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Maximizing 'Cimarron' Little Bluestem Establishment as Secondary Rough for a Golf Course

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Abstract

Native grasses are an important design component in secondary roughs of golf courses due to minimal maintenance requirements and aesthetics. However, problems with seed germination and subsequent establishment limit their use. Two 2-year studies on 'Cimarron' little bluestem were conducted in 2000 and 2002 at Mississippi State University. In each study, seed was planted at five rates: 12.7, 25.4, 38.1, 51, and 63.4 lb of pure live seed (PLS) per acre. Visual percent cover was recorded each month after planting (MAP). The seeding rate of 12.7 lb PLS/acre may not be acceptable for secondary roughs, since coverage was only 6.7 and 4%, respectively, at 2 MAP. This would most likely result in establishment failure during rainfall events. By the end of the first 2-year trial, there were no significant differences among coverage rates ≥ 25.4 lb PLS/acre. By the end of the second 2-year study, there was no difference among seeding rates. Based upon this study, rates at or above 25.4 lb PLS/acre would be recommended. Though these higher 'Cimarron' seeding rates benefit first year establishment, 100% cover is still unlikely and establishment will require a minimum of 2 years. Early management response to weed competition may be a key component for successful establishment of 'Cimarron' little bluestem in golf course secondary roughs.

Introduction

Native grasses continue to be an important component in the design, establishment, and maintenance of golf courses and many of the top golf courses in the US have planted native grasses (Fig. 1). There were an estimated 13,951 golf courses in the United States in 1990 covering an estimated 1.3 million acres of maintained turfgrass (1). These numbers indicate tremendous potential for additional utilization of native grasses on golf courses. The southern and middle Atlantic states are among the states having the greatest density of golf course facilities (1).

Native grasses have been utilized in secondary roughs and natural areas of golf courses because they offer desirable characteristics in terms of size, shape, and color. In addition, they are adapted to a wide range of soils and climates, require minimal to no maintenance, and can provide habitat for many forms of wildlife (2,10). Such areas are established by various means ranging from hand planting to hydro-mulching. However, germination and subsequent establishment are still a major problem and stand failures are common (9). These problems range from weeds to improper variety selection and seeding rate.

Fig. 1. Early development of a little bluestem [*Schizachryium scoparium* (Michx.) Nash] stand on a golf course which illustrates how these areas may come in to play as secondary roughs.

Mitchell and Britton (8) and the USDA (11) discuss managing weeds to establish and maintain warm-season grasses for forage, but little is known about the management of weeds in native grasses within the golfing environment. At least within forages, competition or interference from weeds often limits stand establishment of perennial warm-season grasses or may cause complete stand failure (8). Early establishment of native grasses could be vulnerable to weeds, especially warm-season annual weeds (8). Little information is provided for weed control in little bluestem (8,11), especially during establishment. Broadleaf weed control using 2,4-D on little bluestem during and after the four-leaf stage was cited, but more research is needed for grass weed control. Additionally, some degree of playability is necessary after establishment emphasizing the importance of open voids in the canopy of clump-forming native grasses. However, these open voids between native grass clumps may serve as invasion areas for weeds. More weed control research is needed regarding the establishment, maintenance, and playability of native grasses in the golf environment, especially herbicides with existing turf labels.

In the eastern United States, common, warm-season, native grasses used in low maintenance areas include big bluestem (*Andropogon gerardii* Vitm.), broomsedge (*Andropogon virginicus* L.), indiangrass [*Sorghastrum nutans* (L.) Nash], little bluestem [*Schizachryium scoparium* (Michx.) Nash], and switchgrass (*Panicum virgatum* L.). Little bluestem may be more desirable for secondary golf roughs for finding and playing errant shots when compared to taller native grasses. For example, big bluestem, indiangrass, and switchgrass can reach heights of 3, 2, and 6 ft by year 2, respectively (4). Broomsedge is similar to little bluestem in height, but has shown poor germination during the first year of establish (4,5). Thus, little bluestem was chosen for this study. Even though little bluestem is shorter at maturity, height could still be a problem and some mowing may be necessary. It is probable that it will not compare to the playability of bermudagrass [*Cynodon dactylon* (L.) Pers.] in similar areas. Although this study deals more with establishment issues, more research is needed regarding management and playability of these grasses for secondary roughs.

