COMPARATIVE GROWTH AND MORPHOLOGY RESPONSES OF EIGHT BENTGRASS GENOTYPES FOLLOWING EXTRAORDINARY HEAT STRESS

by
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Creeping bentgrass (*Agrostis stolonifera* var. *stolonifera*) provides a premier surface for putting and bowling greens. The increased usage of creeping bentgrass outside the cool-season turfgrass adaptation range has created a demand for cultivars with more heat-stress resistance for use in these less than optimum temperature-humidity zones. A number of new cultivars have been released, in the past few years, or are near-release, . Unfortunately, there are few field research facilities that adequately assess these cool-season turfgrasses for adaptation to warm-humid climates when maintained as modern, closely- mowed, fast putting green turfs.

There is a continuing need to conduct comparative field assessments of the shoot and root morphological characteristics of existing genotypes with those of recently-released, near-release, and experimental genotypes in order to determine if there are improvements or reductions in any of the assessed botanical parameters. Too often the developer of a cultivar makes general statements about the morphological characteristics, but published data documenting these responses are not available.

The purpose of this study was to conduct comparative morphological assessments of (a) 5 two-year-old bentgrass genotypes on the greens of the Golf School at the Pinehurst Resort and Country Club (PRC), Pinehurst, N.C. and (b) 4 two-year-old bentgrass genotypes in the test area at The Country Club of North Carolina (CCNC), Pinehurst, N.C. after an extended summer period of severe heat stress.

MATERIALS AND METHODS

Seeding or sodding dates, traffic intensity, mower height setting, and root zone composition data were obtained from the golf course superintendents.

Nine comparative morphological assessments were conducted from 19 to 21 October 1995. Each assessment was conducted with four replications.

- Visual turfgrass quality estimates were based on a composite of two main components: (a) uniformity of appearance and (b) shoot density. The rating scale used was 9 = best and 1 = poorest. A rating of 5.5 or above represented acceptable turfgrass quality for putting greens.
- Color determinations were made using The Royal Horticultural Society (RHS) Colour Charts.
- Shoot density counts were made from 1.3 square inch turfed plugs. Each plug was washed and the shoots separated for counting.
- Shoot height, thatch depth, and mat depth, as well as the length of the longest intact root, were measured with a metric rule.
- The shoot\thatch\mat biomass was harvested, washed, dried for 24 hours at 105C, and then weighed.
- Profile root biomass distribution was determined by washing the root biomass, separating into 2 inch (50 mm) segments, drying at 105C for 24 hours, and then weighing. The total root biomass was the weight of all roots from each plug.

Statistical data from this study were analyzed using the LSD t Test at the 5 % level.

RESULTS AND DISCUSSION

Assessments at 3 mm Cutting Height

Comparative assessment data for the bentgrass cultivars maintained at a 3 mm height of cut are presented in Table 1 for color and turfgrass visual quality, in Table 2 for shoot parameters, and in Table 3 for root assessments. The 3 mm mowing height is typical of the heights used on high quality, creeping bentgrass putting greens to obtain the desired ball speed. Unfortunately, these heights also impose a very severe stress on the turfgrass, especially during the hot-humid stress period, when bentgrass growth is minimal.

Visual Turfgrass Quality: The lowest quality of 4.5 occurred with Cato and Pennlinks which were not uniform in appearance or density. The other turf that rated below acceptable was Crenshaw. All other cultivars were acceptable or higher.

Table 1. Comparative genotype assessments of color and turfgrass quality after an extraordinarily hot humid summer.

Assessment location	Bentgrass genotype	RHS Color	Visual turfgrass quality*
Pinehurst Resort and C.C. (3 mm)	Penn G-2	yellow-green	5.9
	Penn A-1	yellow-green	5.8
	Crenshaw	yellow-green	5.3
	Pennlinks	yellow-green	4.5
	Cato	green	4.5
The Country Club of North Carolina (6 mm)	Putter	light-green	6.6
	SR1020	green	6.0
	Providence	green	6.0
	Cato	green	5.5

*Visual turfgrass quality with 9-best possible and 1-poorest.

