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Hybrid Bluegrass, Kentucky Bluegrass, and Tall Fescue Response to Nitrogen Fertilization in the Transition Zone

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***Abstract*. 'Dura Blue' and 'Thermal Blue' hybrid bluegrass have been selected for heat and drought tolerance. These grasses offer alternatives to traditional Kentucky bluegrass and tall fescue in the transition zone. Experiments were conducted in two locations during 2003 and 2004 at the University of Tennessee in Knoxville, Tenn. Nitrogen (N) was applied at 50, 150, or 300 kg·ha^{-1} N per year to 'Apollo' Kentucky bluegrass, 'Dura Blue', and 'Thermal Blue' hybrid bluegrass, and 'Dynasty' and 'Kentucky 31' tall fescue. The main effects of turfgrass and N were significant for color and quality observations. However, their interactions were not significant; therefore, only the main effects are shown. Acceptable turfgrass color (>6) and quality (>6) was observed for all varieties in May, August, and November. All N regimens showed acceptable turfgrass color and quality. However, 150 kg·ha^{-1} N per year was required to achieve optimum color and quality. 'Kentucky 31' produced higher clipping dry weights when N was applied at 50 kg·ha^{-1} per year than the other varieties. Nitrogen applied at 150 and 300 kg·ha^{-1} per year on 'Kentucky 31' and 'Thermal Blue' produced higher clipping dry weights than the other varieties. 'Dynasty' and 'Kentucky 31' had similar brown patch incidences at each nitrogen level. Increases in brown patch incidence occurred as N levels decreased from 300 (21%) to 50 kg·ha^{-1} per year (31%) for 'Dynasty' and 'Kentucky 31'. Dollar spot incidence occurred on all bluegrass varieties from 7% to 24%. However, dollar spot decreased with increased N fertility. All turfgrass species tested were acceptable for use in the transition zone.**

Growing quality turfgrass throughout the year in the transition zone is difficult. The transition zone is identified as the area of transition from cool- to warm-season turfgrasses between the cool and warm regions of the world (Beard, 1973). Traditionally, the main turfgrasses grown in the transition zone are zoysiagrass (*Zoysia japonica* Steud.), bermudagrass [*Cynodon dactylon* (L.) Pers.], Kentucky bluegrass (*Poa pratensis* L.), and tall fescue (*Festuca arundinacea* Schreb.) (Beard, 1973). Zoysiagrass and bermudagrass can successfully be grown in the transition zone; however, winter dormancy and occasional winter kill cause unsightly appearances in the winter and early spring (Munshaw et al., 2004). Kentucky bluegrass and tall fescue can be grown in the transition zone, but high humidity, high temperatures, and droughty soil conditions associated with summer months are often too stressful for Kentucky bluegrass and tall fescue to thrive under these conditions. Diseases such as rust (*Puccinia graminis* Persoon subsp. *graminicola* Urban) and dollar spot (*Sclerotinia homoeocarpa* Bennett) in Kentucky bluegrass and brown patch [*Rhizoctonia solani* (Kühn)] in tall fescue can occur under these stressful conditions (Landshchoot and Park, 1997; Wang and Huang, 2004).

Alternatives to bermudagrass, zoysiagrass, Kentucky bluegrass, and tall fescue are new interspecific hybrid bluegrass varieties (*Poa arachnifera* Torr. × *P. pratensis* L.) (Registered with the USDA as Kentucky bluegrass cultivars; however, for the ease of discussion they will be called hybrid bluegrass). Two varieties, 'Dura Blue' and 'Thermal Blue', have recently been released by The Scotts Company (Marysville, Ohio). Traditionally, Kentucky bluegrass has not been the turfgrass variety of choice in the southern part of the transition zone due to its lack of heat, drought, and disease tolerance. Hybrid bluegrass has displayed the heat and drought tolerance of Texas bluegrass (*P. arachnifera* Torr.) and the desirable turfgrass quality and color of Kentucky bluegrass (Abraham et al., 2004). However, the same diseases (leaf spot, leaf rust, dollar spot, etc.) are still concerns with hybrid bluegrass. The extent of the susceptibility to these diseases is not known for these varieties.

