MP477

Establishing Seeded Bermudagrass on Lawns, Golf Courses or Athletic Fields

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Common bermudagrass (*Cynodon dactylon*) is a warm-season turfgrass species used for lawns, athletic fields and golf course tees, fairways and roughs in Arkansas. Common bermudagrass was first available by seed in the U.S. around 1940, but the first improved cultivar, Arizona Common, was released in the 1960s. Although bermudagrass seed has been available for many years, its use in high-value turfs has increased in recent years due to the release of new cultivars with improved turfgrass quality similar to hybrid bermudagrass. An advantage of seeded bermudagrasses is they can be established at a lower cost compared to sodding or sprigging. Some of the newer seeded cultivars have improved winter hardiness compared to hybrid bermudagrasses commonly used in Arkansas. This publication can be used as a guide by practitioners wishing to establish seeded bermudagrass in Arkansas.

Cultivar Selection

Factors to consider when selecting a bermudagrass cultivar include seed availability, budget, maintenance level, pest tolerance, turfgrass quality and adaptation. However, the most important factors for selecting a cultivar for northern Arkansas are turfgrass quality and winter hardiness. Winter hardiness is a crucial factor in selecting cultivars since bermudagrass can be severely damaged periodically by harsh winters in northern Arkansas. Other factors to consider are color, spring dead spot resistance, establishment vigor and recovery.

Rankings of turfgrass quality, winter hardiness, turfgrass color, spring dead spot resistance, establishment vigor and divot recovery among the commercially available seeded cultivars from the 2002 National Turfgrass Evaluation Program bermudagrass trial are provided in Table 1, based upon data collected in transition zone states like Arkansas. Additionally, the mean of these rankings is provided as well as a weighted mean ranking to help in selecting cultivars (Table 1). The weighted mean ranking places specific emphasis on winter hardiness and turf quality (40% each) since these factors are especially important for selecting well-adapted, high quality cultivars in northern Arkansas. Less emphasis is placed on turfgrass color, spring dead spot resistance, establishment vigor and divot recovery rankings (5% each).

When evaluating both turfgrass quality and winter hardiness, Riviera, Yukon, Contessa, Sovereign, Barbados, Transcontinental, Monaco, and Sunbird were among the commercially available seeded bermudagrass cultivars that had a mean ranking in the top ten. For central and southern Arkansas, Sultan and Veracruz would also be good selections.

Site Preparation

Three common scenarios for establishing seeded bermudagrass include planting on bare soil where there is no existing crop, conversion from an established cool-season sward or conversion from an existing bermudagrass turf. Regardless of establishment scenario, it is important to correct nutrient deficiencies and modify soil pH as well as correct drainage problems prior to establishment. Soil pH should be adjusted above 5.0 prior to planting with 5.8 to 6.5 being optimal. More information on soil testing and liming is available in publication FSA6134, *Liming Your Lawn*.

Scenario 1 – no existing crop. Before seeding into bare ground, perennial grassy weeds should be controlled with glyphosate prior to tilling or by soil fumigation. Seeds should be incorporated into the top ⅛ inch of soil after seeding by dragging a leaf rake across the surface following seeding. Bermudagrass establishes quickest when the soil is tilled prior to seeding and can produce 95% cover by 45 days after planting when there is no weed competition (18).

Scenario 2 – conversion from cool-season turf like tall fescue. The quickest method to successfully establish seeded bermudagrass into an existing stand of cool-season turfgrass such as tall fescue

Table 1. Weighted relative ranking of commercially available seeded bermudagrass cultivars. Table modified from Patton et al. (17).

Cultivar[z]	Weighted mean rankings[r]	Mean rankings[s]	Turf quality[tu]	Winter hardiness[v]	Turf color[w]	Spring dead spot[x]	Establishment vigor[u]	Divot recovery[y]
Riviera	2.7	6.8	1	1	5.5	2	17	14
Yukon	3.2	4.9	3	2	1.5	1	18	4
Contessa (SWI-1045)	3.6	5.0	2	4	3.0	6	8	7
Sovereign (SWI-1012)	4.0	5.3	4	3	1.5	3	19	1
Barbados (SWI-1044)	6.1	8.8	5	5	4.5	20	16	2
Transcontinental	7.7	9.3	8	6	10.0	13	4	15
Sunbird (PST-R68A)	7.9	9.8	7	7	10.0	14	13	8
Veracruz (SWI-1041)	8.9	8.7	6	12	10.0	4	14	6
LaPaloma (SRX 9500)	11.2	10.4	10	13	15.5	12	9	3
Sunsport (SWI-1001)	11.2	10.3	12	11	8.0	8	6	17
Southern Star	11.7	13.3	13	9	9.5	17	12	19
Panama	11.8	10.3	15	10	15.5	10	1	10
Sundevil II	12.5	13.8	16	8	11.5	19	10	18
Sultan (FMC-6)	12.6	12.8	9	16	12.0	15	5	20
SR 9554	13.0	9.3	14	15	14.0	5	3	5
Princess 77	13.4	12.1	11	17	10.5	11	11	12
Sunstar	14.3	11.4	17	14	15.5	7	2	13
Mohawk	17.3	15.5	18	18	18.0	16	7	16
Numex Sahara	18.4	16.8	19	19	19.0	18	15	11
Arizona Common	18.7	15.5	20	20	15.0	9	20	9

