Establishment Rate and Lateral Spread of *Festuca arundinacea* Cultivars

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Keywords: rhizomes, rhizomatous tall fescue

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This paper was published as: Rodney St. John, Jack Fry, Dale Bremer, and Steve Keeley (2009). Establishment rate and lateral spread of *Festuca arundinacea* cultivars. International Turfgrass Society Research Journal, 11:481-487.

ABSTRACT

Tall fescue (*Festuca arundinacea* Shreb.) is usually classified as a bunch grass, but produces short rhizomes. Newer tall fescue cultivars have been developed that reportedly produce longer and more numerous rhizomes. This study was conducted to evaluate the establishment rate and lateral spread of 'Grande II' and 'Regiment II', cultivars with greater rhizome forming capability according to breeders; Water Saver RTF tall fescue blend (RTF blend), which contains the rhizomatous tall fescue 'Labarinth'; 'Barlexus' tall fescue, a non-rhizomatous turf-type cultivar; 'Kentucky-31' tall fescue, a non-rhizomatous cultivar originally developed for forage; and SR2284 Kentucky bluegrass (*Poa pratensis* L.). By six weeks after seeding at Manhattan, KS, USA, Kentucky-31 tall fescue plots had the greatest coverage (80%) and Kentucky bluegrass had the least (60%). Ten months after seeding, plugs were removed from plots and transplanted into bare soil in Manhattan and Olathe, KS. Twenty-one months after transplanting, Kentucky bluegrass plugs had grown to a diameter over twice the size of tall fescue cultivars at Olathe and three times the diameter in Manhattan. Voids were created by cutting a 30.5-cm wide by 10.2-cm deep section sod from the center of each plot, filled with the same field soil, and monitored for encroachment from plants on the perimeter of the void. Void diameters 21 months after creation were 1.0 cm for Kentucky bluegrass and >18 cm for all tall fescue cultivars and the blend, none of which differed in void size. Use of rhizomatous tall fescue cultivars, or a blend containing one such cultivar, did not increase establishment rate or lateral spread relative to tall fescue cultivars not marketed as rhizomatous cultivars.

Tall fescue is a cool-season perennial turfgrass used for home, commercial, and public lawn areas, golf course roughs, and athletic fields. Textbooks usually refer to tall fescue as a bunch grass; as such, it has limited ability to spread laterally. However, it has long been recognized that the species produces short rhizomes (Beard, 1973). Even the first turf-type tall fescue cultivar, ‘Rebel’, produced a limited number of rhizomes (Brilman, 1998). Jernstedt and Bouton (1985) concluded that the short rhizomes found in some tall fescue genotypes were equivalent in their anatomy, pattern of growth, and overall form to rhizomes of other grasses. Despite some limited rhizome production capability, and tillering, traditional tall fescue cultivars are slow to spread and recover. We will refer to traditional tall fescue cultivars as non-rhizomatous types herein.

Turfgrass breeders have recently produced some tall fescue cultivars that produce more and longer rhizomes than traditional cultivars. Herein, we will refer to these as rhizomatous tall fescues. One rhizomatous tall fescue, Labarinth, was developed by crossing a Portugese rhizomatous tall fescue with standard American and European turf-type tall fescues (Singh et al., 2005). After seeding, 88% of Labarinth plants produced rhizomes, whereas 16 to 42% of plants in stands of other cultivars produced rhizomes (Singh et al., 2005). Furthermore, rhizome length and the number of shoots per rhizome were also higher in Labarinth compared to other cultivars. Although rhizomatous tall fescue cultivars and blends have been widely sold, little research has been done to evaluate the ability of these grasses to spread laterally in the field. It would be highly desirable to have a tall fescue that produced rhizomes that would aid in the plant’s ability to withstand traffic, recover from damage, and have good sod strength. At present, seed of Kentucky bluegrass, a prolific rhizome producer, is commonly mixed with tall fescue seed to improve turf recuperative potential and hasten the date of sod harvest after planting (Christians, 2004).

