Kansas State University Agricultural Experiment Station
and Cooperative Extension Service

K-STATE TURFGRASS RESEARCH

2005

Report of Progress 946

FOREWORD

Turfgrass Research 2005 contains results of projects done by K-State faculty and graduate students. Some of these results will be presented at the Kansas Turfgrass Field Day, August 4, 2005, at the Rocky Ford Turfgrass Research Center in Wichita. The enclosed articles present summaries of research projects that were completed recently or will be completed in the next year or two. This year's report presents summaries of research on environmental stresses, turfgrass establishment and culture, and cultivar evaluations.

What questions can we answer for you? The K-State research team strives to be responsive to the needs of the industry. If you have problems that you feel need to be addressed, please let one of us know.
In addition to the CD format, you can access this report, those from previous years, and all K-State Research and Extension publications relating to turfgrass at:
www.oznet.ksu.edu/dp_hfrr/turf/welcome.htm

Personnel Associated with the K-State Turfgrass Program

Faculty

Bob Bauernfeind	Extension Entomologist, KSU, 133A Waters Hall, Manhattan, KS 66506 (785) 532-4752 Fax: (785) 532-6258 rbauernf@oznet.ksu.edu
Dale Bremer	Assistant Professor, Turfgrass, Division of Horticulture, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 532-1429 Fax: (785) 532-6949 bremer@ksu.edu
Jack Fry	Professor, Turfgrass Research and Teaching, Division of Horticulture, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 532-1430 Fax: (785) 532-6949 jfry@oznet.ksu.edu
Jason Griffin	Assistant Professor, Director, John C. Pair Horticultural Center, 1901 E 95th St. South, Haysville, KS 67060 Phone: (316) 788-0492 Fax: (316) 788-3844 jgriffin@oznet.ksu.edu
Steve Keeley	Associate Professor, Turfgrass Teaching and Research, Division of Horticulture, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 532-1428 Fax: (785) 532-6949 skeeley@oznet.ksu.edu
Larry Leuthold	Professor Emeritus, Horticulture
Randy Taylor	Professor, Machinery Systems, Biological and Agricultural Engineering, KSU, 232 Seaton Hall, Manhattan, KS 66506 Phone: (785) 532-2931 Fax: (785) 532-6944 rktaylor@ksu.edu
Position Vacant	Plant Pathologist
Tom Warner	Professor and Head, Department of Horticulture, Forestry and Recreation Resources, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 532-6170 Fax: (785) 532-6949 twarner@oznet.ksu.edu
Bob Wolf	Associate Professor, Application Technology, Biological and Agricultural Engineering, KSU, 229 Seaton Hall, Manhattan, KS 66506 Phone: (785) 532-2935 Fax: (785) 532-6944 rewolf@ksu.edu
Position Vacant	Extension Turfgrass Specialist

Support Staff

Christy Dipman	Secretary, Division of Horticulture, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 532-6173 Fax: (785) 532-5780 cdipman@oznet.ksu.edu
Linda Parsons	Research Assistant, John C. Pair Horticultural Center, 1901 E 95th St. South, Haysville, KS 67060 Phone: (316) 788-0492 Fax: (316) 788-3844
Mike Shelton	Field Maintenance Supervisor, John C. Pair Horticultural Center, 1901 E 95th St. South, Haysville, KS 67060 Phone: (316) 788-0492 Fax: (316) 788-3844 mshelton@oznet.ksu.edu
Ward Upham	Extension Associate, Horticulture, Forestry and Recreational Resources, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 532-1438 Fax: (785) 532-5780 wupham@oznet.ksu.edu
Alan Zuk	Research Technician and Manager of the Rocky Ford Turfgrass Research Center, KSU, 2021 Throckmorton Hall, Manhattan, KS 66506 Phone: (785) 539-9133 Fax: (785) 532-6949 azuk@oznet.ksu.edu

Graduate Students

Kemin Su	Ph.D. Student, Horticulture
Qi Zhang	M.S. Student, Horticulture

Contribution number: 05-306-S

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TITLE: Zoysiagrass NTEP Evaluation

OBJECTIVES: Evaluate performance of standard and experimental zoysiagrass selections.

PERSONNEL: Jack Fry

SPONSOR: National Turfgrass Evaluation Program

INTRODUCTION:

Meyer has long been the standard zoysiagrass cultivar for use in the transition zone. There is interest in identifying vegetative and seeded selections that have finer texture, and a more aggressive growth habit than Meyer, but retain freezing tolerance.

METHODS:

Seeded and vegetative zoysiagrass selections were planted June 27, 2002. Turf was maintained at a 0.5 inch, and received 1 lb. N per 1,000 sq. ft. in June and July. Irrigation was applied to prevent drought stress. Data were collected on turf quality each month and on color in the fall. Plots were rated visually on a 0-to-9 scale, 9 = best. A quality rating of 7 was considered acceptable for a golf course fairway.

RESULTS:

Results from this location and others throughout the United States are available at: www.ntep.org. Best turf quality throughout the summer was observed in cultivars that were fine-textured, dense, and had a dark green color, including Emerald and Zorro. However, the 2003-2004 winter was not severe, and selections were not exposed to temperatures that might result in injury. Emerald is known to have relatively poor cold hardiness, and it is suspected that fine-textured zoysiagrasses do as well.

Table 1. Color and quality ratings of zoysiagrass cultivars maintained under fairway conditions at Manhattan, Kan., in 2004.

Name	Genetic[1] Color	Turfgrass Quality May	Jun	July	Aug	Sept	Mean
Emerald*	4.7	7.7	8.0	8.7	9.0	8.0	8.3
Zorro*	6.0	7.0	8.0	9.0	8.3	7.3	7.9
DALZ 0101	6.0	6.0	8.3	8.0	7.3	6.3	7.2
DALZ 0102	4.0	7.3	7.0	7.7	7.7	6.3	7.2
BMZ 230	4.3	5.3	5.7	6.7	6.7	5.0	5.9
GN-Z	4.3	3.7	5.0	6.7	6.3	5.3	5.4
Zenith*	2.7	4.0	5.3	5.7	5.0	4.0	4.8
PZA 32	2.7	4.0	3.7	5.0	5.7	4.0	4.5
PZB 33	2.7	3.7	4.7	5.3	5.3	3.3	4.5
J-37*	3.0	3.7	4.7	5.0	5.0	3.7	4.4
Chinese Common*	2.3	3.7	4.7	4.7	5.3	3.3	4.3
Companion*	2.0	3.0	4.0	5.3	5.3	3.3	4.2
Himeno	2.0	2.3	4.0	5.7	5.0	3.7	4.1
6186	5.3	1.7	3.3	5.0	5.5	5.0	4.0
DALZ 0104	2.3	2.3	3.7	5.0	5.0	4.0	3.9
DALZ 0105	4.0	0.7	4.0	5.0	4.7	4.7	3.8
PST-R7MA	2.3	2.0	4.0	4.3	4.7	4.0	3.8
Meyer*	2.0	2.7	3.7	4.7	4.0	3.7	3.7
Entry 21	2.0	1.7	4.0	4.3	4.5	3.7	3.6
DALZ 9604	4.7	0.7	3.3	5.0	5.0	4.3	3.5
PST-R7ZM	2.0	2.7	3.3	3.7	4.0	3.3	3.4
LSD**	1.5	1.9	1.4	1.7	1.6	1.7	1.1

1 / Ratings based on a 0 - 9 scale, 9 = best measure.
*Commercially available in the United States in 2005.
**To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding Least Statistical Difference (LSD) value.

TITLE: Buffalograss NTEP Evaluation

OBJECTIVE: Evaluate buffalograss cultivars for use in Kansas.

PERSONNEL: Steve Keeley

SPONSOR: National Turfgrass Evaluation Program

INTRODUCTION:
Buffalograss (*Buchloe dactyloides*) is a warm-season grass native to the Great Plains. It is considered the lowest-maintenance turfgrass for use in Kansas. After establishment, it can be grown without supplemental irrigation. Fertilizer requirements are also minimal: 1 lb. N per 1,000 sq. ft. annually is adequate. However, better turf quality can be obtained with occasional irrigation during very dry periods. An additional pound of nitrogen per 1,000 sq. ft. will darken color and improve density.

MATERIALS AND METHODS:
Ten buffalograss cultivars were planted in July 2002 at the Rocky Ford Turfgrass Research Field in Manhattan. The trial was mowed at 2.5 inches and fertilized with 2 lb. N per 1,000 sq. ft. annually. The turf was irrigated to prevent dormancy. No fungicides or insecticides were applied.

Turf quality was rated monthly from April to October on a visual 1-to-9 scale where 1 = dead turf and 9 = optimum color, density, and uniformity. The cultivars also were rated for genetic color, spring green-up, leaf texture, and fall color retention.

RESULTS:
The 2004 growing season was the second full year after this trial was established. The trial will continue for three more growing seasons, therefore, data reported should be considered preliminary. Data are shown in Tables 1 and 2.

Table 1. Monthly turfgrass quality of buffalograss cultivars grown in Manhattan, Kan., in 2004.

Cultivar	Turfgrass Quality[1]							
	Apr	May	Jun	July	Aug	Sept	Oct	Mean
Legacy	4.3	8.0	7.3	7.7	7.0	7.0	3.7	6.4
SWI-2000	4.3	7.0	6.7	7.0	6.3	6.3	4.0	6.0
Bowie	5.0	6.7	6.3	6.7	6.0	6.0	4.0	5.8
NE 95-55	4.3	7.0	6.0	6.3	6.7	6.7	3.7	5.8
Texoka	5.0	5.7	6.7	7.0	6.0	6.0	4.0	5.8
378	4.7	6.7	7.0	7.0	5.3	5.3	3.0	5.6
Density	2.3	5.3	5.0	6.0	6.0	7.0	5.0	5.2
Bison	4.0	5.0	6.0	6.0	5.7	5.7	3.7	5.1
609	3.0	4.0	4.3	5.3	6.3	6.3	4.7	4.9
Frontier Turfallo	1.3	4.7	5.7	6.7	5.0	5.3	4.7	4.8
LSD (0.05)*	1.1	1.1	1.0	0.8	1.2	1.1	0.7	0.6
CV (%)	17.3	11.1	9.6	7.2	11.8	10.5	10.6	6.4

1 / 1-9 scale, 9 = ideal turf.
*To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding Least Statistical Difference (LSD) value.

Table 2. Spring green-up, genetic color, leaf texture, and fall color retention of buffalograss cultivars grown in Manhattan, Kan., in 2004.

Cultivar	Spring Green-up[1]	Genetic Color[2]	Leaf Texture[3]	Fall Color Retention[4]
Legacy	4.7	7.3	7.0	6.0
SWI-2000	5.0	7.0	7.0	5.0
Bowie	5.0	6.7	7.0	4.7
NE 95-55	5.0	6.7	7.0	5.0
Texoka	5.0	6.7	7.0	6.0
378	4.3	7.0	7.0	3.7
Density	2.0	5.0	7.0	8.0
Bison	4.7	7.0	7.0	5.3
609	3.7	7.0	7.0	7.7
Frontier Turfallo	1.3	6.0	7.0	4.7
LSD (0.05)*	0.9	0.5	NS[5]	0.8
CV (%)	13.3	4.8		8.3

1 / 1-9 scale; 9 = completely green.
2 / 1-9 scale; 9 = darkest green.
3 / 1-9 scale; 9 = very fine.
4 / 1-9 scale; 9 = complete color retention (rated in early October).
5 / Not significant.
*To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Bermudagrass NTEP Evaluation

OBJECTIVE: To evaluate bermudagrass cultivars under Kansas conditions and submit data collected to the National Turfgrass Evaluation Program.

PERSONNEL: Linda R. Parsons and Jack D. Fry

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Bermudagrass is a popular, warm-season turfgrass that is heat and drought tolerant as well as being wear resistant. It has a wide range of uses and is especially suited for athletic-field turf. Kansas represents the northernmost region in the central United States where bermudagrass can be successfully grown as a perennial turfgrass. Historically, few cultivars that have both acceptable quality and adequate cold-tolerance have been available to local growers. New introductions of interest are continually being selected for improved hardiness and quality; seeded varieties, in particular, show the potential for improved winter survival. Both seeded and vegetative types need regular evaluation to determine their long-range suitability for use in Kansas.

MATERIALS AND METHODS:

In June 2002, three replications each of 42 bermudagrass cultivars and experimental numbers were planted in a randomized complete block design at the John C. Pair Horticultural Center in Wichita. Twenty-nine entries were seeded;13 vegetative entries were plugged at 12-inch spacings. Starter fertilizer was incorporated into the study plots at planting time at a rate of 1 lb. N per 1,000 sq. ft. Plot fertility was maintained at 0.5 to 0.75 lb. N per 1,000 sq. ft. each growing month. Plots were mowed once a week during the growing season at 0.75 to 1.0 inch. Irrigation was done as necessary to prevent dormancy; and weeds, insects, and diseases were controlled only to prevent severe stand loss.

During the course of the study, information will be collected on spring green-up, genetic color, leaf texture, seed heads, quality, and other measures when appropriate. Rating is done on a 0-to-9 scale, where 0 = poorest, 6 = acceptable, and 9 = optimum measure.

RESULTS:

By May 11, 2004, the seeded varieties Tift No. 2 and NuMex Sahara, and the vegetative varieties OKC 70-18 and OR 2002 were the greenest (Table 1). At that time, seeded entry Tift No. 1 and vegetative entry Tift No. 3 showed only bare traces of green. Turf quality was rated monthly from May through September. Quality ratings were influenced by degree of coverage and weed infestation as well as turf color, texture, density, and presence of seed heads. The best overall vegetative performers were OKC 70-18, Midlawn, and Patriot; and the best seeded were Riviera, SWI-1045, and Yukon.

Clean looking turf with no seed heads is preferred, so seed head density was rated in spring, summer, and fall. At the end of May, most of the turfgrass plots had few, if any, seed heads (Table 2). In July, vegetative varieties MS-Choice, Midlawn, and Patriot; and seeded variety Yukon had the fewest seed heads. In September vegetative varieties Tifsport, MS-Choice, Midlawn, and Tift No. 4; and seeded variety Yukon had the fewest.

At midseason, turfgrass stands were rated for overall density. Densest were vegetative varieties

OKC 70-18, Tift No. 4, and OR 2002; and seeded varieties SWI-1044 and Yukon. Toward the end of the growing season, turf color and texture were rated, with vegetative entries Patriot, Celebration, and Tifsport; and seeded entries SWI-1044, SWI-1046, Tift No. 1, and Tift No. 2 darkest green. Vegetative entries Ashmore, Midlawn, OR 2002, and Tifway; and seeded entries SWI-1045, SWI-1012, and Yukon had the finest texture. Just before first frost, turf was rated for fall color retention with seeded varieties SWI-1046, Princess 77, and SWI-104; and vegetative varieties Tifway, Tifsport, and Tift No. 4 rated as greenest.

Table 1. Performance of bermudagrass cultivars at Wichita, Kan., in 2004.[1]

Cultivar/ Experimental Number	S or V[2]	Spring Green-up	Quality					
			May	Jun.	Jul.	Aug.	Sep.	Avg.
OKC 70-183	V	4.0	5.3	5.3	5.3	4.7	5.7	5.3
Midlawn*[3]	V	3.3	6.3	5.7	4.7	4.0	4.7	5.1
Riviera*	S	3.7	5.0	5.0	5.0	4.0	6.0	5.0
SWI-1045	S	3.3	4.3	5.0	5.0	4.7	5.7	4.9
Yukon*	S	3.0	5.7	6.0	4.0	4.0	4.7	4.9
Patriot*	V	3.7	4.7	5.7	4.7	4.0	5.3	4.9
SWI-1014	S	3.0	4.7	5.7	5.0	4.0	4.7	4.8
OR 2002	V	4.0	4.7	5.3	4.7	4.3	4.3	4.7
SWI-1012	S	3.7	4.3	5.3	4.3	4.0	5.0	4.6
SWI-1044	S	4.0	4.3	5.3	4.7	4.0	4.7	4.6
SWI-1046	S	2.7	3.3	4.7	5.0	4.7	5.0	4.5
SWI-1041	S	3.0	3.3	5.0	4.3	4.3	5.3	4.5
Sunbird (PST-R68A)*	S	4.0	3.7	5.3	4.0	4.0	5.0	4.4
Aussie Green*	V	3.0	4.0	4.7	4.7	4.0	4.3	4.3
CIS-CD5	S	3.3	3.3	4.7	4.3	4.0	5.3	4.3
CIS-CD6	S	3.7	4.0	4.7	4.0	4.0	4.7	4.3
FMC-6*	S	2.7	3.3	4.7	4.0	4.0	5.3	4.3
MS-Choice*	V	3.0	3.0	4.3	4.0	4.7	5.3	4.3
Panama*	S	3.0	3.3	4.7	4.0	4.0	5.3	4.3
Tifway*	V	3.3	4.0	4.7	4.3	4.0	4.0	4.2
Ashmore*	V	3.0	5.0	4.0	3.3	4.0	4.3	4.1
Celebration*	V	3.3	4.0	4.3	4.3	3.7	4.3	4.1
LaPaloma (SRX 9500)*	S	2.3	3.3	4.0	4.0	4.0	5.0	4.1
Princess 77*	S	3.3	3.0	4.0	4.3	4.0	5.0	4.1
Tifsport*	V	3.7	3.7	4.3	4.7	3.7	4.0	4.1
Transcontinental*	S	3.3	3.3	4.3	4.0	4.0	4.7	4.1
CIS-CD7	S	3.3	3.3	4.3	3.7	4.0	4.7	4.0
Sunstar*	S	3.0	3.7	4.0	3.7	4.0	4.7	4.0
NuMex Sahara*	S	4.0	3.0	4.0	3.7	4.0	5.0	3.9
SR 9554*	S	4.0	3.7	4.0	3.7	4.0	4.3	3.9
Southern Star*	S	3.7	3.3	4.0	3.7	4.0	4.7	3.9
Tift No. 3	V	2.0	3.0	4.3	4.0	4.0	4.3	3.9
SWI-1001	S	2.7	3.3	4.0	3.7	4.0	4.7	3.9
Tift No. 4	V	3.0	3.3	4.3	4.0	3.3	4.3	3.9
Sundevil II*	S	2.7	3.3	3.7	4.0	3.7	4.3	3.8
B-14	S	3.0	3.0	3.7	3.3	4.0	4.7	3.7
Mohawk*	S	2.3	3.0	3.7	3.7	3.7	4.7	3.7
Arizona Common*	S	2.7	3.0	3.7	3.3	3.7	4.7	3.7
GN-1*	V	3.7	3.0	4.0	3.7	3.0	4.0	3.5
SWI-1003	S	3.3	2.0	3.3	3.3	4.0	4.3	3.4
Tift No. 1	S	2.0	1.7	2.7	3.0	2.7	3.7	2.7
Tift No. 2	S	4.3	1.3	1.3	1.7	2.0	2.7	1.8
LSD[4]		5.5	0.8	0.8	1.0	0.7	1.5	0.5

1 / Ratings based on a 0 - 9 scale, 9 = best measure.
2 / Seeded or vegetative varieties.
3 / Cultivars marked with "*" commercially available in 2004.
4 / To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

Table 2. Performance of bermudagrass cultivars at Wichita, Kan., in 2004.[1]

Cultivar Experimental Number	S or V[2]	Genetic Color	Texture	Summer Density	Fall Color	Seed Heads May	Seed Heads July	Seed Heads Sept
OKC 70-183	V	5.7	7.3	7.7	6.3	8.7	8.0	6.0
Midlawn*	V	6.7	8.3	5.7	5.7	9.0	8.3	7.7
Riviera*	S	6.0	4.7	5.3	6.3	7.3	7.0	4.7
SWI-1045	S	6.3	6.0	5.3	6.7	9.0	7.0	5.3
Yukon*	S	6.0	5.7	5.7	4.3	9.0	8.0	7.0
Patriot*	V	7.7	6.0	6.3	5.0	8.7	8.3	7.0
SWI-1014	S	6.0	4.3	5.0	4.7	9.0	7.7	4.7
OR 2002	V	7.0	8.0	6.7	5.3	8.0	8.0	4.7
SWI-1012	S	6.0	5.7	5.0	5.7	8.7	7.3	5.3
SWI-1044	S	6.7	5.3	5.7	6.3	7.3	7.7	5.7
SWI-1046	S	6.7	5.3	5.0	7.3	9.0	7.0	4.0
SWI-1041	S	5.3	4.7	5.0	7.0	9.0	6.3	4.7
Sunbird (PST-R68A)*	S	5.7	4.0	4.3	5.3	5.7	6.7	4.7
Aussie Green*	V	7.0	6.3	5.7	6.0	9.0	8.0	5.7
CIS-CD5	S	6.0	4.0	4.0	6.3	6.7	6.3	4.3
CIS-CD6	S	5.7	4.0	4.7	5.3	5.3	7.0	4.0
FMC-6*	S	6.0	4.0	4.3	6.0	8.7	7.3	5.0
MS-Choice*	V	7.0	5.0	5.0	6.3	9.0	8.7	7.7
Panama*	S	5.0	4.0	4.3	4.7	6.7	7.3	4.3
Tifway*	V	6.7	8.0	6.3	7.0	9.0	7.7	7.3
Ashmore*	V	4.0	8.7	5.3	5.7	7.0	7.3	7.0
Celebration*	V	7.3	5.7	5.0	5.7	9.0	7.3	4.0
LaPaloma (SRX 9500)*	S	5.7	4.0	4.7	5.3	6.3	7.0	4.3
Princess 77*	S	6.3	4.3	5.3	7.0	9.0	6.3	3.3
Tifsport*	V	7.3	7.7	5.3	6.7	9.0	8.0	8.0
Transcontinental*	S	6.3	4.3	4.0	5.3	7.3	6.7	4.7
CIS-CD7	S	6.0	3.7	4.0	5.7	6.3	6.7	4.7
Sunstar*	S	5.3	3.7	3.7	5.7	7.0	7.3	5.0
NuMex Sahara*	S	5.7	4.0	3.7	5.7	7.0	7.0	5.0
SR 9554*	S	6.3	4.0	4.3	5.7	7.3	7.0	4.0
Southern Star*	S	6.0	3.7	4.0	5.7	7.0	6.7	3.0
Tift No. 3	V	6.3	4.7	5.7	6.3	9.0	7.7	6.3
SWI-1001	S	6.0	4.0	4.0	6.0	7.7	7.3	4.7
Tift No. 4	V	6.7	7.3	7.0	6.7	9.0	6.7	7.7
Sundevil II*	S	5.3	4.0	4.0	5.0	6.3	6.7	3.3
B-14	S	5.3	3.7	3.3	5.7	6.3	7.0	4.0
Mohawk*	S	5.7	4.0	3.7	5.7	7.0	7.7	5.0
Arizona Common*	S	5.7	3.7	3.7	5.7	7.0	7.0	3.7
GN-1*	V	7.0	4.0	5.3	6.0	9.0	7.7	5.0
SWI-1003	S	5.3	3.3	4.3	6.3	8.3	6.0	4.0
Tift No. 1	S	6.7	3.3	4.7	6.3	9.0	6.7	5.0
Tift No. 2	S	6.7	4.0	3.0	6.0	9.0	5.7	4.0
LSD[3]		0.9	0.8	1.0	1.5	1.0	0.7	1.7

1 / Ratings based on a 0 - 9 scale, 9 = best measure.

2 / Seeded or vegetative varieties.

3 / To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Kentucky Bluegrass NTEP Evaluation

OBJECTIVE: To evaluate Kentucky bluegrass cultivars under Kansas conditions and submit data collected to the National Turfgrass Evaluation Program.

PERSONNEL: Linda R. Parsons and Jack D. Fry

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:
Kentucky bluegrass is one of several cool-season turfgrasses suitable for use in Kansas lawns. Its dark to medium blue-green color and relatively fine texture enhance its desirability, and its rhizomatous nature contributes to its drought tolerance, allowing it to withstand low-maintenance conditions. Without care, it may go dormant and turn brown in hot, dry periods, but it recovers well from injury and can be considered a water-saving grass. Bluegrass cultivars being evaluated are suitable for home lawns or golf course roughs and tolerate low-maintenance conditions, yet retain a dark leaf color, fine texture, disease resistance, and good sward density.

