Morphology, Turf Quality, and Heat Tolerance of Intermediate Ryegrass

M.D. Richardson
Department of Horticulture, University of Arkansas, Fayetteville, AR 72701

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Abstract. Bermudagrass (Cynodon spp.) turf is often overseeded with a cool-season species such as perennial ryegrass (Lolium perenne L.) to provide an improved winter surface for activities such as golf or athletic events. Perennial ryegrass can become a persistent weed in overseeded turf due to the heat and disease tolerance of improved cultivars. Intermediate ryegrass is a relatively new turfgrass that is a hybrid between perennial and annual ryegrass (L. multiflorum Lam.). Very little information is available on intermediate ryegrass as an overseeding turf. Greenhouse, field, and growth chamber studies were designed to compare two cultivars of intermediate ryegrass (‘Transist’ and ‘Froghair’) with three cultivars of perennial ryegrass (‘Jiffie’, ‘Racer’, and ‘Calypso II’) and two cultivars of annual ryegrass (‘Gulf’ and ‘TAM-90’). In a greenhouse study, the perennial ryegrass cultivars had finer leaf texture (2.9–3.2 mm), shorter collar height (24.7–57.0 mm), and lower weight/tiller (29–39 mg) than the intermediate and annual cultivars. In the field studies, the intermediate cultivar Transist exhibited improved turfgrass quality (6.1–7.1) over the annual cultivars (4.5–5.8) and the other intermediate cultivar Froghair (5.4–5.7). However, neither of the intermediate cultivars had quality equal to the perennial ryegrass cultivars (7.0–7.9). The perennial ryegrass cultivars exhibited slow transition back to the bermudagrass compared to the annual and intermediate ryegrass cultivars. In the growth chamber study, the annual and intermediate cultivars showed increased high-temperature stress under increasing temperatures compared to the perennial cultivars, which did not show stress until air temperature exceeded 40 °C. Collectively, these studies indicate that the intermediate ryegrass cultivar Transist may have promise as an overseeding turfgrass due to its improved quality compared to annual types and a lack of heat tolerance relative to perennial cultivars, but with transition qualities similar to perennial ryegrass.

Bermudagrass (Cynodon spp.) continues as the predominate turfgrass species used for golf courses and sports fields in tropical and transition zone areas of the world. This widespread use reflects an ability of this species to resist wear, pests, and environmental stresses, while producing a high-quality surface for many types of sporting activities. Although bermudagrass has many positive attributes, a negative aspect of the species is the long winter dormancy period that is experienced in many areas of bermudagrass use. In the northern limits of adaptation, bermudagrass may be dormant for as long as 7 months per year. Because of the long dormancy period, bermudagrass is commonly overseeded with a cool-season grass to provide a year-long green surface to enhance sporting activities (Dudek and Peacock, 1980; Schmidt and Shoulders, 1977). Overseeding dormant bermudagrass turf has been an integral component of the continued growth in the golf industry in sunbelt states such as Florida, Texas, Arizona, and California.

The practice of overseeding dates back to the 1930s and was first adapted to golf courses and sports fields from pasture management, where cool-season annual grasses and legumes are often used for winter livestock grazing (Hoveland et al., 1978). Success in overseeding is affected by a number of management decisions and practices, such as the turfgrass species to be used, propagation techniques, and fertilization and water management. Collectively, these studies indicate that intermediate ryegrass cultivar Transist may have promise as an overseeding turfgrass due to its improved quality compared to annual types and a lack of heat tolerance relative to perennial cultivars, but with transition qualities similar to perennial ryegrass.

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1Associate Professor. To whom reprint requests should be addressed. E-mail address: mricha@uark.edu

Materials and Methods

Seven cultivars of intermediate, annual, and perennial ryegrass were compared in all studies (Table 1). The annual (A) cultivars represent an industry standard, ‘Gulf’, and a new cultivar, TAM-90, while the perennial (P) cultivars (‘Racer’, ‘Jiffie’, and ‘Calypso II’) were chosen based on their performance in other tests and their genetic similarity to the intermediate (I) cultivar, ‘Transist’ (D. Floyd, personal communication). The intermediate cultivars Transist and Froghair were the only cultivars available at the time of these studies.