Despite its positive characteristics, establishment of little bluestem tends to be more difficult than taller grasses like switchgrass. This may be due to the selection of inappropriate varieties or seeding rates (4, 5). 'Cimarron' little bluestem was chosen for this study based upon its previous performance (4,5) and adaptation (11). 'Cimarron' had higher stand coverage than 'Aldous,' 'Blaze,' 'Camper,' and 'Itasca' little bluestems in July on soils with a pH near 5.2 (4). On soils with a pH near 6.5, 'Aldous' little bluestem had higher stand coverage (21.7 % compared to 6.9 % for 'Cimarron') (5). It should that although both varieties were planted at recommended seeding rates in both studies, neither was considered acceptable (4,5). Despite this second year difference (5), 'Cimarron' summer colors were more in the gray (chroma 2) range which may contrast better with green bermudagrass turfs. Winter colors for the two grasses are similar, although 'Cimarron' tended to be more yellow or less red compared to 'Aldous' little bluestem (4,5). However, sheath colors on dormant 'Cimarron'

little bluestem were closer to dormant broomsedge leaf colors, which seem to be desirable winter colors. All little bluestem varieties in the studies conducted by Maddox et al. (4,5) tended to be upright in stature, although with low stand coverage lodging potential was probably not optimum. The USDA (11) shows similar ranges of adaptation in the southeastern United States for 'Aldous,' 'Cimarron,' and 'Pastura' little bluestems, but no information on other little bluestem varieties.

Recommended seeding rates for little bluestem are highly variable. Recommendations by USDA (11) were based upon the number of seeds per square foot. However, most seed companies currently recommend rates based on pounds of pure live seed (PLS) per acre. Aside from seed company sales booklets, little information is available on seeding rates and web-source recommendations are highly variable, ranging between 6.7 (Sharp Brothers Seed Company, *personal communications*, 2006; Linda Conway Deuver, *personal communications*, 2006) and 28 lb/acre (James C. Grimes, *personal communications*, 2006). This variability has led to some confusion about what seeding rates are necessary for successful little bluestem establishment. The objective of this study was to evaluate the influence of seeding rate and weeds upon the establishment of 'Cimarron' little bluestem for golf course secondary roughs.

Planting of Studies

Establishment studies were conducted at the Mississippi State University Plant Sciences Research Center, Starkville, MS. The soil was a Marietta fine loam (fine loamy, siliceous, active, thermic Fluvaquentic Eutrochrept). Soil samples were taken in July 2000 and 2002 and analyzed (Table 1). Since little bluestem was native to the area, research plots were fumigated with methyl bromide at 653 lb/acre prior to planting to prevent germination of any pre-existing little bluestem or weed seed. Irrigation was supplied as needed during germination. No irrigation was provided during the second year of either trial.

Table 1. Soil analyses for the Marietta fine loam (fine loamy, siliceous, active, thermic Fluvaquentic Eutrochrept) at the Plant Science Research Center study area, Mississippi State University, Starkville, MS.

Study year[x]	pH	% OM	P	K	Ca	Mg	Zn	S
			lb/acre					
2000	7.0	2.47	183	198	5024	143	2.4	356
2002	7.5	1.82	187	204	5408	127	2.1	262

[x] Soil samples were taken in July of each year prior to study initiation and analyzed by the Mississippi State University Extension Service Soil Testing Lab, Mississippi State, MS.

The first study was planted on 2 August 2000. 'Cimarron' little bluestem seed was obtained from Hamilton Seed Company (Elk Creek, MO). Seed germination was 86%, purity was 70%, 0.05% weed seed, and no dormant seed were reported.

The second study was initiated on 9 August 2002. 'Cimarron' seed was obtained from Bamert Seed Company (Muleshoe, TX) and featured 88% germination, 44.4% purity, 1.1% weed seed, and no dormant 'Cimarron' seed. Both lots were planted within 6 months of seed testing.