MATERIALS AND METHODS:
October 2, 2000, 528 study plots (5 by 5 ft. in a 220 by 60 ft. grid) at the John C. Pair Horticultural Center in Wichita were seeded with 173 Kentucky bluegrass cultivars and experimental numbers in a randomized complete block design. Seeding rate was 2 lb. seed per 1,000 sq. ft. Before seeding, 13-13-13 NPK was incorporated into the study plots at a rate of 1 lb. per 1,000 sq. ft. Plots were fertilized twice in 2004 at 1 lb. N per 1,000 sq. ft. Plots were mowed weekly during the growing season at 2.0 to 2.5 inches, and clippings returned. Irrigation was done as necessary to prevent dormancy, and weeds, insects, and diseases were treated only when they presented a threat to the trial. Turfgrass performance was rated on a 0-to-9 scale: 0 = poorest, 6 = acceptable, and 9 = optimum.

RESULTS:
By April 13, 2004, the cultivars/experimental numbers Allure, Brooklawn, and Fairfax were greenest (Table 1). Turf quality was rated monthly throughout the growing season, with ratings influenced by degree of coverage and weed infestation as well as turf color, texture, and density. The best overall performers were an unknown entry, Moon Shadow (Pick 113-3), NU Destiny (J-2695), Impact, Langara, and Sonoma. At summer's end, turf color and percent cover were rated, with Ba 84-140, Blue Velvet (J-1513), Bluestone (PST-731), and Excursion (J-1648) the darkest green. Moon Shadow (Pick 113-3), the unknown entry, Liberator, Blacksburg II (PST-1BMY), and Champagne provided the best cover.

Table 1. Performance of Kentucky bluegrass cultivars at Wichita, Kan., in 2004.[1]

Cultivar/ Experimental Number	Spring Green-up	Genetic Color	% Fall Cover	Quality May	Jun	Jul	Aug	Sep	Oct	Avg
Unknown[2]	5.3	8.0	96.3	5.7	5.3	4.7	5.7	5.0	6.0	5.4
Moon Shadow (Pick 113-3)*	6.0	6.3	96.3	5.3	5.0	5.0	6.0	5.3	5.3	5.3
Nu Destiny (J-2695)*	5.3	7.7	89.7	5.3	6.0	5.0	4.7	4.3	5.3	5.1
Impact*	5.7	7.7	82.7	5.3	5.3	5.3	4.7	4.7	4.7	5.0
Langara*	6.0	6.0	86.0	5.0	5.3	4.3	5.3	4.3	5.7	5.0
Sonoma*	6.3	6.3	87.0	6.0	5.0	5.0	4.7	4.0	5.3	5.0
Liberator*	5.0	7.7	96.0	4.3	5.0	4.7	5.0	4.7	6.0	4.9
Odyssey*	5.0	7.7	85.0	4.3	5.7	5.0	4.7	4.3	5.3	4.9
Award*	4.7	7.7	83.3	5.3	6.0	4.7	4.3	4.0	5.0	4.9
Champlain (A98-1275)*	5.3	6.0	86.0	5.0	5.0	4.7	5.3	4.3	5.0	4.9
Awesome (J-1420)*	5.3	8.0	82.7	5.3	5.3	5.0	5.0	3.3	5.0	4.8
Princeton 105*	5.0	6.0	87.7	4.7	4.7	5.0	5.3	4.7	4.7	4.8
Excursion (J-1648)*	5.3	8.3	84.3	5.0	6.0	5.0	4.3	3.7	4.7	4.8
Baronette (Ba 81-058)*	6.3	5.3	78.3	5.0	5.0	4.0	5.0	4.3	4.7	4.7
Freedom II*	5.7	7.3	71.0	5.0	5.7	5.0	4.0	3.7	4.7	4.7
Misty*	6.0	6.3	84.7	4.3	5.3	3.7	5.0	4.7	5.0	4.7
Bluestone (PST-731)*	5.3	8.3	74.3	4.7	5.3	4.7	4.0	4.3	4.7	4.6
Skye (A97-1715)*	6.0	6.0	81.7	5.3	4.7	4.3	4.3	4.3	4.7	4.6
Bedazzled*	5.7	6.3	91.3	4.7	4.7	4.0	5.0	4.7	4.7	4.6
Everglade*	5.0	8.0	86.0	4.7	5.7	4.7	4.3	3.3	5.0	4.6
Lily	6.0	4.7	88.7	5.0	5.0	3.3	5.7	4.3	4.3	4.6
SR 2284 (SRX 2284)*	6.0	6.3	84.3	4.7	5.3	4.3	5.0	4.0	4.0	4.6
A98-139	6.0	6.0	82.7	5.3	4.7	4.7	4.7	4.0	3.7	4.5
Rampart (Pick 417)*	5.7	6.0	71.7	5.3	5.7	5.3	4.7	2.7	3.3	4.5
Ba 82-288	5.7	6.3	82.0	5.0	4.7	4.7	4.7	4.0	4.0	4.5
Barrister (J-1665)*	5.3	8.0	80.0	5.0	5.3	5.0	3.7	3.3	4.7	4.5
Champagne*	5.3	6.3	92.7	5.3	4.7	4.3	4.7	3.3	4.7	4.5
Diva (Pro Seeds - 453)*	6.3	5.7	82.7	5.0	5.0	4.0	4.7	4.0	4.3	4.5
Blacksburg II (PST-1BMY)*	6.0	7.0	93.3	5.0	5.0	4.0	4.3	4.3	4.0	4.4
Fairfax*	6.7	4.3	76.3	5.0	4.3	4.0	4.7	4.3	4.3	4.4
B5-43	6.3	5.3	74.3	4.7	4.7	4.0	4.3	4.0	4.7	4.4
Midnight*	5.0	7.3	74.3	4.3	5.0	4.7	4.3	3.7	4.3	4.4
B5-144	5.7	5.7	78.3	5.0	4.3	3.7	4.7	3.7	4.7	4.3
Hallmark*	5.7	6.0	70.0	4.3	5.3	4.3	4.3	4.0	3.7	4.3
Allure*	6.7	5.0	73.3	5.0	4.7	4.0	4.0	4.0	4.3	4.3
Bordeaux*	6.0	6.7	81.0	4.7	5.0	3.3	4.3	4.0	4.7	4.3
Chicago II*	6.3	7.7	73.0	4.7	4.7	4.0	4.0	4.0	4.7	4.3
Marquis*	6.0	5.7	78.3	4.3	4.7	4.3	4.3	4.3	4.0	4.3
Monte Carlo (A96-402)*	6.3	6.7	68.3	5.0	4.7	4.0	5.0	3.3	4.0	4.3
PST-161	5.7	5.3	90.3	4.7	5.0	4.0	4.7	3.7	4.0	4.3
Rambo*	5.7	6.0	75.3	4.3	4.7	4.0	4.0	4.0	5.0	4.3
BH 00-6002	6.0	4.0	86.7	5.3	4.3	3.7	4.3	4.0	4.0	4.3
Royale (A97-1336)*	6.3	5.7	84.3	5.0	5.0	4.0	4.3	3.3	4.0	4.3
Baritone*	5.0	5.0	76.7	5.0	4.7	3.7	5.0	3.7	3.7	4.3
Brooklawn*	6.7	5.3	85.7	4.7	4.7	4.0	4.7	3.7	4.0	4.3
Chateau*	6.3	5.0	89.3	4.3	4.7	3.7	4.3	4.0	4.7	4.3
DLF 76-9032	5.3	4.3	72.7	5.3	4.7	3.7	4.7	3.7	3.7	4.3
Everest*	5.3	8.0	53.0	5.0	4.7	4.3	3.3	3.7	4.7	4.3

Table 1 (cont). Performance of Kentucky bluegrass cultivars at Wichita, Kan., in 2004.[1]

Cultivar/	Spring	Genetic	% Fall	Quality						
Experimental Number	Green-up	Color	Cover	May	Jun	Jul	Aug	Sep	Oct	Avg
Royce (A98-304)*	6.0	6.0	81.0	5.0	4.7	4.0	4.3	3.7	4.0	4.3
A98-1028	5.7	5.7	79.3	5.0	4.3	3.7	4.3	4.0	4.0	4.2
A98-407	6.3	7.0	75.0	4.7	4.3	4.3	4.3	4.0	3.7	4.2
Alpine*	5.7	5.0	74.7	4.7	4.3	4.0	4.7	3.7	4.0	4.2
Baron*	5.7	6.0	81.7	4.7	4.3	3.7	4.7	3.7	4.3	4.2
Durham (A96-427)*	6.3	6.3	65.0	4.7	4.3	4.0	4.3	3.7	4.3	4.2
J-2885	5.0	7.3	78.3	4.0	4.7	4.3	4.0	3.7	4.7	4.2
Mongoose (A98-881)*	6.0	5.3	83.3	5.3	4.3	3.7	4.3	3.7	4.0	4.2
PST-108-79	5.3	5.0	88.3	5.0	4.7	3.7	4.3	3.3	4.3	4.2
Rugby II*	5.0	7.3	67.3	4.3	5.3	4.3	4.0	3.3	4.0	4.2
A97-1409	6.0	7.3	56.7	5.0	5.0	4.3	4.0	3.7	3.0	4.2
A98-365	5.3	7.3	62.7	4.7	4.3	4.3	4.0	3.7	4.0	4.2
Jewel*	6.0	4.7	78.3	4.7	4.3	3.3	4.3	4.0	4.3	4.2
Lakeshore (A93-200)*	5.7	5.3	86.7	4.7	4.3	3.3	4.7	4.0	4.0	4.2
Shamrock*	5.3	6.0	84.3	5.0	4.3	3.3	4.7	3.3	4.3	4.2
Unique*	6.0	5.7	75.0	4.0	4.7	4.0	4.3	4.3	3.7	4.2
AVALANCHE (PST-1701)*	5.3	4.3	91.0	4.0	4.0	3.3	4.3	4.7	4.3	4.1
B5-45	6.3	5.7	66.0	4.0	4.3	4.0	4.3	3.7	4.3	4.1
Coventry*	6.0	4.7	79.3	4.7	4.0	3.7	4.7	3.7	4.0	4.1
Voyager II (PST-1QG-27)*	5.7	6.0	87.7	4.0	4.3	3.7	4.7	4.0	4.0	4.1
Glenmont (H94-293)*	5.3	6.3	69.3	5.0	5.3	4.3	3.7	2.7	3.7	4.1
Goldstar (A98-296)*	6.3	7.0	61.0	5.0	5.0	4.0	3.7	3.7	3.3	4.1
Limousine*	5.7	4.3	84.3	4.7	4.7	3.7	4.7	3.3	3.7	4.1
PST-B4-246	5.7	5.7	63.3	4.3	5.0	4.0	4.0	3.7	3.7	4.1
Serene*	6.0	5.0	89.3	4.3	4.7	3.7	4.7	3.7	3.7	4.1
A96-451	6.3	6.0	53.3	4.7	5.0	4.3	4.0	3.3	3.0	4.1
BAR Pp 0468	6.0	5.3	75.0	4.3	4.7	3.7	4.3	3.3	4.0	4.1
Eagleton*	5.0	4.0	89.7	5.0	4.3	3.3	4.0	4.0	3.7	4.1
Rita*	6.0	6.0	83.3	4.0	4.3	4.0	4.3	3.7	4.0	4.1
Ascot*	6.0	7.3	64.3	4.3	4.7	3.3	4.3	3.7	4.0	4.1
Blue Velvet (J-1513)*	5.0	8.3	75.0	4.0	4.7	4.0	3.7	3.3	4.7	4.1
A98-183	5.3	6.7	70.0	4.3	4.0	4.3	4.0	3.7	3.7	4.0
A97-1330	6.0	6.0	64.3	4.0	4.3	3.7	4.0	4.3	3.7	4.0
DLF 76-9037	5.7	6.0	81.0	4.7	4.3	3.3	4.0	3.7	4.0	4.0
Kingfisher (SRX 2394)*	5.7	6.3	63.3	4.0	4.7	4.0	4.3	3.7	3.3	4.0
Total Eclipse*	5.0	7.3	77.7	3.7	4.3	4.3	3.7	4.0	4.0	4.0
Blue Knight*	6.0	7.3	64.3	4.7	4.7	3.7	4.3	3.0	3.7	4.0
Julius*	5.7	4.0	75.0	4.0	4.7	4.0	4.0	3.0	4.0	3.9
Midnight II (A98-739)*	5.0	7.3	69.3	3.7	4.3	3.7	4.3	3.7	4.0	3.9
PST-H5-35	5.7	6.3	72.7	4.0	4.7	3.7	4.0	3.7	3.7	3.9
SRX 2114	5.3	6.0	55.0	4.3	5.0	4.0	3.7	3.3	3.3	3.9
Boutique*	5.7	6.3	66.7	4.7	4.7	4.0	4.0	3.0	3.3	3.9
SRX 27921	6.0	6.7	70.0	4.7	4.7	4.0	3.7	3.0	3.7	3.9
BAR Pp 0471	6.0	5.7	64.3	4.0	3.7	3.3	4.3	3.7	4.3	3.9
BAR Pp 0573	5.3	6.0	71.0	4.3	4.3	4.0	4.0	3.3	3.3	3.9
Perfection (J-1515)*	5.3	7.7	71.3	4.0	4.0	4.0	3.3	3.7	4.3	3.9
Quantum Leap*	5.0	7.7	65.3	4.0	4.7	3.3	3.7	3.7	4.0	3.9
Abbey*	6.0	6.3	76.7	4.0	4.3	3.3	4.0	3.7	4.0	3.9

Table 1 (cont). Performance of Kentucky bluegrass cultivars at Wichita, Kan., in 2004.[1]

Cultivar/	Spring	Genetic	% Fall	Quality						
Experimental Number	Green-up	Color	Cover	May	Jun	Jul	Aug	Sep	Oct	Avg
H92-203	6.0	5.3	75.0	4.3	4.3	3.3	4.0	3.3	4.0	3.9
PST-222	5.7	7.0	59.3	4.3	4.3	4.0	4.0	3.7	3.0	3.9
A96-742	5.3	5.0	80.3	4.0	4.3	4.0	3.7	3.7	3.3	3.8
Ba 00-6001	6.0	7.0	74.3	4.0	4.0	3.7	4.0	3.3	4.0	3.8
Baronie*	6.0	5.7	76.7	4.7	4.0	3.3	3.3	3.7	4.0	3.8
Blackstone*	5.3	6.3	75.0	4.7	4.3	3.7	4.3	3.0	3.0	3.8
Casablanca (B3-171)*	6.0	5.3	70.0	4.3	4.0	3.7	4.0	3.3	3.7	3.8
BAR Pp 0566	6.3	7.0	65.0	5.0	5.0	4.0	3.0	3.0	2.7	3.8
PST-B5-125	5.0	5.7	76.7	4.0	4.3	3.7	3.7	3.3	3.7	3.8
SRX QG245	5.7	5.0	66.7	4.3	4.3	3.7	4.7	2.7	3.0	3.8
Wildwood*	5.3	5.7	65.0	3.7	4.7	3.7	3.7	3.3	3.7	3.8
Washington*	5.3	4.0	79.3	4.0	4.0	3.3	3.7	3.7	4.0	3.8
Bluemax (PST-B5-89)*	5.3	7.0	59.3	4.3	4.7	4.0	4.0	2.7	2.7	3.7
Limerick	5.3	4.7	66.7	4.7	4.3	3.3	4.0	3.0	3.0	3.7
Mallard (A97-1439)*	5.7	7.0	61.7	4.3	4.3	3.7	4.0	3.3	2.7	3.7
North Star*	5.0	5.3	68.3	3.7	4.0	3.7	3.7	3.7	3.7	3.7
PST-B3-170	5.0	5.7	61.7	4.3	4.3	4.0	3.3	3.0	3.3	3.7
Tsunami (J-2487)*	5.0	7.3	59.3	3.3	4.3	4.3	3.7	3.3	3.3	3.7
Cabernet*	5.7	4.7	55.0	4.7	4.0	3.3	3.7	3.0	3.3	3.7
DLF 76-9034	5.0	4.0	72.0	4.3	3.7	3.3	4.0	3.7	3.0	3.7
Jefferson*	5.7	5.0	63.3	4.0	3.7	3.0	3.7	3.7	4.0	3.7
B4-128A	5.0	5.0	65.0	4.3	4.3	3.3	3.0	3.0	3.7	3.6
DLF 76-9036	5.0	6.7	59.3	4.0	4.0	3.3	4.0	3.0	3.3	3.6
PST-York Harbor 4	5.7	6.0	68.3	4.0	4.7	3.7	3.7	2.7	2.7	3.6
Pp H 7832	5.3	5.7	56.7	4.0	4.3	3.3	4.0	2.7	3.0	3.6
SI A96-386	6.0	6.0	52.7	4.0	4.0	3.7	3.3	3.3	3.0	3.6
Bartitia*	5.0	5.3	68.3	4.5	3.7	3.3	3.3	3.7	3.3	3.5
99AN-53	5.7	5.3	63.3	4.3	4.0	3.3	3.3	2.7	3.3	3.5
Freedom III (J-2890)*	5.0	7.3	51.3	3.3	3.7	3.0	3.7	3.0	4.3	3.5
NuGlade*	6.0	6.7	59.3	4.0	4.3	3.7	2.7	2.7	3.7	3.5
PST-H6-150	5.7	5.3	43.3	4.0	3.3	3.7	3.3	3.3	3.3	3.5
SRX 26351	5.0	6.0	62.7	4.0	4.3	3.0	4.0	2.3	3.3	3.5
(Cheetah) Pp H 6370	5.0	6.3	70.0	3.7	4.0	3.3	3.7	3.0	3.0	3.4
Brilliant*	5.7	5.3	60.0	3.7	3.7	3.3	3.7	3.0	3.3	3.4
CVB-20631	5.3	6.3	61.7	3.3	3.7	3.3	4.0	3.3	3.0	3.4
HV 238	5.3	5.3	73.3	3.3	3.7	3.3	3.7	3.3	3.3	3.4
Julia*	6.0	5.3	71.7	4.3	4.0	3.0	3.0	3.3	3.0	3.4
Kenblue*	5.0	4.0	78.3	3.7	3.7	3.7	3.7	3.0	3.0	3.4
Chelsea*	5.7	4.7	70.0	3.7	3.3	3.3	3.7	3.3	3.3	3.4
Pp H 6366	5.0	4.7	66.7	4.0	4.3	3.3	3.3	2.0	3.3	3.4
A97-857	5.3	5.0	86.7	4.0	3.7	3.0	3.3	3.0	3.3	3.4
BH 00-6003	5.7	7.0	58.0	3.3	4.0	3.0	3.7	3.3	3.0	3.4
Pp H 7097	5.7	6.3	54.3	3.7	3.7	3.3	3.7	2.7	3.3	3.4
Apollo*	5.7	5.3	63.3	4.3	3.3	2.7	3.3	3.3	3.0	3.3
Bodacious*	5.7	7.0	58.3	3.7	3.7	2.7	3.7	3.0	3.3	3.3
Pick 453	5.3	6.0	51.7	3.3	4.0	3.3	3.7	2.7	3.0	3.3
Pp H 7929	5.7	6.3	53.3	3.7	4.0	2.7	3.3	3.0	3.3	3.3
Ba 84-140	6.3	8.3	51.0	3.7	4.0	3.3	3.7	2.3	2.7	3.3

Table 1 (cont). Performance of Kentucky bluegrass cultivars at Wichita, Kan., in 2004.[1]

Cultivar/ Experimental Number	Spring Green-up	Genetic Color	% Fall Cover	Quality						
				May	Jun	Jul	Aug	Sep	Oct	Avg
Wellington*	5.3	4.0	74.3	3.7	3.3	3.3	3.7	2.7	3.0	3.3
A96-739	6.0	6.7	48.3	3.7	3.3	3.3	3.3	3.0	2.7	3.2
HV 140	5.3	6.3	55.0	4.0	3.7	3.0	3.0	2.7	3.0	3.2
PST-604	6.0	7.3	63.3	3.7	3.7	2.7	3.3	3.0	3.0	3.2
Raven*	5.3	6.0	54.3	3.0	3.0	3.3	3.3	3.0	3.7	3.2
Ba 83-113	6.3	7.3	43.3	3.7	3.0	3.0	3.0	3.0	3.3	3.2
Bariris*	5.7	5.3	45.0	3.3	3.0	3.3	3.7	3.0	2.7	3.2
Courtyard (J-1838)*	5.0	7.3	45.0	3.3	3.7	3.7	4.0	2.3	3.0	3.2
Ginney (J-1368)*	5.3	7.0	44.7	3.3	3.7	3.0	3.0	3.0	3.0	3.2
Goldrush*	5.7	6.0	56.7	3.0	4.0	3.3	3.0	2.7	3.0	3.2
Envicta*	5.3	6.3	66.7	3.0	3.0	3.0	3.0	3.3	3.3	3.1
A97-1432	5.7	6.0	58.3	3.7	4.0	3.0	3.0	2.7	2.3	3.1
Blue-tastic (IB7-308)*	6.0	6.7	31.7	3.3	3.3	3.3	3.0	2.7	2.7	3.1
Blue Ridge (A97-1449)*	6.0	7.0	66.7	3.0	3.3	3.0	3.3	3.0	2.3	3.0
GO-9LM9	5.0	5.0	68.7	3.3	3.3	3.0	3.3	2.0	2.7	2.9
Arrow (A97-1567)*	6.0	6.7	56.7	3.7	3.3	3.0	3.0	2.0	2.3	2.9
Barzan*	5.0	5.7	51.0	3.3	2.7	2.7	3.0	2.7	3.0	2.9
Dynamo (B3-185)*	5.7	5.7	45.0	3.0	3.0	2.7	3.3	2.3	3.0	2.9
Alexa (J-2561)*	5.0	7.5	37.3	2.7	3.0	2.7	4.0	2.7	2.7	2.8
Moonshine (PST-1804)*	5.3	5.7	52.0	3.3	3.3	2.3	3.0	2.3	2.3	2.8
Showcase*	5.7	6.0	46.0	3.3	3.0	2.7	2.7	2.3	2.3	2.7
Beyond (J-1880)*	5.0	7.3	35.3	2.7	3.0	2.7	2.3	2.3	2.7	2.6
Boomerang*	6.0	7.0	44.7	3.3	3.0	2.3	2.3	2.0	2.7	2.6
H92-558	5.3	6.3	19.3	3.0	3.3	2.7	2.0	2.3	2.3	2.6
Moonlight*	6.0	7.3	52.0	3.3	3.3	2.7	2.3	2.0	2.0	2.6
Arcadia*	5.3	7.0	38.3	2.7	2.3	2.3	2.7	2.7	2.3	2.5
Mercury (Pick-232)*	6.0	7.0	58.3	3.0	2.7	2.3	2.7	2.0	2.0	2.4
Blue Sapphire (NA-K991)*	5.3	6.7	19.3	2.7	3.0	2.0	2.7	2.0	2.0	2.4
NA-K992	6.0	6.3	15.0	2.0	2.0	1.3	1.7	1.3	1.3	1.6
LSD[3]	0.9	0.9	70.8	3.2	3.5	2.6	3.1	2.0	2.2	2.3

1 / Ratings based on a 0 - 9 scale, 9 = best measure.
2 / Cultivars marked with "*" commercially available in 2005.
3 / To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Tall Fescue NTEP Evaluation

OBJECTIVE: To evaluate tall fescue cultivars under Kansas conditions and submit data collected to the National Turfgrass Evaluation Program.

PERSONNEL: Linda R. Parsons and Jack D. Fry

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:
Tall fescue is the best adapted cool-season turfgrass for the transition zone in Kansas. It tolerates drought and heat, and has few serious insect or disease problems. Tall fescue possesses a rather coarse leaf texture; it lacks stolons and has only very short rhizomes. Efforts to improve cultivar quality include selection for finer leaf texture; a rich, green color; and better sward density, while maintaining good stress tolerance and disease resistance.

