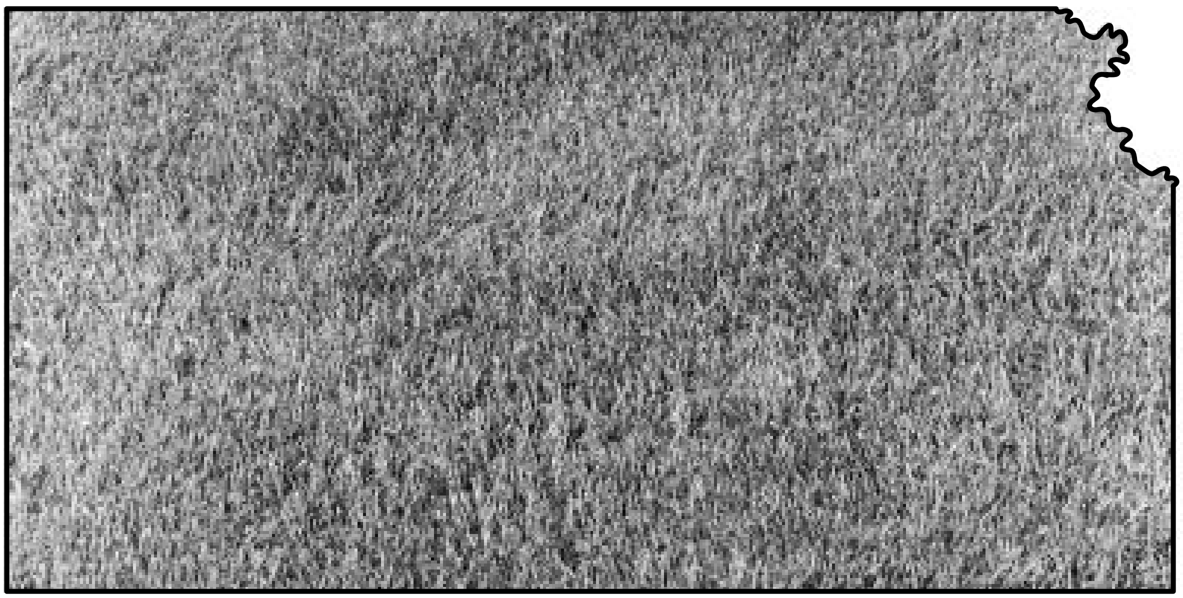
KANSAS STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE



1999 TURFGRASS RESEARCH

Report of Progress 836

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FOREWORD

It might be a simple question, such as "Which tall fescue cultivars are best suited for use on lawns?" or possibly a more complicated one, such as "What causes the quality of my bentgrass greens to decline in July?" Answers to these questions and many others are contained in this 1999 edition of Turfgrass Research.

From a research perspective, 1998 was a good year. Drs. Huang and Tisserat both initiated projects that will receive funding from the United States Golf Association over the next several years. And, in terms of good years for conducting research on turf diseases and environmental stress, 1998 was hard to beat. High temperatures and humidity resulted in the greatest amount of disease we've had in Manhattan since the 1980's.

The cooperation and team effort have never been better among the turf team at K-State. We are now in the final stages of selecting a new director for the John C. Pair Horticultural Center. The staff in Wichita is to be commended for their efforts in continuing turfgrass research efforts there over the past two years. We hope you can all join us for the 1999 Field Day on August 5 at the John C. Pair Center.

Student numbers in the new golf course management program are "going through the roof." Our latest count shows nearly 100 students enrolled in the program. We are seeking assistance to cover the advising demands of these students, hopefully with another full-time turfgrass faculty member. At least seven students will be doing internships during the grow-in phase of the Colbert Hills Golf Course. Colbert Hills, an 18-hole, championship course about 5 miles west of Manhattan, is on schedule to open in May, 2000. We expect that this course will get nationwide attention after it opens, and the same thought is echoed by all who have had the opportunity to tour it. We are all excited about the opportunities it will afford students and researchers at K-State.

Keep this research report handy - it can be useful all year long. This information, and more, is also available on our web page at http:www.oznet.ksu.edu/dp_hfrr/turf/welcome.htm. As always, we're interested in hearing your ideas about future research projects, or comments about the results contained herein.

The K-State Turf Team

Personnel Associated with the K-State Turfgrass Program

Bob Bauernfeind	Extension Entomologist
Mike Darratt	Plant Science Technician, John C. Pair Horticultural Center, Wichita
Jack Fry	Associate Professor, Horticulture, Turfgrass Research & Teaching
Bingru Huang	Assistant Professor of Horticulture, Turfgrass Research & Teaching
Fanny Iriarte	Ph.D. Candidate, Plant Pathology
Yiwi Jiang	Ph.D. Candidate, Horticulture
Steve Keeley	Extension Turfgrass Specialist
Larry Leuthold	Professor Emeritus, Horticulture
Xiaozhong Liu	Ph.D. Candidate, Horticulture
Christy Nagel	Extension Horticulture Secretary
Linda Parsons	Research Assistant, John C. Pair Horticultural Center, Wichita
Derek Settle	M.S. Student, Horticulture
Ned Tisserat	Professor of Plant Pathology, Extension and Research
Ward Upham	Extension Associate, Horticulture
Tom Warner	Professor and Head, Department of Horticulture, Forestry & Recreation Resources
Henry Wetzel	Former Ph.D. Candidate, Department of Horticulture, Forestry, and Recreation Resources
Steve Wiest	Associate Professor of Horticulture, Plant Stress Research
Qingzhang Xu	Postdoctoral Research, Horticulture
Alan Zuk	Research Specialist, Horticulture

TITLE: Buffalograss Cultivar Evaluation

OBJECTIVE: To evaluate seeded and vegetative buffalograss cultivars under Kansas conditions

PERSONNEL: Linda R. Parsons and John C. Pair

INTRODUCTION:

Buffalograss is the only native species used for turfgrass in Kansas. It requires little maintenance and is heat and drought tolerant. The introduction of many new selections, both seeded and vegetative, has aroused considerable interest in growing buffalograss. Further evaluation of the new releases is needed to determine their potential use by Kansas consumers.

MATERIALS AND METHODS:

During the summer of 1997, we established 9 seeded and 11 vegetative buffalograss cultivars and experimental numbers in 60 8 ft × 8 ft study plots at the John C. Pair Horticultural Center in Wichita, KS. Prior to seeding and plugging the plots, we incorporated 13-13-13 into them at a rate of 1 lb NPK/1000 sq ft. We maintained fertility at 0 to 0.25 lb N/1000 sq ft per growing month. We mowed the plots weekly during the growing season at 2.5 to 3.0 inches and returned clippings. We irrigated as necessary to prevent dormancy and controlled weeds, insects, and diseases only when they presented a threat to the trial. At appropriate times during the course of the study, we rated the turfgrass on a scale of 0=brown turf, 6=acceptable, and 9=optimum.

RESULTS:

We rated turfgrass quality monthly throughout the 1998 growing season (Table 1). Ratings were influenced by degree of coverage and weed infestation as well as turf density. The best overall performers were the two vegetative types UCR-95 and 609 followed by the seeded types Sharp’s Improved #2 and Sharp’s Improved. At summer’s end, we looked at turf color and texture and found that the vegetative types Prairie, 609 and UCR-95 and the seeded types Bam-1000, Bison, and Cody were the darkest green. The vegetative types Midget and Prairie and the seeded types Cody and Sharp’s Improved had the finest texture.

Table 1. 1998 performance of buffalograss cultivars at Wichita, KS[1].

Cultivar/ Experimental Number	Seeded/ Vegetative	Color	Texture	Quality						
				5/26	6/23	7/28	8/24	9/16	10/19	Avg.
UCR-95	V	7.0	6.7	7.3	7.0	6.7	5.3	5.7	6.3	6.4
609	V	7.0	6.3	5.7	5.0	5.0	5.7	6.0	6.3	5.6
Sharp's Improved #2	S	6.0	6.3	3.3	6.0	5.7	6.0	6.3	6.3	5.6
Sharp's Improved	S	6.0	6.7	4.0	5.0	5.7	6.0	6.3	6.3	5.6
Tatanka	S	6.0	6.7	2.7	4.3	5.7	6.3	6.3	6.0	5.2
Bison	S	6.0	6.3	3.0	4.3	4.7	5.7	6.0	5.7	4.9
Cody	S	6.0	6.7	3.0	4.7	5.0	5.3	5.7	5.7	4.9
91-118	V	5.3	5.3	4.7	5.7	5.0	5.0	4.0	4.7	4.8
378	V	4.7	5.0	4.7	5.7	5.0	5.0	3.3	4.0	4.6
Sharpshooter	S	5.3	5.7	3.0	5.3	4.3	5.3	4.3	5.3	4.6
Prairie	V	7.3	7.0	3.0	4.0	5.0	5.0	4.3	4.7	4.3
Texoka	S	6.0	6.7	3.0	3.3	4.3	5.0	5.0	5.3	4.3
Bonnie Brae	V	5.0	5.3	3.7	4.3	4.7	5.3	4.3	3.3	4.3
Bam-1000	S	6.0	6.3	2.7	3.7	4.0	4.7	4.0	5.0	4.0
8907	S	5.3	5.7	2.3	4.0	3.7	4.7	3.7	4.3	3.8
Midget	V	6.0	7.0	3.7	3.7	2.7	4.3	4.0	4.3	3.8
86-120	V	4.3	5.0	4.3	4.0	4.0	4.0	3.3	2.7	3.7
86-61	V	4.7	5.0	3.7	4.0	3.7	4.0	2.3	1.3	3.2
Stampede	V	5.7	6.3	2.7	3.7	3.0	3.0	2.3	2.7	2.9
Mobuff	V	4.3	5.0	2.0	2.0	2.0	2.7	2.0	1.3	2.0
LSD[2]		*0.8*	*0.8*	*1.5*	*2.0*	*2.2*	*1.7*	*2.0*	*1.8*	*1.5*

[1] Ratings based on a scale of 0-9 with 9=best color, texture, and quality.
[2] To determine statistical differences among entries, subtract one entry's mean from another's. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: High-Maintenance Kentucky Bluegrass Cultivar Evaluation

OBJECTIVE: To evaluate Kentucky bluegrass cultivars under golf course fairway conditions in the transition zone.