Our objectives were to compare the establishment rate and lateral spread of rhizomatous tall fescue cultivars, and a blend containing a rhizomatous cultivar, with non-rhizomatous cultivars and Kentucky bluegrass.

MATERIALS AND METHODS

Establishment Rate

Five tall fescue cultivars, a tall fescue blend, and a Kentucky bluegrass were seeded into a Chase silt loam (fine, smectitic, mesic, Aquertic Argiudoll) soil in 1.5 x 1.5 m plots arranged in a randomized complete block design on 14 September 2005 at the Rocky Ford Turfgrass Research Center in Manhattan, KS (39°13'53" N, 96°34'51" W); each cultivar or blend was replicated four times. The tall fescues evaluated included Grande II, Regiment II, Barlexus, RTF blend (39.84% Labarinth; 29.93% Barlexus II; 29.86% Barrington); and Kentucky-31. SR2284 Kentucky bluegrass was also included for comparison. The tall fescue cultivars evaluated that are purported to exhibit enhanced rhizome production were Grande II, Regiment II, and RTF blend (Labarinth included in the blend). Tall fescue was seeded at 343 kg ha^{-2} and Kentucky bluegrass at 98 kg ha^{-2}. Seed was mixed with Milorganite (6-2-0, N-P_2O_5-K_2O; Milwaukee, WI) to provide nitrogen at a rate of 98 kg ha^{-2} at the time of seeding. Turf was irrigated lightly and frequently during the first four weeks after establishment. Thereafter, irrigation was applied once or twice weekly to prevent drought stress. Plots were mowed as needed at 7.5-cm using a rotary mower, and clippings were returned.

During establishment, percentage of coverage was determined using digital image analysis described by Karcher and Richardson (2003 and 2005). Briefly, this method uses digital photography and scanning software to quantify the percentage of each plot that is covered with green turfgrass. In our study, digital images of each plot were recorded and analyzed weekly with a digital camera (First Growth, Decagon, Pullman, WA) for the first 9 weeks after seeding.

Lateral Spread from Transplanted Plugs

On 28 July 2006, four 10.2-cm diam. by 10.2-cm deep plugs were removed from the center of each plot, resulting in 16 plugs of each turfgrass cultivar or blend. Eight of the 16 plugs were planted into bare soil at the Rocky Ford Turfgrass Research Center in Manhattan, KS on 28 July 2006, and the remaining 8 were planted at the Olathe Horticulture Research and Extension Center in Olathe, KS (38^{o}53'04" N, 94^{o}59'34" W) on 28 July 2006. The study area in Manhattan was adjacent to the original plots and soil type was the same. Soil type at Olathe was an Oska- (Fine, smectitic, mesic Vertic Argiudolls) Martin (Fine, smectitic, mesic Aquertic Argiudolls) complex.

Prior to planting at each site, weed barrier fabric was laid down in a 9.1 m. x 6.1 m area. Plots measuring 1.5 m by 1.5 m were laid out over the weed barrier, and two holes per plot, each 12-cm in diam., were cut in the weed barrier. One hole was generally located 0.5 m to the northwest of each plot's center, and the other 0.5 m to the southeast of center. A cup cutter was then centered over each hole in the weed barrier, and used to remove a soil core 10.2-cm diam. by 10.2-cm deep to accommodate each plug. On 1 Sept. 2006, holes in the weed barrier were enlarged to a 30.5-cm diam. around each plug to accommodate lateral spread. In early spring, 2007 the weed barrier was removed from plots at each location. In June 2007, weeds were removed by hand and oxadiazon [2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-1,3,4-oxadiazolin-5-one] was applied 4.5 kg a.i. ha^{-1} to prevent emergence of annual grassy weeds. Any weeds that emerged in the study site were removed by hand.

