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Getting better

Investment yields high-quality Bermudagrass cultivars with improved cold hardiness

Bermudagrasses (*Cynodon* species) are the most widely used turfgrasses for golf courses, athletic fields and lawns in the Southern U.S. Tolerance of low mowing, as well as favorable heat, drought and traffic tolerance and few serious pests, makes Bermudagrass an attractive choice in tropical and subtropical areas.

Although widely adapted, Bermudagrass' susceptibility to freeze injury has been a continuing threat in many areas where it's used. Several years of mild winters might occur between catastrophic winter events. When severe winter-kill occurs, considerable time and expense can be involved repairing the damage, not to mention the potential for loss of revenues to severely damaged golf courses. Thus, there has been a long-term need for high-quality Bermudagrasses that have reduced risk of winter-kill.

In 1986, the Oklahoma State University, with support from the USGA, began a joint venture to improve the cold hardiness, as well as visual and performance qualities, of seeded turf Bermudagrass. At the time, the only choice of seeded Bermudagrasses was between the less winter hardy Arizona Common (*C. dactylon* var. *dactylon*) and the more cold hardy but coarse-textured Guymon (*C. dactylon* var. *dactylon* Guymon). The Bermudagrass breeding effort at OSU eventually would grow to encompass vegetatively propagated types.

An interspecific hybrid and an agressive common Bermudagrass duke it out during the establishment phase. Inability to eradicate on-site agressive common Bermudagrass leads to mixtures with reduced playing surface quality. Work is under way at Oklahoma State University to determine if rapid-spreading improved types can compete better against common Bermudagrass. Photo: Oklahoma State University

BERMUDAGRASS DEVELOPMENT

Collection of *Cynodon* germplasm for culture and scientific use began about the start of the 20th century in South Africa and the U.S. (Taliaferro, 2003). Bermudagrass germplasm collection and taxonomic characterization at OSU was under way in the 1950s and '60s by Drs. Harlan, de Witt and Huffine (de Wet and Harlan, 1970; Harland et al. 1970a; 1970b). Turf Bermudagrass improvement at OSU with support by the USGA began in earnest in 1986 under the direction of Charles Taliaferro, Ph.D., with assistance from Mike Kenna, Ph.D., and Jeff Anderson, Ph.D. Joel Barber, Ph.D., joined the development effort in 1987. The initial broad objective was to develop finer textured, seed-propagated, cold-tolerant Bermudagrasses (*C. dactylon* var. *dactylon*) for the U.S. transition zone. The initial efforts involved collecting additional germplasm, characterizing appearance and performance, improving the fertility and texture of breeding populations that were known to be cold tolerant, and improving the cold hardiness in populations known to be highly fertile.

By 1990, the effort was expanded to include the development of high-quality, cold-hardy vegetatively-propagated materials for golf course fairways and tees and to examine the possibility of generating improved African Bermudagrasses (*C. transvaalensis*) for use on putting greens. Field plantings of improved African Bermuda-

Table 3. Mean turfgrass quality ratings of seeded Bermudagrasses during 2006 from nine transition zone locations, 2002-2006 NTEP Bermudagrass Trial. †

Seeded Entry	Mean
Yukon	6.2
Riviera	5.8
Contessa	5.8
SWI-1046	5.7
SWI-1012	5.7
SWI-1044	5.6
CIS-CD6	5.4
Veracruz	5.4
SWI-1014	5.4
CIS-CD7	5.3
SWI-1003	5.2
Sunbird	5.1
SWI-1001	5.1
Princess 77	5.0
Tift No. 2	5.0
Transcontinental	5.0
CIS-CD5	4.9
Tift No. 1	4.8
SR 9554	4.8
Panama	4.7
LaPaloma	4.7
FMC-6	4.7
Arizona Common	4.7
Southern Star	4.7
NuMex Sahara	4.6
Mohawk	4.6
Sundevil II	4.5
Sunstar	4.5
B-14	4.5
LSD (0.05)	0.3
Coeff. of variation (%)	12.3

† Excerpted from Tables 3b, p. 14., of the 2006 NTEP Progress Report NTEP No. 07-6. Quality rated on a 1 – 9 scale where 1 is poor and 9 is excellent.

grasses in tropical areas of the U.S. revealed the species performed well in fall, winter and spring but declined substantially in the summer months in tropical and the more southern subtropical planting sites. Many African Bermudagrass selections also suffered substantially more nematode problems on the sandy gulf coastal plain soils compared to the interspecific hybrid Tifdwarf and its derivatives.