Greenhouse study. A greenhouse study was conducted in which individual seedlings of each cultivar were established in a 10-cm pot (vol. = 1178 cm3) containing a commercial potting mix (Strong-Lite High Porosity Mix; Strong, Pine Bluff, Ark.). Three seeds were placed near the center of each pot and covered lightly with additional potting mix. After germination, each pot was thinned to one seedling for the remainder of the test. Pots were fertilized weekly with 100 mL of a commercial nutri-
ent solution (Peters 20N–4P–16K General Purpose Special) containing N at 50 mg·kg\(^{-1}\).

At 4 and 6 weeks after planting, six replicate pots of each cultivar were harvested at the soil surface and separated into leaf sheath and blade components. Data collected at each harvest included total number of tillers per pot, width of fully expanded leaf blades (average of four sub-samples per rep), dry weight of leaves, dry weight of sheath, and average height of leaf collar (average of four sub-samples per rep).

From the data collected, calculations were used to determine total shoot weight (leaf dry weight + sheath dry weight), leaf blade weight/tiller (leaf dry weight per no. of tillers), and sheath weight per tiller (sheath dry weight per no. of tillers). The experimental design was a randomized complete block.

Field studies. Two field studies were conducted to determine turf characteristics of annual, perennial, and intermediate ryegrass. Plots were established at Pinnacle Country Club in Rogers, Ark., and at the Univ. of Arkansas Research and Extension Center, Fayetteville. The field studies included a planting into a prepared seed bed (Rogers) and an overseeded planting (Fayetteville) on ’Tifway’ bermudagrass. Soil type at the Fayetteville location was a Captina silt loam (typic Hapludult) with a pH of 6.2, while the soil at the Rogers site was a Nixa Cherty silt loam (typic Hapludult) with a pH of 5.9. Plot size at each location was 2 × 2 m and each cultivar was replicated four times at each site. Seedling weights were 20 g·m\(^{-2}\) for the prepared seed-bed test and 50 g·m\(^{-2}\) for the overseeded test. Prior to seeding, the overseeded test area was vertically mowed in two directions prior to seeding and the debris removed from the site. Beginning one month after establishment and continuing throughout the test, plots were fertilized monthly with a N rate of 2.5 g·m\(^{-2}\) as 13N–5.7P–10.8K. Mowing height was 2.54 cm throughout both tests. Plots were rated every 2 weeks for establishment rate, color, and turf quality. Clipping weights for each plot were determined during early spring by taking a representative swath (55.8 cm × 144.1 cm) through each plot. Clippings were dried in a forced-air oven at 60 °C, weighed, and reported on a g·m\(^{-2}\) basis. Turf quality and transition characteristics of each ryegrass cultivar were monitored through June.

**Growth chamber study.** A growth chamber study was conducted to assess the overall heat tolerance of the ryegrass cultivars. Eight replicate 10-cm pots (vol. = 1178 cm\(^3\)) of each experimental cultivar were established in a standard potting mix (Strong-Lite High Porosity Mix). Seeding rates were 20 g·m\(^{-2}\) and pots were fertilized weekly with 100 mL of a complete nutrient solution containing N at 100 mg·kg\(^{-1}\). Pots were established in the greenhouse for 6 weeks and mowed weekly at 5.0 cm using an electric hand clipper. After the 8-week establishment period in the greenhouse, pots were moved into a growth chamber (model PGW36; Conviron, Pembina, N.D.) set at 25 °C with a 14-h light/10-h dark photoperiod and acclimated for 1 week. The photosynthetically active radiation in the growth chamber was maintained at 600 µmol·m\(^{-2}\)·s\(^{-1}\). Beginning in week two, the temperature of the growth chamber was raised 1 °C every 2 d for 40 d. Canopy temperature of each pot was measured every 4 d using a handheld infrared thermometer held ~30 cm above the canopy. Canopy temperature was monitored to assess changes in transpiration rates under increasing temperature (Kluitenberg and Biggar, 1992). Heat stress was indicated when leaf temperature exceeded air temperature.