Mowing and fertilization were performed as described for the establishment study, with fertilization beginning in September, 2006. Automated, in-ground irrigation in Manhattan was used two to three times weekly to deliver about 3 cm of water per week. At Olathe, in-ground irrigation was not available, and water was applied through a hose-end sprinkler only to prevent severe stress.

To measure lateral spread, the diameter of each plug was measured using a tape measure in a north-south and an east-west direction, and an average diameter was determined for each plot. Plug diameter measurements were taken at both locations on 5 May and 7 Oct. 2007 and 9 May 2008.

Lateral Spread into Voids

The same study area in Manhattan as used for the establishment study was used for this study. On 1 August 2006, a circle measuring 30.5-cm in diameter and 10.2-cm deep was cut in the center of each 1.5 x 1.5 m plot, around the perimeter of where plugs had been removed for the above study evaluating lateral spread of plugs. The voids were filled with the same field soil to the original soil level in the plot. Hand weeding within each circular void was done as needed. Nitrogen from urea (46-0-0) was applied at 49 kg ha^{-2} in November 2005, May, September, and November 2006, and May and September 2007. Irrigation was applied in the absence of rainfall to provide about 3 cm water weekly. Mowing was done at least once weekly with a rotary mower at a height of 7.5 cm.

On 31 August and 5 Oct. 2006, the number of emerging daughter plants arising from rhizomes within each void was counted. On 31 August, the greatest distance from the circle's edge that a newly emerging daughter plant was observed was also recorded. On 5 May and 7 Oct. 2007, and 9 May 2008, a tape measure was used to measure the diameter of the voids that remained in the center of the plots. Measurements in each void were taken in a north-south and east-west direction, and then averaged.

Experimental Design and Statistical Analysis

Data on percent coverage during establishment, lateral spread of plugs, and lateral spread into voids were analyzed as a randomized complete block design with four replications Data were subjected to analysis of variance and means separated using Fisher's LSD ($P < 0.05$) employing Statistical Analysis Systems (SAS Institute, 2003).

RESULTS AND DISCUSSION

Establishment Rate

Kentucky bluegrass was slowest to establish following seeding in Fall, 2005 (Fig. 1). Among tall fescues, Kentucky-31 exhibited greater coverage three weeks after seeding than other cultivars, and was greater than at least one other tall fescue cultivar or the blend on all rating dates. Regiment II had the lowest coverage among all tall fescue cultivars between 2 and 5 weeks and at 7 weeks after seeding. Coverage was similar among the other tall fescue cultivars and the RTF blend, and their coverage was generally intermediate between Regiment II and Kentucky-31.

Establishment of tall fescue is recognized to be relatively quick , but slow in Kentucky bluegrass (Christians, 2004) and this was substantiated by our results (Fig. 1). Furthermore, the rhizomatous tall fescue cultivars Grande II and Regiment II, as well as the RTF blend containing Labarinth, were no faster to establish than nonrhizomatous cultivars. Thus, the ability to produce rhizomes does not necessarily equate to more rapid establishment. Singh et al. (2005) reported that the use of Labarinth tall fescue resulted in fewer days to harvest for sod growers due to the aggressive, rhizomatous nature of the cultivar

Not all plants within a seed lot of a rhizomatous tall fescue are capable of producing rhizomes. Singh et al. (2005) found that 88% of Labarinth plants produced rhizomes, whereas 16 to 42% of other (nonrhizomatous) cultivars produced rhizomes. In the RTF blend in our study, competition from non-rhizomatous cultivars may have inhibited rhizome development in Labarinth, and may have affected the blend's overall establishment rate. Bouton et al. (1989) found that when grown for forage, tall fescue rhizome production was reduced due to competition from bermudagrass. Competition among cultivars in a blend or among plants of a single cultivar, however, does not explain why establishment was not faster in any of the other rhizomatous compared with non-rhizomatous cultivars during the study. Clearly, the relationship between rhizome production and establishment rate is poorly understood and may even vary among cultivars within different turfgrass species.