MATERIALS AND METHODS:
After incorporating 13-13-13 NPK at a rate of 1 lb. per 1,000 sq. ft. into 480 5 by 5 ft. study plots at the John C. Pair Horticultural Center in Wichita, the area was seeded September 28, 2001, with 160 tall fescue cultivars and experimental numbers in a randomized complete block design at a rate of 4.4 lb. of seed per 1,000 sq. ft. Fertility was maintained at 0.25 to 0.5 lb. N per 1,000 sq. ft. each growing month. Plots were mowed weekly during the growing season at 2.5 inches with clippings removed. Irrigation was done as necessary to prevent stress; weeds, insects, and diseases were treated only when they presented a threat to the trial.

During the course of the study, we will be collecting information on spring green-up, genetic color, leaf texture, quality, and other measures when appropriate. Rating is done on a 0-to-9 scale: 0 = poorest, 6 = acceptable, and 9 = optimum measure.

RESULTS:
During the summer of 2004, data were collected on turf green-up, quality, color, and texture. By April 27, the cultivars/experimental numbers JTTFF-2000, Dynasty, Gremlin (P-58), K01-8007, Padre (NJ4), Stonewall (JT-18), and Turbo (CAS-MC1) were the greenest (Table 1). Fescue plots were rated monthly throughout the growing season for turf quality. Ratings were influenced by degree of coverage and weed infestation as well as turf color, texture, and density. Those that performed best overall were Finelawn Elite (DLSD), JT-9, CIS-TF-64, Apache III (PST-5A1), BAR Fa 1CR7, and BE1. At the end of the summer, turf color and texture were evaluated with MRF 210, MRF 26 , MRF 27, and NA-TDD the darkest green, and ATF-806, ATF-707, Falcon IV (F-4), Inferno (JT-99), K01-8015, Lancer, PST-5FZ, and Titanium (SBM) with the finest texture.

Table 1. Performance of tall fescue cultivars at Wichita, Kan., in 2004[1]

Cultivar/ Experimental Number	Spring Green-up	Genetic Color	% Fall Cover	Quality						
				May	Jun	Jul	Aug	Sep	Oct	Avg
Finelawn Elite (DLSD)*[2]	6.3	6.0	6.3	5.7	6.0	5.7	5.7	4.7	4.7	5.4
JT-9	6.0	6.0	6.3	6.3	5.3	5.7	5.3	4.3	4.3	5.2
CIS-TF-64	6.3	5.7	6.3	6.3	5.7	5.7	4.7	3.7	4.3	5.1
Apache III (PST-5A1)*	6.3	6.0	6.7	5.3	5.0	5.7	5.0	4.7	4.3	5.0
BAR Fa 1CR7	5.7	6.7	6.7	5.3	5.3	5.3	5.3	4.7	4.0	5.0
BE1	6.3	5.7	5.7	5.0	5.0	5.3	5.0	5.0	4.7	5.0
Constitution (ATF-593)*	6.0	5.7	6.0	5.3	5.7	5.3	4.7	4.7	4.3	5.0
JT-13	6.0	6.3	6.7	5.7	5.3	5.7	5.0	4.3	4.0	5.0
MRF 26	5.7	7.7	6.3	5.0	5.0	5.3	5.0	5.0	4.3	4.9
2nd Millennium*	6.0	6.0	6.7	5.7	5.3	5.0	4.3	4.7	4.7	4.9
Riverside (ProSeeds 5301)*	6.3	6.3	6.3	5.7	5.3	5.0	5.0	4.3	4.3	4.9
Cayenne*	5.7	5.3	5.7	5.7	5.7	5.7	4.3	4.0	4.3	4.9
JT-6	6.0	6.3	6.3	5.3	5.7	6.0	4.7	4.3	3.7	4.9
Pure Gold*	6.3	6.0	6.3	5.3	5.7	5.3	4.7	4.3	4.3	4.9
EA 163	6.0	6.3	6.0	5.7	5.3	5.0	4.7	4.3	4.3	4.9
Turbo (CAS-MC1)*	6.7	6.7	6.3	6.0	5.0	5.0	4.7	4.3	4.3	4.9
Blade Runner (Roberts SM4)*	5.7	6.3	6.3	5.3	5.3	5.3	4.7	4.3	4.3	4.9
Cochise III (018)*	6.0	6.0	6.7	6.0	5.3	5.0	5.3	3.3	4.3	4.9
MA 127	6.0	6.3	6.0	5.3	5.3	5.3	4.3	4.7	4.3	4.9
Raptor (CIS-TF-33)*	6.3	6.0	6.0	6.0	5.7	5.0	5.7	2.7	4.3	4.9
Bingo*	6.0	7.3	6.0	5.3	5.3	5.3	4.7	4.3	4.0	4.8
CIS-TF-60	6.3	7.0	6.0	5.3	5.3	5.3	5.0	3.7	4.3	4.8
Finesse II*	6.3	6.0	6.0	5.7	5.3	5.0	4.7	4.3	4.0	4.8
Forte (BE-2)*	5.7	6.0	6.3	5.0	5.3	5.0	4.7	4.7	4.3	4.8
Grande II*	6.0	5.7	6.7	6.0	5.0	4.3	4.7	4.7	4.3	4.8
Padre (NJ4)*	6.7	6.0	6.0	6.0	5.3	4.7	4.3	4.7	4.0	4.8
Regiment II (SRX 805)*	6.3	7.0	6.0	5.7	5.0	5.3	5.0	4.0	4.0	4.8
Scorpion*	5.7	6.0	6.7	5.3	4.7	5.3	5.0	4.3	4.3	4.8
Silverado II (PST-578)*	6.0	6.0	6.0	5.0	5.3	5.3	5.0	4.0	4.3	4.8
Tahoe (CAS-157)*	6.3	6.0	6.0	5.7	5.0	5.7	4.7	4.0	4.0	4.8
Ultimate (01-RUTOR2)*	5.7	6.0	6.3	5.7	5.0	5.3	4.7	4.0	4.3	4.8
CIS-TF-67	6.0	6.3	6.7	5.3	5.0	5.3	4.3	4.3	4.3	4.8
MRF 210	5.7	7.7	6.0	5.3	5.3	5.3	4.7	4.0	4.0	4.8
MRF 211	5.7	7.3	6.0	5.7	4.7	5.3	4.7	4.0	4.3	4.8
PST-5FZD	6.0	5.7	7.0	5.7	5.3	4.7	4.3	4.3	4.3	4.8
PST-5NAS	6.0	5.7	6.0	5.0	4.7	5.3	5.0	4.0	4.7	4.8
ATF 702	5.7	6.3	5.7	5.3	4.3	5.3	5.3	3.7	4.3	4.7
Dynasty*	6.7	6.0	6.3	5.7	5.0	5.0	4.7	4.0	4.0	4.7
Falcon IV (F-4)*	6.0	6.0	7.0	5.3	4.7	5.0	4.3	4.7	4.3	4.7
Five Point MCN-RC*	6.3	6.3	6.3	5.0	4.7	5.0	5.0	4.7	4.0	4.7
Masterpiece*	6.0	6.3	5.7	5.0	5.0	5.0	4.7	4.3	4.3	4.7
Millennium*	6.3	6.0	6.0	5.7	4.7	5.0	4.3	4.3	4.3	4.7
PST-5KU	5.7	6.3	6.0	5.3	5.3	5.3	4.0	4.3	4.0	4.7
Picasso*	6.3	6.0	6.0	5.3	4.7	5.0	4.7	4.3	4.3	4.7
Pick ZMG	6.3	6.0	5.7	5.7	4.7	5.3	4.7	4.0	4.0	4.7
Southern Choice II*	5.7	7.0	6.0	5.0	5.0	5.3	4.3	4.3	4.3	4.7
Justice (RB2-01)*	5.7	6.0	6.3	5.0	5.0	5.3	4.0	4.3	4.7	4.7
Blackwatch (Pick-OD3-01)*	6.3	6.0	6.3	5.3	5.0	5.3	4.3	4.3	3.7	4.7

Table 1 (continued). Performance of tall fescue cultivars at Wichita, Kan., in 2004.[1]

Cultivar/	Spring	Genetic	% Fall	Quality						
Experimental Number	Green-up	Color	Cover	May	Jun	Jul	Aug	Sep	Oct	Avg
CAS-ED	6.3	7.0	6.3	5.3	4.7	4.7	4.7	4.0	4.7	4.7
Dynamic (PST-57E)*	6.3	5.3	6.3	5.7	5.0	5.3	4.3	3.7	4.0	4.7
Escalade (01-ORU1)*	6.0	6.0	6.3	5.0	4.7	5.0	4.7	4.0	4.7	4.7
Focus*	6.0	6.0	6.0	5.7	4.7	4.7	4.7	4.3	4.0	4.7
Guardian-21 (Roberts DOL)*	6.0	5.7	6.0	5.0	5.0	5.3	4.7	3.7	4.3	4.7
Inferno (JT-99)*	6.3	6.0	7.0	5.7	5.0	5.3	4.3	3.3	4.3	4.7
K01-E03	5.7	6.3	6.7	4.7	5.0	5.3	5.0	4.0	4.0	4.7
Lexington (UT-RB3)*	6.0	6.0	6.0	5.3	5.3	5.3	4.0	4.0	4.0	4.7
Mustang 3*	6.3	6.0	6.0	5.7	5.0	4.7	4.0	4.7	4.0	4.7
PST-5JM	6.0	6.0	6.0	5.3	5.0	4.3	4.3	4.7	4.3	4.7
PST-DDL	6.3	5.7	6.0	6.0	5.0	5.0	4.0	4.3	3.7	4.7
R-4	6.3	6.0	6.7	5.7	5.0	4.7	4.3	4.3	4.0	4.7
Rembrandt*	5.7	5.7	6.0	5.0	5.0	5.0	4.7	4.0	4.3	4.7
SR 8550 (SRX 8BE4)*	6.3	6.0	6.0	5.7	5.0	4.7	4.3	4.3	4.0	4.7
Titanium (SBM)*	6.3	5.7	7.0	4.3	5.3	5.0	4.3	5.0	4.0	4.7
UT-155	6.0	6.3	6.0	5.7	5.0	5.3	4.3	4.0	3.7	4.7
Watchdog*	6.3	5.7	6.7	4.7	5.0	4.7	4.7	4.7	4.3	4.7
CIS-TF-77	6.0	6.0	6.0	5.7	5.0	4.7	4.3	4.3	4.0	4.7
Barrera*	6.0	6.0	6.0	5.3	4.7	5.3	4.7	4.0	3.7	4.6
Falcon II*	5.7	5.7	6.0	4.7	5.0	5.0	4.7	4.0	4.3	4.6
Firebird (CIS-TF-65)*	5.7	7.3	6.0	5.3	5.0	5.0	4.3	4.0	4.0	4.6
K01-E09	6.0	6.0	6.3	5.3	5.0	5.0	4.3	3.7	4.3	4.6
MA 138	6.0	6.7	5.7	5.3	5.0	5.0	4.3	4.0	4.0	4.6
MRF 27	5.7	7.7	6.3	5.3	5.0	5.0	4.7	4.0	3.7	4.6
Rendition*	6.3	5.7	6.3	5.3	4.3	5.0	4.7	4.3	4.0	4.6
Stonewall (JT-18)*	6.7	6.3	6.0	5.7	5.0	5.0	4.3	3.7	4.0	4.6
Coyote*	6.0	6.0	6.3	5.7	4.7	4.7	4.3	4.3	4.0	4.6
Gremlin (P-58)*	6.7	6.0	6.0	5.0	5.0	5.3	4.3	3.7	4.3	4.6
MA 158	6.0	6.3	6.0	5.0	5.0	5.3	4.3	4.0	4.0	4.6
MRF 25	6.0	6.0	6.3	5.7	5.0	5.0	4.0	4.0	4.0	4.6
Matador GT (PST-5TUO)*	6.0	6.0	5.7	5.0	5.3	5.3	4.7	3.7	3.7	4.6
Signia*	6.3	6.0	6.0	5.0	5.3	5.3	4.7	3.7	3.7	4.6
TF66	5.7	6.3	6.0	4.7	5.0	4.7	4.7	4.3	4.3	4.6
DP 50-9226	6.0	6.0	6.0	5.0	5.0	5.0	4.3	4.0	4.0	4.6
JT-12	6.3	6.0	6.7	5.3	5.0	5.0	4.7	3.3	4.0	4.6
Legitimate*	6.0	6.3	6.0	4.3	5.0	5.0	4.7	4.0	4.3	4.6
PST-5BAB	6.0	6.0	6.3	5.0	5.3	4.7	4.3	4.0	4.0	4.6
Quest*	5.7	6.0	6.3	5.0	5.0	5.0	4.0	4.3	4.0	4.6
Barlexas*	5.7	6.0	6.3	5.3	5.3	4.7	4.3	4.0	3.7	4.6
Biltmore*	6.0	6.0	6.0	5.7	5.0	4.7	4.0	4.0	4.0	4.6
BAR Fa 1003	6.3	6.0	5.7	5.0	4.3	5.0	4.7	4.0	4.0	4.5
DP 50-9082	5.7	5.0	6.7	4.7	4.7	4.0	4.7	4.7	4.3	4.5
Davinci (LTP-7801)*	5.7	6.0	6.0	5.3	4.7	4.7	4.3	4.0	4.0	4.5
SR 8600*	6.3	6.0	6.0	5.0	5.0	5.0	4.0	3.7	4.3	4.5
Serengeti (GO-OD2)*	6.3	6.0	6.0	5.3	4.7	5.0	4.0	3.7	4.3	4.5
Matador*	5.7	6.0	6.3	5.3	4.7	5.3	4.0	4.0	3.7	4.5
JTTFF-2000	7.0	5.7	5.7	5.3	4.3	5.0	4.3	3.7	4.0	4.4
K01-8007	6.7	5.0	6.7	6.0	5.0	4.7	4.0	3.0	4.0	4.4

Table 1 (continued). Performance of tall fescue cultivars at Wichita, Kan., in 2004.[1]

Cultivar/ Experimental Number	Spring Green-up	Genetic Color	% Fall Cover	Quality						
				May	Jun	Jul	Aug	Sep	Oct	Avg
MRF 28	6.0	7.3	6.3	5.3	5.0	4.7	4.0	4.0	3.7	4.4
PST-5LO	6.0	6.0	6.7	5.0	4.7	5.0	4.0	3.7	4.3	4.4
PST-5S12	6.3	5.7	6.0	5.0	4.7	4.7	4.3	3.7	4.3	4.4
Silverstar (PST-5ASR)*	5.7	6.0	6.0	5.0	4.7	4.3	4.3	4.7	3.7	4.4
Tar Heel*	6.0	6.0	5.3	4.7	4.7	4.7	4.3	4.3	4.0	4.4
Avenger (L1Z)*	6.0	6.0	6.0	5.0	4.7	5.0	4.3	3.7	4.0	4.4
Bravo*	6.0	6.0	6.3	5.0	4.3	5.3	4.7	3.0	4.3	4.4
JT-15	6.3	6.3	6.7	5.3	4.7	4.3	4.3	4.0	4.0	4.4
K01-8015	5.7	5.7	7.0	5.3	4.7	4.7	4.3	3.7	4.0	4.4
Laramie*	5.7	6.0	6.0	5.0	4.0	4.7	5.0	3.7	4.3	4.4
PST-5BZ	5.3	6.0	6.0	5.3	4.7	4.3	4.3	4.0	4.0	4.4
Barrington*	5.7	6.0	6.0	5.3	4.7	4.7	4.3	3.3	4.0	4.4
Jaguar 3*	5.7	5.7	6.0	4.3	5.0	4.3	4.3	4.3	4.0	4.4
Magellan (OD-4)*	6.3	6.0	6.0	5.3	4.7	4.7	4.0	3.3	4.3	4.4
Pick TF H-97	6.0	5.3	6.7	5.0	4.3	4.3	4.7	4.0	4.0	4.4
Wolfpack*	5.7	5.7	6.3	5.0	4.3	4.3	4.3	3.7	4.7	4.4
B-7001	5.7	6.0	6.3	5.3	4.3	5.3	4.3	3.0	4.0	4.4
Daytona (MRF 23)*	6.0	7.0	5.7	5.0	4.7	4.7	4.3	4.0	3.7	4.4
Prospect*	5.7	6.3	5.7	5.0	4.3	5.0	4.7	3.3	4.0	4.4
Rebel Sentry*	6.3	6.0	6.3	5.3	4.7	4.7	4.0	4.0	3.7	4.4
ATF 806	6.0	5.7	7.3	5.7	5.3	4.3	3.7	3.7	3.3	4.3
K01-WAF	6.0	5.7	6.0	5.0	4.3	5.0	4.0	3.7	4.0	4.3
Kalahari*	6.0	6.0	6.3	5.3	4.3	5.0	4.0	3.3	4.0	4.3
Ninja 2 (ATF-800)*	6.0	6.0	6.0	5.0	4.3	4.7	4.3	3.7	4.0	4.3
PST-53T	6.3	6.3	5.7	5.3	4.3	4.7	4.7	3.3	3.7	4.3
Pick-00-AFA	5.7	6.0	6.3	5.0	4.7	4.3	4.3	4.0	3.7	4.3
Tempest*	6.0	6.7	6.0	4.3	4.7	5.0	4.3	3.7	4.0	4.3
Barlexas II*	6.0	6.0	6.3	5.0	4.3	4.7	3.7	4.0	4.0	4.3
MRF 29	6.3	7.3	5.7	5.7	4.7	4.3	4.3	3.0	3.7	4.3
ATF 707	5.7	6.7	7.0	4.7	4.7	5.0	4.3	3.3	3.7	4.3
Expedetion (ATF-803)*	6.3	7.0	6.7	4.7	4.3	4.7	4.0	3.7	4.3	4.3
Fidelity (PST-5T1)*	6.3	6.0	6.0	5.0	4.7	4.7	4.0	3.7	3.7	4.3
Olympic Gold*	6.0	6.0	6.3	5.0	4.7	4.3	4.0	4.0	3.7	4.3
Rebel Exeda*	6.3	5.7	6.7	5.3	4.7	4.3	4.3	3.3	3.7	4.3
South Paw (MRF 24)*	5.7	6.0	5.7	5.0	4.7	4.3	4.0	3.7	4.0	4.3
Stetson*	6.0	5.7	6.0	4.3	4.7	4.0	4.3	4.0	4.3	4.3
ATF 586	6.3	5.7	6.3	4.7	4.7	4.7	4.3	3.3	3.7	4.2
Lancer*	6.0	5.7	7.0	4.7	5.0	4.3	3.7	4.0	3.7	4.2
SR 8250*	6.0	6.0	5.7	5.0	4.7	4.7	4.3	3.0	3.7	4.2
T991	5.3	7.0	5.7	4.7	4.7	4.3	4.0	3.7	4.0	4.2
Kitty Hawk 2000*	6.0	6.0	6.0	5.0	4.3	4.0	4.0	4.0	4.0	4.2
BAR Fa 1005	6.3	6.0	6.0	5.0	4.3	4.3	4.0	3.3	4.0	4.2
Covenant (ATF 802)*	6.0	6.3	6.0	5.0	4.7	4.7	3.7	3.3	3.7	4.2
Endeavor*	6.0	6.0	6.3	4.3	4.3	4.7	4.3	3.3	4.0	4.2
PST-5KI	6.3	5.7	6.0	5.7	4.0	4.3	3.7	3.3	4.0	4.2
Tar Heel II (PST-5TR1)*	6.0	5.3	6.0	4.3	4.0	4.3	4.0	4.3	4.0	4.2
Titan Ltd.*	5.3	5.3	6.7	4.7	4.3	4.7	3.7	3.7	4.0	4.2
Trooper (T1-TFOR3)*	6.3	6.3	6.0	5.0	4.3	4.3	4.0	3.0	4.3	4.2

Table 1 (continued). Performance of tall fescue cultivars at Wichita, Kan., in 2004.[1]

Cultivar/ Experimental Number	Spring Green-up	Genetic Color	% Fall Cover	Quality May	Jun	Jul	Aug	Sep	Oct	Avg
ATF 704	5.7	6.3	6.0	4.7	4.7	4.3	3.7	3.7	4.0	4.2
DLF-J210	6.3	7.3	6.0	4.7	4.7	4.0	4.0	3.3	4.0	4.1
Plantation*	6.0	6.0	6.0	5.0	4.0	4.3	4.0	3.3	4.0	4.1
Tracer*	6.0	6.7	6.7	5.0	4.3	4.7	4.0	3.0	3.7	4.1
Dominion*	6.3	5.7	5.7	4.3	4.7	4.3	3.7	4.0	3.7	4.1
NA-TDD	6.3	7.7	6.0	4.7	4.3	4.7	4.3	3.0	3.7	4.1
ATF 799	5.7	6.7	6.0	5.0	4.3	4.7	3.7	3.0	3.7	4.1
Tulsa II (ATF 706)*	5.7	6.0	6.3	4.0	4.7	4.7	3.7	3.7	3.7	4.1
Wyatt*	5.7	6.0	6.3	4.3	4.3	4.0	4.0	3.7	4.0	4.1
Bonsai*	5.7	6.0	6.3	4.7	4.3	4.0	4.0	3.3	3.7	4.0
Tomahawk GT*	6.0	6.0	6.0	4.7	4.3	4.7	3.7	3.3	3.3	4.0
Elisa*	6.0	4.3	6.0	4.0	4.0	4.3	3.7	3.7	4.3	4.0
GO-RD4	6.3	6.0	5.7	4.7	4.3	4.0	3.7	3.3	3.7	3.9
Floridian (GO-FL3)*	5.3	5.0	6.3	4.0	4.0	4.0	3.7	3.3	3.7	3.8
GO-SIU2	6.0	5.3	5.7	4.0	4.0	4.0	3.3	3.0	3.3	3.6
Ky-31 E+*	5.7	4.0	3.7	3.0	3.0	3.0	3.0	2.7	3.3	3.0
LSD[3]	2.0	0.7	1.0	0.9	2.0	1.3	2.8	2.6	2.4	0.9

1 / Ratings based on a 0 - 9 scale, 9 = best measure.
2 / Cultivars marked with "*" commercially available in 2004.
3 / To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Fine Fescue NTEP Evaluation

OBJECTIVES: Evaluate performance of fine fescue species and cultivars for adaptation in Kansas.

PERSONNEL: Jack Fry

SPONSOR: National Turfgrass Evaluation Program

INTRODUCTION:
Fine fescues are commonly used in mixtures for shady lawns in Kansas. However, due to the fine texture and good drought resistance in these species there is interest in identifying potential fine fescues for use in full sun as monostands.

METHODS:
Fine fescue species and cultivars were seeded in autumn 2003 in a full-sun location at the Olathe Research Center. Plots were mowed at 3 inches, received no irrigation, and received 3 lb. N per 1,000 sq. ft. each year. Species included strong creeping, hard, chewings, slender creeping, and sheep fescues.

Data were collected on turf quality each month from May through August. Quality was rated visually on a 0-to-9 scale, 9 = best. A quality rating of 6 was considered acceptable for a home lawn.

RESULTS:
Those interested can see results from this location, and others throughout the United States on the Web at www.ntep.org. Cultivars and selections that had a mean quality rating greater than 6 were Jasper II (strong creeping), DP 77-9578 (strong creeping), BUR 4601 (Chewings), PST-8000 (strong creeping), Oxford (hard), PICK CRF 1-03 (strong creeping), 5001 (strong creeping), Predator (hard), IS-FRR 29 (strong creeping), PICK HF #2 (hard), Berkshire (hard), C03-RCE (strong creeping), SPM (hard), SR 3000 (hard), SRX 51G (chewings), Musica (strong creeping), Quatro (sheep), DP 77-9360 (strong creeping), IS-FRR 30 (strong creeping), and IS-FL 28 (hard).

