3-1-2008

Arkansas Turfgrass Report 2007

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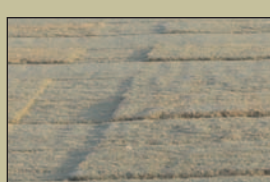
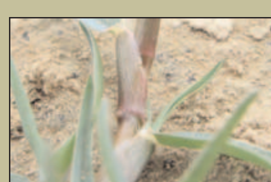

ARKANSAS AGRICULTURAL EXPERIMENT STATION

Division of Agriculture | University of Arkansas System

March 2008 | Research Series 557

This publication is available on the Internet at: http://arkansasagnews.uark.edu/408.htm

Technical editing, layout, and cover design by Camilla Crone

Arkansas Agricultural Experiment Station, University of Arkansas Division of Agriculture, Fayetteville. Milo J. Shult, Vice President for Agriculture. Mark J. Cochran, AAES Director and Associate Vice President for Agriculture–Research. WWW/QX6.52.

ISSN:1941-188X CODEN:AKAMA6

Arkansas Turfgrass Report 2007

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Conversion table

Conversions for commonly used units:

1 ft = 0.30 meters = 30 cm
1 inch = 2.54 cm = 25.4 mm
1 ounce = 28.3 g
1 lb. = 0.454 kg = 454 g
1 PSI = 6.9 kPa
1 ppm = 1 mg / kg
1 gallon / acre = 9.35 L / ha
1 lb. / 1000 ft^2 = 4.9 g / m^2
1 lb. / 1000 ft^2 = 48.8 kg / ha
1 lb. / 1000 ft^2 = 43.56 lb. / acre
1 lb. / acre = 1.12 kg / ha

To our colleagues and constituents...

Turfgrass Industry:

As the green industry continues to expand across Arkansas and the nation, the University of Arkansas, Division of Agriculture, has assembled an outstanding team of researchers, extension personnel, and educators that is working to solve some of the most pressing needs of that industry. One segment of the green industry that continues to provide a significant impact on the state's economy is the turfgrass industry, which includes lawn care, sports turf, sod production, and golf course maintenance. In a recent survey, it was estimated that the turfgrass and lawncare industry in Arkansas provides over 8,600 jobs and contributes over 336 million dollars annually to the state's economy.

The Arkansas Turfgrass Report is a new Research Series that will be published online on an annual basis by the Arkansas Agricultural Experiment Station and will feature significant findings made by turfgrass scientists over the past year. Although this publication will primarily summarize findings from the research program, it will also highlight advancements in teaching and extension programs, as well as significant issues that affect the industry as a whole. It is our desire that this publication will keep our stakeholders abreast of significant changes and advancements that affect our industry.

We are very proud of this first installment of the Arkansas Turfgrass Report, which includes 21 papers from faculty, staff, graduate students, and industry personnel. We hope that these findings will enhance your ability to conduct business in an efficient and productive manner.

We would also like to recognize the many organizations, companies, and individuals who have given their time, money, and talents to make our program successful. We are forever indebted to the many people who contribute to this program.

We hope that this publication will be of value to all persons with an interest in the Arkansas green industry.

Mike Richardson
Professor

Doug Karcher
Associate Professor

Aaron Patton
Assistant Professor

University of Arkansas Turfgrass Research Cooperators

The University of Arkansas turfgrass research team is grateful for assistance in the form of donated equipment and product, and research grants from the following associations and companies. Our productivity would be significantly limited without this support.

Acclima, Inc.
Andersons Golf Products
Aquatrols, Inc.
Arkalite
Arkansas Farm Bureau
Arkansas Turfgrass Association
BASF
Bayer Environmental Science
Brandon Nichols, Fayetteville Country Club
Casey Crittenden, Bella Vista POA
Cebeco International Seeds
Conwed Fabrics
Crossover Liquor
DeWitt Company
Double Springs Sod Farm
Dow AgroSciences
Emerald Isle
Environmental Turf
Ewing Irrigation
FMC Corporation
Georgia Pacific
Golf Course Superintendents Association of America
Golf Course Superintendents Association of Arkansas
Helena Chemical
ISK Biotech
Jacobsen (Textron)
Jerry Musick, Razorback Park Golf Course
Johnston Seed Co.
Lebanon Seaboard
Lee McBurnett, Stonebridge Meadows
Lentz Sand and Gravel
Milorganite
National Turfgrass Evaluation Program
NexGen Research
Pat Berger, University of Arkansas Athletics
Patten Seed Co.
PBI Gordon
Pennington Seed
PermaGreen Supreme, Inc.
Precision Labs
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Profile Products Co.
Pure-Seed Testing
Quail Valley Sod
Scotts Professional Turf
Seed Research of Oregon
Seeds West, Inc.
Segway
Spectrum Brands
Spectrum Technologies
Stillwater Equipment Co.
Syngenta
Texas A&M University
The Toro Company
Tifsport Growers Association
Todd Towery, Pinnacle Country Club
Turfgrass Producers International
United States Golf Association
Winrock Grass Farm

We regret that some individuals or companies may have been inadvertently left off of this list. If your company has provided financial or material support for the program and is not mentioned above, please contact us so that your company's name can be added in future reports.

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Arkansas Certification Program for Vegetatively Propagated Turfgrass Varieties

James Chastain[1], Aaron Patton[2], and Mike Richardson[3]

Additional index words: Blue tag, cultivar, sprig, sod, bermudagrass, zoysiagrass

Chastain, J., A. Patton and M. Richardson. 2008. Arkansas certification program for vegetatively propagated turfgrass varieties. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:9-11.

Photo by Fred Miller

Sod production near Little Rock, Ark.

Summary. In January 2007, the varietal certification program for vegetatively (sod, sprigs, plugs) propagated turfgrass was revised and updated by the Arkansas State Plant Board (ASPB) Seed Division to comply with AOSCA (Association of Official Seed Certifying Agencies) standards. The voluntary program provides a method to verify the genetic source and purity, as well as quality of, vegetative turfgrasses sold in Arkansas. The ASPB turfgrass certification program was revised because turfgrass cultivars were being sold under differing names, consumers were unsure which cultivar they were purchasing, and breeders of new cultivars, along with consumers, needed a guarantee of turfgrass quality and genetic purity. The result of a turfgrass variety (cultivar) certification program is assurance of a quality product that has an unbroken chain of traceability back to a pure source of seed or vegetative plant material. Bermudagrasses and zoysiagrasses are currently being grown under the turfgrass certification program by seven of Arkansas' 53 sod farms. Certified tags (blue tags) or labels, issued by the ASPB accompany the certified turfgrass shipments for inspected and approved turfgrass cultivars.

Abbreviations: AOSCA, Association of Official Seed Certifying Agencies; ASPB, Arkansas State Plant Board.

[1] Arkansas State Plant Board, Seed Certification Section, Little Rock, Ark. 72205
[2] University of Arkansas, Cooperative Extension Service, Department of Horticulture, Fayetteville, Ark. 72701
[3] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

The Latin phrase *Caveat Emptor* is well-known by its English translation: Let the Buyer Beware. These few words have the power to change customer behavior, even to the point of avoiding a purchase due to fear of being sold low- or inconsistent-quality products. To protect consumers and businesses from poor-quality products, certification programs exist in practically every facet of business. Some well-known examples include USDA certified foods and the Underwriters Laboratory (UL-approved) stamp for electronic products. Numerous certification programs also exist for plant materials, including turfgrasses.

The Arkansas State Plant Board (ASPB) Seed Certification Program allows for voluntary participation in a program for varietal certification of agricultural seed and vegetatively (sod, sprigs, plugs) propagated turfgrasses. This program is distinct from the nursery-type "certifications", which assure freedom from disease and insects or noxious plants, as required for interstate shipments. As a member of the Association of Official Seed Certifying Agencies (AOSCA), the ASPB turfgrass certification program follows field and seed standards for production of high-quality seed and sod that satisfy AOSCA requirements, which includes constant supervision of the production of turfgrass with the highest genetic and mechanical purity.

Sod producers participating in the varietal certification program are required to provide evidence of the variety (cultivar) of turfgrass planted, while trained Arkansas State Plant Board field inspectors conduct three or more inspections during the growing season to verify the characteristics of the breeder's description for the variety, as well as the presence of weeds or other crops in the field. These rigid standards of quality have been established by the ASPB for three classes of certified turfgrass: Foundation, Registered, and Certified. Foundation stock is the vegetative increase of plant material from the breeder and these fields are not larger than 10 acres. Registered stock is the increase of foundation stock and these fields are not larger than 10 acres. Certified fields are the increase of registered or foundation stock and are not limited by size. Detailed records are maintained for these three generations of turfgrass production, as well as for the original breeder generation. Certified tags (blue tags) or labels issued by the ASPB accompany the certified turfgrass shipments for inspected and approved turfgrass cultivars.

The result of a turfgrass variety certification program is assurance of a quality product that has an unbroken chain of traceability back to a pure source of seed or sod. Variety certification provides buyers the assurance of receiving a product that has been independently verified which is 1) true to variety, 2) without noxious weeds, and 3) inspected by trained inspectors. Also, breeders/originators of many new turfgrass cultivars require the owner/distributor to sell these cultivars as a class of certified sprigs or sod and participation in the ASPB turfgrass certification program satisfies this requirement.

Some of the reasons the ASPB turfgrass certification program was revised was because 1) cultivars were being sold under differing/confusing names, 2) consumers were unsure which variety they were purchasing, 3) consumers requested a greater guarantee of turfgrass quality and genetic purity, and 4) breeders of new cultivars were often requiring their cultivars to be in an AOSCA approved certification program as a condition of allowing those cultivars to be sold. The Arkansas turfgrass program standards were revised in January 2007 and are patterned similar to turfgrass certification programs in Georgia and other states. Field inspectors were trained in the identification of common turfgrass species and turfgrass weeds by the University of Arkansas Cooperative Extension Service and turfgrass researchers. Additionally, breeder varietal descriptions and accurate information were obtained by the ASPB from university researchers and breeders. A summary of the correct cultivar names, experimental names, acceptable names, unacceptable names, scientific names, and common species names for bermudagrasses (*Cynodon* spp.) and zoysiagrasses (*Zoysia* spp.) grown in Arkansas is provided in Table 1. Currently, several cultivars of bermudagrass and zoysiagrass are being grown under the turfgrass certification program (Table 1) by seven of Arkansas' 53 sod farms.

Persons wishing to participate in the ASPB turfgrass certification program should contact Mary Smith or James Chastain of the ASPB at (501) 225-1598. For more information about nursery inspections of turfgrasses provided by the Plant Board, including nursery inspections for interstate shipments or nursery certificates showing inspections conducted for noxious weeds and fire ants on turfgrasses purchased with State of Arkansas funds, contact Terry Walker of the ASPB, Plant Industry Division, (501) 225-1598.

Literature Cited

Anderson, M.P., C.M. Taliaferro, D.L. Martin, and C.S. Anderson. 2001. Comparative DNA profiling of U-3 turf bermudagrass strains. Crop Sci. 41:1184-1189.

Table 1. Cultivar names, experimental names, acceptable names, unacceptable names, scientific names, and common species names for bermudagrasses and zoysiagrasses grown in Arkansas.

Cultivar name	Experimental name	Acceptable names	Unacceptable names	Species (scientific)	Species (common)
Celebration [z]	Riley's Super Sport	Celebration	other	Cynodon dactylon	Bermudagrass
Quickstand			Quicksand	Cynodon dactylon	Common bermudagrass
Miniverde [z]			other	Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
Patriot	OKC 18-4	Patriot, Patriot (OKC 18-4)	other	Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
Tifdwarf [z]		Tifdwarf	other	Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
Tifgreen [z]	Tifton 328	Tifgreen, Tifgreen (Tifton 328)	Tifgreen 328, 328 bermudagrass, 328, Tifton 328, Tif 328	Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
Tifsport [z]	Tift 94	Tifsport	other	Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
Tifton-10 [z]	Tifton-10	Tifton-10	Tiff 10, T10	Cynodon dactylon	Common bermudagrass
Tifway [z]	Tifton 419	Tifway, Tifway (Tifton 419)	Tifway 419, 419 bermudagrass, 419, Tifton 419, Tif 419	Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
Tifway II	Tifway mutant 71-126	Tifway II		Cynodon dactylon x Cynodon transvaalensis	Hybrid bermudagrass
U-3 [y]	U-3	U-3	U3	Cynodon dactylon	Common bermudagrass
Cavalier [z]	DALZ8507	Cavalier	other	Zoysia matrella	Zoysiagrass or Manilagrass
Crowne [z]	DALZ8512	Crowne	other	Zoysia japonica	Zoysiagrass or Japanese lawngrass
Diamond [z]	DALZ8502	Diamond	other	Zoysia matrella	Zoysiagrass or Manilagrass
El Toro [z]	UCR#1	El Toro	other	Zoysia japonica	Zoysiagrass or Japanese lawngrass
Himeno [z]		Himeno		Zoysia japonica	Zoysiagrass or Japanese lawngrass
Meyer [z]	Z-52	Meyer, Meyer (Z-52)	Z-52, Amazoy, Meyers	Zoysia japonica	Zoysiagrass or Japanese lawngrass
Palisades [z]	DALZ8514	Palisades	other	Zoysia japonica	Zoysiagrass or Japanese lawngrass
Royal	DALZ9006	Royal	other	Zoysia matrella	Zoysiagrass or Manilagrass
Zorro [z]	DALZ8510 or 9601	Zorro	other	Zoysia matrella	Zoysiagrass or Manilagrass

[z] Available as blue tag certified sod in Arkansas as of 1/2/2008.
[y] not available as certified sod due to mechanical contamination of U-3 foundation nursery (Anderson et al., 2001).

Summary of the 2003 NTEP Bentgrass Trial

Doug Karcher[1], Mike Richardson[1], Aaron Patton[2], and Josh Landreth[1]

Additional index words: *Agrostis stolonifera*, *Agrostis canina*, turfgrass, cultivars, turf color, density, dollar spot, brown patch, aerification recovery, putting green

Karcher, D., M. Richardson, A. Patton and J. Landreth. 2008. Summary of the 2003 NTEP Bentgrass Trial. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:12-16.

Photo by John Kauffman

Bentgrass putting green with early-morning dew

Summary. Creeping bentgrass continues to be the prevailing turfgrass species used for golf course putting greens throughout northern and central Arkansas. Identifying cultivars that are well-adapted to the region remains a central focus of the University of Arkansas turfgrass research program. The National Turfgrass Evaluation Program is the predominant means by which cultivars are tested throughout North America. A bentgrass cultivar trial, including selections of creeping and velvet bentgrass was planted in the fall of 2003 at the University of Arkansas Research and Extension Center (Fayetteville, Ark.). The trial was maintained under golf course putting green conditions and data on turfgrass quality, color, density, dollar spot and brown patch incidence, and recovery from core aerification were collected. On average, the velvet bentgrass cultivars were rated low in turf quality due to their lack of heat tolerance. Among the creeping bentgrass entries, the cultivars that consistently had the best turf quality throughout the trial were, 007, Tyee, Shark, Authority, Penn A-1, Declaration, and MacKenzie. There were significant differences among cultivars with regard to turf color, density, dollar spot, brown patch, and recovery from aerification.

Abbreviations: NTEP, National Turfgrass Evaluation Program

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701
[2] University of Arkansas, Cooperative Extension Service, Department of Horticulture, Fayetteville, Ark. 72701

Creeping bentgrass (*Agrostis stolonifera*) provides the most uniform and fastest surface for golf course putting greens in northern and central Arkansas and in environments throughout the transition zone. Over the past several decades, improvements in density, heat tolerance and disease resistance have made this species ideal for putting greens.

The National Turfgrass Evaluation Program (NTEP) is an organization within the US Department of Agriculture that annually oversees turfgrass cultivar evaluation experiments at various sites throughout the US and Canada. Each turfgrass species is tested on a four to five year cycle at sites throughout the growing region for that particular species. The University of Arkansas has been an active participant in the NTEP and was awarded a site for the 2003 NTEP Bentgrass Trial which included both creeping bentgrass and velvet bentgrass (*Agrostis canina*) cultivars. This report will summarize the data from the past four growing seasons of the 2003 NTEP Bentgrass Trial at Fayetteville, Arkansas.

Materials and Methods

This cultivar trial was planted in October 2003 at the University of Arkansas Research and Extension Center in Fayetteville on a sand-based rootzone that was constructed according to USGA recommendations. Twenty six cultivars were officially included in the 2003 NTEP Bentgrass Trial and an additional four cultivars were included at the Arkansas site (L-93, Penn A-2, Penn G-2, and SR 1020) due to their common use in this region (Table 1). Each entry was broadcast seeded into four replicate 8 by 8 ft plots at a seeding rate of 0.5 lb / 1000 ft^2. A 3-ft border of Crenshaw creeping bentgrass, which is particularly susceptible to dollar spot (*Sclerotinia homeocarpa*), was established around the plots to increase dollar spot disease pressure across the experimental area. Plots were maintained under golf course putting green conditions, with a mowing height of 0.125 inch and monthly nitrogen applications of 0.5 lb N / 1000 ft^2 per month of active growth. Irrigation was applied during establishment as needed to promote germination and thereafter to avoid drought stress.

Cultivars were visually rated for turfgrass quality monthly through the duration of the trial using a 1 to 9 scale, where 9 represents ideal dark green, dense, uniform turf and 1 represents dead turf. Turf density was evaluated up to twice per season on a 1 to 9 scale, where 9 represents ideal density and 1 represents very poor density. Turf color was visually rated one to two times per growing season using a 1 to 9 scale, where 9 represents ideal dark green color and 1 represents yellow/brown color. Two separate outbreaks of dollar spot occurred in June and August 2005 and an outbreak of brown patch (*Rhizoctonia solani*) occurred in July 2006. During each disease outbreak, disease severity was rated on a 1 to 9 scale where 9 represents turf completely infected with disease and 1 represents no disease present. Turf recovery at approximately 2 weeks following core aerification was visually rated in April 2006 and September 2007 on a 1 to 9 scale where 9 represents complete turf recovery and 1 represents no recovery.

Results and Discussion

Turf quality. There were significant differences in turf quality among bentgrass cultivars throughout the four years of the trial (Table 1). On average, turf quality improved among cultivars throughout the trial (average quality was 5.9 in 2004 and 6.3 in 2007) as the turf matured and increased in density. This trend was not present among the velvet bentgrass cultivars. Many of the velvet bentgrass cultivars had peak turf quality in 2004 or 2005 and then declined over the next two growing seasons, most likely due to poor heat tolerance and excessive thatch accumulation. In the final year of the trial, all of the velvet bentgrass cultivars produced an average turf quality rating of below acceptable (6.0).

The seven creeping bentgrass cultivars that averaged the best turf quality in each of the four growing seasons were 007, Tyee, Shark, Authority, Penn A-1, Declaration, and MacKenzie. When averaged over the four growing seasons, CY-2, T-1, and Benchmark DSR were also among the best cultivars with regard to turf quality. In the final year of the trial, 13-M, Independence, Kingpin, IS-AP 9, and LS-44 were also among those cultivars with the best turf quality. It should be noted that all of the creeping bentgrass cultivars averaged significantly better turf quality than the older industry standard, Penncross.

Turf density. There were significant differences in density among bentgrass cultivars in the trial (Table 2). On average, the velvet bentgrass cultivars were significantly more dense than the creeping bentgrasses. Velvet bentgrasses have potential to provide a superior putting surface if they are established in regions with limited heat stress. Among the creeping bentgrass cultivars, Tyee, MacKenzie, and Shark were the most dense and exhibited significantly improved density over the Penn A and G cultivars (Penn A-1, Penn A-2 and Penn G-2), which were previously described as high-density cultivars. All bentgrass cultivars had better density than the standards, Penncross, and Pennlinks II.

Turf color. When averaged over the four seasons of the trial, there were significant differences among bentgrass cultivars with regard to turf color (Table 2). It was difficult rating velvet and creeping bentgrass cultivars in the same trial since the velvets had a more brilliant green color (more color saturation), but were not quite as dark as the creeping cultivars. On average, the velvet bentgrasses were rated significantly higher for genetic color than the creeping bentgrass cultivars. Among the creeping bentgrass cultivars, T-1, 007, Authority, IS-AP 9, and Shark were the top-rated group for turf color.

Dollar spot. When averaged across both dollar spot outbreaks in June and August of 2006, there were significant differences in disease severity among bentgrass varieties (Table 2). On average, the creeping bentgrasses were more susceptible to dollar spot than the velvet bentgrasses. The 18 cultivars that ranked highest for dollar spot severity were all creeping bentgrasses. Among the creeping bentgrass cultivars, the most severely infected with dollar spot were, Bengal, SR 1020, T-1, Independence, Tyee, and Penn G-2, whereas the cultivars with the lowest dollar spot severity were Declaration, Memorial, 13-M, Kingpin, Pennlinks II, and Benchmark DSR.

Brown patch. There were a few significant differences among bentgrass cultivars in brown patch severity in July 2006 (Table 2). Only the creeping bentgrass cultivars had brown patch symptoms, with Penn A-1, Authority, Penn A-2, Penn G-2, Pennlinks II, T-1, Kingpin, Penncross, IS-AP 9, Tyee, and Declaration having the most severe brown patch.

Core aerification recovery. The velvet bentgrass cultivars recovered more slowly from core aerification than the creeping bentgrasses when averaged over the two recovery rating dates in April 2006 and September 2007 (Table 2). The only creeping bentgrass cultivars that were not ranked in the top statistical group for fast recovery were, SR 1020, L-93, Penn A-2, Authority, T-1, and Shark.

Conclusions

There were significant differences among bentgrass cultivars with regard to overall turf quality, turf color, density, disease severity, and recovery from core aerification. A more detailed report of the Arkansas NTEP bentgrass data, as well as data from several locations throughout the US, may be obtained at the NTEP web site (www.ntep.org). The University of Arkansas was selected as a site for two new NTEP bentgrass trials (putting green and tee/fairway) to be established in the fall of 2008 and will consist of various new and standard cultivars and will be evaluated over the next several years.

Table 1. Turf quality ratings for creeping and velvet bentgrass cultivars in the 2003 NTEP Bentgrass trial. Cultivars are listed by rank, from best to worst quality, when averaged over the four years of the trial.

Entry	Species	2004	2005	2006	2007	Average
		----------- turfgrass quality (1 to 9 scale) -----------				
007	Creeping	6.6	6.8	7.2	7.7	7.0
Tyee	Creeping	6.9	6.3	7.5	7.3	7.0
Shark	Creeping	6.8	6.3	7.3	7.4	6.9
CY-2 [z]	Creeping	6.1	6.6	7.3	7.5	6.9
Authority	Creeping	6.6	6.3	7.1	7.2	6.8
Penn A-1	Creeping	6.4	6.4	6.9	7.4	6.8
Declaration	Creeping	6.3	6.7	6.8	7.0	6.7
T-1	Creeping	6.7	5.6	6.9	7.1	6.6
MacKenzie	Creeping	6.2	5.9	7.1	6.9	6.5
Benchmark DSR	Creeping	5.7	6.6	6.8	7.0	6.5
LS-44	Creeping	5.9	6.5	6.8	6.9	6.5
Independence	Creeping	6.4	5.7	6.9	7.0	6.5
IS-AP 9 [z]	Creeping	5.9	6.5	6.6	6.9	6.5
Memorial	Creeping	5.8	6.5	6.6	6.8	6.4
13-M [z]	Creeping	5.5	6.6	6.6	7.0	6.4
Alpha	Creeping	5.9	6.1	6.8	6.6	6.4
Kingpin	Creeping	5.7	6.5	6.3	6.9	6.4
Penn A-2 [y]	Creeping	5.8	6.4	6.4	6.5	6.3
Villa	Velvet	6.8	6.8	5.9	5.5	6.3
Penn G-2 [y]	Creeping	5.6	5.9	6.6	6.4	6.1
Bengal	Creeping	6.2	5.2	6.7	6.3	6.1
L-93 [y]	Creeping	5.5	5.9	6.1	6.5	6.0
Pennlinks II	Creeping	5.3	5.5	5.5	5.7	5.5
Venus	Velvet	5.9	6.0	4.9	5.0	5.5
Legendary	Velvet	5.9	5.8	4.7	4.5	5.2
Greenwich	Velvet	6.0	5.5	4.4	4.9	5.2
SR 1020 [y]	Creeping	5.2	4.7	5.8	5.0	5.2
Vesper	Velvet	5.7	5.7	4.8	4.6	5.2
Penncross	Creeping	4.4	5.1	4.7	5.0	4.8
SR 7200	Velvet	5.6	5.4	3.7	3.6	4.6
$LSD_{(0.05)}$		0.75	0.96	0.96	0.83	0.53

[z] Entry is experimental and at this time not commercially available.
[y] Not an official entry of the 2003 NTEP bentgrass trial and was included as an Arkansas standard.

Table 2. Turf density, color, dollar spot, brown patch, and aerification recovery ratings for creeping and velvet bentgrass cultivars in the 2003 NTEP Bentgrass trial. Cultivars are listed alphabetically within species.

Entry	Species	Density	Color	Dollar spot	Brown patch	Aerification recovery
		----------------- rating value (1 to 9 scale) -----------------				
007	Creeping	7.3	6.6	2.8	1.3	6.2
13-M [z]	Creeping	7.0	5.8	1.8	1.0	6.3
Alpha	Creeping	6.9	6.0	4.5	1.3	6.8
Authority	Creeping	7.5	6.4	2.9	3.3	5.8
Benchmark DSR	Creeping	7.1	6.2	2.3	2.0	6.7
Bengal	Creeping	7.0	6.0	5.8	2.0	6.3
CY-2 [z]	Creeping	7.4	6.1	2.8	2.0	6.8
Declaration	Creeping	7.1	6.2	1.3	2.3	6.8
Independence	Creeping	7.2	6.3	5.3	2.0	7.0
IS-AP 9[z]	Creeping	7.3	6.4	2.7	2.7	6.2
Kingpin	Creeping	6.7	6.3	2.0	2.7	6.8
L-93 [y]	Creeping	6.3	5.7	3.7	1.7	5.8
LS-44	Creeping	7.0	6.3	3.1	1.3	6.2
MacKenzie	Creeping	7.8	6.1	4.0	1.0	6.8
Memorial	Creeping	6.8	5.5	1.5	1.3	6.3
Penn A-1	Creeping	7.2	6.6	3.3	4.3	6.3
Penn A-2[y]	Creeping	6.5	6.2	3.3	3.3	5.8
Penn G-2 [y]	Creeping	6.5	5.6	4.8	3.0	6.2
Penncross	Creeping	4.8	5.0	2.8	2.7	6.7
Pennlinks II	Creeping	5.3	5.6	2.0	3.0	6.7
Shark	Creeping	7.7	6.4	4.3	1.7	6.0
SR 1020 [y]	Creeping	6.1	6.1	5.8	1.7	5.5
T-1	Creeping	7.4	6.9	5.3	2.7	6.0
Tyee	Creeping	8.1	6.4	4.8	2.3	6.3
Greenwich	Velvet	8.4	6.7	2.5	1.0	4.3
Legendary	Velvet	8.5	6.5	1.8	1.0	3.8
SR 7200	Velvet	7.9	7.1	2.3	1.0	4.0
Venus	Velvet	8.7	6.8	1.8	1.0	4.5
Vesper	Velvet	8.5	7.3	2.2	1.0	4.2
Villa	Velvet	8.9	6.7	2.0	1.0	4.5
$LSD_{(\alpha = 0.05)}$		0.52	0.49	1.15	2.24	0.87

[z] Entry is experimental and at this time not commercially available.
[y] Not an official entry of the 2003 NTEP bentgrass trial and was included as an Arkansas standard.

Drought Tolerance of Tall Fescue and Bluegrass Cultivars

Doug Karcher[1], Mike Richardson[1], and Josh Landreth[1]

Additional index words: hybrid bluegrass, Kentucky bluegrass, digital image analysis, lawn, irrigation, rain-out shelter

Karcher, D., M. Richardson and J. Landreth. 2008. Drought tolerance of tall fescue and bluegrass cultivars. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:17-20.


Photo by Doug Karcher
Kentucky bluegrass growing in a golf course rough

Summary. Newer cultivars of tall fescue, Kentucky bluegrass, and hybrid bluegrass may have improved drought tolerance and expand the range of cool-season turfgrasses for home lawn use in Arkansas. The objective of this research was to compare the drought tolerance of 42 cultivars of these species when maintained as a lawn.

Cultivars were established in fall 2006 and dried down during the summer of 2007 in a rain-out shelter, which prevented rainfall from reaching the plots. Green turf coverage was evaluated twice weekly as the cultivars were subjected to drought stress. The amount of time after irrigation was withheld until green turf coverage dropped to 50% and varied by over three weeks among cultivars. On average, the tall fescue cultivars were the most drought tolerant and Kentucky bluegrass the least, while there was no clear trend in drought tolerance among the hybrid bluegrass cultivars.

Abbreviations: KBG, Kentucky bluegrass; HBG, hybrid bluegrass; TF, tall fescue

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A desirable trait of cool-season lawn grasses, such as tall fescue (*Festuca arundinacea*) and Kentucky bluegrass (*Poa pratensis*), is that they stay relatively green throughout most of the year and do not go into complete winter dormancy like bermudagrass or zoysiagrass. The use of cool-season grasses for Arkansas lawns has been limited to northern regions of the state due to their poor heat and drought tolerance relative to warm-season grasses. In recent years, hybrid bluegrass cultivars, which are crosses between Kentucky bluegrass and Texas bluegrass (*P. pratensis* x *P. arachnifera*), have been released as a cool-season lawn turf option with improved heat and drought tolerance (Abraham et al., 2004). In addition, it has recently been demonstrated that there is variation in drought tolerance among cultivars within tall fescue (Karcher et al., 2008) and Kentucky bluegrass species (Richardson et al., 2008). Identifying cultivars of tall fescue, Kentucky bluegrass, and hybrid bluegrass with excellent drought tolerance may expand the use of cool-season turfgrasses for lawns in Arkansas. The objective of the following research was to determine the relative drought tolerance of various tall fescue, Kentucky bluegrass, and hybrid bluegrass cultivars.

Materials and Methods

This research was conducted at the University of Arkansas Research and Extension Center in Fayetteville, Ark. Forty-two cultivars of tall fescue, Kentucky bluegrass, or hybrid bluegrass (Table 1) were seeded into three replicate plots in the fall of 2006 on a native soil experimental area that was constructed under a rain-out shelter. The experimental area was maintained as a home lawn and was mowed weekly at a 2 inch height of cut. During the summer of 2007, drought stress was initiated by discontinuing irrigation and activating the rain-out shelter so that an automated, sliding roof would cover the plots, keeping them dry during rainfall events. Digital images were collected from each plot regularly during drought stress to evaluate green turf coverage over time and determine the drought tolerance characteristics of each cultivar. Non-linear regression (using a variable slope, Sigmoid curve) was performed on the digital image analysis data to predict $Days_{50}$ values for each cultivar, which are the estimated number of days after irrigation was withheld until green turf coverage decreased to 50%.

Results and Discussion

The 42 cultivars tested in this trial are ranked from most to least drought tolerant in Table 1. The number of days after irrigation was withheld until green turf coverage dropped to 50% ranged from 52 d for 2nd Millennium tall fescue to 29 d for Solar Green hybrid bluegrass. This range of greater than three weeks (23 d) is significant when considering that a rainfall event would be probable during this period on a non-irrigated lawn in Arkansas. In such a case, cultivars in this trial that were most drought tolerant would be much more likely to retain acceptable green turf coverage between rainfall events compared to the more drought sensitive cultivars and not need supplemental irrigation. The only cultivar that was statistically as drought tolerant as 2nd Millennium was TB 390, an experimental hybrid bluegrass cultivar (Fig. 1). There were three cultivars with drought tolerance as poor as Solar Green: Champlain, A00-1400 Kentucky bluegrass, and TB 676 hybrid bluegrass; the latter two being experimental cultivars (Fig. 1).

