Impact of Overseeding Bermudagrass with Various Amounts of Perennial Ryegrass for Winter Putting Turf

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Abstract. Research was conducted to determine the influence of the rate of seeding perennial ryegrass (*Lolium perenne* L.) over bermudagrass [*Cynodon dactylon* (L.) Pers × *C. transvaalensis* Burt-Davy] on both the establishment of the ryegrass and the quality of bermudagrass golf greens. Increasing seeding rate from 90 to 180 g·m⁻² resulted in more rapid establishment and a linear increase in turf quality. Turf density, as measured by leaf number, displayed linear and quadratic responses to seeding rates, with higher rates producing the greatest leaf numbers. Leaf width declined linearly with seeding rate, suggesting higher putting quality, as did tillers per plant. Spring transition to bermudagrass was slowed at high (150–180 g·m⁻²) seeding rates, with significantly more ryegrass present in late May. Emergence and growth of bermudagrass were suppressed longer at the higher overseeding rates. We conclude that the choice of seeding rate for ryegrass is a compromise between rapid development of, and maintenance of, quality turf vs. early smooth transition to bermudagrass in the spring.

Hybrid bermudagrass greens in the southern United States are usually overseeded in the fall with perennial ryegrass or other cool-season grasses to provide green color, a uniform surface, and tolerance to wear while the bermudagrass is dormant. Perhaps the greatest problem with overseeding is the transition to bermudagrass in the spring. Ideally, this should occur gradually, so that dormant bermudagrass is never visible. If the ryegrass dies abruptly, bermudagrass will require time to replace it. If the ryegrass lives too long, the bermudagrass will be slower to develop and take longer to recover. The ideal overseeding would rapidly establish a high-quality turf, maintain turf quality throughout the dormant period, and provide a smooth transition back to bermudagrass in the spring. Major problems are associated with loss of durability and aesthetics during fall and spring transitions. Establishment of ryegrass is most successful when soil tem-

peratures are 22 to 26 °C at a 10.2-cm depth (Batten et al., 1980; Beard, 1988), which minimizes competition from bermudagrass and reduces likelihood of disease on ryegrass. Ryegrass germination is apparently optimal in that temperature range.

Seedbed preparation affects overseeding establishment, and stand failures may result at any seeding rate if preparation is not performed at the right time (Gill et al., 1967; Ward et al., 1974). Thatch removal and aeration with topdressing are most effective if performed 4 to 6 weeks prior to overseeding (Schmidt, 1970; Ward et al., 1974). Vertical mowing just prior to overseeding reduces competition from bermudagrass and removes thatch with a resulting improvement in seedling stands (Duble, 1978; Gill et al., 1967). Perennial ryegrass seeding rates of 150 to 200 g·m⁻² are common (Duble, 1978; Schmidt, 1970; Ward et al., 1974), but rates of 100 g·m⁻² or less have been recommended to reduce costs and allow more rapid transition to bermudagrass in the spring (Nutter, 1973). Duble (1978) reported more tiller formation, stronger plants, delayed transition, and an abrupt loss of ryegrass with an unacceptable playing surface at low seeding rates. Mazur (1987) reported that core aeration, vertical mowing, and topdressing had no positive influence on spring transition to bermudagrass. Herbicides and plant growth regulators speed spring transition to bermudagrass (Johnson, 1994; Mazur, 1988); however, injury to perennial ryegrass resulted in unacceptable playing surfaces. This study was initiated to determine the effects of overseeding rates of perennial ryegrass on fall transition to ryegrass, maintenance of turf quality, and spring transition to bermudagrass on a golf putting green.