In each study, seed was planted at five rates: 12.7, 25.4, 38.1, 51, and 63.4 lb PLS/acre. The lowest rate of 12.7 lb/acre was based upon the recommendation of Stock Seed Farms (Murdock, NE) in promotional data released in 1992. Rates currently recommended by Stock Seed Farms are similar at 14.5 lb PLS/acre. The seed was mixed with 0.33 pints of damp sand to assist with separating the seed, which has long hairs, and as a guide for coverage uniformity, since it contrasted with the existing soil surface. Once thoroughly mixed, the seed-sand mix was dispersed by hand over each plot using the sand as a guide for coverage uniformity. Sand coverage was light and did not affect soil texture.

Due to broadleaf weed pressure, the first establishment study was treated with 2,4 D at 1.19 lb ae/acre (Weedone LV4 3.8EC, Rhone-Poulenc Ag Company, Research Triangle Park, NC) 3 weeks after planting. Weed cover ratings were determined visually and recorded during the second establishment study followed by mowing at 2.5 in to control weeds. At the time of mowing, little bluestem foliage was only slightly cut during the mowing event.

The experimental design was a randomized complete block with repeated measurements. There were three replications of experimental units 36 ft² in size. Percent cover was determined visually and recorded each month after planting (MAP) during two growing seasons of each trial. Data were analyzed using analysis of variance (ANOVA) and significant ($P < 0.05$) treatment effects were separated with the F-protected LSD mean separation test (SAS Institute Inc., Cary, NC). Orthogonal contrasts were used with the "proc mixed" procedure to determine the response between establishment cover and seeding rate. Pearson's correlation procedure was used to determine the correlation between weed populations and little bluestem coverage.

Interactions and Data Presentation

There were significant study-by-rate interactions in 5 months of the studies, thus data were analyzed and are presented separately. The month-by-rate interaction was not significant.

Study 1 (2000 to 2001). At 1 MAP, there was a significant difference among treatments, except the two highest seeding rates of 51 and 63.4 lb/acre (Fig. 2). 'Cimarron' little bluestem seeded at 12.7 lb/acre had only 5% cover compared to 46.7% cover when seeded at 63.4 lb/acre rate. At 2 MAP and the end of the first season, there were significant differences among treatments, except the 38.1 and 51 lb/acre seeding rate treatments.

