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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. Through this forum, these professionals also 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 1998 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 research papers containing original research findings and reviews covering selected subjects in turfgrass science. The primary objective of this section is to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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PERFORMANCE OF FINE FESCUE CULTIVARS AND SELECTIONS IN NEW JERSEY TURF TRIALS

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The fine fescues consist of a number of species that can persist under limited soil moisture and low nitrogen fertility, but do not tolerate a low height of cut as well as some of the other turfgrasses. Fine fescues can form a dense, attractive turf cover. The species used for turf include bunch types [Chewings fescue (*Festuca rubra* L. subsp. *falax* Thuill., formerly *F. rubra* L. subsp. *commutata* Gaud.), hard fescue (*F. brevipila* (Hack.) Krajina, formerly *F. longifolia* Thuill.), sheeps fescue (*F. ovina* L.), *F. pseudovina*, and blue fescue (*F. glauca* Lam)] and rhizomatous types [slender creeping red fescue (*F. rubra* L. subsp. *littoralis*, formerly *F. rubra* L. subsp. *trichophylla* Gaud.) and strong creeping red fescue (*F. rubra* L. subsp. *rubra* Gaud.)].

The fine fescues are characterized by fine, wiry leaves, which appear tube-like from leaf rolling during dry weather. Chewings fescues form a dense turf, which makes them the densest of the fine fescues for home lawns. The strong creeping red fescues produce a more open turf than the Chewings fescues due to their rhizomatous growth habit. The strong creeping red fescues are more strongly rhizomatous and have a more open growth habit than the slender creeping red fescues. Improved varieties of hard fescues have good turf-type characteristics and are similar in density and texture to the Chewings fescues, but with lower nutrient requirements, higher levels of disease resistance, and a slower growth rate. In addition, the hard fescues are less tolerant to close mowing than the Chewings fescues. Sheeps fescues and blue fescues pos-

sess stiff, bluish-green leaves and require little maintenance.

Strong creeping red fescues and hard fescues have better seedling establishment and vigor than Kentucky bluegrasses, but similar color and density, making them useful in mixtures with Kentucky bluegrass. After establishment, the fescues can dominate in the areas receiving shade and lower maintenance, whereas the Kentucky bluegrasses may comprise the bulk of the stand on good soil and in favorable conditions, such as fertile open areas of a field. Other uses for which the fine fescues are well adapted include the use of hard fescues for soil erosion control in low maintenance areas, and the use of sheeps fescues for stabilization of sandy soils, slopes, and cemeteries. The sheeps and blue fescues have also been readily used in wildflower mixes for soil stabilization, as well as for aesthetic purposes as they provide an attractive, bluish foliar display. The blue fescues have become a regular item in garden and flower catalogs as specimen plants because of their attractive foliage and bunch type growth habit.

High nitrogen fertilization and close mowing can reduce fine fescue populations in a turf of mixed species by decreasing heat tolerance and increasing plant succulence, thereby decreasing resistance to insect pests and diseases. For a fine fescue to persist it should be fertilized with no more than 2 lb of nitrogen per 1000 ft² per year; hard, blue, and sheeps fescues require less nitrogen nutrition than the other species. Most

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fine fescues can tolerate mowing heights of 1.5 to 2.0 inches, but perform best when cut at 2.5 inches or higher.

Fine fescues that contain the *Neotyphodium* endophyte can exhibit enhanced insect, disease, and environmental stress resistance. This endophyte is a fungus that grows within the crown, reproductive structures, and leaf sheath tissues of the turfgrass plants. The endophyte does not affect the growth of a plant during periods of low environmental stress; under stressful conditions, however, the endophyte-plant relationship produces compounds that may improve resistance to some biotic and abiotic stresses.

Breeding efforts continue to enhance the turf-type qualities of fine fescues and improve resistance to diseases, insects, and environmental stresses through genetic improvements. Once improved plant material has been selected, endophytes can be incorporated into a cultivar to increase the competitive ability of the grass. The Rutgers breeding program, in cooperation with the National Turfgrass Evaluation Program (NTEP) and other breeders, is involved in an extensive program that evaluates many cultivars and experimental selections for their turf qualities.