**Data analysis.** Data for all studies were analyzed by analysis of variance (SAS Inst., Cary, N.C.) procedures and means were separated by Fisher’s protected least significant difference (LSD) \((P = 0.05)\).

**Table 1.** Morphological characteristics, at 4 weeks and 6 weeks after planting, of ryegrass cultivars grown as a single plant in a greenhouse.

| Cultivars | Species  | No. of tillers/plant | Leaf texture | Collar Sheath | Leaf Shoot | Total Leaf Sheath | LSD\(_{0.05}\) | LSD\(_{0.05}\) |
|-----------|----------|----------------------|--------------|--------------|------------|------------------|-------------|-------------|
| Gulf      | Annual   | 10.0                 | 6.4          | 54.7         | 226        | 661              | 887         | 89          |
| TAM-90    | Annual   | 11.3                 | 7.0          | 50.3         | 324        | 923              | 1246        | 112         |
| Fogfairy  | Intermediate | 9.7                 | 6.4          | 61.0         | 234        | 688              | 922         | 102         |
| Transit   | Intermediate | 11.3                | 3.8          | 174          | 478        | 652              | 39          | 29          |
| Racer     | Perennial | 15.7                 | 3.0          | 24.7         | 151        | 322              | 483         | 30          |
| Jiffe     | Perennial | 10.3                 | 2.9          | 26.7         | 116        | 265              | 381         | 27          |
| Calypso   | Perennial | 10.7                 | 3.2          | 27.0         | 69         | 238              | 307         | 24          |

**Table 2.** Turf characteristics of ryegrass cultivars grown in a prepared seedbed in Rogers, Ark. and overseeded into ’Tifton 419’ bermudagrass in Fayetteville, Ark.

| Cultivar | Species | Establishment rate | Turf color | Turf Quality | Clipping wt (g·m\(^{-2}\)) |
|----------|---------|-------------------|------------|--------------|--------------------------|
| Gulf     | Annual  | 4.0               | 8.2        | 4.2          | 4.5                      | 5.3          | 5.5         | ND          | 14.2        |
| TAM-90   | Annual  | 4.5               | 8.8        | 4.4          | 4.6                      | 5.0          | 5.7         | ND          | 12.0        |
| Jiffe    | Perennial | 1.0                | 4.2        | 7.4          | 7.6                      | 7.6          | 7.9         | ND          | 8.4         |
| Calypso  | Perennial | 2.5                | 5.5        | 7.9          | 8.0                      | 7.9          | 8.2         | ND          | 7.1         |
| Jiffie   | Perennial | 1.0                | 4.2        | 7.4          | 7.6                      | 7.7          | 7.7         | ND          | 8.1         |
| Calypso  | Perennial | 0.8                | 1.1        | 1.3          | 0.9                      | 1.2          | 1.0         | 2.6         |             |
| TAM-90   | Annual  | 4.9               | 8.4        | 4.0          | 4.9                      | 4.5          | 5.3         | 14.5        |
| Fogfairy | Intermediate | 4.5                | 7.9        | 3.8          | 4.8                      | 5.2          | 5.2         | 13.9        |
| Racer    | Perennial | 3.1                | 7.5        | 4.9          | 6.5                      | 6.1          | 6.6         | 11.9        |
| Jiffe    | Perennial | 2.3                | 5.5        | 6.8          | 7.4                      | 7.0          | 7.2         | 8.5         |
| Calypso  | Perennial | 3.0                | 6.0        | 7.4          | 7.7                      | 7.4          | 7.8         | 8.7         |

**Table 3.** Establishment characteristics of ryegrass cultivars grown in a prepared seedbed in Rogers, Ark. and overseeded into ’Tifton 419’ bermudagrass in Fayetteville, Ark.