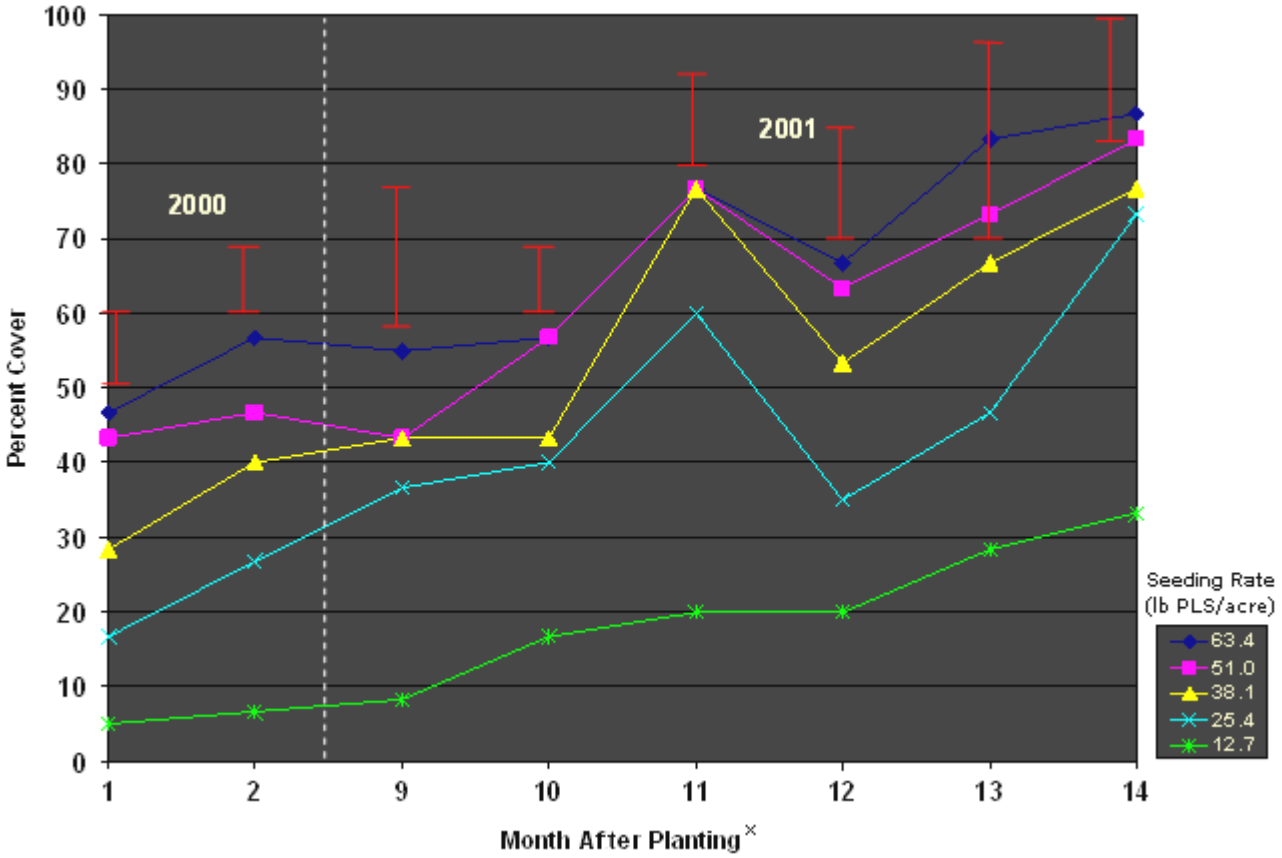


Fig. 2. Influence of five seeding rates on establishment of 'Cimarron' little blustem [*Schizachyrium scoparium* (Michx.) Nash] in 2000 and 2001 with least significant difference (LSD at $P \leq 0.05$) bars for each month in red. Study planted 2 Aug 2000.

[x] No ratings were taken during winter months from 3 through 8 MAP (vertical dotted line).

After ratings resumed in April of 2001 (9 MAP), the 12.7 lb/acre rate had significantly lower coverage ratings than other seeding rates. Plot coverage progressed through 11 MAP, though there was no significant difference between seeding rates ≥ 25.4 lb/acre (Fig. 2). At 12 MAP, disease [Curvularia leaf spot (*Curvularia* sp.), head smuts (*Sporisorium* spp.), and tar spot (*Phyllachora* sp.)] had caused culm and foliar damage which reduced percent coverage ratings. Regardless, the trend remained the same in coverage with no significant difference among the three highest planting rates which had significantly more coverage than either the 12.7 or the 25.4 lb/acre seeding rate.

By 14 MAP there were no significant difference in coverage between seeding rates ≥ 25.4 lb/acre with coverage ranging from 73 to 87%. Maturation and flowering was observed in all treatments by 14 MAP (Fig. 3) and plants were forming clumps (Fig. 4). The clumping characteristic may have prevented plots from reaching near 100% cover. Jung et al. (3) observed 72% cover with 'Aldous' little bluestem after as long as 9 years. It is likely that a goal of achieving 100% cover with Cimarron little bluestem is not possible. However, the influence of intensive management on little bluestem cover has not been fully explored.

A

B

C

Fig. 3. Photos of the 2000 and 2001 establishment study of 'Cimarron' little blustem [*Schizachyrium scoparium* (Michx.) Nash] showing study at (A) 2 months after plantings (MAP), (B) 10 MAP, and (C) 13 MAP.

Fig. 4. Photo of the 2000 and 2001 establishment study of 'Cimarron' little blustem [*Schizachyrium scoparium* (Michx.) Nash] showing voids (lower right-hand corner) between maturing plants at 13 MAP.