PERSONNEL: Steve Keeley

INTRODUCTION:

Turfgrass breeders recently have been directing efforts toward developing Kentucky bluegrass cultivars with improved tolerance to low mowing heights. Successful cultivars must form a dense playing surface at low mowing heights (5/8 inch or less) and must have resistance to summer patch. If such cultivars can be identified, they would provide a viable alternative to perennial ryegrass for cool-season fairway turf in the transition zone.

MATERIALS AND METHODS:

One-hundred and five Kentucky bluegrass cultivars were seeded in September of 1995 at the Rocky Ford Turfgrass Research Center in Manhattan, KS. The trial was mowed at 9/16 inch and was fertilized with 4 lb N/1000 sq ft^2 per year. Because of problems with the irrigation system, the cultivars experienced periodic drought stress. No fungicides or insecticides were applied.

Turf quality was rated monthly from April to November on a visual scale of 0 to 9, where 0=dead turf and 9=optimum uniformity. In this particular trial, most people would find cultivars with an average quality rating of 5.5 or above to be acceptable fairway turfs. The cultivars also were rated for color and density. A severe billbug infestation occurred in the latter part of June and early July, so billbug damage was rated at that time.

RESULTS:

The summer was characterized by extreme heat, heavy billbug pressure, and drought stress until July 23, when 6 inches of rain fell during a 10-day period. Consequently, the Kentucky bluegrass cultivars were subjected to a severe test. During the summer months, most cultivars were in poor condition. However, five cultivars, Unique, PST-B2-42, PST-B0-141, America, and Apollo, had mean quality ratings of 5.5 or higher (Table 1). These cultivars really stood out from the rest over the course of the season. Additionally, all were strong performers in the previous 2 years of the trial. Based on 3 years of observations, then, these five cultivars would be expected to perform better as a fairway turf than the other cultivars in the trial. All five have similar genetic color, so they could be blended together easily for fairway use.

Table 1. Mean turfgrass quality and other ratings of Kentucky bluegrass cultivars in the 1995 National Kentucky Bluegrass Test (high input) at Manhattan, KS. Turgrass quality and other ratings: 1-9; 9 = best (or least damage)

Name	Genetic Color	Spring Green-Up	Summer Density	Billbug Damage	Quality								
					April	May	June	July	Aug	Sep	Oct	Nov	Mean
Unique	6.3	5.7	6.0	7.0	4.3	6.0	6.0	6.7	6.0	6.3	6.7	6.3	6.0
PST-B2-42	6.7	6.7	6.3	6.3	5.0	6.3	6.0	5.7	4.3	5.7	6.0	5.3	5.6
PST-BO-141	6.7	6.0	6.3	6.0	4.3	5.7	6.0	6.0	4.7	5.7	6.3	6.3	5.6
America	6.0	5.7	6.3	5.3	4.3	5.7	4.7	5.3	5.0	6.3	6.7	6.3	5.5
Apollo (PST-BE-180)	6.3	6.7	6.7	6.3	5.0	6.0	5.7	5.7	4.0	5.3	6.0	6.0	5.5
ASP200 (HV 130)	7.0	5.7	6.3	4.3	4.0	6.0	3.7	4.7	4.3	6.0	5.7	4.7	4.9
Pick 8	8.0	5.7	5.7	6.0	4.7	6.3	4.7	4.7	3.7	4.7	4.3	4.7	4.7
SR 2109	6.3	5.3	5.7	5.3	4.7	6.3	4.7	4.7	3.3	4.3	5.0	4.7	4.7
Blackstone (PST-638)	7.0	6.0	6.0	6.0	5.0	7.3	5.3	4.0	3.3	4.0	4.3	3.7	4.6
Goldrush (BA-87-102)	6.7	5.3	6.0	4.3	4.3	6.0	4.3	4.3	3.7	4.7	4.7	5.0	4.6
SRX 2205	6.7	4.7	6.0	7.0	4.0	6.7	6.3	4.3	3.0	3.7	3.3	3.7	4.4
Wildwood	6.7	5.7	6.0	6.0	4.0	6.7	4.7	4.0	3.0	4.3	4.0	4.7	4.4
ZPS-2183	7.3	7.0	6.0	5.0	5.7	6.0	4.7	3.7	2.7	4.7	3.7	4.0	4.4
BA 75-173	6.7	5.7	5.7	5.3	4.3	5.0	4.3	4.0	2.7	4.0	4.7	5.0	4.3
SR 2000	7.3	5.7	6.3	5.3	4.3	4.7	4.3	4.3	3.7	5.0	4.0	3.7	4.3
Arcadia (J-1936)	6.7	5.7	5.3	4.0	4.7	5.3	3.0	3.7	3.3	4.3	4.3	4.7	4.2
BA 81-227	6.0	6.0	5.7	4.0	4.7	4.7	3.3	3.0	3.0	4.3	5.0	5.3	4.2
Chateau	5.7	6.3	6.3	3.7	4.3	5.7	3.0	2.7	2.7	4.0	5.7	5.3	4.2
Livingston	6.0	6.0	5.3	3.7	4.3	4.3	3.7	4.0	3.0	4.3	4.7	5.0	4.2
Platini	6.7	6.0	5.0	4.7	4.7	4.7	3.7	3.3	3.7	4.3	4.3	5.0	4.2
BAR VB 5649	7.0	6.3	5.7	4.7	4.7	4.7	3.3	3.7	3.0	4.7	4.7	4.0	4.1
Challenger	6.3	6.0	5.3	4.3	4.3	4.7	3.7	4.0	3.7	4.0	4.3	4.3	4.1
Champage (LTP-621)	6.0	6.7	6.0	3.3	5.3	4.3	3.0	3.0	2.7	4.7	4.7	5.3	4.1
Jefferson	6.0	6.7	6.0	3.3	5.0	5.0	3.3	3.0	1.7	4.3	5.3	5.0	4.1
PST-BO-165	5.3	6.3	5.7	4.0	4.7	5.0	3.3	3.0	2.7	3.7	5.0	5.3	4.1
LKB-95	6.7	6.3	6.7	4.3	4.7	5.7	3.3	3.0	2.3	3.7	5.0	4.3	4.0
Marquis	6.7	5.7	6.3	5.3	4.3	5.3	4.3	4.0	2.3	4.0	4.0	3.3	4.0
BA 76-197	6.3	5.7	5.3	4.3	4.0	4.7	3.7	4.0	4.0	3.7	3.7	3.7	3.9
BA 81-220	7.0	4.3	5.7	4.7	3.3	4.7	3.7	3.7	2.7	3.3	4.7	5.0	3.9
BAR VB 233	6.3	5.7	6.0	4.7	5.0	5.3	4.0	3.0	2.3	4.0	4.0	3.3	3.9
Baronie	5.0	6.0	6.0	3.7	4.3	5.0	3.3	2.7	2.3	4.0	5.3	4.3	3.9
Blacksburg	7.7	6.3	6.7	5.3	5.3	6.7	4.7	3.0	1.7	3.7	3.3	3.0	3.9
Explorer (PICK-3561)	6.0	5.7	6.0	4.3	5.0	5.3	4.0	3.3	2.3	3.3	4.0	4.0	3.9
Liberator (ZPS-2572)	7.7	4.7	6.3	4.0	3.7	5.3	3.3	4.0	3.0	4.0	3.7	4.0	3.9

Name	Genetic Color	Spring Green-Up	Summer Density	Billbug Damage	Quality								
					April	May	June	July	Aug	Sep	Oct	Nov	Mean
Quantum Leap (J-1567)	6.7	5.0	6.0	5.0	4.3	5.3	4.3	3.3	2.3	3.7	4.0	3.7	3.9
Abbey	6.0	5.3	5.7	5.0	4.0	5.3	4.0	3.3	2.3	3.7	3.7	4.0	3.8
BA 70-060	6.0	5.3	5.3	4.7	3.7	5.3	4.0	3.3	2.7	3.3	4.0	4.0	3.8
BA 75-490	6.3	5.7	6.0	3.3	4.0	4.0	3.0	3.3	2.7	4.0	4.7	4.7	3.8
BA 81-113	6.3	6.0	5.3	4.7	3.7	4.7	4.0	4.0	2.7	3.7	4.0	3.7	3.8
Fortuna	6.7	6.0	5.7	4.0	4.7	5.3	3.7	3.3	2.7	3.3	3.7	3.3	3.8
Glade	7.0	6.0	6.3	4.3	5.3	6.0	3.7	2.7	1.3	3.0	4.3	4.0	3.8
Limousine	6.3	6.3	6.7	4.7	5.0	5.0	4.0	4.0	2.7	4.0	2.7	2.7	3.8
Lipoa	7.7	6.3	6.0	4.3	5.7	6.3	3.7	3.0	1.7	3.0	3.7	3.7	3.8
Midnight	8.0	4.3	6.7	4.0	3.3	5.3	3.7	3.0	2.0	4.7	4.0	4.0	3.8
NJ-54	6.3	6.0	6.0	3.3	5.0	5.0	3.7	3.3	2.3	3.7	3.7	3.7	3.8
SR 2100	6.3	5.7	5.3	4.3	4.3	4.7	3.7	3.7	2.0	3.7	4.0	4.0	3.8
BA 75-163	7.0	6.3	5.3	4.0	4.3	4.3	3.0	4.0	2.7	3.7	3.7	3.7	3.7
BAR VB 3115B	5.0	6.0	5.7	4.3	4.3	5.0	3.7	2.7	2.3	3.7	4.0	3.7	3.7
Caliber	6.3	6.0	5.7	4.0	4.7	4.7	3.3	3.0	2.0	3.7	4.7	3.7	3.7
H86-690	7.7	5.7	5.0	4.3	3.7	4.3	3.7	4.0	2.7	3.3	4.3	3.7	3.7
Impact (J-1576)	8.0	4.7	5.7	4.0	3.0	4.7	3.3	4.0	3.3	3.7	4.0	3.7	3.7
Misty (BA 76-372)	6.0	6.3	5.0	4.3	5.0	5.0	4.0	3.0	1.7	3.7	3.7	3.3	3.7
Serene (PST-A7-245A)	6.0	6.0	5.7	4.0	4.3	4.7	3.3	2.3	2.0	3.7	4.7	4.7	3.7
BA 77-702	6.3	5.7	5.7	4.7	4.7	5.7	4.0	3.3	1.7	2.7	3.7	3.3	3.6
BA 81-058	6.7	6.3	6.0	4.0	5.0	5.0	3.7	3.0	2.3	3.0	3.7	3.3	3.6
Bartitia	6.7	5.0	6.3	5.0	4.0	6.3	4.7	3.3	2.3	2.7	3.0	2.7	3.6
Coventry	5.3	5.7	6.3	4.0	4.3	5.3	3.3	2.3	1.3	3.0	5.0	4.3	3.6
Dragon (ZPS-429)	7.0	6.3	5.0	4.0	4.3	4.7	3.7	3.7	2.7	3.0	3.3	3.3	3.6
Entry 104	5.0	6.3	4.7	3.7	4.3	4.0	3.3	2.7	2.3	3.7	4.7	3.7	3.6
HV 242	6.7	7.0	6.3	4.0	5.7	4.7	3.3	3.0	1.3	3.0	4.3	3.7	3.6
Nimbus	6.0	6.0	5.7	4.3	4.7	5.0	4.0	3.7	1.7	3.0	3.3	3.3	3.6
NJ-GD	6.0	7.0	5.0	3.3	5.0	4.7	3.0	3.0	2.0	3.7	4.0	3.7	3.6
North Star (PST-A7-60)	7.0	4.7	7.0	5.7	3.7	7.0	4.7	2.7	1.7	2.3	3.3	3.6	
PST-P46	7.3	5.3	6.0	5.0	4.0	6.3	4.0	3.7	2.3	2.7	2.7	3.0	3.6
Rugby II (Med-18)	8.0	4.7	6.0	4.0	3.7	5.0	3.3	2.7	2.0	4.0	4.0	4.0	3.6
Shamrock	6.3	6.3	5.3	3.7	5.0	4.3	3.7	3.0	2.0	3.0	4.0	3.7	3.6
ZPS-309	7.0	5.7	6.0	4.3	5.0	4.7	4.0	3.0	1.3	3.0	4.0	4.0	3.6
BA 73-373	6.3	5.3	6.3	4.3	3.7	5.0	3.7	3.0	2.0	3.3	4.0	3.7	3.5
BA 81-270	5.7	6.0	6.3	4.0	4.3	5.3	3.3	2.0	1.7	3.3	4.0	4.0	3.5
Chicago (J-2582) 6.0	5.7	5.7	3.7	4.7	4.7	3.0	2.7	2.0	3.7	3.7	3.7	3.5	
Classic	5.3	6.0	5.7	3.0	5.0	4.0	2.7	2.3	2.0	3.7	4.3	4.3	3.5