Table 1. Quality ratings of fine fescue species and cultivars at Olathe, Kan., in 2004.[1]

	Turfgrass Quality				
Name	May	June	July	August	Mean
Jasper II*	4.7	7.7	6.3	7.3	6.5
BUR 4601 (Zodiac)*	4.7	7.0	6.3	7.3	6.3
DP 77-9578	5.0	7.0	5.3	8.0	6.3
Oxford*	5.7	6.3	6.7	6.3	6.3
PICK CRF 1-03	4.7	7.3	6.0	7.0	6.3
PST-8000	4.7	7.0	6.3	7.3	6.3
Predator*	5.0	6.3	7.0	6.3	6.2
Berkshire*	5.3	6.7	6.3	6.0	6.1
CO3-RCE	4.7	7.0	5.7	7.0	6.1
IS-FRR 29	4.3	7.3	5.7	7.0	6.1
Musica*	6.0	7.0	5.3	6.0	6.1
Pick HF #2	4.7	6.3	7.0	6.3	6.1
SPM	4.7	6.7	6.3	6.7	6.1
SR 3000*	5.0	6.3	6.7	6.3	6.1
SRX 51G	4.3	6.7	6.3	7.0	6.1
DP 77-9630	4.7	7.3	5.7	6.3	6.0
IS-FL 28	5.0	6.3	6.3	6.3	6.0
IS-FRR 30	4.7	7.0	6.0	6.3	6.0
Quatro*	4.7	7.0	6.7	5.7	6.0
DLF-RCM	4.0	7.0	5.7	7.0	5.9
DP 77-9579	5.0	6.7	5.7	6.3	5.9
Reliant IV (AO163OREL)	4.7	6.7	6.0	6.3	5.9
Ambassador*	4.3	7.0	5.0	7.0	5.8
ASC 245	4.0	7.0	5.3	7.0	5.8
DP 77-9886	5.7	7.0	4.7	6.0	5.8
Razor*	5.3	7.0	5.3	5.7	5.8
Scaldis*	5.3	5.7	6.3	6.0	5.8
Seabreeze*	5.0	6.0	5.0	7.0	5.8
SRX 3K	4.3	6.0	6.7	6.0	5.8
SRX 55R	4.3	6.3	5.7	6.7	5.8
TL-53	3.0	7.0	5.7	7.3	5.8
BMXC-S02	4.3	5.7	6.3	6.3	5.7
TL1	4.4	6.0	5.3	7.0	5.7
Audubon*	5.0	7.0	4.7	5.7	5.6
Celestial*	4.3	6.7	5.0	6.3	5.6
7 Seas*	4.3	6.7	4.7	6.3	5.5
C-SMX	5.0	6.3	5.3	5.3	5.3
C03-4676	4.7	6.3	5.3	5.7	5.5
Pathfinder*	5.0	6.7	4.3	6.0	5.5
ACF 188	4.0	6.3	5.0	6.3	5.4
DP 77-9884	3.7	6.3	5.7	6.0	5.4
Cascade*	5.0	6.0	4.3	5.7	5.3
Culumbra II (ACF 174)	4.0	6.7	5.3	5.3	5.3
Dawson E*	5.0	5.7	5.0	5.7	5.3
IS-FRC 17	4.0	7.0	4.7	5.7	5.3
IS-FRR 23	4.3	6.0	4.7	6.3	5.3
Jamestown 5*	4.3	6.3	4.7	6.0	5.3
Longfellow II*	4.0	7.0	4.7	5.7	5.3
Shademaster*	5.0	5.3	5.0	6.0	5.3
Oracle*	4.7	5.3	5.0	4.7	4.9
Boreal	6.7	4.3	3.7	4.0	4.7
LSD**	1.4	1.7	2.1	1.9	1.0

1 / Ratings based on a 0 - 9 scale, 9 = best measure.

* / Cultivars marked with "*" commercially available in 2005.

** / To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Creeping Bentgrass Fairway NTEP Evaluation

OBJECTIVES: Evaluate performance of creeping bentgrass cultivars under golf course fairway management conditions.

PERSONNEL: Jack Fry

SPONSOR: National Turfgrass Evaluation Program

INTRODUCTION:
Creeping bentgrass is used for putting greens in Kansas, but several courses are using it on fairways. In the eastern half of the United States, creeping bentgrass fairways are commonplace. Information is needed on which creeping bentgrass cultivars are best suited to use under golf course fairway conditions.

METHODS:
Creeping bentgrass was seeded September 24, 2004, in 6 by 6 ft. plots. In 2004, the study area received 3 lb. N per 1,000 sq. ft. Turf was mowed at 0.5 inch. Irrigation was applied to prevent drought stress. An insecticide was applied in July for white grub control; no other pesticides were applied.

Data were collected on turf quality each month and color in the fall. Ratings, except coverage, were done visually on a 0-to-9 scale, 9 = best. A quality rating of 7 was considered acceptable for a golf course fairway. Scalping injury was rated on a 0-to-9 scale, 9 = no evidence of scalping.

RESULTS:
Those interested can see results from this location, and others throughout the United States on the Web at www.ntep.org. Quality was higher early in the season and declined in August and September, due to summer stresses and the presence of dollar spot. Cultivars having a mean quality rating of at least 6 were Kingpin, T-1, Penncross, 13-M, SR 1119, but these were not statistically different from many of the other cultivars. Best genetic color was observed with T-1 and Kingpin. Dollar spot did not differ among cultivars. Cultivars that exhibited greatest scalping injury were 235050, Declaration, SRX 1PDH, Independence, PST-0EB, Bengal, IS-AP 14, 23R, and SRX 1GPD.

Table 1. Visual rating of creeping bentgrass cultivars maintained under fairway conditions at Manhattan, Kan., in 2004.[1]

				Turf quality						
Name	Color	Dollar spot	Scalping	May	June	July	Aug	Sept	Oct	Mean
Kingpin	8.0	7.0	7.0	6.3	7.3	6.3	6.3	5.7	6.0	6.3
T-1*	8.3	6.7	7.0	6.7	8.0	6.3	6.7	5.0	4.7	6.2
13-M	6.7	8.7	7.0	7.0	7.3	6.3	6.3	3.7	5.7	6.1
Penncross*	6.7	6.0	8.7	6.0	7.0	8.0	6.7	3.7	5.0	6.1
SR 1119*	7.3	4.3	7.3	6.7	7.7	7.0	6.7	4.3	3.7	6.0
23R	6.7	6.3	6.3	7.0	7.7	6.0	5.7	5.0	4.0	5.9
Alpha*	7.3	8.3	7.3	7.3	7.7	6.3	6.0	3.7	4.3	5.9
L-93*	6.7	6.3	6.3	6.7	6.3	6.7	5.7	5.3	5.0	5.9
Pennlilnks II*	6.3	7.3	7.3	6.7	6.7	6.0	6.7	4.3	5.0	5.9
PenneagleII	7.3	5.3	7.7	6.3	7.7	6.3	5.6	4.7	4.0	5.8
Princeville*	6.3	6.0	7.7	6.3	7.0	6.7	6.7	4.0	4.3	5.8
PST-9NBC	5.3	63.	9.0	6.0	5.7	7.3	6.0	4.7	4.7	5.7
PST-OEB	6.3	7.0	5.0	7.3	8.0	5.7	5.0	4.0	4.0	5.7
Bengal*	7.0	6.7	6.0	6.0	7.0	6.0	6.0	3.7	5.0	5.6
SRX 1GPD	6.7	6.7	6.3	6.0	7.0	6.0	5.7	3.7	5.0	5.6
IS-AP 14	6.0	4.0	6.0	6.7	6.7	5.7	5.0	4.0	4.3	5.4
IS-AT 7	5.3	8.0	8.7	6.0	5.3	7.3	5.7	3.7	4.3	5.4
PST-9VN	5.0	8.7	9.0	6.0	5.3	6.7	6.0	3.7	5.0	5.4
235050	6.7	8.0	4.0	7.7	7.3	4.3	4.0	3.3	5.0	5.3
Bardot*	5.3	6.3	9.0	5.0	5.3	7.0	5.7	3.7	5.0	5.3
Declaration*	6.7	8.3	4.3	7.0	7.0	4.3	4.7	3.3	5.7	5.3
SRX 1PDH	6.0	6.0	4.3	7.0	6.7	5.0	4.0	4.0	5.0	5.3
EWTR	5.3	7.3	9.0	4.7	5.0	6.3	6.0	3.7	4.7	5.1
Independence*	6.3	5.3	4.3	6.7	7.3	4.7	4.7	3.3	3.3	5.0
Seaside*	6.0	5.3	8.3	5.0	5.0	5.3	5.7	4.7	4.0	4.9
Tiger II	5.3	6.3	8.3	5.3	5.0	6.0	5.3	3.3	4.3	4.9
SR 7150	5.3	8.3	8.7	5.3	5.7	6.3	4.3	3.0	4.0	4.8
LSD**	0.8	4.4	2.4	1.2	0.8	2.3	2.2	1.5	3.1	0.9

1 / Ratings based on a 0 - 9 scale, 9 = best measure.
*Commercially available in 2005.
**To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Creeping Bentgrass Putting Green NTEP Evaluation

OBJECTIVE: Evaluate performance of creeping bentgrass cultivars under golf course putting green conditions.

PERSONNEL: Jack Fry

SPONSOR: National Turfgrass Evaluation Program

INTRODUCTION:
Creeping bentgrass is used on putting greens in Kansas, and there is interest in comparing traditionally used cultivars to new releases.

METHODS:
Creeping bentgrass was seeded September 24, 2003, in 6 by 6 ft. plots. In 2004, approximately 6 lb. N per 1,000 sq. ft. was applied. Irrigation was applied to prevent drought stress, and mowing was done six days weekly at 5/32 inch. An insecticide was applied in August for white grub control; no other pesticides were applied.

Data were collected on turf quality each month from May to October. Quality was rated visually on a 0-to-9 scale, 9 = best. A quality rating of 7 was considered acceptable for a golf course putting green.

RESULTS:
Results from this location, and others throughout the United States, are on the Web at www.ntep.org. Quality differences occurred in all months except May. Selections in the highest statistical grouping for average quality were CY-2, A03-EDI, IS-AP 9, 23R, Benchmark DSR, LS-44, and Penn A-1.

Table 1. Visual quailty ratings of creeping bentgrass cultivars maintained under putting green condition at Manhattan, Kan., in 2004.[1]

Name	Turfgrass Quality						
	May	June	July	Aug	Sept	Oct	Mean
CY-2	4.7	6.3	7.0	6.0	5.7	8.0	6.3
A03-EDI	4.3	6.0	5.7	7.0	6.3	7.7	6.2
IS-AP 9	4.0	6.0	6.7	5.7	5.3	7.7	5.9
23R	4.7	6.3	6.3	5.3	4.7	7.3	5.8
Benchamark DSR*	4.0	5.7	6.0	6.3	5.3	7.3	5.8
LS-44*	4.0	6.0	6.3	6.0	5.3	6.7	5.7
13-M	4.0	5.7	5.3	6.0	5.0	7.3	5.6
PENN A-1*	4.3	6.0	7.3	5.3	4.3	6.3	5.6
235050	4.0	5.7	6.0	5.0	4.7	7.0	5.4
Declaration*	4.0	6.3	5.3	4.3	4.7	7.7	5.4
Pennlinks II	4.0	5.3	5.0	6.0	6.0	6.0	5.4
SRX 1GPD	4.0	6.0	6.3	5.3	4.7	6.3	5.4
Alpha*	4.0	5.7	5.7	5.0	4.7	7.0	5.3
DSP	3.7	6.0	5.3	5.7	4.3	7.0	5.3
Kingpin (9200)	3.3	4.7	5.7	5.7	5.0	6.3	5.1
Penncross*	4.0	4.7	4.7	5.3	4.7	6.3	4.9
SRX 1GD	4.0	5.7	6.0	4.0	3.7	6.0	4.9
Independence*	3.7	5.3	5.7	5.0	4.0	5.3	4.8
T-1*	4.0	5.0	4.3	4.7	4.0	6.7	4.8
Greenwich*	4.0	4.3	5.3	4.0	4.3	5.0	4.5
EFD	3.7	4.0	4.3	4.0	4.3	5.0	4.2
IS-AC 1	4.0	4.0	4.0	4.0	4.0	5.0	4.2
Legendary*	4.0	4.0	3.7	3.7	4.0	5.0	4.1
Vesper*	3.3	4.0	4.3	3.7	4.0	5.0	4.1
SR 7200	3.0	3.0	3.7	3.3	3.7	4.7	3.6
LSD**	1.6	1.0	1.9	1.5	1.6	1.8	1.7

1 / Ratings based on a 0 - 9 scale, 9 = best measure.
*Commercially available in the United States in 2005.
**To determine statistical differences among entries, subtract the mean of one entry from that of another. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Evaluation of Abscisic Acid (ABA) in Drought Stress Suppression on Turfgrass

OBJECTIVE: Evaluate the efficacy of two ABA products applied at different rates alone, or combined with a plant growth regulator for drought stress suppression on turfgrass.

PERSONNEL: Qi Zhang, Jack Fry, Dale Bremer, and Steve Keeley

SPONSORS: Valent Corporation

INTRODUCTION:
Maintaining quality turf with less water on golf courses continues to be a primary objective of golf course superintendents. Abscisic acid is a naturally occurring plant hormone that may influence water use and drought resistance. Our objective was to evaluate the potential for two forms of ABA to reduce drought stress on Kentucky bluegrass and creeping bentgrass.

MATERIALS AND METHODS:
Two ABA products (VBC30025 and VBC30030) were initially applied to Apollo Kentucky bluegrass at different rates, alone or combined with the plant growth regulator Primo, July 18, 2004, at Rocky Ford Turfgrass Research Center, Manhattan (Table 1). Apollo was mowed at a 0.5 inch every other day, and received 3 lb. N per 1,000 sq. ft. per year (May, September, and November). Before the ABA application, the Kentucky bluegrass was well watered; after the initial application, only natural precipitation occurred. Two-liter solutions of each treatment were applied with a CO^2 sprayer at 30 psi every two weeks, except Primo, which was applied every four weeks. On August 10 (the fourth week), rapid decline in quality of Kentucky bluegrass occurred when it was scalped (new employee mistake). This led us to initiate a separate test on an area of fairway-height L-93 creeping bentgrass. This experiment ran from August 16 to September 12, 2004. Plot maintenance and treatments on creeping bentgrass were identical to those on Kentucky bluegrass, except that Primo was applied at 0.5 fl. oz. per 1,000 sq. ft. instead of 0.25 fl. oz. per 1,000 sq. ft. Data were collected on turfgrass visual quality, canopy reflectance, canopy temperature, and net photosynthesis. Analysis of variance was performed on data, and means were separated when significant ($P < 0.05$) effects occurred.

RESULTS:
Turfgrass visual quality. In week 3, untreated Kentucky bluegrass and that treated VBC30025 (100 ppm) and VBC30030 (10 ppm) exhibited better quality than other turf, except that receiving Primo (Table 1).

Canopy reflectance. In week 1, untreated Kentucky bluegrass had the highest vegetation index (NDVI) (Table 2) and leaf area index (LAI) (Table 3); turf treated with VBC30030 at 50 ppm had lowest indices. In week 2, turf treated with VBC30030 (50 ppm) and Primo + VBC30025 (100 ppm) had lower growth indices than that receiving other treatments.

Canopy temperature. No differences were observed in canopy temperature on either Kentucky bluegrass or creeping bentgrass (Table 4).

Net photosynthesis. In week 2 on creeping bentgrass, lower net photosynthesis was detected in turf treated with VBC30025 applied at 500 ppm and in turf receiving the combination of Primo + VBC30025 (100 ppm) (Table 5).

SUMMARY:
No solid conclusions could be drawn from these experiments, due in part to relatively cool and wet weather conditions. During the eight-week period these experiments were conducted, it rained nearly once a week, and total rainfall was 6.1 inches. The high rate of VBC30025 (500 ppm) and VBC30030 (50 ppm), and the combination of VBC30025 + Primo, reduced Kentucky bluegrass quality and biomass indices, and net photosynthesis in creeping bentgrass. Further testing is needed to evaluate the effects of VBC30025 and VBC30030 in turfgrass drought resistance.

Table 1. Turfgrass visual quality as influenced by two abscisic acids, VBC30025 and VBC30030, at Manhattan, Kan., in 2004.

Treatment	Kentucky bluegrass			Creeping bentgrass			
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3	Week 4
Control	6.75	6.00	6.00 a	6.25	6.00	5.50	5.25
30025 (100 ppm)	6.75	5.75	5.75 a	6.50	5.75	6.00	5.25
30025 (500 ppm)	6.25	5.75	4.75 b	5.75	5.50	5.50	5.25
30030 (10 ppm)	7.00	6.25	6.00 a	6.00	6.50	6.00	5.75
30030 (50 ppm)	6.50	5.50	4.50 b	6.00	6.25	5.50	5.25
Primo†	6.50	6.00	5.50 ab	6.50	6.00	6.00	5.50
Primo†+30025 (100 ppm)	6.25	5.50	4.75 b	5.75	5.75	5.00	4.75
ANOVA	NS	NS	*	NS	NS	NS	NS

Turfgrass visual quality was rated with a 0-9 scale, where 0 = poorest quality, 6 = acceptable quality for golf fairway, and 9 = best quality.
NS, * indicate no significant difference and significant difference at $P \leq 0.05$.
†Primo was applied at 0.25 fl. oz. per 1,000 sq. ft. on Kentucky bluegrass; 0.5 fl. oz. per 1,000 sq. ft. on creeping bentgrass.

Table 2. Normalized difference vegetation index (NDVI) on turfgrass as influenced by two abscisic acids, VBC30025 and VBC30030, at Manhattan, Kan., in 2004.

Treatment	Kentucky bluegrass			Creeping bentgrass			
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3	Week 4
Control	0.84 a	0.811a	0.73	0.75	0.76	0.82	0.82
30025 (100 ppm)	0.84 ab	0.81 a	0.72	0.75	0.78	0.83	0.83
30025 (500 ppm)	0.82 bc	0.79 ab	0.70	0.73	0.76	0.81	0.82
30030 (10 ppm)	0.83 ab	0.80 a	0.73	0.75	0.76	0.82	0.83
30030 (50 ppm)	0.81 d	0.78 b	0.70	0.73	0.76	0.80	0.82
Primo†	0.83 b	0.80 a	0.73	0.76	0.76	0.81	0.82
Primo†+30025(100 ppm)	0.82 c	0.79 b	0.70	0.74	0.73	0.78	0.80
ANOVA	*	*	NS	NS	NS	NS	NS

NS, * indicate no significant difference and significant difference at $P \leq 0.05$.
†Primo was applied at 0.25 fl. oz. per 1,000 sq. ft. on Kentucky bluegrass; 0.5 fl. oz. per 1,000 sq. ft. on creeping bentgrass.

Table 3. Leaf area index (LAI) on turfgrass as influenced by two abscisic acids, VBC30025 and VBC30030, at Manhattan, Kan., in 2004.

Treatment	Kentucky bluegrass			Creeping bentgrass			
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3	Week 4
Control	11.67 a	9.63 a	6.38	7.03	7.67	10.18	10.24
30025 (100 ppm)	11.19 b	9.40 a	6.04	7.21	8.19	10.66	11.11
30025 (500 ppm)	10.43 b	8.74 ab	5.69	6.42	7.51	9.79	10.10
30030 (10 ppm)	11.10ab	9.20 a	6.36	7.13	7.46	10.25	11.01
30030 (50 ppm)	9.45 d	8.04 b	5.65	6.69	7.54	9.40	10.31
Primo†	10.90 b	9.08 a	6.52	7.50	7.66	9.61	10.50
Primo†+30025 (100 ppm)	10.17 c	8.53 b	5.76	6.70	6.58	8.39	9.16
ANOVA	*	*	NS	NS	NS	NS	NS

NS, * indicate no significant difference and significant difference at $P \leq 0.05$.

†Primo was applied at 0.25 fl. oz. per 1,000 sq. ft. on Kentucky bluegrass; 0.5 fl. oz. per 1,000 sq. ft. on creeping bentgrass.

Table 4. Canopy temperature (NC) on turfgrass as influenced by two abscisic acids, VBC30025 and VBC30030, at Manhattan, Kan., in 2004.

Treatment	Kentucky bluegrass			Creeping bentgrass			
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3	Week 4
Control	34.8	37.3	44.1	39.4	35.7	34.0	34.5
30025 (100 ppm)	35.3	37.7	43.8	39.4	35.8	33.1	33.9
30025 (500 ppm)	34.8	37.2	44.6	39.8	35.6	34.0	34.4
30030 (10 ppm)	35.0	36.5	44.2	39.8	35.7	33.9	33.7
30030 (50 ppm)	35.7	37.1	44.9	39.6	35.5	33.6	34.4
Primo†	34.9	38.0	44.5	38.9	35.9	33.1	33.3
Primo†+30025 (100 ppm)	35.5	37.9	44.2	39.1	36.2	33.9	34.0
ANOVA	NS	NS	NS	NS	NS	NS	NS

NS, * indicate no significant difference and significant difference at $P \leq 0.05$.

†Primo was applied at 0.25 fl. oz. per 1,000 sq. ft. on Kentucky bluegrass; 0.5 fl. oz. per 1,000 sq. ft. on creeping bentgrass.

Table 5. Net photosynthesis (CO^2 exchange:μmol^{-2} m^{-2} s^{-1}) on turfgrass as influenced by two abscisic acids, VBC30025 and VBC30030, at Manhattan, Kan., in 2004.

Treatment	Kentucky bluegrass			Creeping bentgrass			
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3	Week 4
Control	6.73	4.86	5.80	1.83	7.33 a	10.14	5.23
30025 (100ppm)	6.83	4.62	5.99	2.58	6.73 ab	10.11	4.63
30025 (500ppm)	6.45	4.85	6.35	1.33	5.08 c	9.51	4.65
30030 (10ppm)	6.96	4.70	5.98	3.19	6.76 ab	9.40	6.85
30030 (50ppm)	5.20	3.03	6.44	2.92	5.60 bc	7.54	4.96
Primo†	6.73	5.32	5.87	3.20	6.41 ab	8.36	5.01
Primo†+30025(100ppm)	7.10	4.96	6.12	1.85	4.89 c	8.76	4.12
ANOVA	NS	NS	NS	NS	*	NS	NS

NS, * indicate no significant difference and significant difference at $P \leq 0.05$.

†Primo was applied at 0.25 fl. oz. per 1,000 sq. ft. on Kentucky bluegrass; 0.5 fl. oz. per 1,000 sq. ft. on creeping bentgrass.

TITLE: Drought Resistance of Two Cultivars of Texas Bluegrass Hybrids Compared with Kentucky Bluegrass and Tall Fescue

OBJECTIVES: Evaluate the qualities of Texas bluegrass hybrids, Kentucky bluegrass, and tall fescue under varying irrigation regimes and deficits. Investigate the effects of mowing height and irrigation deficit on the qualities and drought tolerance of a Texas bluegrass hybrid and Kentucky bluegrass.

PERSONNEL: Dale Bremer, Jack Fry, Steven Keeley, and Kemin Su

SPONSORS: The Scotts Co., Inc.; Golf Course Superintendents Association of America; and Kansas Turfgrass Foundation

INTRODUCTION:
Kentucky bluegrass (*Poa pratensis L.*) is a cool-season grass that is commonly used on fairways and roughs of golf courses in the United States. Tall fescue (*Festuca arundinacea Schreb.*), also a cool-season grass, is sometimes used in roughs. In some areas of the country these grasses are subjected to frequent drought, which results in either heat and drought symptoms or high irrigation rates to maintain acceptable quality. Kentucky bluegrass commonly goes dormant and loses color during periods of high temperature and drought. Tall fescue has good drought resistance, but some superintendents prefer the finer texture that Kentucky bluegrass offers.

New Texas bluegrass (*Poa arachnifera Torr.*) hybrids, which are genetic crosses between Kentucky bluegrass and native Texas bluegrasses, have the appearance of Kentucky bluegrass but may be able to withstand higher temperatures and extended drought without going dormant, and may maintain their green appearance during all but extreme conditions. In warm-season climates such as the South, Texas bluegrasses stay green all year long. Furthermore, Texas bluegrass hybrids may use significantly less water than other cool-season species while maintaining their green color. The latter is important given the increasing competition for water and the rising costs of irrigation.

At least one hybrid of Texas bluegrass – Reveille – has demonstrated disease resistance to leaf rust, powdery mildew, and summer patch, although it shows susceptibility to brown patch, especially when over-fertilized. Reveille also has shown resistance to fall armyworms and white grubs, but tests have revealed it performs poorly in saline soils. Observations of other Texas bluegrass hybrids have suggested that disease resistance and susceptibility are similar to Kentucky bluegrasses.