[r] Weighted mean of turf quality (40%), winter hardiness (40%), turf color (5%), spring dead spot (5%), establishment vigor (5%) and divot recovery rankings (5%). Overall turf quality and winter hardiness were deemed the most important selection criteria for managers in the transition zone and were weighted accordingly. For example, the weighted mean for Princess 77 was calculated as follows: [(11*0.4)+(17*0.4) +(10.5*0.05)+(11*0.05)+(11*0.05) +(12*0.05)] = 13.4.

[s] Mean of turf quality, winter hardiness, turf color, spring dead spot, establishment vigor and divot recovery rankings.

[t] Rankings for turf quality, winter hardiness, turf color, spring dead spot, establishment vigor and divot recovery are from 1 to 19 with 1 being most desirable.

[u] Turf quality (turf quality is based on visual ratings of turfgrass color, density, uniformity, texture and susceptibility to disease or environmental stress) and establishment vigor rankings were compiled from the NTEP. Rankings were developed after averaging values across 10 states [Arkansas, Indiana, Illinois (Carbondale), Kansas, Kentucky, Missouri, North Carolina (Raleigh), Oklahoma, South Carolina (Clemson) and Virginia] in the transition zone across four years (2003-2006) and across two management regimes (Schedules A and B, NTEP) where available (12).

[v] Winter hardiness rankings were determined using NTEP winterkill (Oklahoma or Kansas) and percent living ground cover in spring ratings (Illinois, Indiana, Missouri, South Carolina and Virginia) (12).

[w] Turf color was determined as the mean of genetic color NTEP values (12) from 10 states averaged over four years with dark green color indices determined by Karcher (unpublished) using digital image analysis of Fayetteville, AR NTEP plots in 2005. Dark green color index values were determined based upon the method of Karcher and Richardson (7) with dark green turf being preferred.

[x] Spring dead spot rankings were determined as the mean ranking from NTEP spring dead spot measurements from inoculated plots in Oklahoma (2003-2006) (12).

[y] Divot recovery rankings were adapted from values reported by Karcher et al. (8).

[z] All cultivars in this table were commercially available in the United States in 2007.

(*Festuca arundinacea*) is to remove all plant competition prior to seeding by killing the existing turf with glyphosate, followed by aerification and/or verticutting to prepare the seedbed prior to seeding. This is a successful method for renovating athletic fields or golf course turf.

Attempts to establish seeded bermudagrass in existing tall fescue without applying glyphosate prior to seeding will be unsuccessful. Additionally, plant growth regulators applied prior to interseeding bermudagrass will not suppress tall fescue enough to allow seedlings to emerge and compete with existing turf. As with seeded zoysiagrass (*Zoysia japonica*), interseeding directly into an existing turf is unsuccessful, likely because of decreased light penetration and soil temperatures at the base of the canopy, reduced seed-to-soil contact and increased plant competition (31).

Scenario 3 – conversion from existing bermudagrass. Converting an existing common bermudagrass turf to an improved seeded bermudagrass cultivar is difficult. Fumigation is an option for removing existing bermudagrass prior to seeding (28), but there are limited fumigant options and the process can be costly. If fumigation is not an option, three applications of glyphosate over the growing season (May, June and August) will adequately control preexisting bermudagrass (6). Additional research has shown that tank mixing glyphosate with fluazifop will improve bermudagrass control over glyphosate alone, but two to three applications are still necessary for adequate control (4,25). Treated areas should be allowed to regrow from stolons and rhizomes before making the sequential applications. Fluazifop has residual soil activity, so seeding should be delayed for 30 days after application. This process will require most of the growing season, requiring an additional growing season for conversion. To reduce the time needed for conversion, applications of glyphosate or glyphosate + fluazifop two weeks prior to autumn frosts followed by an early spring seeding of an improved bermudagrass cultivar is a successful way to convert an existing common bermudagrass sward (14).

Seeding Date

Seeded bermudagrasses are most susceptible to winter damage during the initial winter after planting (19). Therefore, it is important to seed early in the growing season to enhance winter hardiness. April and May seeding dates improve bermudagrass winter survival compared to June and July seeding dates in Arkansas. (20). Also, the researchers found cultivars with excellent winter hardiness, such as Yukon, can be seeded later in the season with reduced risk of winterkill (20).

