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The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, Cook College, Rutgers University in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. It also allows these professionals to reach a more general audience, which includes the public. Articles appearing in these proceedings are divided into two sections.

The first section includes lecture notes of papers presented at the 1995 New Jersey Turfgrass Expo. Publication of the New Jersey Turfgrass Expo Notes provides a readily available source of information covering a wide range of topics. The Expo Notes include technical and popular presentations of importance to the turfgrass industry.

The second section includes technical research papers containing original research findings and reviews covering selected subjects in turfgrass science. The primary objective of these papers is to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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PERFORMANCE OF BENTGRASS CULTIVARS AND SELECTIONS IN NEW JERSEY TURF TRIALS

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Bentgrasses used for golf course turf fall into four species: creeping bentgrass (*Agrostis palustris*, also known as *Agrostis stolonifera*); colonial bentgrass (*Agrostis capillaris*); highland or dryland bentgrass (*Agrostis castellana*); and velvet bentgrass (*Agrostis canina*). Creeping bentgrasses have relatively vigorous stolon growth and are generally the best adapted of the bentgrass species for use as golf turf in both the cool temperate and the warm, humid environments of the United States. Creeping bentgrasses are particularly useful for golf course putting greens because of their good tolerance of low mowing heights. Colonial bentgrasses produce a turf with fine-textured, upright-growing leaves, and a bunch-type to weakly creeping (short stolons and rhizomes) growth habit. The rhizomatous growth of colonial bentgrasses is beneficial because it provides the capacity for recovery from damage. Colonial bentgrasses, sometimes called browntop, generally have a brighter green color and better color retention during cool weather than creeping bentgrasses. Dryland bentgrasses are similar in adaptation and appearance to colonial bentgrasses but are somewhat more blue-green in color and are more likely to have rhizomes. Velvet bentgrasses are sometimes used instead of creeping bentgrasses in cool, moist, maritime climates. Velvet bentgrasses are very fine-leaved, stoloniferous grasses that can form an attractive turf of very high density with bright green color. The lack of heat tolerance in current cultivars of velvet bentgrass limits its range of adaptation.

The number of commercially available creeping and colonial bentgrass cultivars has been increasing steadily in recent years. Increased demand for high quality bentgrass turf has encouraged the development of new cultivars. It is critical that new bentgrass cultivars be thoroughly evaluated over several years and locations, particularly in the areas of intended use. These tests provide useful data that can assist a turf manager in the selection of cultivars for use in construction of golf courses, overseeding practices, or turfgrass species conversion projects.

The turf quality of a particular cultivar is an important consideration in the selection process. Cultivars that exhibit consistently low quality ratings in tests may be poorly adapted older cultivars or newer cultivars that are highly sensitive to environmental stresses and/or pests. A large portion of turf management resources are devoted to combating pest and stress related problems. Proper cultivar selection, based on demonstrated field resistance to turfgrass pests, is an extremely valuable pest management strategy that should not be overlooked. Unfortunately, no single cultivar will have tolerance to all the potential stresses and pests. However, the major stresses and pests should be identified for a site so that cultivars with a high level of tolerance can be selected to address those problems. Selecting high quality cultivars that exhibit higher tolerance to important environmental stresses and pests can lead to a reduction of management resources needed to manage those pests.

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For many years, bentgrass cultivars have been evaluated for their overall adaptation to the environmental conditions in New Jersey. The New Jersey Agricultural Experiment Station participates in the National Turfgrass Evaluation Program (NTEP) coordinated by the USDA in Beltsville, Maryland. This program evaluates many species of turfgrasses, including bentgrasses, throughout the United States. The Rutgers turfgrass breeding program conducts a number of independent trials of materials generated by its program and by cooperating breeding programs at other institutions.