Reveille is advertised as a “multi-use, cool-season grass for the Eastern Seaboard, transition zone, arid West, and Southern United States” that has similar water requirements to common bermudagrass. Tests with Reveille revealed no significant decline in visual quality ratings when irrigation was decreased from 2/3 to 1/3 of open-pan evaporation (in Texas; James Read, personal communication). This suggests that Texas bluegrass is a high quality, low water-use, and high heat-tolerant turfgrass that may be well suited for golf course fairways and roughs in some parts of the United States, including the transition zone.

Despite the promising role that Texas bluegrass may play on U.S. golf courses, little scientific data is available about its qualities under the various forms of management and stress that it would be subjected to on golf courses. For example, the effect of different mowing heights on the drought- and heat-tolerance characteristics is unknown. Some parts of the transition zone are subjected to extreme cold during winter months, and its cold hardiness compared to that of Kentucky bluegrass has not been evaluated. It is also uncertain how it compares in quality to Kentucky bluegrass under various irrigation regimes and deficits.

OBJECTIVES:

The main objectives of this study were to: 1) compare the drought resistance characteristics of two cultivars of Texas bluegrass hybrids to those of Kentucky bluegrass and tall fescue, and 2) compare the drought tolerance of a Texas bluegrass hybrid with Kentucky bluegrass under different irrigation regimes and mowing heights.

METHODS:

Study 1

Plots for Study 1 were seeded in September 2002. Two cultivars of Texas bluegrass hybrids – Thermal Blue and Dura Blue; seed provided by the O.M. Scotts Co. – were compared with Kentucky bluegrass Apollo and tall fescue Dynasty in the water-deficit trial at Rocky Ford Turf Research Center near Manhattan, Kan. Two irrigation treatments and a control were applied to plots. Irrigation treatments included the replacement of 60% or 100% of the water lost from plants and soil via evapotranspiration (ET). Control plots received minimal irrigation (i.e., only enough to maintain survival). Water was applied by hand and the amount applied measured with a metering device. The split-plot design included twelve whole plots (8 by 3 m each) of one irrigation treatment each, arranged in a randomized block design (i.e., three blocks). Each main plot was subdivided into four subplots (2 by 1 m each). The subplots within each whole plot contained one each of Kentucky bluegrass, tall fescue, and each of two Texas bluegrass hybrids – Thermal Blue (formerly HB 129) and Dura Blue (formerly HB 329). All plots were mowed at a height of 2.5 inches once or twice weekly, depending upon growth rate. Turf received 4 lb. N per 1,000 sq. ft. in 2004. Pesticides for billbugs and broadleaf weeds were applied as needed. ET was calculated using empirical equations and weather data obtained from the weather station located at the research center. Precipitation was monitored with a tipping-bucket rain gauge.

All plots were evaluated biweekly for visual quality. This included a relative ranking of the overall density, uniformity, texture, and color of the turfgrass in each plot. Because rainfall was above average during the summer of 2004, comparisons of drought resistance among varieties were hindered. Therefore, most data were comparisons of the varieties or cultivars under well-watered conditions. One dry period occurred during the cooler months of September and October. Comparisons of turfgrass performance among irrigation treatments were evaluated during that period.

Study 2

Plots were established under the large rainout shelter at Rocky Ford in September 2003. The objective was to evaluate the effect of mowing height and irrigation treatment on the various qualities of a Texas bluegrass hybrid, Thermal Blue (formerly HB 129), and a Kentucky bluegrass, Apollo. Treatments included two mowing heights: 1.5 or 3 inches. Two irrigation treatments included the replacement of 100% or 60% of the water lost from plants and soil via evapotranspiration (ET), which were estimated with the Penman-Monteith equation. Time domain reflectometry (TDR) and dual-probe heat-pulse sensors were used to monitor soil moisture to prevent the over- or under-application of water. Water was applied by hand using a meter to control precisely the amount applied to each plot. A split-split plot design included eight main plots (2.72 by 3.52 m each) of one irrigation treatment each that were arranged in a randomized block design (i.e., four blocks). Each main plot was subdivided into two subplots (1.36 by 3.52 m) that consisted of the two mowing treatments. Each subplot (mowing treatment) was divided into two sub-subplots that contained one each of Apollo and Thermal Blue. This study will continue through the end of 2005. Plots were evaluated visually for quality, color, and density using the same methods as described in the first study. Photosynthesis measurements were collected on plots to determine the effects of mowing and water deficit on basic plant processes.

RESULTS:

Study 1

Precipitation was 4.05 inches above normal for the period April 1 through August 31 and 5.4 inches below normal from September 1 through October 31 (Figure 1). Most of the data presented are for the summer period when the turfgrass was well-watered. However, evaluations from the dry period in September and October revealed that all varieties and cultivars performed well when irrigated at 100% ET replacement (Figure 2). Irrigation-deficit reduced visual quality, particularly in the bluegrasses. In general, quality was significantly lower in the bluegrasses than in Dynasty in the irrigation deficit treatments ($P<0.05$). Within each variety, irrigation deficit significantly reduced visual quality in the bluegrasses, whereas quality was not significantly affected by irrigation deficit in tall fescue (Figure 3).

Quality ratings during the wet summer were generally highest in Dynasty (Figure 4); Apollo tended to have the second highest ranking among species, and HB 329 was the lowest. Color ratings showed Dynasty and Apollo in the lead early in the growing season (Figure 5). Thermal Blue was generally lower, primarily because of a lighter color. The lighter color also reduced its overall quality rating during the summer (Figure 4). The improvement in color in Thermal Blue on July 12 (day of year 194) was likely caused by fertilization. Thus, Thermal Blue is capable of high color ratings but may require more fertilizer. Density ratings also were highest in Dynasty throughout the growing season, and density was satisfactory in Apollo and Thermal Blue (Figure 6). Density was lowest in HB 329, as it had been since establishment. HB 329 may require a higher seeding rate to establish the desired density (our plots were seeded at 3 lb. per 1,000 sq. ft.). Canopy heights before mowing were similar among species early in the summer, although Thermal Blue tended to be higher throughout the period (Figure 7). Canopy heights decreased in Apollo in late July and August. Vertical growth rates during the period also tended to be higher in Thermal Blue, and the growth rate of Apollo was lower during late July and August (Figure 8). The amount of clippings collected from the plots was generally highest in Thermal Blue early in the season, but by July and August Dynasty was producing the same amount (Figure 9). The lowest clippings were measured on Apollo and HB 329 during most of the summer.

Study 2

Irrigation treatments began late in the summer of 2004. Problems with summer patch, primarily in Thermal Blue but also in Apollo, caused a substantial delay in the study, and results are tentative. Initial observations indicate that Thermal Blue may perform well at the lower mowing height (1.5 inches). In 2005, plots are being treated routinely with fungicide beginning in April to control summer patch. As in the last two years, billbugs will be controlled aggressively with both systemic and contact insecticides.

CONCLUSIONS:

In Study 1, Dynasty was the most robust of the four turfgrasses overall, as indicated by most measurements and ratings (Figures 2-9). Above-normal rainfall during the summer prevented comparisons of drought resistance among varieties during most of the year, although measurements during a dry period in the fall indicated tall fescue performed better than any of the bluegrasses. In Study 2, problems with summer patch in Thermal Blue and Apollo prevented collection of meaningful data. The study will continue into 2005 and will include a preventative fungicide program to control summer patch.

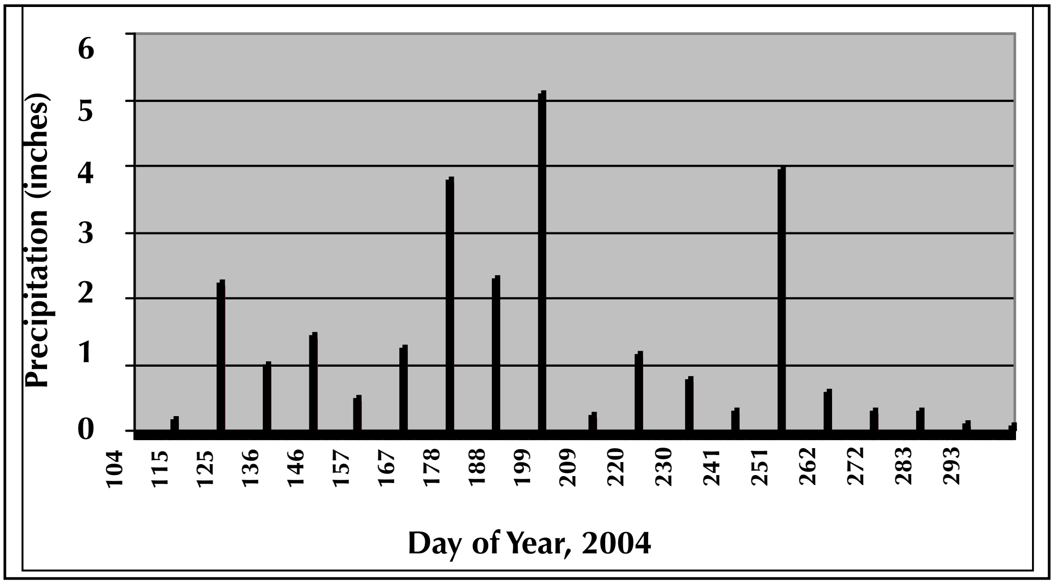

Figure 1. Precipitation (10-day sums) at Rocky Ford Turfgrass Research Center during the 2004 growing season. Precipitation from April through August (day of year 91 to 243) was 4.05 inches above the 30-year average for the same period.

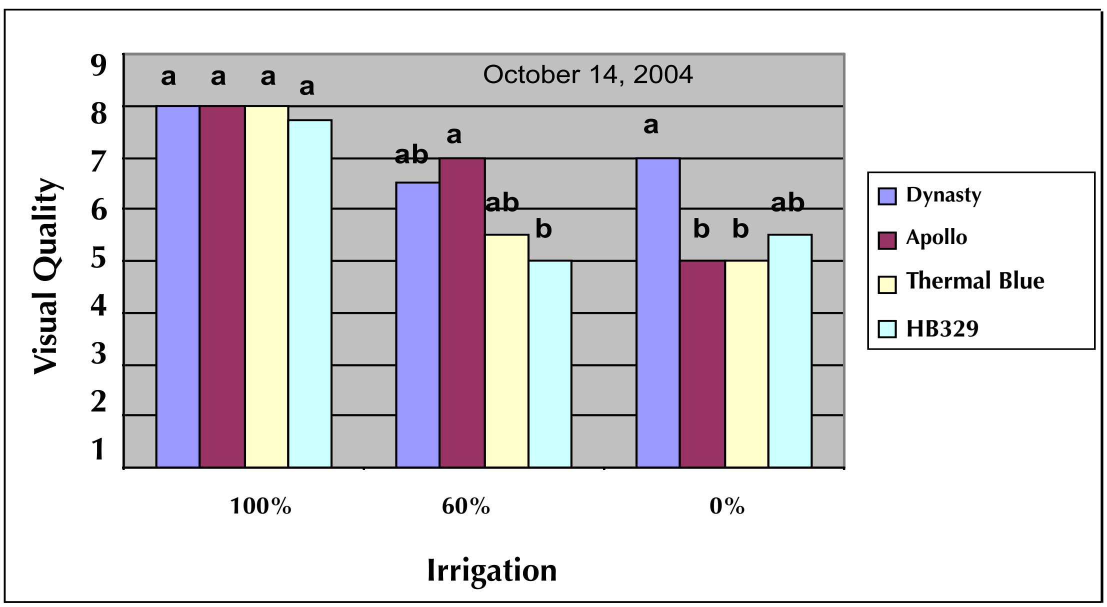

Figure 2. Comparisons of visual quality of varieties/cultivars within each irrigation treatment after a dry period during September and early October. Means with same letters within each irrigation group were not significantly different (P<0.05). Varieties/cultivars include two Texas bluegrass hybrids (Thermal Blue and Dura Blue); Kentucky bluegrass (Apollo); and tall fescue (Dynasty).

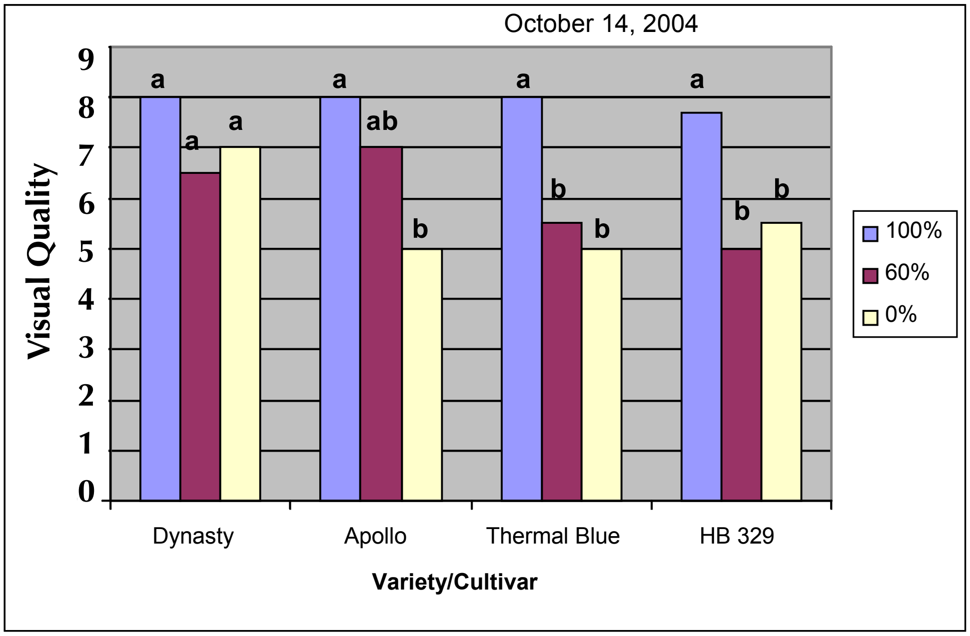

Figure 3. Effects of irrigation deficits on the visual quality of each variety or cultivar after a dry period in September and early October. Means with same letter within each variety were not significantly different (P<0.05).

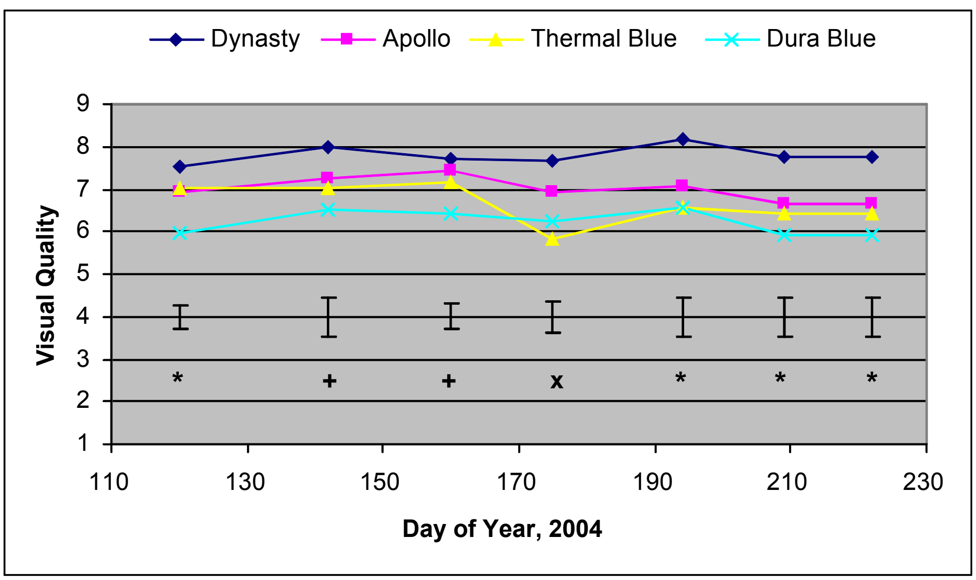

Figure 4. Visual quality ratings of the four varieties/cultivars of turfgrasses from April 21 to August 9 (day of year 120 to 222), 2004. Ratings are on a 1-to-9 scale: 9 = best, 6 = minimally acceptable, and 1 = poor. Symbols along the abscissa represent significant differences: * = between one and three other varieties/cultivars; + = between one and two other varieties/cultivars; and x = among three varieties ($P < 0.05$). Error bars represent one standard error (9 replicates each).

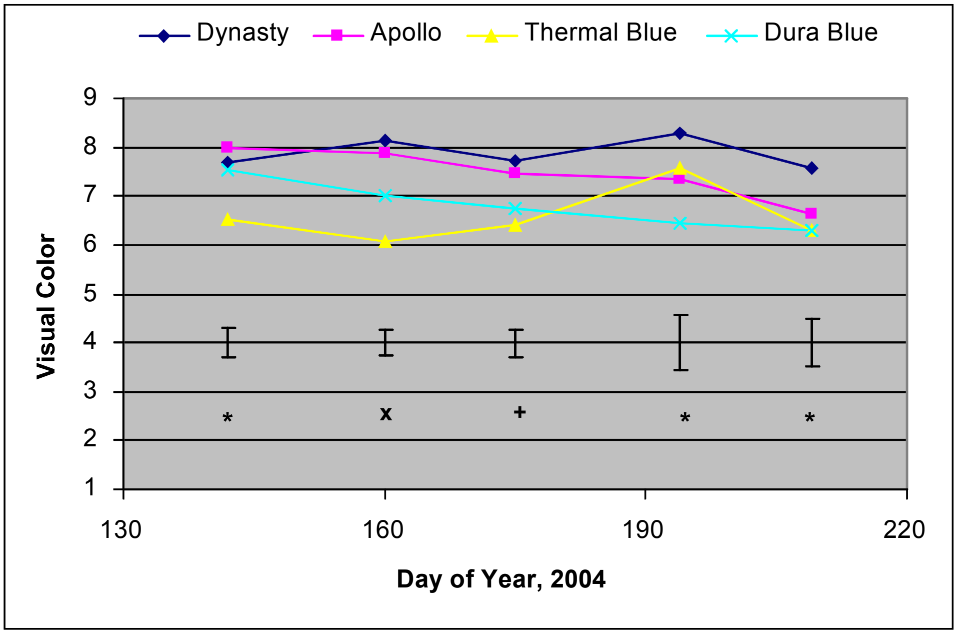

Figure 5. Visual color ratings of the four turfgrasses from May 21 to July 27 (day of year 142 to 209), 2004, on a 1-to-9 scale: 9 = dark green, 6 = minimally acceptable, 1 = yellow. Symbols along the abscissa represent significant differences: * = between one and three other varieties/cultivars; + = between one and two other varieties/cultivars; and x = among three varieties ($P < 0.05$). Error bars represent one standard error (9 replicates each).

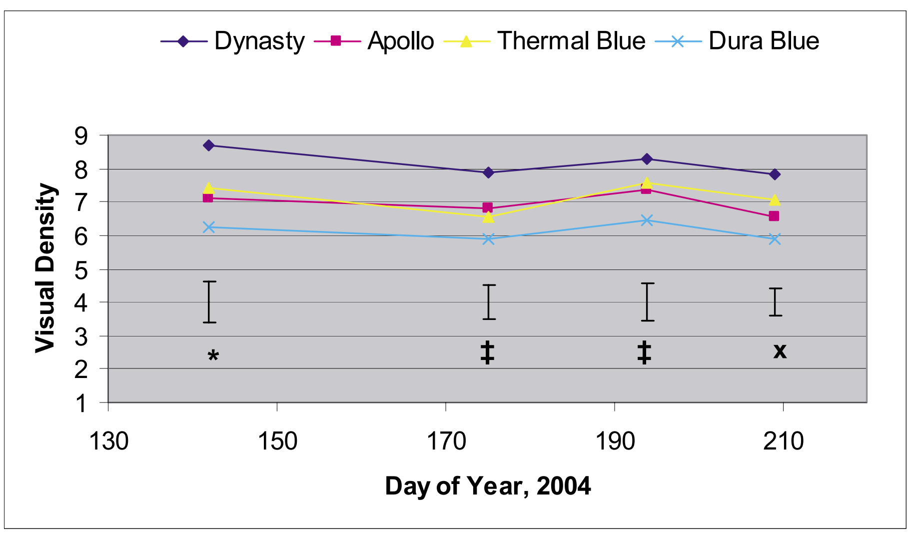

Figure 6. Density ratings for the four turfgrasses from May 21 to July 27 (day of year 142 to 209), 2004, on a 1-to-9 scale: 9 = total cover, 1 = no cover. Symbols along the abscissa represent significant differences: * = between one and three other varieties/cultivars; x = among three varieties/cultivars; and ‡ = between two varieties ($P < 0.05$). Error bars represent one standard error (9 replicates each).

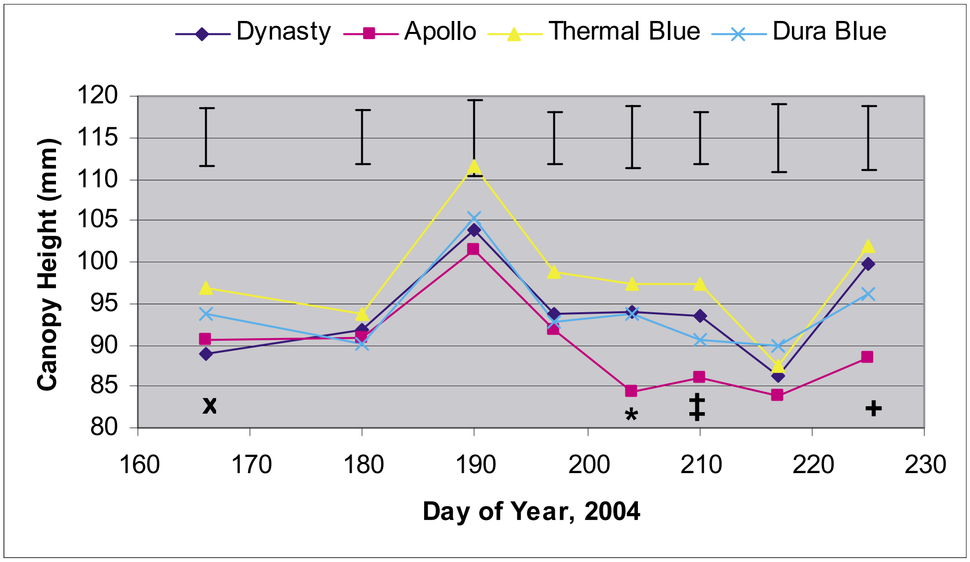

Figure 7. Canopy heights (prior to mowing) from June 14 to August 12 (day of year 166 to 225). Symbols along the abscissa represent significant differences: x = among three varieties/cultivars; * = between one and three other varieties/cultivars; ‡ = between two varieties; and + = between one and two other varieties/cultivars ($P < 0.05$). Error bars represent one standard error (9 replicates).

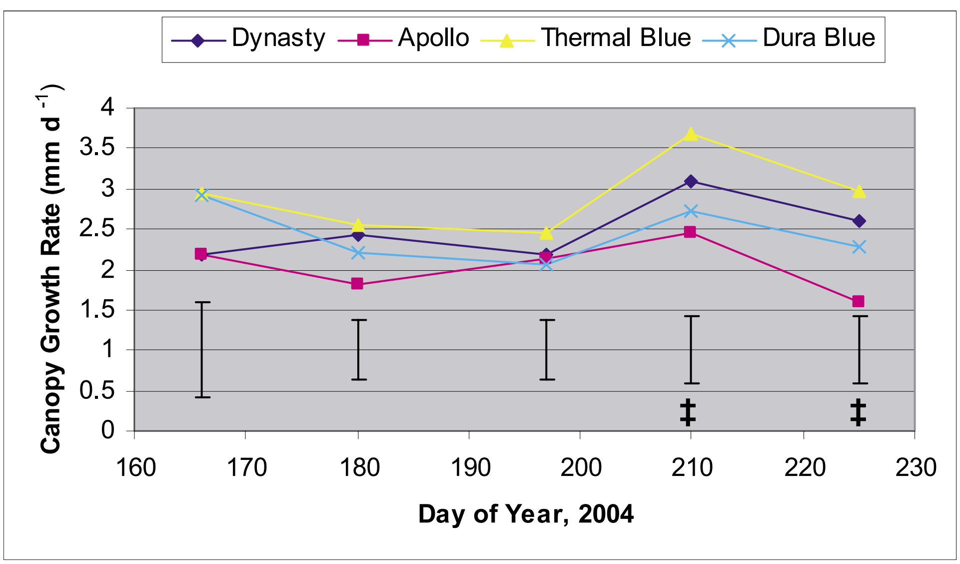

Figure 8. Canopy vertical growth rates (millimeters per day) of the canopy in the four turfgrasses from June 8 to August 12 (day of year 160 to 225). Symbols along the abscissa (‡) represent significant differences between two varieties ($P < 0.05$). Error bars represent one standard error (9 replicates).