Separate experiments were conducted in 1987–88 and 1988–89 on a 'Tifgreen' bermudagrass putting green mowed daily at 0.6 cm with normal cultural practices. The green had a 70% sand and 30% pine bark (v/v) root-zone medium. Applications of 5 g·m⁻² N, 2.2 g·m⁻² P, and 4.2 g·m⁻² K from urea (45% N), superphosphate (8% P), and potassium sulfate (50% K), respectively, were made in September of each year. Isobutylidene diurea was applied monthly to supply 5 g·m⁻² N from October to May each year. One week prior to overseeding, the area was vertically mowed in two directions with 1-mm-thick blades spaced at 1.27 cm and set to penetrate 2 mm into the soil. 'Gator' perennial ryegrass was overseeded at 90, 120, 150, and 180 g·m⁻² on 2 Oct. 1987 and 7 Oct. 1988. Immediately after seeding, plots were topdressed with washed sand at 1.8 kg·m⁻². Overseeding treatments were arranged in a randomized block design with four replications. Plot size was 2.3 × 2.3 m. The plots were mowed for 2 weeks at a cutting height of 1.3 cm, which was gradually lowered to 0.6 cm by the first week in November. The height was maintained at 0.6 cm for the duration of the study. Irrigation was applied to maintain optimum growth of the ryegrass.

Visual estimates of turf quality were made biweekly in 1987–88 and approximately monthly in 1988–89. Biweekly leaf counts, as an estimate of turf density, were made on three 12.5-cm² areas of each plot. Tiller counts were made on 10 randomly selected plants per plot on four dates in 1988 and 1989 to estimate seeding rate effects on plant size. In 1988–89, leaf widths were measured for 15 random plants per plot on five dates to estimate texture of the putting surface. Analysis of variance for each trait-year combination was performed as a split-plot in time with date as the sub-plot. Orthogonal comparisons were used to determine the response of seeding rates, dates of observation, and their interactions.

Results and Discussion

Turf quality increased linearly with increasing seeding rate (Table 1). The 150 and 180 g·m⁻² rates produced high-quality turf more rapidly than did the lower rates; the turf reached quality ratings of 8.0 and 8.9, respectively, in <30 d, whereas the 120 g·m⁻² rate required 60 d and the 90 g·m⁻² 120 d to reach the minimal acceptable quality rating of 7.0. After 120 d, quality consistently increased with increasing seeding rate. The results suggest that 150 or 180 g·m⁻² are required to achieve rapid establishment of high-quality turf.

Leaf counts (an objective measure of turf density) displayed significant linear and quadratic responses to seeding rates in both years (Table 2), and seeding rate × date interaction was significant. Linear effects accounted for the majority of the variation in leaf number, and the increases in leaf number as seeding rate increased were larger during December and January. The incremental increases in leaf

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Table 1. Effect of seeding rate on turf quality ratings^a of perennial ryegrass on an overseeded bermudagrass putting green.

Seeding rate (g·m ⁻²)	Date of rating					
	1987-88					
	29 Oct.	8 Nov.	13 Nov.	19 Nov.	3 Dec.	17 Dec.
90	6.2	5.6	6.1	6.0	6.9	6.2
120	7.2	6.6	6.8	7.0	7.5	7.1
150	8.0	8.0	7.9	8.1	8.2	8.1
180	8.9	9.0	8.8	8.9	8.9	8.9
Linear	**	**	**	**	**	**
Quadratic	NS	NS	NS	NS	NS	NS
Cubic	NS	NS	NS	NS	NS	NS
	5 Jan.	18 Jan.	5 Feb.	18 Feb.	3 Mar.	11 Mar.
90	6.1	7.0	7.1	6.9	5.9	8.0
120	6.6	8.0	7.6	7.5	6.9	8.1
150	7.9	8.5	8.2	8.2	7.4	8.5
180	8.5	9.0	8.9	8.9	8.4	9.0
Linear	**	**	**	**	**	**
Quadratic	NS	NS	NS	NS	NS	*
Cubic	NS	NS	NS	NS	NS	NS
	25 Mar.	30 Mar.	12 Apr.	22 Apr.	4 May	27 May
90	7.1	7.4	8.0	8.0	8.2	7.2
120	7.4	8.1	8.5	8.5	8.8	8.0
150	7.5	8.1	8.5	8.5	8.9	8.0
180	7.9	8.6	8.9	8.9	9.0	8.8
Linear	**	**	**	**	**	**
Quadratic	NS	NS	NS	NS	NS	NS
Cubic	NS	*	**	**	NS	*
	1988-89					
	28 Oct.	18 Nov.	9 Dec.			
90	5.6	6.8	6.4			
120	7.4	7.8	7.2			
150	8.2	8.5	7.8			
180	8.9	8.8	8.5			
Linear	**	**	**			
Quadratic	**	NS	NS			
Cubic	NS	NS	NS			
	6 Jan.	8 Feb.	21 Feb.	17 Mar.	21 Apr.	24 May.
90	6.5	6.8	7.9	8.2	8.8	7.9
120	7.4	7.4	8.4	8.2	8.2	7.8
150	8.5	8.1	8.5	8.5	8.1	8.1
180	8.5	8.8	9.0	8.6	7.6	8.4
Linear	**	**	**	NS	*	**
Quadratic	NS	NS	NS	NS	NS	NS
Cubic	NS	NS	NS	NS	NS	NS

