Turfgrass and Environmental Research Online

…Using Science to Benefit Golf

Unlike other cultivar trials sponsored by the National Turfgrass Evaluation Program that compared cultivar performance from plots located on university research stations, this research evaluated turfgrass trials located on golf courses throughout the U.S. The Southern California Golf Association's course at Murietta (shown above) compared the abilities of new cultivars of creeping bentgrass to resist invasion by annual bluegrass. Newer cultivars like Penn A-4, Penn A-6, Penn A-1, and Penn G-1 had the least amount of annual bluegrass after four years of testing.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 215 projects at a cost of $21 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Bentgrasses and Bermudagrasses for Today's Putting Greens

Kevin Morris

SUMMARY

- The National Turfgrass Evaluation Program (NTEP), the United States Golf Association Green Section (USGA), and the Golf Course Superintendents Association of America (GCSAA) agreed in 1997 to jointly fund and cooperate in an "on-site" testing program. Instead of comparing newly released cultivars at university field stations, bentgrasses and bermudagrasses intended for putting green use were evaluated on participating golf courses.
- Eighteen creeping bentgrass cultivars were seeded at eight sites in fall, 1997, or spring, 1998. Seven bermudagrass cultivars were established at three sites in summer, 1998. Five of the sites established both bentgrass and bermudagrass on-site trials.
- After four years of data collection, 'Penn A-4' has been the outstanding entry in this trial. Turfgrass quality ratings averaged over the four years and thirteen sites show 'Penn A-4' alone in the top statistical grouping , followed by 'Penn A-1' and 'Penn G-1'.
- Turfgrass quality ratings from the four years and eight sites show 'Mini-Verde' and 'TifEagle' at the top with 'Champion' slightly below, statistically equal to 'TifEagle', but statistically below 'Mini-Verde'. 'MS-Supreme' was statistically equal to 'Champion', but did not perform statistically as well as 'Mini-Verde' or 'TifEagle' in data averaged over all locations.

As the popularity of golf continues to increase worldwide, golf course owners, managers and superintendents are asking for grasses that produce superior quality and fast putting surfaces, especially during periods of intense use. And with environmental concerns at an all-time high, new grasses need to produce this high putting quality with less water, fertilizer and pesticides. This is a daunting challenge for plant breeders with over 17,000 U.S. golf courses located in highly varied climatic zones, and receiving different levels of management expertise and available resources.

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Improvement of grasses for use on putting greens is an on-going process. Plant breeders are constantly searching for that "perfect" cultivar that encompasses dark green color, fine leaf texture, high density, and excellent disease, insect, drought, heat and cold resistance. New cultivars also need to have high traffic tolerance, quick establishment, and good seed or vegetative production to keep them affordable. Although no single cultivar has been developed that has all of these desired qualities, consumers look to purchase those cultivars that contain what they consider are the most desirable traits for their areas.

Early on

As golf gained popularity in the U.S in the early 1900s, the selection of grasses available for putting greens was very limited. Many greens consisted of either closely-mowed grasses that already existed in pastures or other grassy areas, or consisted of South German bentgrass (*Agrostis spp.*) mixtures, or locally adapted bermudagrass

An important part of putting green performance is disease resistance. Here, Dr. Peter Landschoot, turfgrass pathologist, discusses that aspect of culitvar performance with Superintendent Tom Wolff at the TPC at Snoqualimie Ridge site in Washington state.