Lateral Spread from Transplanted Plugs

In May, 2007 and 2008, and October, 2007, diameters of transplanted Kentucky bluegrass plugs were larger than plugs of all tall fescue cultivars and the RTF blend (Table 1). By October 2007, Kentucky bluegrass plug diameter was twice that of all tall fescue cultivars and the blend at Olathe, and three times larger in Manhattan; the latter may have been caused by more frequent irrigation in Manhattan than in Olathe. None of the plugs of rhizomatous tall fescue cultivars or the RTF blend had larger diameters than non-rhizomatous cultivars.

Lateral Spread into Voids

Kentucky bluegrass had significantly more emerging daughter plants than any tall fescue cultivar or blend on each evaluation date in 2006 (Table 2). Kentucky bluegrass had produced > 11 daughter plants per 30.5-cm void on 31 August and > 18 on 5 October. The average number of daughter plants emerging in voids in tall fescue plots was ≤ 2 on both evaluation dates. On 31 August, the greatest distance from the circle's edge that a Kentucky bluegrass daughter plant emerged was about 8 cm. Tall fescue daughter plants emerged no greater than 2.25 cm from the circle's edge. Singh et al. (2005) noted that tall fescue cultivars that were more rhizomatous, Labarinth and Torpedo in their study, had rhizomes 2.6 cm longer than those of Kentucky-31 12 months after planting. We observed no difference in the length of rhizomes between the RTF blend, which contained Labarinth, and Kentucky-31 at 12 months after planting; 31 August was about 12 months after planting and about one month after voids had been created.

In May and October, 2007, Kentucky bluegrass had a void diameter that was less than half of that for tall fescue cultivars and blends; no differences occurred among the tall fescues (Table 3). By

May 2008, the voids in the Kentucky bluegrass plots measured 1 cm in diam; whereas, voids in all tall fescue plots were similar and average diameter was about 21 cm. None of the rhizomatous tall fescue cultivars or the blend reduced the diameter of the voids more quickly than the non-rhizomatous cultivars.

Labarinth tall fescue required 20 months in the field before rhizome production was substantially higher than production in other cultivars (Singh et al., 2005). In May 2008, our tall fescue plants were over 32 months old, and there still had not been lateral spread from rhizomatous tall fescues that was superior to non-rhizomatous types. Best production of rhizomes in Labarinth tall fescue occurred on a sandy loam soil compared to a clay loam (Singh et al., 2005). The silt loam soil at the Rocky Ford site and silty clay loam at Olathe may have also reduced rhizome formation compared to what was observed on the sandy loam used by Singh et al. (2005).

In summary, establishment rate of Kentucky-31 tall fescue, a nonrhizomatous cultivar, was faster than that of Grande II and Regiment II (rhizomatous turf-type cultivars), Barlexus (a nonrhizomatous turf-type cultivar), and RTF blend (containing the rhizomatous cultivar Labarinth). Rate of lateral spread from plugs, and into voids, was similar among all tall fescue cultivars and the RTF blend, but significantly slower than Kentucky bluegrass. Use of tall fescue cultivars marketed as having rhizome-forming capability, either in monostands or in a blend, did not hasten establishment rate or lateral spread in this study.

ACKNOWLEDGMENTS

This project was sponsored, in part, by the Kansas Turfgrass Foundation. We are also grateful to Hummert International, Barenbrug USA, and Seed Research of Oregon for providing seed, and to Jake Wilson, undergraduate research assistant, for help with data collection.

Fig. 1. Percentage coverage of tall fescue cultivars and a blend, and Kentucky bluegrass, for nine weeks after seeding on 14 Sept. 2005. Points represent the mean of four replicates. Closed and open symbols denote rhizomatous and non-rhizomatous tall fescue cultivars, respectively. Points followed by the same letter in a week are not statistically different ($P < 0.05$).