In general, the tall fescue cultivars were more drought tolerant (higher $Days_{50}$ values) than the bluegrasses. Ten of the eleven most drought tolerant cultivars were tall fescue whereas only one of the six least drought tolerant cultivars was tall fescue. All of the Kentucky bluegrass cultivars were among the bottom half of those tested with regard to drought tolerance. There was not a clear trend in drought tolerance among hybrid bluegrass cultivars with two of the four (TB 390 and Thermal Blue) having $Days_{50}$ values greater than 43, and the other two cultivars (TB 676 and Solar Green) having $Days_{50}$ values below 33.

Previous research has shown that drought tolerance among tall fescue cultivars is primarily a function of high root/shoot ratio (Karcher et al., 2008). However, root/shoot ratios were not evaluated in the present study. The mechanisms responsible for improved drought tolerance in Kentucky bluegrass are less clear and do not appear to be related to root/shoot ratio (Richardson et al., 2008). Other factors, such as stomatal resistance, osmotic adjustment, reduced electrolyte leakage, and increased photosynthetic efficiency, probably play a greater role in the drought tolerance of Kentucky bluegrass compared to tall fescue. None of these factors were evaluated in the present study.

Conclusions

These results demonstrate that there are differences in drought tolerance among cool-season grasses used in Arkansas lawns. Therefore, drought tolerance screening should be performed routinely on these species so that cultivars may be selected that are best adapted for lawns where irrigation in not available or is limited.

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Richardson, M.D, D.E. Karcher, K. Hignight, and D. Rush. 2008. Drought tolerance and rooting capacity of Kentucky bluegrass cultivars. Crop Sci. (in review).

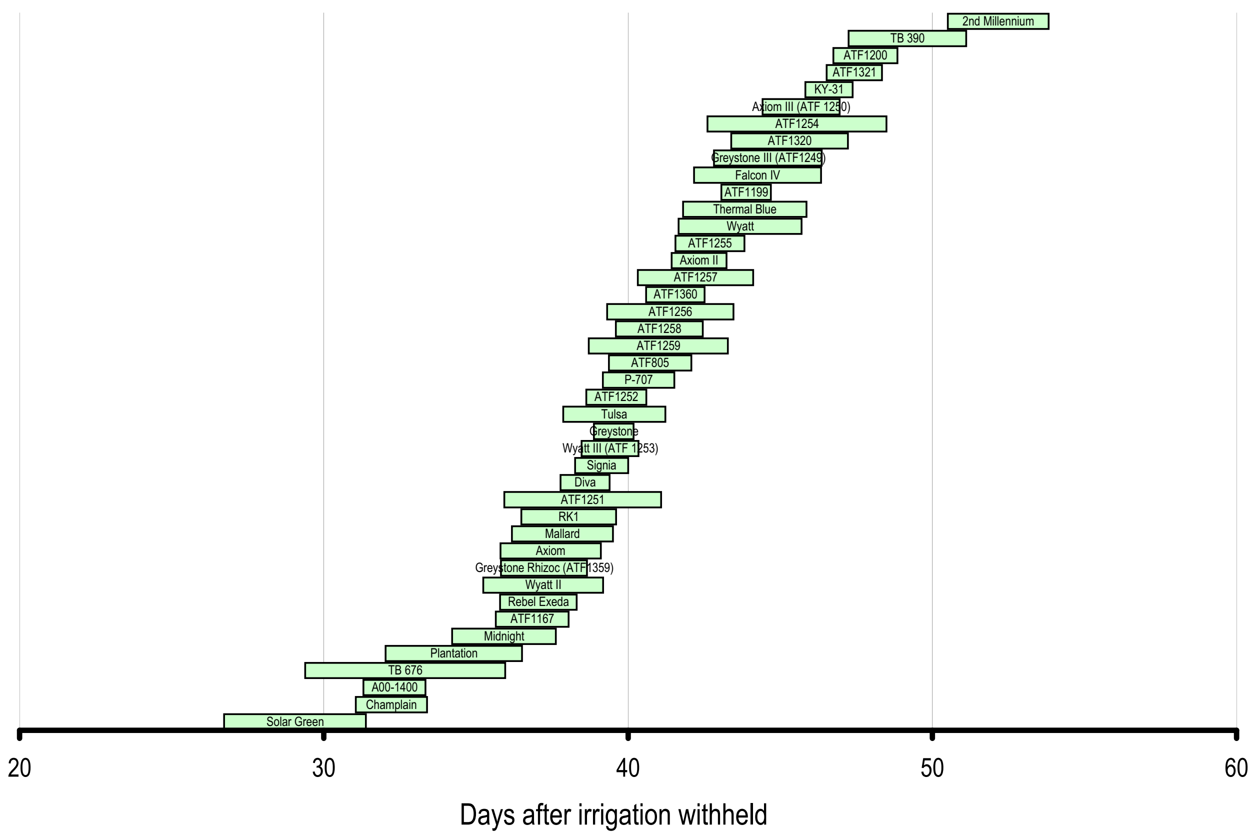

Fig. 1. Confidence intervals (95%) for the number of days after irrigation is withheld before cultivars reach 50% green cover. Cultivars with overlapping bars are not significantly different.

Table 1. Drought tolerance ranking of tall fescue, Kentucky bluegrass, and hybrid bluegrass selections based on the $Days_{50}$ values, the predicted number of days after irrigation is withheld when 50% green turf cover is reached.

Rank	Selection	Species[z]	$Days_{50}$
1.	2nd Millennium	TF	52.2
2.	TB 390	HBG	49.2
3.	ATF1200	TF	47.8
4.	ATF1321	TF	47.4
5.	KY-31	TF	46.6
6.	Axiom III (ATF 1250)	TF	45.7
7.	ATF1254	TF	45.6
8.	ATF1320	TF	45.3
9.	Greystone III (ATF1249)	TF	44.6
10.	Falcon IV	TF	44.3
11.	ATF1199	TF	43.9
12.	Thermal Blue	HBG	43.8
13.	Wyatt	TF	43.7
14.	ATF1255	TF	42.7
15.	Axiom II	TF	42.3
16.	ATF1257	TF	42.2
17.	ATF1360	TF	41.6
18.	ATF1256	TF	41.4
19.	ATF1258	TF	41.0
20.	ATF1259	TF	41.0
21.	ATF805	TF	40.7
22.	P-707	KBG	40.4
23.	ATF1252	TF	39.6
24.	Tulsa	TF	39.6
25.	Greystone	TF	39.5
26.	Wyatt III (ATF 1253)	TF	39.4
27.	Signia	TF	39.1
28.	Diva	KBG	38.6
29.	ATF1251	TF	38.5
30.	RK1	TF	38.1
31.	Mallard	KBG	37.9
32.	Axiom	TF	37.5
33.	Greystone Rhizoc (ATF1359)	TF	37.2
34.	Wyatt II	TF	37.2
35.	Rebel Exeda	TF	37.1
36.	ATF1167	TF	36.9
37.	Midnight	KBG	35.9
38.	Plantation	TF	34.3
39.	TB 676	HBG	32.7
40.	A00-1400	KBG	32.3
41.	Champlain	KBG	32.2
42.	Solar Green	HBG	29.1

[z] HBG = hybrid bluegrass, KBG = Kentucky bluegrass, and TF = tall fescue.

Traffic Tolerance of a Bermudagrass Fairway to Segway Vehicles

Doug Karcher[1] and Josh Landreth[1]

Additional index words: golf cart, 'Tifway', *Cynodon dactylon* x *C. transvaalensis*, digital image analysis

Karcher, D. and J. Landreth. 2008. Traffic tolerance of a bermudagrass fairway to Segway vehicles. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:21-23.

Photo by Doug Karcher

Damage caused by golf cart traffic

Summary. The Segway X2 was recently introduced as an alternative vehicle to a riding golf cart and is an updated version of the Segway GT. The objective of this research was to compare the wear caused by traffic from a typical golf cart, a Segway X2, and a Segway GT applied to a bermudagrass fairway. Over the duration of the study, plots trafficked with Segway models had better turf coverage, turf color, and softer surfaces than plots trafficked with a golf cart. These results suggest that both the X2 and GT Segway models can be used as an alternative to golf carts without adversely affecting turf quality under normal operating conditions.

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Regular golf cart traffic on golf course turf will decrease turfgrass quality over time, particularly in areas used to enter and exit the fairway. The Segway GT model was introduced to the golf industry a few years ago as an alternative to traditional, riding golf carts. Research conducted on the Segway GT at the universities of Arkansas and Tennessee concluded that this vehicle caused significantly less wear to bermudagrass fairway turf compared to a standard riding golf cart (Sorochan et al., 2006). The Segway X2 is a new golfer transport vehicle that is an update of the GT model and is designed for better maneuverability on golf course terrain. The Segway X2 has a new steering mechanism and larger tires with aggressive tread, so it is unclear how this new model will wear fairway turf compared to the GT. The objective of this research was to compare fairway turfgrass wear caused by traffic from a typical riding golf cart, a Segway GT, and a Segway X2.

Materials and Methods

Experimental area. This study was conducted at the University of Arkansas Research and Extension Center in Fayetteville, Ark., on a silt loam soil established with 'Tifway' bermudagrass (*Cynodon dactylon* x *C. transvaalensis*). Twelve plots that were each 15 by 15 ft. were constructed for traffic application. All plots were mown three times per week at a 0.5 inch height and otherwise maintained similar to golf course fairway conditions.

Treatments. Traffic treatments included a standard Club Car golf cart, the Segway GT, and the Segway X2. Beginning on 21 June 2007, each traffic treatment was applied to four replicate plots two days per week for four weeks. During the first three weeks of traffic application, 30 passes were made on each plot with the appropriate vehicle on days when traffic was applied. During the final week of traffic application, 60 passes were made per plot on each traffic application day to represent very intensive traffic pressure. A traffic pass consisted of either the golf cart or a Segway pulling onto the plot and stopping at a fixed point, then starting rapidly and finally turning sharply at another fixed point to exit the plot. Traffic treatments were discontinued when significant wear damage was present on the experimental area.

Evaluations. Green turf coverage (color data were removed) and surface hardness were evaluated throughout the study on each plot at each fixed start/stop and turning point: Green turf coverage was evaluated twice weekly using digital image analysis techniques. Surface hardness was evaluated using a Clegg Impact Soil Tester at the beginning, mid-point, and end of the study.

Results and Discussion

Percent green cover. The golf cart treatment resulted in significantly less turf coverage than the Segway treatments on all but the initial evaluation date and the 9 July evaluation date (Fig. 1). No traffic had been applied on the initial evaluation date, so no differences were expected. Between 9 July and the previous traffic application, weather conditions were ideal for recovery (hot temperatures and significant rainfall). However, wet soil conditions during the next treatment date resulted in substantial differences in turf coverage on the 13 July evaluation date. These results suggest that the Segway vehicles cause much less damage to turf when soil conditions are relatively wet.

Surface hardness. Surface hardness was not affected by vehicle type during the first two evaluation dates, corresponding to 2.5 weeks and 150 traffic passes (Fig 3). However, at the end of the study, after 4 weeks and 300 passes of traffic, vehicle type significantly affected surface hardness. The golf cart treatment had a significantly harder surface than either Segway treatment.

Results from this study demonstrate that both the Segway X2 and Segway GT do less damage to fairway turf than a traditional golf cart and are similar to findings by Sorochan et al. (2006), which showed that a Segway GT caused less turfgrass wear damage than a golf cart. In the present study, there were no significant differences between the two Segway models; thus, both would be considered ideal for golf course use compared to a golf cart with respect to turfgrass wear damage.

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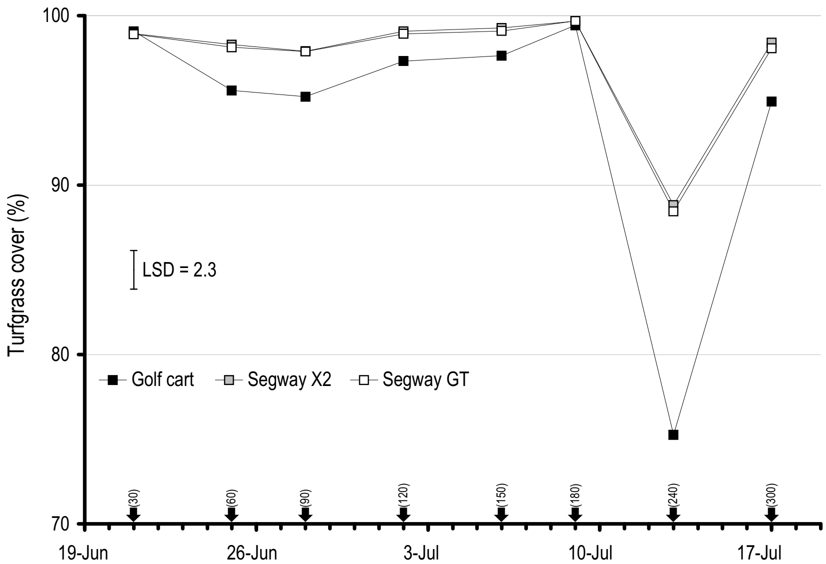

Fig. 1. Percent green turf coverage as affected by vehicle type and evaluation date. Arrows along the x-axis indicate dates of traffic application and cumulative number of passes applied. Error bar represents Fisher's least significant difference value (α = 0.05) for comparing vehicle treatments within dates.

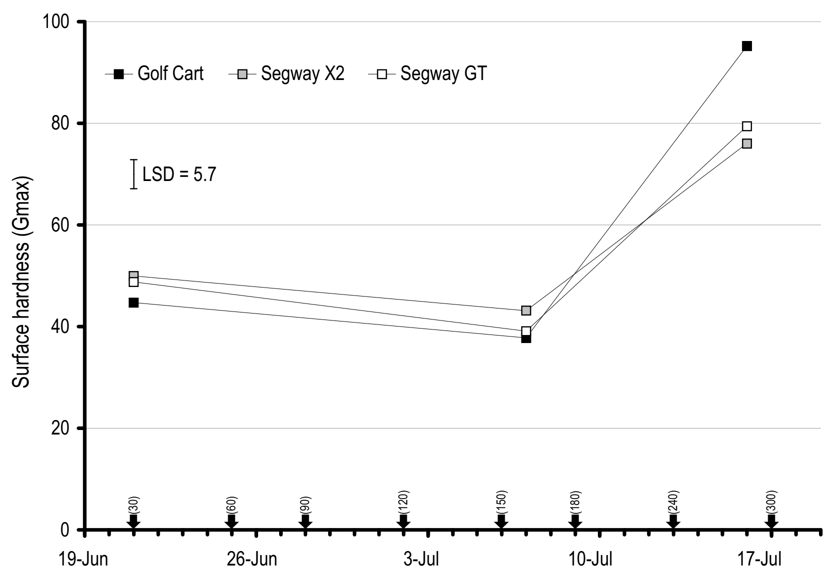

Fig. 2. Surface hardness as affected by vehicle type and evaluation date. Higher Gmax values correspond to harder surfaces. Arrows along the x-axis indicate dates of traffic application and cumulative number of passes applied. Error bar represents Fisher's least significant difference value (α = 0.05) for comparing vehicle treatments within dates.

Wetting Agents Affect Localized Dry Spot and Moisture Distribution in a Sand-based Putting Green

Doug Karcher[1], Mike Richardson[1], Josh Landreth[1], and John McCalla[1]

Additional index words: creeping bentgrass, irrigation, time domain reflectometry

Karcher, D., M. Richardson, J. Landreth and J. McCalla. 2008. Wetting agents affect localized dry spot and moisture distribution in a sand-based putting green. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:24-28.

Photo by Doug Karcher

Localized dry spots occurring on a creeping bentgrass green

Summary. It is not clear how various wetting agent products affect moisture distribution throughout sand-based putting green rootzones. The objective of this research was to determine how localized dry spot (LDS) incidence, and soil moisture values and uniformity, were affected by the application of five commercially available wetting agents. Wetting agents were applied during the 2007 growing season and evaluated under conditions of frequent, moderate, and infrequent irrigation application. All of the wetting agents tested in this study significantly reduced LDS formation compared to the untreated control. In addition, none of the wetting agents significantly increased soil moisture values during periods of frequent or moderate irrigation. The wetting agent products Cascade Plus, One Putt, and Revolution were the most consistent in improving rootzone moisture uniformity. These results suggest that specific wetting agents can be used to manage LDS without adversely affecting rootzone moisture distribution.

Abbreviations: LDS, localized dry spot

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Previous research on wetting agent efficacy on sand-based putting greens has focused mainly on evaluating visual dry spot symptoms or rootzone hydrophobicity (water droplet penetration times). However, many turf managers are also concerned with how various wetting agent products affect moisture distribution throughout the rootzone. It is believed by many that some products move water rapidly through the rootzone while others retain considerable moisture near the surface; but there has been little published data to substantiate such claims. The objective of this research was to determine the effects of several wetting agent treatments on the distribution of moisture throughout the upper eight inches of a sand-based putting green rootzone.

Materials and Methods

This experiment was conducted from mid-May through mid-August in 2007 on a creeping bentgrass (*Agrostis stolonifera* cv. SR 1020) putting green built according to United States Golf Association specifications. The green was mowed at a 0.125-in. height six days/week and otherwise maintained under typical golf course conditions.

Wetting agent treatments consisted of five commercially available wetting agent products plus an untreated control (Table 1). Treatments were applied according to manufacturer's label instructions and irrigated with 0.25 inch of water following application. Treatments were applied monthly from 15 May through 15 July, except for Cascade Plus, which was applied only on 15 May and 22 May. Each treatment was applied to four replicate plots, measuring 4 by 8 ft each. Irrigation was applied judiciously, moderately, and sparingly following the May, June, and July treatment applications, respectively, to compare the wetting agents under a range of irrigation management regimes.

Treatments were evaluated for localized dry spot (LDS) incidence and soil moisture characteristics. Localized dry spot incidence was rated weekly as a visual estimate of the percentage within each plot affected with LDS. Volumetric soil moisture was evaluated twice monthly by taking 32 measurements on a 1 by 1-ft. grid at three sampling depths (3, 5, and 8 inches) within each plot with time domain reflectometry probes. From the moisture data, average rootzone moisture and soil moisture variance (measured by standard deviation) were calculated for each wetting agent at each sampling depth.

Results and Discussion

LDS incidence. Wetting agent treatment significantly affected LDS formation on 7 June and from mid-July through the end of the trial (Fig. 1). When irrigation was applied judiciously in May, there was little LDS formation, regardless of wetting agent treatment. On dates when there were significant differences in LDS formation among treatments, the control had the most LDS, except on 7 June when turf treated with Dispatch had slightly more LDS than untreated turf. Untreated turf had LDS incidence of approximately 50% during the last four evaluation dates, while all turf treated with a wetting agent had less than 25% LDS incidence during the same period.

Among wetting agent treatments, One Putt, Revolution, and Soaker Plus consistently had the least LDS formation throughout the trial. Cascade Plus was among the top-performing wetting agent treatments throughout most of the study; however, LDS incidence increased for this treatment during the last two weeks of the study. This may have been the result of Cascade Plus being applied only in May, whereas all other treatments were applied in May, June, and July. These results suggest that a repeat application of Cascade Plus may be beneficial during the summer in Arkansas. Dispatch was the most inconsistent wetting agent treatment with regard to LDS formation, as turf treated with Dispatch had significantly more LDS compared to turf treated with other wetting agents on three evaluation dates.

Soil moisture values. On average, soil moisture was very similar among treatments at the 5- and 8-inch sampling depths (Fig. 2). At these depths, untreated turf had a slightly drier rootzone than turf treated with wetting agent. At the

3-inch sampling depth, there were significant differences in soil moisture among treatments in July and August when the area was irrigated sparingly. At that time, the untreated control had lower soil moisture values than wetting agent treatments. Under conditions of judicious irrigation in May, none of the wetting agent treatments resulted in soil moisture values that were significantly higher than the control.

Soil moisture variation. On average, moisture values were less uniform closer to the surface of the putting green (Fig. 3). However, there were significant differences among treatments at all three depths during the study. Except for the final evaluation date, untreated turf had the least uniform soil moisture. Towards the end of the study, the control treatment improved with regard to moisture uniformity mainly because those plots had become uniformly very dry, as indicated by a high incidence of LDS (Fig. 1). Among wetting agent treatments, Cascade Plus, One Putt, and Revolution were the most consistent in reducing variation in soil moisture throughout the rootzone.

Conclusions

The wetting agents tested in this study provided good control of LDS without significantly increasing or decreasing soil moisture values. When coupled with deep, infrequent irrigation practices, these products could be used in a putting green management program to minimize LDS occurrence and provide a firm and moderately dry surface between irrigation events. Since there are several other wetting agents currently available besides those tested in this trial, and because new products are introduced regularly, similar studies will be conducted regularly in the future at the University of Arkansas to provide turf managers with up-to-date information on how LDS and rootzone moisture are affected by wetting agents.

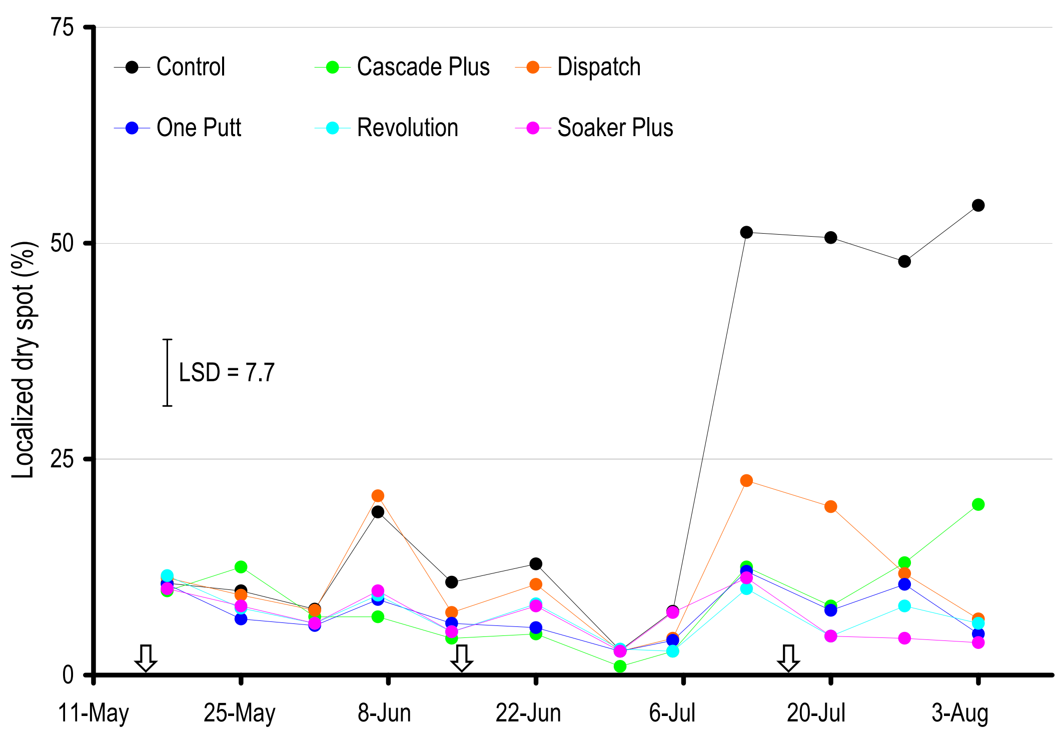

Fig. 1. Localized dry spot incidence as affected by wetting agent treatment. Arrows along the x axis indicate treatment dates for all products, except for Cascade Plus which was applied only on 15 May and 22 May. Error bar represents Fisher's least significant difference value (α = 0.05) for comparing wetting agent treatments within dates.

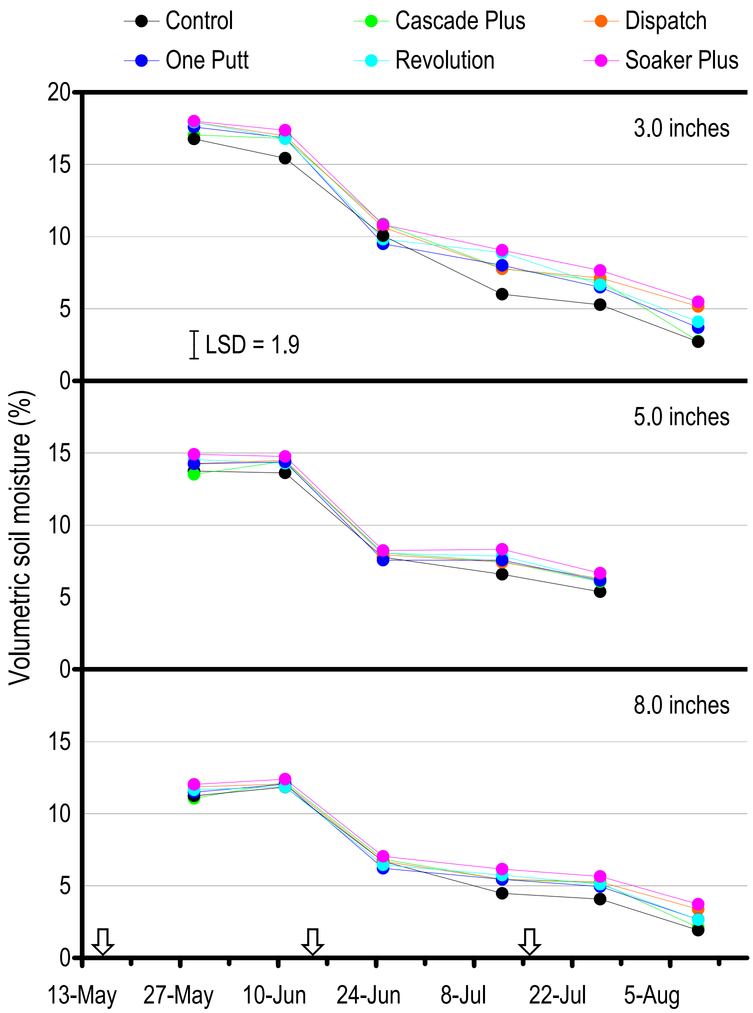

Fig. 2. Volumetric soil moisture as affected by wetting agent treatment and sampling depth. Arrows along the x axis indicate treatment dates for all products, except for Cascade Plus which was applied only on 15 May and 22 May. Error bar represents Fisher's least significant difference value (α = 0.05) for comparing wetting agent treatments within depths and dates.

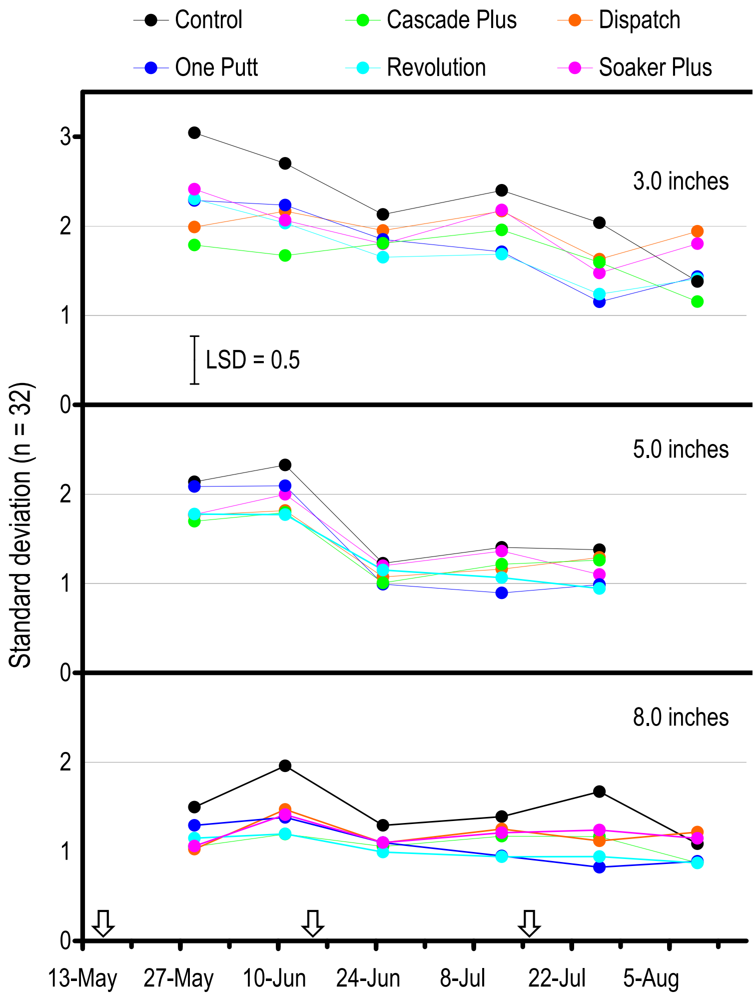

Fig. 3. Soil moisture variation as affected by wetting agent treatment and sampling depth. High standard deviation values correspond to less uniform soil moisture conditions. Arrows along the x axis indicate treatment dates for all products, except for Cascade Plus which was applied only on 15 May and 22 May. Error bar represents Fisher's least significant difference value ($\alpha = 0.05$) for comparing wetting agent treatments within depths and dates.

Table 1. Wetting agent treatment information

Product	Rate	Application dates
Control		
Cascade Plus	8 oz / 1000 ft^2	15 May and 22 May
Dispatch	12 oz / 1000 ft^2	15 May, 15 June, and 15 July
One Putt	8 oz / 1000 ft^2	15 May, 15 June, and 15 July
Revolution	6 oz / 1000 ft^2	15 May, 15 June, and 15 July
Soaker Plus	6 oz / 1000 ft^2	15 May, 15 June, and 15 July

Effects of Mowing Height, Fertilizer, and Trinexapac-ethyl on Ball Lie of Tifsport Bermudagrass

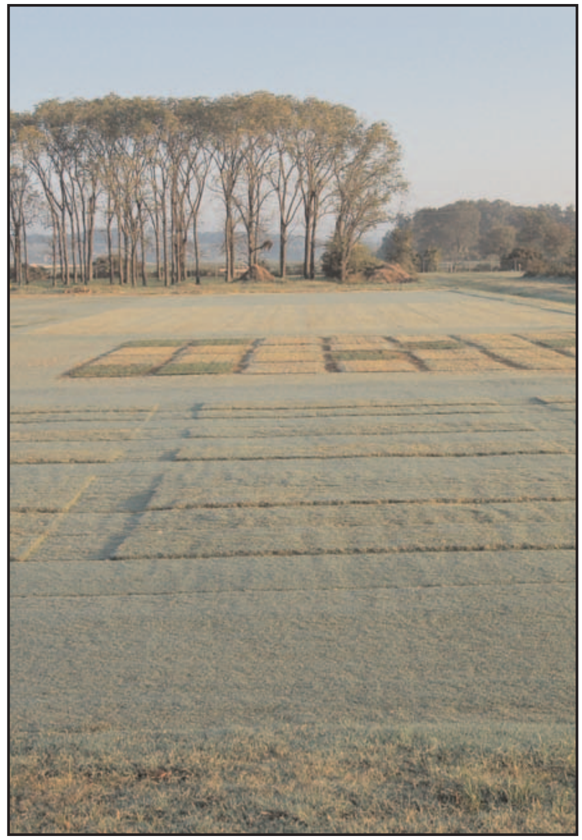
Photo by Mike Richardson

Tifsport bermudagrass research at Fayetteville, Ark.