Kentucky bluegrass fertility and management are different from tall fescue. Kentucky bluegrass nitrogen (N) fertilization ranges from 19 to 64 kg·ha^{-1} per month depending on variety (Beard, 1973). Kentucky bluegrass may have increased incidence of dollar spot and leaf rust when managed with low N levels. Tall fescue N fertilization ranges from 19 to 50 kg·ha^{-1} per month (Beard, 1973). Brown patch is a problem in tall fescue during summer heat stress, and increased levels of brown patch may occur with excess N fertilization (Christians, 1998).

One consideration with the introduction of new turfgrass varieties such as 'Dura Blue' and 'Thermal Blue' is determining whether these varieties are better suited for establishment and use than traditional species. The objectives of this experiment were to determine if N levels affected turfgrass color, quality, clipping yield, and disease incidence of 'Apollo' Kentucky bluegrass, 'Dura Blue' and 'Thermal Blue' hybrid bluegrass, and 'Dynasty' and 'Kentucky 31' tall fescue.

Materials and Methods

Turfgrasses were seeded on 23 Oct. 2002 at the Horticultural Trial Gardens (Campus location) and on 26 Sept. 2003 at the Plant Science Farm (PSF location) at the University of Tennessee in Knoxville, Tenn. The soil at the Campus location was an Etowah silt loam (typic Paleudalt fine, loamy, siliceous thermic) and the soil at the PSF was a Sequatchie loam (fine-loamy, siliceous, thermic Humic Hapudult). Treatments were arranged in a randomized block design with a factorial treatment arrangement with turfgrass variety being one factor and N fertilization being the other. Kentucky bluegrass and tall fescue varieties were seeded at 100 and 300 kg·ha^{-1} respectively, with 'Apollo', 'Dura Blue', 'Thermal Blue', 'Dynasty', and 'Kentucky 31' having 3200, 1500, 2500, 420, and 440 thousand seeds per kg, respectively. Turfgrasses were fertilized at the time of seeding and monthly thereafter until December with N applied at 24 kg·ha^{-1} to ensure adequate turfgrass density. Treatment regimens started in April of each year included N applied at 50, 150, and 300 kg·ha^{-1} per year. The 50 kg·ha^{-1} N treatments were applied as 25 kg·ha^{-1} N in April and September. The 150 kg·ha^{-1} N treatments were applied as 25 kg·ha^{-1} N in April and May and 50 kg·ha^{-1} N in September and December. The 300 kg·ha^{-1} N treatments were applied as 50 kg·ha^{-1} N in April, May, June, July, September, and December. The April fertilization for all treatments was an 18–0–8.3 analysis fertilizer with dithiopyr [*S*, *S*-dimethyl 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3,5-pyridinedicarbohthioate] for pre-emergence crabgrass

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(*Digitaria* spp.) control. Nitrogen sources for this fertilizer were urea and sulfur-coated urea, of which 8% was slowly available. All other nitrogen treatments were derived from a commercial fertilizer with a 29–1.3–3.3 analysis derived from ammonium sulfate, urea, monoammonium phosphate, methylenediurea, and dimethylenetriurea, of which 37% of N was slowly available and 0.9% was water insoluble. Soil tests were performed at both locations. Phosphorus and potassium were not limiting, therefore all assumptions on turfgrass growth were made based on nitrogen. Turfgrasses were mowed weekly at 7.5 cm at both locations. Plots were watered at both locations to ensure adequate germination and establishment. After establishment, subsequent water was applied at both locations as needed.

Visual observations of color and quality were recorded monthly. However, for brevity only February, May, August, and November evaluations are shown. Color was visually evaluated on a scale of 1 to 9, with 1 being brown turfgrass and 9 being the darkest green turfgrass. A color standard of 6 was the minimum acceptable turfgrass color level. Quality was based on color, density, uniformity, texture, and disease incidence or environmental stress effect. Quality was visually evaluated on a scale of 1 to 9, with 1 being brown or dead turfgrass and 9 being ideal turfgrass (Skogley and Sawyer, 1992). A quality standard of 6 was the minimum acceptable turfgrass quality level. Turfgrass clippings were collected monthly from March through December for both locations. Turfgrass clippings were collected using a rotary mower with a special bagger attachment that allowed clippings to be caught in a cotton bag. Each plot had individual bags that were reused in subsequent months. Dry weights were recorded following 4 d of forced-air drying at 65 °C. Brown patch and dollar spot incidence were monitored monthly from the first visual symptoms and data were recorded until the disease symptoms disappeared. Brown patch and dollar spot were visually estimated on a 0% to 100% scale, with 0% being no disease and 100% equaling dead turf.