| Cultivar | Species | Establishment rate | Turf color | Turf Quality | Clipping wt (g·m\(^{-2}\)) |
|----------|---------|-------------------|------------|--------------|--------------------------|
| Gulf     | Annual  | 4.0               | 8.2        | 4.2          | 4.5                      | 5.3          | 5.5         | ND          | 14.2        |
| TAM-90   | Annual  | 4.5               | 8.8        | 4.4          | 4.6                      | 5.0          | 5.7         | ND          | 12.0        |
| Jiffe    | Perennial | 1.0                | 4.2        | 7.4          | 7.6                      | 7.7          | 7.7         | ND          | 8.1         |
| Calypso  | Perennial | 2.5                | 5.5        | 7.9          | 8.0                      | 7.9          | 8.2         | ND          | 7.1         |
| TAM-90   | Annual  | 4.9               | 8.4        | 4.0          | 4.9                      | 4.5          | 5.3         | 14.5        |
| Jiffe    | Perennial | 2.3                | 5.5        | 6.8          | 7.4                      | 7.0          | 7.2         | 8.5         |
| Calypso  | Perennial | 3.0                | 6.0        | 7.4          | 7.7                      | 7.4          | 7.8         | 8.7         | 8.0         |

**Notes:**

1. LSD\(_{0.05}\) = 0.05.

2. LSD\(_{0.05}\) = 1.42.

3. LSD\(_{0.05}\) = 1.3.

4. LSD\(_{0.05}\) = 0.8.

5. LSD\(_{0.05}\) = 0.7.

**Nonsignificant.**
Results and Discussion

Cultivar differences were observed for all morphological parameters measured in the greenhouse, with the exception of tiller number per plant (Table 1). As expected, leaf texture was significantly coarser for the annual cultivars (6.4–7.0 mm) compared to the perennial cultivars (2.9–3.2 mm). However, leaf texture of the two intermediate cultivars was not truly intermediate between the other species. ‘Froghair (I) had a leaf texture (6.4 mm) that was similar to the annual cultivars, while leaf texture of ‘Transist’ (I) was 3.8 mm and was not significantly different from the perennial cultivars. Other parameters, including total weight per tiller, leaf weight per tiller, and sheath weight per tiller exhibited similar results. There was not a significant difference in the tillering capacity between the cultivars, which suggests that they would be equally competitive in a mixed-species stand.

Collar height was significantly different between the two intermediate cultivars (Table 1), as ‘Froghair (I) had an average collar height of 61.0 mm, while ‘Transist’ (I) had a collar height of 43.3 mm. The perennial ryegrass cultivars all had significantly lower collar heights than the annual and intermediate ryegrasses (Table 1), evidence of advances made in breeding for lower collar heights relative to the perennial cultivars or Transist (I). However, the annual cultivars performed similar to ‘Froghair (I).

Growth rates in the field tests were assessed by harvesting and weighing clipping samples on two dates in the spring. The annual and intermediate cultivars had significantly formed an acceptable turfgrass stand by 20 d after planting (DAP) (Table 2).

The effect of cultivar and species on turfgrass color and quality was very similar across rating dates, so the data were summarized for two evaluation dates. The perennial ryegrass cultivars exhibited better overall turf quality than either of the annual cultivars or the intermediate cultivar Froghair (I) and there were no significant differences between the perennial cultivars (Table 2). Within the intermediate cultivars, ‘Transist’ (I) had better color and quality than ‘Froghair (I). The annual ryegrass cultivars produced an inferior turf relative to the perennial cultivars or Transist (I). However, the annual cultivars performed similar to ‘Froghair (I).