^aVisual estimates based on color, growth, and stand on a scale of 1 to 9, where 1= completely brown and 9= no discoloration with uniform stand density and growth.

NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

Table 2. Effect of seeding rate on mean leaf counts (number/cm²) of perennial ryegrass on an overseeded bermudagrass putting green.

Seeding rate (g.m ⁻²)	Date of rating						
Fall 1987							
	<u>23 Oct.</u>	<u>9 Nov.</u>	<u>20 Nov.</u>	<u>4 Dec.</u>	<u>17 Dec.</u>		
90	1.8	2.9	3.6	3.6	4.0		
120	2.4	3.4	4.2	4.0	4.9		
150	2.9	4.1	4.8	4.5	5.6		
180	3.3	4.3	5.2	5.7	6.3		
Linear	**	**	**	**	**		
Quadratic	NS	NS	NS	**	NS		
Cubic	NS	*	NS	NS	NS		
Winter and Spring 1988							
	<u>20 Jan.</u>	<u>5 Feb.</u>	<u>17 Feb.</u>	<u>1 Mar.</u>	<u>22 Mar.</u>	<u>7 Apr.</u>	
90	4.2	4.4	5.2	4.9	5.6	4.4	
120	5.0	4.8	5.9	5.3	5.8	4.8	
150	5.4	5.2	6.3	5.8	6.3	5.3	
180	6.0	6.3	6.9	6.8	6.8	6.1	
Linear	**	**	**	**	**	**	
Quadratic	NS	**	NS	NS	NS	NS	
Cubic	NS	NS	NS	NS	NS	NS	
Fall 1988							
	<u>2 Nov.</u>	<u>14 Nov.</u>	<u>1 Dec.</u>	<u>14 Dec.</u>			
90	2.8	4.2	4.2	4.6			
120	3.6	4.6	4.7	5.0			
150	4.5	5.3	5.4	5.8			
180	5.2	5.7	6.1	6.5			
Linear	**	**	**	**			
Quadratic	NS	NS	NS	*			
Cubic	NS	NS	NS	NS			
Winter and Spring 1989							
	<u>16 Jan.</u>	<u>30 Jan.</u>	<u>22 Feb.</u>	<u>13 Mar.</u>	<u>27 Mar.</u>	<u>10 Apr.</u>	<u>24 Apr.</u>
90	4.9	5.7	6.8	6.4	6.5	5.6	3.7
120	5.6	6.4	7.3	7.0	7.1	6.6	3.8
150	6.3	7.1	7.8	7.7	7.7	7.2	5.0
180	7.5	8.0	9.2	8.8	8.5	7.5	5.4
Linear	**	**	**	**	**	**	**
Quadratic	NS	NS	**	NS	NS	NS	NS
Cubic	NS	NS	NS	NS	NS	NS	*

NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

numbers and, therefore, turf density, were larger at the higher seeding rates. Turf density was thus higher at higher seeding rates and the effect was accentuated at the two highest rates.

