Variety Trials

Change over Time in Quality and Cover of Various Turfgrass Species and Cultivars Maintained in Shade

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Additional index words. ***Festuca arundinacea*****,** ***Festuca rubra*****,** ***Festuca rubra*** **var.** ***commutata*****,** ***Festuca longifolia*****,** ***Lolium perenne*****,** ***Poa pratensis*****,** ***Poa trivialis*****, cultivar selection**

Summary. In 1992, a cultivar trial was initiated in Columbus, Ohio to evaluate differences in establishment and long-term performance of cultivars of tall fescue (*Festuca arundinacea*), creeping red fescue (*F. rubra*), chewings fescue (*F. rubra* ssp. *fallax*), hard fescue (*F. brevipila*), kentucky bluegrass (*Poa pratensis*), rough bluegrass (*P. trivialis*), and perennial ryegrass (*Lolium perenne*) under low maintenance conditions in a shaded environment. Fertilizer and supplemental irrigation were applied until 1994 to establish the grasses, after which no supplemental irrigation, or pesticides were applied and fertilizer rates were reduced to 48.8 kg·ha^{-1} (1 lb/1000 ft^2) of N per year. Percentage cover and overall quality data were collected in 2000 and compared with data collected in 1994. Initial establishment success does not appear to be a good predictor of long-term success of a cultivar in a shaded environment. There was some variability in cultivar performance under shade within a given turfgrass species. The tall fescue cultivars, as a group, had the highest overall quality and percentage cover under shade, followed by the fine fescues, kentucky bluegrass, rough bluegrass, and perennial ryegrass cultivars.

Recommending a single turfgrass species, cultivar, or blend to thrive in a particular shaded site is challenging. Shaded areas vary in sunlight availability, soil type and nutrient status, moisture holding capacity, drainage, and air circulation. Light interception usually becomes the most important limiting factor when other factors such as nutrients and water are optimized for growth (Dudeck and Peacock, 1992).

It is estimated that about 20 to 25% of all turfgrass is maintained under some degree of shading caused either by buildings and other structures, trees, and shrubs (Beard, 1973). Few turfgrass species are adapted for growth in a shaded environment (Wilkinson et al., 1975). The success of a turfgrass in a shaded area is influenced not only by the ability to cope with the reduction in available light, but also tree root competition for water and nutrients and the plants ability to resist the increase in potential disease activity. Previous research suggests that red fescue is more tolerant of shade than kentucky bluegrass due primarily to structural features that increase resistance to disease infection (Wilkinson et al., 1975).

Tall fescue cultivars have acceptable to good performance in 70% tree shade (Wu et al., 1985). The general consensus, however, is that among the cool season grasses, the fine fescues have superior shade tolerance, while tall fescue, rough bluegrass, and creeping bentgrass have good shade tolerance. Perennial ryegrass and kentucky bluegrass have fair to poor shade tolerance (Beard, 1973).

The objective of this study was to evaluate the long-term persistence of turfgrass species and cultivars in shaded conditions. Inputs of fertilizer, supplemental irrigation, and pesticides were held to a minimum so that the evaluation could reflect conditions and management intensity typical of golf course roughs, parks, and recreational facilities.

Materials and methods

The trial was established on 30 Sept. 1992 at the Ohio State Turfgrass Foundation Research and Education Center, Columbus, Ohio. The soil was a Brookston silty clay loam with a pH of 7.5 and 90 g·kg^{-1} (9%) of organic matter. Soil test results indicated an adequate phosphorus (P) level for turfgrass [10 mg·kg^{-1} (20 lb/acre) of P], and a low level of potassium (K) for turfgrass [121 mg·kg^{-1} (242 lb/acre) of K], using the Bray-P1 extraction method for phosphorus and the ammonium acetate extraction method for potassium (Tisdale et al., 1993).