John McCalla[1], Mike Richardson[1], Doug Karcher[1], Aaron Patton[2], and Wayne Hanna[3]

Additional index words: digital image analysis, Lie-N-Eye, trinexapac-ethyl, nitrogen, fairway, rough

McCalla, J., M. Richardson, D. Karcher, A. Patton and W. Hanna. 2008. Effects of mowing height, fertilizer, and trinexapac-ethyl on ball lie of Tifsport bermudagrass. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:29-32.

Summary. Ball lie describes how a golf ball comes to rest in the turf canopy following a stroke. Ball lie is often considered uniform and adequate on the tee box or if it comes to rest in the fairway, but in the intermediate or deep rough, ball lie is variable. This project was conducted to investigate how different management techniques affect how a ball is positioned within the canopy of the turf. Different mowing heights, fertilizer rates, and trinexapac-ethyl (tradename Primo) rates were applied to Tifsport bermudagrass and they were evaluated to see how they affected ball lie. On all rating dates, ball lie improved as mowing height decreased. There was an interaction between mowing height and Primo, with Primo having a positive effect on ball lie at higher mowing heights, but no effect at lower mowing heights. Nitrogen fertilization did not affect ball lie of Tifsport bermudagrass.

Abbreviations: TE, trinexapac-ethyl

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A golf ball is more easily hit when the ball has a clean lie on the top of the canopy of short cut uniform turf. Golf ball lie is affected by several different factors, most importantly the height at which the turf is mown (Cella and Voigt, 2001). A golf ball's lie is often defined as the amount of the golf ball that remains above the turfgrass canopy after the ball comes to rest. The Lie-N-Eye was a device developed at the University of Illinois to evaluate the lie of a golf ball. The Lie-N-Eye uses a Vernier caliper attached to a base to measure the amount of ball above the canopy. This device was designed to measure turfgrass maintained between 0.75 and 1.0 inches. A second, similar device, called the Lie-N-Eye II, was developed to measure shorter cut turf between 0.375 and 0.625 inch (Cella et al, 2004). The Lie-N-Eye was initially tested with several different varieties of Kentucky bluegrass (*Poa pratensis*). It was successful in measuring differences in ball lie in varieties that were mowed at 0.875 inch (Cella and Voigt, 2001; Cella et al, 2005).

The use of digital image analysis (DIA) has changed the way data can be collected in turfgrass research. Recently, a device was designed and tested at the University of Arkansas that measures ball lie in turfgrass systems using DIA (Fig. 1, Richardson et al., 2007). With the development of this simplified technique, the opportunity to study cultivar differences and cultural practice effects on golf ball lie are now possible.

The objective of the current study was to determine the effect of mowing height, nitrogen rate, and trinexapac-ethyl (TE) on golf ball lie in Tifsport bermudagrass (*Cynodon dactylon* x *C. transvaalensis*).

Materials and Methods

This study was conducted at the University of Arkansas Agricultural Research and Extension Center, Fayetteville. Tifsport bermudagrass was established from sod in the spring of 2006 and cultural treatments were initiated in the fall of 2006. The experimental design was a strip-split-plot, with nitrogen rate and mowing height as strip factors and trinexapac-ethyl (Primo Maxx, Syngenta Professional Products, Greensboro, N.C.) as the split plot. Following establishment, three different mowing heights (0.5, 1.0, and 1.5 inches) were initiated and maintained by mowing three times weekly throughout the growing season with clippings returned. Three different nitrogen fertilizer rates (0.5, 1.0, and 1.5 lb N / 1000 ft^2 / month) were applied as urea (46-0-0) every two weeks at half the monthly rate. Trinexapac-ethyl was applied at three different rates, including 6 oz / A every four weeks, 3 oz / A every two weeks, and an untreated control. Application volume for TE was 30 gal / A and all treatments were applied with a CO_2-propelled backpack sprayer.

For analysis of golf ball lie, three golf balls were rolled onto each plot and digital images were taken of each ball using the device developed at the University of Arkansas which measures the percentage of the golf ball that is above the canopy (Richardson et al., 2007). Ball lie data were collected on 19 July, 29 July, and 10 August 2007.

Results and Discussion

There was a significant mowing height effect on ball lie on all three evaluation dates and when averaged across dates. In addition, there was also a significant TE x mowing height interaction at two dates and when averaged across dates. Nitrogen rates did not affect ball lie in this study. When analyzing the main effects of mowing height, shorter mowing heights improved ball lie (Table 1). These results follow a similar trend to what was seen by Hanna (2008). At the 0.5 inch mowing height, 92.0% of the ball was above the canopy, while ball lie at the 1.0 and 1.5 inch mowing height was 89.1 and 77.1%, respectively. The decrease in the percentage of golf ball above the canopy was greater when mowing height was increased from 1.0 to 1.5 inch compared to the change that occurred when raising mowing height from 0.5 to 1.0 inch.

There was a significant TE x mowing height interaction on the first two evaluation dates and when averaged across all three evaluation dates. At the 0.5 inch mowing height, there was no significant difference in ball lie between the TE treatments (Table 2). However, when the mowing height was raised to either 1.0 or 1.5 inch, the TE-treated plots generally had more favorable ball lie compared to the untreated check (Table 2), which is likely due to the increased turfgrass density from TE treatments.

In summary, mowing height had a significant effect on ball lie across all rating dates, which is similar to results reported earlier on Kentucky bluegrass (Cella and Voigt, 2001). The growth regulator, TE, also improved ball lie, but only when the turf was maintained at a higher height of cut (1.0 or 1.5 inches). Increasing nitrogen fertilizer had no significant effect on ball lie in Tifsport bermudagrass. Therefore, golf course superintendents can improve golf ball lie on bermudagrass by maintaining low mowing heights or from applications of TE on intermediate and rough mowing heights (≥1.0 inch). More work is ongoing to see how cultivar and other cultural practices impact ball lie.

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Fig. 1. Device used to collect images of a golf ball resting in the turf and later analyzed using digital image analysis.

Table 1. Mowing height influence on ball lie in Tifsport bermudagrass.

Mowing height	19 July	29 July	10 August	Avg.
(inches)	------------------------ % of ball -----------------------			
0.5	96.3	91.0	88.6	92.0
1.0	92.8	88.3	86.1	89.1
1.5	79.0	74.6	77.7	77.1
LSD (0.05)[z]	2.0	1.8	1.5	1.4

[z] Least significant difference (P=0.05) for comparing means within a date or within the average.

Table 2. Interaction effect of mowing height and trinexapac-ethyl (TE) applications on ball lie in Tifsport bermudagrass.

Mowing height	TE	19 July	29 July	10 August	Avg.
(inches)	(oz. Primo / acre)	----------------% of ball above canopy----------------			
0.5	0	96.3	91.4	88.3	92.0
	3	96.5	91.2	89.3	92.3
	6	96.2	90.3	88.3	91.6
LSD (0.05)[z]		ns [y]	ns	ns	ns
1.0	0	91.4	86.8	86.1	88.1
	3	94.1	89.1	86.2	89.8
	6	92.9	89.2	86.0	89.4
LSD (0.05)		ns	1.6	ns	1.3
1.5	0	75.9	69.4	76.7	74.0
	3	82.9	77.3	78.9	79.7
	6	78.1	77.0	77.4	77.5
LSD (0.05)		6.5	5.5	ns	4.0

[z] Least significant difference (P=0.05) for comparing means within a mowing height and date.

[y] ns, not significant.

2002 NTEP Bermudagrass Trial – Summary

Aaron Patton[1], Mike Richardson[2], Doug Karcher[2], John McCalla[2], and Josh Landreth[2]

Additional index words: *Cynodon dactylon*, *Cynodon dactylon* x *C. transvaalensis*, turfgrass, cultivars, quality, color, spring green-up, leaf texture, seedheads

Patton, A., M. Richardson, D. Karcher, J. McCalla and J. Landreth. 2008. 2002 NTEP bermudagrass trial – summary. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:33-36.

Photo by Aaron Patton

Bermudagrass cultivar trial at Fayetteville, Ark.

Summary. Bermudagrass (*Cynodon* spp.) continues to be the prevailing turfgrass species used in Arkansas for golf courses, sports fields, home lawns and utility turf situations. Identifying adapted cultivars for the region remains a central focus of the University of Arkansas turfgrass research program. The National Turfgrass Evaluation Program (NTEP) is the predominant means by which cultivars are tested throughout North America. A bermudagrass cultivar trial was planted in the summer of 2002 at Fayetteville, Ark. This trial has been maintained under golf course fairway conditions and data on spring green-up, overall quality, leaf color, leaf texture, and seedhead formation were collected from 2003 to 2006. Across rating dates and years, Tifsport had the highest average quality rating of 7.1, although Aussie Green, OKC 70-18, Patriot, Premier, Tifway, Midlawn, Celebration, GN-1, and Tifton No. 4, statistically, were rated equal to Tifsport. Tifsport and Celebration are two new varieties being grown in Arkansas that have similar quality to Tifway, which is considered the industry standard for bermudagrass. Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass varieties. Planting well-adapted cultivars will improve turfgrass quality, reduce reestablishment costs from winterkill or drought, and ultimately increase sustainability.

Abbreviations: NTEP, National Turfgrass Evaluation Program.

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Bermudagrass (*Cynodon* spp.) remains the most commonly used turfgrass for golf, sports, lawns and other activities in Arkansas and throughout southern U.S. and transition zone environments. Bermudagrass has many positive attributes that have made it a successful turfgrass species, including good heat and drought tolerance, pest resistance, traffic tolerance, and tolerance to a wide range of soil types and water quality.

The National Turfgrass Evaluation Program (NTEP) is an organization within the US Dept. of Agriculture that annually oversees turfgrass cultivar evaluation experiments at various sites throughout the US and Canada. Each turfgrass species is tested on a four to five year cycle at sites throughout the growing region for that particular species. The University of Arkansas has been an active participant in the NTEP and has conducted several tests on bermudagrass cultivars over the past 15 years. This report summarizes the data collected at Fayetteville, Arkansas, from 2003 to 2006 for the 2002 NTEP Bermudagrass Trial.

Materials and Methods

The cultivar experiment was planted on 2 July 2002 at the University of Arkansas Research and Extension Center in Fayetteville. The plot size was 8 by 8 ft. and there were three replications of each cultivar. Vegetative cultivars were planted as 2 inch diameter plugs on 12 inch spacings within the plots, while seeded cultivars were broadcast planted at a seeding rate of 1.0 lb / 1000 ft^2. Plots were maintained under golf course fairway or sports field conditions, with a mowing height of 0.5 inch and monthly applications of 1.0 lb N / 1000ft^2 during the growing season. Irrigation was applied as needed to promote germination and establishment and to prevent stress.

Overall turf quality was evaluated monthly from May through October in each year of the trial (2003-2006). Quality was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green, uniform, fine-textured turf and 1 representing dead turf. Turf genetic color was visually evaluated on a scale of 1 to 9, with 9 representing ideal, dark green turf and 1 representing tan or brown turf. Leaf texture was visually evaluated on a scale of 1 to 9, with 9 representing extremely fine turf texture and 1 representing extremely coarse texture. Cultivars were visually evaluated for spring green-up using a scale of 1 to 9, with 9 representing complete green color and 1 representing a completely dormant turf stand

Cultivars were visually assessed for frost damage each fall using a 1 to 9 scale, with 9 representing no frost damage and 1 representing complete leaf kill. Divot recovery was evaluated in two years of the trial using digital image analysis after artificially divoting 3 subsamples per plot (9 per cultivar). Seedheads were rated using a 1 to 9 scale, with 9 representing maximum presence of seedheads and 1 representing no seedheads present. An analysis of variance was computed for each evaluation and cultivar means were separated using Fisher's protected least significant difference test ($\alpha = 0.05$).

Results and Discussion

There were significant differences in turf quality among cultivars across the entire 4-yr study (Table 1). Across the four years of the trial, Tifsport had the highest average quality rating of 7.1, although Aussie Green, OKC 70-18, Patriot, Premier, Tifway, Midlawn, Celebration, GN-1, and Tifton No. 4 were statistically equal to Tifsport. The cultivars, CIS-CD5, LaPaloma, SR 9554, SWI-1014, Panama, Transcontinental, Mohawk, Southern Star, Arizona Common, Numex Sahara, Sundevil II, and B-14 were all consistently rated low in quality throughout the trial.

There were significant color differences among cultivars during the trial (Table 1). Patriot had the darkest green color with an average rating value of 8.0. GN-1, Aussie Green, Celebration, MS-Choice, Tifsport, Tifton No. 4, Sovereign, Tifton No. 1, Premier, Barbados, Yukon, Riviera, and Midlawn were also rated high for color and were statistically equal to Patriot. Conversely, LaPaloma, Numex Sahara, Panama, CIS-CD6, Arizona Common, Mohawk, B-14, and Ashmore were rated lowest for turf color.

There were significant leaf texture differences among cultivars (Table 1). Ashmore, Tifway, Premier, Midlawn, OKC 70-18, Tifsport, Tift No. 4, Patriot, Aussie Green, and SWI-1046 had the finest leaf texture, with average rating values ranging from 6.8-7.8. B-14 had the coarsest leaf texture with a rating of 4.2 and several other cultivars had similar leaf texture ratings.

There were significant differences in spring green-up among cultivars (Table 1). OKC 70-18, Midlawn, and Premier exhibited the earliest spring green-up, with an average rating value of 6.3, 5.5, and 5.3, respectively. Sunsport, Veracruz, GN-1, MS-Choice, SWI-1046, Celebration, Princess 77, SWI-1003, Tifton No. 2, and Tifton No. 1 were the slowest to green-up in spring.

There were significant differences among cultivars in frost tolerance (Table 1). Tifsport, Ashmore, Midlawn, MS-Choice, Premier, Tifway, Sovereign, Celebration, Contessa, Patriot, SWI-1046, Tifton No. 1, Tifton No. 4, and Yukon had the least frost damage.

OKC 70-18, Tifton No. 3, Barbados, Contessa, Patriot, SWI-1014, Aussie Green, Celebration, Tifton No. 2, MS-Choice, Sovereign, Veracruz, Riviera, Tifton No. 1, Tifton No. 4, SWI-1003, Princess 77, Midlawn, and Premier were among the group of cultivars with the quickest recovery from divot injury. Mohawk, Ashmore, Sundevil II, and CIS-CD5 were among the cultivars with the slowest recovery from divot injury.

There were significant differences among cultivars with regard to the presence of seedheads (Table 1). No seedheads were present among Ashmore, Aussie Green, Patriot, and Premier and similar levels of seedheads were observed with SWI-1003, SWI-1046, Celebration, Barbados, Tifway, Yukon, Midlawn, OKC 70-18, Tifsport, and Tifton No. 4. Arizona Common, Numex Sahara, Sunbird, SWI-1014, B-14, LaPaloma, Transcontinental, Mohawk, Sovereign, and Sunstar were the most prolific seedhead producing cultivars.

Since its release in 1960, Tifway has been a popular choice for Arkansas lawns and golf courses. Because of its popularity and steady performance in current trials, there are few new varieties being used in Arkansas and Tifway is still produced at 28 sod farms in Arkansas (Patton et al., 2008). Tifsport and Celebration are two new varieties being grown in Arkansas that have similar quality to Tifway. Another new cultivar with improved cold tolerance and quality similar to Tifway is Patriot bermudagrass. Patriot is not currently grown in Arkansas, but is produced in Oklahoma and Missouri and will likely be produced in Arkansas in the future due to its strong performance in this region of the country.

Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass varieties. Planting well-adapted cultivars will improve turfgrass quality, reduce reestablishment costs from winterkill or drought, and ultimately increase sustainability.

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Table 1. Bermudagrass turfgrass quality, genetic color, texture, spring green-up, frost tolerance, divot recovery, and seedhead abundance evaluations for various cultivars in Fayetteville, Ark. Data are averaged across 4 seasons (2003-2006).

	Turf quality z	Genetic color y	Leaf texture x	Spring green-up w	Frost tolerance v	Divot recovery u	Seedheads t
	-----------------------	visually rated on a 1-9 scale	-----------------------			%	Rating (1-9)
Tifsport	7.1	7.5	7.2	3.6	6.2	70.0	1.3
Aussie Green	6.9	7.8	6.9	3.0	4.0	92.3	1.0
OKC 70-18	6.9	6.4	7.2	6.3	3.7	97.0	1.3
Patriot	6.9	8.0	7.0	3.8	5.2	94.0	1.0
Premier (OR 2002)	6.9	7.0	7.4	5.3	5.7	81.7	1.0
Tifway	6.9	7.2	7.6	4.5	5.7	75.7	1.7
Midlawn	6.8	6.7	7.2	5.5	5.7	82.7	1.3
Celebration	6.6	7.8	6.3	2.1	5.2	91.7	1.7
GN-1	6.5	7.9	6.4	2.4	2.8	77.0	2.3
TIFT NO. 4	6.5	7.4	7.1	2.9	4.7	88.3	1.3
Contessa (SWI-1045) s	6.2	6.6	5.6	3.1	5.2	95.3	2.3
Barbados (SWI-1044) s	6.2	7.0	6.1	2.8	3.8	96.0	1.7
TIFT NO. 3	6.2	6.6	6.0	2.9	4.5	96.7	2.7
Yukon s	6.2	6.9	6.1	4.7	4.7	76.7	1.7
MS-Choice	6.1	7.7	5.9	2.3	5.7	91.0	2.3
Riviera s	6.1	6.8	5.8	4.7	3.8	90.0	2.7
Sovereign (SWI-1012) s	6.0	7.3	5.7	3.0	5.3	90.3	4.0
Veracruz (SWI-1041) s	6.0	6.3	6.4	2.5	4.0	90.3	2.3
SWI-1046 s	5.9	7.2	6.8	2.2	4.8	76.7	2.0
Princess 77 s	5.8	6.4	6.3	1.8	4.5	85.7	2.3
TIFT NO. 1 s	5.8	7.3	6.3	1.6	4.7	89.7	3.3
SWI-1003 s	5.7	6.1	6.4	1.8	3.7	87.3	2.0
Ashmore	5.5	4.2	7.8	4.3	5.8	61.3	1.0
TIFT NO. 2 s	5.5	6.6	6.2	1.7	4.5	91.7	3.7
CIS-CD6 s	5.4	5.3	4.9	4.0	3.7	79.0	3.0
Sultan (FMC-6) s	5.4	6.1	5.3	3.2	3.2	68.7	3.3
Sunsport (SWI-1001) s	5.4	6.2	5.3	2.7	3.7	75.0	2.7
CIS-CD7 s	5.3	5.6	5.0	3.8	3.7	75.3	2.3
Sunbird (PST-R68A) s	5.2	6.0	5.4	3.5	3.2	79.0	4.7
CIS-CD5	5.1	5.7	4.9	3.9	3.5	67.3	2.7
LaPaloma (SRX 9500) s	5.1	5.5	5.2	3.9	4.0	77.7	4.3
SR 9554 s	5.1	5.7	4.9	3.5	3.3	78.7	3.0
SWI-1014 s	5.1	6.1	4.8	3.7	3.8	93.3	4.7
Panama s	5.0	5.4	4.8	3.4	3.7	68.7	2.3
Transcontinental s	5.0	5.8	5.2	3.8	3.7	73.7	4.3
Mohawk s	4.9	5.1	4.8	3.2	3.2	52.0	4.0
Sothern Star s	4.9	5.8	4.9	3.3	3.7	74.0	3.7
Sunstar s	4.9	5.6	4.9	3.4	3.0	67.7	4.0
Arizona Common sr	4.8	5.1	4.7	3.4	3.5	71.3	5.0
Numex Sahara s	4.8	5.5	4.9	3.8	3.3	71.3	4.7
Sundevil II s	4.8	5.7	5.0	3.4	3.5	64.7	3.7
B-14 s	4.5	5.0	4.2	3.5	3.7	73.0	4.3
LSD (P=0.05)	0.6	1.3	1.1	1.1	1.5	15.6	1.2

z Turf quality rated on a scale of 1 to 9 (9= ideal dark green, uniform, dense, fine-textured turf, 1=dead).

y Genetic color rated on a scale of 1 to 9 (9= ideal dark green turf, 1= brown/tan turf).

x Texture rated on a scale of 1 to 9 (9=very fine texture, 1 = very coarse texture).

w Spring green-up rated on a scale of 1 to 9 (9= complete green turf, 1 = complete dormant turf).

v Frost tolerance was rated on a scale of 1 to 9 (9 = fully green turf, with no damage from frost, 1 = brown turf).

u Divot recovery was evaluated with digital image analysis after artificially devoting 3 subsamples per plot (9 per cultivar)

t Seedheads were rated on a scale of 1 to 9 (9 = maximum presence of seedheads, 1 = no seedheads).

s Seeded bermudagrass cultivar.

r Cultivars are sorted in descending order by turfgrass quality.

Herbicide Safety on Sea Spray Seashore Paspalum Seedlings

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Additional index words: establishment, salt, *Paspalum vaginatum*

Patton, A., J. Trappe and M. Richardson. 2008. Herbicide safety on Sea Spray seashore paspalum seedlings. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:37-41.

Seashore *paspalum stolon*

Photo by Aaron Patton

Summary. There are no reports of herbicide tolerance on seedling seashore paspalum, and currently only one herbicide is labeled for use on these seedlings. The objective of this study was to determine which herbicides cause the least amount of injury to seashore paspalum seedlings. Field studies were conducted in 2007 to assess the tolerance of seashore paspalum (cv. Sea Spray) to various herbicides. Herbicide treatments included sulfentrazone, carfentrazone, triclopyr, clopyralid, fluroxypyr, carfentazone + 2,4-D + MCPP + dicamba, 2,4-D + MCPP + dicamba, quinclorac, MSMA, imazaquin, metsulfuron, sulfosulfuron, halosulfuron, pronamide, siduron, oxadiazon, pendimethalin, dithiopyr, prodiamine, ethofumesate, and fluazifop-P-butyl.

Treatments were applied two weeks after emergence of seedlings and compared to an untreated control and a salt water treatment. Turfgrass coverage at two weeks after application was greatest for seashore paspalum treated with clopyralid, halosulfuron, metsulfuron, quinclorac, carfentrazone, salt water, or the untreated check. Greatest phytotoxicity and reduction in turfgrass coverage resulted from application of fluazifop-P-butyl, MSMA, imazaquin, ethofumesate, 2,4-D + MCPP + dicamba, and triclopyr.

Abbreviations: WAA, weeks after application; WAE, weeks after emergence

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In the past decade, a number of new seashore paspalum (*Paspalum vaginatum*) cultivars have appeared on the market, as several commercial and academic breeding programs began to identify and work with new germplasm. The interest in this species, which has superior salinity tolerance, has grown to the point that cultivars are being evaluated nationally starting in 2007 through the National Turfgrass Evaluation Program, including a location in Fayetteville, Ark. (Morris, 2008).

Seeded varieties provide a quick, easy, and economical way to establish a high-quality seashore paspalum turf. As the seeded cultivars are relatively new, there are several factors that need to be investigated. Weed control is often very important in establishing turf from seed as effective weed control programs will decrease competition, increase establishment rate, and decrease the grow-in period.

The ability to control weeds during the first six to eight weeks after emergence is a key factor to the success of seeded warm-season grasses such as bermudagrass and zoysiagrass. Summer annual grasses such as crabgrass and goosegrass are very competitive with new seedings and broadleaf weeds may also create problems through shading of young seedlings. Therefore, competition during the seedling stage could significantly prolong stand establishment and reduce overall stand density. Little is known about effective herbicides that may be used during the establishment of seashore paspalum from seed.

There are no reports of herbicide tolerance on seedling seashore paspalum, and currently only quinclorac is labeled for use on seashore paspalum seedlings. Most labels specify use only on established seashore paspalum. On established 'Salam' seashore paspalum clopyralid, dicamba, halosulfuron, imazaquin, mecoprop + 2,4-D + dicamba, metsulfuron, and quinclorac were found to cause little toxicity (Unruh et al., 2006). Duncan (1998) also identified that pronamide (Kerb), oxadiazon (Ronstar), and pendimethalin (Pendulum) could be used for preemergence control of weeds in seashore paspalum turf. Lastly, seawater has even been found to be an effective herbicide for postemergence control of weeds in 'Adalyad' seashore paspalum (Wiecko, 2003). It is important to evaluate a range of herbicides to determine which are optimal during establishment from seed.

Currently, sulfentrazone (Dismiss), carfentrazone (Quicksilver), clopyralid (Lontrel), carfentrazone + 2,4-D + mecoprop + dicamba (Speedzone), quinclorac (Drive 75DF), halosulfuron (SedgeHammer), oxadiazon (Ronstar), dithiopyr (Dimension), and prodiamine (Barricade) are labeled for use on established seashore paspalum, but not on seedlings. The objective of this research study was to determine which herbicides are safe for use on 'Sea Spray' seashore paspalum seedlings.

Materials and Methods

Research was conducted at the Arkansas Agricultural Research and Extension Center, Fayetteville, Ark. Experiments were seeded 20 June 2007 with 0.7 lbs pure live seed per 1000 ft^2 of Sea Spray seashore paspalum in an area that was tilled, fumigated with methyl bromide, and raked to prepare the soil for seeding prior to seeding. This provided a weed-free site on which herbicide injury could be closely monitored. Plots were covered with a germination blanket until germination occurred to prevent the movement of seed. Experimental design was a randomized complete block with four replications and an individual plot size of 20 ft^2. Plots were treated with various herbicides (Table 1) at two weeks after emergence (WAE) which occurred on 4 July 2007. Emergence was defined as a uniform stand of one-leaf seedlings. A non-ionic surfactant (Latron AG-98, 0.25% v/v) was added to each herbicide prior to application on 19 July 2007. Herbicides were applied in 30 gallons / A with a CO_2-pressurized sprayer at 30 psi. A salt water treatment was included and applied as 32,000 ppm (50 dS / m) in 288 gallons / A per plot using NaCl. Salt water was applied on three consecutive days starting at 2 WAE. Two untreated checks were included for comparison. Plots were mown as needed at 0.5 inch when seedlings first reached 0.75 inch.

Digital image analysis was used to determine seashore paspalum coverage (Richardson et al., 2001). Herbicide injury was rated visually on a scale of 0 to 100 where 0 = no visible phytotoxicity and 100 = brown turf. All data were analyzed using analysis of variance and treatment means were separated using Fisher's protected least significant difference at $\alpha = 0.05$.

Results and Discussion

There were significant differences in herbicide phytotoxicity and bermudagrass coverage following application. Greatest phytotoxicity and reduction in turf coverage resulted from applications of Fusilade II, MSMA, Image, Prograss, Trimec Classic, Turflon Ester (Table 2). Turfgrass coverage at 2 weeks after application (WAA) was greatest for Lontrel, SedgeHammer, Blade, Drive, Quicksilver, salt water treatment, and the untreated check (Table 2). Coverage at 4WAA was greatest for Lontrel, SedgeHammer, Blade, Quicksilver, Kerb, Pendulum, salt water treatment, and the untreated check (Table 2). Coverage at 8WAA was greatest for Dismiss, Quicksilver, Lontrel, Spotlight, Speedzone, Trimec Classic, Trimec Southern, Drive, Balde, Certainty, SedgeHammer, Kerb, Ronstar, Pendulum, Dimension, Barricade, salt water treatment, and the untreated check (Table 2). Coverage at 8WAA was least for MSMA, Image, Tupersan, Turflon, Fusilade, and Prograss (Table 2). Based on first year results, Lontrel, SedgeHammer, Blade, Drive, Quicksilver, or salt water treatment are recommended if weed control is needed in Sea Spray seedlings (Table 3). This study will be repeated in the summer of 2008.

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Table 1. Herbicides, trade names, and application rates evaluated for safety on 'Sea Spray' seedlings.

Common name	Trade name	Rate	
		pounds ai / A	oz product/A
2,4-D + MCPP + dicamba	Trimec classic	0.5 + 0.13 + 0.05	32
carfentrazone	Quicksilver	0.031	2.1
carfentrazone + 2,4-D + MCPP + dicamba	Speedzone southern	0.01 + 0.13 + 0.05 + 0.01	32
clopyralid	Lontrel 3L	0.37	16
dithiopyr	Dimension 2EW	0.5	32
ethofumesate	Prograss 1.5EC	1.5	128
fluazifop-P-butyl	Fusilade II	0.06	4
fluroxypyr	Spotlight 1.5L	0.37	32
halosulfuron	Sedge Hammer	0.05	1.0
imazaquin	Image 1.5 EC	0.5	42.7
MCPP + 2,4-D + dicamba	Trimec southern	0.33 + 0.36 + 0.07	32
metsulfuron	Blade	0.02	0.5
MSMA	MSMA 6	2.0	42.6
oxadiazon	Ronstar G	3.0	2400
pendimethalin	Pendulum Aquacap 3.8 AC	1.5	50
prodiamine	Barricade 4L	1.5	48
pronamide	Kerb 50WP	1.0	32
quinclorac	Drive 75DF	0.75	16
siduron	Tupersan 50WP	4.0	128
sulfentrazone	Dismiss 4L	0.25	8
sulfosulfuron	Certainty	0.05	1.0
triclopyr	Turflon Ester 4L	1.0	32

Table 2. Herbicide injury and Sea Spray seashore paspalum coverage at various timings after application.

	Herbicide injury		Seashore paspalum coverage			
Treatment	0.5 [z]WAA	1 WAA	1WAA	2WAA	4WAA	8WAA
	%					
Check B[y x]	10.0 ghi	6.3 j	13.1 a-d	32.8 abc	79.3 ab	94.0 a
SedgeHammer	7.5 ghi	12.5 ij	16.3 ab	37.5 ab	89.7 a	93.9 a
Salt	13.8 f-i	7.5 j	16.7 ab	43.2 a	89.5 a	93.9 a
Drive	12.5 f-i	12.5 ij	13.5 a-d	28.0 bc	69.7 b-e	93.5 a
Quicksilver	25.0 efg	11.3 ij	10.5 b-g	27.7 bc	88.5 a	92.7 a
Dismiss	73.8 ab	60.0 cde	3.9 g-k	14.2 d-g	51.6 fg	92.7 a
Check A[x]	5.0 i	7.5 j	14.7 abc	39.3 ab	83.6 abc	91.8 a
Ronstar	16.3 e-i	16.3 hij	9.1 c-h	24.6 cd	63.3 b-f	91.1 a
Kerb	17.5 e-i	21.3 hij	11.7 a-f	23.6 cde	73.0 a-d	90.7 a
Blade	6.3 hi	15.0 hij	13.5 a-d	34.1 abc	82.1 ab	89.4 a
Speedzone Southern	28.8 ef	47.5 efg	5.2 f-k	10.4 f-h	54.3 ef	88.5 a
Lontrel	2.5 i	5.0 j	17.7 a	41.9 a	89.6 a	88.4 a
Certainty	23.8 e-h	33.8 fgh	6.8 d-k	10.4 f-h	54.0 ef	88.4 a
Pendulum	15.0 f-i	23.8 hij	12.9 a-e	22.5 c-f	74.6 abc	88.3 a
Barricade	17.5 e-i	18.8 hij	8.6 c-i	23.5 cde	68.9 b-f	84.6 a
Spotlight	25.0 efg	52.5 def	6.2 e-k	6.8 gh	35.2 gh	83.0 a
Trimec southern	48.8 cd	70.0 bcd	3.3 h-k	2.7 gh	22.2 hi	82.2 a
Trimec classic	28.8 ef	77.5 abc	3.3 h-k	3.8 gh	22.4 hi	81.4 a
Dimension	11.3 f-i	31.3 ghi	8.4 e-i	11.4 e-h	56.9 def	80.1 ab
MSMA	77.5 a	90.0 ab	1.3 jk	2.3 gh	14.2 ij	64.9 bc
Image	48.8 cd	83.8 ab	1.8 ijk	0.8 h	8.3 ij	63.4 c
Tupersan	17.5 e-i	30.0 ghi	7.7 d-j	9.4 gh	13.8 ij	39.7 d
Turflon	57.5 bc	76.3 abc	2.0 ijk	0.4 h	0.1 j	18.9 e
Fusilade	33.8 de	95.5 a	0.8 k	0.0 h	0.0 j	15.2 e
Prograss	50.0 cd	81.3 ab	1.9 ijk	0.1 h	0.4 j	13.1 e

[z] WAA, weeks after application.
[y] Treatments sorted according to turfgrass coverage at 8 weeks after application.
[x] Check A and check B refer to the two untreated control plots used in this study.