Shoot Density. The shoot density ranged from a high of 2,888 for Penn G-2 to a low of 738 for Cato. A high shoot density also was found for Penn A-1.

Table 2. Comparative assessments of shoot height, mat depth, shoot\mat dry weight, and shoot density for five creeping bentgrass genotypes. The assessment dates were October 19-21 , 1995 after an extraordinarily hot-humid summer season.

Bentgrass genotype	Shoot height (mm)	Mat depth (mm)	Shoot \mat biomass (g dry wt./ sq. dm)	Shoot density count (sq. dm)
Penn G-2	3	15 a	79 a	2,888 a
Penn A-1	3.5	12 b	78 a	2,601 b
Pennlinks	3	14 ab	43 bc	1,840 c
Crenshaw	3.3	9 c	38 c	1,482 d
Cato*	3.0/7.0	7 d	46 bc	738 e

Means followed by the same letter in the same column are not significantly different at the 5 % level LSD t-Test.
* All turfs were mowed at 3 mm, however the Cato height of cut was raised to 6 mm in mid-September of 1995 to slow an excessive loss of stand.

Shoot\Mat Biomass. Penn G-2 and Penn A-1 had the highest biomass, while Crenshaw ranked the lowest. The Cato was being mowed 4 mm higher than for the other genotypes, which would contribute to a higher relative ranking than would have been observed otherwise.

Mat Depth. Penn G-2, Pennlinks, and Penn A-1 had the thickest mat depths, with Cato and Crenshaw having the least. These differentials reflect the shoot density counts. There was no significant thatch present on any of the cultivar plots.

Root Biomass. The root biomass is expressed as the weight of dry roots in grams per surface square decimeter. Three profile depths were assessed: 0 to 2 inches, 2 to 4 inches, and 4 to 6 inches. There were no roots below this lowest depth.

0 to 2 inches. Most of the roots were in the upper 2 inches (50 mm) of the soil profile after the extraordinarily hot summer. Penn A-1 and Penn G-2 exhibited the most root biomass. Crenshaw and Cato had poor rooting, while Pennlinks ranked intermediate.

2 to 4 inches. Four of the cultivars had a similar measurable root biomass at this depth, while Cato had no roots below 2 inches (50 mm).

4 to 6 inches. All turfs had minimal roots at this depth. Crenshaw had no roots below 4 inches (100 mm).

Table 3. Comparative assessments of the length of the longest intact root, root biomass for 0 to 2 inch, 2 to 4 inch, 4 to 6 inch depths, and total root biomass for five creeping bentgrass genotypes. The assessment dates were October 19-21 , 1995 after an extraordinarily hot-humid summer season.

Bentgrass genotype	Length longest root (mm)	Root biomass dry wt.(g/sq.dm)			Total biomass
		0-2 inches	2 to 4 inches	4 to 6 inches	
Penn A-1	107 b	66 ab	0.5 a	0.2 bc	67 a
Penn G-2	122 ab	44 bc	0.7 a	0.6 a	46 a
Pennlinks	137 a	22 cd	0.6 a	0.4 ab	23 bc
Crenshaw	83 c	5 d	0.5 a	0.0 c	6 c
Cato *	43 d	0.4 d	0.0 b	0.0 c	0.4 c

Means followed by the same letter in the same column are not significantly different at the 5 % level LSD t-Test.
*All turfs were mowed at 3 mm, except for the Cato height of cut that was raised to 6 mm in September, 1995 to slow an excessive loss of stand.

Total Root Biomass. Penn A-1 had a significantly higher total root mass after the severe hot summer. Penn G-2 had the second highest total root biomass. Crenshaw and Cato had a very low total root biomass following the extraordinarily high temperatures during the summer of 1995 in Pinehurst, North Carolina.