Thirty cultivars were established on three replicate plots. Each plot was 1.9 m^2 (20 ft^2) and plots were arranged in a randomized complete block design with three rows of 10 plots per block. The three blocks were arranged from east to west and placed in the center of a 9-m (29-ft) wide strip of turf that lies between, and under the canopy of, a single row of mature trees [primarily sugar maple (*Acer saccharinum*) and sycamore (*Platanus occidentalis*)] and a grove of mature woods. The area where the trial was established varies from partial sun to deep shade (40 to 300 µmol·m^{-2}·s^{-1}). Shade level across the area of the study was uniform throughout the day and shade variability within individual plots exceeded the shade variability between plots within a replication. However, shade density was generally higher in the first replication, due to two additional trees placed between the tree hedge and the research plots. Blocking was across this shade variability. Cultivars and species selected for this trial represent a broad cross section of the grasses available for establishing as turfgrass as well as then-experimental cultivars of several seed companies (Table 1).

One inch of topsoil was added before establishment. All entries were seeded by hand at the recommended seeding rate for the species (Table 1). Nitrogen was applied as urea (46N–0P–0K) at a rate of 97.6 kg·ha^{-1} (2 lb/1000 ft^2) of N during the first year (August 1992 – August 1993) of the trial and at a rate of 48.8 kg·ha^{-1} (1 lb/1000 ft^2) of

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N in subsequent years. No other fertilizer was applied. The turfgrass was mowed at a 8.9-cm (3.5-inch) height. Supplemental irrigation was provided August 1992 to May 1993 to encourage growth. Supplemental irrigation was provided four times during Summer 1993 to prevent stress to the trial. No other supplemental irrigation was provided. With the exception of a single application of a contact fungicide to control brown patch on the tall fescues in June 1994, no pesticides were used.

Estimates of turfgrass visual quality and percentage cover were made in June 1994 and September 2000. Turfgrass visual quality was evaluated on a scale of 1 to 9 where 1 = poorest quality, 6 = lowest acceptable quality, and 9 = best quality based on overall color and density. The 2000 data were analyzed using the general linear models (GLM) procedure of SAS (SAS Institute, 1990). Data collected in July, Aug., and Sept. were pooled and analyzed as a randomized complete block design with cultivars nested within species. Orthogonal contrasts were used to test hypothesis of species performance. Fishers's least significant difference (LSD) test was used to compare means over all cultivars.

Results

PERCENT COVER. In the establishment year (August 1992 to August 1993), best germination and cover were achieved by the ryegrasses, followed by the fine fescues, tall fescues, and rough bluegrass (data not shown). Poorest germination and cover were recorded for the kentucky bluegrasses. In the second year (August 1993 to August 1994), the ryegrasses still had the highest cover, followed by the fine fescues, tall fescues, and rough bluegrass. Kentucky bluegrass had some lateral growth, but still rated poorly in cover.

The tall fescue cultivars maintained the highest cover (Table 2). Most cultivars maintained 63% to 87% cover and increased in percentage cover when compared to measurements taken in 1994 (Table 3). The variability in percentage cover among the tall fescue cultivars tested was nonsignificant, with the exception of 'LDTF II-92', which had 50% cover in 2000, a loss of 12% compared to 1994.

The fine fescues (chewings fescue, red fescue, and hard fescue) maintained higher cover during 2000 than did kentucky bluegrass, rough bluegrass, or perennial ryegrass (Table 2). The chewing fescues maintained better cover than the red fescues, and the red fescues maintained better coverage than the hard fescues. The chewings fescue cultivars 'RUCF-92' and 'Jamestown II' produced cover that was comparable to the best tall fescue cultivars (Table 3).

The kentucky bluegrasses maintained higher cover during 2000 than did the perennial ryegrasses and rough bluegrass. 'Coventry' produced significantly better cover than did '4 Aces' or 'Blacksburg', but was significantly lower than the top performing tall fescues. No differences between the ryegrasses and rough bluegrasses were observed. The perennial ryegrasses had some of the highest percentage cover estimates during 1994. However, the percentage cover for the perennial ryegrasses and rough bluegrass decreased 45% to 70% during the study period.

OVERALL QUALITY. In 1993, most of the grasses had acceptable quality (data not shown). The bluegrasses received the lowest ratings due to poor cover, and the fine fescues had poor color. Rough bluegrass had high quality in 1993 but declined in 1994 due to poor color and loss of cover. The fine fescues scored higher in quality in 1994. The tall fescues had good color, but scored lower in 1994 due to loss of cover caused by brown patch (*Rhizoctonia solani*).