Table 3. Recommendations for herbicide application to Sea Spray seashore paspalum based on preliminary research.

Application timing	Herbicides
Recommended for use on seedlings 2WAE:	Clopyralid, halosulfuron, metsulfuron, quinclorac, carfentrazone, salt water treatment
Safe to use on seedlings at least one month after emergence:	Sulfentrazone, carfentrazone, fluroxypyr, carfentrazone + 2,4-D + MCPP + dicamba, 2,4-D + MCPP + dicamba, MCPP + 2,4-D + dicamba, sulfosulfuron, pronamide, oxadiazon, pendimethalin, dithiopyr, prodiamine
Do not use on 'Sea Spray' seedlings:	MSMA, imazaquin, siduron, triclopyr, fluazifop, and ethofumesate

Seed Covers and Germination Blankets Influence the Establishment of Seeded Warm-Season Grasses

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Additional index words: bermudagrass, buffalograss, centipedegrass, seashore paspalum, zoysiagrass, *Cynodon dactylon*, *Buchloe dactyloides*, *Eremochloa ophiuroides*, *Zoysia japonica*, *Paspalum vaginatum*.

Patton, A., J. Trappe and M. Richardson. 2008. Seed covers and germination blankets influence the establishment of seeded warm-season grasses. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:42-46.


Photo by Aaron Patton

Various covers used to establish turfgrass seed

Summary. Covers and blankets are often used to reduce erosion, retain soil moisture, increase soil temperature, and enhance plant germination and establishment rates. There are reports of various effects of seed cover technology on the germination and establishment of warm-season grasses. The objective of this study was to determine how diverse seed covers influence the establishment of seeded bermudagrass, buffalograss, centipedegrass, seashore paspalum, and zoysiagrass. Plots were seeded on 9 June 2007 with various species and covered with seed cover technologies including Blue Yellow, Curlex, Deluxe, Futerra, Jute, Poly Jute, polypropylene, straw, straw blanket, Thermal blanket, and an uncovered control. Light transmission, soil moisture, and turf coverage were monitored throughout the study. Across species, Futerra products, Poly Jute, Jute and Curlex produced the greatest coverage at 6 weeks after planting, while the untreated check and BlueYellow had the least coverage.

Abbreviations: PLS, pure live seed

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Covers and blankets are often used to protect turf during winter and spring, to warm the soil and increase germination rates, and also to reduce erosion. Seed germination blankets allow light penetration and gas exchange, facilitate soil warming, and increase soil moisture holding capacity, all of which increase germination rates without the risk of excessive temperature build-up. It is known that germination of warm-season turfgrasses increases as temperatures rise, with maximum germination rate occurring between 86 and 95°F (Portz et al., 1981; Zuk et al., 2005).

Yu and Yeam (1967) reported that the germination rate of zoysiagrass (*Zoysia japonica* Steud.) seed could be doubled by using a polyethylene film, while Portz et al. (1993) found that clear polyethylene covers placed over the seedbed for 7 or 14 days after seeding increased germination and zoysiagrass coverage in Illinois and Maryland. Other materials tested, such as straw (80 lb / 1000 ft^2), did not enhance germination because they excluded light and reduced soil temperatures (Portz et al., 1993). Organic fiber mats increased establishment when used in non-irrigated areas, likely due to increased soil moisture retention, but did not increase establishment when used in irrigated plots (Hensler et al., 2001). Anecdotal evidence suggests that porous germination blankets could also be useful for increasing bermudagrass and zoysiagrass germination and coverage (Patton et al., 2004).

Overall, past research shows different effects from cover technologies, but no broad comparison has been made between different cover technologies. Additionally, no cover research has been done with seeded seashore paspalum (*Paspalum vaginatum*), and very little work with seeded bermudagrass (*Cynodon dactylon*), buffalograss (*Buchloe dactyloides*), and centipedegrass (*Eremochloa ophiuroides*). The objective of this study is to determine how various seed covers influence the germination and establishment of seeded bermudagrass, buffalograss, centipedegrass, seashore paspalum, and zoysiagrass.

Materials and Methods

Research was conducted at the University of Arkansas Agricultural Research and Extension Center, Fayetteville, Ark. Experiments were seeded 9 June 2007 with bermudagrass was seeded at a rate of 1.0 lb. pure live seed (PLS) / 1000 ft^2, zoysiagrass at a rate of 2.0 lb. PLS / 1000 ft^2, seashore paspalum at a rate of 1.0 lb. PLS / 1000 ft^2, centipedegrass at a rate of 0.5 lb. PLS / 1000 ft^2, and buffalograss at a rate of 8.0 lb. PLS / 1000 ft^2. Prior to seeding, the plot area was tilled, fumigated with methyl bromide, and raked to prepare the soil for seeding. This provided a weed-free site on which establishment of various grasses could be closely monitored.

After seeding, plots were covered with various germination blanket technologies (Table 1, Fig. 1). Plots were irrigated for one week after seeding and then irrigation was not applied for the remainder of the study. Temporary covers (Table 1) were removed 14 days after seeding. The experimental design was a strip plot design with three replications. Covers were applied as strips and species applied as the whole plot treatment.

Soil moisture data were collected 14 days after seeding using time domain reflectometry moisture meter (Spectrum Technologies). The amount of sunlight allowed (inversely measuring shading) was measured for each cover technology. Turfgrass coverage was determined by visual estimates. All data were analyzed by analysis of variance and coverage means were separated using Fisher's protected least significant difference at $\alpha = 0.05$.

Results and Discussion

Above average rainfall frequency and amounts occurred for 40 days after planting. Therefore, soil moisture was not likely a contributing factor to establishment. The Futerra products, Poly Jute, Jute, and Curlex were among the products with the greatest turfgrass coverage across all species 6 weeks after planting (Table 2), while the untreated check and BlueYellow had the least coverage. Turf coverage rankings among species at 6 weeks after planting (Table 2) was as follows; bermudagrass > seashore paspalum > buffalograss > centipedegrass = zoysiagrass.

There was also a significant cover by species interaction. This was most notable for seashore paspalum and zoysiagrass. Seashore paspalum coverage was greatest with the Futerra products, Poly Jute, Jute, polyethylene, Deluxe, and Thermal Blanket (Table 2). Zoysiagrass coverage was greatest with the Futerra products or Curlex (Table 2). Bermudagrass coverage was similar with all products except Blue Yellow and the uncovered check, which resulted in the least amount of bermudagrass coverage (Table 2). Buffalograss coverage was also similar across cover technology except for Blue Yellow, Thermal blanket and the uncovered check, which resulted in less buffalograss coverage (Table 2). Centipedegrass coverage was greatest when covered with the Futerra products, Curlex, Jute, straw blankets, straw, or Poly Jute (Table 2).

The amount of photosynthetically active radiation (PAR) passing through each of these materials was determined (Fig. 2), but these data provide little insight into how cover technology influenced establishment. Many of the turfgrass species performed more poorly than expected, which was likely due to above average rainfall and cloud cover during the establishment period. This study will be repeated in 2008.

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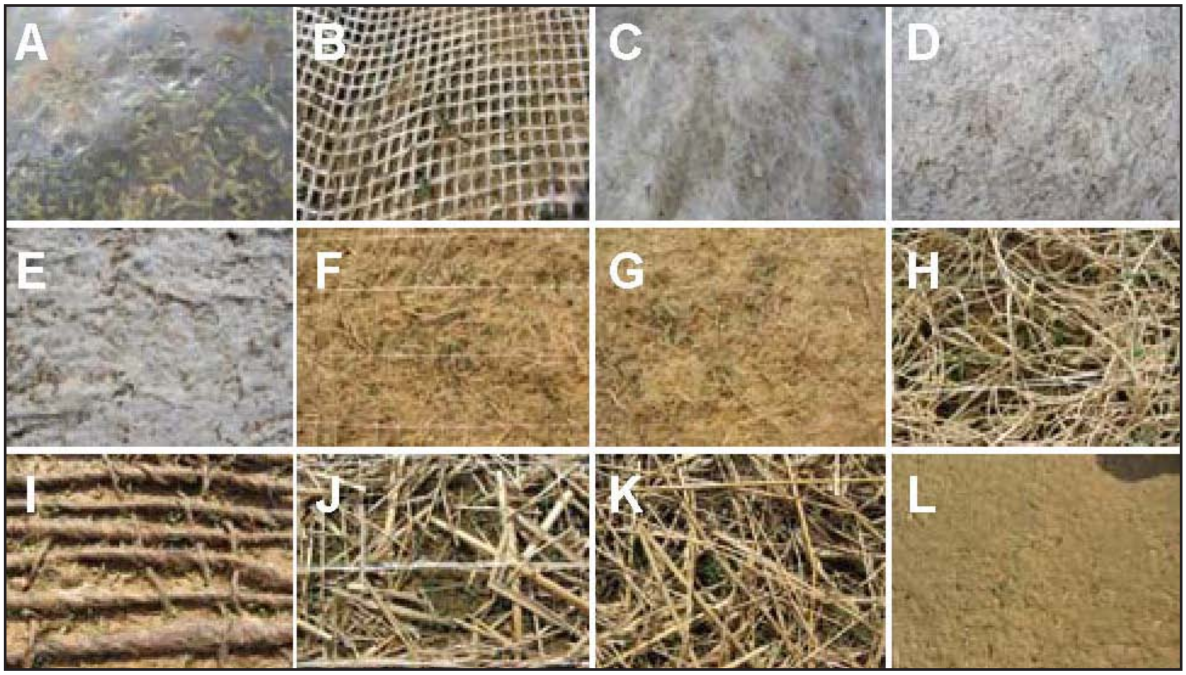

Fig. 1. Clear polyethylene (A), Poly Jute (B), Deluxe (C), Thermal blanket (D), BlueYellow (E), Futerra F4 Netless (F), Futerra (G), curlex (H), jute mesh (I), straw blanket with polypropylene netting (J), straw (K), uncovered control (L). Photo taken of bermudagrass plots 12 days after planting under various blankets and covers.

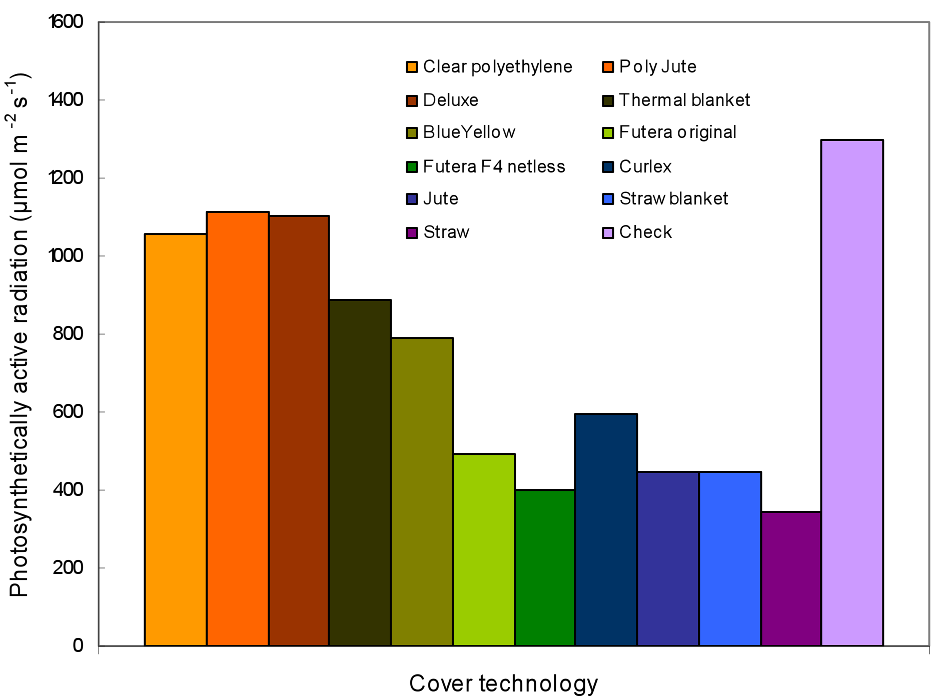

Fig. 2. Amount of photosynthetically active radiation (PAR) passing through various blankets and covers.

Table 1. Cover technologies tested in the trial.

Cover technology	Cover construction	Cover type
BlueYellow, BlueYellow, LLC	bleached kraft southern pine fiber	Temporary
Clear polyethylene cover 4 mil (0.1 mm, 4/1000")	Polyethylene	Temporary
Curlex, natural color	curled excelsior aspen wood fiber mat	Permanent
Deluxe (0.5 oz crop protection fabric), Dewitt Company	[z]	Temporary
Futerra F4 Netless, natural color, Profile Products LLC (6.5' × 90')	[z]	Permanent
Futerra original, natural color, Profile Products LLC (82" × 135')	[z]	Permanent
Jute mesh erosion control mat (mesh fabric)	[z]	Permanent
Poly Jute erosion control blanket, Dewitt Company	polypropylene multifilament yarn	Permanent
Straw [y], (Portz et al., 1993)	[z]	Permanent
Straw blanket with polypropylene netting	Straw and polypropylene	Permanent
Thermal blanket (3 oz.), Dewitt Company	polypropylen	Temporary
Uncovered control		

[z] Information about the material used to construct the covers was not readily available on company websites.
[y] 80 lbs $1000ft^{-2}$.

Table 2. Turfgrass coverage across species for various seeding blankets.

Cover treatment	Species					Mean
	Bermudagrass	Buffalograss	Centipedegrass	Seashore	Zoysiagrass	
	---	---	%	---	---	
Futerra F4 Netless	99.0 a	50.0 a	23.5 a	80.0 ab	25.0 a	58.9 a
Poly Jute	99.3 a	50.0 a	7.7 abc	84.3 a	11.5 bc	56.8 ab
Futerra	100.0 a	40.7 ab	20.0 ab	90.0 a	25.0 a	55.0 ab
Jute	95.7 ab	42.0 ab	15.3 abc	87.0 a	12.7 bc	50.5 abc
Curlex	94.3 ab	53.3 a	23.3 a	50.0 bc	23.3 ab	48.9 abc
Polyethylene	99.0 a	29.5 abc	1.5 c	85.0 a	9.5 c	44.9 bcd
Deluxe	100.0 a	28.3 abc	4.7 bc	80.0 ab	8.7 c	44.3 bcd
Straw	75.7 abc	50.0 a	7.7 abc	46.7 c	7.5 c	38.8 cd
Thermal blanket	99.5 a	9.0 c	3.5 c	60.0 abc	6.5 c	35.7 d
Straw blanket	82.7 abc	40.0 ab	10.0 abc	32.3 cd	8.3 c	34.7 de
Blueyellow	58.3 c	14.0 bc	2.5 c	30.0 dc	4.0 c	22.7 ef
Uncovered check	73.3 bc	6.0 c	0.0 c	7.7 d	3.0 c	18.0 f
Mean	88.9	35.0	10.3	60.8	11.7	

[z] Data collected 45 days after planting.
[y] Means within a column followed by the same letter are not significantly different.

2002 NTEP Zoysiagrass Trial – Summary

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Additional index words: *Zoysia japonica, Zoysia matrella*, manilagrass, Japanese lawngrass, turfgrass, cultivars, quality, color, spring green up, leaf texture, frost damage, seedheads

Patton, A., D. Karcher, M. Richardson, J. McCalla and J. Landreth. 2008. 2002 NTEP zoysiagrass trial – summary. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:47-51.

Photo by Aaron Patton

Zoysiagrass cultivar trial at Fayetteville, Ark.

Summary. Zoysiagrass continues to increase in popularity in transition-zone environments, due to its excellent turfgrass quality, persistence under adverse conditions, and low maintenance requirements. The National Turfgrass Evaluation Program is the predominant means by which cultivars are tested throughout North America. A zoysiagrass cultivar trial was planted in the summer of 2002 at Fayetteville, Arkansas. This trial has been maintained under golf course fairway conditions and data on spring green-up, overall turf quality, leaf color, leaf texture, seedheads, and frost damage were collected from 2003 to 2006. Zorro, Emerald, and Cavalier were among the commercially available cultivars with the best turf quality across four years. Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass varieties. Planting well-adapted cultivars will improve turfgrass quality, reduce reestablishment costs from winterkill or drought, and ultimately increase sustainability.

Abbreviations: NTEP, National Turfgrass Evaluation Program

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Zoysiagrass (*Zoysia* spp.) has become an increasingly popular turfgrass for golf courses and home lawns in the transition zone due to its excellent turfgrass quality, persistence under adverse conditions, and low maintenance requirements. Currently, approximately 13% of lawns in Arkansas are zoysiagrass (Slaton, 2006). The popularity of the species is due to its enhanced cold tolerance, slow growth rate, and competitiveness against weeds. Until recently, most of the zoysiagrass used in the United States and Arkansas has been the cultivar Meyer. However, in the past twenty years, new germplasm has been collected and released and is starting to be used more frequently in the turfgrass industry. An integral part of the turfgrass research program at the University of Arkansas is the testing of new and improved cultivars of turfgrass for adaptation to this geographic region. The following report summarizes four years of data from the 2002 zoysiagrass cultivar evaluation trial sponsored by the National Turfgrass Evaluation Program.

Materials and Methods

This experiment was planted on 2 July 2002 at the University of Arkansas Research and Extension Center in Fayetteville on a Captina silt-loam soil. The plot size was 8 by 8 ft. and there were three replications of each cultivar. The vegetative cultivars were planted as 2-inch diameter plugs on 12-inch centers within the plots, while the seeded cultivars were broadcast planted at a seeding rate of 1.0 lb / 1000ft^2. Plots were maintained under golf course fairway or sports field conditions, with a mowing height of 0.5 inch and monthly applications of 0.5 lb N / 1000ft^2 during the growing season. Irrigation was applied as needed to promote germination and establishment and to prevent stress.

Cultivars were visually evaluated for spring green-up using a scale of 1 to 9, with 9 representing complete green color and 1 representing a completely dormant turf stand. Overall turf quality was evaluated monthly from May through October in each year of the trial (2003-2006). Quality was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green, uniform, fine-textured turf and 1 representing dead turf. Turf genetic color was visually evaluated on a scale of 1 to 9, with 9 representing ideal, dark green turf and 1 representing tan or brown turf. Leaf texture was visually evaluated on a scale of 1 to 9, with 9 representing extremely fine turf texture and 1 representing extremely coarse texture. Cultivars were visually assessed for frost damage each fall using a 1 to 9 scale, with 9 representing no frost damage and 1 representing complete leaf kill. Seedheads were rated using a 1 to 9 scale, with 9 representing maximum presence of seedheads and 1 representing no seedheads present.

An analysis of variance was computed for each evaluation and cultivar means were separated using Fisher's protected least significant difference test ($\alpha = 0.05$).

Results and Discussion

There were significant differences in turf quality among cultivars in each year and across the entire 4-yr study (Table 1). Zorro was the only cultivar to be among the highest statistical rating group in each year of the trial. Zorro, Emerald, Cavalier, DALZ0104, and DALZ0101 had the best turf quality when averaged across four years with rating values of 7.2, 6.9, 6.9, 6.7, and 6.7, respectively. Chinese Common and PZA 32 were consistently rated lowest for turf quality with average values of 3.9 and 4.0, respectively.

Based on the four-year trial average, Zorro, Emerald, Cavalier, DALZ0104, and DALZ0101 have superior turf quality compared to the industry standard of Meyer, whereas Meyer had superior quality compared to Zenith, PZB 33, J-37, Compadre, PZB 32, and Chinese Common. The cultivars Himeno, PST-R7ZM, GN-Z, DALZ9604, DALZ0105, El Toro, Palisades, DALZ0102, BMZ230, Crowne, 6186, and PST-R7MA had four-year trial averages of turf quality similar to Meyer.

There were significant differences in spring green-up among cultivars (Table 2). BMZ230 and Meyer had the earliest spring green turf cover with average ratings of 6.2 and 5.7, respectfully. DALZ0104, DALZ9604, and 6186 had the least green-up with average ratings of 2.1, 2.0, and 1.4, respectively.

There were significant leaf texture differences among cultivars (Table 2). DALZ0101, DALZ0104, Zorro, Cavalier, and Emerald had the finest leaf texture, averaging rating values ranging between 8.0 and 8.6. BMZ230, J-37, Crowne, DALZ0102, Palisades, Chinese Common, Compadre, El Toro, PZB33, and PZB32 had the coarsest leaf texture ratings with average rating values ranging from 4.7 to 5.3.

There were significant genetic color differences among cultivars (Table 2). DALZ0104, DALZ0101, 6186, Emerald, Zorro, Cavalier, DALZ0105, and Meyer were rated darkest green, with average rating values between 6.8 and 7.5. All cultivars had acceptable turf color (>5.0) except the lowest valued (4.3) cultivar Chinese Common.

There were significant differences among cultivars in frost damage (Table 2). Emerald, Zorro, DALZ0101, Cavalier, DALZ0105, and DALZ9604 had the least frost damage with average rating values of 6.8, 6.8, 6.7, 6.5, 6.5, and 6.2, respectively. Chinese Common, J-37, Zenith, PST-R7MA, PZA 32, PZB 33, and PST-R7ZM had the most visible frost damage as all these cultivars averaged rating values below 4.4.

Few zoysiagrass cultivars produced a significant numbers of seedheads in this trial (Table 2). Seedheads were most prevalent on BMZ230, El Toro, Himeno, and Palisades. Meyer is considered to be a heavy seedhead producer in the spring, but compared to most zoysiagrass cultivars, it has similar seedhead production.

In the early 1990's, Meyer was the main zoysiagrass cultivar being grown in Arkansas. Although Meyer is still produced at 25 sod farms in Arkansas, there are now 8 new cultivars being grown in Arkansas, including Cavalier, Crowne, Diamond, El Toro, Empire, Himeno, Palisades, and Zorro (Patton et al., 2008). Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass varieties. Planting well-adapted cultivars will improve turfgrass quality, reduce reestablishment costs from winterkill or drought, and ultimately increase sustainability.

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Table 1. Annual turfgrass quality ratings for 24 zoysiagrass cultivars at Fayetteville, Ark. Data are also averaged across all 4 seasons (2003-2006) of the trial and ranked according to the 4-yr average.

Entry	2003	2004	2005	2006	Average
	---------------------------- turfgrass quality [z]				---------------------------
Zorro [x] [w]	8.2	6.8	7.0	6.6	7.2 [x]
Emerald [x]	7.6	6.8	6.9	6.3	6.9
Cavalier [x]	7.1	6.9	6.7	6.8	6.9
DALZ 0104	7.6	6.9	5.7	6.5	6.7
DALZ 0101	8.1	6.3	6.6	5.8	6.7
Himeno [x]	5.8	6.1	6.2	5.9	6.0
PST-R7ZM [y]	6.6	5.9	5.8	5.6	6.0
GN-Z	6.7	5.9	6.3	5.0	6.0
DALZ 9604	6.9	6.2	4.6	5.8	5.9
DALZ 0105	7.3	6.1	4.9	5.1	5.9
El Toro [x]	6.0	6.3	5.4	5.8	5.9
Palisades [x]	5.1	5.9	6.2	5.8	5.8
DALZ 0102	6.2	5.5	5.6	5.7	5.7
Meyer [x]	5.6	6.0	5.9	5.1	5.6
BMZ 230	5.8	5.9	5.2	5.4	5.6
Crowne [x]	5.6	6.1	5.4	5.6	5.6
6186	6.6	5.9	3.7	5.2	5.3
PST-R7MA [y]	6.5	5.2	4.2	4.9	5.2
Zenith [y] [x]	5.9	4.7	4.5	4.6	4.9
PZB 33 [y]	5.7	5.0	4.4	4.3	4.9
J-37 [y]	5.1	4.3	4.6	4.7	4.7
Compadre (Companion) [y] [x]	5.2	4.8	4.5	4.5	4.7
PZA 32 [y]	5.6	4.2	3.1	3.2	4.0
Chinese Common [y]	4.6	3.7	3.7	3.7	3.9
LSD (P=0.05)	0.6	0.6	0.8	1.0	0.5

[z] Turfgrass quality was visually rated on a scale of 1-9, with 9 = ideal turfgrass quality
[y] Seeded zoysiagrass entries.
[x] Commercially available in Arkansas by seed or sod.
[w] Cultivars are sorted in descending order according to their 4 yr average.

Table 2. Spring greenup, leaf texture, genetic color, frost damage, and seedhead ratings for 24 zoysiagrass cultivars at Fayetteville, Ark. All data represent the average of multiple ratings over four seasons (2003-2006).

Entry	Spring greenup[z]	Leaf texture[y]	Genetic color[x]	Frost damage[w]	Seedheads[v]
	---------------------- Visually rated on a 1-9 scale ------------------				
6186 [t]	1.4	6.0	7.2	4.5	1.0
BMZ 230	6.2	4.7	6.1	5.3	3.0
Cavalier [s]	5.0	8.4	6.8	6.5	1.0
Chinese Common	3.7	4.9	4.3	3.3	2.2
Compadre (Companion) [u s]	5.3	5.0	5.8	4.8	1.7
Crowne [s]	4.3	4.8	6.5	5.3	2.3
DALZ 0104	2.1	8.5	7.5	5.7	1.0
DALZ 0101	4.7	8.6	7.3	6.7	1.0
DALZ 0102	4.6	4.8	5.7	4.8	1.2
DALZ 0105	2.3	7.8	6.8	6.5	1.0
DALZ 9604	2.0	6.5	6.2	6.2	1.0
El Toro [s]	4.4	5.0	6.5	5.2	3.2
Emerald [s]	5.0	8.0	7.2	6.8	1.0
GN-Z	4.4	6.8	5.8	4.8	1.2
Himeno [s]	2.6	5.6	6.3	4.7	3.5
J-37 [u]	4.6	4.7	5.2	4.0	1.7
Meyer [s]	5.7	6.6	6.8	5.0	1.5
Palisades [s]	4.6	4.8	6.6	4.7	2.8
PST-R7MA [u]	4.9	6.1	5.6	4.2	1.7
PST-R7ZM [u]	5.2	6.0	6.4	4.3	2.0
PZA 32 [u]	4.1	5.3	5.2	4.2	1.2
PZB 33 [u]	4.7	5.1	5.9	4.2	1.3
Zenith [u s]	4.7	5.6	5.8	4.0	2.2
Zorro [s]	4.1	8.5	7.0	6.8	1.2
LSD (P=0.05)	0.7	0.6	0.8	1.0	1.0

[z] Spring greenup was rated on a scale of 1-9, with 9 = fully green
[y] Leaf texture was rated on a scale of 1-9, with 9 = finest texture
[x] Genetic color was rated on a scale of 1-9, with 9 = darkest green
[w] Frost damage was rated on a scale of 1-9, with 9 = fully green turf, with no damage from frost
[v] Seedheads were rated on a scale of 1-9, with 9 = maximum presence of seedheads and 1 = no seedheads present
[u] Seeded zoysiagrass entries.
[t] Cultivars are sorted alphabetically.
[s] Commercially available in Arkansas by seed or sod.

Mowing Height, Mowing Frequency, and Rolling Frequency Affect Putting Green Speed

Jay Richards[1], Doug Karcher[1], Thom Nikolai[2], Mike Richardson[1], Aaron Patton[3], and Josh Landreth[1]

Additional index words: ball roll distance, Pelzmeter, turf quality, transition zone, USGA rootzone

Richards, J., D. Karcher, T. Nikolai, M. Richardson, A. Patton and J. Landreth. 2008. Mowing height, mowing frequency, and rolling frequency affect putting green speed. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:52-56.

Photo by Doug Karcher

Bentgrass greens and tees in Seattle, Wash.

Summary. Rolling putting greens may allow turf managers to decrease mowing frequency or increase mowing height without losing green speed. An increase in mowing height would be beneficial in minimizing summer stress on creeping bentgrass putting greens in Arkansas and throughout the transition zone. The objective of this study was to determine the effects of mowing and rolling frequency and mowing height on turf quality and green speed (ball roll distance) on a sand-based putting green. This study contained eight combinations of mowing and rolling treatments, which were applied over a six-week period. Turf quality was rated weekly and ball roll distance was measured twice weekly. Rolling treatments had a greater impact on increasing ball roll distance than reducing mowing height. Furthermore, mowing frequency could be reduced without a decrease in ball roll distance if turf was rolled on days when mowing was skipped.

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Light-weight rolling of putting greens is a cultural practice that dates back to over 100 years. However, in the 1920s rolling declined due to fears that putting green soils would compact, resulting in drainage and aeration problems (Piper and Oakley, 1921). The practice of rolling greens was mostly abandoned for the next 70 years. However, in the early 1990s, when the demand for faster greens grew, rolling putting greens re-emerged as a viable cultural practice (Nikolai, 2002). Most new putting greens are built according to either United States Golf Association (USGA) specifications (USGA, 1993) or with other techniques that include a predominately sand rootzone, which makes them less susceptible to compaction than previous soil-based putting green rootzones. The technology of rollers has also improved significantly and new rollers are designed specifically for rolling golf course putting greens.

A recent greens rolling study concluded that most greens rollers increase green speed by over a foot on the day rolling is applied and retains over 6 inches of that increase the day after rolling (Nikolai, 2005). If greens rolling can improve green speeds for as long as 48 hours, daily mowing may not be necessary. This could reduce stress to the putting green surface, especially during hot, humid conditions. The objective of this research was to determine the optimal combination of mowing and rolling frequency and mowing height on a USGA putting green that results in the best overall quality and ball roll characteristics.

Materials and Methods

This research was conducted at the University of Arkansas Agriculture Research and Extension Center in Fayetteville, Arkansas on a 5-yr old creeping bentgrass (*Agrostis stolonifera* cv. L-93) putting green that was constructed according to USGA specifications (USGA, 1993).

Fertilization, growth regulator and pesticide application, aerification, irrigation, and topdressing were uniform across the experimental area throughout the study and were consistent with typical golf course putting green management practices.

In this study, there were 8 different mowing and rolling treatments, each replicated three times for a total of 24 plots (4.5 by 18 ft). The treatments, which are summarized in Table 1, were chosen to compare the effects caused by different mowing heights, mowing frequencies, and rolling frequencies on putting green speed and turf quality. Treatment application began 28 Sept. 2007 and continued for six weeks. All mowing treatments were applied using a walk-behind greens mower (Toro Greensmaster 1600, Toro Company, Bloomington, MN). After the plots were mowed, rolling treatments were applied (Fig. 2) using a commercially available greens roller (RS48-11C Golf Roll 'n' Spike, Tru-Turf Rollers, Ernest Junction, Queensland, Australia). Rolling was applied as a single pass across appropriate plots. Putting green speed was evaluated by measuring ball roll distance with a Pelzmeter (Nikolai, 2005). On each plot, three golf balls were rolled in opposite directions and the six resultant ball roll distances were averaged. Ball roll measurements were collected twice per week, once on a day in which all rolling treatments were applied and once on a day when only plots that were rolled 6 times per week were treated. Turf quality was measured weekly by rating each plot on a scale from 1-9, with 1 being poor and 9 being exceptional.