Early seeding is important for proper establishment, and dormant seeding allows for an extended seeding window. Dormant seeding refers to any seeding when soil temperatures are below the normal range required for germination, and this practice is common with cool-season turf. Bermudagrass germination is reported to occur when temperatures reach 68°F, with optimum germination occurring between 77 and 104°F (23). Dormant seeding dates of February 15 and March 15 in Arkansas are successful with germination typically occurring around the middle of April (24). Additionally, plants established faster as a dormant seeding than traditional April and May seeding dates. Bermudagrass germination in dormant-seeded plots occurs in the field at soil temperatures (1 inch depth) as low as 59°F (24). Seeding in late winter is a viable option for golf course or athletic field schedules as workloads and use patterns are typically lighter during these months compared to April or May. Dormant seeding in northern Arkansas where late-spring frosts are common may be more risky since frost could damage bermudagrass seedlings. However, no damage to seedlings from early frosts has been documented in Arkansas.

Although recommended, it is not always possible to seed early during the growing season. It is still possible to seed bermudagrass as late as the first of August in Arkansas and still achieve 95% or more coverage prior to winter. However, it is imperative to seed bermudagrass as early as possible to reduce the risk of winter injury (20), especially in northern Arkansas. Therefore, our recommendation is to seed no later than early June.

Seeding Rate

Arizona Common bermudagrass has historically been established by seeded 2.0 lb pure live seed (PLS)/1,000 ft^2, but research favors lower seeding rates. Seeding rates of 0.25 to 0.5 lb PLS/1,000 ft^2 produced plants that had thicker stolons than those seeded at higher rates (15).

Although low seeding rates may increase stolon growth, winter survival of seeded bermudagrass has not been measurably affected by seeding rate (15,18). Higher seeding rates can produce higher initial tiller and seedling densities, but bermudagrass establishment is not enhanced shortly after seeding by seeding rates greater than 1.0 lb PLS/1,000 ft^2 (18). Based on research, a seeding rate of 0.5 to 1.0 lb PLS/1,000 ft^2 is recommended in most situations.

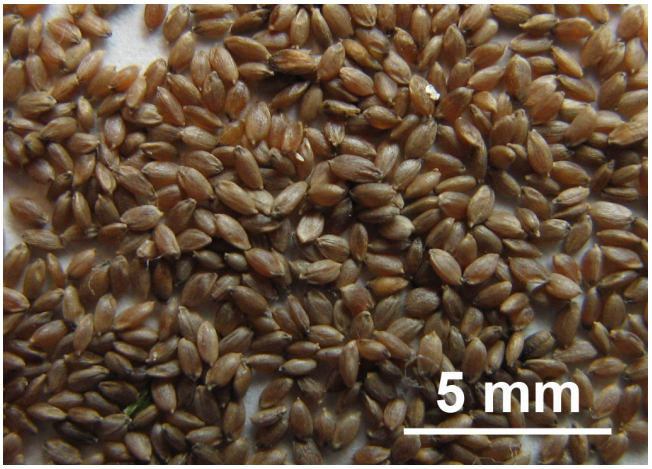

Fig. 1. Hulled 'Riviera' bermudagrass (2,900,000 seeds/lb).

Fig. 2. Unhulled 'Riviera' bermudagrass (1,700,000 seeds/lb).

Fig. 3. Coated 'Riviera' bermudagrass (725,000 seeds/lb).

Although the number of seeds per pound differs by cultivar and coating (hulled vs. unhulled vs. coated) (Figs. 1 and 2), there is typically no distinction made when recommending a seeding rate. Many improved bermudagrass cultivars, such as Monaco, Riviera and Yukon, are sold with a seed coating containing fertilizer, fungicide or other products to improve handling, germination and establishment (Fig. 3). This coating decreases the number of pure live seeds per pound by dramatically lowering purity; therefore, seeding costs increase because higher seeding rates are needed. By definition, pure live seed is determined by multiplying the germination percentage by the percent purity of the seed lot. The weight of seed required to supply 1.0 lb of PLS is approximately 1.09 lb with uncoated seed and approximately 2.32 lb of coated seed.

Post-Seeding Weed Control

Weed control is important when seeding bermudagrass in nonfumigated soil because the optimum seeding period coincides with the germination of summer grassy and broadleaf weeds. Grassy and broadleaf weeds compete for resources and reduce seeded bermudagrass establishment if they are not completely controlled before renovation or after seeding. Though weed species and pressure vary among sites, weeds that commonly reduce bermudagrass establishment in the transition zone include crabgrass, goosegrass and sedges.