Name	Genetic Color	Spring Green-Up	Summer Density	Billbug Damage	Quality April	May	June	July	Aug	Sep	Oct	Nov	Mean
Compact	5.0	6.3	5.0	4.3	4.3	4.3	3.3	3.0	2.0	3.0	4.0	4.0	3.5
Haga	5.3	6.3	5.7	3.0	5.0	4.3	2.3	2.0	2.0	3.7	4.3	4.3	3.5
J-1555	6.7	5.7	4.7	3.3	4.3	4.7	2.7	2.7	2.7	3.3	4.0	3.7	3.5
LTP-620	6.7	6.0	5.0	3.3	4.3	3.7	2.3	3.0	2.7	3.7	4.0	4.3	3.5
NJ 1190	6.0	6.0	7.0	4.0	4.3	5.7	3.3	2.7	2.0	3.3	3.3	3.0	3.5
Princeton 105	6.7	6.3	6.0	3.3	4.7	5.0	2.7	2.3	1.3	3.3	4.3	4.3	3.5
Total Eclipse (TCR-1738)	7.3	5.0	6.0	4.7	3.3	6.0	3.7	3.0	1.7	3.7	3.7	3.3	3.5
Ascot	7.0	5.3	5.3	4.3	4.0	5.0	3.7	3.0	1.7	3.0	3.7	3.0	3.4
Baron	6.0	6.0	5.3	4.7	4.7	5.0	4.0	2.7	1.7	2.7	3.7	3.0	3.4
Eclipse	6.0	6.3	5.3	3.3	4.7	4.3	3.0	2.7	2.0	3.0	4.0	3.7	3.4
Entry 105	5.7	5.7	5.3	3.7	4.0	4.0	3.0	2.3	1.7	3.7	4.7	4.0	3.4
Odyssey (J-1561)	7.0	5.7	6.7	3.3	4.7	5.0	3.0	2.7	1.7	3.0	3.7	3.3	3.4
Pick-855	6.7	6.3	5.0	4.7	4.3	4.3	4.0	3.7	2.3	2.7	3.0	2.7	3.4
A88-744	6.7	6.7	6.0	3.3	4.0	4.0	2.7	2.7	2.3	3.7	3.7	3.7	3.3
Award	7.3	5.0	6.7	3.7	4.7	5.3	3.0	2.0	.7	3.0	3.7	3.3	3.3
Med-1580	7.0	6.0	5.3	3.7	4.0	5.0	3.3	2.3	1.7	2.7	3.7	3.3	3.3
Moonlight (PST-A18)	8.0	5.7	5.3	4.7	4.0	5.0	3.7	3.0	2.0	3.0	2.7	2.7	3.3
Nuglade	7.0	5.0	5.7	3.3	3.3	4.3	3.0	2.7	1.7	3.3	4.0	3.7	3.3
Raven	6.3	5.3	5.3	4.3	4.0	4.3	3.7	3.7	1.7	2.7	3.3	3.3	3.3
Seabring (BA 79-260)	7.3	5.0	5.7	4.0	3.3	4.7	3.3	2.3	1.7	3.7	4.3	3.3	3.3
Conni	6.0	5.7	7.0	4.0	4.7	6.0	3.7	2.0	1.0	2.3	3.0	2.7	3.2
Nustar	6.0	6.3	5.7	4.0	4.7	5.0	3.3	2.7	1.3	2.3	3.0	3.0	3.2
Bluechip (Med-1991)	7.0	5.7	4.7	4.0	4.0	4.0	3.0	3.3	2.0	2.3	3.3	3.0	3.1
Kenblue	4.7	5.3	4.3	3.0	3.3	3.3	2.7	3.3	2.0	3.3	3.7	3.0	3.1
Rambo (J-2579)	6.3	5.7	6.0	3.7	4.3	5.3	3.0	1.7	1.7	2.7	3.0	3.0	3.1
Absolute (Med-1497)	8.0	5.7	5.7	3.0	4.0	4.7	3.0	2.3	1.3	2.7	3.0	3.3	3.0
Allure	5.7	6.0	6.3	3.0	4.3	5.0	2.7	1.7	1.3	2.3	3.3	3.3	3.0
Sidekick	6.0	5.7	5.3	4.0	4.0	4.7	3.3	2.3	1.0	2.3	3.7	3.0	3.0
BAR VB 6820	7.0	4.7	5.7	4.0	3.0	4.7	3.0	2.7	1.3	2.3	3.0	3.0	2.9
Sodnet	7.7	5.0	4.3	4.3	2.7	4.0	3.0	3.7	2.3	2.3	2.7	2.3	2.9
Cardiff	7.0	7.0	6.0	3.7	4.7	3.7	2.7	2.0	1.0	2.0	2.7	2.3	2.6
Pepaya (DP 37-192)	8.0	5.0	5.0	3.3	2.7	4.3	2.3	2.0	1.3	2.3	2.7	2.7	2.5
VB 16015	7.3	6.3	5.0	3.0	4.3	3.0	2.7	2.0	1.3	1.7	2.3	2.0	2.4
Baruza	7.3	4.7	5.3	3.3	3.3	3.0	2.3	2.0	1.3	1.7	1.7	1.3	2.1
LSD Value	0.8	1.9	1.8	1.4	1.7	1.5	1.2	2.0	3.0	3.1	1.8	1.9	1.3

TITLE: Tall Fescue Cultivar Evaluation

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

PERSONNEL: Linda R. Parsons, Ned A. Tisserat, and John C. Pair

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

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

MATERIALS AND METHODS:

We seeded 390 5 ft × 5 ft study plots at the John C. Pair Horticultural Center in Wichita, KS on 11 September 1996 with 130 tall fescue cultivars and experimental numbers. Seeding rate was 4.4 lb seed/1000 sq ft. Prior to seeding, we incorporated 13-13-13 into the study plots at a rate of 1 lb NPK/1000 sq ft. We maintained fertility of the plots at 0.25 to 0.5 lb N/1000 sq ft per growing month. We mowed the plots weekly during the growing season at 2.5 inches and returned clippings. We irrigated as necessary to prevent stress and controlled weeds, insects, and diseases only when they presented a threat to the trial.

In the months following seeding, we rated the fescue cultivars on seedling vigor; height, to help distinguish dwarf from standard cultivars; texture; genetic color; and density. During 1997 and 1998, we collected data on turf quality, green-up, color, texture, and resistance to pythium blight. Rating was on a scale of 0=brown turf, 6=acceptable, and 9=optimum.

RESULTS:

The best overall performers for 1998 (Table 1) included Rembrandt, Masterpiece, Mustang II, Plantation, and Southern Choice. Arid, Falcon II, Marksman, and Mustang II were among those that greened up most rapidly in the spring. At summer's end, we looked at turf color and texture and found that MB 213, MB 29, Plantation, and ZPS-5LZ were the darkest green and that BAR Fa6 UD, Jaguar 3, and Kitty Hawk S.S.T. had the finest texture.

In terms of performance over the course of the study (Table 2), Arid and Kentucky-31 w/endo. demonstrated the greatest seedling vigor. Their shorter height indicated that Gazelle and Shortstop II were among the most dwarf selections, and Millennium, Plantation, and Rembrandt had formed some of the most dense stands by the end of their first growing season. In 1997 as a result of the extremely wet spring and early summer, most of the turf was affected by pythium blight. Tomahawk-E2, Kentucky-31 w/endo., Kitty Hawk S.S.T., and Renegade proved among the most resistant, and Plantation, Gazelle, and Rebel 2000 the least resistant to the blight. MB 213, 2PS-5LZ, and MB 29 averaged the darkest color, and Gazelle, Rembrandt, and MB 29, the finest texture. The best average quality for the past 2 years was demonstrated by Masterpiece, MB 210, PST-5M5, Southern Choice, Empress, and PST-5E5.