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Golf Course	Location	Superintendent	Research Cooperator
Bentgrass only			
Crystal Springs Golf Course	Burlingame, CA	Ray Davies	Dr. Ali Harivandi, California Cooperative Extension
Fox Hollow at Lakewood	Lakewood, CO	Bruce Nelson	Dr. Tony Koski, Colorado State University
Lassing Pointe Golf Course	Florence, KY	Jerry Coldiron	Dr. A. J. Powell, University of Kentucky
North Shore Country Club	Glenview, IL	Dan Dinelli	Dr. Tom Voigt, University of Illinois
Purdue Univ. Kampen Course	West Lafayette, IN	Jim Scott	Dr. Zac Reicher, Purdue University
TPC at Snoqualmie Ridge	Snoqualmie, WA	Tom Wolff	Dr. Gwen Stahnke, Washington State University
Westchester Country Club	Rye, NY	Joe Alonzi	Dr. James Murphy, Rutgers University
Westwood Golf Course	Vienna, VA	Walter Montross	Dr. David Chalmers, Virginia Tech University
Bentgrass and Bermudagrass			
Bent Tree Country Club	Dallas, TX	Keith Ihms	Dr. Milt Engelke, Texas A&M University
C.C. of Birmingham	Birmingham, AL	Lee McLemore	Dr. Elizabeth Guertal, Auburn University
C. C. of Green Valley	Green Valley, AZ	Mike Bates	Dr. David Kopec, University of Arizona
The Missouri Bluffs	St. Charles, MO	Alan Zelko	Dr. Barb Corwin, University of Missouri
SCGA Members Club	Murrieta, CA	John Martinez	Dr. Robert Green, University of California-Riverside
Bermudagrass only			
Country Club of Mobile	Mobile, AL	Ron Wright	Dr. Bryan Unruh, University of Florida
Jupiter Island Club	Hobe Sound, FL	Rob Kloska	Dr. John Cisar, University of Florida
Lakeside Country Club	Houston, TX	Mike Sandburg	Dr. Richard White, Texas A&M University

Table 1. Test locations used in evaluating creeping bentgrass and bermudagrass cultivars in NTEP's on-site testing program

(*Cynodon spp.*) strains. Improved cultivars of vegetatively-propagated creeping bentgrass (*Agrostis stolonifera* L.) such as Arlington, Cohansey, Toronto and Congressional were selected and released in the 1930s and 1940s (2, 4).

'Penncross' creeping bentgrass, released in 1954, quickly became popular for putting greens because its quality matched or exceeded the existing vegetatively-propagated cultivars, yet it was seed-propagated which significantly reduced establishment costs (1). These traits made 'Penncross' the most popular putting green cultivar in the U. S. for over thirty years.

For putting greens in the warmer, southern U. S., 'Tifgreen' bermudagrass was released in 1956 and produced superior quality compared to other bermudagrass cultivars (1). In 1965, 'Tifdwarf' bermudagrass, a dwarf mutant selection from 'Tifgreen', was released (1). 'Tifdwarf' produced better quality at lower mowing heights than 'Tifgreen' and quickly became the standard cultivar for putting surfaces in tropical, subtropical and low desert areas.

The on-site cultivar trials were established on participating golf courses where golfers could practice putting, chipping and pitching, such as Lassing Pointe Golf Course in Florence, KY, shown above. It was felt that cultivars needed to be exposed to the traffic stresses that golf courses must endure for results to be completely applicable.

As faster, higher quality putting surfaces were demanded in the late 1970s, cutting heights continued to be lowered on putting greens across the U.S. This led to a gradual reduction of heights of cut to where the majority of U.S. courses had settled on 1/8 - 5/32" as their preferred greens height. At these cutting heights, however, the standard cultivars 'Penncross', 'Tifgreen' and 'Tifdwarf' began to exhibit more disease, heat, drought stress and scalping. The need was increasing for improved cultivars with better disease, heat, and drought resistance, as well as the ability to produce high putting quality at the new, lower cutting heights.

Along with this need for improved putting green cultivars came the need to test these cultivars on a national scale. The National Turfgrass Evaluation Program (NTEP) initiated its first national trials of bentgrass for putting greens in 1989. Data from 29 university locations averaged over four years beginning in 1990, showed that only two entries, 'Providence' and 'PRO/CUP', out of a total of 22, performed statistically better than 'Penncross' (5, 6). However, in a subsequent national bentgrass putting green trial initiated in 1993 at 27 university locations, 21 entries performed statistically better than 'Penncross' in data averaged over four years and all locations (7).