Although efforts to generate putting green types of African Bermudagrass were discontinued by early 1997, the breeding and selection effort in that species resulted in improved types that had value in generating improved interspecific hybrid crosses (*C. dactylon* X *C. transvaalensis*) for the golf turf industry.

Taliaferro led the turf and forage Bermudagrass breeding/development effort from its inception until his retirement in December 2005. Guymon, Yukon, Riviera and Patriot turf Bermudagrasses as well as a number of promising experimental types (still under study) were developed under his leadership. Additionally, his familiarity with cultivar development helped facilitate cooperative releases of Midlawn and Midfield hybrid Bermudagrasses between Kansas State University and OSU in 1991. Midlawn and Midfield were developed by Ray Keen, Ph.D., of KSU with field testing assistance by John Pair, Ph.D., and Jack Fry, Ph.D., of KSU amongst other scientists.

The successes of the OSU turf Bermudagrass development program are because of USGA investment and the leadership of Taliaferro in concert with a number of past and current faculty, staff, graduate students and cooperating industry scientists.

Following the retirement of Taliaferro, an extensive search was conducted that resulted in the hiring of Yanqi Wu, Ph.D., in July 2006 to head up the OSU Bermudagrass breeding and development effort. Wu completed his Ph.D. under the tutelage of Taliaferro in 2004. A substantial portion of the newer Bermudagrass germplasm in our program was collected by and is in an ongoing state of characterization by Wu.

CULTIVAR RELEASES

Preceding the USGA-funded turf development effort at OSU, the forage/pasture effort resulted in the release of Guymon Bermudagrass (*C. dactylon* var. *dactylon* Guymon) in 1982 (Taliaferro et al. 1983). Guymon was arguably the first seeded Bermudagrass with improved cold hardiness over Arizona Common. Guymon found favor in soil erosion control areas, roadsides, rangeland and pastures. With only the noncold-hardy Arizona common Bermudagrass seed being available during the 1980s, the coarse-textured but cold-hardy and vigorous Guymon was often used on lower maintenance sports fields and lawns in the transition zone.

Yukon Bermudagrass (*C. dactylon* var. *dactylon* Yukon), tested as OKS 91-11, was released in 2000 (Taliaferro et al. 2003). It was the first turf Bermudagrass from OSU developed with grant funding from the USGA. Yukon is a high-quality, seeded turf-type Bermudagrass with improved cold hardiness (Anderson et al., 2002) and improved spring dead spot disease tolerance (Martin et al. 2001, Morris, 2005).

Yukon found favor on some golf courses, sports fields and in the lawn and landscape industry. It performs well at the 0.5 inch mowing height typical of Bermudagrass fairways. Divot recovery rate of Yukon varies from intermediate (Martin, unpublished) to rapid (Karcher et al. 2005). Although Yukon seed availability has been limited recently, increased availability of seed is anticipated in the near future. Yukon continues to provide excellent quality in transition zone climates (Table 3). Yukon seed production rights are licensed to Seed Research of Oregon, a division of Pick Seed USA.

Riviera Bermudagrass (*C. dactylon* var. *dactylon* Riviera), tested as OKS 95-1, was released in 2001. Riviera is a high-quality, medium fine textured seeded Bermudagrass. Riviera seed production yields are typically higher than those of Yukon (Taliaferro et al. 2004). Riviera has improved cold hardiness (Anderson et al. 2007) and improved tolerance to spring dead spot disease (Morris, 2002b; 2005). Its divot recovery rate varies from intermediate (Karcher et al. 2005) to rapid (Martin, unpublished). Riviera is receiving increased use on fairways, tee boxes, athletic fields and lawns when a high-quality seeded Bermudagrass with improved cold hardiness is desired. Although originally created as a seed-propagated Bermudagrass, arrangements have been made to allow for the production of Riviera sod for use on sites where installation deadlines are too tight for seeding or high erosion potential demands sodding. Riviera seed production rights are licensed to Johnston Seed Co.

Patriot Bermudagrass (*C. dactylon* X *C. transvaalensis* Patriot), tested as OKC 18-4, was released in 2003. Patriot is a vegetatively propagated hybrid characterized as having improved color, quality and cold hardiness (Anderson et al, 2007). Divot recovery rate has been characterized as medium (Karcher et al. 2005) to rapid (Martin, unpublished). Licensed producers have reported rapid sod production cycles from planting to harvest. Improved tolerance to spring dead spot disease (Morris, 2002b; 2005) has been documented in Patriot. We believe Patriot to be the first commercialized interspecific hybrid turf-type Bermudagrass that's a tetraploid. It was created by the cross of the hexaploid 'Tifton 10' and an improved African Bermudagrass (a diploid) from our collection.