Study 2 (2002 to 2003)

At 1 MAP in 2002, all seeding rates ≥ 25.4 lb/acre had similar establishment ratings and the only significant differences were between the 12.7 lb/acre level and the 51 or 63.4 lb/acre rates (Fig. 5). The 12.7 lb/acre rate had only 2% cover compared to 15.7% cover for the 63.4 lb/acre rate. At 2 MAP at the end of the first growing season there was a similar trend, but no significant differences between treatments with percent coverage ranging from 4% for the 12.7 lb/acre rate to 38.3% in the 63.4 lb/acre rate treatment.

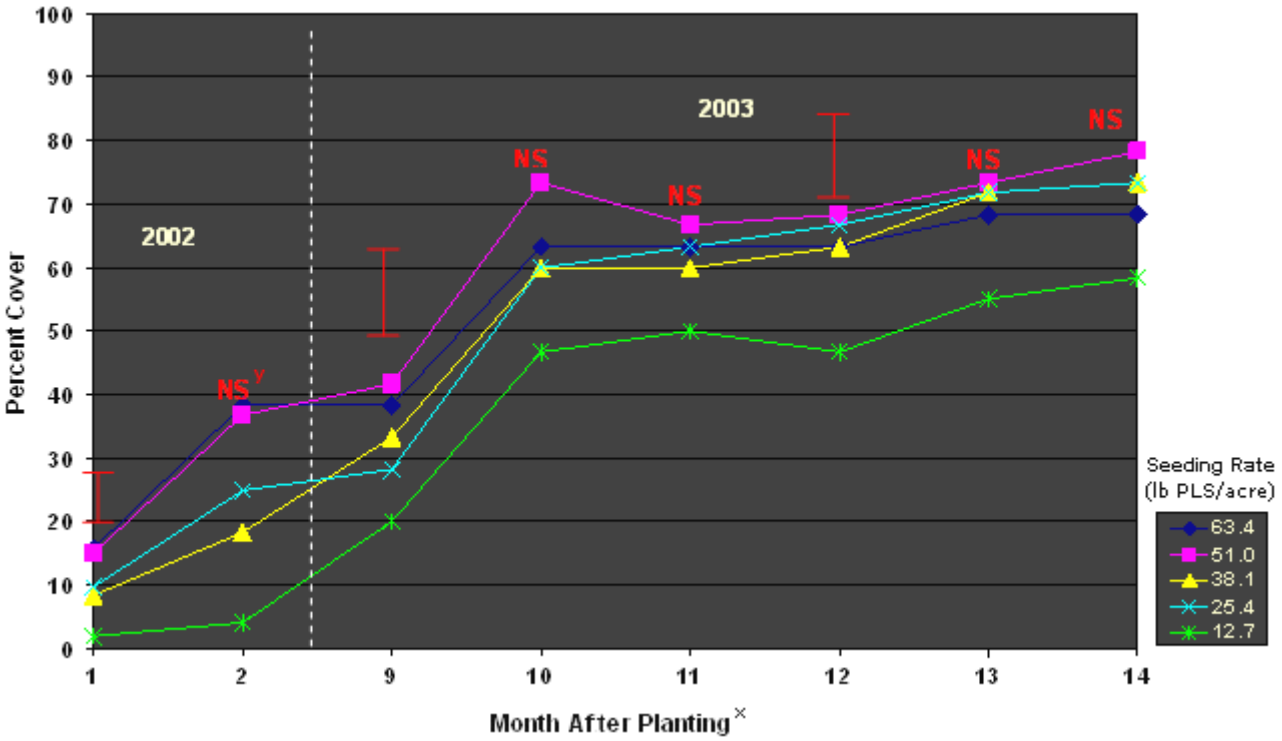


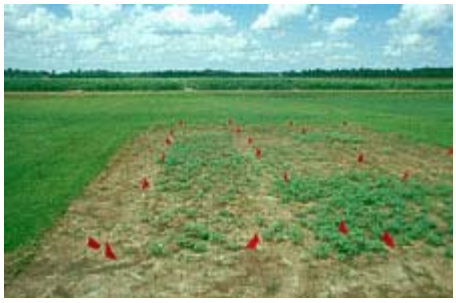
Fig. 5. Influence of five seeding rates on establishment of 'Cimarron' little blustem [*Schizachyrium scoparium* (Michx.) Nash] in 2002 and 2003 with least significant difference (LSD at $P \leq 0.05$) bars for each month in red when significant. Study planted 9 Aug 2002.