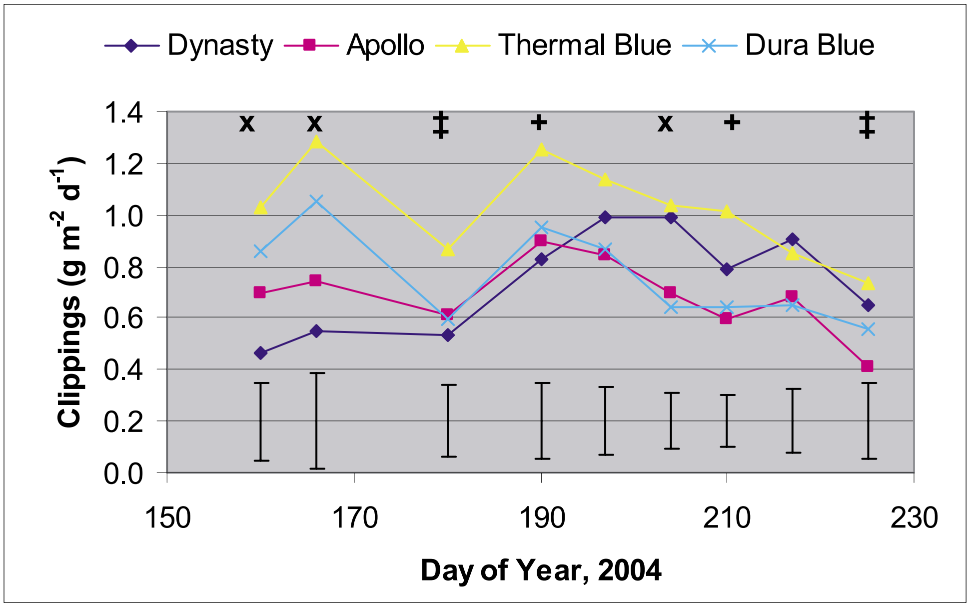

Figure 9. Clippings of the four turfgrasses from June 8 to August 12 (day of year 160 to 225). Symbols along the abscissa represent significant differences: x = among three varieties/cultivars; ‡ = between two varieties; and + = between one and two other varieties/cultivars ($P < 0.05$). Error bars represent one standard error (9 replicates).

TITLE: Effects of nitrogen fertilizer types and rates and irrigation on nitrous oxide fluxes in turfgrass

OBJECTIVE: Quantify the magnitude and patterns of nitrous oxide (N_2O) fluxes in turfgrass and determine how management practices may be used to reduce those fluxes and mitigate the greenhouse effect.

PERSONNEL: Dale Bremer

SPONSORS: Kansas National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR) and the Kansas Turfgrass Foundation (KTF).

INTRODUCTION:

Anthropogenic activities have contributed to an increase in concentrations of atmospheric nitrous oxide (N_2O), and agriculture is considered a significant source. A number of studies have determined that N_2O fluxes into the atmosphere are higher in croplands where N fertilization and irrigation rates are high. However, urbanization in the United States and elsewhere is replacing significant tracts of land that were once occupied by natural or agricultural ecosystems. More than 20 million hectares of urbanized land are covered by turfgrass (e.g., golf courses, sports fields, parks, home lawns, etc.), which is often irrigated and heavily fertilized with N. Urban areas may represent an unappreciated, but significant contributor to atmospheric N_2O. Adopting best management practices (BMPs) in turf ecosystems may help to mitigate the greenhouse effect by reducing effluxes of N_2O, which has 310 times the warming power of CO_2. Research is needed to determine BMPs in turfgrass ecosystems.

Little information is available in the literature on the effect of management practices on N_2O fluxes in turf. In one study, flux rates of 2021 ng N_2O-N m^{-2} s^{-1} were reported in turfgrass after N fertilization. In that study, it was also determined that fertilizer type had significant effects on N_2O fluxes, with urea-based fertilizers resulting in lower N_2O emissions than other fertilizer types. Others reported that soil temperatures of 30°C or higher, coupled with saturated soil conditions, increased denitrification rates in Kentucky bluegrass sod; higher denitrification rates typically result in higher N_2O emissions. Soil texture and soil organic carbon also may affect N_2O fluxes.

Modelers have determined that patterns of N_2O fluxes are evident at the ecosystem scale in forest, cropland, and rangeland ecosystems, which may be useful in predicting regional and global N_2O fluxes. Although N_2O emissions from urbanized land (e.g., turfgrass ecosystems) also may be important on regional and global scales, the role of turfgrass ecosystems in the nation's N_2O inventory is unknown. Therefore, N_2O flux data from turfgrasses are needed to test and improve those models of N_2O fluxes. Figure 1 illustrates how N fertilizer types and amounts, along with precipitation and irrigation, may affect N_2O emissions from the surface of a turfgrass (or any plant ecosystem) surface.

In this study, N_2O emission data from turfgrass were collected under various forms of irrigation and N-fertility management regimes. The site for this project was the Rocky Ford Turfgrass Research Center, which was established more than 40 years ago and contains approximately 5.25 hectares of turfgrass.

The specific objectives for the 12-month period of this research were to:

1. quantify the magnitude and patterns of N_2O flux rates in a turfgrass ecosystem;
2. determine the effect of nitrogen fertilization rates on N_2O fluxes in turfgrass;
3. determine the effect of nitrogen fertilizer types on N_2O fluxes in turfgrass;
4. determine the effect of irrigation amounts on N_2O fluxes in turfgrass.

METHODS:

The study was conducted from October 2003 to early October 2004 at the Rocky Ford Turfgrass Research Center near Manhattan (Rocky Ford; 39.12°N, 96.35°W). The soil at the site was a Chase silt loam (fine, montmorillonitic, mesic, Aquic, Arquidolls). Mean annual air temperature was 11.6°C, which was 1.1°C below the 30-year mean; precipitation was 887 mm, or 3 mm above normal. The summer months were substantially wetter and cooler than normal: Precipitation between June and August 2004 was 468 mm, which was 148 mm above normal; average temperature was 23.2°C, or 2.1°C below normal for the same period.

The study was conducted in two phases. Phase 1 included the investigation of fertilizer type and amounts on N_2O fluxes from the turfgrass surface and was conducted from October 2003 to August 2004. In Phase 2, the study was expanded to include the effects of irrigation on N_2O fluxes and included a high irrigation treatment and a control with minimal irrigation. Initially, Phase 2 was scheduled to run from June through September 2004. However, higher than normal precipitation kept soils wet among plots from June through August, and irrigation requirements were low and erratic during that period. Phase 2 was delayed until September when precipitation curtailed; precipitation was 26 mm during September (67 mm below normal) and no precipitation occurred in early October before the study ended. Therefore, Phase 2 was a shorter study that lasted about one month (DOY 250 to 280, 2004) and was conducted after Phase 1 on the same plots.

Phase 1

Thirty-six plots (2 by 2 m each) were established in September 2003 in an existing sward of perennial ryegrass (*Lolium perenne L.*); plots were separated by at least two meters. Three treatments representing combinations of N fertilizer types and amounts were applied to plots arranged in a randomized block design. Treatments included: 1) urea N at a high rate (UH; 250 kg N ha^{-1} yr^{-1}); 2) urea N at a low rate (UL; 50 kg N ha^{-1} yr^{-1}); and 3) ammonium sulfate N at a high rate (AS; 250 kg N ha^{-1} y^{-1}). Treatments were replicated two times per block for a total of 12 replications each. In the high N treatment, urea and ammonium sulfate were applied in split-applications of: 75 kg N ha^{-1} on DOY 279, 2003; 50 kg N ha^{-1} on DOY 318, 2003; DOY 86, 2004; and DOY 128, 2004, respectively; and 25 kg N ha^{-1} on DOY 191, 2004. In the low N treatment, 50 kg N ha^{-1} was applied on DOY 279, 2003.

After fertilizations, plots were irrigated with about 15 mm of water to incorporate fertilizer into the soil and reduce ammonia volatilization. Plots were irrigated one to three times weekly or as needed. Irrigation applications were measured with in-line flow meters; a separate flow meter was installed in each block to measure irrigation amounts. Plots were mowed once or twice weekly as needed, at a height of 7.5 cm with a walk-behind rotary mower.

The plot area was treated with herbicides on DOY 295, 2003, and DOY 148, 2004, for broadleaf control (carfentrazone-ethyl) and on DOY 148, 2004, for control of grassy weeds (dithiopyr). Fungicide (daconil) was applied on DOY 149, 2004, for dollar spot control and an insecticide (halofenozide) was applied on DOY 191, 2004, to control white grubs.

Phase 2

In September 2004, irrigation treatments were added to existing fertilizer treatments to evaluate the effects of irrigation on N_2O fluxes. Irrigation treatments, including one well-watered and one essentially non-irrigated control, were applied to entire blocks in a split-plot design where the whole plot represented the irrigation treatment and the subplots included the same three N fertilizer treatments in the same plots as described in Phase 1. Irrigation treatments (whole plots) were replicated three times each, and N-fertilizer treatments were replicated two times each within each whole plot, resulting in six N-fertility and irrigation combinations being replicated six times each. All plots were arranged in a randomized block design. Treatments included: 1) high N urea (250 kg N ha^{-1} yr^{-1}) and high irrigation (100% evapotranspiration [ET] replacement) (UHwet); 2) low N urea (50 kg N ha^{-1} yr^{-1}) and high irrigation (ULwet; 3) high N ammonium sulfate (250 kg N ha^{-1} y^{-1}) and high irrigation (ASwet); 4) high N urea and low irrigation (UHdry); 5); low N urea and low irrigation (ULdry); and 6) high N ammonium sulfate (250 kg N ha^{-1} y^{-1}) and low irrigation (ASdry). During Phase 2 only the fall fertilization was applied. On DOY 260, 75 kg N ha^{-1} was applied in UHwet, ASwet, UHdry, and ASdry; and 50 kg N ha^{-1} was applied on ULwet and ULdry, as described in Phase 1. All plots including dry were irrigated with 15 mm of water after fertilization to incorporate N into the soil and minimize ammonia volatilization. This was the only irrigation received in the dry plots outside of natural precipitation during the month-long study. Wet plots were irrigated one or two times weekly, as needed, by hand to ensure uniform application; water application amounts were measured with a hand wand meter.

Measurements of nitrous oxide fluxes

Soil-surface N_2O fluxes were measured using static chambers. Twelve vented, closed chambers, (7.5 cm high by 20 cm diameter) were built for this study from polyvinyl chloride (PVC). Permanent PVC collars were placed randomly at one location in each plot and driven approximately 8 cm into the soil. Gas samples from inside the chambers were removed with 12 ml polypropylene syringes fitted with nylon stopcocks at 0, 30, and 60 minutes after the chambers were installed onto the collars. Gas samples were transported to the lab and analyzed by a gas chromatograph (Shimadzu GC14B, Shimadzu Scientific Instruments, Columbia, MD) equipped with an electron capture detector and Porapak Q column (3.175 by 10^{-3} m diameter by 1 m, 80/100 mesh). Gas samples were always analyzed on the same day as collected, and generally within 6 hours.

Sampling frequency in the field was once weekly with the exception of one 35-day period from late January to early February (DOY 20-55, 2004) when snow cover prevented the measurement. The frequency of flux measurements was greater after fertilizations to capture transient peaks in N_2O fluxes; measurement frequency was typically two to three times in the week after fertilizations. Gas samples were usually collected from 0700 to 1100 CST on each measurement day. On DOY 196, 2004, N_2O fluxes were measured every two to three hours from 0500 to 1900 CST to determine diurnal fluctuations.

Ancillary Measurements

Soil properties, including pH, texture and bulk density, were measured in the 0-to-10, 10-to-20, and 20-to-30 cm profiles. Ammonium and nitrate levels in the 0-to-10 cm profile were measured on four days concurrent with N_2O flux measurements during the growing season (DOY 147, 174, 202, and 216, 2004) to determine their effect on N_2O fluxes.

Climatological variables were measured at a weather station located at Rocky Ford Turfgrass Research Center. To determine irrigation requirements, evapotranspiration (ET) was calculated with data from a weather station located at Rocky Ford using the Penman-Monteith equation (FAO-56; FAO 1998).

Volumetric soil water content ($Ø_v$) and temperature at 5 cm were measured automatically using the dual-probe heat-pulse (DPHP) technique. Sensors were fabricated in the turfgrass laboratories at Kansas State University. Measurements of $Ø_v$ were logged once daily at 0600 CST and soil temperatures every 60 minutes. All data acquisition and control were accomplished with a micrologger and accessories (CR10x and one AM16/32, Campbell Scientific, Logan, UT). Bulk density of the soil at 5 cm was 1.35 g cm^{-3} (determined from volumetric samples 5.4 cm diameter by 3 cm) and organic matter was 4% (Soil Testing Laboratory, Kansas State University).

Clippings were collected from DOY 159 to 288, 2004, with a walk-behind rotary mower equipped with a modified collection bag that allowed for complete capture of clippings from each plot. Clipped biomass was determined gravimetrically after samples had been dried in a forced-air oven for 48 hours at 70^{o}C.

Data Analysis
Fluxes of N_2O were calculated for each plot on each measurement day, and cumulative values for the study periods in Phase 1 and 2 were estimated by summing the products of weekly mean flux rates and the number of days between samples. Tests of differences among treatments in measurements of N_2O fluxes, $Ø_v$ and soil temperatures from DPHP sensors, gravimetric estimates of clipping biomass, and ammonium and nitrate levels in the soil were conducted using the mixed linear model of SAS ($P<0.05$; SAS Institute Inc, Cary, NC).

RESULTS:
Fertilization increased emissions of N_2O by 4 to 14 times within three days in UH and AS treatments in the fall of 2003 (Figure 2a). In the fall of 2004, N fertilization changed the ecosystem from a net consumer of atmospheric N_2O before fertilization (i.e., negative fluxes as denitrifying soil microbes in the soil consumed N_2O during denitrification) to a high net emitter of N_2O one day after fertilization (Figure 2b). Peak fluxes were higher in 2003 than in 2004; 36 mm of rainfall two days after fertilization (DOY 282) may have contributed to the greater fluxes observed in 2003. In 2003, fluxes in UH peaked at 3,128 µg N_2O m^{-2} h^{-1} and at 2,899 µg N_2O m^{-2} h^{-1} in AS. In 2004, fluxes peaked one day after fertilization among all plots and were 932 µg N_2O m^{-2} h^{-1} in UH, 533 µg N_2O m^{-2} h^{-1} in UL, and 465 µg N_2O m^{-2} h^{-1} in AS plots. Fluxes decreased rapidly after peaking and generally leveled off after about two to three weeks. Fluxes in 2003 were significantly higher ($P<0.05$) in UH than in AS on DOY 280, than in UL on DOY 283, and than in both AS and UL on DOY 290 (Figure 2a). In 2004, fluxes in UH were significantly higher than in AS on DOY 260, in AS than in UL on DOY 272, and in UH and AS than in UL on DOY 279 (Fig. 2b).

Cumulative emissions of N_2O were significantly greater in UH and AS than in UL plots during the study period of Phase 1 (Figure 3). Emissions were greatest following fertilizations (denoted by vertical dashed lines). During the winter and on other brief occasions, N_2O fluxes were negative, indicating the surface was absorbing atmospheric N_2O. This occurred mainly when soil water content was high and soil microbial denitrifiers consumed N_2O to form N_2 during denitrification (Figure 1). Total cumulative N_2O emissions during the study were 13.11, 7.87, and 12.47 kg N_2O ha^{-1} in UH, UL, and AS plots, respectively. When compared to the amount of N fertilizer applied during Phase 1, soils emitted the equivalent of 3.2 to 10% of applied N fertilizer. Higher fertilization rates increased N_2O emissions significantly in turfgrass. However, the type of fertilizer (e.g., urea or ammonium sulfate) did not significantly affect N_2O emissions during the course of this study.

Withholding irrigation significantly reduced N_2O fluxes from September through early October 2004

(Table 1). Cumulative fluxes were 76 to 93% lower in non-irrigated than in irrigated plots. The effect of non-irrigation was also evident in measurements of clippings, which were 61 to 70% lower than in irrigated plots.

Conclusions

During an 11-month period from October 2003 to August 2004, the equivalent of 3.2 to 10% of annually applied N fertilizer was lost to the atmosphere as the greenhouse gas N_2O in an established perennial ryegrass sward. Cumulative emissions of N_2O were 58 to 67% higher from plots fertilized at a high rate of 250 kg N ha^{-1} yr^{-1} (5 lb. per 1,000 sq. ft. yr^{-1}) compared with plots fertilized at a lower rate of 50 kg N ha^{-1} yr^{-1} (1 lb. N per 1,000 sq. ft. yr^{-1}). Fertilizer type did not affect emissions of N_2O in this study; nor were differences in emissions between ammonium sulfate and urea (both applied at the high rate) significant. Finally, withholding irrigation reduced N_2O emissions by 76 to 93% from September through early October, 2004. These data suggest that cultural practices may be useful in mitigating emissions of the greenhouse gas nitrous oxide (N_2O) from turfgrasses, although further research is required to find practical ways to implement these mitigations.

Table 1. Cumulative aboveground biomass (clippings from mowing) and N_2O emissions from perennial ryegrass during Phase 2, in the fall of 2004 when "dry" plots were not irrigated. Means within a row with the same letter are not significantly different (P<0.05).

	Clippings			N_2O Fluxes		
	Wet	Dry	% Reduction	Wet	Dry	% Reduction
	-----g m^{-2} -------			------kg ha^{-1} --------		
UH	19.9a	6.2b	69	1.03a	0.07b	93
UL	10.1a	3.0a	70	0.89a	0.21b	76
AS	19.8a	7.6b	61	1.10a	0.17b	85

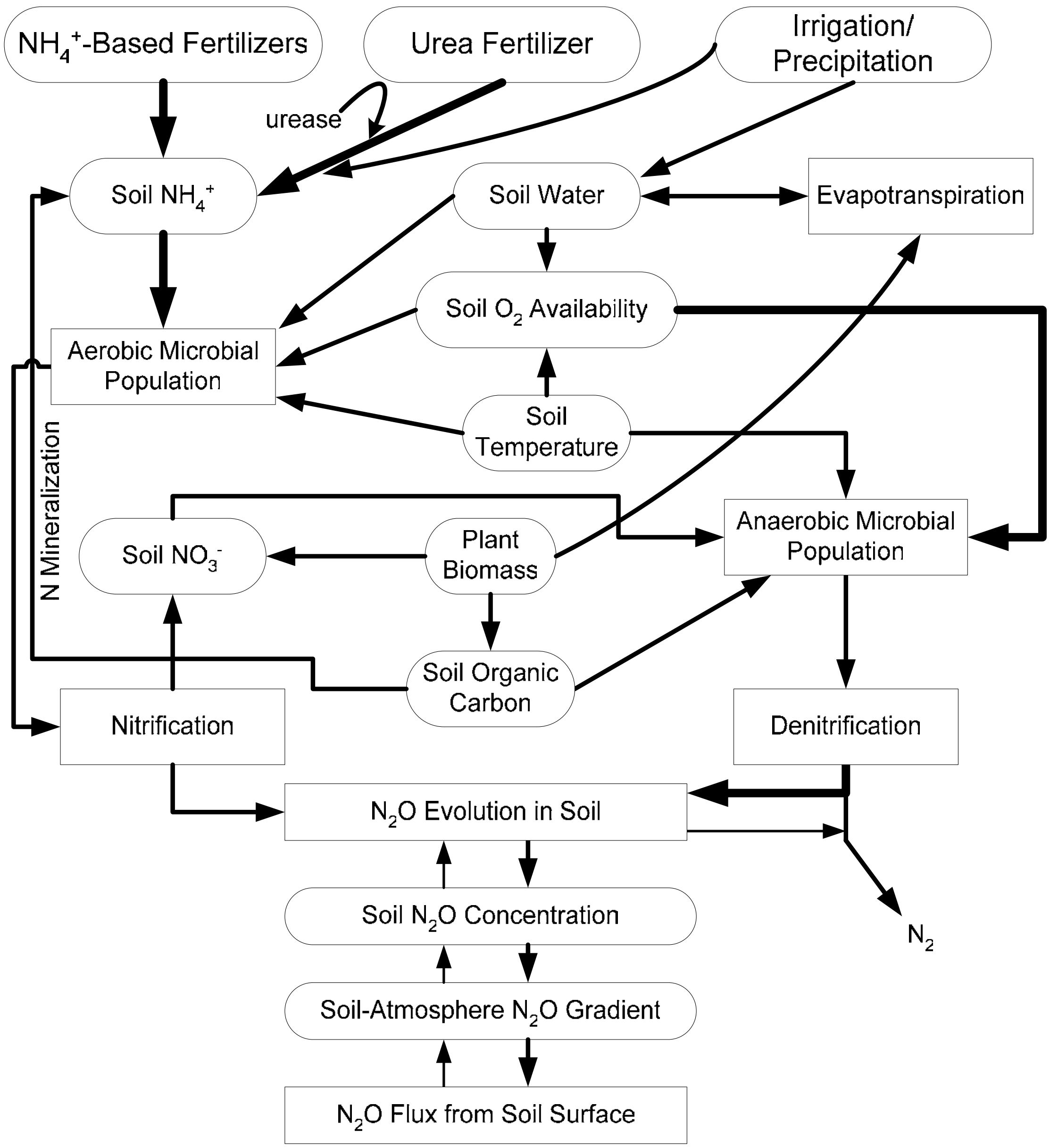

Figure 1. Conceptual model illustrating the effects of fertilizer types and amounts and irrigation and precipitation amounts on fluxes of N_2O from the surface of a landscape.