Back to the future

As many new cultivars and experimental selections were developed in the mid-to-late 1990s, the need was increasing for a new bentgrass trial. About the same time, several improved "ultradwarf" bermudagrass cultivars were being developed for southern golf courses to address the same problem of high putting quality at low mowing heights. These new ultradwarfs also needed to be compared in national performance trials.

However, many golf course superintendents and some researchers questioned the usefulness of NTEP data collected at universities that may not be managed as intensively as actual, in-play putting greens. To address this issue, NTEP, the United States Golf Association Green Section (USGA), and the Golf Course Superintendents Association of America (GCSAA) agreed in 1997

Entry	Turf[1] Quality	Genetic Color	Spring Density	Summer Density	Fall Density
BACKSPIN	6.6	5.9	7.6	7.3	7.5
CATO	6.2	6.6	6.9	6.9	7.0
CENTURY	6.8	5.8	7.8	7.7	7.9
CRENSHAW	6.4	6.9	7.2	6.9	7.0
GRAND PRIX	6.7	6.0	7.4	7.6	7.5
IMPERIAL	6.7	6.1	7.8	7.7	7.3
L-93	6.8	6.9	7.5	7.2	7.5
PENN A-1	7.1	6.6	8.0	7.8	7.7
PENN A-4	7.3	6.8	8.4	8.2	8.1
PENNCROSS	5.3	5.4	5.9	5.6	5.4
PENN G-1	6.9	6.7	7.8	7.8	7.7
PENN G-6	6.7	6.6	7.6	7.5	7.5
PROVIDENCE	6.3	6.5	7.0	6.4	6.7
PUTTER	5.9	5.9	6.0	6.2	6.3
SR 1020	6.4	6.3	7.1	6.9	7.0
SR 1119	6.6	7.0	7.6	7.3	7.1
TRUELINE	6.1	6.4	6.8	6.7	6.5
VIPER	6.1	6.9	6.8	6.6	6.8
LSD[2]	0.1	0.2	0.4	0.4	0.4

[1]Rating scale used is 1-9; 9=ideal turf, dark green color, maximum density.

[2]LSD (Least Significant Difference) statistic at the 5% (0.05) confidence level rating. Cultivar means must be more than this value apart to be deemed statistically significant.

Table 2. Mean turfgrass quality, genetic color and density ratings of creeping bentgrass cultivars grown on golf course practice greens. Data collected from 1998-2001 at thirteen sites.

to jointly fund and cooperate in an "on-site" testing program. Instead of comparing newly released cultivars at university field stations, bentgrasses and bermudagrasses intended for putting green use were to be planted on participating golf courses, much like they were in the 1920s and 1930s. This was to ensure that the trials would receive the level of maintenance commonly practiced on high-level golf courses, while facing the traffic stress from golfers.

With significant funding from the USGA, new putting greens were built on 16 golf courses across the United States according to USGA recommended construction methods (Table 1). These greens were intended to be used as practice putting, chipping, or target greens, and thus receive the same "real life" stresses that golf course turfs must endure.

Eighteen creeping bentgrass cultivars were seeded at eight sites in fall, 1997, or spring, 1998. Seven bermudagrass cultivars were established at three sites in summer, 1998. Five of the sites established both bentgrass and bermudagrass on-site trials. A cooperating university turfgrass scientist was assigned to each trial site for the establishment and data collection of each trial (Table 1).

On-Site Creeping Bentgrass Trial

The on-site trials were limited to commercially available cultivars, or those selections close to commercialization. Seventeen creeping bentgrasses were entered by sponsoring companies with one standard entry, 'Penncross', being included by NTEP. Entries were seeded in 50 sq. ft. plots, replicated three times in a randomized complete block design. Seeding rate was 25 grams per plot or 1.1 lbs. per 1000 sq. ft.