Table 1. 1998 performance of tall fescue cultivars at Wichita, KS[1].

Cultivar/ Experimental Number	Green-Up	Color	Texture	Quality 4/30	5/18	6/16	7/21	8/24	9/15	10/30	11/24	Avg.
Rembrandt (LTP-4026 E+)*	6.0	7.0	7.0	7.7	8.0	7.3	6.7	6.7	7.0	7.3	5.3	7.0
MB 210	6.0	7.0	6.3	7.7	7.7	7.0	7.3	6.7	7.0	7.0	5.3	7.0
MB 211	6.0	7.3	6.3	7.3	8.0	7.0	6.7	7.3	7.0	7.0	5.0	6.9
MB 213	5.7	8.3	7.0	8.0	8.3	7.0	6.7	6.0	6.3	7.3	5.7	6.9
Masterpiece (LTP-SD-TF)*[2]	6.3	7.0	7.0	8.7	7.3	6.3	7.0	6.0	6.7	7.7	5.7	6.9
Mustang II*	7.0	7.0	6.7	7.7	7.0	6.7	7.0	6.3	7.0	7.3	6.0	6.9
PST-5M5	6.3	7.0	6.7	8.0	7.3	7.0	6.7	6.0	6.7	7.3	6.0	6.9
Plantation (Pennington-1901)*	6.3	8.3	6.7	7.0	8.3	6.7	6.7	6.3	6.3	7.3	6.3	6.9
Southern Choice*	6.3	7.3	6.3	8.0	7.7	7.0	6.7	6.7	6.0	7.0	6.0	6.9
MB 28	6.0	7.3	6.3	7.7	8.0	7.0	7.0	6.0	6.3	7.0	5.7	6.8
PST-523	6.3	6.7	7.0	7.7	7.3	7.0	7.0	6.3	6.7	7.0	5.7	6.8
ZPS-2PTF	6.7	7.3	7.0	7.3	8.0	6.7	7.0	6.7	6.3	7.0	5.7	6.8
Coronado*	6.0	7.3	7.0	7.7	7.0	7.3	7.0	7.0	6.3	6.7	5.3	6.8
MB 26	6.3	7.3	7.0	8.3	7.7	7.3	6.3	6.7	5.7	7.0	5.3	6.8
BAR Fa6D USA	6.0	7.7	6.7	7.3	7.0	7.0	6.7	6.3	7.3	7.0	5.3	6.8
Bonsai 2000 (Bullet)*	6.3	7.0	7.0	7.3	8.3	6.7	6.7	6.3	6.3	7.0	5.3	6.8
Bravo (RG-93)*	6.3	7.7	6.3	7.7	7.3	7.0	6.3	6.3	6.3	7.3	5.7	6.8
Crossfire II*	6.3	7.0	6.3	7.3	7.7	6.7	7.0	6.0	6.7	7.0	5.7	6.8
Genesis*	6.0	7.0	6.7	7.3	7.0	7.0	6.7	7.0	6.0	7.0	6.0	6.8
MB 212	6.3	7.7	6.7	7.0	7.7	7.0	7.0	7.0	6.3	7.0	5.0	6.8
Marksman*	7.0	7.0	6.3	7.3	7.0	7.0	7.0	6.7	6.3	7.0	5.7	6.8
PST-5TO	6.7	7.3	7.0	7.3	7.3	6.7	7.0	6.3	6.7	7.3	5.3	6.8
Rebel Sentry (AA-A91)*	6.3	8.0	6.3	8.0	7.3	6.7	6.7	6.7	6.0	7.0	5.7	6.8
SRX 8500	6.0	7.0	6.7	7.3	7.0	7.0	7.0	6.7	6.7	7.0	5.3	6.8
Shenandoah*	6.7	6.0	7.0	7.0	7.0	7.3	6.3	6.7	7.0	7.0	5.7	6.8
ATF-188	6.3	6.7	6.3	7.0	7.0	6.7	7.0	6.7	6.3	7.0	6.0	6.7
ATF-257	6.0	7.0	7.0	7.0	7.0	7.0	7.0	6.3	6.3	7.0	6.0	6.7
Aztec II (TMI-AZ)*	6.7	7.0	7.0	8.0	7.7	7.0	6.7	5.3	6.0	7.0	6.0	6.7

Cultivar/ Experimental Number	Green-Up	Color	Texture	Quality								
				4/30	5/18	6/16	7/21	8/24	9/15	10/30	11/24	Avg.
BAR FA 6LV	6.7	7.7	7.0	7.3	7.7	7.3	6.7	6.0	6.3	7.0	5.3	6.7
BAR Fa6 US2U	6.3	7.3	7.0	7.3	8.0	6.3	7.0	6.7	6.0	7.0	5.3	6.7
Coronado Gold (PST-5RT)*	6.3	7.3	7.0	7.3	7.0	7.0	6.7	6.7	6.3	7.0	5.7	6.7
Falcon II*	7.0	7.0	6.7	7.3	7.3	7.3	6.7	6.0	6.3	7.0	5.7	6.7
PRO 8430	6.0	7.0	6.7	7.0	7.7	7.0	7.0	6.3	6.0	7.0	5.7	6.7
Arid 3 (J-98)*	5.7	7.3	6.3	7.3	8.0	6.7	6.7	6.0	6.3	6.7	5.7	6.7
J-101	5.7	7.0	6.3	7.0	7.7	6.7	6.7	6.0	6.7	7.0	5.7	6.7
Jaguar 3*	6.3	7.0	7.3	7.3	7.0	6.7	6.7	6.0	6.7	7.3	5.7	6.7
OFI-96-31	7.0	7.7	7.0	8.0	7.7	6.7	6.3	6.0	6.0	7.0	5.7	6.7
Rebel 2000 (AA-989)*	5.7	7.3	6.3	7.3	7.7	6.3	7.0	6.0	6.7	6.7	5.7	6.7
Tar Heel*	6.3	7.0	6.7	7.7	6.7	7.0	7.0	6.7	6.0	7.0	5.3	6.7
Twilight II (TMI-TW)*	6.3	7.3	6.3	8.0	7.7	6.7	6.3	6.0	6.3	6.7	5.7	6.7
CU9502T	6.3	6.0	6.7	7.3	7.3	7.0	7.0	6.3	6.3	6.7	5.3	6.7
PC-AO	6.3	7.0	6.7	7.3	7.3	7.0	6.7	6.0	6.3	7.3	5.3	6.7
SR 8210	6.0	6.7	7.0	7.3	7.3	7.0	7.0	6.3	6.3	6.7	5.3	6.7
Anthem II (TMI-FMN)*	6.7	7.3	6.7	7.7	7.3	7.3	6.3	5.7	6.3	7.0	5.3	6.6
Apache II*	5.7	7.0	6.0	7.7	7.0	6.3	6.7	6.7	6.3	7.0	5.3	6.6
BAR FA 6D	7.0	7.0	7.3	7.7	7.3	6.3	6.7	6.0	6.3	7.3	5.3	6.6
BAR Fa6 US3	5.7	7.3	6.3	7.3	7.7	6.7	6.3	6.3	6.0	7.0	5.7	6.6
Bandana (PST-R5AE)*	6.0	7.3	7.0	7.7	7.3	6.7	6.3	6.0	6.3	7.0	5.7	6.6
Duster*	6.3	7.3	6.3	7.7	7.7	7.0	6.3	6.0	6.3	7.0	5.0	6.6
ISI-TF11	6.3	7.0	6.3	7.7	7.7	6.3	6.7	6.0	6.0	7.0	5.7	6.6
Kitty Hawk S.S.T. (SS45DW)*	6.3	7.0	7.3	7.0	7.0	6.3	7.0	6.7	6.3	7.0	5.7	6.6
Millennium (TMI-RBR)*	6.0	7.0	7.0	7.0	7.0	7.0	7.0	6.0	6.7	7.0	5.3	6.6
Pixie E+*	6.0	7.3	6.0	7.3	7.3	7.3	6.3	6.0	6.0	7.0	5.7	6.6
Renegade*	6.0	6.3	6.7	7.3	7.3	6.7	6.7	6.3	6.3	7.3	5.0	6.6
Safari*	7.0	6.7	6.7	7.0	7.3	7.0	6.3	6.0	6.7	7.0	5.7	6.6
Titan 2*	5.3	6.7	6.3	7.0	7.3	7.0	6.7	6.0	6.0	7.0	6.0	6.6