PROCEDURES

Bentgrass evaluation trials were established in September 1989 and in May 1994 at the Rutgers Turfgrass Research Facility in North Brunswick, New Jersey. These trials included all of the entries of the 1989 and 1993 National Bentgrass Tests coordinated by the NTEP. Two tests were seeded, one in September 1989 (Table 1) and the other in May 1994 (Table 2), to simulate putting greens on unmodified, native soil. A third test, seeded in May 1994 (Table 3), on native soil was intended to approximate fairway conditions. All tests were established on a well-drained, Nixon sandy loam and had an open exposure to both sunlight and air circulation. Plot size was 6 x 6 ft in the 1989 trial and 4 x 6 ft in the trials seeded May 1994. A 6 inch unseeded border surrounded each plot to minimize seed contamination from adjacent plots. Plots were hand-seeded at a rate of approximately 1.0 lb/1000 ft² in the 1989 test and 0.5 lb/1000 ft² in the 1994 tests. All tests used a randomized complete block design with three replications.

The annual rate of nitrogen fertilization and mowing height for each test are presented in Table 4. Plots in the 1989 greens test were mowed and clippings were removed three times per week prior to 1994. After 1994, all greens tests were mowed five to six times per week during periods of active growth with a triplex reel mower equipped to collect clippings. The fairway test seeded in May 1994 was mowed and clippings were removed at least three times per week with a triplex reel mower during periods of active growth. Soil pH was maintained in the range of 6.0 to 6.5 with agricultural limestone. All tests were irrigated to avoid drought stress.

DCPA or bensulide was applied each spring for preemergence control of summer annual weeds, and a combination of 2,4-D and dicamba or MCPP was applied in autumn to control broadleaf weeds. The tests seeded in May 1994 received an additional application of MCPP in the spring of 1995 for broadleaf weed control and an application of bensulide in the autumn of 1995 for preemergence control of *Poa annua*.

The 1989 greens test was cultivated with hollow tines in June 1992, May 1994, and March 1995. Cores were collected and removed after each operation. A sand/organic matter (90:10) topdressing was applied to the 1989 greens test in May 1994 and in May 1995. To permit evaluation of disease resistance on the 1989 test, fungicides were applied through 1991 on a curative basis. After 1992, a preventive fungicide program was implemented on the 1989 test using Daconil 2787, Chipco 26019, or Bayleton. The 1989 greens test received an application of Dursban in 1992 and Turcam 76 in 1993 for cutworm control.

The greens test seeded May 1994 was cultivated with hollow tines in March and October 1995. Cores were collected and removed after each operation. A sand/organic matter (90:10) topdressing was applied to the greens test in March, May, and October 1995. The fairway test seeded May 1994 was cultivated with hollow tines in October 1995. Cores were collected and removed. A preventive fungicide program, using Daconil 2787 or Chipco 26019, was used during

establishment of both tests seeded May 1994. After seedling establishment, a curative fungicide program was maintained on both tests seeded in May 1994 to permit evaluation of disease resistance. The greens test received an application of Turcam 2.5G in June 1995 and Turcam 76 in September 1995 for cutworm control. The fairway test received an application of Turcam 76 in September 1995 for cutworm control.

Plots were evaluated frequently during the growing season for overall turf quality (i.e., turf density, texture, uniformity, color, growth habit, and freedom from disease and insect damage). Separate ratings for color, leaf texture, dollar spot disease, and brown patch disease were taken for the tests seeded in May 1994 (Tables 2 and 3). Turf quality, color, leaf texture, dollar spot disease, and brown patch disease were rated on a 1 to 9 scale, where 9 represented the best turf quality, darkest green color, finest leaf texture, or least disease.

Percent annual bluegrass invasion of the 1989 greens test was evaluated in May 1995 using a line-intersect counting method. A 3 x 6 ft wooden frame was fitted with nylon line to create line-intersects on a 3 x 3 inch pattern (253 intersect points per grid). The line-intersect grid was centered on a plot, and each line-intersect over an annual bluegrass plant was counted.