Pre-plant soil preparation and post-plant care varied from site to site, but followed general-

Entry	Turf Quality	Genetic Color	Spring Density	Summer Density	Fall Density
CHAMPION	6.1	6.6	6.5	6.4	7.7
FLORADWARF	5.8	6.6	6.1	5.7	6.9
MINI-VERDE	6.4	7.1	6.9	7.0	8.0
MS-SUPREME	6.0	6.3	6.3	6.4	6.8
TIFDWARF	5.9	6.6	6.5	6.2	7.3
TIFEAGLE	6.3	6.7	6.8	6.9	7.8
TIFGREEN	5.0	5.3	5.1	5.4	5.8
LSD[3]	0.2	0.3	1.0	0.8	0.5

[1]Rating scale used is 1-9; 9=ideal turf, dark green color or maximum density.

[2]LSD (Least Significant Difference) statistic at the 5% (0.05) confidence level. Cultivar means must be more than this value apart to be deemed statistically significant.

Table 3. Mean turfgrass quality, genetic color and density ratings of bermudagrass cultivars grown on golf course practice greens. Data were data collected from 1998-2001 at eight sites.

ly accepted practices of fertilization, pH adjustment, irrigation, and mowing. These greens were used for practice by golfers. Since cutting, moving and replacing cups would compromise the integrity of plots, target flags were used instead of cutting actual cups.

Monthly turfgrass quality ratings were collected. Turfgrass quality ratings were scored on a scale of 1-9, where 9=ideal turf (8). Quality ratings include all the factors that are important to turfgrass managers, including color, density, texture, uniformity, disease or insect damage, drought, heat and cold injury. Other required data included genetic color, spring green-up, leaf texture, and putting speed as measured by a modified stimpmeter (3). Other information, such as disease and insect damage, winter injury, percent living ground cover, frost tolerance and thatch accumulation was recorded if the cooperator found it reasonable and feasible to collect.

On-Site Bermudagrass Test

This trial was established at eight locations (Table 1) in spring and summer of 1998. All entries were vegetatively-propagated cultivars. Planting rate was 24 3 x 3-inch plugs (live plant material and soil) of each entry per plot. Each plug was broken into many small pieces (sprigs) and hand-planted. Plots were then rolled and irrigated carefully so sprigs were not washed from their planting site. Some sites also used a lightweight planting cover to protect the sprigs from erosion.

Five new cultivars were submitted for inclusion in the trial, and 'Tifgreen' and 'Tifdwarf' were included as comparative standards. As with the bentgrass trial, each green was used for practice by golfers. Maintenance was performed by the golf course superintendent in a manner similar to the other greens on the course, or other bermudagrass greens in the area. Data collection methods and stimpmeter measurements were identical to those used in the bentgrass trial.

Creeping Bentgrass Performance

After four years of data collection, 'Penn A-4' has been the outstanding entry in this trial. Turfgrass quality ratings (see Table 2) averaged over the four years and thirteen sites show 'Penn A-4' alone in the top statistical grouping, followed by 'Penn A-1' (7.1) and 'Penn G-1' (6.9). Surprisingly, 'Century', a cultivar that has turf quality ratings in the middle statistical grouping of the 1998 Official Bentgrass Test, is next with a turf quality rating of 6.8, making it statistically equal to 'Penn G-1' and 'L-93'. This may have been due to Century's susceptibility to dollar spot (*Sclerotinia homoeocarpa*). The superintendents

managing the on-site trials effectively controlled dollar spot through the use of preventative fungicide applications. In contrast, the official trial sites at university field stations are encouraged to allow disease development before treating, lowering overall quality ratings.

'Penn A-4' was also very consistent across locations. At ten of thirteen locations, turf quality ratings of 'Penn A-4' from 1998-2001 placed it as the highest scoring entry. 'Penn A-4' was the only entry to finish in the top statistical group for turf quality at each location averaged over the entire four-year period.