[x] No ratings were taken during winter months from 3 through 8 MAP (vertical dotted line).

[y] NS = Not significant at $P \leq 0.05$.

Cover ratings resumed in April of 2003 (9 MAP), where again seeding rates of 51 or 63.4 lb/acre had significantly higher cover than the 12.7 lb/acre rate. At this rating date, no treatments were significantly different than the 25.4 and 38.1 lb/acre rates. Plot coverage improved through 10 MAP, at which time coverage remained relatively constant. Although coverage for the 12.7 lb/acre rate remained lower compared to other treatments, it only showed significantly less cover at 12 MAP. All plots showed some level of flowering by 14 MAP (Fig. 6).

At 14 MAP, percent cover ranged from 68.3 to 78.3 for seeding rates ≥ 25.4 lb/acre and plants were maturing and forming clumps. As in the first study, this clumping characteristic may have prevented plots from reaching near 100% cover.



A

B

C

Fig. 6. Photos of the 2002 and 2003 establishment study of Cimarron little bluestem [*Schizachyrium scoparium* (Michx.) Nash] showing study at (A) 2 months after planting (MAP) with weeds, (B) 10 MAP, and (C) 13 MAP.

Influence of Seeding Rate and Weeds Upon Establishment

In both studies, the establishment response to seeding rate was linear ($P < 0.0001$ and $P = 0.0055$, respectively), indicating that higher seeding rates resulted in higher percent cover in each study.

In study 1, there were incremental increases in little bluestem percent cover as seeding rate increased. The lowest seeding rate of 12.7 lb/acre showed poor performance in both studies. Although the percent cover showed a highly significant linear response to seeding rate in study 1 (SE = 9.73, $P < 0.0001$), it was not as apparent in study 2 (SE = 11.65, $P < 0.0055$). This response in study 1 may be due to reduced weed competition during establishment. Despite fumigation, weeds had to be chemically treated shortly after planting during the first study.

Since weeds can be a serious problem with little bluestem establishment, weeds were not eradicated in 2002 in order to perform correlation analyses between early weed coverage and little bluestem density. The seed label for the bluestem indicated 1.12% weed seed at the time of analysis. This was much higher than the 0.05% in seed in the previous study. On 26 Aug 2002, 2 MAP, redroot pigweed (*Amaranthus retroflexus* L. # AMARE) cover ranged from 5 to 90% across the plots (Fig. 6). There was a positive correlation ($P < 0.0001$) between percent redroot pigweed and little bluestem seeding rate with a Pearson correlation coefficient of 0.85. This correlation with seeding rate, in addition to plot fumigation, indicates that redroot pigweed seed were a component of the planted seed. Although weeds were mowed following cover ratings, it is possible that some residual influence was manifested throughout the study. Weeds often limit stand establishment of perennial warm-season grasses and can cause complete stand failure (6,7). The relatively slow establishment of little bluestem, its clumping growth habit, and the likelihood of weed seed in the bag indicate that a weed control program may be necessary in order to gain the desired establishment.

The seeding rate response in study 1 (Fig. 2) indicates that a higher seeding rate results in better initial coverage, but monthly means indicated no significant differences between seeding rates ≥ 25.4 lb/acre by the end of the study (MAP 14). Study 2 also indicated a similar pattern, but no significant differences (Fig. 5) were observed by the end of the study (MAP 14).

Conclusions

Based upon these studies, a seeding rate of 12.7 lb PLS/acre recommended by seed companies for 'Cimarron' little bluestem may not provide acceptable coverage for secondary golf course rough. Percent cover for this rate was considered unacceptable in studies 1 and 2 with cover of only 6.7 and 4%, respectively, at 2 MAP. Rainfall events during early establishment can be problematic, particularly on slopes, and coverage of 6.7 and 4% would most likely result in establishment failure. In addition, aesthetics is often essential and poor coverage combined with weed competition issues would result in poor success.