Results and Discussion

Ball roll distance data were averaged over the five evaluation weeks, for the day of rolling and day after rolling (Fig. 1). There were no significant differences in ball roll distance between turf mowed at 1/8 inch and 5/32 inch when rolling was not applied. Decreasing the mowing height from 5/32 to 1/8 inch increased green speed by an average of 6 inches and, according to golfer perception surveys, golfers cannot detect differences in green speed of 6 inches or less on adjacent putting greens (Karcher et al., 2001).

Rolling the turf three times per week resulted in an increase in ball roll distance of approximately 1 foot on the day of rolling and 9 to 10 inches on the day after rolling, compared to non-rolled plots at a given mowing height (Fig. 1). Plots that were rolled six times per week had an increase in green speed over those rolled three times per week; however, this difference was not significant at the 1/8-inch mowing height on days when all plots were rolled. Conversely, at the 5/32-inch mowing height, plots that were rolled six times per week had ball roll distances one ft. longer than plots rolled three times per week on days that all plots were rolled. Furthermore, on days when rolling was only applied to plots rolled six times per week, those plots had ball roll distances of 1.5 ft. greater than plots rolled three times per week at both mowing heights.

At the 1/8-inch mowing height, decreasing mowing frequency to 3 times per week actually increased ball roll distance (+ 1 ft.) when plots were rolled on alternate days and by approximately 1.5 ft. when plots were rolled every day. Throughout the 5-week study, there were little to no quality differences among treatments (data not shown). It is important to note that this study was performed during the fall, coinciding with ideal growing conditions for creeping bentgrass. The study will be repeated during the summer of 2008 to determine if daily rolling treatments negatively impact turf quality during periods of summer stress in the transition zone.

In summary, rolling treatments were more effective at increasing putting green speed than reducing the mowing height in this study. In fact, with rolling, ball roll distances were increased even when mowing frequency was reduced to every other day. Therefore, those managing putting greens in the transition zone may be able to mow less frequently during hot, humid periods to minimize turf stress and produce healthier putting green turf, without sacrificing green speed.

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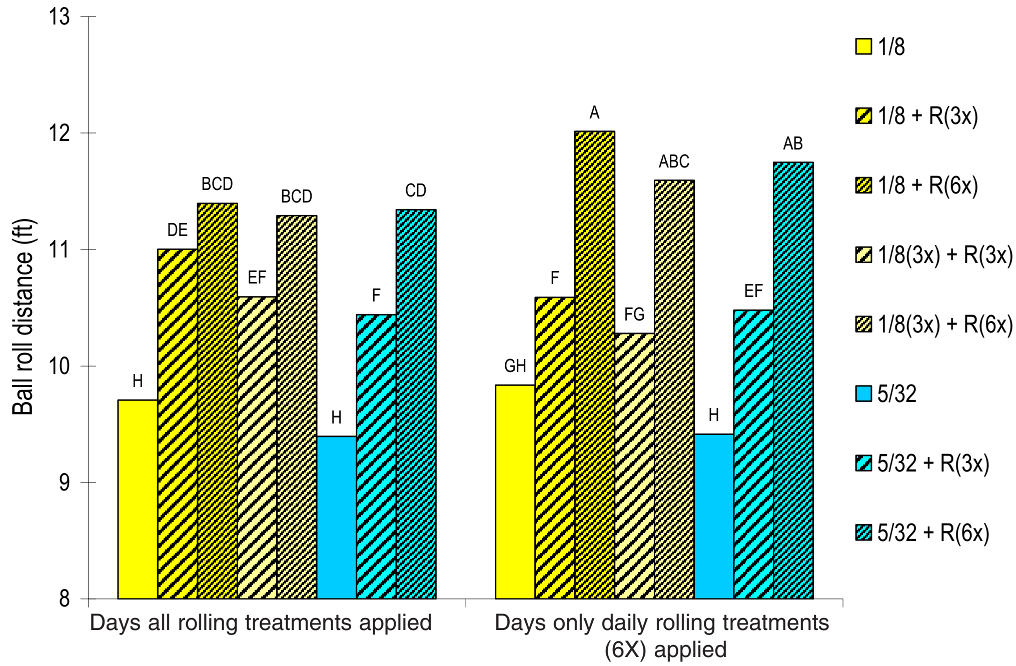

Fig. 1. Ball roll distance as affected by mowing height and mowing and rolling frequency. Bars sharing a letter are not significantly different according to Fisher's LSD (α = 0.05).

Fig. 2. Tru-Turf roller that was used to apply treatments.

Table 1. Summary of mowing and rolling treatments.

Mowing height	Mowing frequency	Rolling frequency	Treatment ID
inches	days/wk	days/wk	
1/8	6	0	1/8
1/8	6	3	1/8 + R(3x)
1/8	6	6	1/8 + R(6x)
1/8	3	3	1/8(3x) + R(3x)
1/8	3	6	1/8(3x) + R(6x)
5/32	6	0	5/32
5/32	6	3	5/32 + R(3x)
5/32	6	6	5/32 + R(6x)

A Method to Measure Golf Ball Lie in Various Turf Types Using Digital Image Analysis

Mike Richardson[1], Doug Karcher[1], Aaron Patton[2], and John McCalla[1]

Additional index words: Lie-N-Eye, fairway, rough

Richardson, M., D. Karcher, A. Patton and J. McCalla. 2008. A method to measure golf ball lie in various turf types using digital image analysis. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:57-62.


Photo by Mike Richardson

Golf ball in deep rough

Summary. Golf ball lie describes the characteristics of how a golf ball comes to rest on the turf after a golf stroke. Although the lie of a golf ball is an important factor affecting the play of the next shot, there have been few attempts to measure this characteristic or determine how management practices, turfgrass species, or cultivars affect ball lie. A new technique utilizing digital image analysis was developed for measuring ball lie. The image analysis technique could easily distinguish changes in ball height within a turfgrass canopy. In addition, the new technique was easier and faster to collect data compared to the Lie-N-Eye, the only other method of ball lie analysis available. The development of this technique will allow us to study a range of factors that can influence ball lie, including turfgrass species, cultivars, and a range of cultural practices.

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The lie of a golf ball after it comes to rest after a stroke can have a significant impact on the ability of a golfer to play their next shot. Although golf ball lie is generally considered to be uniform and adequate on fairway or tee-height turf, turf that is maintained at higher heights of cut, such as found in intermediate or deeper cuts of rough, will produce significant variability between the lie of balls landing in close proximity. Although the effects of species, cultivars or management practices on ball lie are often mentioned in turfgrass management textbooks, there have been limited efforts to quantify ball lie under a range of conditions or identify morphological or physiological parameters that impact ball lie. One of the major limitations to such an effort has been the lack of quantifiable measurements of ball lie that can be applied over a range of turfgrass systems.

Cella and co-workers at the University of Illinois developed two tools, identified as the Lie-N-Eye and Lie-N-Eye II (Fig. 1), to measure golf ball lie on turf mowed at either 0.6 to 1.0 inch, or 0.5 inch, respectively (Cella and Voigt, 2001; Cella et al., 2004). Using this technique, they were able to measure the height of a golf ball above the canopy and differentiate ball lie among both Kentucky bluegrass cultivars and bentgrass species and cultivars. Although this technique effectively separated differences in ball lie on closely-mown turf, it was not applied to taller-cut turf in any of their studies. In an effort to improve the speed and accuracy of measuring golf ball lie over a range of turf conditions, digital image analysis (DIA) techniques may be capable of quantifying the amount of golf ball visible within the turf canopy over a range of turf management conditions. The objective of this study was to determine the effectiveness of DIA to measure ball lie in turf maintained over a range of conditions.

Materials and Methods

Ball lie measurement device. A device was developed that uniformly takes a digital photo of a red golf ball from a fixed focal length (Fig. 2). Adjustable legs on the device can be set to match the mowing height of the turf, which positions the camera precisely at the top of the canopy. Digital images were obtained using an Olympus SP-510UZ Digital Camera (Olympus Optical Co.). The images were collected in the JPEG (.jpg) format, with an image size of 1024 x 768 pixels. Camera settings included a shutter speed of 1/250 s and an aperture of F8.0. Digital images were batch-analyzed using SigmaScan Pro (v. 5.0, SPSS, Inc., Chicago, Ill., 60611) software. For these studies, a hue range from 200 to 256 and a saturation range from 20 to 100 were found to selectively identify the red ball in the image (Fig. 3). The number of pixels represented by the ball in an image was divided by the number of pixels from when the ball was positioned fully above the canopy to calculate the percent of ball exposed.

Calibration of the device. In order to determine the ability of the device to detect changes in ball lie within the canopy, a calibration study was conducted in which golf balls were placed on tees (Super Korectee, www.korectee.com) that could be set to a predetermined height above the soil in a Kentucky bluegrass (*Poa pratensis*, cv. Midnight) turf maintained at a height of 2.0 inches. Nine replicate balls were placed at each tee height above the soil, which ranged from 0.48 – 1.8 inches. Digital images were collected for each ball using the device described in Figure 2. After analysis, the percent of ball exposed above the canopy was compared to the height at which the ball was placed above the soil.

Comparing digital image analysis to the Lie-N-Eye. The ability of the two devices to measure ball lie was compared in a cultural practice study on ‘Tifsport’ bermudagrass that was maintained at mowing heights of 0.5, 1.0, or 1.5 inch. Within each mowing height, nine balls were rolled onto the turf using a modified Stimpmeter. Without disturbing the lie of the nine balls, three raters each measured the height of each ball above the canopy using the Lie-N-Eye II and also collected digital images of each ball for DIA. Each rater was also timed as they collected data on the nine balls using each method. Coefficients of variation (CV) were determined for each method and the number of analyses that could be conducted per minute using each method was also determined. In addition, regression analysis was performed on the data collected with both devices to assess the relationship between the results using the two techniques.

Results and Discussion

Calibration of the device. There was a strong linear relationship between height above the soil and percent ball exposed (data not shown), but the data best fit a sigmoidal equation (Fig. 3). Since the golf ball is a sphere, the first incremental drops of the golf ball into the turf canopy only shielded very small percentages of the ball, resulting in relatively small decreases in percent ball exposed. As the center of the ball moved into the canopy, larger sections of the ball were shielded with each decrease in ball height, until the top of the ball was reached, when small changes again occurred with further decreases in the canopy. These results clearly indicated that DIA could detect small changes in ball height within and above the canopy of taller-cut turfgrass such as bluegrass rough.

Comparing digital image analysis to the Lie-N-Eye. Across all mowing heights, both techniques produced consistent results using different data collectors, with CV values of 5.8% for DIA and 5.7% for the Lie-N-Eye II (Fig. 5). The biggest advantage of the DIA technique over the Lie-N-Eye II was the speed at which data could be collected (Fig. 5). With DIA, an average of 5.4 measurements could be made per minute, while the average measurements per minute with the Lie-N-Eye II were 2.2 (Fig. 2). In addition to increased speed of data collection, the DIA technique was also less physically demanding, as the data collector must kneel down on the ground using the Lie-N-Eye II to accurately determine the ball height (Fig. 1). When the results obtained with the two techniques were compared, there was a positive, linear relationship observed between the techniques and a good fit ($R^2 = 0.89$) to the data (data not shown). These results clearly demonstrate that DIA is a viable means to evaluate ball lie and the results are comparable to the only other technique available for such analysis. The development of this technique will allow us to study a range of factors that can influence ball lie, including turfgrass species, cultivars, and a range of cultural practices.

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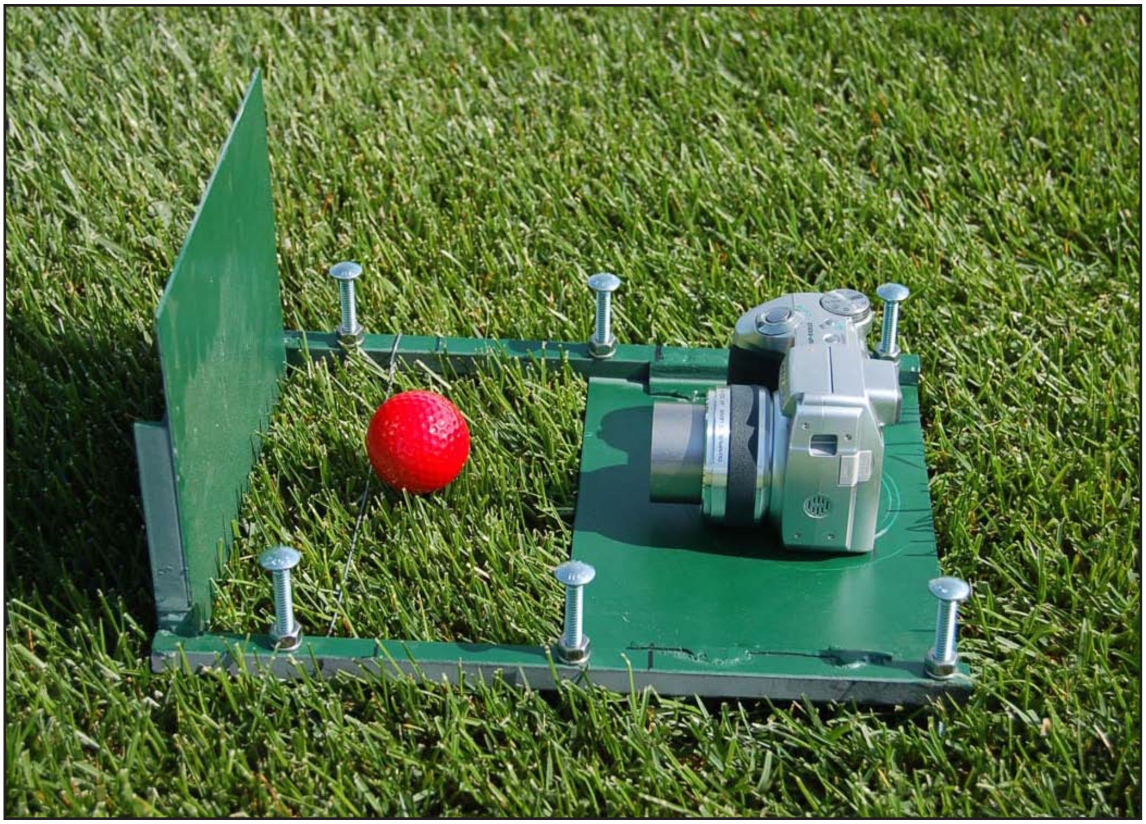

Fig. 1. Device developed at the University of Arkansas to collect digital photos of golf ball lie, which are subsequently analyzed using image analysis software.

Fig. 2. The Lie-N-Eye II, a device developed by the University of Illinois to measure the height of a golf ball above the canopy.

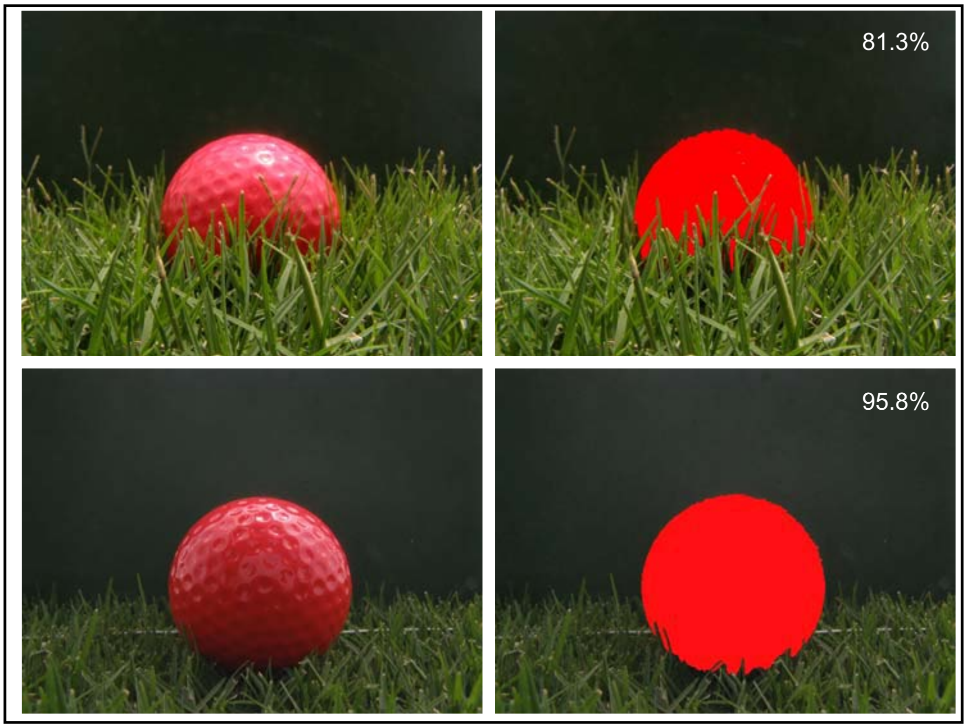

Fig. 3. Golf ball lie images collected with the digital camera (Photo 2) and then analyzed using image analysis software. Images on right demonstrate the software analysis, which identifies red pixels in the image.

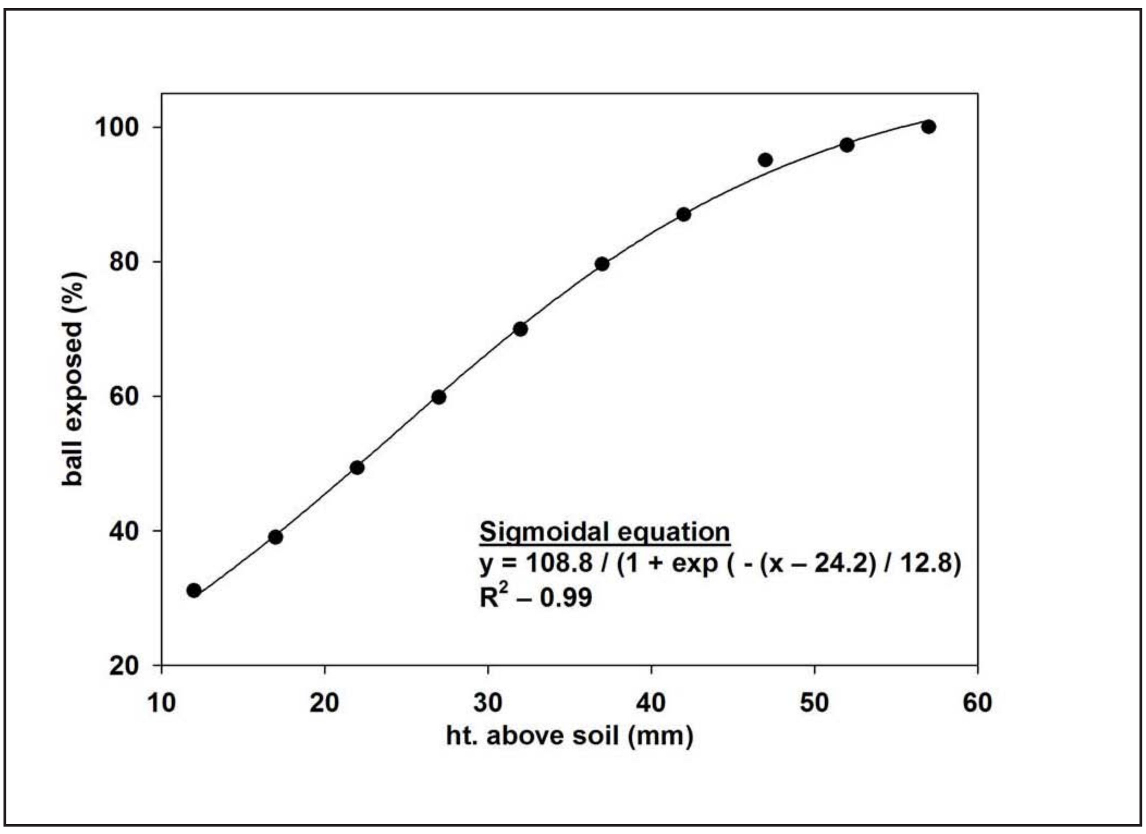

Fig. 4. Calibration curve showing the relationship between ht. of a golf ball above the soil and the % of ball identified with digital image analysis.

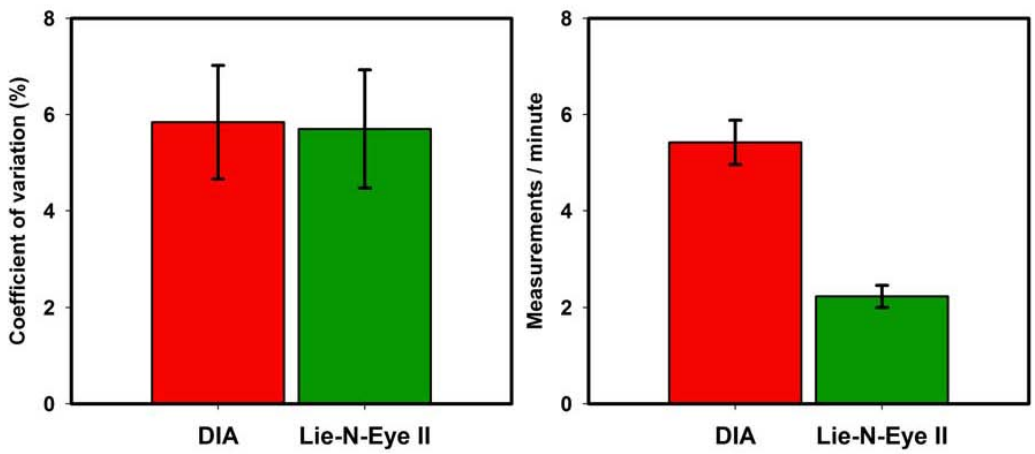

Fig. 5. Comparison of digital image analysis and the Lie-N-Eye II, showing the coefficient of variability of repeated measures with the two devices and the number of measurements obtained per minute using the two devices. Error bars represent 95% confidence intervals for the true CV values and number of measurements/minute, respectively.

Germination of Three Ryegrass Species and Meadow Fescue Under Saline Conditions

Mike Richardson[1] and John McCalla[1]

Additional index words: *Festuca pratensis*, *Lolium perenne*, tetraploid ryegrass, intermediate ryegrass, overseeding

Richardson M. and J. McCalla. 2008. Germination of three ryegrass species and meadow fescue under saline conditions. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:63-65.

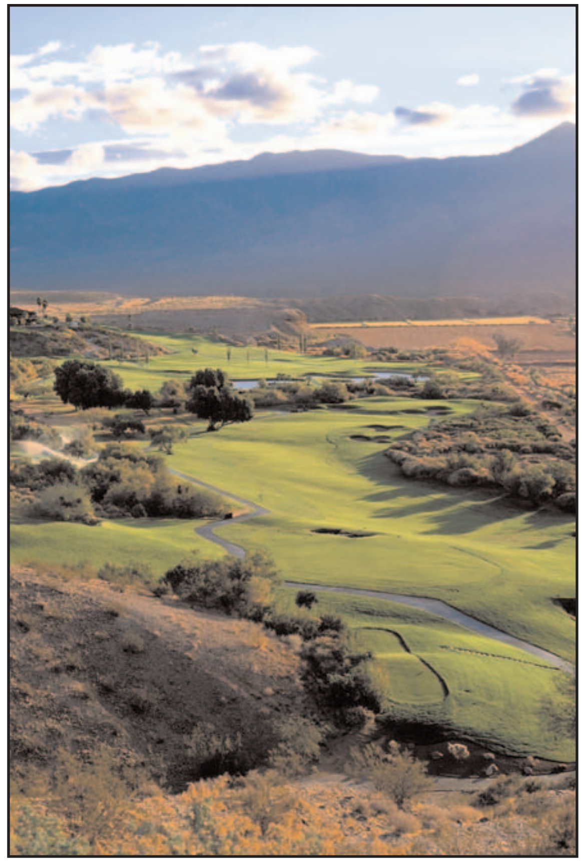

Photo courtesy of Mike Richardson

Overseeded fairways at Palms Hills Golf Club, Mesquite, Nev.
http://www.mesquitecoupleschampionship.com/palmshilltopbest.jpg

Summary. Bermudagrass is often overseeded during the dormant winter months to enhance playability of the turf and extend the growing season. Although diploid perennial ryegrass (2n=2x=14) is the major turfgrass species used for overseeding, recent research indicates the potential use of alternative overseeding species, including tetraploid perennial ryegrass (2n=4x=28), intermediate ryegrass, and meadow fescue. An issue that is becoming increasingly prevalent in overseeding regions is the use of non-potable water sources that may have a high salt content. The objective of this study was to determine the germination potential of four overseeding species in the presence of increasing salt concentrations. The study was conducted in a hydroponic system in the greenhouse. There were no major differences in germination among diploid, tetraploid, or intermediate ryegrass at any of the salinity levels, but germination of all ryegrasses was inhibited at salt concentrations greater than 12500 ppm NaCl. Meadow fescue was more sensitive to salt than the ryegrasses and was severely inhibited at the highest salt concentration (15000 ppm NaCl).

Abbreviations: DAS, days after seeding

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Bermudagrass (*Cynodon* spp.) is often overseeded with a cool-season turfgrass to provide full-year playing conditions. One of the most important decisions in an overseeding program is the selection of an appropriate cool-season species for a specific application. Recent improvements in the turfgrass characteristics of both meadow fescue (*Festuca pratensis*) and tetraploid ryegrass (*Lolium perenne*, 2n=4x=28) suggest that these species have great potential for overseeding dormant bermudagrass (Richardson et al., 2007).

Increased demand for potable water in southern locations where overseeding is practiced has increased the use of lower quality irrigation sources at many golf courses and sports turf facilities. As such, alternative grasses or cultivars with improved tolerance of poor-quality water are of great benefit to turfgrass managers. The objective of this study was to determine the effects of saline water on the germination of four overseeding species, including diploid perennial ryegrass (*L. perenne*, 2n=2x=14), intermediate ryegrass (*L. perenne* x *L. multiflorum*), tetraploid perennial ryegrass, and meadow fescue.

Materials and Methods

A greenhouse study was conducted during the winter of 2006 in which the four overseeding species were germinated in hydroponic solutions adjusted to four irrigation-water salinity levels. The salinity levels included 7500, 10000, 12500, and 15000 ppm NaCl solutions, which correspond to electrical conductivity values of ~12, 16, 20, and 24 dS / m. These levels were chosen based on results from a preliminary study where there was no inhibition of germination of any of these species up to 5000 ppm NaCl. The hydroponic system consisted of tubs (11 by 14 by 5.5 inch) in which a foam insulation board (thickness = 0.56 inch) was cut to fit inside the perimeter of the tub and floated on the hydroponic solution. Twelve holes (1.5 inch diam.) were cut into each board and a nylon screen (18 x 16 mesh) was affixed with silicon glue to the bottom side of the insulation board, which placed the screen in contact with the solution. The base solution for each salinity treatment consisted of a complete nutrient solution that delivered 50 ppm N using a fertilizer formulation (5-11-26, HYDRO-SOL, Peters Professional) specifically designed for hydroponic culture. Air was continuously supplied to each solution via an air stone (Aqua Mist, Penn Plax, Inc., Hauppauge, N.Y.) connected to an aquarium pump (Silent Air, Penn Plax, Inc.). Each solution concentration was replicated four times.

Twenty-five seeds of each species were placed in each of 3 subsample cells on top of the screen that was in contact with each solution. Germination was monitored frequently (every 1-2 days over the next 14 days) and a seed was considered to have germinated when both the radicle and coleoptile had emerged. Once a seed had germinated, it was counted and removed from the solution.

Results and Discussion

Germination was first observed with intermediate ryegrass in the lowest salt solution at 4 days after seeding (DAS) (Fig. 1). All of the ryegrasses began germinating in the 7000 and 10000 ppm solutions at 5 DAS. In the 12500 and 15000 ppm solutions, ryegrass germination was first observed at 7 DAS. In all solutions except the 15000 ppm, germination of meadow fescue was first observed at 8 DAS, which is consistent with earlier reports comparing these species (Richardson et al., 2007). Minimal germination of meadow fescue was observed at the highest salt concentration (Fig. 1).

All of the ryegrasses obtained similar germination levels in each solution by 14 DAS and exceeded 80% germination in the lowest two salt concentrations (Fig. 1). There was a reduction in final germination of the ryegrasses observed at the 12500 and 15000 ppm, with maximum germination of approximately 60% and 45%, respectively (Fig. 1). Meadow fescue followed a similar trend, except the final germination of this species was reduced to approximately 75% in the 10000 ppm solution, 20% in the 12500 ppm solution, and less than 5% in the highest salt concentration.

The overall conclusion from this study is that tetraploid ryegrass has similar salt tolerance, relative to seed germination, as other commonly used ryegrass species. As these grasses are being applied to many overseeding situations, further research on its salt tolerance as a mature plant would be worthwhile. Germination of meadow fescue appears to be more sensitive to increasing salt levels compared to the ryegrasses and would not be currently recommended in areas where low-quality water is being used. However, it should be noted that the salt concentrations used in this study were quite high. The 10000 ppm solution would approximate a 1:1 mixture of freshwater and seawater and there was minimal germination inhibition observed in any species at that salinity level.

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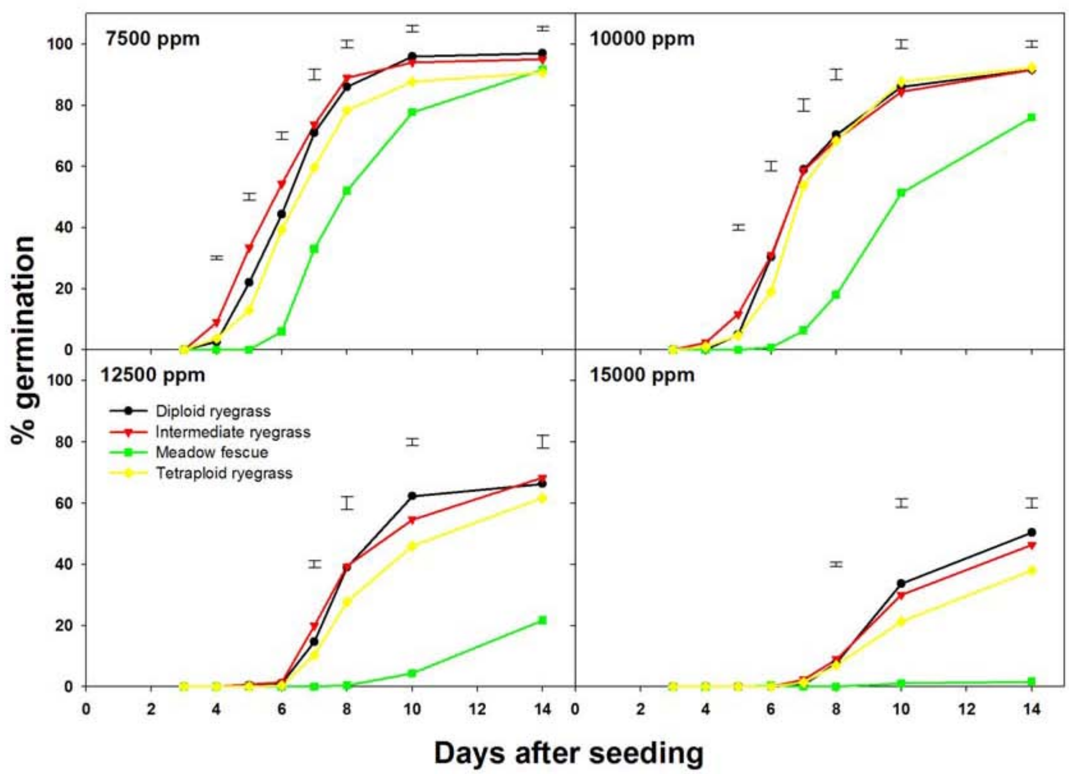

Fig. 1. Germination of four, cool-season turfgrass species in solutions with various NaCl concentrations. Error bars represent the least significant difference (P=0.05) for comparing species within a salinity level.