Many herbicides are labeled for weed control in established bermudagrass, but only Quicksilver (carfentrazone) and Drive (quinclorac) are currently labeled for use on bermudagrass seedlings, to the knowledge of the authors. Despite the lack of products labeled for use in bermudagrass seedlings, many products have been screened for their safety. Herbicide applications are often based on the date emergence occurs or on plant age. Emergence is defined as a uniform stand of one-leaf seedlings about 0.5 inch tall, or where 75% of seedlings had emerged. Germination typically occurs 7 to 10 days after seeding under optimum conditions (Fig. 4). Emergence occurs once the majority of the stand has germinated and begun to develop. Although emergence typically occurs after germination approximately 14 days after seeding under optimum conditions, emergence can occur later if bermudagrass is dormant seeded, seeded when soil and air temperatures are cool or when soil moisture is limiting.

A summary of the research evaluating safety of herbicide applications on various cultivars is in Table 2. Herbicide tolerance may vary among seeded cultivars, with Yukon generally being more susceptible to herbicide injury than Princess 77, Riviera, NuMex Sahara and Savannah (9,10).

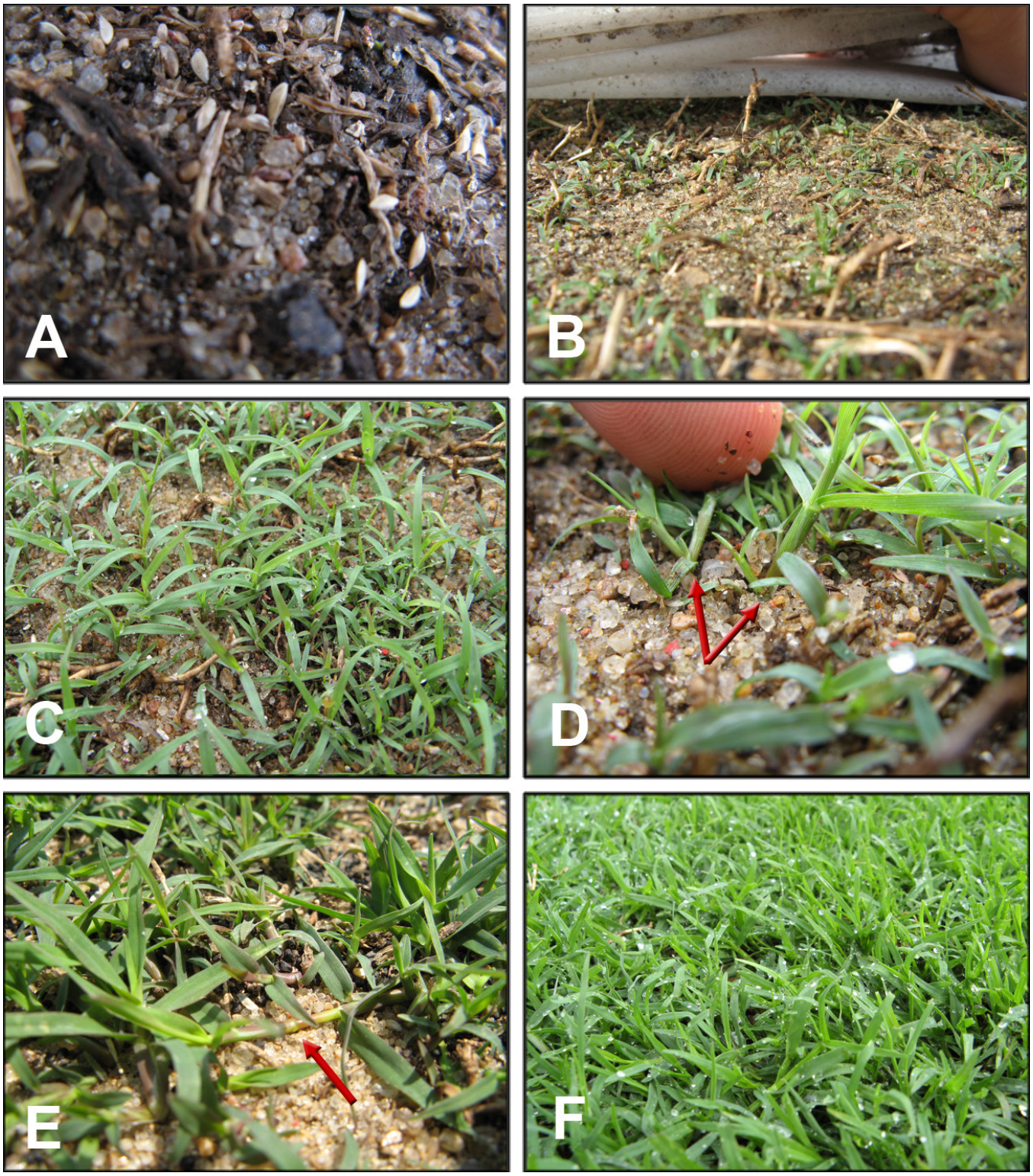

Fig. 4. Pictorial guide to the interpretation of Riviera bermudagrass seedling maturation when planted April 28, 2007, on a fumigated site and seeds were covered for 14 days after seeding with a 0.5 oz germination blanket. Five days after seeding (DAS), seeds are yet to germinate (A), but seeds were germinating 12 DAS (B). Seventeen DAS the seedlings were one- to two-leaf in size (C) and started tillering (D). Stolon development began 23 DAS (E), and the turf approached full coverage by 27 DAS (F). Results will vary based upon soil and air temperatures and soil moisture.

Table 2. Safety margins for herbicides applied at various timings to bermudagrass seedlings and the target weeds controlled. Listed in approximate order of least phytotoxic to most phytotoxic on bermudagrass seedlings with their appropriate application timing. Only products labeled for use on established bermudagrass are listed. MSMA is no longer labeled for home lawns and is now only a restricted use product for golf courses and sod farms. Table modified from Patton et al. (17).

Herbicide(s)	Product rate (oz/A)	Rate (lb a.i. per acre)	Target weeds controlled preemergently or postemergently	Pre or Post[u]	Margin of safety (delay after emergence)	Susceptibility to herbicide injury[v]