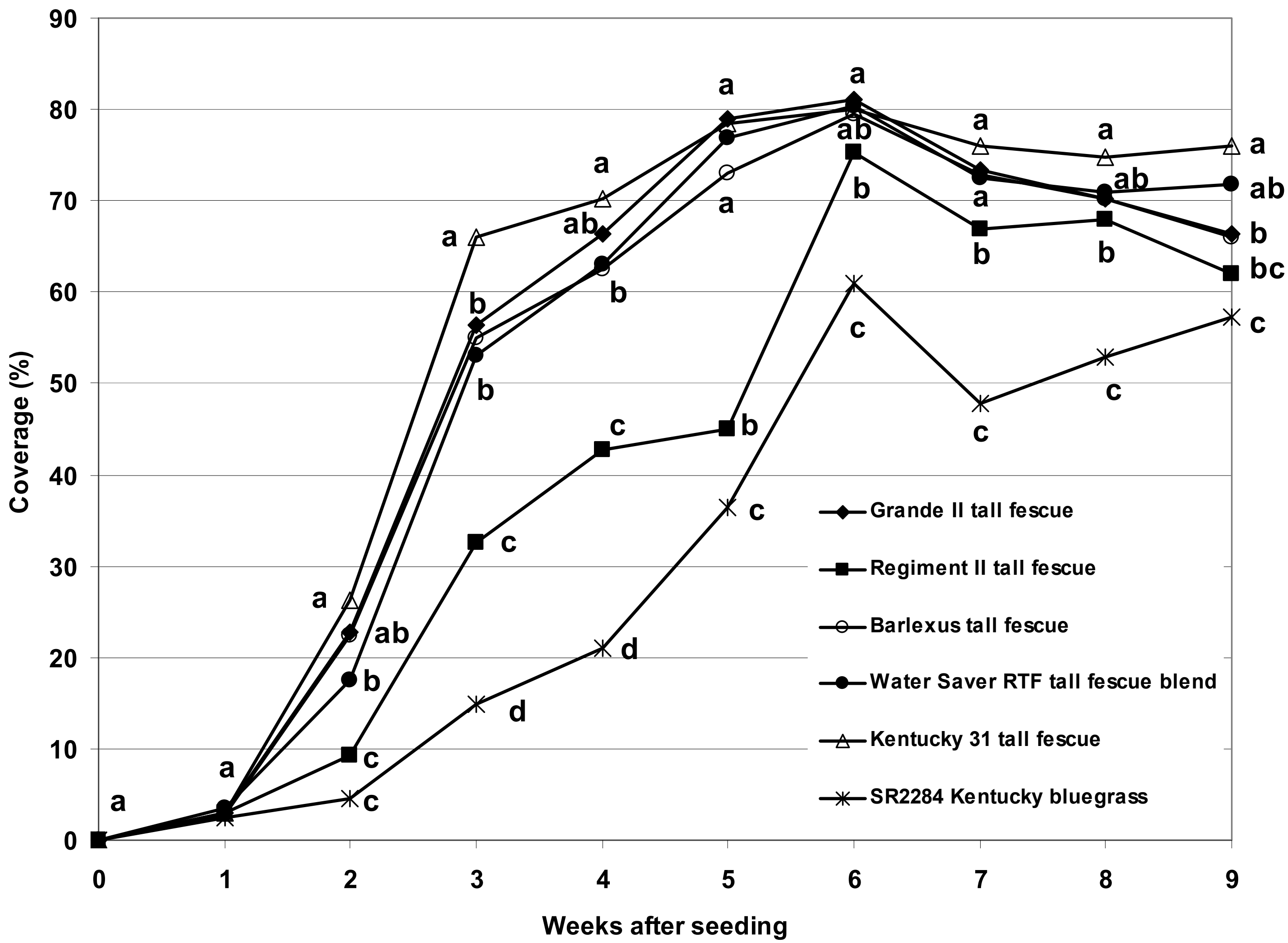

Table 1. Diameter of plugs of five tall fescue cultivars, one tall fescue blend, and a Kentucky bluegrass that were originally 10.2 cm in diameter when planted into bare soil on 28 July 2006 in Manhattan and Olathe, KS.

