and the search for basic scientific knowledge on plant growth can we fulfill our mandate in today's society. Dr. Relf noted that already, some horticulturists are becoming team members with researchers and educators in the areas of human physical, psychological, and social well-being; these activities are seeking answers to the stresses of modern life. People-plant or human issues research will result, it is anticipated, in a better understanding of the needs of plants by people in schools, homes, communities, etc., for their physical and mental well-being.

(See: *The Role of Horticulture in Human Well-Being and Social Development* (Diane Relf, ed.). 1992. Timber Press: Portland, Oregon, 254 pp.) (VAG 2-28-94).

People-Plant Interaction

A study of people's attitudes toward gardening and surrounding plants was recently reported following survey questions to hundreds of study participants. It was found that a very large percentage (88%) of the participants, corresponding to 81.4 million households, felt that trees and flowers were important beyond their beauty. A third of the sample population agreed that one of the most satisfying aspects of gardening is the peace and tranquility that it brings. Half of the gardeners reported this perception while only a fifth of nongardeners held this view. Also, half of the respondents indicated that plants add to the enjoyment gained from theme parks, historic sites, golf courses, and restaurants which, the authors note, aids in the justification of plant investment and culture at such tourist sites. A third of the sample felt that the presence of man-made landscapes offset the loss of nearby natural areas to development, pointing out that although landscapes are valued, the need for natural areas is held in very high esteem. Previous work had shown that viewing plants was of value in reducing stress and increasing the self-reported feelings of calm and relaxation. This study found that 40% of the sample population also held this perception, including one-third of the nongardeners.

This article is one of several in this HortTechnology issue that address the importance of plants in people's surroundings, whether the importance is commonly recognized or not.

(See: Relf, D., A. R. McDaniel, and B. Butterfield. 1992. Attitudes toward plants and gardening. HortTechnology 2:201-204) (VAG 2-25-94).

Sting Nematode in California

J. Ole Becker [1]

For several years, patches of poor growth of bermudagrass (*Cynodon* ssp.) were observed on several Coachella Valley golf courses. The first indications of disease problems normally appeared in April. Plant growth was stunted and exhibited symptoms usually associated with drought stress and nutritional deficiency. However, the bermudagrass did not respond to an increase of watering and fertilization. At this stage, it was easy to pull the grass off the ground. In the following weeks, larger areas of grass turned brown and died. Certain weeds such as spotted spurge *(Euphorbia maculata)* took advantage of the reduced competition by the declining bermudagrass. This pattern of succession was particularly obvious on those golf courses where herbicides were either not or rarely used.

In 1992, sod samples were taken from areas of declining bermudagrass and processed for nematode extraction by members of the Nematology Department at UC Riverside. A rather large-bodied plant parasitic nematode was detected and identified as *Belonolaimus longicaudatus*, the sting nematode. This ell-like roundworm is an important pest in turf and on most agricultural and horticultural crops. Its main geographical distribution is in the southeastern part of the U.S. Like all plant parasitic nematodes, *B. longicaudatus* feeds by puncturing plant cells with a mouth sylet and withdrawing cell contents. It does not enter the roots, but attacks from the outside, mainly near the root tip. These wounds are often points of entry for bacteria and fungi which otherwise would not be able to enter plant tissues. These secondary infections increase plant stress and can accelerate cell and root death. Sting nematode problems are limited to soils of more than 80% sand content, soil temperatures between 70 and 9O F, and constant moisture levels.

The detection of an A-rated pest such as the sting nematode in a sample legally requires the lab and its client to inform the California Department of Food and Agriculture (CDFA) and the local County Agricultural Agency. Subsequent surveys by the CDFA revealed the presence of this nematode in at least eight golf courses in the Coachella Valley. In addition, *B. longicaudatus* has been found in several home lawns adjacent to one of the golf courses.

To limit the spread of this pest into other turfgrass and agriculturally utilized areas, the movement of sting nematode-infested plants and soil has to be restricted. Humans are, by far, the most important vectors by spreading them with soil, plants or plant products, soiled tools, or vehicle tires. Golf courses where sting nematodes were detected have been subjected to quarantine conditions. However, realistically, we have to expect that through ignorance and negligence, the sting nematode will eventually be spread to noninfested areas. Fenamiphos and ethoprop are currently labeled for nematode control on turfgrass in California. Although effective in suppressing sting nematode populations, the relief is only temporary and may be utilized best at the beginning of the growing season to support the establishment of new grass roots.

Other New Books

There have been two turfgrass texts recently released that will be excellent references in their subject area. *Management of Turfgrass Diseases* by J.M. Vargas contains information aimed at the turfgrass undergraduate student and those interested in landscape maintenance, lawn care operations, and golf

1 Extension Nematologist, UC Riverside.

course culture. Although emphasizing diseases, Dr. Vargas presents cultural and biological programs to minimize disease occurrence and activity. In that regard, he presents chapters discussing issues such as "Using Disease Resistance in Turfgrass Management," and "Cultural Aspects of Turfgrass Disease Management," as examples. The book is published by Lewis Publishers.

Was&water Reuse for Golf Course Irrigation was sponsored by the United States Golf Association and also published by Lewis Publishers. The book is based on a symposium that was held on the subject with each participant preparing a section for this text. The topics are arranged into five chapters as follows: Why Use Effluent?; Regulations, Ordinances and Legal Liabilities; Wastewater Quality, Treatment and Delivery Systems; Effects of Wastewater on the Turfgrass/Soil Environment; and Feasibility of Using Wastewater on Golf Courses. It is the most recent, up-to-date reference on this alternative source of irrigation water. (VAG 12/94).

WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, away from food or feeds and out of the reach of children, unauthorized persons, pets and livestock.

Recommendations are based on the best information currently available, and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. THE GROWER IS LEGALLY RESPONSIBLE for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

Consult your County Agricultural Commissioner for correct methods of disposing of leftover spray material and empty containers. Never **burn pesticide containers.**

PHYTOTOXICITY: Certain chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts of the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents and solvents, can cause plant injury. Since formulations are often changed by mauufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

NOTE: Progress reports give experimental data that should not be considered as recommendations for use. Until the products and the uses given appear on a registered pesticide label or other legal, supplementary direction for use, it is illegal to use the chemicals as described.

Correspondence concerning *California Turfgrass Culture* should be sent to:

Victor A. Gibeault
Batchelor Hall Extension
University of California
Riverside, CA 92521-0124