Report from the 2006 NTEP Tall Fescue Trial – First Year Data

Mike Richardson[1], John McCalla[1], Doug Karcher[1], and Aaron Patton[2]

Additional index words: *Festuca arundinacea*, turfgrass, cultivars, quality, color, brown patch

Richardson, M., J. McCalla D. Karcher and A. Patton. 2008. Report from the 2006 NTEP tall fescue trial – first year data. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:66-70.

Photo by Mike Richardson

Cool-season turfgrass trials at the University of Arkansas in Fayetteville

Summary. Tall fescue is a very popular grass for lawn areas in northern Arkansas and throughout the transition zone. Identifying adapted cultivars for the region remains a central focus of the University of Arkansas turfgrass research program. The National Turfgrass Evaluation Program is the predominant means by which cultivars are tested throughout North America. A tall fescue cultivar trial, containing 113 entries, of which 30 were commercially available cultivars, was planted in the fall of 2006 at Fayetteville, Arkansas. During establishment in the fall of 2006 and across the 2007 growing season, cultivars were rated for establishment vigor, overall turf quality, and incidence of brown patch and Pythium blight. The cultivars that consistently rated high for turfgrass quality included Bullseye, Z-2000, Plato, Aristotle, Van Gogh, Turbo, Biltmore, Tulsa III, Speedway, and RK-1, while the cultivars with the worst overall quality throughout 2007 were Silverado and Ky-31. There were significant differences among cultivars in brown patch severity during a disease outbreak in early August 2007.

Abbreviations: NTEP, National Turfgrass Evaluation Program

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Tall fescue (*Festuca arundinacea*) is one of the most popular cool-season turfgrasses in the transition zone regions of the United States and is widely used in lawns, sports fields and on utility turf in the region. Tall fescue is known for it superior drought tolerance, good shade tolerance, and ability to grow on poor soils relative to other cool-season grasses. Breeding efforts in the past three decades have made tremendous strides in improving the overall quality of this species.

The National Turfgrass Evaluation Program (NTEP) is an organization within the US Department of Agriculture that annually oversees turfgrass cultivar evaluation experiments at various sites throughout the U.S. and Canada. Each turfgrass species is tested on a four to five year cycle at sites throughout the growing region for that particular species. The University of Arkansas has been an active participant in the NTEP and has conducted several tests on tall fescue cultivars over the past 20 years. This report will describe the first year performance data, including establishment rate, turfgrass quality, and disease resistance, for the 2006 NTEP tall fescue trial at Fayetteville, Arkansas.

Materials and Methods

This cultivar experiment is being conducted at the University of Arkansas Research and Extension Center in Fayetteville. The plot size was 4 by 5 ft. and there were three replications of each cultivar. Prior to seeding, the entire trial area was fumigated with methyl bromide and a pre-plant fertilizer (10-20-20) was applied at 10.0 lb. / 1000 ft^2. One-hundred and thirteen tall fescue cultivars and experimental lines were broadcast planted on 2 Oct 2006 at a seeding rate of 6 lb. / 1000 ft^2. Plots were maintained under lawn conditions throughout the duration of the study. Mowing height was maintained at 1.5 inch throughout the season with clippings returned. Four nitrogen applications were made during the 1st season with 2.0 lb N / 1000 ft^2 applied in November 2006 and 1.0 lb N / 1000 ft^2 applied in April, June, and September, 2007. All N applications were made as urea (46-0-0). Irrigation was supplied as needed to promote establishment, maintain vigorous growth, and prevent drought stress.

Turfgrass establishment was measured using digital image analysis at 4 weeks after seeding. Overall turf quality was evaluated monthly from March through November in 2007, but is presented as the seasonal average in this paper. Quality was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green, uniform, fine-textured turf and 1 representing dead turf. An outbreak of Pythium blight (*Pythium ultimum*) occurred in early July and was visually evaluated as percent disease on 12 July 2007. After data collection of the Pythium damage, the entire trial was treated with Subdue Maxx (mefenoxam) at 43 oz / A. Brown patch (*Rhizoctonia solani*) was evaluated on 15 Aug 2007 and was visually rated as both disease incidence (% of plot infected) and as disease intensity (1 to 9 scale, with 1 = no damage to turf from disease and 9 representing completely dead turf in diseased areas). An overall rating of disease severity was calculated by multiplying disease incidence by disease intensity. For this report, the only data that will be presented and discussed are from those cultivars (30 total) that were commercially available at the time this paper was published. A full report of the data, including all experimental cultivars, will be available through the NTEP program at www.ntep.org.

Results and Discussion

All of the commercially available cultivars had good seedling vigor and adequate establishment at 4 weeks after seeding. The range in turfgrass cover at 4 weeks after seeding went from 50% (Rembrandt) up to 83% (Lindbergh) (Table 1). There were no cultivars that appeared to be exceptionally strong or weak with regards to establishment and all plots had 100% cover by the end of the fall season.

A significant outbreak of Pythium blight occurred in the plots in early June (Fig. 1), but was not completely uniform across the trial (Fig. 2). As a result, there was a significant amount of variability in the data among replicate plots within cultivars, making it difficult to statistically separate cultivars. Commercially available cultivars with the highest incidence of blight included Tulsa III and Hemi, while cultivars such as Silverado, Ky-31, Falcon IV, and Skyline exhibited the least amount of Pythium damage (Table 1).

Brown patch disease was active in the experimental area for several weeks in late summer and, on 28 August 2007, average rating values for disease incidence for cultivars ranged from 7% up 60.0% and disease intensity ranged from 1.3 to 4.7 (Table 1). Cultivars with the lowest brown patch severity ratings included Ky-31 and Rhambler. However, it should be cautioned that these are first-year trials and data on brown patch resistance will be more dependable as these plots mature and they are evaluated over several seasons.

Significant differences in turf quality were present among cultivars on every rating date in 2007 (data not shown), but were also significantly different when averaged over the entire season (Table 1). Some of the cultivars with the highest turf quality over the growing season included Bullseye, Z-2000, Plato, Aristotle, Van Gogh, Turbo, Biltmore, Tulsa III, Speedway, and RK-1. The cultivars with the worst overall quality throughout 2007 were Silverado and Ky-31.

These data represent an initial evaluation of tall fescue cultivars that will begin to appear in the market in the coming years. Data will continue to be collected on these varieties through the 2010 growing season. Yearly summaries of the data from this site and all sites around the United States will be published by NTEP and be available at their website (www.ntep.org).

Fig. 1. Mycelium of Pythium blight evident on plots in early morning (photo taken 7/11/2007)

Fig. 2. Damage from Pythium blight on the 2006 NTEP Tall fescue trial (photo taken 7/12/2007)

Table 1. Turfgrass establishment, pythium blight, brown patch and seasonal turfgrass quality at Fayetteville, Ark. for 30 commercially available tall fescue entries in the 2006 National Turfgrass Evaluation Program tall fescue test. Cultivars are arranged by average turf quality ratings across the season.

Entry	Establishment	Pythium blight (12 July 2007)	Brown patch (15 August 2007) disease incidence	disease intensity [z]	disease severity [y]	Turf quality [x]
	(% cover)	(% infected)	(% infected)	(1-9)	(incidence x intensity)	(1-9)
Bullseye	77.2	25.0	11.7	1.3	15.0	7.5
Z-2000	75.8	10.0	11.7	1.7	22.0	7.4
Plato	76.7	23.3	11.7	1.3	18.0	7.4
Aristotle	59.9	8.3	31.7	2.0	77.0	7.4
Van Gogh	73.2	11.7	21.7	2.0	48.0	7.4
Turbo	63.0	10.0	16.7	2.0	33.0	7.4
Biltmore	80.7	16.7	20.0	2.7	53.0	7.4
Tulsa III	70.5	35.0	36.7	3.3	140.0	7.4
Speedway	72.3	15.0	5.0	1.7	12.0	7.4
RK-1	68.0	8.3	21.7	3.0	67.0	7.4
Lindbergh	82.7	11.7	20.0	2.3	57.0	7.3
Einstein	77.7	5.0	36.7	2.7	100.0	7.3
Monet	63.7	13.3	30.0	2.0	63.0	7.3
Cezanne RZ	64.9	25.0	13.3	1.7	33.0	7.3
Skyline	78.1	3.3	38.3	3.3	120.0	7.3
Hunter	52.0	11.7	45.0	3.3	180.0	7.3
Padre	68.0	8.3	35.0	2.3	83.0	7.3
Magellan	73.3	13.3	18.3	1.7	33.0	7.3
Escalade	72.0	5.0	36.7	2.7	103.0	7.3
Rembrandt	50.0	16.7	15.0	1.3	25.0	7.3
Justice	75.8	13.3	6.7	2.3	20.0	7.3
Rebel IV	78.5	8.3	33.3	2.7	93.0	7.3
Millennium SRP	69.0	13.3	21.7	1.7	42.0	7.3
Rhambler	66.1	15.0	6.7	1.0	7.0	7.3
Firenza	73.3	18.3	20.0	2.0	47.0	7.3
Falcon IV	78.9	3.3	26.7	2.3	73.0	7.3
Hemi	73.8	26.7	15.0	1.7	27.0	7.2
Tahoe II	71.3	20.0	11.7	2.0	27.0	7.2
Silverado	80.1	3.3	60.0	3.3	205.0	7.0
Ky-31	71.3	3.3	6.7	1.0	7.0	6.8
LSD (0.05)	19.4	27.5	27.6	1.6	100.3	0.2

[Z] Disease intensity was rated on a 1-9 scale, with 1=no damage and 9=severe damage

[Y] Disease severity was calculated as disease incidence (%) x disease intensity (1-9)

[X] Turfgrass quality was rated on a scale of 1-9 with 9 = ideal quality

Impact of Common Annual Bluegrass Control Programs on Overseeded Meadow Fescue and Tetraploid Ryegrass

Ryan Rolfe[1], Mike Richardson[1], John McCalla[1], John Boyd[2], Aaron Patton[3], and Doug Karcher[1]

Additional index words: *Lolium perenne, Festuca pratensis, Poa annua,* fairway

Rolfe, R., M. Richardson, J. McCalla, J. Boyd, A. Patton and D. Karcher. 2008. Impact of common annual bluegrass control programs on overseeded meadow fescue and tetraploid ryegrass. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:71-75.

Photo by Mike Richardson

Overseeded grasses treated with herbicides during establishment

Summary. Because of its long dormancy period, bermudagrass is often overseeded with a cool-season grass species in the fall to provide a green surface during cool weather. Recently, two new grass species, meadow fescue and tetraploid perennial ryegrass, have shown promise for use in overseeding situations. The objective of this study was to determine how typical annual bluegrass management strategies used on overseeded perennial ryegrass will perform on these new species. Several annual bluegrass control programs commonly used on diploid perennial ryegrass were tested on tetraploid perennial ryegrass and meadow fescue. Meadow fescue was more sensitive to ethofumesate, foramsulfuron, and fenarimol, which were relatively safe on other species. Meadow fescue was also significantly injured by bispyribac-sodium, having an almost 50% reduction in cover compared to the untreated control.

Abbreviations: DBS, days before seeding; WAE, weeks after emergence

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Bermudagrass (*Cynodon* spp.) is a warm-season grass that grows best under high temperatures and mild winters. When average temperatures drop below 50°F, growth stops and the turf begins to discolor as it enters winter dormancy. In many regions where bermudagrass is used, this species can be partially or completely dormant for up to 6 months, which is undesirable for many sporting activities. To combat this problem, the practice of overseeding a cool-season turfgrass immediately prior to the start of the dormant period can produce a dense green playing surface for use when the bermudagrass is dormant. The overseeded turfgrass is treated like an annual plant and is managed during the cool periods of the growing season and then removed chemically or culturally when bermudagrass resumes active growth in late spring.

Recently, two new overseeding species, tetraploid perennial ryegrass (*Lolium perenne*, 2n = 4x = 28) and meadow fescue (*Festuca pratensis*), have shown promise as alternatives to traditional overseeding grasses (Richardson et al., 2007). These two new overseeding species show promise because of their desirable transition characteristics. However, very little is known about the management of these species compared to diploid perennial ryegrass (*L. perenne*, 2n=2x=14), which is the major turfgrass species for overseeding bermudagrass athletic turf. The objective of this study was to determine how annual bluegrass (*Poa annua*) control strategies that are commonly used for overseeded perennial ryegrass will affect the establishment and performance of these new species.

Materials and Methods

A field study was conducted during the 2006-2007 season at the University of Arkansas Research and Extension Center in Fayetteville, Arkansas. The study was conducted on two different soil types, including a native soil and a sand-capped rootzone. The sand-capped site had a 5-inch base of medium-coarse sand over a native Captina silt loam. Three overseeding species, including diploid perennial ryegrass (cv. Integra), tetraploid perennial ryegrass (cv. T3), and meadow fescue (Expt. AMF29) were compared to a non-overseeded control. Overseeding grasses were established in a mature Tifway bermudagrass turf on both soil types and were seeded at rates designed to produce equal seeding densities for each species (Table 1). The plots were maintained before and after overseeding under simulated fairway conditions, with a mowing height of 0.5 inch.

Eight herbicide treatments were applied at a rate and timing consistent with manufacturers' recommendations (Table 2). Herbicides and timings included prodiamine (Barricade) at 45 days before seeding (DBS), dithiopyr (Dimension) at 45 DBS, pronamide (Kerb) at 45 DBS, fenarimol (Rubigan) at two applications 14 days apart with last application at 14 DBS, two rates of foramsulfuron (Revolver) at 7 DBS, ethofumesate (Prograss) at 2 weeks after emergence (WAE), bispyribac-sodium (Velocity) at 8 WAE and a non-treated control. All herbicides were applied in a spray volume of 39.4 gallons / A at a spray pressure of 30 psi with a CO_2-propelled backpack sprayer.

Days to germination were assessed by visually checking plots daily and recording the germination date. Germination vigor was visually assessed weekly and recorded on a scale of 1 to 9 with 1 = poor germination vigor and 9 = excellent germination vigor. Visual herbicide phytotoxicity ratings were taken on all plots weekly and rated on a 1 to 9 scale with a 1 = no injury and a rating of 9 = dead turf. Turfgrass establishment rate was quantified weekly using digital image analysis (Richardson et al., 2001).

Results and Discussion

None of the herbicides tested in this study delayed germination of tetraploid ryegrass (Table 2). The two rates of foramsulfuron slightly delayed germination of diploid ryegrass and meadow fescue, but the short delay (< 1 day) from these herbicides did not reduce establishment (Fig. 1). Prodiamine also delayed germination in the meadow fescue by 1 day (Table 2) but did not reduce establishment (Fig. 1).

Turfgrass coverage was assessed weekly and was not affected in any species by fenarimol, dithiopyr, or pronamide (Fig. 1). Turfgrass coverage of tetraploid ryegrass was affected by two herbicides, foramsulfuron_high and bispyribac-sodium, and coverage of diploid ryegrass was slightly reduced by bispyribac-sodium at one observation date (Fig. 1). Several herbicides significantly reduced coverage of meadow fescue, including ethofumesate, foramsulfuron, prodiamine, and bispyribac-sodium (Fig. 1). The most damaging herbicide on all species was bispyribac-sodium, which reduced the coverage of meadow fescue nearly 50% compared to the untreated control.

In summary, many annual bluegrass control herbicides that have been commonly used on diploid perennial ryegrass behaved similarly on tetraploid perennial ryegrass and meadow fescue. However, meadow fescue was more sensitive to specific herbicides that are relatively safe on other species, including ethofumesate, foramsulfuron, and fenarimol. Meadow fescue, diploid perennial ryegrass, and tetraploid perennial ryegrass were significantly injured by bispyribac-sodium, with meadow fescue having an almost 50% reduction in cover compared to the untreated control. Therefore, bispyribac-sodium should not be used on newly overseeded turf for the control of annual bluegrass based on these findings.

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Table 1. Number of pure live seeds per pound and seeding rates for the three overseeding grass species.

Species	Seed counts	Seeding rate	Seeding density
	pure live seeds / lb	lb / 1000 ft^2	PLS / ft^2
Tetraploid ryegrass	135097	23.4	3158
Meadow fescue	242245	13	3158
Diploid ryegrass	254089	12.4	3158

Table 2. Effects of various annual bluegrass control programs on days until germination of three overseeding grasses.

Herbicide	Product Rate	Diploid ryegrass	Tetraploid ryegrass	Meadow fescue
	per acre	------------ germination (days after seeding) ------------		
prodiamine (Barricade)	12 oz	8.5	8.6	9.3
dithiopyr (Dimension)	8 fl oz	8.3	8.5	8.4
pronamide (Kerb)	2 lbs	8.5	8.5	8.5
ethofumesate (Prograss)	0.75 gal	8.4	8.6	8.3
fenarimol (Rubigan)	261 fl oz	8.4	8.5	8.3
foramsulfuron-low (Revolver)	13 fl oz	8.9	8.5	8.9
foramsulfuron-high (Revolver)	26 fl oz	9.0	8.6	8.6
byspiribac-sodium (Velocity)	2 oz	8.4	8.5	8.4
untreated control		8.4	8.5	8.5
LSD (0.05)		0.4	ns	0.4

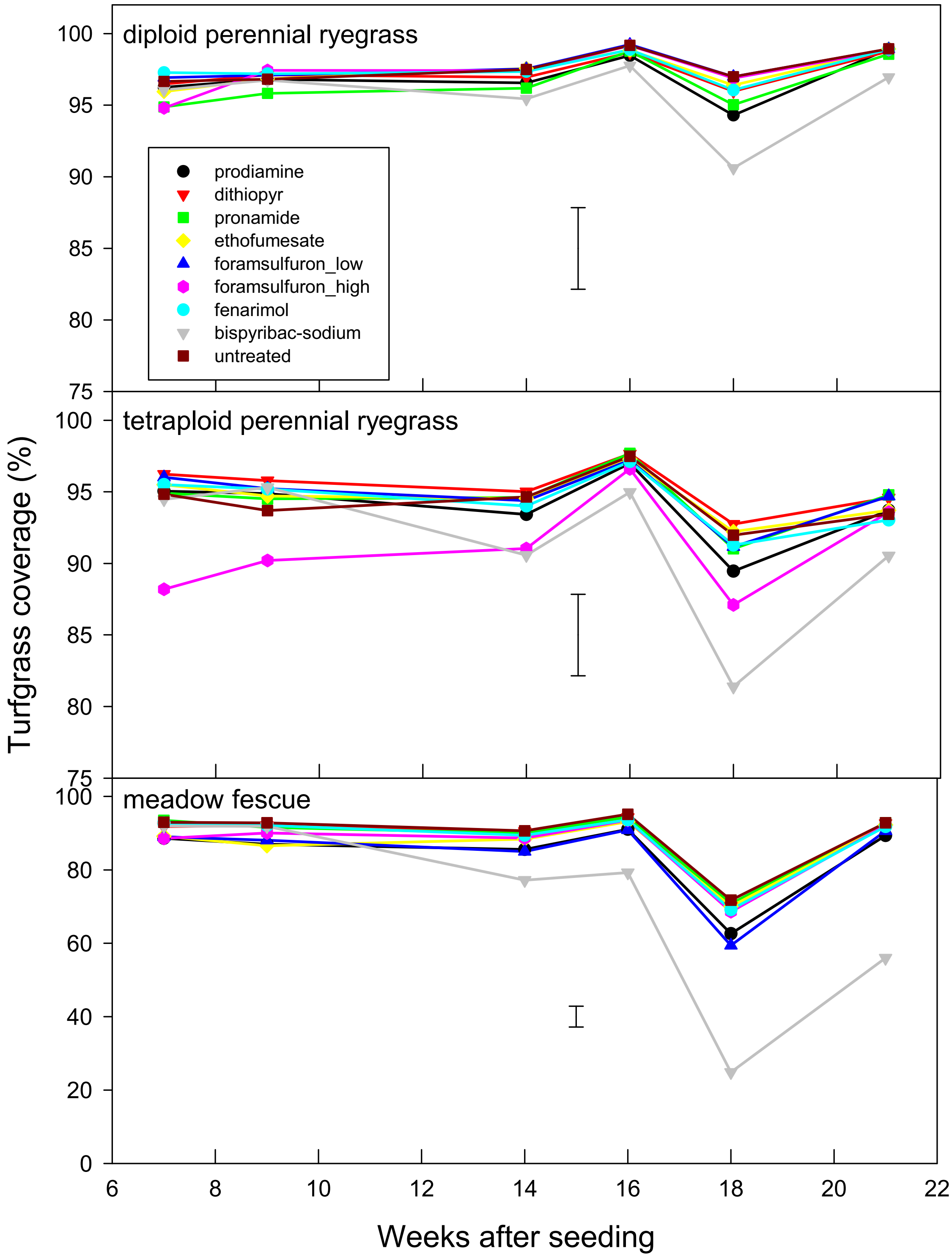

Fig. 1. Turfgrass coverage of three overseeding grass species, as affected by various *Poa annua* control programs. Error bars can be used to determined statistical differences (P=0.05) between treatments within a species and rating date.

Transition Herbicide Effects on Overseeded Meadow Fescue and Tetraploid Perennial Ryegrass

Ryan Rolfe[1], Mike Richardson[1], John McCalla[1], John Boyd[2], Aaron Patton[3], and Doug Karcher[1]

Additional index words: fairway, *Lolium*, *Festuca*, sulfonylurea

Rolfe, R., M. Richardson, J. McCalla, J. Boyd, A. Patton and D. Karcher. 2008. Transition herbicide effects on overseeded meadow fescue and tetraploid perennial ryegrass. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:76-79.

Photo by Mike Richardson

Overseeded grasses treated with herbicides to hasten transition

Summary. Bermudagrass is often overseeded with a cool-season grass species in the fall to provide a green surface during cool weather. Recently, two new turfgrass species, meadow fescue and tetraploid ryegrass, have shown promise for use in overseeding situations. The objective of this study was to determine the performance of herbicides commonly used to remove (transition) perennial ryegrass from an overseeded bermudagrass. Ten herbicides that are commonly used to eradicate diploid perennial ryegrass from overseeded bermudagrass were tested on tetraploid perennial ryegrass and meadow fescue at recommended label rates. Most of the herbicides commonly used to transition diploid perennial ryegrass produced similar results on tetraploid ryegrass, with flazasulfuron providing the best control. Meadow fescue was more easily removed with herbicides compared to ryegrass and is easily removed with lower herbicide application rates. These data will provide turfgrass managers with information regarding herbicide efficacy on new overseeding grasses.

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Bermudagrass (*Cynodon* spp.) is an extensively used turfgrass species in the southern region of the United States, although it can be partially or completely dormant for up to six months during winter. Bermudagrass loses its green pigment during winter resulting in a tan/straw color. To improve turfgrass color during winter, a cool-season grass is often overseeded into bermudagrass during winter dormancy to produce a dense, green playing surface. One problem with overseeding is the persistence of the cool-season grass in the spring. This is referred to as the transition period and is commonly aided by removing the overseeding species with herbicides. Recently, two new overseeding species, tetraploid perennial ryegrass (*Lolium perenne*, 2n = 4x = 28) and meadow fescue (*Festuca pratensis*), have shown promise as alternatives to traditional overseeding grasses (Richardson et al., 2007). The objective of this study was to determine how transition herbicide strategies that are commonly used for overseeded perennial ryegrass (*L. perenne*, 2n=2x=14) will affect these new species.

Materials and Methods

A field study was conducted during the 2006-2007 season at the University of Arkansas Research and Extension Center in Fayetteville, Arkansas. The study was conducted on two different soil types, including a native soil and a sand-capped rootzone. The sand-capped site had a 5-inch base of medium-coarse sand over a native Captina silt loam. Three overseeding species, including diploid perennial ryegrass (cv. Integra), tetraploid perennial ryegrass (cv. T3), and meadow fescue (Expt. AMF29) were compared to a non-overseeded control. Overseeding grasses were established in a mature Tifway bermudagrass turf on both soil types and were seeded at rates designed to produce equal seeding densities for each species (Table 1). The plots were maintained before and after overseeding under simulated fairway conditions, with a mowing height of 0.5 inch.

Ten herbicide treatments (Table 2) commonly used for transitioning overseeding grasses were applied at either 30 or 70% bermudagrass greenup, as determined by the non-overseeded control. These dates corresponded to 2 April 2007 and 12 May 2007. Each species x herbicide treatment was replicated four times, with overseeding species as whole plots and herbicide treatments as split-plots within each species plot. All herbicides were applied in a spray volume of 39 gallons / A at a spray pressure of 30 psi with a CO_2 sprayer using a single nozzle spray wand with a hollow cone nozzle and a spray shield to prevent drift between plots.

A line-intersect analysis (LIA) was conducted at 6 weeks after herbicide treatment to assess the percentage overseeded grass remaining in each plot. For LIA analysis, a 12 by 12-inch frame was constructed that contained a line grid with 1.0 by 1.0-inch openings. The grid was randomly tossed on each plot, the species of turf at each line intersect determined, and grid counts were converted to percentage overseeded grass.

Results and Discussion

Greater efficacy was observed on the sand site compared to the soil site for most herbicides tested in this trial when averaged over the 30% and 70% application timings (Table 3). Flazasulfuron provided the most complete control on both sites and with all species. When applied to meadow fescue, rimsulfuron, metsulfuron, and trifloxysulfuron performed similarly within the soil and sand sites (Table 3). Pronamide also provided excellent control of meadow fescue on the sand site (Table 3). Diploid and tetraploid perennial ryegrass behaved similarly to most treatments tested in the trial, whereas meadow fescue had the lowest percent overseeded grass after herbicides applications (Table 3). Several herbicides that have been very popular transition herbicides in recent years, especially foramsulfuron and rimsulfuron, provided poor control of all species in this trial, especially on the soil site.

In summary, herbicides that are commonly used to transition diploid perennial ryegrass can be used as a tool to transition two new overseeding species, meadow fescue and tetraploid perennial ryegrass. Meadow fescue is an overseeding species that was easier to control with lower rates of herbicides, which would be an economical and environmental advantage for this species. More work needs to be done to confirm whether or not these herbicides provide more consistent control of overseeded grasses on sand rootzones compared to soil-based rootzones.

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Richardson, M.D., K.W. Hignight, R.H. Walker, C.A. Rodgers, D. Rush, J.H. McCalla, and D.E. Karcher. 2007. Meadow fescue and tetraploid perennial ryegrass - two new species for overseeding dormant bermudagrass. Crop Sci. 47:83-90.

Table 1. Number of pure live seeds per pound and seeding rates for the three overseeding grass species.

Species	Seed counts	Seeding rate	Seeding Density
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Meadow fescue	242245	13	3158
Diploid ryegrass	254089	12.4	3158

Table 2. Transition herbicides tested in this study. All herbicides were applied in spring at both 30% and 70% bermudagrass greenup.

Herbicide	Product rate	Active ingredient	Active ingredient rate
	(per acre)		(oz / a)
Kerb	2.0 lb	pronamide	15.98
Manor	0.5 oz	metsulfuron	0.30
Revolver (Low)	8.8 fl oz	foramsulfuron	0.21
Revolver (High)	17.4 fl oz	foramsulfuron	0.41
Monument (Low)	0.11 oz	trifloxysulfuron	0.08
Monument (High)	0.33 oz	trifloxysulfuron	0.25
Katana (Low)	0.5 oz	flazasulfuron	0.13
Katana (High)	1.0 oz	flazasulfuron	0.25
Tranxit (Low)	1.0 oz	rimsulfuron	0.25
Tranxit (High)	2.0 oz	rimsulfuron	0.50
Control			

Table 3. Percent overseeding grass coverage at 6 weeks after treatment on both the soil and sand site.

Species	pronamide	metsulfuron	flazasulfuron		trifloxysulfuron		foramsulfuron		rimsulfuron		control	LSD (0.05)[z]
			high	Low	high	low	high	low	high	Low		
					% overseeding coverage							
					Soil							
Diploid	31.5	38.3	13.8	24.6	55.4	59.8	56.1	64.8	47.4	57.9	58.5	
Tetraploid	29.3	35.8	10.9	20.3	41.3	53.5	50.0	49.6	47.9	52.0	54.3	11.8
Meadow	23.0	1.9	0.4	5.6	10.3	49.3	39.4	66.4	11.8	41.5	56.5	
					Sand							
Diploid	1.9	14.9	3.3	12.6	9.3	26.0	27.3	33.0	17.6	27.0	57.8	
Tetraploid	2.9	10.9	3.0	7.5	8.0	36.4	20.9	32.1	6.8	22.1	65.0	11.8
Meadow	4.5	1.5	1.1	2.3	6.6	5.6	21.3	15.8	1.4	3.3	57.5	
					LSD (0.05)[y] = 12.7							

[z] Least significant difference (LSD) values (P=0.05) for comparing herbicide means within a species

[y] Least significant difference (LSD) values (P=0.05) for comparing species means within a herbicide

Indirect Measurement of Ammonia Volatilization Following Foliar Applications of Urea on a Cool- and Warm-season Putting Green Turfgrass Species

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Additional index words: creeping bentgrass, ultradwarf bermudagrass, nitrogen

Stiegler, C., M. Richardson, J. McCalla, J. Landreth and T. Roberts. 2008. Indirect measurement of ammonia volatilization following foliar applications of urea on a cool- and warm-season putting green turfgrass species. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:80-84.

Photo by Mike Richardson

Volatilization studies conducted on creeping bentgrass

Summary. Foliar nitrogen (N) fertilization continues to gain popularity with golf course superintendents, especially in regard to putting green nutrition. However, little is currently known about the efficiency of this practice in the field or the significance of the possible N loss mechanisms associated with foliar applications. This project was conducted to document the extent of ammonia volatilization from turfgrasses managed as putting greens, following the applications of foliar N using urea (46-0-0), over a 24 h period. Two different foliar fertilizer rates (0.10 and 0.25 lb N / 1000ft^2) were applied once monthly (May through September) to 'Penn A-1' creeping bentgrass and 'Tifeagle' ultradwarf bermudagrass established putting greens. Ammonia volatilization over a 24 h period was measured via boric acid trapping. Month of year and N rate both had a significant effect on the amount of N volatilized from the turfgrass canopy. At each sampling date and on both species, measurement of ammonia volatilization was consistently small with a maximum observed loss of 7%.

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Foliar fertilization is a common practice on today's intensively managed golf courses. A recent survey of golf course superintendents in Arkansas indicated that all respondents are using foliar fertilization on their putting greens and many superintendents apply over half of the nutrients to greens in this fashion (data not shown).

Urea and/or urea-ammonium nitrate (UAN) are common sources of nitrogen (N) included in foliar fertilizer products and when applied to the plant surface, there is risk of considerable N loss to the atmosphere as ammonia (NH_3) with these N sources. The presence of the urease enzyme both on the surface, and within most plants (Witte et al., 2002), underlies ammonia volatilization N-loss potential. Urease catalyzes the hydrolysis of urea into NH_3 and carbon dioxide. Under most conditions, the NH3 then undergoes protonation ($NH_3 + H^+ \longleftrightarrow NH_4^+$). While this is a highly important process for plants to assimilate urea-N into a plant available form of ammonium (NH_4+), NH_3 gas may also escape from the system (volatilize) during the process. Factors known to favor NH_3 volatilization include increased soil pH, increased surface temperature, moisture or relative humidity, and wind speed (Joo, 1987; Knight et al., 2007).