	Plug diameter (cm)					
	5 May 2007		7 Oct. 2007		9 May 2008	
Cultivar or blend	Manhattan	Olathe	Manhattan	Olathe	Manhattan	Olathe
Grande II tall fescue †	17.0b*	16.4b	22.2b	18.7b	31.5b	34.3b
Regiment II tall fescue †	18.7b	13.5b	20.3b	17.0b	30.6b	28.6b
Water saver RTF tall fescue blend ‡	16.2b	15.4b	21.4b	16.8b	29.8b	30.4b
Barlexus tall fescue	18.3b	15.2b	21.0b	17.3b	28.6b	29.8b
Kentucky-31 tall fescue	16.3b	16.5b	18.8b	20.2b	27.9b	34.3b
SR2284 Kentucky bluegrass	38.8a	30.0a	73.7a	45.1a	91.8a	65.5a

* Means followed by the same letter on a date are not significantly different ($P < 0.05$). Numbers represent the means of 2 plugs per plot and four replications.

†These cultivars have been reported to produce more and longer rhizomes than standard tall fescue cultivars.

‡The Water Saver RTF blend contained 39.84% Labarinth; 29.93% Barlexus II; and 29.86% Barrington tall fescue. Labarinth has been reported to have greater capacity for rhizome production than standard tall fescue cultivars.

Table 2. Number of daughter plants emerging in 30.5-cm circular voids in the center of tall fescue and Kentucky bluegrass plots, and the farthest distance away from the circle's edge that any one daughter plant emerged in the void at Manhattan, KS in 2006. Voids were created on 28 July 2006.

	Daughter plants (no.)		Distance (cm)
Cultivar or Blend	Aug. 31	Oct. 5	Aug. 31
Grande II tall fescue †	0.5 b*	0.5 b	1.3 b
Regiment II tall fescue †	2.0 b	0.0 b	2.3 b
Water saver RTF tall fescue blend ‡	0.3 b	0.5 b	0.3 b
Barlexus tall fescue	1.5 b	1.0 b	1.5 b
Kentucky-31	1.3 b	2.0 b	1.0 b
SR2284 Kentucky bluegrass	11.5 a	18.8 a	8.3 a

*Means followed by the same letter on a date are not significantly different ($P < 0.05$).

†These cultivars have been reported to produce more and longer rhizomes than standard tall fescue cultivars.

‡The Water Saver RTF blend contained 39.84% Labarinth; 29.93% Barlexus II; and 29.86% Barrington tall fescue. Labarinth has been reported to have greater capacity for rhizome production than standard tall fescue cultivars.

Table 3. Diameter of voids, originally 30.5-cm wide on 28 July 2006, in plots of tall fescue and Kentucky bluegrass that were seeded in September, 2005 in Manhattan, KS. Voids were created on 28 July 2006.

	Void diameter (cm)		
Cultivar or Blend	5 May 2007	7 Oct. 2007	9 May 2008
Grande II tall fescue †	29.6 a*	21.7 a	18.3 a
Regiment II tall fescue †	27.7 a	21.8 a	22.3 a
Water saver RTF tall fescue blend ‡	29.5 a	24.6 a	20.5 a
Barlexus tall fescue	29.5 a	24.1 a	22.8 a
Kentucky-31 tall fescue	27.9 a	26.1 a	23.0 a
SR2284 Kentucky bluegrass	10.8 b	10.5 b	1.0 b

*Means followed by the same letter on a date are not significantly different ($P < 0.05$). Numbers represent the means of four replications.

†These cultivars have been reported to produce more and longer rhizomes than standard tall fescue cultivars.

‡The Water Saver RTF blend contained 39.84% Labarinth; 29.93% Barlexus II; and 29.86% Barrington tall fescue. Labarinth has been reported to have greater capacity for rhizome production than standard tall fescue cultivars.

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