RESULTS AND DISCUSSION

As a group, the creeping bentgrass plots have sustained less annual bluegrass ingress than colonial bentgrasses in the 1989 greens test (Table 1). However, within the creeping bentgrasses, the cultivars 'National' and 'Penncross' showed the greatest ingress of annual bluegrass. Many of the newer creeping bentgrass cultivars appear to resist annual bluegrass invasion better than older creeping bentgrass cultivars. Turf quality data from the 1989 greens trial indicate that the performance of many newer creeping bentgrass cultivars was better than many older cultivars based on the 5-year quality average (Table 1). There was a strong association between turf quality and annual bluegrass ingress; higher turf quality was related to less annual bluegrass.

Based on the 2-year (1994-1995) quality average from the greens test seeded May 1994 (Table 2), many of the newer creeping bentgrass cultivars and selections performed better than older cultivars. Colonial bentgrass performance was not as good as most of the creeping bentgrasses, particularly at a greens height of cut. Ratings from the fairway/tee trial indicate that progress in developing improved colonial bentgrass cultivars has been made (Table 3).

A relatively broad range of color and leaf texture was observed in the bentgrass tests seeded in May 1994 (Tables 2 and 3). A number of bentgrasses possess a more upright growth with a finer leaf texture and higher shoot density compared to the older standard 'Penncross.'

Ratings for dollar spot incidence indicated colonial bentgrasses were affected less by this disease than the creeping bentgrasses (Tables 2 and 3). There was considerable variation in the susceptibility to dollar spot among the creeping bentgrass cultivars. Some cultivars showed a high susceptibility whereas others had good tolerance.

Brown patch ratings indicate that colonial bentgrasses were more susceptible to this disease than the creeping bentgrasses (Tables 2 and 3). Although some creeping bentgrasses demonstrated medium resistance to brown patch, more improvement is needed.

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Table 1. Performance of bentgrass cultivars and selections in a putting green turf trial seeded September 1989 at North Brunswick, NJ. (Includes the 1989 National Bentgrass Greens Test - NTEP.)

	Cultivar or Selection	Species	Turf Quality ¹ 1990-1994 Avg.	<i>Poa annua</i> ² June, 1995 (%)
1	Southshore	creeping	6.6	4.2
2	Providence	creeping	6.5	7.1
3	Lopez	creeping	6.3	5.0
4	Viper	creeping	6.3	8.3
5	Pro/Cup	creeping	6.3	6.7
6	Penneagle	creeping	6.2	2.8
7	88 CBE	creeping	6.1	11.7
8	Cobra	creeping	6.1	10.5
9	Regent	creeping	6.0	6.1
10	Putter	creeping	5.9	5.0
11	Pennlinks	creeping	5.8	5.0
12	SR-1020	creeping	5.8	9.9
13	Penncross	creeping	5.5	19.7
14	Carmen	creeping	5.5	13.3
15	Emerald	creeping	4.6	12.8
16	National	creeping	4.4	31.7
17	Bardot	colonial	4.4	15.3
18	Tracenta	colonial	4.3	13.2
19	SR-7100	colonial	4.2	15.7
20	Egmont	colonial	4.2	10.1
21	Allure	colonial	3.1	14.1
22	SR-7000	colonial	3.1	27.0
23	Astoria	colonial	2.9	24.8
24	BR-1518	dryland	2.9	26.9
	LSD at 5% =		0.3	6.8

¹ 9 = best turf quality

² Percent *Poa annua*

Table 2. Performance of bentgrass cultivars and selections in a putting green turf trial seeded May 1994 at North Brunswick, N.J. (Includes the 1993 National Bentgrass Greens Test - NTEP.)