Atmospheric losses of N as NH_3 gas, following the application of N fertilizers, have been well studied in agricultural research, while this same N loss pathway from turfgrass stands has received considerably less research attention. Though several investigations into NH_3 volatilization from turfgrass stands have been reported (Turner and Hummel, 1992), no such studies are known to be specific to N loss from the putting green turfgrass canopy following foliar-applied urea-N. Characteristics of foliar fertilization, such as soluble urea treatments made directly over the top of the plant canopy with low carrier rates, should negate the possibility of denitrification and/or leaching losses, as these are strictly soil phenomena. Therefore, ammonia volatilization should be the most important N-loss mechanism associated with typical N foliar fertilizer practices (McCarty, 2005). However, no studies to date have attempted to measure volatilization of NH_3 from golf course putting greens following foliar N applications. The objective of this study was to document the extent of N loss from seasonal foliar applications of urea to a putting green turfgrass canopy.

Materials and Methods

This field research study was conducted at the University of Arkansas Research and Extension Center in Fayetteville, Arkansas. Experimental areas of creeping bentgrass (*Agrostis stolonifera* cv. Penn A1) and ultradwarf bermudagrass (*Cynodon dactylon* x *C. transvaalensis* cv. Tifeagle) were established on a sand-based putting green (USGA, 1993) and were maintained according to typical putting green management practices for the region. Within the experimental areas, four replicated plots were designated for each sampling date and each turfgrass species.

Applications of foliar N were made once-monthly using urea (46-0-0), May 2007 through September 2007, to 2 by 4 ft plots with 6 inch borders. Foliar N was applied in 58 gallons / A with the aid of a spray shield and a single nozzle CO_2-pressurized sprayer. A Teejet® (TX-VS2) hollow cone spray nozzle was selected in order to produce a fine atomized spray pattern for even, thorough plot coverage facilitating foliar uptake. Rates of 0.10 and 0.25 lb N / 1000 ft^2 were used and designated as a low and high rate, respectively. These correspond with foliar N application rates commonly used by golf course superintendents. For a 24-hr period after treatment, plots received no irrigation or rainfall in order to limit all N absorption to the foliar uptake pathway.

Estimates of ammonia volatilization were obtained through the use of an acid collection trap (4% H_3BO_3 solution with pH color indicator) housed in a small Petri dish, suspended within a bottomless 1-pint Mason jar (Fig. 1). Immediately after foliar-N treatments were applied, these apparatuses were directly inserted into the putting green turf, completely enclosing a portion of the plot previously treated with urea fertilizer solution. These air-tight traps were modified in form and function, but were designed after original specification details outlined by Mulvaney, et al. (1997). The chambers were deployed for a period of 24 h after N application, then acid traps were collected, stabilized in-field, and transported to the laboratory for analysis. Acidimetric titration with 0.01 M H_2SO_4 back to the original end point pH of the boric acid solution allowed for an indirect measurement of N loss via NH_3 volatilization.

Results and Discussion

Percentages of N applied and lost via NH_3 volatilization from Tifeagle bermudagrass putting green surface ranged from a maximum of 7.1% (May-high N rate) to a minimum value of 0.55% (June and July-low N rate) (Fig. 2). On three of the five monthly sampling dates, the higher N application rate created volatile N losses that were significantly higher than those achieved with the lower N rate (Fig. 2). This is not unexpected based on principles of enzyme kinetics. Increased urea (substrate) concentration on turfgrass leaves should result in increased urease enzyme activity, and a subsequently higher amount of NH_3/NH_4 (product) conversion coupled with an increased likelihood for volatile loss as NH_3.

When foliar urea-N was applied to Penn A1 creeping bentgrass, NH_3 volatilization losses ranged from a maximum of 1.4% (September-low N rate) to a minimum value of 0.2% with both N rates at several monthly sampling dates. On the last two experimental dates (August and September), the low foliar N-rate plots had significantly more N loss via NH_3 volatilization than was observed in plots receiving a higher N rate (Fig. 2). This is dissimilar to what was seen on Tifeagle bermudagrass and is not easily explained based on the previously applied enzyme kinetic approach. It could simply be an aberration that arose due to the extremely low percentage of applied N generally lost from Penn A-1 creeping bentgrass via NH_3 volatilization (Fig. 2). While, statistically, there was enough difference between the low and high rate during August and September to indicate significance, the numerical differences of 0.3% and 0.6% for these months, respectively, is not likely to have an agronomic significance.

These preliminary data suggest that NH_3 volatilization from foliar urea-N application may not be a significant N loss mechanism. Due to the design and use of our measurement devices (Fig. 1), much higher than normal ambient air/plant surface temperatures and a 100% relative humidity environment were inevitable within our NH_3 volatilization chambers. This should have created a worst-case scenario in regard to volatile losses of N. Despite this fact, the largest loss observed in 2007 monthly applications was 7% of applied N volatilized from Tifeagle bermudagrass at the high rate on the May application date. It should be noted that a hard freeze in early April 2007 served as a physiological set back for the Tifeagle putting green species and therefore, at the time of our May applications, this particular experimental area had yet to achieve full green-up. This altered state of turfgrass growth and activity could have rendered the Tifeagle bermudagrass canopy less receptive to foliar uptake and resulted in greater than normal NH_3 volatilization. Indeed, subsequent observations on Tifeagle were lower than this first month.

Comparing our results to previously reported NH_3 volatilization losses in turfgrass scientific literature, in general, we observed much lower numbers with our methodology and experimental parameters. The substantially lower N rates used in this study, which are inherent to foliar fertilizer applications, could be the reason for this discrepancy. Another possible explanation for this could be that the high-density plant community created by the low mowing heights of putting green turfgrass culture makes for an ultra-receptive environment for foliar absorption of urea. This is a premise that we are currently investigating with a co-related foliar nutrient uptake study using 15N labeled urea on the same experimental areas. The ability of plant leaves to absorb the urea molecule shortly after foliar fertilization application (Wittwer et al., 1963) also has the capacity to limit NH_3 volatilization, since urea hydrolysis could take place inside the plant, rather than on the leaf surface.

No conclusive statements regarding volatile NH_3-N losses and foliar urea-N applications to putting green turf can be made until summer 2008 data collection is complete. However, 2007 data suggest that this supplemental nutritional strategy can be employed throughout the growing season by golf course superintendents without concern for substantial N loss via this pathway.

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Fig. 1. Apparatus used for in-field ammonia volatilization estimates.

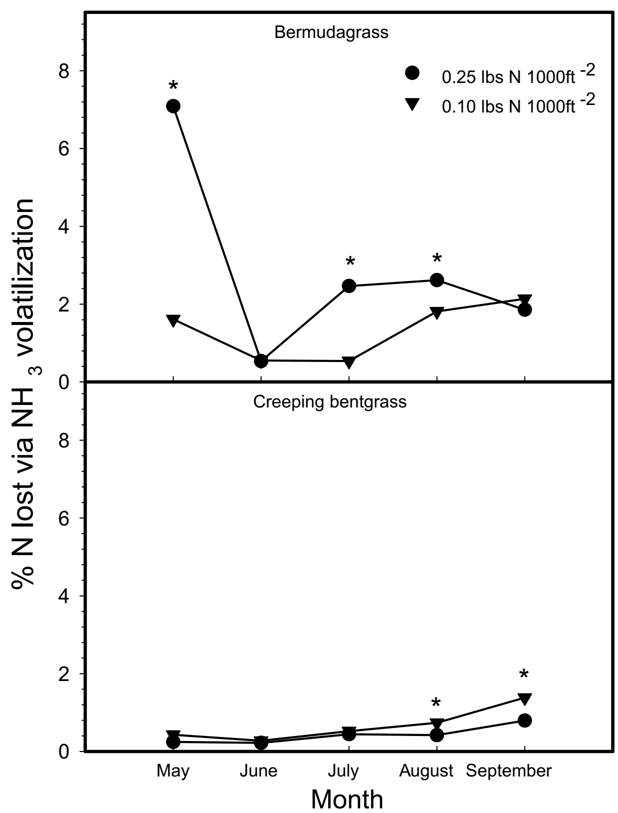

Fig. 2. Ammonia volatilization as affected by foliar urea application rate and sampling month. (* denotes significance at the 0.05 probability level)

Cultural Practices to Improve the Performance of Overseeded Meadow Fescue and Tetraploid Ryegrass

Josh Summerford[1], Doug Karcher[1], Mike Richardson[1], Aaron Patton[2], and John Boyd[3]

Additional index words: athletic fields, Cady Traffic Simulator, overseeding, spring transition, transition zone

Summerford, J., D. Karcher, M. Richardson, A. Patton and J. Boyd. 2008. Cultural practices to improve the performance of overseeded meadow fescue and tetraploid ryegrass. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:85-90.

Photo by Josh Summerford

Overseeding trials at the University of Arkansas in Fayetteville

Summary. Overseeding is a common practice used by turf managers in the transition zone to provide actively growing, green turf surfaces during the winter dormancy of warm-season grasses such as bermudagrass. The most commonly used turf species for overseeding is perennial ryegrass due to its excellent turf characteristics and rapid establishment. Continued improvements in heat and disease tolerance of perennial ryegrasses have resulted in cultivars that persist into the summer and interfere with the spring green-up of bermudagrass. Two new turf species, meadow fescue and tetraploid perennial ryegrass, have demonstrated good turf characteristics when overseeded as well as easier spring transition to bermudagrass. Little is known about the mowing and nitrogen (N) fertilization practices that will optimize turf quality for these species. The objective of this study was to determine the effects of mowing height and N fertility rate on turf quality and coverage of these overseeding species. A range of mowing heights and N fertility treatments was applied to plots of diploid perennial ryegrass, tetraploid perennial ryegrass, and meadow fescue. In addition, simulated traffic was applied across each combination of species, mowing height, and N rate. Increased N fertility and mowing height improved the overall quality and traffic tolerance of both tetraploid perennial ryegrass and meadow fescue in this study.

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The demand for year-round, high quality sports turf surfaces has resulted in the practice of overseeding becoming more common at all levels of turf management. The most common turf species used in overseeding is perennial ryegrass (*Lolium perenne*). In the transition zone overseeding is commonly done in the fall when bermudagrass (*Cynodon dactylon*, *C. dactylon* x *C. transvaalensis*) enters dormancy, and ideally the overseeded species will naturally die out in the spring when temperatures increase and bermudagrass breaks dormancy. In such cases, perennial ryegrass acts as an annual species; however, improvements in the heat and disease tolerance of perennial ryegrass cultivars have increased the tendency of this species to behave as a perennial and persist late into the summer and interfere with bermudagrass spring green-up (Horgan and Yelverton, 2001).

Currently, there are two solutions for the problem of overseeded perennial ryegrass persisting into the summer. An overseeding species with less heat tolerance, such as annual ryegrass (*L. multiflorum*) or intermediate ryegrass (*L. perenne* x *L. multiflorum*), could be used but they both have inferior turf quality compared to perennial ryegrass (Richardson, 2004). Alternatively, a spring application of herbicide to remove perennial ryegrass from the bermudagrass is a more expensive solution for species transition.

Recent breeding efforts have resulted in two species new to the turf industry that have turf quality characteristics similar to perennial ryegrass, but with a much earlier spring transition (Richardson et al., 2007). Both tetraploid perennial ryegrass (*Lolium perenne*, 2n=4x=28) and meadow fescue (*Festuca pratensis*) have shown promise for use as overseeding species due to good turf quality and early spring transition (Richardson et al., 2007). Little is known about the cultural practices necessary to maximize turf quality for these two species. Best management practices must be developed as a reference for turf managers considering the use of these species as overseeding turfgrasses. The objective of this research was to determine the effects of mowing height and nitrogen (N) fertility rate on the quality and coverage of overseeded meadow fescue and tetraploid perennial ryegrass under trafficked and non-trafficked conditions.

Materials and Methods

This study was conducted at the University of Arkansas Research and Extension Center, Fayetteville, Ark., and replicated on two sites: a native Captina silt loam soil, and a silt loam with a 5-inch sand-cap. On 20 September 2006, perennial ryegrass (cv. Integra), tetraploid perennial ryegrass (cv. T3), and meadow fescue (Expt. AMF29) were each seeded into 9 x 24 ft. plots at a rate of 3150 pure live seeds per ft^2 (12.4, 23.4, and 13 lbs. PLS / $1000ft^2$ for diploid ryegrass, tetraploid ryegrass, and meadow fescue, respectively). Three common athletic field mowing heights were applied to each species in this study, including a low (0.25 inch), medium (0.5 inch), and high (0.75 inch) height. In addition, three N fertility rates were also applied, including a low, medium, and high rate of 0.5, 1.0, and 1.5 lbs N / $1000ft^2$ / month, respectively. Each combination of species, mowing height, and N rate was replicated in four plots. Visual turf quality and coverage ratings were taken bi-weekly beginning two weeks after planting. Traffic was applied weekly to half of each plot at a rate of three passes per week, beginning 21 March 2007, using a Cady Traffic Simulator to simulate the forces of a football game on the turf surface (Henderson et al., 2005). Traffic tolerance was assessed using digital image analysis of the amount of green turfgrass present in the plots one week after each traffic application (Richardson et al., 2001). The main objective of the fall evaluations was to look at how the management variables affected visual turf quality, on a scale of 1-9 (1= completely dead turfgrass, 9= optimum turf quality, 6= minimum acceptable turf quality), during establishment. Following the establishment of the overseeded species in the fall and winter, the main objective of the spring evaluations was to determine how each of the variables in this study affected traffic tolerance, as measured by green turf coverage.

Results and Discussion

Turf quality. Tetraploid ryegrass was the earliest of these species to germinate and produced the highest quality at the first evaluation date in early November (Fig. 1). However, by six weeks after planting, all three species produced similar turf quality. As the temperature decreased in December and January, meadow fescue proved to be the least cold-tolerant species with quality ratings falling significantly lower than the other two species (Fig. 1).

In general, as mowing heights increased, turf quality increased, especially for tetraploid perennial ryegrass and meadow fescue (Fig. 2). Meadow fescue produced the lowest turf quality at all mowing heights, and tetraploid perennial ryegrass produced similar quality to diploid perennial ryegrass at the medium and high mowing heights, while producing slightly lower quality at the low mowing height compared to diploid perennial ryegrass (Fig. 2). When using either tetraploid perennial ryegrass or meadow fescue as an overseeding species, mowing heights should be maintained at or above 0.5 inch to optimize turf quality.

Turf cover. There was a significant 4-way interaction of species, N rate, mowing height, and evaluation date on turfgrass coverage (Fig. 3). All three species produced green turf cover near 100% throughout the study at the high mowing height, regardless of N fertility rates. At the medium mowing height, diploid and tetraploid perennial ryegrasses produced turf quality near 100%; however, meadow fescue showed a significant decrease in turf cover during April when temperatures fell below 20°F for several days (Fig. 3). At the low mowing height, N fertility played a more important role in increasing turf cover. Meadow fescue produced the least turf cover throughout most of the study, but coverage was significantly increased at both the medium and high N rates compared to the low rate. Coverage of tetraploid perennial ryegrass decreased during the cold period in April, though higher N rates increased turf cover throughout this period. Diploid perennial ryegrass demonstrated the greatest tolerance to the low mowing height at all N rates.

There was also a significant 4-way interaction of species, mowing height, traffic, and evaluation date on turfgrass coverage (Fig. 4). Mowing height significantly affected traffic tolerance, especially for meadow fescue and tetraploid perennial ryegrass. At the low mowing height all species showed significant reductions in turf coverage on trafficked plots. In early April, the most significant decrease of turf coverage, as affected by traffic, was 8% less coverage for diploid perennial ryegrass, 17% less coverage for tetraploid perennial ryegrass, and 50% less coverage for meadow fescue on trafficked plots. At the medium and high mowing heights, fewer differences were noted in turf coverage for both the diploid and tetraploid perennial ryegrasses; however, meadow fescue turf coverage was significantly reduced at all mowing heights on trafficked plots (Fig. 4).

Tetraploid perennial ryegrass performed similarly to diploid perennial ryegrass throughout most of the study, with the exception of treatments under the low mowing height. Therefore, the use of tetraploid ryegrass as a substitution for perennial ryegrass might be a possibility; however, under decreased mowing heights, increased N fertility may be needed to obtain similar turf coverage. Meadow fescue is the least tolerant of the three species to traffic and should not be used in overseeding situations where excessive traffic is expected. However, meadow fescue could be a good alternative overseeding species in higher-cut areas with little traffic, such as lawns, in the southern US transition zone.

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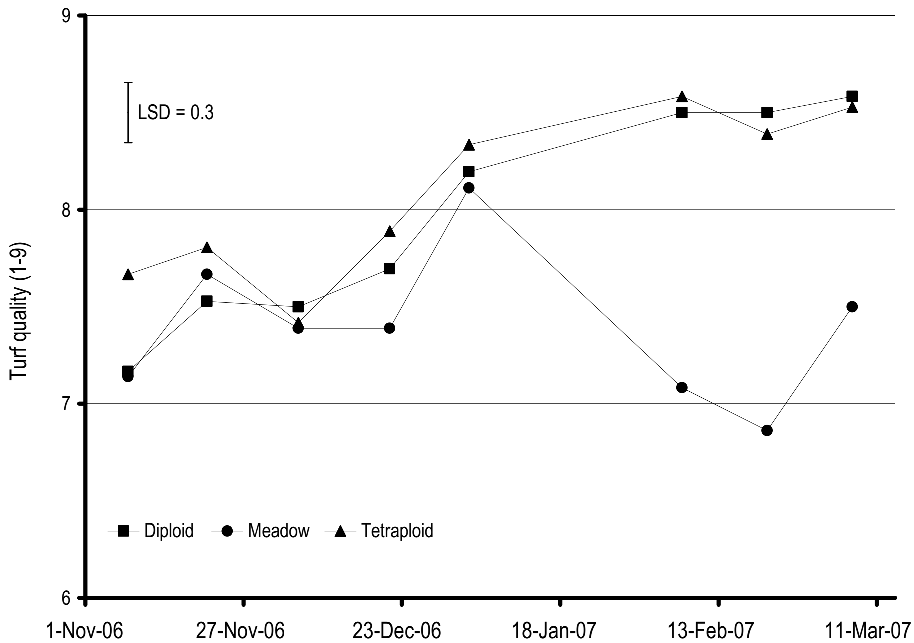

Fig. 1. Turf quality of overseeding species as affected by evaluation date. Error bar represents Fisher's least significant difference value, within dates (α = 0.05).

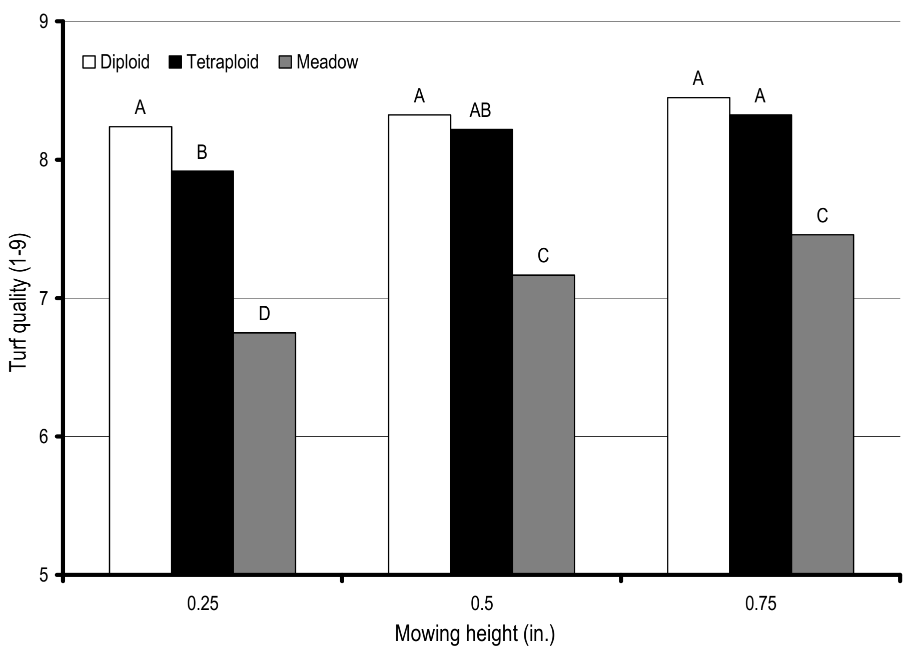

Fig. 2. Turfgrass quality of species as affected by mowing height. Bars not sharing a letter are significantly different according to Fisher's least significant difference test (α = 0.05).

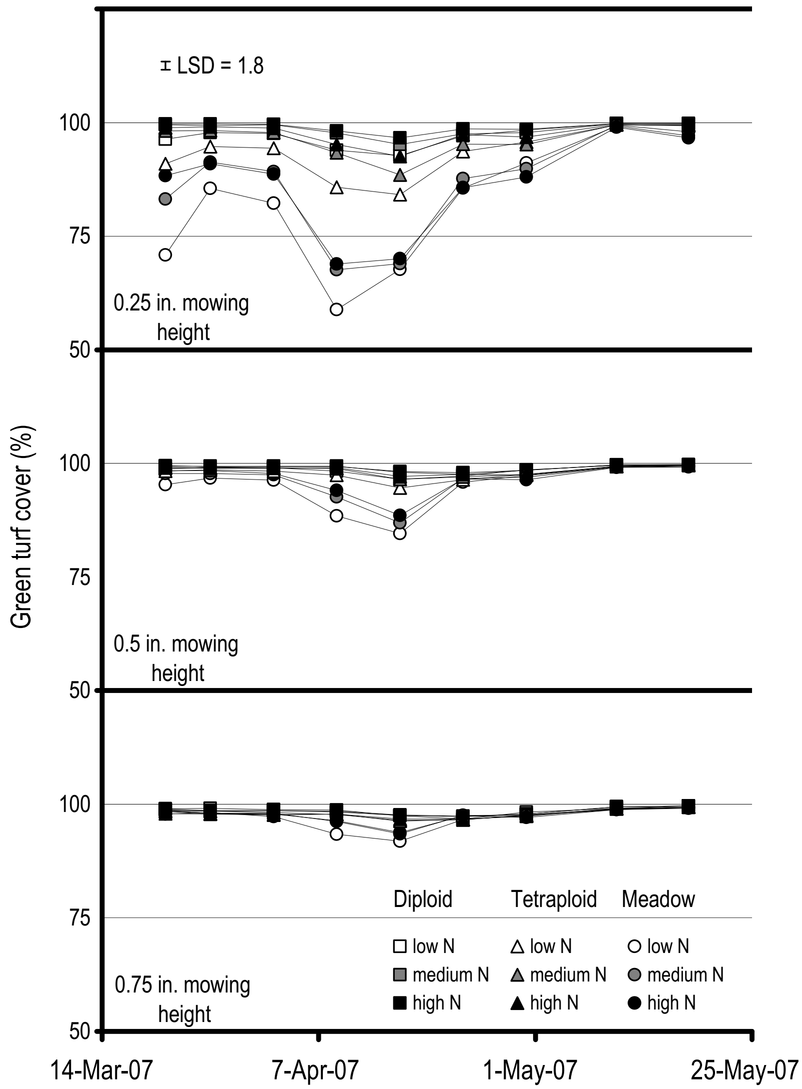

Fig. 3. Turf cover of overseeded species as affected by N rate and mowing height. Error bar represents Fisher's least significant difference value, within dates (α = 0.05).

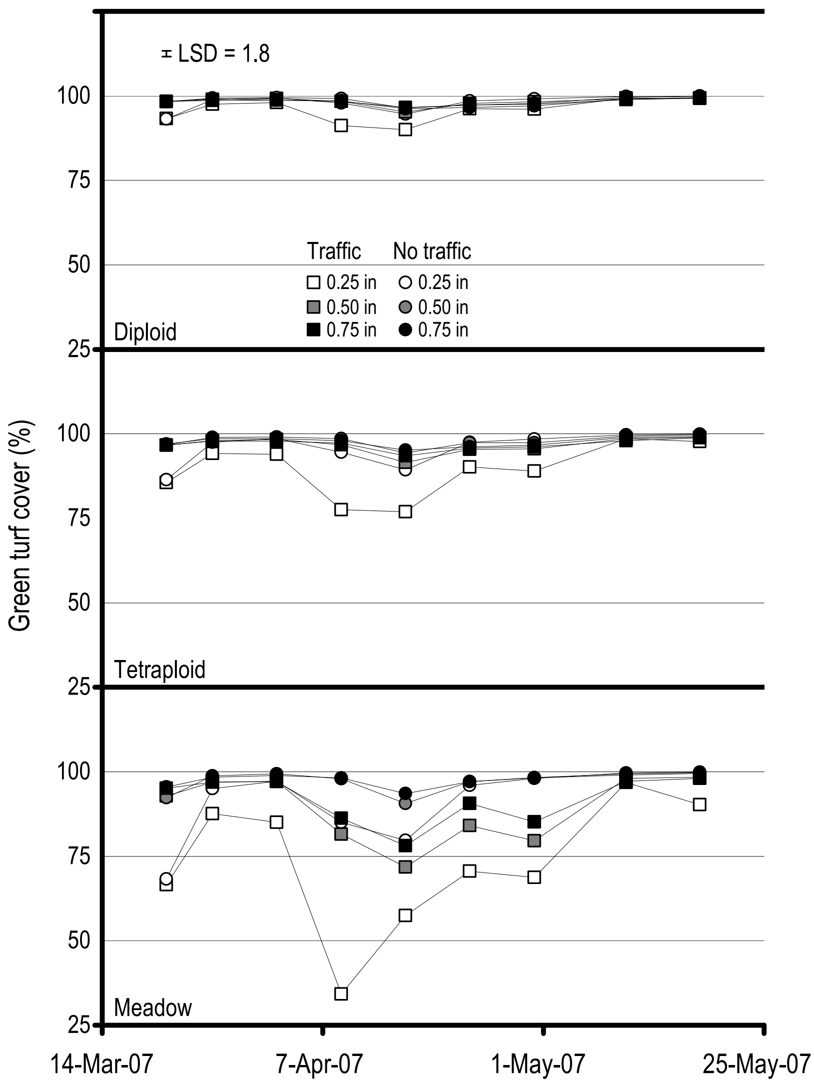

Fig. 4. Turf cover of overseeded species as affected by traffic and mowing height. Error bar represents Fisher's least significant difference value, within dates ($\alpha = 0.05$).

Seeding Rate Effects on the Quality and Traffic Tolerance of Overseeded Meadow Fescue and Tetraploid Perennial Ryegrass

Josh Summerford[1], Doug Karcher[1], Mike Richardson[1], Aaron Patton[2], and John Boyd[3]

Additional index words: athletic fields, Cady Traffic Simulator, overseeding, spring transition, transition zone

Summerford, J., D. Karcher, M. Richardson, A. Patton and J. Boyd. 2008. Seeding rate effects on the quality and traffic tolerance of overseeded meadow fescue and tetraploid perennial ryegrass. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:91-95.

Photo by Josh Summerford

Overseeding trials at the University of Arkansas in Fayetteville

Summary. Overseeding is a common practice used by turf managers in the transition zone to provide actively growing, green turf surfaces during winter dormancy of warm-season grasses such as hybrid bermudagrasses. The most commonly used turf species for overseeding is perennial ryegrass due to its excellent turf characteristics and rapid establishment. Continued improvements in perennial ryegrasses have resulted in cultivars that persist into the summer and interfere with the spring green-up of bermudagrass. Two new turf species, meadow fescue and tetraploid perennial ryegrass, have demonstrated good turf characteristics in overseeding, as well as easier spring transition. Seeding rates for overseeding are commonly higher than the rates used for permanent turf; however, rates vary depending on the overseeding species because of growth habit and seed size. The objective of this study was to determine the optimum seeding rates for meadow fescue and tetraploid perennial ryegrass that optimize turf quality and traffic tolerance. Three seeding rates, comparable to recommended overseeding rates, were examined in this study. Moderate and high seeding rates provided similar turf quality and green turf coverage for each species. Low seeding rates produced the lowest turf quality and green turf coverage for each species. Meadow fescue was the least traffic tolerant of the three species producing the lowest green turf coverage. The medium and high seeding rates produced the most traffic tolerant turf, with the low seeding rate provided the lowest green turf coverage.

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The demand for year-round high quality sports turf surfaces has resulted in the practice of overseeding becoming more common at all levels of turf management. The most common turf species used in overseeding is perennial ryegrass (*Lolium perenne*). In the transition zone, overseeding is commonly done in the fall when bermudagrass (*Cynodon dactylon*, *C. dactylon* x *C. transvaalensis*) enters dormancy, and ideally the overseeded species will naturally die out in the spring when temperatures increase and bermudagrass breaks dormancy. In such cases, perennial ryegrass acts as an annual species; however, improvements in the heat tolerance of perennial ryegrass cultivars have increased the tendency of this species to behave as a perennial and persist late into the summer interfering with bermudagrass spring green-up (Horgan and Yelverton, 2001).

Currently, there are two solutions for the problem of overseeded perennial ryegrass persisting into the summer. An overseeding species with less heat tolerance, such as annual ryegrass (*Lolium multiflorum*), can be used but annual ryegrass produces inferior turf quality compared to perennial ryegrass. Alternatively, a spring application of herbicide to remove perennial ryegrass from the bermudagrass is a more expensive solution for species transition.

Recent breeding efforts have resulted in two species that have demonstrated turf quality characteristics similar to those of perennial ryegrass, but with a much earlier spring transition, potentially without the need for expensive chemicals (Richardson et al., 2007). Both tetraploid perennial ryegrass (*Lolium perenne*, 2n=4x=28) and meadow fescue (*Festuca pratensis*) have shown promise for use as overseeding species due to good turf quality and early spring transition (Richardson et al., 2007). Seeding rate is an important part of a successful overseeding, and seeding rates vary depending on which species is used. The objective of this research was to determine the effect of seeding rate on establishment and turf quality of these new species in the fall and on traffic tolerance the following spring.

Materials and Methods

This study was conducted at the University of Arkansas Research and Extension Center, Fayetteville, Ark., and replicated on two sites: a native Captina silt loam soil, and a silt loam with a 5-inch sand-capped layer. Diploid perennial ryegrass (cv. Integra), tetraploid perennial ryegrass (cv. T3), and meadow fescue (Expt. AMF29) were each seeded at three different seeding rates at both sites. The seeding rates were adapted to apply the same number of seeds per area for each of the three species, and were set at low, moderate, and high rates of 2400, 3150, and 3900 pure live seeds / ft^2 (9.5, 12.4, and 15.4 lbs. / 1000 ft^2 diploid ryegrass, 17.9, 23.4, and 28.9 lbs. / 1000 ft^2 tetraploid ryegrass, and 10.0, 13.0, and 16.1 lbs. / 1000 ft^2 meadow fescue). All plots were seeded on 20 September 2006. Turf quality and coverage ratings were taken bi-weekly beginning two weeks after planting. Traffic was applied weekly to half of each species x seeding rate plot at a rate of three passes per week, beginning 21 March 2007, using a Cady Traffic Simulator, which simulates the forces of a football game on the turf surface (Henderson et al., 2005). Traffic tolerance was assessed by evaluating green turf cover using digital image analysis, one week after each traffic application (Richardson et al., 2001).