Drive 75DFw (quinclorac)	16 (1.0 pound)	0.75	Crabgrass, clover and other broadleaves	Post	Safex to apply 1 WAEyz or later. More injury on Yukon (2,9,10, 18,21,29). The Drive XLR8 formulation is reported to have similar safety.	○
MSMA 6.6	20-40	2.0	Crabgrass, goosegrass, dallisgrass, sedges,kyllinga	Post	Safe to apply 1 WAE or later. Sequential applications also safe (2,9,10).	○
Quicksilver w (carfentrazone)	1.0-2.1	0.0150.031	Clover, spurge, other broadleaves	Post	Label states "applied…7 days or more after emergence."	○
Revolver (foramsulfuron)	17.4	0.027	Annual bluegrass, perennial ryegrass, goosegrass, dallisgrass	Post	Safe to apply before seeding or 1 WAE or later (1,10,30).	○
Certainty (sulfosulfuron)	1.25	0.06	Annual bluegrass, perennial ryegrass, tall fescue, sedges, kyllinga	Post	Safe to apply before seeding or 1 WAE or later (1,30).	○
Manor/Blade (metsulfuron methyl)	0.5	0.019	perennial ryegrass, broadleaves	Post	Applications 1 WAE will cause moderate, but short lived phytotoxicity (9,30).	○
Lontrel (clopyralid)	16	0.8	Clover, spurge, other broadleaves	Post	Safe to apply 1 WAE or later (9).	○
Weedar 64 (2,4-D)	16	0.48	Clover, spurge, other broadleaves	Post	Safe to apply 1 WAE or later (9).	○
Banvel (dicamba)	16	0.50	Clover, knotweed, spurge, other broadleaves	Post	Safe to apply 1 WAE or later (9).	○
Trimec Classic (2,4-D + dicamba + mecoprop)	28-56	0.420.84	clover, spurge, other broadleaves	Post	(10)	○
Dimension 1EC (dithiopyr)	64	0.5	Crabgrass, goosegrass, annual bluegrass	Pre + Post	Safe to apply 1 WAE or later (2,18).	○
Dimension 1EC + MSMA	64 + 40	0.5 + 2.0	Crabgrass, goosegrass, dallisgrass, annual bluegrass	Pre + Post	Safe to apply 1 WAE or later (2).	○
Lontrel + MSMA 6.6	16 + 40	0.8 + 2.0	Crabgrass, goosegrass, dallisgrass, clover, spurge, other broadleaves	Post	Safe to apply 2 WAE or later (21).	○
Manor /Blade (metsulfuron) + MSMA 6.6	0.5 + 40	0.019 + 2.0	Crabgrass, goosegrass, dallisgrass, perennial rye-grass, broadleaves	Post	Safe to apply 2 WAE or later (21).	○
Telar XP (chlorsulfuron)	2	0.09	Perennial ryegrass, tall fescue, broadleaves, wild garlic	Post	Safe to apply 3 WAE or later (1). Label states to wait at least 1 year after establishment.	○
Sedgehammer (halosulfuron)	1.33	0.062	Sedges and kyllinga	Post	Safe to apply 3 WAE or later (1).	○
Pendulum 60DF (pendimethalin)	40-80 (1.5-3.0 pounds)	0.9 + 1.8	Crabgrass, goosegrass and some broadleaves	Pre	Safe to apply 3 WAE or later (1).	○
Barricade 65WDG (prodiamine)	18.4 (1.15 pounds)	0.75	Crabgrass, goosegrass and some broadleaves	Pre	Safe to apply 3 WAE or later (1).	○

Table 2 (cont.)