During 2000, the tall fescue entries maintained higher overall visual quality than the other species in the trial (Table 4). Tall fescue has a more course leaf texture, but the density, cover, and color were superior to the other grasses tested. Few differences among the cultivars were observed (Table 5). However, 'Rebel 3D' and 'LDTF II-92' had significantly lower quality compared to 'Tribute' which had the highest overall quality among the cultivars tested.

The fine fescues outperformed the kentucky bluegrasses, perennial ryegrasses, and rough bluegrass. No differences between the chewings fescue, hard fescue, or red fescue were observed. Several of the fine fescues had lower overall quality in 2000 compared to 1994. Among the fine fescues, 'RUCF-92', 'Jamestown II', 'Molinda', and 'SCR-92' had overall quality comparable to some of the tall fescues. However, only 'RUCF-92' was comparable to 'Tribute' tall fescue.

The kentucky bluegrasses, perennial ryegrasses, and rough bluegrass had the lowest overall quality in 2000. The kentucky bluegrasses evaluated were similar in quality to the ryegrasses and rough bluegrass. Several of these cultivars had decreased over time in quality since 1994.

Discussion

Long term quality and cover of the tall fescue cultivars observed in this study may be due to their greater adaptability to extreme climatic conditions than the other species in the study tolerate. Columbus, Ohio is slightly north of what is traditionally considered the transition zone [along and roughly 100 miles (161 km) either side of a line from Washington D.C. to St. Louis to Topeka, Kans.]. However, temperature and moisture extremes, particularly in the summer, may have favored the tall fescue in this trial (Turgeon, 1991).

During the study period, the tall fescues gained in overall quality and cover. However, many of the kentucky bluegrass, perennial ryegrass, and rough bluegrass cultivars that had established well decreased in overall cover and quality during the study period. Since no additional supplemental irrigation and only minimal fertilizer was applied after the first year, tall fescue, with its deeper and more extensive root system (McCarty, 2001), may have had a competitive advantage over the other species for nutrient acquisition.

The results of this study were consistent with previous suggestions that tall fescue has a long-term competitive advantage that offsets the rapid initial establishment of other species such as perennial ryegrass (Engel, 1974; Turgeon, 1991). The tall fescues had the highest quality, primarily due to darker green color, cover, and density (Fig. 1A). The fine fescues maintained acceptable cover, but were more subject to encroachment by weeds and other grasses and had a lighter green color (Fig. 1B). The other species tested did not maintain acceptable stand density and were subject to extensive weed encroachment (Fig. 1C).

Specific cultivar recommendations for turfgrass in shade was not the objective of this study. Some of the cultivars tested were experimental in 1992 and never released by the registrant. Also, variability in cultivar performance would be expected in different levels of shade or in different soils, locations, etc. However, in this study, we note that the long-term performance of the tall fescue cultivars tested was superior to the other grasses (Fig. 1). Also, initial establishment success does not appear to

Table 1. Species and cultivars of turfgrass evaluated for long-term performance in shaded conditions in Columbus, Ohio.

Common name	Scientific name	Cultivar	Seed Co.[y]	Seeding rate ($g\cdot m^{-2}$)[z]
Kentucky bluegrass	*Poa pratensis*	4 Aces	Turf Seed	4.9
Kentucky bluegrass		Blacksburg	Turf Seed	4.9
Kentucky bluegrass		Bristol	O.M. Scott	4.9
Kentucky bluegrass		Coventry	O.M. Scott	4.9
Kentucky bluegrass		SKB-712	Lesco	4.9
Kentucky bluegrass		WWKB-92	Lesco	4.9
Rough bluegrass	*Poa trivialis*	Laser	Lofts Seed	4.9
Chewings fescue	*Festuca rubra* ssp. *fallax*	Banner	O.M. Scott	19.5
Chewings fescue		Jamestown II	Lofts Seed	19.5
Chewings fescue		Molinda	O.M. Scott	19.5
Chewings fescue		RUCF-92	Lesco	19.5
Chewings fescue		SCF-E	Lesco	19.5
Hard fescue	*Festuca brevipila*	Aurora	Turf Seed	19.5
Hard fescue		Brigade	O.M. Scott	19.5
Hard fescue		Reliant	Lofts Seed	19.5
Red fescue	*Festuca rubra*	SCR-92	Lesco	19.5
Red fescue		Shademaster	Turf Seed	19.5
Red fescue		SMWE-92	Lesco	19.5
Tall fescue	*Festuca arundinacea*	Aztec	O.M. Scott	34.3
Tall fescue		LDTF II-92	Lesco	34.3
Tall fescue		PSFL-92	Lesco	34.3
Tall fescue		Rebel 3D	Lofts Seed	34.3
Tall fescue		Rebel Jr.	Lofts Seed	34.3
Tall fescue		SFL	O.M. Scott	34.3
Tall fescue		Silverado	Turf Seed	34.3
Tall fescue		Tomahawk	Turf Seed	34.3
Tall fescue		Tribute	Lofts Seed	34.3
Perennial ryegrass	*Lolium perenne*	Alliance	Turf Seed	34.3
Perennial ryegrass		Brightstar	Turf Seed	34.3
Perennial ryegrass		Citation II	Turf Seed	34.3