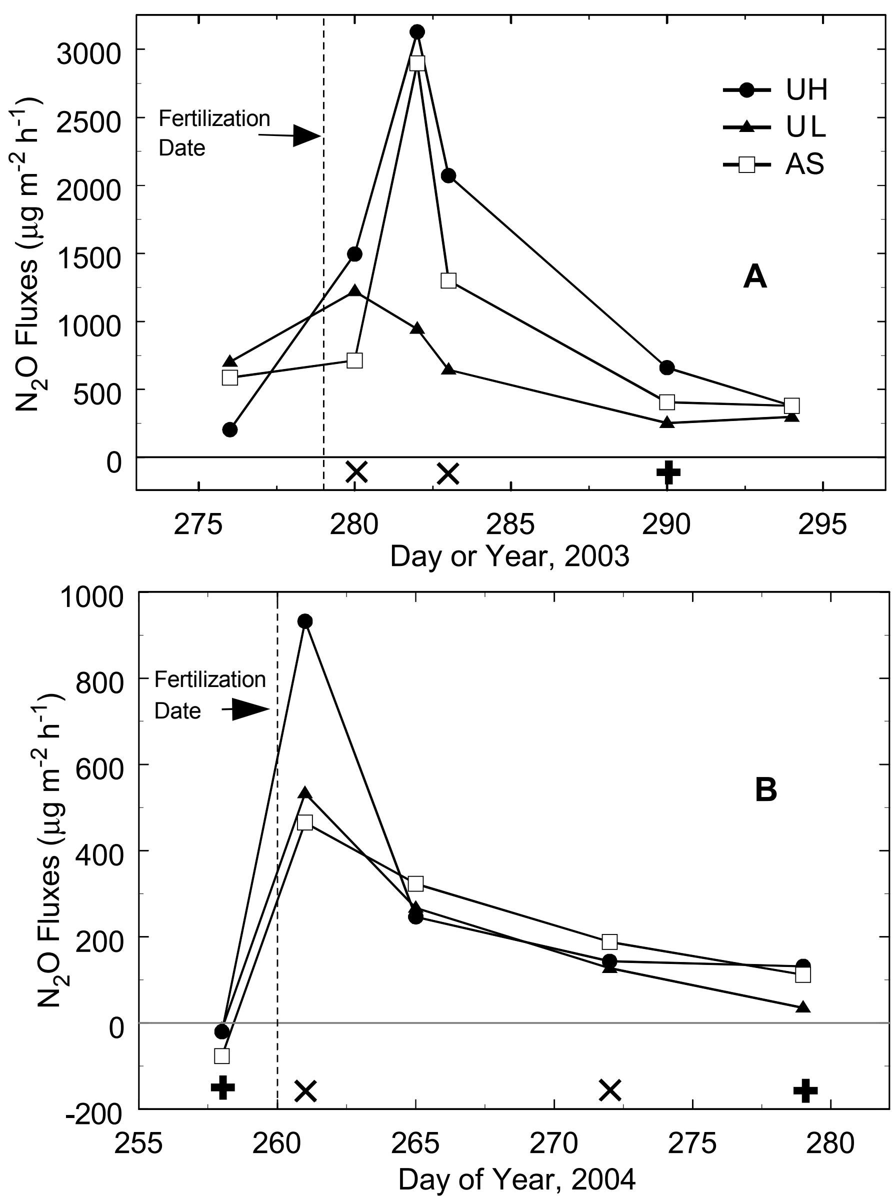

Figure 2. Fluxes of nitrous oxide (N_2O) from perennial ryegrass in the fall of 2003 (A) and 2004 (B). Vertical dashed lines represent fertilization dates each year. Symbols (x) along the abscissa of each graph indicate significant differences between at least two treatments ($P<0.05$) and plus (+) indicate significant differences between one and the other two treatments. Note the different scales on the y-axis.

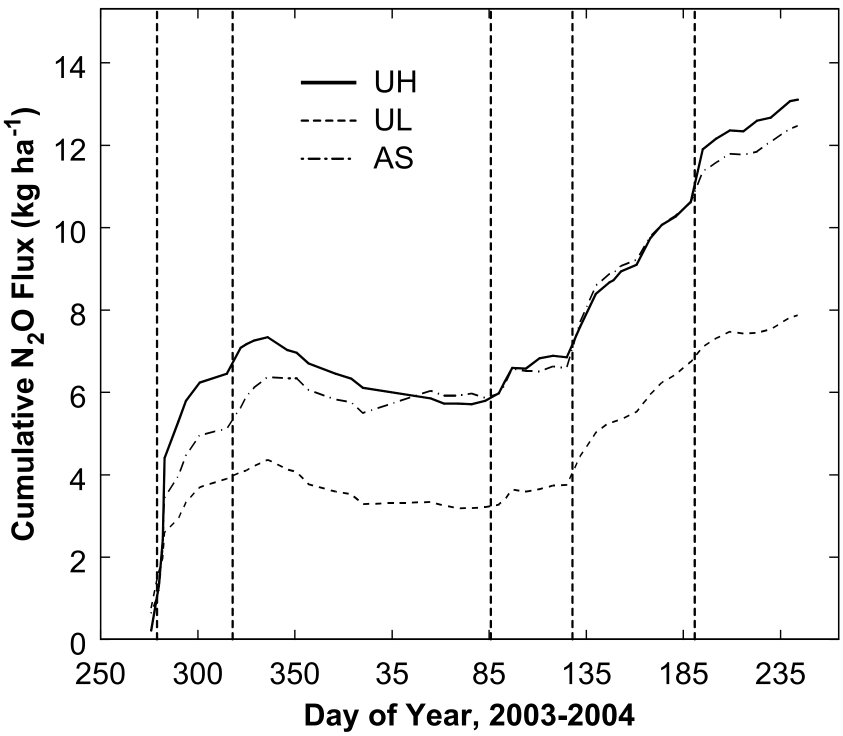

Figure 3. Cumulative fluxes of N_2O during Phase 1 from plots treated with high rates of urea (UH), low rates of urea (UL), and high rates of ammonium sulfate (AS), from DOY 276, 2003, to DOY 244, 2004. Vertical dashed lines represent fertilization dates; UL plots were fertilized only once, on DOY 279, 2003.

TITLE: Evaluation of Turfgrass Quality with Multispectral Radiometry

OBJECTIVES: Evaluate the use of multispectral radiometry to rate the visual qualities of cool-season turfgrasses. Multispectral radiometry data were compared to visual estimates of turfgrass quality in a Texas bluegrass hybrid, Kentucky bluegrass, and tall fescue under nonstressed conditions during the summer of 2004.

PERSONNEL: Dale Bremer and Kemin Su

SPONSORS: The Scotts Co., Inc.; Golf Course Superintendents Association of America; and Kansas Turfgrass Foundation

INTRODUCTION:

Turfgrass quality is typically estimated by visual observations of uniformity, color, and density. Consequently, quality ratings are subjective and may vary among evaluators or even with the same evaluator over time. Conversely, multispectral radiometry (MSR) measures plant light reflectance in the visible and near-infrared ranges and may provide a more objective, quantitative method for estimating turfgrass quality. Previous research by others has determined that reflectance of radiation in the narrow wavelength ranges of 661 and 813 nm and also ratios in different wavelengths or ranges of wavelengths using MSR have been highly correlated with turfgrass quality in warm-season grasses (i.e., normalized difference vegetation index [NDVI] and infrared to red [IR/R]; specific calculations for each are described in the methods section below). However, data are limited on the use of MSR in evaluating turfgrass quality, particularly in cool-season grasses.

OBJECTIVES:

The objectives of this research were to compare MSR data with visual quality ratings in three cool-season turfgrasses to determine if correlations were significant enough to warrant the use of MSR in providing objective, quantitative estimates of turfgrass quality.

METHODS:

This research was conducted at the Rocky Ford Turfgrass Research Center in Manhattan, Kan. MSR measurements and visual quality ratings were obtained on six days in 2004 (June 24, July 12, July 27, August 9, August 18, and September 10) from 21 plots of cool-season turfgrasses. The 21 plots were composed of seven replicates each of a Texas bluegrass (*Poa arachnifera Torr.*) hybrid (Thermal Blue), Kentucky bluegrass (*Poa pratensis L.*) (Apollo), and tall fescue (*Festuca arundinacea Schreb.)* (Dynasty). Turfgrass quality was estimated on a 1-to-9 scale: 9 = best, 6 = minimally acceptable, and 1 = poor. Data among plots on all dates were pooled (126 observation points total) for comparisons of MSR data with visual ratings. Reflectance at 661 and 813 nm, as well as the ratios NDVI (computed as [R935 - R661] / [R935 + R661]) and IR/R (or LAI, computed as R935/R661) were compared with visual estimates of turf quality. These wavelengths and ratios were selected because they were found to be highly correlated with visual quality in warm-season turfgrasses in a study by researchers at another institution.

RESULTS:

Correlation analyses indicated some degree of association between turfgrass quality and MSR data (Table 1). The strongest correlations were -0.70 and 0.70 and were between quality and R661 and NDVI, respectively; the weakest correlation was with R813 ($r = 0.41$). Regression analyses revealed that the best fit, describing the relationships between quality and MSR data, was with quadratic models for all variables (i.e., R661, R813, NDVI, and IR/R; Figures 1 through 4). With quadratic models, the r^2 values were similar between quality and R661, NDVI, and IR/R ($r^2 \approx 0.50$; Figures 1, 3 and 4); thus, only about half of the variability among measurements was explained by those models. The relationship was again poorest between quality and R813 with an r^2 value of only 0.20 (Figure 2).

Results from this study indicate that further research is required before MSR can be recommended for estimating quality in cool-season turfgrasses. A larger dataset may be required to evaluate the use of MSR for this purpose. Furthermore, the additional wavelengths provided by MSR but not evaluated in this study (e.g., 507, 559, 613, 706, 760, and 935 nm) may result in a better model with which to quantitatively estimate quality in cool-season turfgrasses; those wavelengths should be investigated in future research. Nevertheless, the associations observed between MSR data and quality suggests that MSR may have applications in turfgrass research and management.

Table 1. Correlation coefficients for reflectance vs. turfgrass quality in three cool-season turfgrasses.

Wavelength	Quality
R661	-0.70
R813	0.41
NDVI	0.70
IR/R	0.60

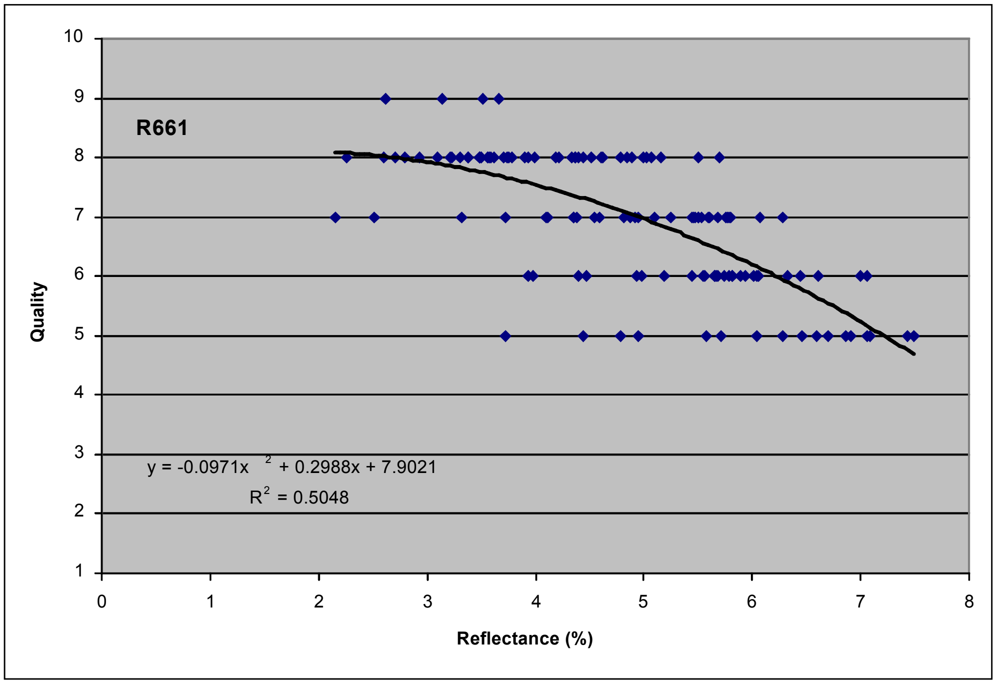

Figure 1. Relationship between visual quality ratings of three cool-season turfgrasses and percent reflectance at 661 nm.

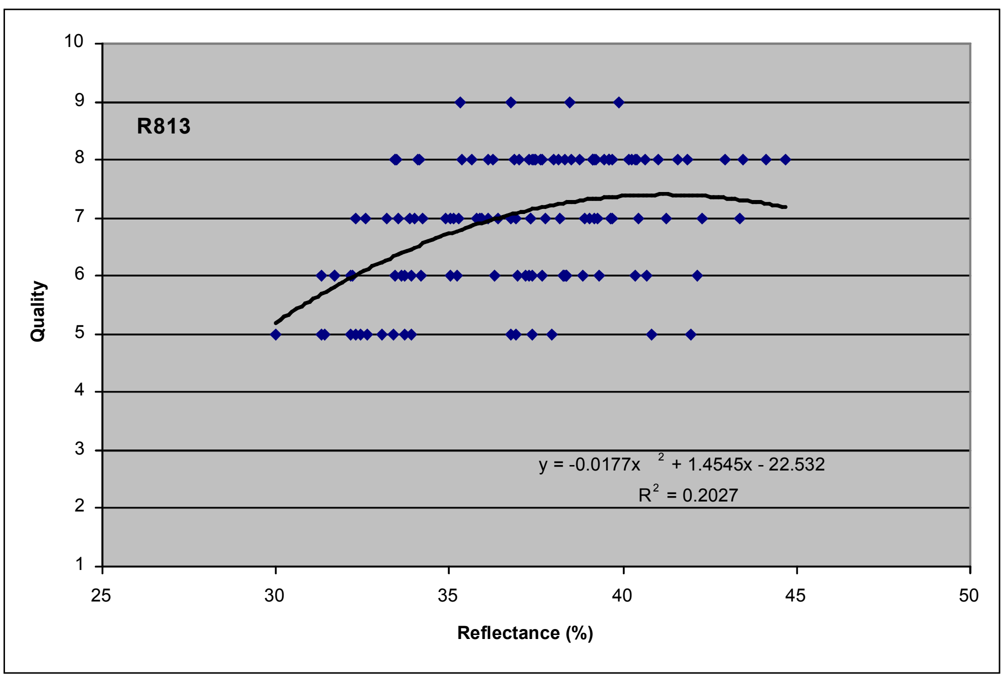

Figure 2. Relationship between visual quality ratings of three cool-season turfgrasses and percent reflectance at 813 nm.

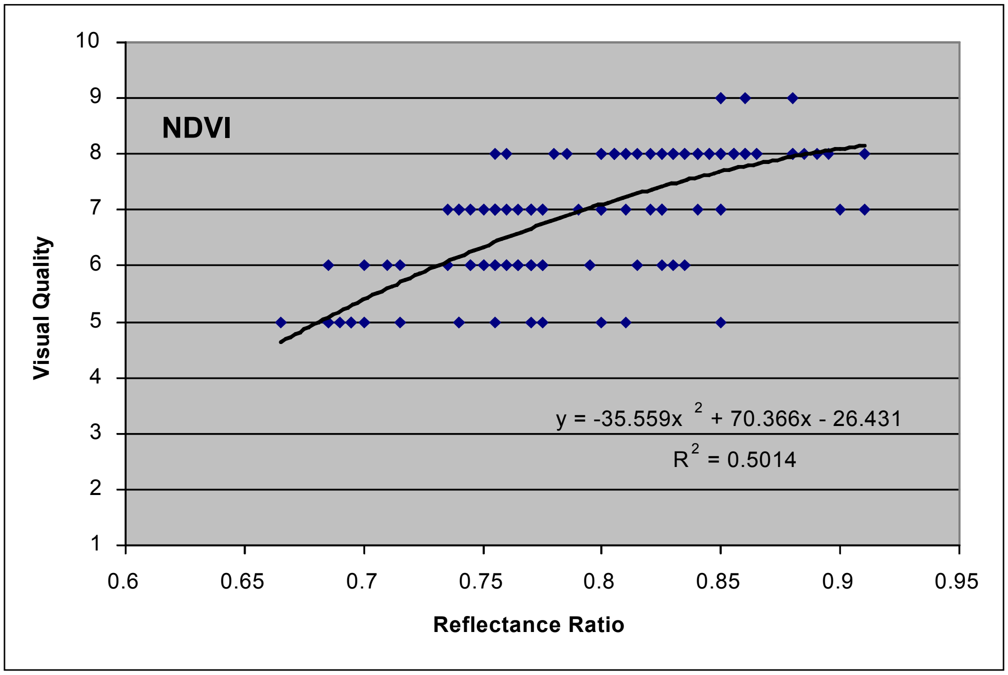

Figure 3. Relationship between visual quality ratings of three cool-season turfgrasses and the reflectance ration of the normalized difference vegetation index (NDVI; computed as (R935 - R661) / (R935 + R661).

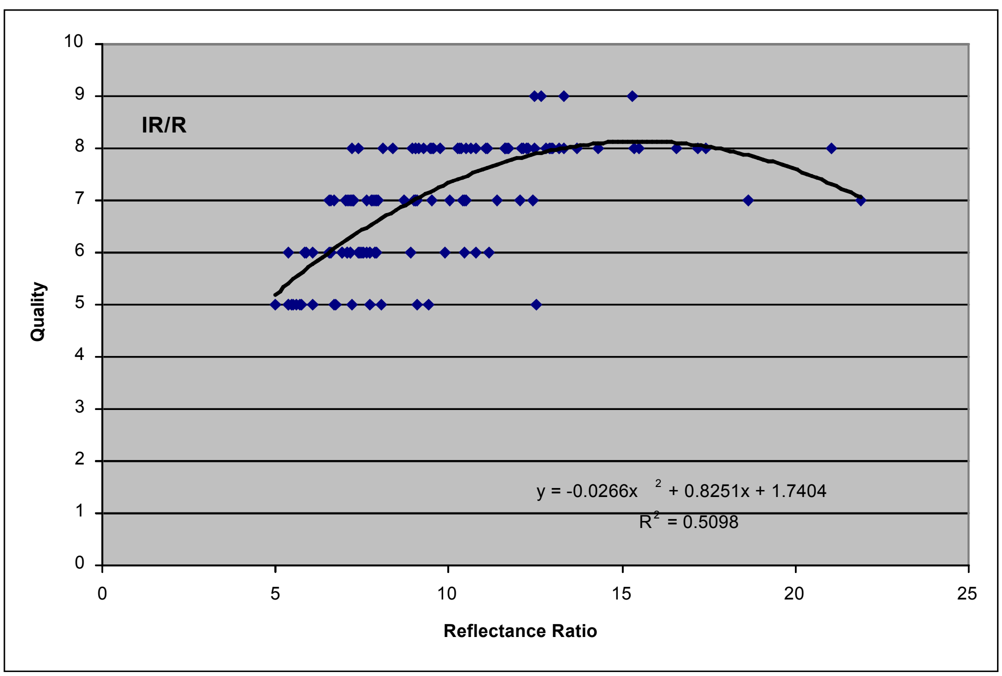

Figure 4. Relationship between visual quality ratings of three cool-season turfgrasses and the reflectance ratio of the near infrared to red (IR/R; computed as R935 / R661).

TITLE: Comparison of the Heat and Drought Tolerances of a Texas Bluegrass Hybrid Compared with Kentucky Bluegrass and Tall Fescue: A Growth Chamber Study

OBJECTIVES: 1) Investigate the effects of high temperature and drought stresses on photosynthesis in a Texas bluegrass hybrid (Thermal Blue), Kentucky bluegrass (Apollo), and tall fescue (Dynasty); 2) compare electrolyte leakages of leaf cell membranes among species after exposure to irrigation deficits and high temperature; higher electrolyte leakages indicate cell membrane breakdown and thus, lower tolerance to stresses; 3) determine the effects of heat and drought stresses on visual quality; and 4) evaluate heat and drought tolerance of the three cool-season turfgrasses.

PERSONNEL: Kemin Su, Dale Bremer, Steven Keeley, and Jack Fry

SPONSORS: The Scotts Co., Inc.; Golf Course Superintendents Association of America; and Kansas Turfgrass Foundation

INTRODUCTION:
Kentucky bluegrass (*Poa pratensis L.*) is a cool-season grass commonly used on fairways and roughs of golf courses in the United States. Tall fescue (*Festuca arundinacea Schreb.*), also a cool-season grass, is sometimes used in roughs. In some areas of the country these grasses are subjected to frequent drought, which results in either heat and drought symptoms, or high irrigation rates to maintain acceptable quality. Kentucky bluegrass commonly goes dormant and loses color during periods of high temperature and drought. Tall fescue has good drought resistance, but some superintendents prefer the finer texture that Kentucky bluegrass offers.

New Texas bluegrass (*Poa arachnifera Torr.*) hybrids, which are genetic crosses between Kentucky bluegrass and native Texas bluegrasses, have the appearance of Kentucky bluegrass but may be able to withstand higher temperatures and extended drought without going dormant, and may maintain their green appearance during all but extreme conditions. In warm-season climates such as the South, Texas bluegrasses stay green all year long. Furthermore, Texas bluegrass hybrids may use significantly less water than other cool-season species while maintaining their green color. The latter is important, given the increasing competition for water and the rising costs of irrigation.

At least one hybrid of Texas bluegrass (Reveille) has demonstrated disease resistance to leaf rust, powdery mildew, and summer patch, although it shows susceptibility to brown patch especially when over-fertilized. Reveille also has shown resistance to fall armyworms and white grubs, but tests have revealed it performs poorly in saline soils. Observations of other Texas bluegrass hybrids have suggested that disease resistance and susceptibility are similar to Kentucky bluegrasses.

Texas bluegrass Reveille is advertised as a multi-use cool-season grass with similar water requirements to common bermudagrass for the eastern seaboard, transition zone, arid west, and southern United States. Tests with Reveille revealed no significant decline in visual quality ratings when irrigation was decreased from 2/3 to 1/3 of open-pan evaporation (in Texas; James Read, personal communication). This suggests that Texas bluegrass is a high quality, low water-use, and high heat-tolerant turfgrass that may be well suited for golf course fairways and roughs in some parts of the United States, including the transition zone.

Despite the promising role that Texas bluegrass may play on U.S. golf courses, little scientific data is available about its qualities under various forms of management and stress that it would be subjected to on golf courses. For example, the effect of different mowing heights on the drought- and heat-tolerance characteristics of Texas bluegrass is unknown. Some parts of the transition zone are subjected to extreme cold during winter months, and the cold-hardiness of Texas bluegrass compared to Kentucky bluegrass has not been evaluated. It is also uncertain how it compares in quality to Kentucky bluegrass under various irrigation regimes and deficits.

METHODS:

Three turfgrass species were planted in 36 polyvinyl chloride (PVC) tubes (10 cm diameter, 60 cm high) filled with mixture of sand and topsoil (1:1,v:v) in a greenhouse for 4.5 months. The three species included 1) a Texas bluegrass hybrid (Thermal Blue); 2) Kentucky bluegrass (Apollo); and 3) tall fescue (Dynasty). The tubes were transferred to and acclimated in growth chambers at optimum temperature [22°C day (14 hours), 15°C night (10 hours)] for two weeks. Turfgrasses were then exposed for 48 days to high (35/25°C, 14/10 hours day/night) or optimum (22/15°C, 14/10 hours day/night) temperatures under water-deficit (60% ET replacement) or well-watered (100% ET replacement) irrigation regimes. Experimental design was split-plot. Whole plots were temperature treatments (individual growth chambers) in a randomized complete block design. Species/cultivar and irrigation were subplots. Net photosynthesis and respiration were measured with a Li-6400 (Licor) equipped with a custom surface chamber; total photosynthesis (Pt) was estimated as the sum of net photosynthesis and respiration. A conductance meter (YSI Model 32) was used to measure electrolyte leakage.

RESULTS:

Total Photosynthesis (Pt)

High temperature and drought stress combinations caused a rapid decline in Pt among species In Thermal Blue, Pt was generally higher toward the end of the study (Figure 1A). In well-watered, high temperature treatments, Pt was consistently and significantly higher in Thermal Blue than in Dynasty beginning on day 24 and in Apollo on day 42 (Figure 1B). In optimum temperature, drought-stressed treatments, Pt declined among species, and differences were not significant (Figure 1C).

Living Leaf Electrolyte Leakage (EL)

High temperature and drought stress combined to cause EL to increase among species. EL was significantly higher in Apollo and Dynasty than in Thermal Blue late in the study (Figure 2A). High temperature had no effect on EL in well-watered Thermal Blue, but EL increased significantly in well-watered Apollo and Dynasty (Figure 2B). Drought stress in optimal temperature treatments had no significant effect on EL among species (Figure 2C).

Visual Quality

The high temperature and drought stress combination reduced visual quality among species. Visual quality in Thermal Blue was significantly higher than in Dynasty and Apollo late in the study (Figure 3A). In well-watered, high temperature treatments, visual quality of Thermal Blue was significantly higher than Dynasty and Apollo (Figure 3B). In optimum temperature, drought-stressed treatments, visual qualities declined among species, and differences were not significant (Figure 3C). The higher visual quality of Thermal Blue in high temperature treatments is illustrated in Figure 4.

Conclusions

In well-watered, high-temperature treatments, Thermal Blue exhibited significantly higher Pt and visual quality and significantly lower EL than Apollo and Dynasty. The high temperature and drought combination caused a reduction in Pt and visual quality among species, although Thermal Blue was generally higher in both Pt and visual quality late in the study. High temperature and drought combined to cause EL to increase among species, although EL was significantly higher in Apollo and Dynasty than in Thermal Blue late in the study ($P<0.05$). In optimum-temperature, drought-stressed treatments, Pt and visual quality declined and EL was unchanged with no significant differences among species. No significant differences in drought tolerance were found among species. In general, Thermal Blue exhibited higher heat tolerance than Apollo and Dynasty in a growth chamber study.