SAS (1999) Proc Mixed software was used to perform analysis of variance for turfgrass color, quality, clipping yield, brown patch, and dollar spot. All data were checked for normality and arcsine square root transformations were performed if the Shapiro-Wilk test for homogeneity of variance were <0.90. Main effects and all possible interactions were tested using appropriate expected mean square values as recommended by McIntosh (1983). Nitrogen regimens, sampling interval, turfgrass species, and their interactions were highly significant ($P < 0.0001$) for color and quality. However, there was no effect ($P > 0.05$) of location, trial, year, or their interactions. Therefore, color and quality data were separated by month and reanalyzed. Nitrogen regimens and turfgrass species were significant ($P < 0.01$) at each month; however, their interaction was not significant ($P > 0.05$). Therefore, data were pooled by nitrogen regimens and turfgrass species using Fisher's protected LSD at the 5% significance level. Dry weight data analysis indicated that nitrogen regimens, turfgrass species, and their interaction were highly significant ($P < 0.0001$). There was no effect ($P > 0.05$) of time, location, trial, year, or their interactions. Therefore, dry weight data were pooled across studies and means were separated using Fisher's protected LSD at the 5% significance level. Nitrogen regimens, turfgrass species, and nitrogen by turfgrass interaction were highly significant ($P < 0.0001$) for brown patch and dollar spot. However, there was no effect ($P > 0.05$) of sampling interval, location, year, or their interactions. Therefore, brown patch and dollar spot data were pooled across studies and means were separated using Fisher's protected LSD at the 5% significance level.

Results and Discussion

In February, 'Dura Blue' was a darker green color than the other grasses; however, all grasses were unacceptable (<6; Table 1). Poor color during February was due to cold temperatures. In May, 'Dura Blue' (7.6) was visibly darker than all other varieties; however, it was closely followed by 'Apollo' (7.4) and 'Dynasty' (7.4). During August, there were no differences in 'Dura Blue' and 'Dynasty'. 'Apollo' had a slightly lower color and was followed by 'Thermal Blue' and 'Kentucky 31'. By November, there were little differences in the grasses with the exception of 'Kentucky 31', which had a lighter color (6.4). All varieties displayed acceptable color (>6) throughout the growing season. 'Dura Blue' had the best overall color, and 'Kentucky 31' exhibited lowest overall color.

All turfgrasses responded similarly to increasing N indicating that Kentucky bluegrass, hybrid bluegrass, and tall fescue have similar color responses to N applications (Table 2). During times of environmental stress from cold and hot weather (February and August), increased N increased color. However, during ideal growing periods of spring and fall (May and November), there were differences from 50 to 150 $kg \cdot ha^{-1}$ N per year, but no advantage was observed from in increased N rates.

In February, all grasses had unacceptable quality (<6; Table 3). Poor quality during February was due to cold temperatures. In May, 'Dynasty' (7.4) had the highest quality of the varieties tested. All other grasses were similar, ranging from 6.8 to 7.0. In August, 'Dura Blue' (7.1) had higher quality evaluations than all other varieties except 'Apollo' (6.9). By November, 'Dura Blue' had the highest quality. However, all grasses ranged from 6.9 to 7.4. All varieties displayed acceptable quality (>6) in all months except February.

All turfgrasses responded similarly to increasing N, indicating that Kentucky bluegrass, hybrid bluegrass, and tall fescue have similar quality responses to N applications (Table 4). Similar to color evaluations, increased N increased quality during February and August. However, during May, 50 to 150 $kg \cdot ha^{-1}$ N were different and there was no advantage in increased N. In November, the only difference was with the 50 and 300 $kg \cdot ha^{-1}$ N regimens. This was consistent

Table 1. Pooled monthly turfgrass color evaluations of 'Apollo', 'Dura Blue', 'Thermal Blue', 'Dynasty', and 'Kentucky 31' at two locations in Knoxville, Tenn., in 2003 and 2004.