Herbicide(s)	Product rate (oz/A)	Rate (lb a.i. per acre)	Target weeds controlled preemergently or postemergently	Pre or Post[u]	Margin of safety (delay after emergence)	Susceptibility to herbicide injury[v]
Dismiss (sulfentrazone)	12	0.375	Sedges, kyllinga, broadleaves, goosegrass	Post	Safe to apply 3 WAE or later (1).	○
Monument 75WG (trifloxysulfuron)	0.47	0.022	Annual bluegrass, perennial ryegrass, sedges, kyllinga, broadleaves	Post	Apply 4 WAE or later (29,30). More injury on Yukon (10).	○
TranXit (rimsulfuron)	1-4	0.0160.063	Annual bluegrass, perennial ryegrass	Post	Injurious at 1 WAE or later with no reduction in coverage (30).	⊙
Revolver + MSMA 6.6	17.4 + 40	0.027 + 2.0	Annual bluegrass, perennial ryegrass, crabgrass, goosegrass, dallisgrass	Post	Safe to apply 2 WAE or later with moderate, but short-lived phytotoxicity (22).	⊙
Drive 75DF + MSMA 6.6	16 (1 pound) + 40	0.75 + 2.0	Crabgrass, goosegrass, dallisgrass, clover, spurge, other broadleaves	Post	Safe to apply 2 WAE or later with moderate, but short-lived phytotoxicity (22).	⊙
Trimec Classic + MSMA 6.6	56 + 40	0.84 + 2.0	Crabgrass, goosegrass, dallisgrass, clover, spurge, other broadleaves	Post	Safe to apply 2 WAE or later with moderate, but short-lived phytotoxicity (22).	⊙
Monument + MSMA 6.6	0.75 + 40	0.022 + 2.0	Annual bluegrass, perennial ryegrass, nutsedge, crabgrass, goosegrass, dallisgrass	Post	Safe to apply 2 WAE or later with moderate, but short-lived phytotoxicity (22).	⊙
Confront (triclopyr + clopyralid) + MSMA 6.6	16 + 40	0.28 + 0.09 + 2.0	Crabgrass, goosegrass, dallisgrass, clover, spurge, other broadleaves	Post	Safe to apply 2 WAE or later with moderate, but short-lived phytotoxicity (22).	⊙
Confront (triclopyr + clopyralid)	16-32	0.28 + 0.09	Clover, spurge, other broadleaves	Post	Phytotoxicity moderate, but short lived. More injury on Yukon (10).	⊙
Katana (flazasulfuron) + MSMA 6.6	3 + 40	0.047 + 2.0	Perennial ryegrass, broadleaf weeds, sedges, kyllinga, crabgrass, goosegrass, dallisgrass	Post	Safe to apply 2 WAE or later with moderate, but short-lived phytotoxicity (22).	⊙
Katana (flazasulfuron)	3	0.047	Perennial ryegrass, broadleaf weeds, sedges, crabgrass	Post	Do not apply within four weeks of seeding (1,30).	⊙
Aatrex 4L (atrazine)	64	2.0	Annual bluegrass, perennial ryegrass, broadleaves	Pre + Post	(1,10)	●
Illoxan (diclofop)	43.5	1.0	Goosegrass, ryegrass	Post	(9)	●
Image 70DG (mazaquin)	11.4	0.5	Perennial ryegrass, broadleaves, sedges	Post	(1)	●
Sencor (metribuzin) + MSMA 6.6	8 + 40	0.375 + 2.0	Crabgrass, goosegrass, dallisgrass, broadleaves	Post	(22)	●

[u] Herbicides controlled target weeds preemergently (Pre) or postemergently (Post) or both (Pre+Post).

[v] Susceptibility to herbicide injury. Herbicides causing acceptable phytotoxicity were classified as mild (○), those causing phytotoxicity below acceptable limits without killing bermudagrass seedlings were classified as moderate (⊙) and those killing bermudagrass seedlings were classified as severe (●).

[w] Labeled for use on bermudagrass seedlings.

[x] Herbicides were deemed to be safe when an application did not cause any reduction in seedling coverage.

[y] Weeks after bermudagrass seedling emergence.

[z] Emergence is defined as a uniform stand of one-leaf seedlings about 0.5 inches tall.

Injury or phytotoxicity to bermudagrass varies among herbicides and varies depending upon timing of application after emergence. However, under dense weed populations, the risk of herbicide injury from early applications may be justified by decreased weed competition, allowing increased bermudagrass coverage.