Leaf widths (an objective measure of texture) were measured in 1988-89. Leaf widths decreased as seeding rates increased, with no interaction with date (Table 3). The finest texture occurred at the highest seeding rates.

Since tiller number was counted on 10 plants per sample and the data were divided into single- and multiple-tiller plants (plants with one stem and plants with more than one stem), the analysis of variance is identical for the two traits. Tillering rate decreased significantly with increasing seeding rate (Table 3). The greater tillering rate of the low seeding rates would decrease potential differences in

density, quality, and leaf width.

The percentage of green bermudagrass in the turf displayed significant linear, quadratic, cubic, and linear $\times$ date effects in 1987-88 (Table 4), but only linear effects were detected in 1988-89. At the time of the first rating on 4 May 1988, bermudagrass had largely displaced ryegrass at the lower seeding rates, especially at 90 g·m⁻². The turf at 180 g·m⁻² was less than half bermudagrass and by late May was still almost 30% ryegrass. Earlier ratings in 1989 showed a somewhat clearer transition, with $\approx$ 55% bermudagrass by late May at the 180 g·m⁻² rate. Emergence of bermudagrass was delayed as seeding rate increased. This response is opposite to that reported by Duble (1978). Apparently, the higher seeding rates did not result in weakened perennial ryegrass

plants that died sooner. Bermudagrass suppression thus lasted longer at the higher seeding rates of perennial ryegrass.

Increasing perennial ryegrass seeding rates from 90 to 180 g·m⁻² resulted in higher turf quality sooner, with higher density and finer leaf texture. The higher seeding rates produced turf of better quality throughout the ryegrass growing season. In contrast, lower seeding rates resulted in plants with more tillers, and earlier bermudagrass emergence in the spring. The choice of seeding rate is thus a compromise between turf quality and spring transition. If higher turf quality is desired, then the higher seeding rates should be used. The 150 g·m⁻² rate may be an appropriate choice, but delays transition to bermudagrass in the spring.

Table 3. Effects of seeding rate of perennial ryegrass on mean leaf width of seedlings, and on number of plants with a single tiller following overseeding on a bermudagrass putting green.

Seeding rate (g·m ⁻²)	Leaf width (mm)				No. plants with single tiller			
	1988				1988			
	15 Dec.				2 Mar. 1 Apr. 6 May 6 June			
90	1.44				4.9	4.2	6.7	6.9
120	1.30				6.3	6.8	8.1	8.3
150	1.15				9.1	8.8	9.2	9.1
180	1.09				8.8	9.2	9.2	9.8
Linear	**				**	**	**	**
Quadratic	NS				NS	NS	NS	NS
Cubic	NS				NS	NS	NS	NS
	1989				1989			
	20 Jan.	1 Mar.	21 Mar.	19 Apr.	20 Jan.	1 Mar.	21 Mar.	19 Apr.
90	1.38	1.36	1.58	1.48	4.6	4.3	3.7	5.2
120	1.30	1.36	1.51	1.38	6.4	6.1	5.8	7.1
150	1.23	1.27	1.34	1.21	7.8	6.4	8.3	8.2
180	1.14	1.23	1.26	1.15	9.5	7.5	8.8	9.4
Linear	**	**	**	**	**	**	**	**
Quadratic	NS	NS	NS	NS	NS	NS	NS	NS
Cubic	NS	NS	NS	NS	NS	NS	NS	NS

NS, **Nonsignificant or significant at $P \leq 0.01$, respectively

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Table 4. Bermudagrass spring transition (%) at four seeding rates of perennial ryegrass on an overseeded putting green.

Seeding rate (g·m ⁻²)	Date of rating			
	1988		1989	
	4 May	25 May	21 Apr	19 May
90	87.5	94.5	43.8	88.8
120	72.5	85.8	33.8	67.5
150	72.5	83.8	20.0	63.5
180	40.4	71.2	19.2	54.8
Linear	**	**	**	**
Quadratic	**	NS	NS	NS
Cubic	**	*	NS	NS

NS, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.