Cultivar/ Experimental Number	Green-Up	Color	Texture	Quality								
				4/30	5/18	6/16	7/21	8/24	9/15	10/30	11/24	Avg.
WRS2	5.7	8.0	6.7	7.7	7.0	6.7	7.0	6.3	6.3	6.7	5.3	6.6
BAR Fa6 US1	5.3	7.0	6.7	7.0	7.0	6.7	7.0	6.3	6.3	7.0	5.3	6.6
Good-EN (Koos 96-14)*	6.3	7.0	6.7	7.3	7.0	6.7	7.0	6.0	6.3	7.0	5.3	6.6
MB 216	5.0	7.7	6.0	7.3	8.0	6.3	5.7	6.3	6.3	7.0	5.7	6.6
OFI-931	5.7	7.7	7.0	7.3	7.0	7.0	7.0	6.7	6.0	6.7	5.0	6.6
Reserve (ATF-182)*	6.0	6.3	6.7	7.3	6.7	6.3	6.7	7.0	6.0	7.0	5.7	6.6
Tulsa*	6.0	6.3	6.7	7.3	7.3	6.7	6.3	6.3	6.3	7.0	5.3	6.6
Wolfpack (PST-R5TK)*	6.3	7.0	6.0	7.0	7.0	6.7	6.7	6.0	6.3	7.3	5.7	6.6
ATF-253	6.0	6.7	6.3	7.0	7.0	7.0	7.0	5.7	6.3	7.0	5.3	6.5
Arid 2 (J-3)*	6.3	7.7	6.3	7.7	7.0	7.0	6.0	6.0	6.3	7.0	5.3	6.5
Comstock (SSDE31)*	6.0	6.7	6.3	7.3	6.7	6.3	7.0	6.0	6.3	7.0	5.7	6.5
EC-101	6.3	7.0	6.3	7.3	7.0	6.3	6.7	6.3	6.0	7.0	5.7	6.5
Empress*	6.0	7.0	7.0	7.3	6.7	6.7	6.7	6.3	6.3	7.0	5.3	6.5
ISI-TF9	6.3	6.7	7.0	7.7	7.0	6.3	6.7	6.3	6.0	7.0	5.3	6.5
Lion*	6.0	6.7	6.0	7.7	7.3	7.0	6.0	6.3	6.0	6.7	5.3	6.5
OFI-951	6.3	7.0	6.7	7.0	7.3	6.7	7.0	6.3	6.0	7.0	5.0	6.5
OFI-96-32	6.3	7.0	6.3	7.3	6.7	6.7	7.0	6.3	6.0	7.0	5.3	6.5
PSII-TF-10	6.0	7.0	6.7	7.0	7.0	7.0	6.7	6.3	6.0	7.3	5.0	6.5
PST-5E5	6.7	7.0	6.7	7.7	7.3	6.7	6.7	5.7	6.0	7.3	5.0	6.5
Pick GA-96	6.0	6.7	6.7	7.0	7.3	7.3	7.0	5.7	6.0	7.0	5.0	6.5
Gazelle*	5.3	7.0	7.0	7.0	7.3	6.3	6.3	6.3	6.0	7.3	5.7	6.5
AA-983	5.7	7.7	7.0	7.0	7.0	6.0	6.3	6.3	6.7	7.0	5.7	6.5
ATF-192	6.0	6.7	6.0	7.0	7.0	7.0	6.3	6.3	5.7	7.0	5.7	6.5
Leprechaun*	5.7	6.3	6.3	7.0	7.0	6.3	6.7	6.7	6.0	7.0	5.3	6.5
MB 214	5.7	8.0	6.7	7.0	7.3	6.7	6.0	6.7	6.7	6.7	5.0	6.5
MB 215	6.0	7.7	6.3	7.0	7.0	6.7	6.7	6.0	6.0	7.0	5.7	6.5
MB 29	6.0	8.3	7.0	7.0	6.7	6.7	6.3	6.7	6.3	7.0	5.3	6.5
Pick FA 6-91	5.3	7.3	6.7	7.0	7.7	7.0	7.0	5.7	5.7	6.7	5.3	6.5
Pick FA N-93	5.3	8.0	6.3	6.0	7.3	6.7	6.7	6.3	6.3	7.0	5.7	6.5

Cultivar/ Experimental Number	Green-Up	Color	Texture	Quality 4/30	5/18	6/16	7/21	8/24	9/15	10/30	11/24	Avg.
Pick FA XK-95	6.0	7.3	6.7	7.0	7.0	6.3	6.7	6.0	6.0	7.3	5.7	6.5
ZPS-5LZ	6.0	8.3	7.0	7.3	7.3	7.0	6.0	6.0	5.7	7.0	5.7	6.5
Tomahawk-E*	6.0	7.0	7.0	7.0	6.7	6.7	6.7	6.7	6.3	7.0	4.7	6.5
ATF-022	5.7	6.7	6.7	7.0	6.7	6.0	7.0	6.7	6.0	7.0	5.3	6.5
Alamo E*	6.0	7.3	6.3	7.3	7.7	7.0	6.3	5.7	6.0	6.7	5.0	6.5
Bonsai*	5.7	7.0	6.7	6.7	7.0	6.7	7.0	6.3	5.7	7.0	5.3	6.5
DLF-1	7.3	7.0	7.0	7.7	7.0	6.3	6.3	6.0	6.0	7.0	5.3	6.5
Finelawn Petite*	6.3	7.0	6.3	7.3	6.7	6.3	6.7	6.3	6.3	7.0	5.0	6.5
OFI-FWY	6.3	7.0	6.3	7.3	7.0	6.7	6.7	6.0	5.7	7.0	5.3	6.5
R5AU	5.7	7.0	6.7	7.0	7.3	6.7	6.3	5.3	6.0	7.0	6.0	6.5
Sunpro*	6.0	7.7	6.0	7.0	6.7	6.3	7.0	6.3	6.0	6.7	5.7	6.5
TA-7	6.0	7.3	6.3	7.3	7.0	6.7	6.7	6.3	6.0	6.7	5.0	6.5
WVPB-1D	6.0	7.0	6.3	7.3	7.0	6.3	6.3	6.0	6.0	7.0	5.7	6.5
ATF-020	5.7	6.7	6.0	7.3	6.7	6.7	6.7	5.7	6.0	6.7	5.7	6.4
ATF-196	5.7	7.0	6.3	7.0	7.3	6.3	6.7	6.3	5.7	6.3	5.7	6.4
CU9501T	6.7	7.0	6.0	6.7	7.0	6.7	6.7	6.3	5.7	7.0	5.3	6.4
Cochise II*	6.3	7.0	6.3	7.3	6.7	6.7	6.7	5.7	5.7	7.0	5.7	6.4
DP 7952	7.0	6.7	5.7	6.7	7.0	6.7	6.3	5.3	6.0	7.0	6.3	6.4
ISI-TF10	6.3	7.7	6.3	7.3	7.0	6.7	6.0	5.7	6.3	7.0	5.3	6.4
JSC-1	6.0	6.0	6.0	7.0	6.7	6.3	6.7	6.3	6.0	7.0	5.3	6.4
JTTFC-96	6.7	6.0	6.3	7.0	7.0	7.0	6.3	6.0	6.0	6.3	5.7	6.4
Overtime mix	6.7	6.3	6.0	7.0	7.0	6.7	6.7	5.7	5.7	7.0	5.7	6.4
Pick FA 15-92	5.7	6.7	6.7	7.0	7.7	7.0	6.3	5.7	5.7	7.0	5.0	6.4
Pick RT-95	5.7	7.0	7.0	6.3	6.7	5.7	6.7	6.7	6.7	7.0	5.7	6.4
SRX 8084	5.3	7.0	6.3	6.3	7.0	6.7	6.3	6.7	6.3	7.0	5.0	6.4
Shortstop II*	5.7	7.3	6.3	6.7	7.0	7.3	6.7	6.0	5.7	6.7	5.3	6.4
WVPB-1B	6.7	7.0	7.0	7.0	7.0	6.3	6.7	6.0	5.7	7.0	5.7	6.4
WX3-275	6.0	7.0	6.0	7.0	7.0	6.7	6.7	5.7	6.0	7.0	5.3	6.4
ATF-038	6.3	7.0	6.3	6.7	6.7	7.0	6.0	7.0	6.0	6.3	5.3	6.4

Cultivar/ Experimental Number	Green-Up	Color	Texture	Quality								
				4/30	5/18	6/16	7/21	8/24	9/15	10/30	11/24	Avg.
BAR FA6 US6F	7.0	7.3	7.0	6.7	7.0	6.3	5.7	6.3	6.7	6.7	5.7	6.4
Coyote*	5.7	7.7	7.0	7.0	7.0	6.7	6.3	6.3	5.3	7.3	5.0	6.4
Equinox (TMI-N91)*	6.0	7.0	6.7	7.0	6.7	6.3	6.7	6.0	6.0	7.0	5.3	6.4
Pick FA B-93	6.3	7.3	6.7	7.0	7.0	6.3	6.0	5.7	6.3	7.0	5.7	6.4
Regiment*	6.0	7.0	6.7	7.7	7.0	6.3	6.3	6.0	5.7	6.3	5.7	6.4
WPEZE (WVPB-1C)*	5.7	7.0	5.7	6.7	7.0	7.0	6.7	6.3	5.7	6.3	5.3	6.4
PSII-TF-9	5.7	7.0	5.7	7.0	6.7	6.7	6.7	5.7	5.7	7.0	5.3	6.3
AV-1	6.3	5.7	6.7	6.7	6.7	6.3	6.0	5.7	5.7	6.3	6.0	6.2
EA 41	6.0	7.7	6.7	6.0	6.3	6.0	5.7	6.7	6.7	6.7	5.3	6.2
Arabia (J-5)*	5.3	7.3	6.3	6.7	7.0	6.3	6.0	5.3	5.7	7.0	5.0	6.1
DP 50-9011	6.3	7.0	6.7	6.7	6.7	5.7	6.0	5.7	5.7	7.0	5.3	6.1
Pick FA 20-92	5.7	7.7	7.0	7.0	7.0	6.0	6.3	5.0	5.3	6.7	5.0	6.0
Arid*	7.0	5.7	6.0	6.7	6.0	6.0	6.0	5.7	5.0	6.0	6.0	5.9
JTTFA-96	6.7	5.7	6.7	6.7	6.7	6.7	6.0	5.3	4.7	5.7	5.3	5.9
Pick FA UT-93	6.0	8.0	6.7	6.3	7.3	5.7	5.7	6.0	5.3	6.0	4.3	5.8
Kentucky-31 w/endo.*	6.3	4.0	4.0	5.0	5.0	5.0	5.0	4.0	4.0	5.0	4.7	4.7
LSD[3]	*1.0*	*0.8*	*0.8*	*1.0*	*0.9*	*0.9*	*0.9*	*1.1*	*1.0*	*0.6*	*0.8*	*0.4*

[1] Ratings based on a scale of 0-9 with 9=best green up, color, texture, and quality.
[2] Cultivars marked with * will be commercially available in 1999.
[3] To determine statisrical differences among entries, subtract one entry's mean from another's. A statistical difference occurs when the value is larger than the corresponding LSD value.

Table 2. Comparative performance of tall fescue cultivars at Wichita, KS[1].