Patriot is well adapted to golf course tee box and fairway use and is experiencing increased use by the golf course industry. Patriot has been widely accepted as a sports turf playing surface for football, baseball and soccer in the transition zone and upper region of Bermudagrass adaptation.

DOWNSIDES

For those unfamiliar with Bermudagrass, types with improved cold hardiness still experience canopy (leaf and aerial shoot) discoloration under short day length and chilling temperatures, as well as when death of leaves occurs from freeze injury.

Although these Bermudagrasses often perform suitably in full sun areas of USDA Hardiness zones 5a or 5b during summer, they still can experience significant winter-kill during cold winters as seen in National Turfgrass Evaluation Program Trials (Morris, 1997). The USDA Cold Hardiness zone map it is located at: http://www.usna.usda.gov/Hardzone/ushzmap.html. Prospective Bermudagrass users are urged to conduct a thorough risk/benefit analysis before making a decision to switch from one Bermudagrass to another or if switching from a cool-season grass to Bermudagrass.

SELECTIONS WITH PROMISE

OKC 70-18 Bermudagrass developed in part with funding from the USGA recently has undergone intensive internal as well as external testing (2002-2006 NTEP Bermudagrass trial). This variety ranked first in overall quality at nine transition zone test sites during several years of the 2002 to 2006 NTEP trial. OKC 70-18 has several meritorious characteristics and a decision concerning possible release is forthcoming.

Three promising experimental Bermudagrasses from our program were entered into the 2007-2011 NTEP Bermudagrass trial. These included OKC 11-19 and OKC 11-34, vegetatively propagated types and a seeded type, OKS 2004-2. Sixteen NTEP testing sites are in place for the 2007 NTEP trial. Besides the traditional parameters of color, quality, texture, density, green-up and living cover, additional parameters monitored at selected sites will include sod tensile strength as well as tolerance to spring dead spot disease, salinity and traffic (Morris, 2007b).

CURRENT BREEDING

A new broad-based breeding population recently was formed using desirable Chinese *Cynodon* material selected from a collection by Wu made in 11 provincial regions of China. Selections were made based on extensive evaluation of chromosomal, morphological, seed yield potential and DNA marker investigations completed in 2004 (Wu et al. 2004, 2005, 2006a, 2006b). The population contains favorable traits for turf cultivar development, including darker green color, relatively fine texture, good winter hardiness and good sod density. Study of genetically relatedness assists the turf breeder in elimination of possible duplication of breeding efforts due to close relatedness of parents. Additionally, this work might help in locating crosses that have increased likelihood of compatibility. Complimentary to this work, Kevin Kenworthy, Ph.D., (now of the University of Florida Turfgrass Program) recently completed an assessment of the variability in 21 performance traits of African Bermudagrass while in our program (Kenworthy et al. 2006). The work determined which traits can most easily be improved in the African Bermudagrass parents that are subsequently used for developing interspecific crosses.

Applied field trials comparing later-stage promising experimental entries and industry standards are on-going for turf quality, divot recovery, spring dead spot disease resistance and sod tensile strength. Because of the inability to eradicate preexisting aggressive *C. dactylon* var. *dactylon* types from many installation sites, some superintendents choose not to renovate to improved Bermudagrass cultivars. To address this issue, a preliminary study investigating the resistance of hybrid Bermudagrasses to encroachment by common Bermudagrass was initiated in 2006 by master's candidate Holly Han.

IMPROVING QUALITIES

Development of Bermudagrasses with high turf quality and suitable cold hardiness will remain a key focus of OSU's efforts. However, pursuit of additional improvements has begun. Limited fresh water resources threaten the vitality of the golf turf and landscape industry. Work commenced in late summer 2007 by master's candidate Santanu Thapa of OSU's program to evaluate the water use rate of several experimental OSU Bermudagrasses. Evaluation of leaf-firing resistance under drought will also be incorporated into OSU's screening program in the future. Development of Bermudagrasses with delayed leaf firing might help superintendents maintain quality turf during periods of limited natural rainfall and during irrigation restrictions.

Lack of suitable shade tolerance is a key limitation of Bermudagrass (Beard, 1973). As the golf course landscape matures, increased shading of turf occurs. Breeding and selection for improved shade tolerance in Bermudagrass has been conducted successfully by turfgrass scientists at the University of Georgia (Hanna and Maw, 2007). Screening of Bermudagrass germplasm for improved shade tolerance commenced in our program in summer of 2007 by Greg Bell, Ph.D., and Yanqi Wu, Ph.D. The work incorporates the use of a combination of natural and artificial shade.