PROCEDURES

Fine fescue trials were conducted at the Rutgers Plant Science Research Farm in Adelphia, NJ (Tables 1 to 3). Tests were established in open areas with good air circulation. All entries were seeded in 3 X 5 ft plots at a rate of 3.7 lb/1000 ft². Plots were replicated at least three times in a randomized complete block design. Tests were fertilized at different nitrogen rates, mowed at different heights, and subjected to varying levels of drought stress depending on the objectives of the test during the evaluation period. Mowing height and annual nitrogen fertilization rate for each trial are listed in Table 4. After establishment, tests were only irrigated to avoid severe drought stress and dormancy. Plots were mowed at frequent intervals to avoid excessive accumulation of clippings. Weed con-

trol consisted of a yearly application of a preemergence herbicide for crabgrass and other annual grasses, and a broadleaf weed control herbicide applied either in spring or fall. Insecticides and fungicides were not routinely applied to any tests.

The three tests were evaluated throughout the year by visually rating for turf quality. Turf quality is a subjective rating that is based on density, texture, uniformity, color, growth habit, and freedom from disease or insect damage. Furthermore, the test seeded in 1995 (Table 1) was evaluated for the leaf spot disease, and the test seeded in 1997 (Table 3) was evaluated for establishment. All ratings were done on a 1 to 9 scale, where 9 represented the best quality turf, best establishment, or least disease.

RESULTS AND DISCUSSION

Data presented in Tables 1 to 3 are grouped by species and ranked by their multiple year average. This was done to facilitate comparison of cultivars and selections within a species. In general, the Chewings and hard fescues performed better than the other species with many selections producing a dense, attractive turf (Tables 1 to 3). Some of the newer selections within the strong creeping red fescues also performed well (Table 3). Although improvements in turf quality in the sheeps and slender creeping red fescues continue to be made, only the slender creeping selection ASRO 10 had an acceptable average quality rating (average = 5.7) in 1998 (Tables 1 to 3).

Establishment in the fine fescues varied among the cultivars within any given species. Many of the newer selections, however, rated above average in establishment and were better than many of the older cultivars (Table 3). Hard and sheep fescues are typically slower to establish than the Chewings and strong creeping red fescues. In the test seeded September 1995, the hard fescues exhibited the best resistance to leaf spot disease (Table 1). Many of the other cultivars and selections had poor resistance to leaf spot. Breeding efforts continue

to improve turf-type characteristics in the fine fescues. Although improvements in resistance to insect and diseases have not been as dramatic as those in turf quality, these areas continue to be an important focus for the Rutgers program.

The premise about endophytes at Rutgers has always been that the use of such endophytes to enhance cultivar performance should not supersede the genetic breeding of improved stress resistance of the plants. Endophytes should be used, however, to further strengthen the cultivar's natural ability to persist under such stresses. The successful efforts of various breeding programs are documented in the superior quality exhibited by the newer cultivars

and experimental selections, although further work is needed (Tables 1 to 3).

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Table 1. Performance of fine fescue cultivars and selections in a turf trial seeded September 1995 at Adelphia, NJ.

Cultivar or Selection	-----Turf Quality ¹ -----				Leaf Spot ² 1998	
	1996-1998 Avg.	1996 Avg.	1997 Avg.	1998 Avg.		
CHEWINGS FESCUES						
1	Ambassador	5.1	5.9	4.5	4.9	3.0
2	WS-CF94-Rx	5.0	5.7	4.3	5.0	3.7
3	Brittany	4.7	5.3	3.9	4.9	3.7
4	Southport	4.6	4.9	4.0	5.0	3.3
5	FC 14	4.6	4.7	4.3	4.8	3.3
6	Jamestown II	4.2	4.0	3.9	4.6	3.7
7	Shetland	3.7	3.6	3.2	4.1	3.0
8	ML 45	3.6	3.1	3.5	4.2	2.3
HARD FESCUES						
1	LTP 4821	6.5	6.2	6.0	7.1	5.7
2	Oxford	6.2	6.5	5.7	6.4	5.0
3	W5-HF94-Rx	5.8	6.1	5.5	5.9	5.0
4	Serra E+	5.4	5.4	5.3	5.7	5.3
5	Aurora E+	5.4	5.4	5.3	5.5	4.7
6	Ecostar	5.3	5.2	5.1	5.6	4.7
7	Reliant	5.1	4.8	5.1	5.3	5.3
8	Spartan	5.1	4.7	5.1	5.4	5.0
9	Med 13	5.1	5.2	5.3	4.6	5.3
10	Warwick	5.0	4.7	5.0	5.4	4.7
11	LCHF	4.6	4.6	4.6	4.5	5.3
12	Med 13 E+	4.3	4.4	4.1	4.3	3.0
SHEEPS FESCUES						
1	LBS-95	4.1	4.2	4.1	4.1	3.3
2	LGS-95	3.7	4.0	3.6	3.5	3.3
3	LO44	3.6	4.0	3.2	3.7	3.7
4	Bighorn	3.6	3.5	3.4	3.8	4.0
5	Mx-86	3.4	3.5	3.2	3.6	4.3