		Color[z]			
Cultivar	Turfgrass species	February	May	August	November
Apollo	Kentucky bluegrass	2.8	7.4	6.9	7.2
Dura Blue	Hybrid bluegrass	3.6	7.6	7.3	7.4
Thermal Blue	Hybrid bluegrass	2.6	6.9	6.4	7.0
Dynasty	Tall fescue	2.7	7.4	7.3	7.1
Kentucky 31	Tall fescue	2.5	6.5	6.4	6.4
LSD[y]		0.4	0.1	0.2	0.3

[z]Turfgrass color was visually estimated on a 1–9 scale, with 1 being brown turf and 9 equaling dark green turf.

[y]LSD, least significant difference at the 5% probability level.

Table 2. Pooled monthly color evaluations of 'Apollo', 'Dura Blue', 'Thermal Blue', 'Dynasty', and 'Kentucky 31' at 50, 150, and 300 $kg \cdot ha^{-1}$ N per year at two locations in Knoxville, Tenn., in 2003 and 2004.

Nitrogen	Color[z]			
($kg \cdot ha^{-1}$ per yr)	February	May	August	November
50	2.2	7.0	6.5	6.8
150	3.0	7.2	6.9	7.1
300	3.4	7.2	7.2	7.2
LSD[y]	0.3	0.1	0.2	0.2

[z]Turfgrass color was visually estimated on a 1–9 scale, with 1 being brown turf and 9 equaling dark green turf.

[y]LSD, least significant difference at the 5% probability level.

Table 3. Pooled monthly turfgrass quality evaluations of ‘Apollo’, ‘Dura Blue’, ‘Thermal Blue’, ‘Dynasty’, and ‘Kentucky 31’ at two locations in Knoxville, Tenn., in 2003 and 2004.

Cultivar	Turfgrass species	Quality[z] February	May	August	November
Apollo	Kentucky bluegrass	3.4	6.8	6.9	7.1
Dura Blue	Hybrid bluegrass	3.9	7.0	7.1	7.2
Thermal Blue	Hybrid bluegrass	3.4	6.8	6.6	7.0
Dynasty	Tall fescue	3.5	7.4	6.6	7.4
Kentucky 31	Tall fescue	3.3	7.0	6.7	6.9
LSD[y]		ns	0.3	0.3	0.2

[z]Turfgrass quality was visually estimated on a 1–9 scale, with 1 being dead turf and 9 equaling ideal turf.
[y]LSD, least significant difference at the 5% probability level.

Table 4. Pooled monthly quality evaluations of ‘Apollo’, ‘Dura Blue’, ‘Thermal Blue’, ‘Dynasty’, and ‘Kentucky 31’ at 50, 150 and 300 $kg \cdot ha^{-1}$ N per year at two locations in Knoxville, Tenn., in 2003 and 2004.

Nitrogen ($kg \cdot ha^{-1}$ per yr)	Quality[z] February	May	August	November
50	2.9	6.5	6.6	6.9
150	3.6	7.2	6.7	7.2
300	4.1	7.3	7.0	7.3
LSD[y]	0.3	0.2	0.2	0.2

[z]Turfgrass quality was visually estimated on a 1–9 scale, with 1 being dead turf and 9 equaling ideal turf.
[y]LSD, Least significant difference at the 5% probability level.