[z]$4.9\ g\cdot m^2 = 1\ lb/1000\ ft^2$.
[y]Turf Seed = Turf-Seed Inc., Hubbard, Ore.; Lofts Seed = Lofts Seed, a division of Budd Seed, Winston-Salem, N.C; Lesco = Lesco, Inc., Rocky River, Ohio; O.M. Scott = The Scotts Company, Marysville, Ohio.

Table 2. Mean percentage cover estimates during 2000 for various turfgrass species grown in moderate shade in Columbus, Ohio.

Species	Cultivars tested (no.)	Mean cover (%)[z]	
Tall fescue	9	72.2	
Chewings fescue	5	62.7	
Red fescue	3	50.0	
Kentucky bluegrass	6	32.5	
Hard fescue	3	27.2	
Rough bluegrass	1	10.0	
Perennial ryegrass	3	8.9	
Analysis of variance			
Source	df	MS	$P > F$
Replication	2	2064	<0.01
Entry	29	1920	<0.01
Species	6	7566	<0.01
Tall fescue vs. other species	1	23469	<0.01
Fine fescues vs. bluegrasses and ryegrass	1	10935	<0.01
Chewings fescue vs. hard fescue and red fescue	1	4735	<0.01
Hard fescue vs. red fescue	1	2335	<0.01
Kentucky bluegrass vs. ryegrass and rough bluegrass	1	3920	<0.01
Perennial ryegrass vs. rough bluegrass	1	3	0.93
Cultivar (species)	23	447	0.15
Error	58	318	

[z]Values are the average of visual estimates of three replicate plots for each cultivar evaluated.

Table 3. Change in percentage cover of turfgrass cultivars maintained in a shaded location from 1994–2000 in Columbus, Ohio.

Cultivar	Species	Mean cover (%) 2000	Mean cover (%) 1994	Change (%)
Tribute	Tall fescue	87	73	14
RUCF-92	Chewings fescue	87	79	8
SFL	Tall fescue	80	38	42
Rebel 3D	Tall fescue	80	48	32
Tomahawk	Tall fescue	80	85	–5
PSFL-92	Tall fescue	77	77	0
Rebel Jr.	Tall fescue	73	63	10
Jamestown II	Chewings fescue	70	60	10
Silverado	Tall fescue	67	55	12
Aztec	Tall fescue	63	58	5
SCR-92	Red fescue	57	62	–5
Banner	Chewings fescue	53	57	–4
Molinda	Chewings fescue	53	60	–7
SMWE-92	Red fescue	50	60	–10
LDTF II-92	Tall fescue	50	62	–12
Coventry	Kentucky bluegrass	47	32	15
SKB-712	Kentucky bluegrass	43	20	23
Shademaster	Red fescue	43	68	–25
SCF-E	Chewings fescue	43	73	–30
Brigade	Hard fescue	40	45	–5
WWKB-92	Kentucky bluegrass	37	10	27
Bristol	Kentucky bluegrass	33	28	5
Aurora	Hard fescue	22	67	–45
Reliant	Hard fescue	20	73	–53
4 Aces	Kentucky bluegrass	18	27	–9
Blacksburg	Kentucky bluegrass	17	17	0
Laser	Rough bluegrass	13	58	–45
Brightstar	Perennial ryegrass	13	75	–62
Alliance	Perennial ryegrass	7	72	–65
Citation II	Perennial ryegrass	7	77	–70
$LSD_{0.05}$ [z]		29		

[z]According to Fisher's least significant difference test (n = 3).