(Continued)

Table 1 (continued).

Cultivar or Selection	-----Turf Quality ¹ -----				Leaf Spot ² 1998
	1996- 1998 Avg.	1996 Avg.	1997 Avg.	1998 Avg.	
STRONG CREEPING RED FESCUES					
1 Pathfinder	4.8	4.8	4.6	5.0	2.0
2 LTP 4731	4.8	4.9	4.3	5.1	2.7
3 R Str Cr-95 E+	4.4	4.6	3.9	4.5	3.0
4 Audubon	4.4	4.7	3.9	4.4	3.0
5 FR 27	4.2	4.6	3.8	4.2	2.7
6 PL E+	4.1	4.5	3.7	4.1	2.0
7 Salem	3.9	4.3	3.3	4.0	3.0
8 Wx5-396	3.8	3.9	3.3	4.1	2.3
9 FR 13	3.4	4.4	3.4	2.4	2.3
LSD at 5% =	0.4	0.5	0.5	0.8	1.9

¹9 = best turf quality

²9 = least leaf spot disease

Table 2. Performance of fine fescue cultivars and selections in a turf trial seeded in September 1996 at Adelphia, NJ.

Cultivar or Selection	-----Turf Quality ¹ -----			
	1997-1998 Avg.	1997 Avg.	1998 Avg.	
CHEWINGS FESCUES				
1	Brittany	5.2	5.3	5.1
2	96-CF94-1	5.1	5.3	4.9
3	NJF-93	4.9	5.0	4.7
4	Shadow II	4.8	4.6	5.0
5	Columbra	4.6	4.5	4.7
6	Victory E+	4.2	4.1	4.3
7	Tiffany	4.2	4.5	3.9
8	FC 51	4.1	4.4	3.8
9	FC 12	4.0	3.6	4.4
10	Southport	3.9	3.4	4.4
11	Jamestown II	3.8	3.7	3.8
12	Banner II	3.8	3.5	4.0
13	SR 5100	3.6	3.5	3.6
14	Shadow	2.5	2.3	2.6
HARD FESCUES				
1	96-HF 94-1	5.9	5.9	5.9
2	Discovery	5.5	5.5	5.5
3	SR 3100	5.5	5.2	5.7
4	EL 20	5.4	5.6	5.1
5	Ecostar	5.4	5.7	5.1
6	Nordic	5.0	5.3	4.7
7	Aurora E+	4.9	4.8	5.0
8	Heron	4.9	5.0	4.7
9	Defiant	4.8	4.8	4.8
10	Spartan	4.6	4.8	4.4

(Continued)

Table 2 (continued).

Cultivar or Selection	-----Turf Quality ¹ -----			
	1997-1998 Avg.	1997 Avg.	1998 Avg.	
HARD FESCUES (continued)				
11	Brigade	4.6	4.8	4.4
12	Reliant	4.6	4.6	4.6
13	Reliant II	4.5	4.3	4.8
14	Serra	4.5	4.8	4.2
15	Warick	3.8	3.3	4.2
16	LL 22	.	.	1.7
SHEEPS FESCUES				
1	Bighorn	4.4	4.1	4.7
2	MX-86	3.7	3.8	3.6
3	LO 44	2.7	2.5	2.4
4	Teal	.	.	1.3
SLENDER CREEPING RED FESCUES				
1	Seabreeze	4.3	4.4	4.2
2	Dawson	3.9	4.1	3.7
STRONG CREEPING RED FESCUES				
1	PST 4ST	5.0	5.2	4.8
2	Pathfinder	4.9	4.7	5.0
3	OFI-JH	4.6	5.1	4.1
4	Florentine	4.6	4.8	4.4
5	Flyer II	4.6	4.9	4.2
6	RSTR-CR	4.1	4.2	4.0
7	Shademaster II	4.1	4.4	3.8
8	WX5 386	4.0	4.2	3.8
9	PST 4DT	3.9	3.7	4.0
10	Flyer	3.8	3.9	3.7