Length of Longest Intact Root. Pennlinks had the longest root length, with Penn G-2 next best, followed by Penn A-1. The longest root for each of the three was 100 mm or deeper.

Assessments at 6 mm Cutting Height

Comparative assessments of the four genotypes maintained at a 6 mm cutting height are in Table 4 for shoot data and in Table 5 for root responses. This height of cut may be used when environmental conditions are so severe that they threaten loss of the green or when a period of recovery from lower mowing heights is necessary. The putting speed is slower, but plant health and survival potential are enhanced.

Table 4. Comparative assessments of shoot height, mat depth, shoot\mat dry weight, and shoot density counts for four creeping bentgrass genotypes. The assessment dates were October 19 to 21, 1995 after an extraordinarily hot-humid summer season.

Bentgrass genotype	Shoot height (mm)	Mat depth (mm)	Shoot/mat biomass (g dry wt./ sq dm)	Shoot density count (sq dm)
Putter	6 a	7 a	25 b	1,852 a
Providence	6 a	7 a	40 a	1,851 a
SR1020	6 a	8 a	25 b	1,806 a
Cato	7 b	7 a	46 a	738 b

Means followed by the same letter in the same column are not significantly different at the 5 % level LSD t-Test.

Shoot Density. Putter, Providence, and SR 1020, were similar in shoot density following the severe summer heat stress. Cato was very low.

Shoot\Mat Biomass. Providence had a significantly higher shoot and mat biomass. Since there was no difference in shoot density and in mat depth this may indicate a higher individual plant biomass.

Mat Depth. There was no accumulation of thatch, and there were no differences in the mat depths among the four genotypes.

Assessments of older plantings of Penncross nearby both test sites, which were maintained similarly, revealed that Penncross was superior in total root biomass, exceeding 100 gm/dm sq. Is this one of the key reasons for the world-wide adaptation range of Penncross in terms of heat and drought resistance?

Table 5. Comparative assessments of the length of the longest intact root, biomass for 0 to 2 inches, 2 to 4 inches, 4 to 6 inches, and total biomass for four creeping bentgrass genotypes. The assessment dates were October 19 to 21, 1995 after an extraordinarily hot-humid summer season.

Bentgrass genotype	Length longest root (mm)	Root biomass dry wt (grams per sq dm)			
		0 to 2 inches	2 to 4 inches	4 to 6 inches	Total biomass
SR1020	112 a	44 a	1.4 a	0.2 a	46 a
Providence	85 b	27 b	0.8 ab	0.0 b	27 b
Putter	85 b	15 b	1.0 ab	0.0 b	16 b
Cato	43 c	4 c	0.0 b	0.0 b	0.4 c

Means followed by the same letter in the same column are not significantly different at the 5 % level LSD t-Test.

Root Biomass. A long root length contributes to survival in low moisture conditions since the moisture located deeper in the root zone can be accessed by the plant. There were no roots below 5 inches (125 mm).

0 to 2 inch depth. SR1020 had the highest root biomass, with Providence and Putter being intermediate. The Cato root biomass was very poor.

2 to 4 inch depth. The top three genotypes had similar root biomasses. Cato had no roots below 2 inches (50 mm).

4 to 6 inch depth. SR 1020 had the only roots below 4 inches (100 mm).

Total Root Biomass. SR 1020 had a significantly higher total root biomass after the extraordinarily hot summer. Providence and Putter were intermediate, while Cato was very poor in root biomass.

Length of the Longest Intact Root. SR 1020 had the longest root. Providence and Putter were intermediate, while Cato had the shortest individual root length.

Acknowledgment. The assistance of Mr. Bob Farren, CGCS, Assistant Director of Golf Course Maintenance, and his staff at Pinehurst Resort and Country Club and of Mr. George B. Thompson, CGCS, Superintendent of Golf Courses and his staff at The Country Club of North Carolina is greatly appreciated.

Note. This article has been excerpted from the full paper published as International Sports Turf Institute Research Report No. 204 (1996).