Results and Discussion

Turf quality. Turf quality was significantly affected by overseeding species and seeding rate at the soil site (Fig. 1). The low seeding rate produced lower turf quality than the moderate and high seeding rates during the first six ratings of the study, with the exception of the third rating. In January, the low and moderate seeding rates had lower quality compared to the high rate; however, by mid-February all seeding rates produced similar turf quality.

Species had a greater effect on turf quality throughout the fall and winter evaluations than seeding rate. Tetraploid ryegrass was the earliest to germinate and produced the highest turf quality at two weeks after planting at the soil site (Fig. 1). By six weeks after planting, all three species produced similar turf quality. Throughout the remainder of the study meadow fescue produced lower turf quality than both tetraploid perennial ryegrass and diploid perennial ryegrass, which were similar. The decline in quality of meadow fescue was due to a loss of green color during extended cold periods, demonstrating a lack of cold tolerance compared to the perennial ryegrass. Species and seeding rate affected quality similarly at the sand site (data not shown).

Turf cover. On the soil site, seeding rate did not affect turf coverage on the untrafficked plots, with the exception of the first evaluation date (Fig. 2), where differences were present although the differences in coverage were small (< 5%). The trafficked plots decreased in turf coverage at the low seeding rate from mid-April through early May (Fig. 2). On average, trafficked turf at the low seeding rate had 10% lower turf coverage from mid-April through early May than the medium and high seeding rates, which were similar. Seeding rate did not affect turf coverage under trafficked conditions at the sand site (data not shown) likely because sand is more resistant to compaction.

The turf coverage in trafficked plots was affected more by overseeding species than seeding rate, with meadow fescue showing the least tolerance to traffic at the soil site (Fig. 3). Diploid perennial ryegrass produced the highest turf coverage throughout the study when the turf was trafficked. Tetraploid perennial ryegrass provided the next highest turf cover, and was similar to diploid ryegrass throughout most of the study, except for one evaluation date in mid-April. Meadow fescue was the least tolerant species to traffic providing less than 80% turf coverage for five of the evaluation dates and even dropping below 50% turf coverage at the 16 April evaluation date. The untrafficked plots had near 100% turf coverage throughout the spring evaluations, with the exception of mid-April when temperatures dropped below 20°F and leaf senescence reduced green turf coverage. On that date, meadow fescue had significantly less coverage than the ryegrasses. Turf coverage was similar at the sand site (data not shown).

Moderate and high seeding rates produced higher turf quality and cover for all three species throughout the study compared to the low seeding rate. Therefore, the low seeding rate should be avoided, especially for turf areas that will be subjected to traffic. This study also demonstrated that the amount of traffic and cold tolerance should both be considered when selecting an overseeding species. Tetraploid ryegrass is much more traffic and cold tolerant than meadow fescue; however if traffic and cold stress are not anticipated then meadow fescue may be a viable option.

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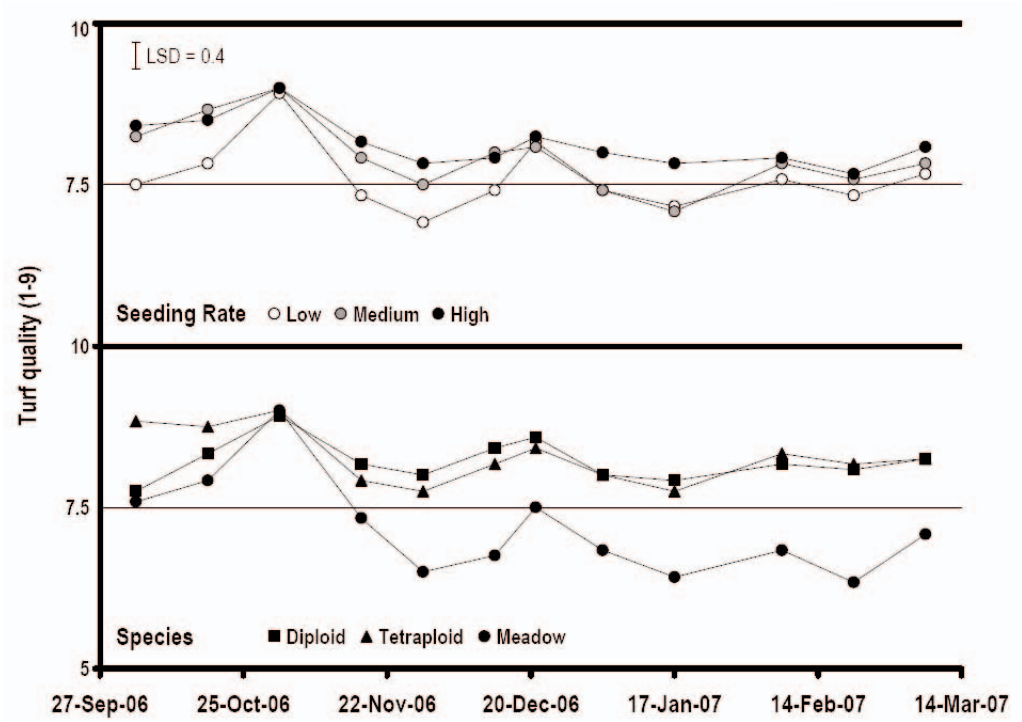

Fig. 1. Turf quality of overseeded species as affected by seeding rate (top) and species (bottom) at a soil site. Error bar represents Fisher's least significant difference value (α = 0.05), within dates.

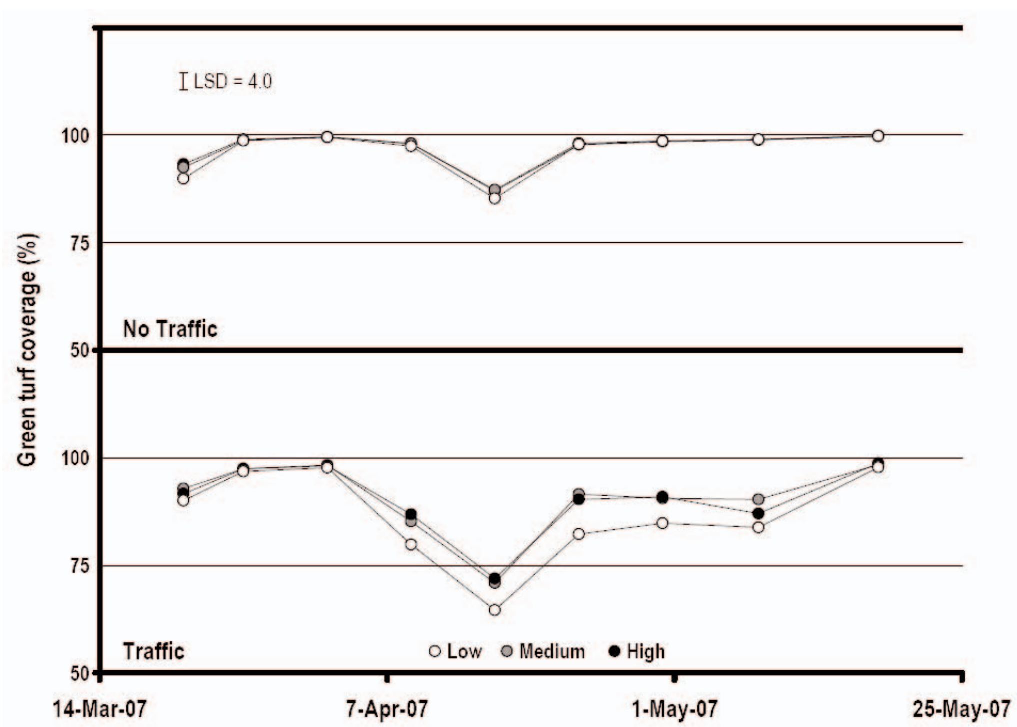

Fig. 2. Turf coverage as affected by seeding rate for trafficked (bottom) and non-trafficked (top) turf at a soil site. Error bar represents Fisher's least significant difference value (α = 0.05), within dates.

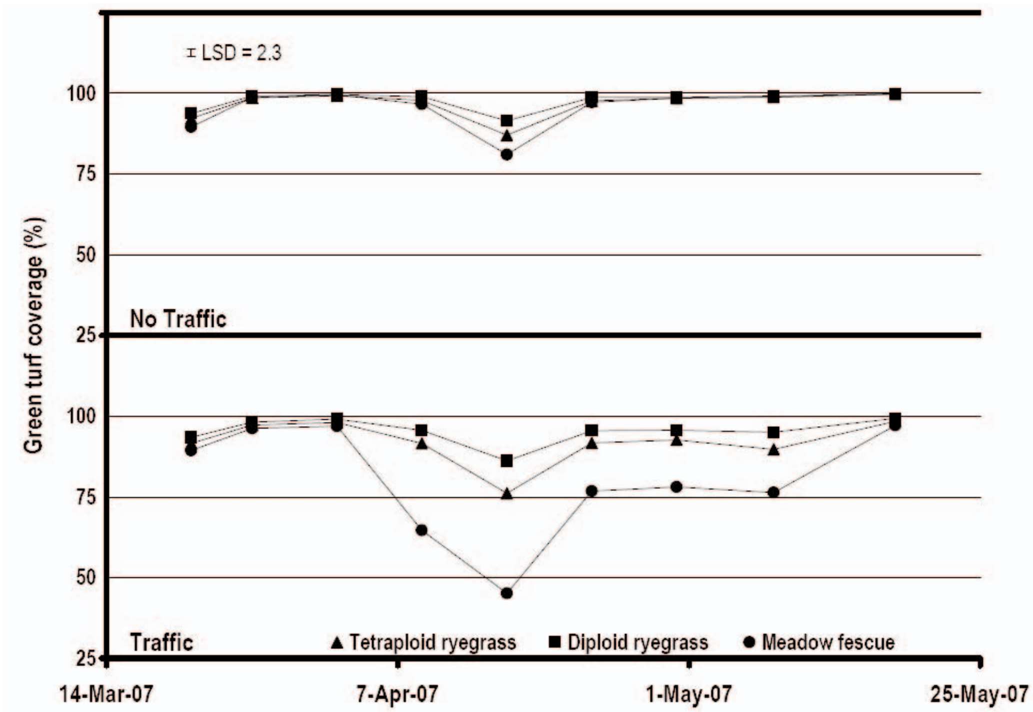

Fig. 3. Turf coverage as affected by overseeding species rate for trafficked (bottom) and non-trafficked (top) turf at a soil site. Error bar represents Fisher's least significant difference value (α = 0.05), within dates.

Cultural Practice Effects on the Transition of Overseeded Meadow Fescue and Tetraploid Ryegrass

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Additional index words: overseeding, vertical mowing, scalping, aerification

Summerford, J., D. Karcher, M. Richardson, A. Patton and J. Boyd. 2008. Cultural practice effects on the transition of overseeded meadow fescue and tetraploid ryegrass. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:96-100.

Photo by Josh Summerford

Overseeding trials at the University of Arkansas in Fayetteville

Summary. Overseeding is a common practice used by turf managers in the southern and transition zone to provide actively growing, green turf surfaces during the winter dormancy of warm-season grasses such as bermudagrass. The most commonly used turf species for overseeding is perennial ryegrass due to its excellent turf quality and rapid establishment. Continued improvements in perennial ryegrasses have resulted in cultivars that persist into the summer and interfere with the spring green-up of bermudagrass. Two new turf species, meadow fescue and tetraploid perennial ryegrass, have demonstrated good turf characteristics in overseeding as well as easier spring transition. Turf managers often employ various cultural practices to hasten the spring transition of an overseeded species back to bermudagrass. The objective of this study was to determine the effect of some commonly used cultural practices, including aerification, scalping, vertical mowing and a combination of scalping and vertical mowing, on the transition of these new species. Cultural practices did not improve spring transition period to bermudagrass regardless of the overseeding species.

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The demand for year-round, high quality sports turf surfaces has resulted in the practice of overseeding becoming more common at all levels of turf management. The most common turf species used in overseeding is perennial ryegrass (*Lolium perenne*). Overseeding is commonly done in the fall when hybrid bermudagrass (*Cynodon dactylon*, *C. dactylon* x *C. transvaalensis*) enters dormancy, and ideally, the overseeded species will naturally die out in the spring when temperatures increase and bermudagrass breaks dormancy. In such cases, perennial ryegrass acts as an annual species; however, improvements in the heat tolerance of perennial ryegrass cultivars have increased the tendency of this species to act as a perennial when overseeded, and persist late into the summer interfering with the spring green-up of bermudagrass (Horgan and Yelverton, 2001).

Currently, there are two solutions for the problem of overseeded perennial ryegrass persisting into the summer. An overseeding species with less heat tolerance, such as annual ryegrass (*Lolium multiflorum*), can be used but annual ryegrass produces inferior turf quality compared to perennial ryegrass. Alternatively, a spring application of herbicide to remove perennial ryegrass from the bermudagrass is a more expensive solution for species transition.

Recent breeding efforts have resulted in two overseeding species that have turf characteristics more similar to those of perennial ryegrass, but with a much earlier and complete spring transition. Both tetraploid perennial ryegrass (*Lolium perenne*, 2n=4x=28) and meadow fescue (*Festuca pratensis*) have shown promise for use as overseeding species due to good turf quality and early spring transition (Richardson et al., 2007). Although these species have proven to transition earlier than diploid perennial ryegrass there may still be a need to hasten the transition in an effort to increase the number of growing days for the bermudagrass. Chemical transition can be very costly; therefore, an alternative means of speeding up the spring transition would be beneficial. The objective of this study was to determine the effect of four common cultural practices on the spring transition of overseeded turf to bermudagrass.

Materials and Methods

This study was conducted at the University of Arkansas Research and Extension Center, Fayetteville, Ark., on a native Captina silt loam soil. On 20 September 2006, diploid perennial ryegrass (cv. Integra), tetraploid perennial ryegrass (cv. T3), and meadow fescue (Expt. AMF29) were each seeded into 6 by 20 ft. plots at a rate 3150 pure live seeds / ft^2 (12.4, 23.4, and 13 lbs. PLS / $1000ft^2$ for diploid ryegrass, tetraploid ryegrass, and meadow fescue, respectively). An unseeded control was also used in this study as a comparative standard for bermudagrass green-up. Five cultural practices, including core-aerification, scalping, vertical mowing, and scalping + vertical mowing, and an untreated control were applied to each overseeding species beginning on 22 March 2007, and continuing every two weeks until the conclusion of the study on 29 June 2007. All species and cultural practice treatments were applied in four replicate plots. Digital image analysis was used to determine percent green turf cover (Richardson et al., 2001) and assess turf injury, and visual estimates of the amount of bermudagrass present in the plots was assessed bi-weekly as a measure of transition (1 = little to no bermudagrass, 5 = 50% bermudagrass, 9 = 100% bermudagrass).

Results and Discussion

Bermudagrass presence. Cultural practices had little effect on hastening the transition to bermudagrass in this study (Fig. 1). The only significant differences among cultural practices occurred on the 6 June evaluation, when bermudagrass presence was rated significantly higher (~ 7) in meadow fescue and tetraploid ryegrass plots receiving vertical mowing treatments. In contrast, bermudagrass presence for these species was rated at 5 or below where no cultural practices were applied. However, by mid-June, bermudagrass presence was similar within species, regardless of cultural practice treatment.

The tetraploid perennial ryegrass and meadow fescue had similar transition during the final month of the study regardless of cultural practice (Fig. 1). The diploid perennial ryegrass had the slowest transition and had the least bermudagrass present in the plots during the same period. The improved transition of meadow fescue and tetraploid ryegrass was very evident beginning on the 6 June evaluation date when both species had significantly higher amounts of bermudagrass present than the diploid perennial ryegrass regardless of treatment. This trend continued for the remainder of the trial.

Turf cover. Cultural practice treatments and overseeding species had minimal effects on turf coverage in this study (Fig. 2). The more aggressive cultural practices reduced turf coverage slightly on the first evaluation date; however, once the bermudagrass began to green-up, turf cover remained near 100% regardless of treatment. Also, on the earliest evaluation date, the non-overseeded control had less green turf cover than overseeded plots, due to the fact that the bermudagrass was still in the process of breaking winter dormancy. There were no species differences in green turf coverage throughout the remainder of the study.

In summary, cultural practices did very little to improve the transition of overseeding grasses back to bermudagrass, similar to earlier studies (Horgan and Yelverton, 2001). Implementing these cultural practices was very labor intensive when considering the time required to both treat the turf and remove excess debris. Therefore, there is little evidence that cultural practices provide a significant benefit over natural transition. However, this study further demonstrates the improved transition that occurs with the two new species, tetraploid perennial ryegrass and meadow fescue.

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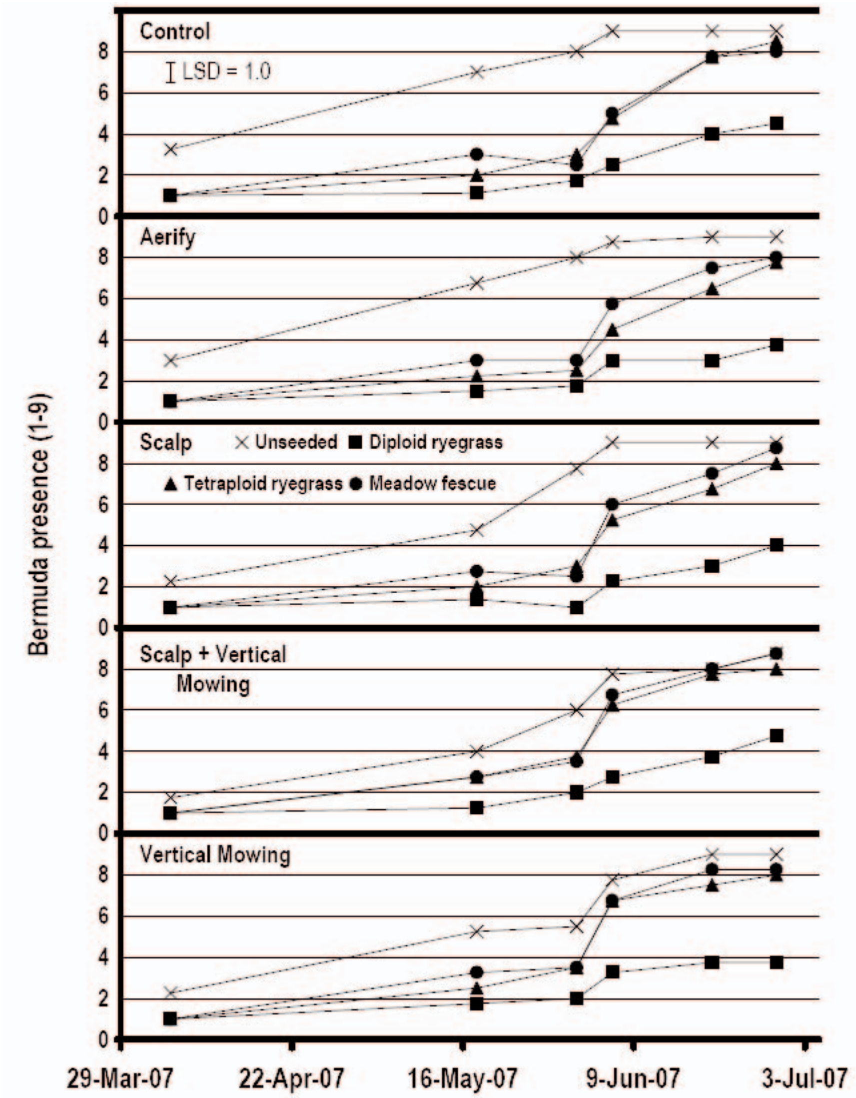

Fig. 1. Bermudagrass presence (1-9, 1 = little to no bermudagrass, 5 = 50% bermudagrass, 9 = 100% bermudagrass) within an overseeded turf as affected by a species x cultural practice interaction. Error bar represents Fisher's least significant difference value, within cultural practices and dates (α = 0.05). Cultural practices included untreated (Control), core-aerification (Aerify), scalping (Scalp), scalping + vertical mowing (Scalp + Vertical), and vertical mowing (Vertical Mowing).

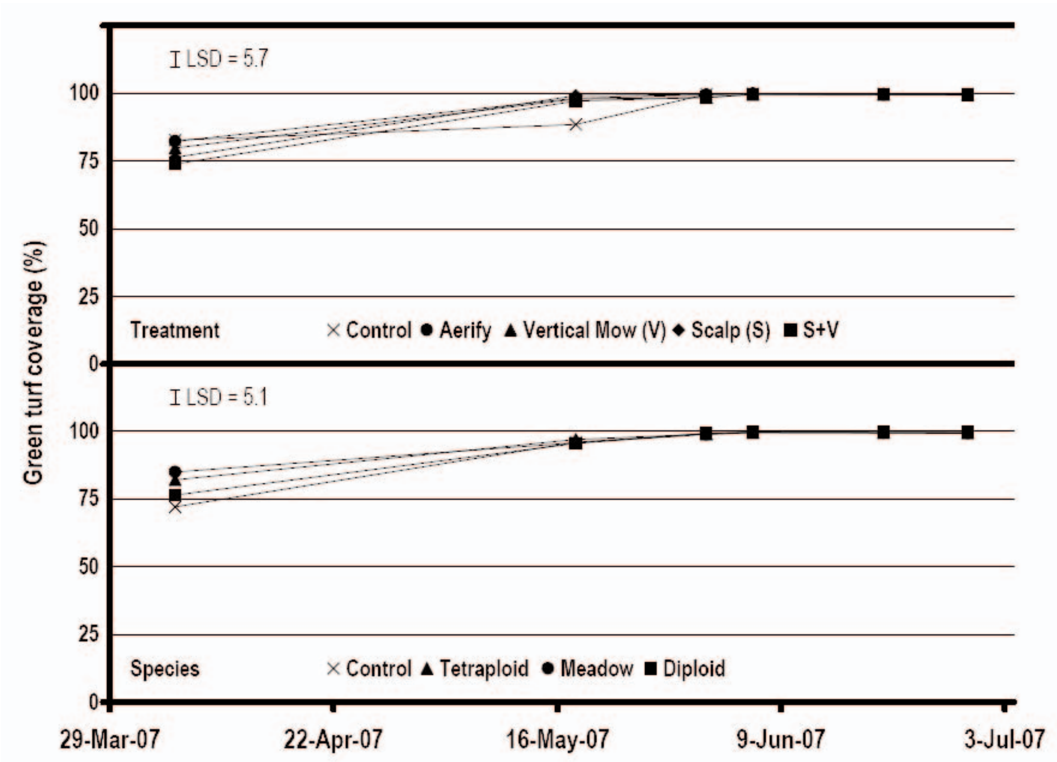

Fig. 2. Turf coverage as affected by overseeding species (bottom) and cultural practice (top). Cultural practices included untreated (Control), core-aerification (Aerify), scalping (S), scalping + vertical mowing (S+V), and vertical mowing (V). Species displayed were bermudagrass (Control), tetraploid perennial ryegrass (Tetraploid), meadow fescue (Meadow), and diploid perennial ryegrass (Diploid). Error bar represents Fisher's least significant difference value, within dates (α = 0.05).

Bermudagrass Cultivars Differ in Their Traffic Tolerance

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Additional index words: Cady traffic simulator, turfgrass coverage

Trappe, J., A. Patton,and M. Richardson. 2008. Bermudagrass cultivars differ in their traffic tolerance. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:101-103.

Photo by Mike Richardson

Device used to simulate traffic in turfgrass research

Summary. Bermudagrass is the most widely used turfgrass species for golf courses and sports fields in the southern U.S. and transition zone. Continuous trafficking from play or equipment can reduce bermudagrass coverage and turf quality. This study evaluated 42 bermudagrass cultivars for their traffic tolerance. Traffic was applied in summer with a Cady traffic simulator to determine differences in traffic tolerance. Twenty-four cultivars were rated highest in traffic tolerance including Barbados, CIS-CD5, CIS-CD7, Contessa, Midlawn, OKC 70-18, OR 2002, Panama, Patriot, Princess 77, Riviera, Sovereign, Sultan, Sunbird, Sunsport (SWI-1001), SWI-1003, SWI-1014, SWI-1046, Southern Star, Sundevil II, Tifsport, Transcontinental, Veracruz, and Yukon. The cultivars Arizona Common, Ashmore, Aussie Green, and B-14 were found to have poor traffic tolerance.

Abbreviations: WAT, weeks after traffic treatment; TPI, turf performance index

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Bermudagrass (*Cynodon* spp.) is the most widely used turfgrass species within the state of Arkansas and throughout the southern US and transition zone due to its low establishment costs, drought tolerance, ability to be grown at a wide range of mowing heights, aggressive growth rate, and traffic tolerance. Regular traffic that occurs on sports fields, golf courses, and residential areas can be detrimental to bermudagrass growth. Previous research has determined which cultivars are the most traffic tolerant (Youngner, 1961; Shearman and Beard, 1975), but more research is needed to examine new cultivars of bermudagrass for traffic tolerance. The objective of this study was to quantify differences in traffic tolerance of bermudagrass cultivars.

Materials and Methods

This study was conducted in both the summer and autumn of 2007 to simulate seasonal differences in traffic tolerance within bermudagrass cultivars. The study was located at the University of Arkansas Research and Extension Center in Fayetteville, Arkansas on the 2002 National Turfgrass Evaluation Program Bermudagrass Trial (Morris, 2007). There was a total of 42 cultivars in the study including 30 cultivars that are currently commercially available. Plot size was 8 by 8 ft., and there were three replications of each cultivar. Plots were maintained under golf course fairway or sports field conditions, with a mowing height of 0.5 inch and monthly applications of 1.0 lb N / 1000ft^2 during the growing season. Traffic was applied weekly using the Cady traffic simulator (Henderson et al., 2005). Once each week for four consecutive weeks, four passes in forward direction were made to each plot. Traffic was applied to half of each plot for summer traffic evaluations and the other half of each plot was used for autumn traffic evaluations.

Digital images were taken prior to each of four traffic applications and after the final traffic application to evaluate damage. Digital image analysis was used to evaluate the amount of green turfgrass cover as affected by the traffic simulator (Richardson et al, 2001). Turf Performance Index (TPI) was used to compare differences among the cultivars. Turf Performance Index was determined as the number of times each cultivar was ranked in the highest statistical category.

Results and Discussion

Although the study was performed in both the summer and autumn to show seasonal differences in traffic tolerance, only summer data are reported here. Autumn coverage data were difficult to interpret as plants began to go into winter dormancy, which made it difficult to determine if green turf coverage was affected by traffic or by the plants losing their green pigment as they entered winter dormancy. For the summer data, however, there were differences in traffic tolerance among the cultivars on each rating date (Table 1).

Twenty-four of the 42 cultivars were ranked in the highest statistical grouping for all four data collection dates, including: Barbados, CIS-CD5, CIS-CD7, Contessa, Midlawn, OKC 70-18, OR 2002, Panama, Patriot, Princess 77, Riviera, Sovereign, Sultan, Sunbird, Sunsport (SWI-1001), SWI-1003, SWI-1014, SWI-1046, Southern Star, Sundevil II, Tifsport, Transcontinental, Veracruz, and Yukon (Table 1). Arizona Common, Ashmore, Aussie Green, and B-14 each had a TPI rating of 0, indicating that they did not have equal traffic tolerance to the best cultivars at any time during the study (Table 1).

The ultimate goal of this study is to help golf course and sports field managers select cultivars that have good traffic tolerance and avoid those cultivars with poor traffic tolerance. Although traffic compacts soil and decreases rooting, this study only measured the immediate response of the turf to the simulated wear that it received. These results demonstrate that several bermudagrass cultivars possess superior traffic tolerance, and some have poor traffic tolerance. Selecting improved, traffic tolerant bermudagrasses will help reduce maintenance inputs and increase sustainability of golf courses and athletic fields. Additional data will be collected during bermudagrass spring green-up of these plots to determine the effect of autumn traffic on bermudagrass cultivars.

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Table 1. Percent bermudagrass cover after summer traffic treatments and turfgrass performance indices for various cultivars.

	WAT1[z]	WAT2	WAT3	WAT4	TPI[y]
	--------------------% coverage--------------------				
Arizona Common[xw]	76.3	81.2	83.7	89.5	0
Ashmore[x]	85.1	87.5	86.5	89.2	0
Aussie Green[x]	82.9	76.6	85.2	89.9	0
B-14[w]	75.1	79.0	79.9	87.6	0
Barbados [xw] (SWI-1044)	91.0	92.8	94.3	96.4	4
Celebration[x]	91.1	92.6	89.3	93.3	3
CIS-CD5[w]	88.9	89.8	90.6	94.7	4
CIS-CD6[w]	89.6	89.0	93.3	94.7	3
CIS-CD7[w]	90.3	91.1	91.5	93.8	4
Contessa[xw] (SWI-1045)	95.0	96.0	93.6	96.1	4
GN-1[x]	88.1	80.8	88.9	92.8	2
LaPaloma [xw] (SRX 9500)	84.7	88.6	88.0	93.7	1
Midlawn[x]	94.1	95.9	93.9	96.3	4
Mohawk[xw]	86.2	89.3	90.2	93.7	2
MS-Choice[x]	87.5	91.9	90.1	89.1	1
NuMex Sahara[xw]	85.4	88.5	87.6	93.7	1
OKC 70-18	96.5	94.5	97.8	97.6	4
OR 2002[x]	94.5	94.2	94.9	97.6	4
Panama[xw]	90.0	92.6	92.7	94.6	4
Patriot[x]	92.3	92.8	94.3	93.1	4
Princess 77[xw]	93.4	93.6	92.7	94.9	4
Riviera[xw]	93.5	97.2	96.0	96.6	4
Southern Star[xw]	90.8	94.5	91.3	96.2	4
Sovereign [xw] (SWI-1012)	92.6	93.7	92.8	97.5	4
SR 9554[xw]	87.4	87.8	88.5	93.1	1
Sultan [xw] (FMC-6)	89.0	90.9	90.4	94.2	4
Sunbird[xw] (PST-R68A)	92.9	94.7	92.7	93.4	4
Sundevil II[xw]	89.9	91.9	91.9	95.7	4
Sunsport [xw] (SWI-1001)	91.4	96.1	96.4	97.1	4
Sunstar[xw]	84.5	88.7	89.3	94.1	1
SWI-1003[w]	93.6	94.1	92.9	93.6	4
SWI-1014[w]	89.8	91.5	91.7	94.7	4
SWI-1046[w]	91.9	95.3	93.5	97.1	4
Tifsport[x]	93.3	90.6	94.6	97.7	4
Tift No. 1[w]	87.0	91.3	91.5	95.3	3
Tift No. 2[w]	90.6	92.7	90.3	95.8	3
Tift No. 3	93.8	91.7	89.7	94.6	3
Tift No. 4	93.2	92.7	88.1	95.2	3
Tifway[x]	88.3	90.9	90.6	95.1	3
Transcontinental[xw]	92.0	93.2	94.5	95.6	4
Veracruz[xw] (SWI-1041)	93.9	96.1	96.2	93.4	4
Yukon[xw]	95.8	97.0	94.0	97.7	4
Mean	89.8	91.2	91.3	94.4	
LSD (0.05)	8.0	7.9	7.5	5.2	

[z] weeks after first traffic treatment (WAT). Traffic was applied on four consecutive weeks (0-3 WAT – 7/14/07 to 8/08/07).

[y] Turf Performance Index (TPI) indicates the number of times that particular cultivar was in the highest statistical group.

[x] indicates commercially available cultivar in 2007(www.ntep.org).

[w] indicates seeded bermudagrass cultivar.

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