(Continued)

Table 2 (continued).

	Cultivar or Selection	-----Turf Quality ¹ -----		
		1997-1998 Avg.	1997 Avg.	1998 Avg.
STRONG CREEPING RED FESCUES (continued)				
11	Shademark	3.8	4.1	3.4
12	Melody	3.6	3.9	3.3
13	Common Cr	3.6	3.8	3.3
	LSD at 5% =	0.9	0.9	1.0

¹9 = best turf quality

Table 3. Performance of fine fescue cultivars and selections in a turf trial seeded September 1997 at Adelphia, NJ.

	Cultivar or Selection	Turf Quality ¹ 1998 Avg.	Establishment ² 1997
CHEWINGS FESCUES			
1	ISI-FRC 2	6.4	5.7
2	PCH comp	6.2	5.3
3	Ambassador	6.1	5.0
4	Shadow II	6.0	5.3
5	Treasure E+	6.0	6.0
6	R94-299	6.0	6.7
7	FRC A-93-97	5.6	4.7
8	Victory II	5.5	6.3
9	SRX 5941-2	5.5	6.3
10	FRC 4-92-97	5.4	4.0
11	SRX 5N5942-2	5.4	5.7
12	SR 5100	5.3	6.7
13	FRC B-93-97	5.2	4.7
14	SRX 5022	5.0	5.3
15	Tiffany	4.9	5.7
16	TMI-3CE	4.8	4.3
17	FC 51	4.6	4.7
18	Syn 4BCT	4.5	5.3
19	FC 50	4.5	4.3
20	Sandpiper	4.3	8.0
21	Victory	4.2	5.0
22	Jamestown II	4.0	4.0
23	Dover	3.7	3.3
24	Shadow E+	2.8	1.0
25	SR 5000	1.2	1.0
HARD FESCUES			
1	Hard 97 E-	5.9	4.3
2	Hard 97 E+	5.9	4.3
3	Oxford	5.8	3.3
4	SRX 3022-3	5.4	4.3
5	GBM comp	5.3	4.3

(Continued)

Table 3 (continued).

	Cultivar or Selection	Turf Quality ¹ 1998 Avg.	Establishment ² 1997
HARD FESCUES (continued)			
6	ISI-FL12	5.3	4.7
7	FF B-97	5.3	4.7
8	Heron	5.2	4.3
9	SRX 3113	5.2	3.3
10	GGE comp	5.0	4.3
11	Nordic E+	5.0	4.3
12	LL-22	5.0	4.7
13	Ecostar	5.0	4.3
14	R-94	5.0	4.3
15	SRX 3324 E-2	5.0	4.7
16	ISI-FL11	4.9	4.7
17	Osprey	4.9	4.0
18	SR 3100	4.9	1.7
19	SRX 3MO941-2	4.9	4.0
20	47TH	4.8	3.0
21	Attila	4.8	3.0
22	FF A-97	4.8	4.0
23	SR 3000	4.8	3.3
24	ISI-FL8	4.7	4.3
25	ISI-FL10	4.6	5.3
26	Serra	4.6	3.7
27	FF-5-94-97	4.6	3.7
28	Syn 4R6	4.5	3.0
29	FFD-97	4.5	3.7
30	Syn 4CU	4.4	3.7
31	FF-2-94-97	4.4	3.0
32	FF-6-94-97	4.4	2.7
33	ISI-FL9	4.3	4.7
34	FF-7-94-97	4.3	3.7
35	FF-2-94 1-7	4.2	3.7

(Continued)

Table 3 (continued).