CONCLUSIONS

USGA support has been instrumental in continuing a long-term turf Bermudagrass development effort at OSU. A comprehensive, interdisciplinary team of scientists has been assembled focusing on turf Bermudagrass improvement. The effort has resulted in extensive collection, characterization and improvement of breeding populations of Bermudagrasses from the *Cynodon dactylon* and *C. transvaalensis* species.

Studies aiding in the understanding of fundamental mechanisms of stress tolerance occurred. Improvements in turf quality, cold hardiness and spring dead spot tolerance occurred.

The improved turf Bermudagrasses Yukon, Riviera and Patriot were direct results of the

USGA investment.

Training of a number of graduate students occurred.

Two clonally propagated and one seed propagated selection with improved characteristics for the golf industry were entered into the 2007 NTEP Bermudagrass trial.

A new germplasm from China has been introduced recently into OSU's program.

Incorporation of increased water use efficiency, leaf firing resistance under drought and improved shade tolerance in Bermudagrass are future goals of OSU's development effort. **GCI**

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Editor's note: Literature cited in this article can be found on GCI's Web site, www.golfcourseindustry.com, posted with this article.

IMPACT ON THE BUSINESS

Turf trial and error

New variations of Bermudagrass could benefit turfgrass managers working in the transition zone. BY KATIE MORRIS

Superintendents rely on the health and beauty of the course to attract golfers. If the turf is brown and damaged from cold temperatures or drought, a facility can lose money. That's why it's important for superintendents to use reliable and effective turfgrass.

Bermudagrass is one of the most commonly used turfgrasses seen on golf courses in the South, but even it has its limitations. Superintendents in the transition zone, including Colorado, Tennessee, Oklahoma and Missouri are constantly searching for ways to keep their turf green and healthy.

BENEFITS

Turfgrass managers agree Bermudagrass has its advantages over other turfgrasses such as bentgrass, Kentucky bluegrass and St. Augustinegrass. Ken Bennett, golf course superintendent at McAlester (Okla.) Country Club, manages Yukon Bermudagrass on his fairways and tees. Bennett says the benefit of using Bermudagrass instead of other turfs is its heat tolerance and recovery time.

"[With Bermundagrass], if the turf gets hot and brown, it comes back in a couple of days; or if there are divots on the tee box or on the fairway, Bermudagrass grows back a lot faster than any other turf," he says.

In addition to healing quickly, Bermudagrass adapts well to low mowing heights and is best used for tees, greens and fairways. Mike Larson, general manager at Boulder (Colo.) County Club, likes Bermudagrass because it's a hardier grass that's tightly wound, which makes the greens extremely smooth, fast and consistent.

"It's a marvelous grass for surrounds around the green and on fairways," Larson says. "The balls will stand real nice on it with the short cut."

Doug Estes, director of grounds maintenance at the Colonial Country Club in Cordova, Tenn., manages Tifway 419 Bermudagrass because it makes the course more playable.

"The golfers like Bermudagrass better than other turfs because it makes for a firmer and faster course," Estes says.

SAVINGS

When it comes to whether or not Bermundagrass saves money on pesticide and fertilizer use, turfgrass managers are split. Estes says Bermudagrass saves him money especially during the summer season when the temperatures keep the grass growing so he doesn't have to fertilize as much. Larson, on the other hand, says Bermudagrass would save superintendents money if they didn't have to overseed in the winter.

"What Bermudagrass saves you in pesticides and fertilizers, you're going to spend back in your overseeding product," he says.

Overseeding with ryegrass is one way superintendents protect their turfgrass during the winter season. The problem superintendent's encounter is they don't know when the first frost is going to occur, and if they miss their window of opportunity, they're going to have a lot of damage to repair in the spring.

LIMITATIONS.

The main concern superintendents have with Bermudagrass is its lack of resistance to cold weather. Bermudagrass is ideal for golf courses in tropical and subtropical areas, but when it comes to areas susceptible to freezing conditions, superintendents are in need of a variation with cold hardiness.

"Bermudagrass does well in heat and humidity but not so well in cold climates such as ours in Colorado," Larson says.

Researchers in the turf Bermudagrass breeding and development program at Oklahoma State University strive to develop a higher quality Bermudagrass with a higher tolerance to cold and shade.

A new shade tolerant Bermudagrass would help Estes fix a lot of weak areas under trees where the grass isn't as dense.

And despite the expense of overseeding, Larson says that if Bermudagrass had a variation with a higher cold tolerance he would certainly use it. **GCI**