Abbreviations

ET: Evapotranspiration

Pt: Total photosynthesis (estimated as the sum of canopy photosynthesis and plant respiration)

EL: Electrolyte leakage

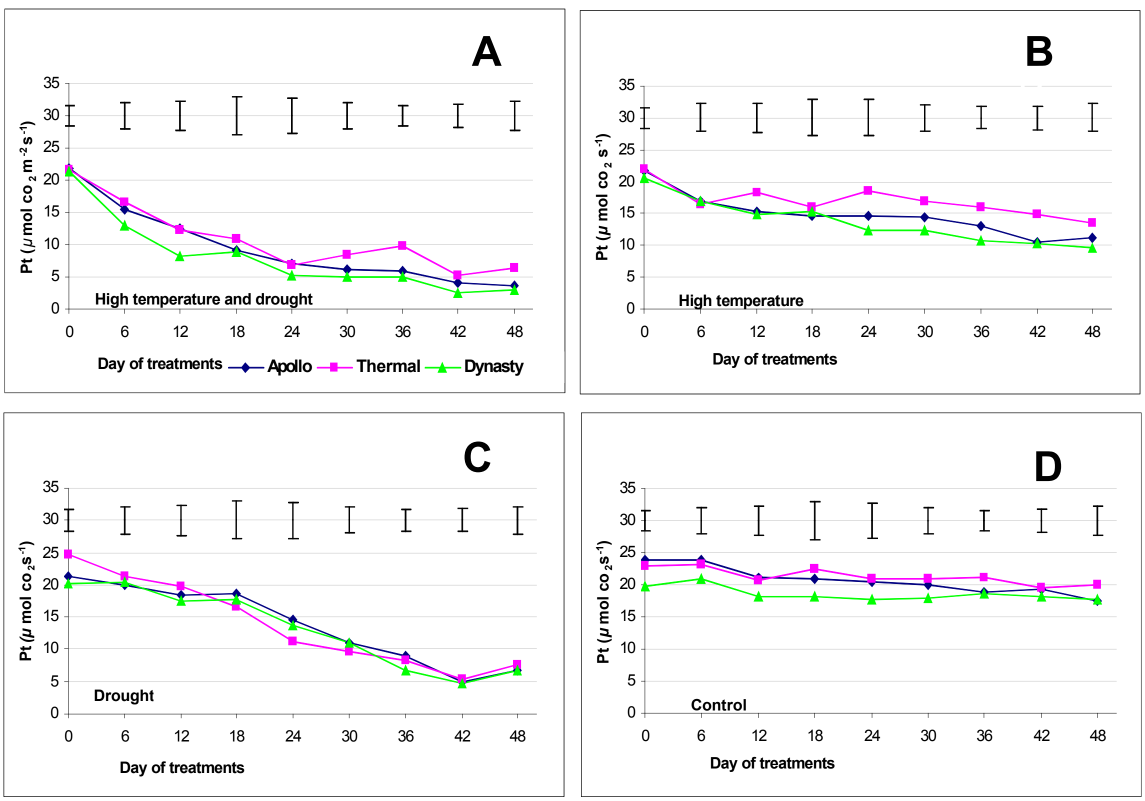

Figure 1. Effects of high temperature and drought on total photosynthesis (Pt) in Apollo, Thermal Blue, and Dynasty. Vertical bars indicate LSD values (P = 0.05) among treatments on a given day following treatment initiation (day of treatments).

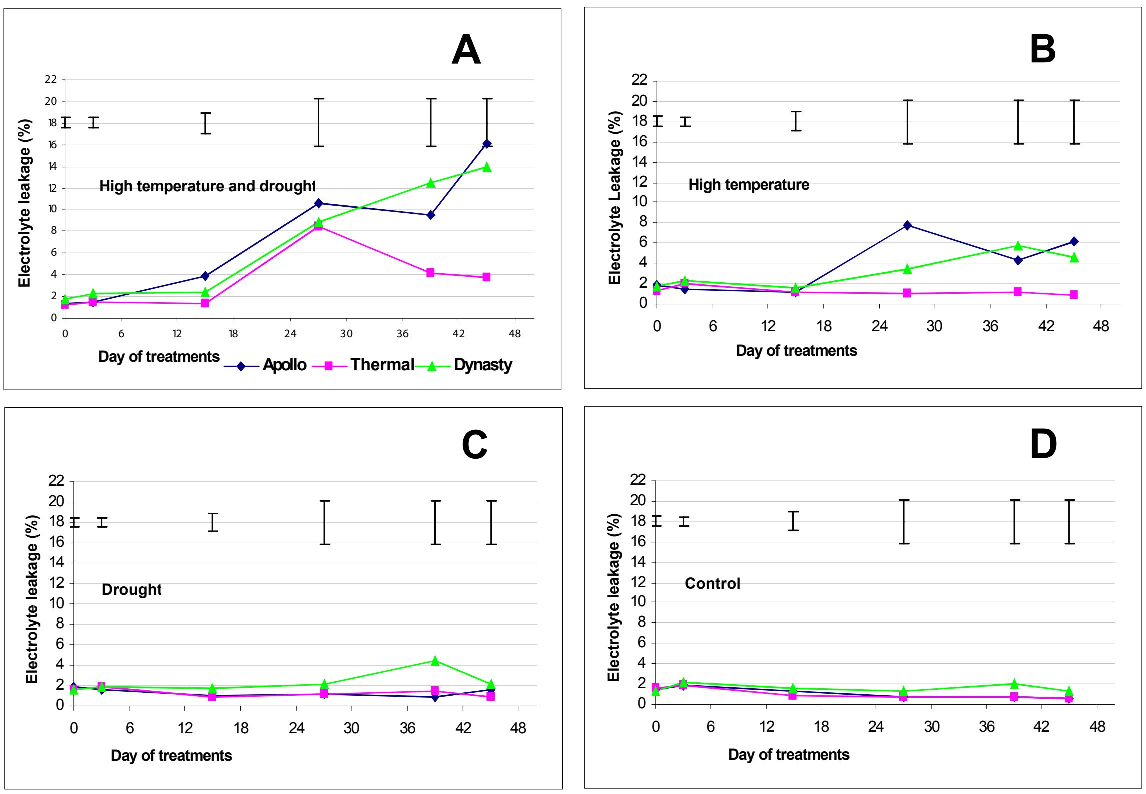

Figure 2. Effects of high temperature and drought on electrolyte leakages in Apollo, Thermal Blue, and Dynasty. Vertical bars indicate LSD values (P = 0.05) among treatments on a given day following treatment (day of treatments).

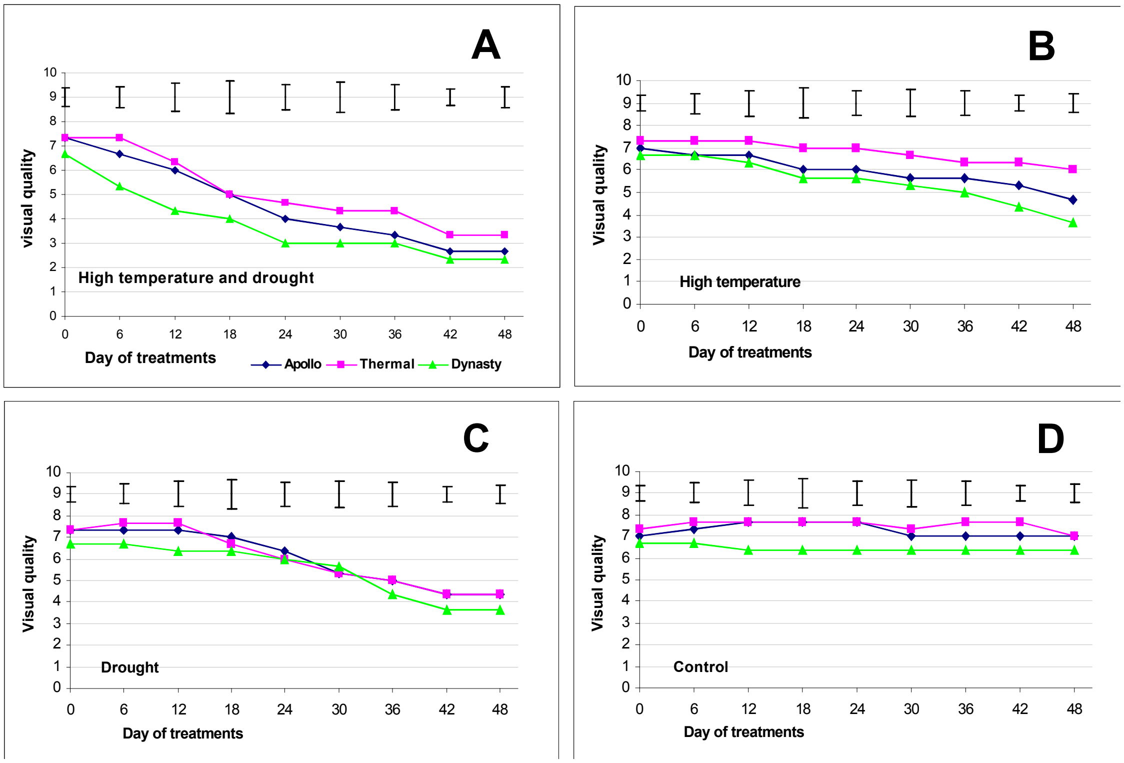

Figure 3. High temperature and drought effects of Apollo, Thermal Blue, and Dynasty on their visual qualities. Ratings are on a 1-to-9 scale: 9 = best, 6 = minimally acceptable, and 1 = poor. Vertical bars indicate LSD values (P = 0.05) for treatment comparisons as a given day of treatments.

Figure 4. Visual appearance of Apollo (KBG), Thermal Blue (TB), and Dynasty (TF) in the first replication after 36 days of temperature and irrigation deficit treatments. Front row is high temperature; back row is low temperature treatment. From left to right (both rows) KBG (60% evapotranspiraion [ET]); KBG (100% ET); TV (60% ET); TV (100% ET); TF (60% ET); and TF (100% ET).

TITLE: Establishment of Seeded Zoysiagrass in a Perennial Ryegrass Sward: Effects of Soil-Surface Irradiance and Temperature

OBJECTIVE: Estimate soil-surface irradiance levels and measure seedbed temperatures under perennial ryegrass canopies mowed at different heights and under glyphosate-treated canopies.

PERSONNEL: Alan Zuk, Dale Bremer, and Jack Fry

SPONSOR: Kansas Turfgrass Foundation

METHODS:
This project was included as part of Alan Zuk's Ph.D. dissertation, and the complete manuscript will be published in the 2005 International Turfgrass Research Journal. The abstract from this publication follows.

Conversion from perennial ryegrass (*Lolium perenne L.)* to zoysiagrass (*Zoysia japonica Steud.*) in the transition zone of the United States may reduce irrigation and fungicide requirements. However, environmental conditions under perennial ryegrass canopies may inhibit establishment of seeded zoysiagrass. Our objectives were to quantify solar irradiance and temperatures at the soil surface and determine their effects on establishment of Zenith zoysiagrass seeded into existing perennial ryegrass canopies.

A 31-day shade study was conducted during 2002 near Manhattan, Kan. Zoysiagrass was seeded into bare-soil plots, each covered with shade cloth that blocked 40%, 65%, or 85% of solar irradiance. Additionally, two separate experiments were conducted in 1999-2000 (Study 1) and 2002 (Study 2) in which perennial ryegrass canopies were maintained at: 1) 1.4 cm (untreated); 2) 0.6 cm (scalped); or 3) treated with glyphosate (N-phosphonomethyl glycine [glyphosate-treated]). Irradiance below the canopy was modeled in both experiments, and seedbed temperatures were measured with thermocouples in Study 2. In the shade study, zoysiagrass seedling emergence and growth decreased as shade increased in bare-soil plots ($r = -0.59$ to -0.69) (Table 1). In perennial ryegrass, scalped and untreated turf shaded the seedbed surfaces by 36% and 72%, respectively (Figure 1), and soil temperatures averaged 1.1°C cooler compared to glyphosate-treated turf. In scalped and glyphosate-treated plots, zoysiagrass seedling emergence was 90% greater the first year and coverage 59% greater the second year compared to untreated perennial ryegrass. Higher light penetration and seedbed temperatures during the initial five to seven weeks after seeding contributed to higher zoysiagrass establishment in scalped and glyphosate-treated plots.

Table 1. Shade impact on seedling morphology of zoysiagrass four weeks after seeding on bare soil August 8, 2002, in Manhattan, Kan.

Morphology†	Untreated	% Shade 40	% Shade 65	% Shade 85	Correlation Coefficients‡ (Among 40, 65, 85% Shaded Plots)
Seedlings (no. m^{-2})	55.6	138.9a*	44.4b	36.7b	-0.59
Tillers (no. $plant^{-1}$)	18.8	31.0a	6.0b	4.8b	-0.63
Leaf Area (cm^2)	18.2	52.9a	13.6ab	5.9b	-0.65
Root Area (cm^2)	261	252a	202a	204a	-0.20
Root Length (cm)	59.3	84.0a	30.6b	24.8b	-0.69
Leaf Dry Wt. (g)	0.037	0.044a	0.009ab	0.004b	-0.66
Root Dry Wt. (g)	0.008	0.008a	0.002ab	0.001b	-0.64

*Means followed with the same letter within a row are not significantly different ($P < 0.05$).
†Plots were seeded at 678 PLS m^2.
‡Correlation coefficients are presented only on data from shaded plots because establishment in untreated plots was deleteriously affected by significant soil-drying between irrigations.

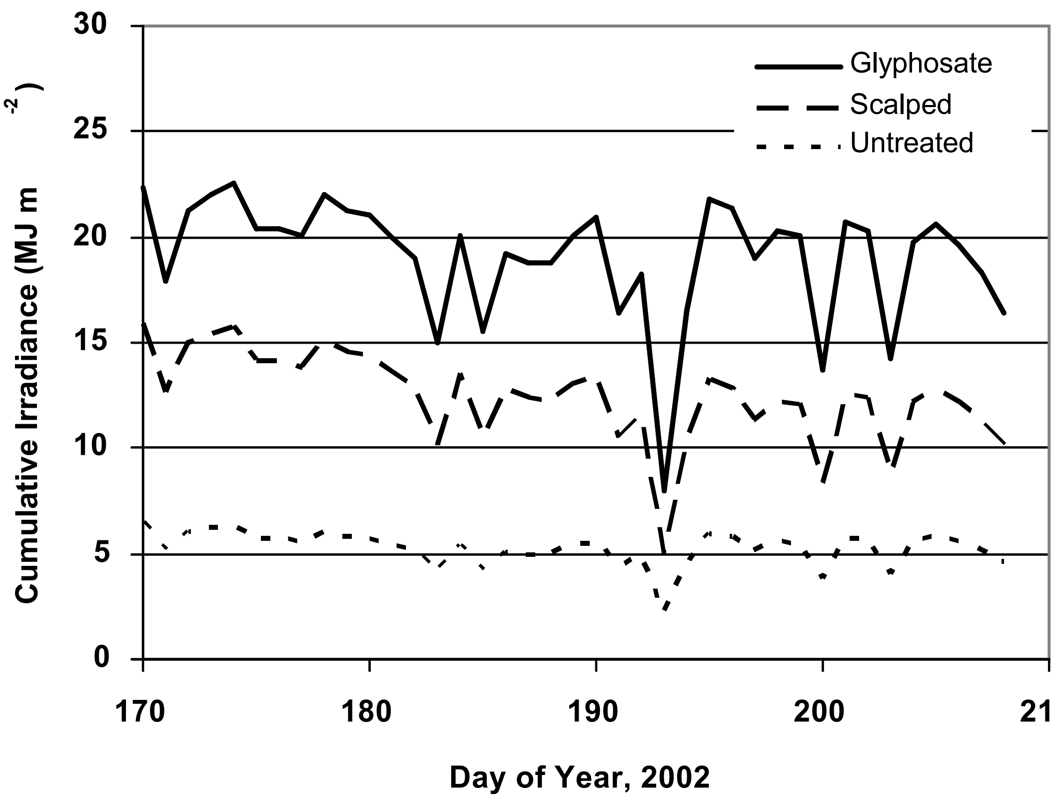

Figure 1. Daily seedbed-surface irradiance within glyphosate-treated, scalped, and untreated perennial ryegrass plots during the first five weeks (June 19 to July 27, 2002) in a study in which zoysiagrass was seeded into an existing perennial ryegrass sward.

TITLE: Bluegrass Billbug (*Sphenophorous parvulus Gyllenhal*) Control

OBJECTIVE: Compare insecticides for billbug control

PERSONNEL: Bob Bauernfeind

SPONSOR: Kansas Turfgrass Foundation

INTRODUCTION:

Bluegrass billbugs are a yearly presence at the Rocky Ford Turf Field. Occurring in high numbers, they are especially detrimental to projects in bluegrass research plots. An unassigned bluegrass stand was made available to test the efficacy of insecticides for the control of bluegrass billbugs.

METHODS:

Linear pitfall traps were used to monitor the movements of adult billbugs into the test plots. Each trap consisted of a 15-foot section of 3.5-inch PVC pipe with a 1-inch section removed down the length of the pipe to create a slot through which adult billbugs would tumble into the trap. An end cap prevented the escape of billbugs from that end, forcing them to wander to the opposite "uncapped" end. A capture container collected billbugs as they moved out of the PVC pipe.

Trenches were dug, and PVC piping buried so tops were flush with the soil surface. Sand was used to fill in gaps and create a natural walkway to the slots. One trap each was place on the N-S-E-W ends of the large plot area.

Seven ranges of plots were established. In each range, 15 plots (5 by 5 ft.) were laid out. Of the 105 plots, 70 containing the best stands of turf were utilized for the trials. Each of the five treatments, as well as the untreated check, were thus replicated 10 times. Treatments/plots were randomly spaced/assigned.

Treatments:	1)	Merit 0.5G	0.4 lb. AI per acre
	2)	Merit 75WP	0.4 lb. AI per acre
	3)	TalstarOne	0.5 oz. per 1,000 sq. ft.
	4)	Talstar EZ	1.15 lb. per 1,000 sq. ft.
	5)	Merit 0.5G	0.29 oz. per 1,000 sq. ft.
		+	
		TalstarOne	0.7 oz. per 1,000 sq. ft.

Treatment applications: May 20, 2004

Irrigation: approximately 0.2 inches, 33 hours post spray

Sampling

Samples were collected July 8, 2004. An eight-inch diameter "turf repairer" was used to remove a turf plug from each plot. Plugs were placed in labeled plastic zip bags and stored in a walk-in cooler until they could be examined for the presence of billbugs.

RESULTS:

Stage	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	Untreated
1st instar	1	1	0	4	1	3
2nd instar	3	10	17	18	6	12
3rd instar	19	47	87	66	25	50
Pupa	3	7	33	23	3	11
Adult	0	1	5	3	1	3
Total:	26	66	144	114	36	79

The results of the trial are somewhat misleading. The bifenthrin active ingredient of TalstarOne and Talstar EZ has proven efficacy against billbugs. However, the intended target-stage for bifenthrin is the adult: the rationale being that adults are killed before they deposit eggs in the crown tissue of the grass. Due to the late arrival of the test materials, bifenthrin treatments were applied after egg deposition. As a contact, bifenthrin has no effect on the small larvae protected within the crown as they feed. There is no explanation as to why a substantially higher number of billbugs occurred in both the TalstarOne and Talstar EZ treatments as compared to untreated checks.

Applied at the same time as the bifenthrin treatments, the systemic activity of Merit (the active ingredient imidacloprid) effectively reduced billbug numbers. Merit, then, was present in the plant tissues as the larvae initially fed in the crown, and later (when larger and after moving into the soil) fed on root tissues. The effectiveness of imidacloprid was further substantiated, as seen in combination with bifenthrin (Treatment 5). That low billbug number was attributed to the imidacloprid component of that treatment.

The Merit 0.5G formulation in both Treatments 1 and 5 performed better than when imidacloprid was applied as a spray (Merit 75WP).

TITLE: Evaluation of a Granular Fungicide for Brown Patch Suppression in Tall Fescue

OBJECTIVE: Evaluate the efficacy of an experimental granular fungicide for brown patch reduction in tall fescue.

PERSONNEL: Qi Zhang and Jack Fry

SPONSORS: Bayer

INTRODUCTION:
Tall fescue is one of the most widely used turfgrasses for home lawns in the transition zone because of its heat and drought resistance and ease of establishment; however, tall fescue is susceptible to brown patch. Successful fungicides have been developed for brown patch suppression in tall fescue, but most of the products on the market are applied as foliar sprays. This test was done to evaluate an experimental granular fungicide for brown patch control

MATERIALS AND METHODS:
This experiment was conducted on a blend of turf-type tall fescue at the Rocky Ford Turfgrass Research Center at Manhattan, Kan. Turf was mowed at 3 inches; fertilized with 4 lb. N per 1,000 sq. ft. annually (1 lb. in September, November, May, and June); and irrigated two to three times weekly in the evening to encourage disease. Treatments included an untreated control; an experimental granular fungicide, EXP 0357 (0.157 GR), applied at 5 and 10 lb. per 1,000 sq. ft.; and Compass (50 WG) applied at 0.2 oz. product per 1,000 sq. ft. Plots measured 5 by 10 ft. and were arranged in a randomized complete block design with four replicates. The treatments were applied on 14-day intervals from June 9 to August 27, 2004. Compass was applied with a CO^2 sprayer at 30 psi in water equivalent to 10.6 gal. per 1,000 sq. ft. Data were collected on brown patch infection, turfgrass visual quality, and phytotoxicity. Brown patch infection was rated visually on a 0-to-100% scale. Turf quality was rated on a 0-to-9 scale: 0 = poorest quality and 9 = best quality. Phytotoxicity was evaluated on a similar scale where 0 = brown, dead turf, and 9 = no injury.

RESULTS:
Brown patch was first observed in untreated turf July 16, and symptoms continued until August 27. In general, pressure was light, and greatest damage observed was 12.5% in the untreated plots. Tall fescue treated with the experimental granular fungicide or Compass had significantly less brown patch on all rating dates compared to untreated turf.

No significant differences were seen in tall fescue quality, and all turf was visually acceptable for a home lawn. None of the fungicides caused phytotoxicity.

Table 1. Brown patch infection (%) in tall fescue as affected by experimental granular fungicides and Compass.

Treatment	July 16	July 25	Aug 4	Aug 11	Aug 19	Aug 27
Control	2.5 a	11.3 a	12.5 a	11.3 a	3.0 a	1.3 a
Exp (5 lb. per 1,000 sq. ft.)	0.3 b	0.3b	0.5 b	1.3 b	0.0 b	0.0 b
Exp (10 lb. per 1,000 sq. ft.)	0.3 b	0.0 b	0.5 b	0.8 b	0.0 b	0.0 b
Compass (0.2 oz. per 1,000 sq. ft.)	0.0 b	0.0 b	0.3 b	2.0 b	0.0 b	0.0 b
ANOVA	*	*	*	*	*	*

NS, * indicate no significant difference and significant difference at $P \leq 0.05$.

Table 2. Tall fescue visual quality as affected by an experimental granular fungicide and Compass.

Treatment	July 16	July 25	Aug 4	Aug 11	Aug 19	Aug 27
Control	7	6	6	6	8	8
Exp (5 lb. per 1,000 sq. ft.)	7	7	7	7	8	8
Exp (10 lb. per 1,000 sq. ft.)	7	7	7	7	8	8
Compass (0.2 oz. per 1,000 sq. ft.)	7	7	7	7	8	8
ANOVA	NS	NS	NS	NS	NS	NS

Turfgrass visual quality was rated with a 0-9 scale, 0 = poorest quality, 6 = acceptable quality for a home lawn, and 9 = best quality.
NS, * indicate no significant difference and significant difference at $P \leq 0.05$.

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Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan, KS 66506

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