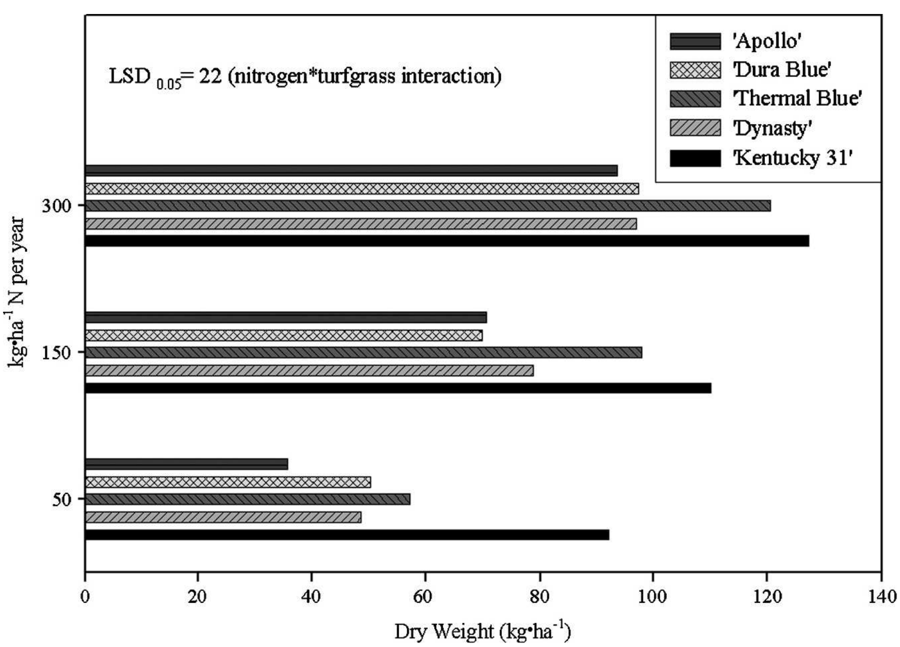

Fig. 1. Pooled dry weight analysis of ‘Apollo’, ‘Dura Blue’, ‘Thermal Blue’, ‘Dynasty’, and ‘Kentucky 31’ at 50, 150, and 300 $kg \cdot ha^{-1}$ N per year at two locations in Knoxville, Tenn., in 2003 and 2004.

with Miltner et al. (2004), who observed increased turfgrass quality with November and December soluble N applications.

Clipping dry weights increased with increased N for all turfgrasses (Fig. 1). ‘Kentucky 31’ produced the most biomass production for each N level. ‘Thermal Blue’ was the second highest biomass producer when treated with 150 and 300 $kg \cdot ha^{-1}$ N. ‘Thermal Blue’ was not different from ‘Dura Blue’ or ‘Dynasty’ at 50 $kg \cdot ha^{-1}$ N. At 50 $kg \cdot ha^{-1}$ N, ‘Apollo’ had a lower dry weight than the other turfgrasses. This research indicated that 150 $kg \cdot ha^{-1}$ N produced acceptable quality for all turfgrasses while offering the lowest clipping production. Previous research indicated that N use and efficiency were increased by returning clippings to the soil, and N requirements may be decreased as much as half after the first year (Kopp and Guillard, 2002). Also, increasing N increases the density of turfgrasses, which decreases invasion of species like crabgrass and dandelion (*Taraxacum officinale* Weber) (Busey, 2003).

No differences occurred for brown patch incidence when tall fescue varieties were compared at any N level. Brown patch incidence from May to August decreased 9% in ‘Dynasty’ when N increased from 50 to 150 $kg \cdot ha^{-1}$ (Table 5). There was no difference in brown patch incidence on ‘Kentucky 31’ when N increased from 50 to 150 $kg \cdot ha^{-1}$. Brown patch incidence was reduced in ‘Dynasty’ and ‘Kentucky 31’ when N was increased from 50 to 300 $kg \cdot ha^{-1}$. These results were unexplained; generally, brown patch increases with increasing N. However, these results were similar to a previous study conducted on perennial ryegrass (*Lolium perenne* L.), where 96 and 392 $kg \cdot ha^{-1}$ N per year decreased brown patch over 46 and 96 $kg \cdot ha^{-1}$ N per year (Settle et al., 2001). Also, Watkins et al. (2001) showed inconsistent brown patch results when treated with various N regimens. On the other hand, Vincelli et al. (1997) reported increased brown patch on tall fescue one year when N increased from 50 to 196 $kg \cdot ha^{-1}$ per year; however, no differences in brown patch severity the next.

All bluegrass varieties tested exhibited more dollar spot with decreased N. ‘Thermal Blue’ and ‘Dura Blue’ showed reduced dollar spot incidence when N rate increased from 50 to 150 $kg \cdot ha^{-1}$ N. Dollar spot incidence was less prevalent at higher N rates for all bluegrass varieties (Table 5). This is consistent with the report of Golembiewski and Danneberger (1998), who observed decreases in dollar spot on creeping bentgrass (*Agrostis stolonifera* L.) with increased N fertilization.

In summary, there were few differences in color and quality for ‘Apollo’, ‘Dura Blue’, and ‘Dynasty’. ‘Thermal Blue’ and ‘Kentucky 31’ had similar quality evaluations to ‘Apollo’, ‘Dura Blue’, and ‘Dynasty’.

Table 5. Average percent brown patch incidence from May to August and average percent dollar spot incidence from June to October on five turfgrasses and three nitrogen regimens at two locations in Knoxville, Tenn., in 2003 and 2004.