Weed competition in study 2 may have influenced the fact that there were no significant differences between any rates at the end of that study. Weeds were controlled in the first study, but left in the second for evaluation. This is an indication that, in addition to higher seeding rates, high quality seed and/or weed control may be necessary for acceptable establishment. If weed seed are present in the bag at planting, increased little bluestem planting rates will likely lead to increased weed competition due to slow establishment rates and the clumpy characteristics of little bluestem. Early management response to weed competition may be a key component for successful establishment of little bluestem in golf course secondary roughs.

This study indicates that establishment will require a minimum of 2 years. Additionally, there were no significant cover differences among seeding rates ≥ 25.4 by the end of each study. There were some significant differences early on in each study, but these differences tended to fade by the end of each study. Thus, higher seeding rates may only be beneficial during the first year of establishment, particularly if rainfall is an issue. If not, higher seeding rates may not be worth the additional costs over a two-year establishment period.

Despite high planting rates, 86.7 was the highest percent cover obtained in any plot in either study. Obtaining 100% cover may not be a reasonable goal with little bluestem. This was apparent by the end of each study, in that plants began to clump leaving voids between plants. No plant densities were recorded, but it is probable that plant density was much lower by the end of the study. However, some voids may be beneficial in secondary roughs by assisting in locating balls while still providing some level of penalty. Additional research is needed to determine the effect of little bluestem management, such as mowing, upon the level of penalty.

Acknowledgments

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Literature Cited

1. Balogh, J. C., and Walker, W. J., eds. 1992. Golf Course Management and Construction: Environmental Issues. Lewis Publ., Chelsea, MI.
2. Dodson, R. G. 2000. Landscaping for wildlife. Pages 55-73 in: Managing Wildlife Habitat on Golf Courses. Ann Arbor Press, Chelsea, MI.
3. Jung, G. A., Shaffer, J. A., Stout, W. L., and Panciera, M. T. 1990. Warm-season grass diversity in yield, plant morphology, and nitrogen concentration and removal in Northeastern USA. Agron. J. 82:21-26.
4. Maddox, V. L., Goatley, J. M., Jr., Philley, H. W., Krans, J. V., Stewart, B. R., and Wells, D. W. 2003. Evaluation of native grass cultivars for Mississippi golf course natural areas under variable management: Part 1, soil pH of 5.2. Miss. Agric. and For. Exp. Stat. Bull. 1132, Miss. State Univ.
5. Maddox, V. L., Goatley, J. M., Jr., Philley, H. W., Krans, J. V., Stewart, B. R., and Wells, D. W. 2004. Evaluation of native grass cultivars for Mississippi golf course natural areas under variable management: Part 1, soil pH of 6.5. Miss. Agr. and For. Exp. Stat. Bull. 1137, Miss. State Univ.
6. Martin, A. R., Moomaw, R. S., and Vogel, K. P. 1982. Warm-season grass establishment with atrazine. Agron. J. 74 916-920.
7. Masters, R. A. 1995. Establishment of big bluestem and sand bluestem cultivars with metolachlor and atrazine. Agron. J. 87:592-596.

8. Mitchell, R. B., and Britton, C. M. 2000. Managing weeds to establish and maintain warm-season grasses. Pages 159-176 in: Native Warm-season Grasses: Research Trends and Issues. K. J. Moore and B. E. Anderson, eds. CSSA and ASA, Madison, WI.
9. Moser, L. E. 2000. Morphology of germinating and emerging warm-season grass seedlings. Pages 35-47 in: Native Warm-season Grasses: Research Trends and Issues. K. J. Moore and B. E. Anderson, eds. CSSA and ASA, Madison, WI.
10. Tietge, R. M. 1992. Wildlife and golf courses. Pages 441-478 in: Golf Course Management and Construction: Environmental Issues. J. C. Balogh and W. J. Walker, eds. Lewis Publ., Chelsea, MI.
11. USDA. 1991. Native perennial warm season grasses for forage in the Southeastern United States (except South Florida). USDA-SCS Ecolog. Sci. and Planning Staff, Fort Worth, TX.