The highest genetic color ratings in the on-site trial belonged to 'SR 1119' with 'L-93', 'Crenshaw' and 'Viper' just below (6.9), but statistically equal to 'SR 1119'. Highest genetic color ratings did not belong to the cultivars with the highest overall turfgrass quality. However, top-performing entries, such as 'Penn A-4', 'Penn G-1' and 'Penn A-1' rated high for genetic color. The exception is 'Century' which rated almost at the bottom of all the entries.

Density ratings in each of spring, summer and fall were very consistent over the three-year period. 'Penn A-4' had the highest density rating in each season. In spring, 'Penn A-1', had the next highest density rating , statistically equal to 'Penn A-4'. Summer density of 'Penn A-4' placed it the same statistical group as 'Penn G-1' and 'Penn A-1'. Fall density ratings had 'Century', 'Penn A-1', and 'Penn G-1' in the same statistical group as 'Penn A-4'.

Annual bluegrass (*Poa annua*) invasion is a major problem for in many areas of the U.S. for those golf courses wishing to limit its presence on putting greens. Density ratings also seem to impact the percentage of annual bluegrass in the turf stand. Data collected from the Murrieta, CA site in December, 2001, showed that 'Penn A-4' 'Penn G-6' 'Penn A-1' and 'Penn G-1' had the least amount of annual bluegrass after four years. Other new cultivars such as 'Century', 'L-93', 'Imperial', 'Providence', 'Putter' and 'Viper' had significantly more *Poa annua*. 'Cato', SR 1020, and 'Penncross' had the greatest invasion of annual bluegrass after four years.

For golf course superintendents, any cultivar difference in ball roll or putting speed is important. Stimpmeter ratings were collected at the different sites on 46 total dates over the four-year period. Data collected on 32 of those rating dates yielded stimpmeter ratings with no statistical differences among any entries. Stimpmeter ratings on six dates had statistically significant differences between only the top and bottom entries.

Bermudagrass Performance

Bermudagrasses that can tolerate 1/8" mowing heights with the density of some of the best bentgrasses are new to the turfgrass industry. Five entries, 'Mini-Verde', 'TifEagle', 'Champion', 'MS-Supreme' and 'Floradwarf' were included in this trial along with two standard entries, 'Tifdwarf' and 'Tifgreen'. Data was collected in summer and fall of 1998, which mainly reflected rate of establishment, and then during the growing seasons of 1999-2001. One site, The Missouri Bluffs Golf Course in St. Charles, Missouri, suffered complete kill during the winter of 1998-99 therefore, data was collected only in 1998.

Turfgrass quality ratings from the four years and eight sites (Table 3) show 'Mini-Verde' and 'TifEagle' at the top with 'Champion' slightly below, statistically equal to 'TifEagle', but statistically below 'Mini-Verde'. 'MS-Supreme' was statistically equal to 'Champion', but did not perform statistically as well as 'Mini-Verde' or 'TifEagle' in data averaged over all locations. 'Floradwarf' was statistically below 'Mini-Verde', 'TifEagle' and 'Champion' as well as being statistically equal to the standard entry 'Tifdwarf'. 'Tifgreen' was clearly at the bottom with a turf quality rating of 5.0. A closer examination of the data revealed that some entries performed better or equal to 'Mini-Verde' or 'TifEagle' at individual sites, but not averaged over all sites.

'Mini-Verde' had the highest average genetic color ratings at 7.1, statistically higher than all other entries. Density ratings in spring showed little statistical difference among all the entries. 'Mini-Verde' finished with the highest average density rating in summer, however, statis-

tically better than only 'Floradwarf' and 'Tifgreen'. Fall density ratings showed more statistical differences with 'Mini-Verde', 'Champion' and 'TifEagle' in the top statistical group.

The high color and density ratings most likely have resulted in the excellent turf quality ratings for these grasses. In addition, as with the bentgrasses, stimpmeter ratings produced very little statistical differences among the entries. Out of 19 stimpmeter rating dates, ten showed no statistical differences among any of the entries, while five ratings produced statistical differences between only the top and bottom entries.

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