Cultivar/ Experimental Number	Seed Vigor '96	Growth '96	Fall Density '96	Color '96	Color '97	Color '98	Texture '96	Texture '97	Texture '98	Green Up	Quality '97	Quality '98	Pythium Resist. '97
AA-983	5.3	5.0	7.3	8.0	7.7	7.7	4.7	7.3	7.0	5.7	6.3	6.5	2.7
ATF-020	6.7	5.7	6.3	6.7	7.3	6.7	5.0	7.3	6.0	5.7	6.2	6.4	3.3
ATF-022	5.7	7.0	7.0	6.3	6.3	6.7	4.3	7.3	6.7	5.7	6.0	6.5	3.3
ATF-038	6.3	6.3	7.3	6.3	6.7	7.0	4.7	7.3	6.3	6.3	6.1	6.4	3.3
ATF-188	5.7	6.3	6.3	6.7	7.0	6.7	4.3	7.3	6.3	6.3	6.0	6.7	2.7
ATF-192	5.7	6.7	7.0	5.7	6.3	6.7	4.7	7.3	6.0	6.0	6.2	6.5	2.7
ATF-196	5.7	6.3	6.3	6.7	7.0	7.0	4.7	8.3	6.3	5.7	5.7	6.4	3.3
ATF-253	5.7	6.7	7.3	6.3	6.0	6.7	4.0	7.0	6.3	6.0	6.5	6.5	4.7
ATF-257	6.3	7.7	7.0	6.3	6.3	7.0	3.7	6.7	7.0	6.0	6.1	6.7	2.7
AV-1	6.3	8.0	6.7	5.3	5.0	5.7	4.0	6.0	6.7	6.3	5.6	6.2	6.7
Alamo E*	6.3	7.0	7.7	6.7	7.3	7.3	5.0	7.7	6.3	6.0	5.9	6.5	5.0
Anthem II (TMI-FMN)*	6.7	7.3	7.0	6.7	7.0	7.3	5.3	8.0	6.7	6.7	6.5	6.6	4.3
Apache II*	7.0	6.3	7.3	6.3	7.3	7.0	5.3	7.7	6.0	5.7	6.3	6.6	5.7
Arabia (J-5)*	5.7	5.3	6.3	8.3	8.0	7.3	5.7	8.0	6.3	5.3	5.9	6.1	4.7
Arid 2 (J-3)*	5.3	6.0	6.7	7.7	7.7	7.7	5.3	7.3	6.3	6.3	6.1	6.5	3.3
Arid 3 (J-98)*	6.0	5.7	7.0	8.3	7.3	7.3	6.0	8.0	6.3	5.7	6.2	6.7	3.7
Arid*	9.0	9.0	7.7	3.7	4.7	5.7	3.3	5.3	6.0	7.0	5.7	5.9	4.0
Aztec II (TMI-AZ)*	7.7	7.3	7.3	6.0	7.3	7.0	5.3	8.0	7.0	6.7	6.3	6.7	4.7
BAR FA 6D	6.3	5.7	6.7	7.3	8.0	7.0	5.7	8.0	7.3	7.0	6.8	6.6	5.3
BAR FA 6LV	6.3	7.0	8.0	8.7	8.0	7.7	6.0	8.3	7.0	6.7	6.2	6.7	4.7
BAR FA6 US6F	5.7	5.7	7.7	7.3	7.7	7.3	5.7	7.7	7.0	7.0	6.0	6.4	4.0
BAR Fa6 US1	5.0	5.3	6.7	8.3	7.7	7.0	6.0	8.7	6.7	5.3	6.7	6.6	5.0
BAR Fa6 US2U	5.7	5.0	6.7	8.0	7.7	7.3	5.7	8.0	7.0	6.3	6.3	6.7	3.3
BAR Fa6 US3	5.3	5.3	6.7	8.0	7.7	7.3	6.0	7.7	6.3	5.7	6.1	6.6	4.3
BAR Fa6D USA	6.3	5.3	7.3	7.7	7.7	7.7	5.3	7.7	6.7	6.0	6.7	6.8	5.3
Bandana (PST-R5AE)*	6.3	6.3	7.0	7.3	7.3	7.3	5.0	7.0	7.0	6.0	6.6	6.6	2.7
Bonsai 2000 (Bullet)*	7.7	7.7	7.7	6.3	7.0	7.0	5.0	7.7	7.0	6.3	6.2	6.8	4.3
Bonsai*	5.7	6.3	6.0	6.3	6.3	7.0	4.0	7.7	6.7	5.7	6.0	6.5	5.0

Cultivar/ Experimental Number	Seed Vigor '96	Growth '96	Fall Density '96	Color			Texture			Green Up	Quality		Pythium Resist. '97
				'96	'97	'98	'96	'97	'98		'97	'98	
Bravo (RG-93)*	7.0	7.3	8.0	6.3	7.0	7.7	5.0	7.7	6.3	6.3	6.3	6.8	4.0
CU9501T	7.7	6.7	7.0	6.7	7.3	7.0	4.7	7.3	6.0	6.7	6.6	6.4	4.0
CU9502T	7.7	7.7	7.7	5.7	6.3	6.0	5.7	7.3	6.7	6.3	6.1	6.7	5.7
Cochise II*	5.3	5.7	5.7	6.7	6.7	7.0	4.3	8.0	6.3	6.3	6.1	6.4	3.7
Comstock (SSDE31)*	7.7	8.0	7.3	6.7	7.0	6.7	3.7	6.7	6.3	6.0	6.6	6.5	4.0
Coronado Gold (PST-5RT)*	5.7	6.7	7.3	7.3	7.0	7.3	4.7	7.3	7.0	6.3	6.6	6.7	4.0
Coronado*	5.3	5.7	6.3	7.3	7.7	7.3	5.0	7.7	7.0	6.0	6.4	6.8	5.0
Coyote*	5.7	6.3	7.3	7.7	8.0	7.7	5.3	8.0	7.0	5.7	6.2	6.4	3.3
Crossfire II*	6.3	7.0	7.3	6.7	7.0	7.0	4.3	7.3	6.3	6.3	6.1	6.8	3.3
DLF-1	7.3	8.3	7.3	4.7	6.7	7.0	4.0	6.7	7.0	7.3	6.1	6.5	5.7
DP 50-9011	7.3	8.3	7.3	6.0	6.3	7.0	4.0	8.0	6.7	6.3	6.1	6.1	5.3
DP 7952	7.7	8.7	7.3	4.7	5.0	6.7	3.0	6.7	5.7	7.0	5.7	6.4	6.3
Duster*	7.0	7.0	7.3	7.0	7.3	7.3	5.0	7.7	6.3	6.3	6.4	6.6	3.0
EA 41	6.3	6.3	7.0	7.7	8.0	7.7	5.7	7.0	6.7	6.0	5.4	6.2	4.3
EC-101	6.0	7.3	7.7	6.3	6.3	7.0	4.3	7.7	6.3	6.3	6.1	6.5	3.3
Empress*	6.7	7.0	7.7	6.7	6.7	7.0	5.0	8.0	7.0	6.0	7.0	6.5	4.0
Equinox (TMI-N91)*	7.3	7.7	7.7	5.7	7.0	7.0	4.3	7.7	6.7	6.0	6.1	6.4	4.3
Falcon II*	7.3	8.3	7.7	6.3	6.7	7.0	5.3	7.3	6.7	7.0	6.6	6.7	6.0
Finelawn Petite*	7.0	7.3	7.3	6.7	7.0	7.0	4.3	7.0	6.3	6.3	6.6	6.5	6.0
Gazelle*	4.7	4.3	5.7	8.0	8.0	7.0	6.3	8.0	7.0	5.3	6.0	6.5	1.3
Genesis*	7.0	6.3	7.7	7.0	6.7	7.0	5.3	7.0	6.7	6.0	6.4	6.8	4.7
Good-EN (Koos 96-14)*	6.0	6.7	6.7	6.3	7.0	7.0	4.0	7.3	6.7	6.3	6.1	6.6	6.3
ISI-TF10	6.7	6.7	7.0	6.3	6.7	7.7	5.7	7.7	6.3	6.3	6.4	6.4	6.7
ISI-TF11	7.0	7.7	8.0	6.3	6.7	7.0	4.3	7.0	6.3	6.3	6.6	6.6	4.0
ISI-TF9	7.3	7.3	7.3	6.0	6.7	6.7	4.0	7.0	7.0	6.3	6.4	6.5	4.0
J-101	6.3	6.0	7.7	7.7	7.3	7.0	6.3	8.0	6.3	5.7	6.0	6.7	2.0
JSC-1	6.7	8.0	7.7	6.0	5.7	6.0	3.7	7.3	6.0	6.0	6.4	6.4	6.7
JTTFA-96	7.3	7.0	6.3	4.7	4.7	5.7	3.3	6.0	6.7	6.7	5.4	5.9	2.3
JTTFC-96	7.7	8.0	7.3	4.7	5.0	6.0	3.7	6.7	6.3	6.7	6.2	6.4	6.3