The transition from the overseeded, perennial ryegrass back to the base bermudagrass turf was a problem in the overseeding trial, as the perennial ryegrass cultivars had only reached ≈50% to 60% transition on 15 June, even though active bermudagrass growth had initiated in the surrounding, non-overseeded plots (Table 3). Both of the intermediate ryegrass cultivars had significantly improved transition over the perennial cultivars, but ‘Transist’ (I) still had 28% ryegrass remaining in the plot on 15 June, while ‘Froghair (I) was almost completely transitioned on that date. The annual ryegrass cultivars also transitioned very easily back to bermudagrass.
In the growth chamber study (Fig. 1), the perennial grasses had a slightly higher canopy temperature under low or moderate air temperatures, presumably due to the darker overall genetic color of the perennial ryegrasses (Table 2). However, as the temperature of the growth chamber was raised to about 38 °C, the annual ryegrass cultivars started to show severe signs of physiological heat stress. Relative to the perennial ryegrasses, canopy temperatures of the annual cultivars increased significantly as temperatures exceeded 40 °C, while the perennial cultivars were able to maintain transpiration and moderate canopy temperature. The intermediate cultivar Transist (I) had intermediate heat tolerance between the annual and perennial, while ‘Froghair’ (I) responded to the increased air temperature similar to the annual cultivars.

The differential morphological and physiological characteristics between ‘Froghair’ (I) and ‘Transist’ (I) would suggest that, while both cultivars are intermediate species, ‘Froghair’ (I) performs more like the annual parent, while ‘Transist’ (I) behaves much more like a true intermediate. Results from the field trials also suggest that ‘Transist’ (I) had much better overall turf quality than ‘Froghair’ (I). Although these initial observations suggest that certain intermediate ryegrass cultivars have desirable turf characteristics, long-term evaluations of these species under various field conditions are needed to fully assess the value of intermediate ryegrass to southern turf managers.

**Literature Cited**

Dudeck, A.E. and C.H. Peacock. 1980. Effects of several overseeded ryegrass on turf quality, traffic tolerance, and ball roll, p. 75–81. In: R.W. Sheard (ed.). Proc. Fourth Intl. Turf. Res Conf., Ontario Agr. Coll., Guelph, Ont.

Horgan, B.P. and F.H. Yelverton. 2001. Removal of perennial ryegrass from overseeded bermudagrass using cultural methods. Crop Sci. 41:118–126.

Hoveland, C.S., W.B. Anthony, J.A. McGuire, and J.G. Starling. 1978. Beef cow-calf performance on Coastal bermudagrass overseeded with winter annual clovers and grasses. Agron. J. 70:418–420.

Johnson, B.J. 1976. Transition from overseeded cool-season grass to warm-season grass with pronamide. Weed Sci. 24:309–311.

Kluitenberg, G.J. and J.W. Biggar. 1992. Canopy temperature as a measure of salinity stress on sorghum. Irrig. Sci. 13:115–121.

Kneebone, W.R. and G.L. Major. 1969. Differential survival of cool-season turfgrass species overseeded on different selections of bermudagrass. Crop Sci. 9:153–155.

Mazur, A.R. and J.S. Rice. 1999. Impact of overseeding bermudagrass with various amounts of perennial ryegrass for winter putting turf. HortScience 34:864–870.

Mazur, A.R. and D.F. Wagner. 1987. Influence of aeration, topdressing, and vertical mowing on overseeded bermudagrass putting green turf. HortScience 22:1276–1278.

Meyer, W.A. and C.R. Funk. 1989. Progress and benefits to humanity from breeding cool-season grasses for turf, p. 31–48. In: D.A. Sleper, K.H. Asay, and J.F. Pedersen (eds.). Contributions from breeding forage and turf grasses. CSSA Spec. Pub. No. 15.

Schmidt, R.E. and J.F. Shoulders. 1977. Seasonal performance of selected temperate turfgrasses overseeded on bermudagrass turf for winter sports, p. 75–86. In: J.B. Beard (ed.). Proc. Third Intl. Turf. Res Conf., Munich, West Germany, Amer. Soc. Agron., Madison, Wis.

Schmitz, J. 1999. A smooth transition. Golf Course Mgt. 67(7):108.

Ward, C.Y., E.L. McWhirter, and W.R. Thompson, Jr. 1974. Evaluation of cool-season turf species and planting techniques for overseeding bermudagrass golf greens, p. 480–495. In: E.C. Roberts (ed.). Proc. Second Intl. Turf. Res Conf., Blacksburg, W.V. Amer. Soc. Agron., Madison, Wis.