Table 4. Mean monthly turfgrass visual quality ratings during 2000 for various turfgrass species grown in moderate shade in Columbus, Ohio.

Common name	Cultivars tested (no.)	Mean quality rating[z]	
Tall fescue	9	6.1	
Chewings fescue	5	4.6	
Hard fescue	3	4.2	
Red fescue	3	4.1	
Kentucky bluegrass	6	3.7	
Rough bluegrass	1	3.6	
Perennial ryegrass	3	2.9	
Analysis of variance			
Source	df	MS	$P > F$
Replication	2	17	<0.01
Entry	29	5	<0.01
Species	6	19	<0.01
Tall fescue versus Other species	1	90	<0.01
Fine fescues versus bluegrasses and ryegrass	1	13	<0.01
Chewings fescue versus hard fescue and red fescue	1	2	0.21
Hard fescue versus red fescue	1	0	0.94
Kentucky bluegrass versus ryegrass and rough bluegrass	1	3	0.08
Perennial ryegrass versus rough bluegrass	1	1	0.30
Cultivar (species)	23	2	0.05
Error	58	1	

[z]Turfgrass visual quality was evaluated on a scale of 1-9 where 1 = poorest quality, 6 = acceptable turfgrass, and 9 = best quality based on overall color, cover, and density.

Table 5. Change in overall quality of turfgrass cultivars maintained in a shaded location from 1994 to 2000 in Columbus, Ohio.

Cultivar	Species	Mean quality rating[z] 2000	1994	Change 1994–2000
Tribute	Tall fescue	7.2	5.8	1.4
PSFL-92	Tall fescue	6.9	6.3	0.6
SFL	Tall fescue	6.3	4.0	2.3
Rebel Jr.	Tall fescue	6.3	6.3	0.0
Tomahawk	Tall fescue	6.2	7.8	–1.6
Aztec	Tall fescue	6.0	5.7	0.3
RUCF-92	Chewings fescue	5.8	7.4	–1.6
Silverado	Tall fescue	5.6	6.0	–0.4
Rebel 3D	Tall fescue	5.4	4.2	1.2
LDTF II-92	Tall fescue	5.1	6.3	–1.2
Jamestown II	Chewings fescue	4.9	6.3	–1.4
Molinda	Chewings fescue	4.7	7.5	–2.8
SCR-92	Red fescue	4.6	6.4	–1.8
Bristol	Kentucky bluegrass	4.4	3.8	0.6
Coventry	Kentucky bluegrass	4.4	5.0	–0.6
Aurora	Hard fescue	4.3	7.2	–2.9
SCF-E	Chewings fescue	4.2	7.7	–3.5
Brigade	Hard fescue	4.1	6.0	–1.9
Reliant	Hard fescue	4.1	6.5	–2.4
Brightstar	Perennial ryegrass	4.1	7.0	–2.9
SMWE-92	Red fescue	4.1	8.0	–3.9
SKB-712	Kentucky bluegrass	3.9	2.5	1.4
WWKB-92	Kentucky bluegrass	3.9	3.0	0.9
Shademaster	Red fescue	3.8	6.3	–2.5
Laser	Rough bluegrass	3.6	5.9	–2.3
Banner	Chewings fescue	3.4	5.7	–2.3
Blacksburg	Kentucky bluegrass	2.9	3.3	–0.4
4 Aces	Kentucky bluegrass	2.8	5.0	–2.2
Citation II	Perennial ryegrass	2.7	7.7	–5.0
Alliance	Perennial ryegrass	1.9	6.2	–4.3
$LSD_{0.05}$[y]		1.6		

[z]Turfgrass visual quality was evaluated on a scale of 1 to 9 where 1 = poorest quality, 6 = acceptable turfgrass, and 9 = best quality based on overall color, cover, and density.
[y]According to Fisher's least significant difference test (n = 3).

Fig. 1. Appearance of a representative tall fescue (left), fine fescue (middle), and kentucky bluegrass (right) cultivar after establishment and maintenance under moderate shade for the 8-year period 1992–2000 in Columbus, Ohio. Signs are printed on 28 × 21.5-cm (11.0 × 8.5-inch) cardstock.

be a good predictor of long-term success of a cultivar. Finally, there appears to be some variability in cultivar performance under shade within a given turfgrass species.

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