Cultivar/ Experimental Number	Seed Vigor '96	Growth '96	Fall Density '96	Color '96	Color '97	Color '98	Texture '96	Texture '97	Texture '98	Green Up	Quality '97	Quality '98	Pythium Resist. '97
Jaguar 3*	6.0	7.0	6.7	6.7	7.3	7.0	4.0	7.3	7.3	6.3	6.4	6.7	4.0
Kentucky-31 w/endo.*	9.0	9.0	6.7	3.0	4.0	4.0	2.3	5.0	4.0	6.3	4.6	4.7	7.0
Kitty Hawk S.S.T. (SS45DW)*	7.0	6.7	6.7	6.7	6.7	7.0	4.0	7.3	7.3	6.3	6.5	6.6	6.7
Leprechaun*	7.3	7.0	7.0	6.3	7.0	6.3	4.7	7.3	6.3	5.7	6.3	6.5	5.7
Lion*	5.7	6.3	6.7	7.0	7.3	6.7	4.3	6.7	6.0	6.0	6.2	6.5	3.7
MB 210	6.3	7.0	7.7	7.3	7.7	7.0	5.7	7.3	6.3	6.0	6.8	7.0	5.3
MB 211	6.3	6.7	7.0	7.7	7.7	7.3	5.7	7.0	6.3	6.0	6.0	6.9	3.3
MB 212	7.0	7.3	7.7	7.7	7.3	7.7	5.3	7.7	6.7	6.3	6.5	6.8	4.3
MB 213	6.0	7.0	8.3	8.7	8.7	8.3	5.3	7.7	7.0	5.7	6.5	6.9	4.7
MB 214	6.3	6.0	7.3	8.0	8.0	8.0	5.0	8.0	6.7	5.7	6.5	6.5	4.7
MB 215	6.7	6.3	7.7	8.0	8.3	7.7	5.7	7.0	6.3	6.0	6.3	6.5	3.0
MB 216	6.3	6.7	7.0	8.0	8.7	7.7	4.3	7.3	6.0	5.0	6.3	6.6	5.3
MB 26	5.3	5.3	6.0	7.7	8.0	7.3	5.7	8.0	7.0	6.3	5.9	6.8	4.7
MB 28	6.0	7.3	8.0	8.0	8.0	7.3	5.7	7.0	6.3	6.0	6.6	6.8	4.0
MB 29	6.7	6.7	7.7	8.3	8.0	8.3	6.7	7.7	7.0	6.0	6.5	6.5	5.3
Marksman*	6.7	7.7	8.0	6.0	6.3	7.0	5.0	7.3	6.3	7.0	6.3	6.8	5.0
Masterpiece (LTP-SD-TF)*	6.7	6.0	7.7	7.3	7.3	7.0	4.7	7.7	7.0	6.3	6.8	6.9	5.7
Millennium (TMI-RBR)*	6.7	6.3	8.3	7.3	7.3	7.0	5.7	8.0	7.0	6.0	6.7	6.6	3.0
Mustang II*	6.7	7.0	8.0	6.0	6.7	7.0	5.0	8.0	6.7	7.0	6.3	6.9	2.0
OFI-931	7.7	7.0	8.7	6.7	7.0	7.7	5.0	7.7	7.0	5.7	6.7	6.6	6.3
OFI-951	5.3	5.3	6.3	7.3	7.7	7.0	5.3	8.0	6.7	6.3	6.0	6.5	2.7
OFI-96-31	6.3	6.7	7.7	7.3	7.3	7.7	5.0	7.3	7.0	7.0	6.4	6.7	5.0
OFI-96-32	6.3	7.0	7.3	7.0	6.7	7.0	5.3	7.3	6.3	6.3	6.6	6.5	5.0
OFI-FWY	5.7	7.0	7.7	6.3	7.0	7.0	5.0	7.7	6.3	6.3	6.5	6.5	5.0
Overtime mix	8.0	8.3	7.0	5.3	6.0	6.3	4.0	7.0	6.0	6.7	6.2	6.4	6.3
PC-AO	6.3	7.3	6.7	6.7	6.3	7.0	4.0	7.3	6.7	6.3	6.1	6.7	4.3

Cultivar/ Experimental Number	Seed Vigor ’96	Growth ’96	Fall Density ’96	Color ’96	Color ’97	Color ’98	Texture ’96	Texture ’97	Texture ’98	Green Up	Quality ’97	Quality ’98	Pythium Resist. ’97
PRO 8430	6.3	6.3	6.3	6.3	6.7	7.0	4.7	7.0	6.7	6.0	6.1	6.7	6.0
PSII-TF-10	6.0	6.7	7.0	7.0	6.7	7.0	4.0	7.3	6.7	6.0	6.3	6.5	5.0
PSII-TF-9	7.0	7.0	7.7	6.7	6.7	7.0	4.0	6.7	5.7	5.7	6.3	6.3	4.0
PST-523	6.7	6.3	7.7	6.7	6.7	6.7	4.7	7.3	7.0	6.3	6.5	6.8	3.3
PST-5E5	6.3	6.3	7.0	7.0	7.3	7.0	4.7	7.3	6.7	6.7	7.0	6.5	5.7
PST-5M5	6.3	6.7	7.7	7.0	6.7	7.0	4.3	7.3	6.7	6.3	6.8	6.9	5.0
PST-5TO	5.7	7.0	7.0	6.0	7.3	7.3	4.0	7.7	7.0	6.7	6.5	6.8	5.0
Pick FA 15-92	5.7	5.3	6.0	7.7	7.3	6.7	5.3	7.7	6.7	5.7	6.0	6.4	3.3
Pick FA 20-92	5.7	6.0	6.0	8.0	7.7	7.7	5.3	8.7	7.0	5.7	6.5	6.0	4.7
Pick FA 6-91	6.0	5.3	6.3	8.3	7.7	7.3	6.0	8.3	6.7	5.3	6.5	6.5	5.7
Pick FA B-93	5.3	5.3	6.3	7.3	7.0	7.3	6.0	7.0	6.7	6.3	5.8	6.4	2.0
Pick FA N-93	4.0	3.3	5.0	7.7	8.3	8.0	6.3	8.0	6.3	5.3	5.1	6.5	3.7
Pick FA UT-93	5.3	4.3	5.3	8.0	7.0	8.0	6.0	7.7	6.7	6.0	5.0	5.8	2.0
Pick FA XK-95	6.0	5.7	7.0	7.7	7.7	7.3	5.0	7.7	6.7	6.0	6.3	6.5	3.7
Pick GA-96	5.3	5.7	6.0	7.0	7.0	6.7	5.3	7.7	6.7	6.0	6.0	6.5	1.3
Pick RT-95	5.3	5.3	7.0	7.7	7.3	7.0	6.3	7.7	7.0	5.7	5.8	6.4	4.3
Pixie E+*	7.3	7.3	7.7	6.3	7.0	7.3	4.3	7.3	6.0	6.0	6.0	6.6	2.7
Plantation (Pennington-1901)*	6.7	6.7	8.3	8.0	8.0	8.3	6.3	7.7	6.7	6.3	6.4	6.9	1.7
R5AU	7.7	7.3	7.7	7.0	7.0	7.0	4.7	7.0	6.7	5.7	6.3	6.5	2.7
Rebel 2000 (AA-989)*	6.3	6.0	7.7	7.3	7.3	7.3	5.3	7.0	6.3	5.7	6.2	6.7	1.0
Rebel Sentry (AA-A91)*	7.0	6.7	8.0	7.7	8.0	8.0	5.3	7.7	6.3	6.3	6.3	6.8	3.3
Regiment*	7.3	7.7	8.0	6.0	6.7	7.0	5.7	7.7	6.7	6.0	6.2	6.4	2.0
Rembrandt (LTP-4026 E+)*	7.0	6.7	8.3	7.7	7.3	7.0	6.3	8.0	7.0	6.0	6.3	7.0	2.3
Renegade*	8.0	8.0	8.0	5.7	6.0	6.3	3.7	7.7	6.7	6.0	6.4	6.6	6.7
Reserve (ATF-182)*	6.3	5.7	7.3	6.0	7.0	6.3	5.0	7.7	6.7	6.0	6.4	6.6	4.0
SR 8210	7.3	7.7	8.0	6.3	6.0	6.7	5.0	7.3	7.0	6.0	5.9	6.7	4.3
SRX 8084	6.7	7.0	7.3	6.7	7.3	7.0	5.0	7.3	6.3	5.3	6.0	6.4	4.3
SRX 8500	6.0	5.0	6.3	7.3	6.7	7.0	5.3	7.3	6.7	6.0	6.2	6.8	3.0

Cultivar/ Experimental Number	Seed Vigor '96	Growth '96	Fall Density '96	Color '96	Color '97	Color '98	Texture '96	Texture '97	Texture '98	Green Up	Quality '97	Quality '98	Pythium Resist. '97
Safari*	8.3	8.0	7.7	5.3	6.3	6.7	4.0	7.0	6.7	7.0	6.1	6.6	6.0
Shenandoah*	7.7	7.3	8.0	6.0	5.7	6.0	4.3	6.7	7.0	6.7	6.4	6.8	4.3
Shortstop II*	5.7	5.0	5.3	7.3	7.3	7.3	6.0	7.7	6.3	5.7	5.5	6.4	2.0
Southern Choice*	7.7	7.0	8.0	7.3	7.7	7.3	5.3	7.7	6.3	6.3	6.8	6.9	2.7
Sunpro*	5.3	5.7	5.7	8.0	7.7	7.7	5.0	7.7	6.0	6.0	5.9	6.5	3.0
TA-7	7.3	6.7	7.3	7.0	7.7	7.3	5.0	7.3	6.3	6.0	6.3	6.5	3.3
Tar Heel*	6.7	5.3	6.0	6.0	7.0	7.0	3.7	7.7	6.7	6.3	6.7	6.7	4.0
Titan 2*	8.7	8.3	8.0	6.3	6.3	6.7	4.0	6.7	6.3	5.3	6.6	6.6	4.3
Tomahawk-E*	5.0	6.0	6.7	6.7	6.3	7.0	4.3	7.7	7.0	6.0	6.4	6.5	7.3
Tulsa*	6.7	6.7	7.0	6.7	6.3	6.3	5.3	7.7	6.7	6.0	6.3	6.6	3.0
Twilight II (TMI-TW)*	5.7	6.3	6.3	7.0	7.3	7.3	4.7	8.0	6.3	6.3	6.3	6.7	4.0
WPEZE (WVPB-1C)*	6.7	7.7	7.0	6.3	7.0	7.0	4.7	6.7	5.7	5.7	6.2	6.4	3.3
WRS2	6.3	6.0	7.7	7.3	8.0	8.0	4.3	8.3	6.7	5.7	6.4	6.6	4.7
WVPB-1B	7.3	7.7	7.0	5.3	6.7	7.0	4.0	7.3	7.0	6.7	6.4	6.4	5.7
WVPB-1D	7.3	7.7	8.0	6.0	6.3	7.0	3.7	6.7	6.3	6.0	5.9	6.5	4.3
WX3-275	7.0	7.3	7.3	6.7	7.0	7.0	4.7	7.3	6.0	6.0	6.1	6.4	5.3
Wolfpack (PST-R5TK)*	6.3	7.3	7.7	6.3	6.7	7.0	4.0	7.0	6.0	6.3	6.5	6.6	2.7
ZPS-2PTF	6.0	6.3	6.7	7.7	7.7	7.3	5.3	7.7	7.0	6.7	6.4	6.8	4.3
ZPS-5LZ	4.7	4.0	5.3	8.3	8.3	8.3	5.0	8.0	7.0	6.0	6.1	6.5	2.3
LSD[3]	*1.0*	*1.2*	*1.3*	*0.9*	*0.9*	*0.8*	*1.2*	*1.0*	*0.8*	*1.0*	*0.6*	*0.4*	*3.2*

[1] Ratings based on a scale of 0-9 with 9=best green up, color, texture, and quality.
[2] Cultivars marked with * will be commercially available in 1999.
[3] To determine statistical differences among entries, subtract one entry's mean from another's. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Bermudagrass Cultivar Evaluation

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

PERSONNEL: Linda R. Parsons and John C. Pair

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Bermudagrass is a popular warm-season turfgrass that is heat and drought tolerant and wear resistant. Recent introductions of interest are being selected for their improved hardiness and quality. Both seeded and vegetative types need further evaluation to determine their potential use by Kansas turfgrass managers.