Turfgrass	Nitrogen ($kg \cdot ha^{-1}$ per yr)	Disease incidence (%) Brown patch[z]	Dollar spot[z]
Apollo	50	0	20
	150	0	10
	300	0	7
Dura Blue	50	0	21
	150	0	12
	300	0	7
Thermal Blue	50	0	24
	150	0	17
	300	0	11
Dynasty	50	31	0
	150	22	0
	300	21	0
Kentucky 31	50	29	0
	150	23	0
	300	21	0
LSD[y]		7	4

[z]Percent brown patch and dollar spot was visually estimated on a 0–100 scale, with 0 being no disease and 100 equaling dead turf.
[y]LSD, least significant difference at the 5% probability level.

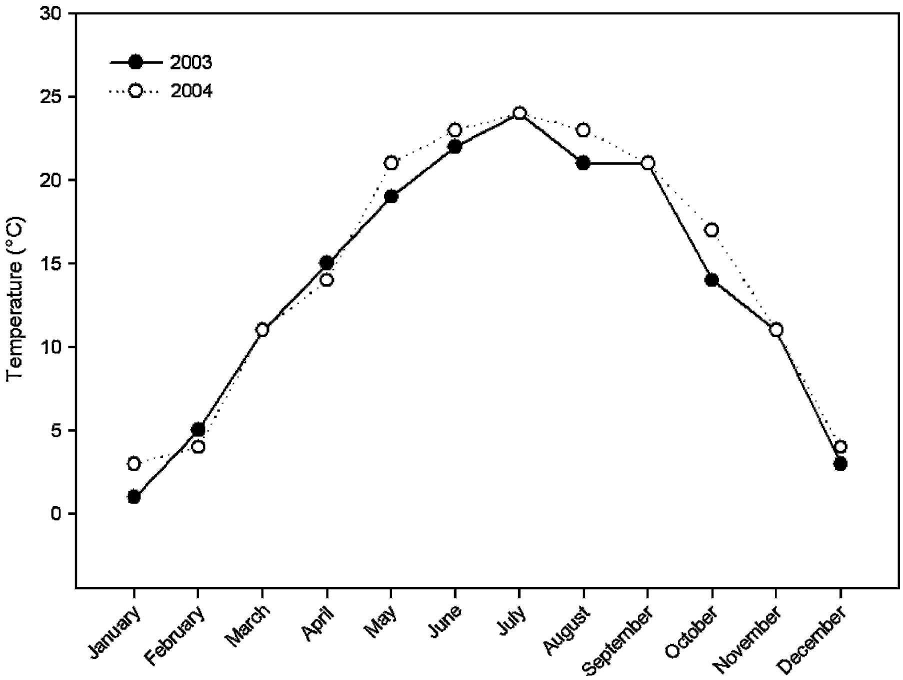

Fig. 2. Average monthly temperatures in Knoxville, Tenn., during 2003 and 2004.

However, both 'Thermal Blue' and 'Kentucky 31' displayed lower color evaluations. 'Thermal Blue' and 'Kentucky 31' also had the highest biomass production when N was applied 150 and 300 $kg \cdot ha^{-1}$ per year. There was little difference in brown patch severity in tall fescue varieties. 'Apollo', 'Dura Blue', and 'Thermal Blue' had similar incidence of dollar spot.

All turfgrasses tested would make suitable turfgrasses for the transition-zone lawns. All varieties evaluated exhibited acceptable color and quality under high temperature stress during both summers (Fig. 2). Homeowners and turfgrass managers may prefer 'Apollo', 'Dynasty', and 'Dura Blue' due to their dark, aesthetically pleasing color. Nitrogen fertilization for these varieties should be between 150 and 300 $kg \cdot ha^{-1}$ per year. 'Thermal Blue' had good color and quality, but excessive clipping production was problematic at higher N rates. 'Dynasty' and 'Kentucky 31' require less N and would be desirable in a reduced maintenance situation. However, both tall fescue varieties are susceptible to brown patch regardless of N rate. If a finer texture turfgrass is required, 'Kentucky 31' would not be a favorable choice. All of the bluegrass varieties should only be used in high-maintenance situations, such as golf courses, sports fields, or high-maintenance home lawns in the transition zone. 'Apollo', 'Dura Blue', or 'Thermal Blue' or possibly blends of the three species would produce a high-quality turfgrass; however, further research is needed to investigate the performance of these blends.

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