	Cultivar or Selection	Species	-----Turf Quality ¹ -----			Color ² Oct. 11 1995	Leaf Texture ³ 1995 Avg.	Dollar Spot ⁴ 1995 Avg.	Brown Patch ⁴ 1995 Avg.
			1994- 1995 Avg.	1994 Avg.	1995 Avg.				
1	L-93	creeping	7.2	7.1	7.3	8.0	7.3	7.7	4.9
2	A-1	creeping	7.0	7.0	7.0	7.3	8.5	7.3	5.1
3	G-2	creeping	6.6	6.5	6.6	7.0	8.2	6.5	6.3
4	G-6	creeping	6.4	6.5	6.2	6.7	7.5	6.0	5.1
5	Cato	creeping	6.1	5.7	6.5	7.0	7.2	7.0	5.1
6	A-4	creeping	6.1	5.9	6.3	5.7	7.7	6.1	5.3
7	Providence	creeping	6.1	6.1	6.0	7.0	5.5	6.7	4.4
8	Southshore	creeping	5.7	5.8	5.6	5.3	6.5	5.8	4.2
9	Syn 92-5-93	creeping	5.6	6.1	5.2	4.0	7.0	4.6	4.8
10	Atlanta	creeping	5.6	5.5	5.7	4.3	7.3	5.4	5.5
11	Pennlinks	creeping	5.4	5.3	5.5	4.3	5.0	7.7	4.3
12	MSUEB	creeping	5.3	5.8	4.9	4.3	4.5	7.2	4.3
13	Regent	creeping	5.3	5.7	4.9	5.3	4.5	6.4	3.9
14	Syn 92-1-93	creeping	5.2	5.7	4.8	4.0	7.3	3.6	4.5
15	ISI-Ap-89150	creeping	5.2	5.3	5.2	5.3	5.3	6.9	4.1
16	Putter	creeping	5.2	5.7	4.8	5.0	4.7	6.5	3.9
17	Syn 92-2-93	creeping	5.2	6.0	4.3	3.3	6.3	3.8	5.1
18	Lopez	creeping	5.2	5.7	4.6	5.0	4.3	6.0	4.1
19	Pro/Cup	creeping	5.1	5.6	4.7	4.3	4.5	6.2	4.5
20	DG-P	creeping	5.1	5.3	4.9	5.0	5.2	7.2	3.8

Table 2 (continued).

Cultivar or Selection	Species	-----Turf Quality ¹ -----			Color ² Oct. 11 1995	Leaf Texture ³ 1995 Avg.	Dollar Spot ⁴ 1995 Avg.	Brown Patch ⁴ 1995 Avg.	
		1994- 1995 Avg.	1994 Avg.	1995 Avg.					
21	Trueline	creeping	5.1	5.8	4.3	5.7	3.7	6.1	3.7
22	Crenshaw	creeping	5.0	6.4	3.6	5.0	5.0	3.1	4.7
23	Cobra	creeping	5.0	5.6	4.3	5.3	4.2	6.0	3.3
24	BAR Ws 42102	creeping	5.0	4.7	5.2	4.7	6.7	7.0	5.5
25	SR 1020	creeping	4.8	5.0	4.6	4.7	5.7	5.1	4.0
26	Syn-1-88	creeping	4.4	5.2	3.6	2.7	2.8	6.0	2.7
27	18 th Green	creeping	4.4	5.1	3.6	6.0	4.0	3.7	4.5
28	Penncross	creeping	4.0	4.5	3.5	4.7	3.0	7.7	2.9
29	Tendez	colonial	3.3	4.1	2.5	3.0	2.5	8.7	1.3
30	BAR As 493	creeping	3.2	3.4	2.9	3.0	3.2	8.6	2.1
31	Exeter	colonial	2.5	2.4	2.7	5.0	3.7	8.2	1.9
32	Seaside	creeping	2.4	2.8	1.9	1.3	1.5	7.5	3.0
LSD at 5% =			0.4	0.6	0.5	1.2	1.0	0.8	0.9

¹ 9 = best turf quality

² 9 = darkest green color

³ 9 = finest leaf texture

⁴ 9 = least disease

Table 3. Performance of bentgrass cultivars and selections in a fairway turf trial seeded May 1994 at North Brunswick, NJ. (Includes 1993 National Bentgrass Fairway/Tee Test - NTEP.)