Crabgrass control. Drive and MSMA (only labeled as restricted use on golf courses and sod farms) are safe to use for postemergence control of annual grassy weeds on bermudagrass seedlings as early as one week after emergence (WAE) (9,18,21). Some minor herbicide injury can be expected with MSMA and Drive, but effects are short-lived, and herbicide injury from early applications can be justified by decreased weed competition (21). Avoid using Drive on Yukon seedlings since they are especially prone to herbicide injury (10). Tank mixes of MSMA with other herbicides can also be used, but some tank mixes with MSMA cause more phytotoxicity than MSMA applied alone (21). Preemergence crabgrass control can be achieved with applications of Dimension (dithiopyr), Barricade (prodiamine) or Pendulum (pendimethalin) as early as 3 WAE on bermudagrass seedlings (1).

Goosegrass control. Goosegrass is a difficult weed to control in seedling turf and often requires sequential applications with postemergence herbicides for control. Goosegrass control is best accomplished with postemergence herbicide applications prior to goosegrass tillering. Revolver (foramsulfuron) and MSMA are safe to use 1 WAE on bermudagrass seedlings (9). Preemergence control can be obtained with Dimension, Barricade or Pendulum applied as early as 3 WAE on bermudagrass seedlings (1). Ronstar (oxadiazon) and Specticle (indaziflam) are highly effective preemergence herbicide for goosegrass, but they are yet to be evaluated for safety on bermudagrass seedlings. Illoxan (diclofop) works well for postemergence goosegrass control in established bermudagrass but is phytotoxic to bermudagrass seedlings (9).

Other grassy weed control. It is often necessary to remove grassy weeds such as annual bluegrass (*Poa annua*) or perennial ryegrass (*Lolium perenne*) from seedling bermudagrass areas if they are not completely controlled prior to seeding or if they germinate during grow-in. Revolver and TranXit (rimsulfuron) control annual bluegrass and perennial ryegrass and are safe to apply prior to seeding or as early as 1 WAE (1,10). Manor/Blade (metsulfuron) and Monument (trifloxysulfuron) can also be used but should be delayed until 3 or 4 WAE to reduce injury (9,29,30).

Broadleaf control. Quicksilver and Drive are both labeled for broadleaf control in bermudagrass seedling turf and can be applied as early as 1 WAE (2,9,29,30). Lontrel (clopyralid) and Banvel (dicamba) are also safe on bermudagrass seedlings 1 WAE (9). Other three-way mixtures of herbicides such as Trimec (2,4-D + dicamba + mecoprop (MCPP)) can be used on bermudagrass seedlings at the onset of stolon development (10). Confront (clopyralid + triclopyr) causes more toxicity than other broadleaf herbicides (21,38), and other products should be used or applications made after 2 WAE.

Sedge control. Of the products labeled for sedge or kyllinga control in established bermudagrass, MSMA and Certainty (sulfosulfuron) are the safest and can be applied before seeding or as early as 1 WAE (1,9). SedgeHammer (halosulfuron), Dismiss (sulfentrazone) and Monument can be applied 3 WAE or later (1). Monument + MSMA can also be used on bermudagrass seedlings 2 WAE or later with some short-lived phytotoxicity (21). Image (imazaquin) should not be used on bermudagrass seedlings (1).

Post-Seeding Fertilization

Nitrogen (N) fertilization is often applied to increase seedling establishment, but increasing monthly N fertilization from 1.0 to 2.0 lb/1,000 ft^2 using urea does not speed the establishment of seeded bermudagrass (18). Researchers in Kentucky found that applying lower N rates (4 lb/1,000 ft^2/yr) using urea during establishment resulted in larger stolons and greater carbohydrate reserves than did higher N rates (12 lb/1,000 ft^2/yr), although they did not observe higher N rates leading to increased winter injury (15). Additional research demonstrated that late-season N applications prior to frost promote fall color retention and do not have a negative effect on bermudagrass winter hardiness (13). Therefore, our current recommendations are to apply 1.0 lb N/1,000 ft^2 at emergence and again monthly throughout the growing season with the last application being applied in September.

Traffic Tolerance

Compaction is known to reduce the vegetative growth and root development of established bermudagrass (26). Seedlings are likely even more susceptible to damage. Therefore, limiting or diverting golf cart and equipment traffic after seeding is

strongly advised. Once fully established, some seeded bermudagrass cultivars exhibit better wear tolerance and divot recovery than hybrid bermudagrass cultivars (8,11). Studies in Indiana demonstrated that Riviera is more traffic tolerant than other seeded cultivars such as Mirage and Yukon (3). In Tennessee, Riviera had similar traffic tolerance to Tifway (13). Research in 2008 in Arkansas found that Barbados, Riviera, Southern Star, Sovereign, and Tifway had the best traffic tolerance (27). Arizona Common has poor traffic tolerance (27). In North Carolina, Monaco demonstrated comparable traffic tolerance to Riviera, while Sun Queen was less traffic tolerant (32).