	Cultivar or Selection	Turf Quality ¹ 1998 Avg.	Establishment ² 1997
HARD FESCUES (continued)			
36	Syn 46U	4.1	3.3
37	Discovery	4.1	1.7
38	4GH	4.0	2.7
39	Spartan	4.0	2.7
40	Aurora E+	3.8	2.7
41	Syn 4HI-97	3.7	3.0
42	18089	2.4	3.0
SHEEPS FESCUES			
1	Syn 4MB	4.8	3.3
2	4HZ	4.3	3.3
3	4UB	4.2	3.3
4	Bighorn	4.1	3.3
5	FO G-93-97	3.6	3.3
6	FO I-92-97	3.5	4.0
7	FO D-93-97	3.4	4.3
8	Teal	3.1	3.3
SLENDER CREEPING RED FESCUES			
1	ASRO 10	5.7	5.7
2	Seabreeze	5.2	5.0
3	ASRO 25	5.0	5.7
4	ASRO 36	4.6	5.3
5	ASRO 14	4.5	6.3
6	SRX 5SL952-2	4.5	4.3
7	ASRO 11	4.4	6.3
8	SRX 5SL953-2	4.2	4.3
9	4S3	3.9	5.0
10	Syn 4S3 E	3.8	3.7
11	Syn 4SD	3.7	4.0
12	Syn 4SDY	3.3	4.0

(Continued)

Table 3 (continued).

	Cultivar or Selection	Turf Quality ¹ 1998 Avg.	Establishment ² 1997
STRONG CREEPING RED FESCUES			
1	FLT comp	5.9	5.7
2	FLM E+ comp	5.7	5.7
3	FLM E- comp	5.4	5.3
4	4FR	5.3	5.0
5	SRX 52NJ961-1	5.2	5.7
6	ISI-FRR 5	5.2	4.7
7	Syn 4 FRR	5.1	4.7
8	47TCL	5.1	5.3
9	Syn 46T-97	5.1	4.7
10	Shademaster II	5.1	5.0
11	ISI FRR 6	5.1	5.0
12	ISI-H FRR E+	5.1	6.3
13	Pathfinder	5.1	4.7
14	Syn 4CRE-97	5.0	5.7
15	Syn 4TDD	5.0	4.7
16	Syn 4PH	5.0	5.0
17	4TD	4.9	4.7
18	ISI HRR E+/E-	4.9	5.7
19	Florentine	4.8	4.0
20	Syn 4TB	4.8	5.0
21	SRX 52MO962-1	4.8	5.0
22	Syn 4BBL	4.7	5.3
23	Syn 4V3	4.7	5.0
24	Audubon	4.7	5.7
25	Fenway E+	4.6	5.7
26	SRX 52NJ943-2	4.6	5.3
27	SRX 5SL951-2	4.5	4.7
28	Aruba	4.5	5.0
29	Trapeze	4.5	5.7
30	SRX 52NJ94-1-2	4.4	6.0

(Continued)

Table 3 (continued).

	Cultivar or Selection	Turf Quality ¹ 1998 Avg.	Establishment ² 1997
STRONG CREEPING RED FESCUES (continued)			
31	Fenway E-	4.3	7.3
32	Syn 4RTM	4.2	4.3
33	4CRE	4.2	5.3
34	Flyer II	4.2	5.7
35	SRX 52NJ941-3	4.2	5.3
36	SRX 52NJ942-2	4.0	6.0
37	Vista	4.0	6.7
38	FR 46	3.8	3.3
39	FR 47	3.6	3.0
40	SR 5200 E	3.5	6.0
41	Common Creeper	3.0	6.3
42	Victor	3.0	6.3
	LSD at 5% =	0.7	1.1

¹9 = best turf quality

²9 = best establishment

Table 4. Yearly nitrogen (N) applied and mowing height (Ht) on fine fescue tests established at Adelphia, NJ.

	1995		1996		1997		1998	
	N ¹	Ht ²	N	Ht	N	Ht	N	Ht
Table 1 (1995).....	4.6	2.0	1.4	2.0	1.7	1.5	0	0
Table 2 (1996).....			0	0	1.4	1.5	0	0
Table 3 (1997).....					5.0	1.5	3.3	1.5

¹Annual N applied (lbs/1000 ft²).

²Mowing height in inches.