Cultivar or Selection	Species	-----Turf Quality ¹ -----			Color ² Oct. 1995	Leaf Texture ³ 1995 Avg.	Dollar Spot ⁴ 1995 Avg.	Brown Patch ⁴ 1995 Avg.
		1994- 1995 Avg.	1994 Avg.	1995 Avg.				
1 Cato	creeping	7.0	6.8	7.2	7.3	6.7	6.6	6.2
2 G-6	creeping	6.9	7.4	6.5	6.0	8.0	5.6	5.2
3 G-2	creeping	6.8	7.0	6.5	6.0	8.0	6.1	6.0
4 L-93	creeping	6.8	6.7	6.9	7.0	6.7	7.3	6.4
5 Providence	creeping	6.4	6.2	6.5	5.7	6.0	6.5	7.1
6 Penneagle	creeping	6.3	6.3	6.2	5.7	5.0	6.7	5.8
7 Putter	creeping	6.2	6.6	5.8	4.3	5.0	5.6	5.4
8 Crenshaw	creeping	6.2	7.5	4.9	5.3	5.7	3.8	7.2
9 Atlanta	creeping	6.2	6.7	5.7	6.0	8.3	5.6	6.6
10 Southshore	creeping	6.2	6.3	6.0	5.7	6.3	5.6	6.1
11 DF-1	creeping	5.7	5.7	5.6	5.0	4.3	6.8	5.6
12 Pennlinks	creeping	5.6	5.6	5.7	5.0	5.0	6.7	7.0
13 Cobra	creeping	5.5	5.8	5.3	5.0	3.7	5.8	6.0
14 Trueline	creeping	5.5	5.9	5.1	5.0	3.3	4.7	6.9
15 Lopez	creeping	5.4	5.8	5.0	4.7	4.3	5.7	6.6
16 ISI-At-90162	colonial	5.4	5.7	5.1	3.3	5.0	7.0	4.1
17 BAR Ws 42102	creeping	5.3	5.3	5.2	4.0	7.0	6.1	5.1
18 SR 7100	colonial	5.1	5.1	5.0	3.0	6.0	7.7	5.4
19 Pro/Cup	creeping	4.9	5.5	4.4	4.0	3.7	5.0	6.9
20 Penncross	creeping	4.8	5.0	4.6	5.0	2.3	6.3	6.1

Table 3 (continued).

Cultivar or Selection	Species	-----Turf Quality ¹ -----			Color ² Oct. 1995	Leaf Texture ³ 1995 Avg.	Dollar Spot ⁴ 1995 Avg.	Brown Patch ⁴ 1995 Avg.	
		1994- 1995 Avg.	1994 Avg.	1995 Avg.					
21	OM-At-90163	colonial	4.6	4.9	4.3	3.3	5.0	6.8	4.7
22	BAR As 493	creeping	4.5	4.3	4.6	3.3	5.0	8.3	5.0
23	18th Green	creeping	4.4	5.2	3.6	6.0	5.0	3.7	7.2
24	Tendez	colonial	4.1	4.5	3.6	4.3	4.3	8.1	4.6
25	Exeter	colonial	3.4	2.9	4.0	4.7	3.0	6.6	4.4
26	Seaside	creeping	2.6	3.1	2.1	1.7	1.0	6.4	4.6
LSD at 5% =			0.6	0.7	0.6	1.2	1.2	0.9	1.0

¹ 9 = best quality

² 9 = darkest green color

³ 9 = finest leaf texture

⁴ 9 = least disease

Table 4. Yearly nitrogen (N) applied and mowing height (Ht) on bentgrass trials established in 1989 and 1994 at North Brunswick, NJ.

	1990		1991		1992		1993		1994		1995	
	N ¹	Ht ²	N	Ht	N	Ht	N	Ht	N	Ht	N	Ht
Table 1 (1989 Greens Trial)	5.8	1/4	4.0	1/4	5.0	1/4	3.9	1/4	3.2	5/32	3.5	5/32
Table 2 (1994 Greens Trial)									4.1	5/32	5.0	5/32
Table 3 (1994 Fairway/Tee Trial)									4.1	17/32	3.0	17/32

¹ Annual N applied (lbs/1000 ft²).

² Mowing height in inches.