Costs

Bermudagrass can be established by seed more rapidly and typically at a lower cost than by sprigging (16). Seed costs are often around $5/lb for hulled or unhulled bermudagrass seed that has no coating. If seeded at a rate of 1.0 lb PLS/1,000 ft^2, then seed cost per acre is about $242 using noncoated seed. Many improved bermudagrass cultivars are available only as coated seed. Coated bermudagrass seed typically costs from $5 to $25/lb, which if seeded at a rate of 1.0 lb PLS/1,000 ft^2, would increase the cost per acre from $519 to $3,094. By comparison, sprigging costs for bermudagrass are about $1,000/A with sodding costs near $7,500/A.

One method to further reduce the costs of establishing new, improved seeded bermudagrasses is to blend an improved cultivar such as Riviera with a lower-quality cultivar (5). Previous research has shown that planting 50:50% and 75:25% blends of Riviera: Arizona Common eventually resulted in a population shift, and over time, these blends have turf quality similar to 100% Riviera plots (5). Therefore, blending up to 50% Riviera with lower-quality, faster-establishing bermudagrass seed can result in Riviera-dominated stands over time and allow for up to 40% seed cost savings (5). This benefit from blending may work well with other high-quality cultivars but has only been tested with Riviera.

Herbicide costs during establishment will vary based upon weed pressure, site preparation and seeding technique. A typical herbicide program during establishment might include applications of glyphosate prior to seeding, Drive or MSMA as needed to control summer annual grassy weeds, Quicksilver or Drive to control summer annual and perennial broadleaves, Revolver or Monument for annual bluegrass and perennial ryegrass control and Certainty for sedge control, with an estimated cost ranging from $80 to $200/A.

Fertilizer cost is approximately $200/A to apply 1.0 lb N/1,000 ft^2 at emergence and again monthly throughout the growing season using urea. If herbicide and fertilizer costs are added to 1.0 lb PLS/1,000 ft^2 seeding costs, then estimated establishment cost excluding labor ranges from $525 to $3,500/A, depending upon seed coating, weed pressure, herbicide selection and cultivar selection.

Summary

Seeded bermudagrass cultivars with improved turfgrass quality and winter hardiness are commercially available in Arkansas. This publication summarizes a large body of research conducted over the last decade that demonstrates how seeded bermudagrass can be established on golf courses or athletic fields. Establishing seeded bermudagrass will reduce irrigation and pesticide inputs when compared to those needed for cool-season swards in golf course fairways or athletic fields. Additionally, renovating existing swards of bermudagrass with improved bermudagrass cultivars will improve turfgrass quality and reduce reestablishment costs from winterkill and ultimately increase sustainability.

Summary of Procedures for Establishing Seeded Bermudagrass

1. Apply glyphosate to designated areas to remove existing turf. If bermudagrass is among the existing turf, fumigation or multiple applications of glyphosate or glyphosate + fluazifop will be necessary for control.
2. Correct nutrient deficiencies and soil pH as indicated by a soil test.
3. Lightly till area and correct any drainage problems. If an area cannot be tilled, then core aerify and verticut aggressively to break up soil cores and prepare the seedbed.
4. Seed 0.5 to 1.0 lb PLS/1,000 ft^2 of bermudagrass between February and May. Bermudagrass seeded later than June will be more susceptible to winter injury. Shallow seeding (< 0.125 inch) is recommended for optimum germination.
5. Apply a starter fertilizer at 1.0 to 1.5 lb P_2O_5/1,000 ft^2 or as soil tests recommend.
6. Maintain a moist seedbed with light, frequent irrigation until plants mature to a point where irrigation frequency can be reduced and amount increased.

7. Apply herbicides for weed control as soon as possible depending upon safety of individual herbicide, weed species and weed pressure (multiple herbicide applications may be necessary).

8. Begin mowing at 0.5 to 0.75 inch or at desired height as soon as needed.

9. Apply 1.0 lb N/1,000 ft^2 after emergence and again monthly throughout the growing season with the last application being applied no later than four weeks prior to the first anticipated frost autumn.

10. Expect 90% bermudagrass coverage in four weeks assuming adequate soil temperatures and moisture. Estimated establishment costs excluding labor will range from $525 to $3,500/acre depending upon cultivar selection, seeding rate, seed coating, herbicide choice and weed pressure.

Additional Information

Additional publications available at http://www.uaex.edu/.

Additional information about turfgrass management available at http://turf.uark.edu/.

The information given herein is for educational purposes only. Reference to products and turfgrass cultivars is made with the understanding that no discrimination is intended nor endorsement by the Arkansas Cooperative Extension Service.

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