MATERIALS AND METHODS:

During the summer of 1997, we established 18 seeded and 10 vegetative bermudagrass cultivars and experimental numbers at the John C. Pair Horticultural Center in Wichita, KS. Preparation for the study included incorporating 13-13-13 into 84 5 ft × 5 ft study plots at a rate of 1 lb N/1000 sq ft. We seeded or plugged the plots in a randomized complete block design. We maintained fertility of the plots at 0.5 to 0.75 lb N/1000 sq ft per growing month. We mowed the plots weekly during the growing season at 1.0 to 1.5 inches and returned clippings. Irrigation was done to prevent dormancy, and weeds and insects were controlled as needed. At appropriate times during the course of the study, we rated the turfgrass on a scale of 0=brown or no turf, 6=acceptable, and 9=optimum.

Best seedling vigor was observed in Arizona Common, NuMex-Sahara, and Savannah (Table 1). In the next spring, three vegetative types, Midlawn, Tiffgreen, and Cardinal, were the earliest to green up. The earliest seeded types to green up were OKS 95-1 and Mini-Verde, and the latest was Arizona Common. Turfgrass quality ratings were influenced by degree of coverage and weed infestation as well as turf density. The best overall performers were the vegetative type Midlawn and the seeded type OKS 95-1. Other good vegetative selections were Tifway, OKC 18-4, and Shanghai. Two seeded selections that performed nearly as well were J-1224 and Princess. At summer's end we looked at turf color and texture and found that Shanghai, OKC 18-4, OKS 95-1, and Tifway were the darkest green and that vegetative types Cardinal, Tifgreen, Tift 94, Midlawn, and OKC 18-4 had the finest texture. OKS 95-1 was the most finely textured seeded type. A severe winter is needed to determine which of these selections is best adapted to our climate.

Table 1. Performance of bermudagrass cultivars at Wichita, KS[1].

Cultivar/ Experimental No.	Seeded/ Vegetative	Seedling Vigor 8/21/97	'98 Green-Up	'98 Color	'98 Texture	'98 Quality 5/26	6/23	7/28	8/24	9/16	10/19	Avg.
Midlawn*	V		8.0	6.7	7.0	7.7	8.3	7.0	6.7	5.7	7.0	7.1
OKS 95-1	S	2.7	5.7	7.3	6.0	7.0	7.7	6.0	5.7	6.3	7.7	6.7
Tifway*	V		6.0	7.3	6.7	7.0	8.0	7.0	4.7	5.0	8.0	6.6
OKC 18-4	V		6.0	7.7	7.0	6.7	7.7	6.7	5.3	6.0	7.0	6.6
Shanghai*	V		5.7	8.0	5.0	5.7	6.7	6.0	6.7	6.3	7.3	6.4
J-1224	S	3.3	4.7	6.0	5.3	6.7	7.7	4.7	6.0	5.7	6.3	6.2
CN 2-9	V		6.0	6.7	6.3	5.3	7.0	7.0	5.3	5.3	6.7	6.1
Princess*	S	4.3	2.7	7.0	6.0	5.7	7.3	5.7	4.7	6.0	7.3	6.1
Cardinal	V		7.0	5.0	9.0	8.0	8.0	5.7	3.7	4.0	7.0	6.1
SW 1-7	S	3.3	2.7	6.3	5.3	5.3	7.3	5.7	5.0	5.7	6.3	5.9
Blackjack*	S	3.0	3.0	6.0	5.0	4.7	7.3	4.7	6.0	6.0	6.0	5.8
J-540	S	3.7	3.3	6.0	5.3	5.3	7.0	5.0	5.3	5.7	6.3	5.8
Pyramid*	S	3.3	3.0	6.3	5.0	5.3	6.7	5.0	5.3	6.0	6.3	5.8
Tifgreen*	V		7.3	6.0	8.0	5.7	7.0	5.7	5.3	5.3	5.3	5.7
Blue-Muda*	S	5.3	1.3	6.7	5.0	3.7	7.0	6.0	6.0	5.3	6.3	5.7
Savannah*	S	5.7	2.7	6.3	5.7	5.0	7.0	5.0	5.7	4.7	6.7	5.7
Tift 94 (Tifsport)*	V		6.7	7.0	7.3	5.3	6.0	6.3	4.3	5.0	6.7	5.6
Mirage*	S	5.3	1.7	6.0	5.0	4.0	7.3	5.0	5.7	5.3	6.3	5.6
Majestic*	S	5.0	1.7	6.3	5.0	4.3	6.3	5.0	5.3	5.7	6.7	5.6
OKC 19-9	V		6.7	7.0	5.3	4.3	5.0	5.3	6.0	5.7	6.7	5.5
Shangri La*	S	5.3	1.0	6.3	5.0	3.3	6.7	5.7	5.7	5.0	6.3	5.4
NuMex-Sahara*	S	6.3	1.0	6.7	5.0	2.0	6.7	5.3	6.0	5.3	6.0	5.2

Cultivar/ Experimental No.	Seeded/ Vegetative	Seedling Vigor 8/21/97	’98 Green-Up	’98 Color	’98 Texture	’98 Quality						
						5/26	6/23	7/28	8/24	9/16	10/19	Avg.
SW 1-11	S	4.7	1.3	6.3	6.0	3.0	5.7	5.0	5.3	5.0	6.3	5.1
Sundevil II*	S	3.3	3.0	5.7	5.0	5.0	5.7	4.0	4.7	4.7	5.3	4.9
Jackpot*	S	5.3	1.3	6.3	5.0	2.0	5.3	4.0	5.3	5.7	4.7	4.5
Arizona Common*	S	6.7	0.7	6.3	5.0	1.7	4.7	4.7	5.3	5.0	5.0	4.4
PST-R69C	S	1.3	2.7	5.7	5.3	3.0	4.3	3.0	4.3	4.3	5.7	4.1
Mini-Verde*			4.3	6.0	6.0	3.0	4.0	3.3	3.0	3.0	2.3	3.1
LSD		*3.0*	*1.3*	*0.8*	*0.9*	*1.9*	*2.0*	*1.6*	*1.5*	*1.1*	*1.2*	*1.1*

[1]Ratings based on a scale of 0-9 with 9 = best seedling vigor, green-up, color, texture, and quality.
[2]Cultivars marked with * will be commercially available in 1999.
[3]To determine statistical differences among entries, subtract one entry’s mean from another’s. A statistical difference occurs when the value is larger than the corresponding LSD value.

TITLE: Zoysiagrass Cultivar Evaluation

OBJECTIVE: To evaluate performance of seeded and vegetatively established cultivars in Kansas.

PERSONNEL: Jack Fry

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Meyer zoysiagrass has long been the standard cultivar for the Midwest. It has several characteristics that make it an excellent choice for this area, including good turf quality, good freezing resistance, and relatively low requirements for pesticide and fertilizer. Meyer is slow to establish, however, and establishment from plugs can take two or more growing seasons. Sodding Meyer can be expensive. It is also relatively drought sensitive. Identification of one or more cultivars that have qualities equal to or better than Meyer, but that are more easily and quickly established at less cost, would be of benefit to Kansas turfgrass managers.

MATERIALS AND METHODS:

Grasses were established from seed or plugs in July, 1996 at the Rocky Ford Turfgrass Research Center in Manhattan, KS. Seeded selections were ZEN 500, ZEN 400, Zenith, J-36, J-37, Chinese Common, Z-18, and Korean Common. Plots measured 5 by 5 ft and were arranged in a randomized complete block design with three replicates. Seeding rate was approximately 2 lbs/1,000 sq ft. Six 2-inch-diameter plugs of vegetative selections were planted in each plot. Mowing was done 3 days weekly during summer at a 0.75-inch height. Nitrogen was applied in June to provide 1 lb N/1,000 sq ft. Irrigation was applied to prevent dormancy.

RESULTS:

Most rapid spring green-up was observed in Chinese Common, ZEN-400, Emerald, J-36, J-37, Meyer, Zenith, J-14, and ZEN-500 (Table 1).

Cultivars with the finest leaf textures were Emerald, DALZ 9601, and Zeon. Coarsest textures were observed for J-14, Korean Common, Z-18, J-36, J-37, and Chinese Common.

Billbug damage was relatively severe in some cultivars: HT-210, Zenith, J-36, Meyer, and ZEN-500.

Twelve cultivars had a mean quality ranking equal or superior to that of Meyer. This could be somewhat deceiving, however, because the winter of 1997-1998 was relatively mild. Some of the better performing cultivars, such as Emerald and El Toro, are known to have poor freezing resistance, and a severe winter could result in entire stand loss.

Some of the seeded cultivars are performing well enough to be evaluated in larger plots. Zenith is relatively fast to establish from seed. In a separate test, we planted Zenith in mid-July, and had 90% coverage by first frost. Zenith was susceptible to billbug in 1998, but no different than Meyer. It has a slightly coarser texture than Meyer but is finer than most of the other seeded selections. Mr. Alan Zuk, a Ph.D. student, is now evaluating Zenith and other selections for establishment characteristics in fallow soil and interseeded into established perennial ryegrass.

Table 1. Performance of zoysiagrass cultivars at Manhattan, KS in 1998.

Cultivar	Seeded (S) or Vegetative (V)	Green-Up[1]	Leaf Texture	Billbug Damage	Turf Quality April	May	June	July	August	Sept	Mean
Emerald	V	5.7	8.3	9.0	5.7	7.3	8.3	8.7	8.0	8.0	7.7
DALZ 9601	V	5.0	8.3	9.0	4.3	6.7	8.0	8.0	7.7	7.0	6.9
Jamur	V	4.3	5.7	8.7	4.7	6.7	7.7	7.3	7.0	6.3	6.6
El Toro	V	4.7	5.3	8.7	4.7	5.7	7.0	7.0	6.7	6.7	6.3
Zeon	V	4.7	8.0	8.7	4.0	5.7	7.0	6.7	7.7	6.7	6.3
ZEN-400	S	6.0	5.7	7.0	6.0	6.7	6.0	6.3	5.3	6.3	6.1
Chinese Common	S	6.3	5.0	7.3	6.3	6.3	6.3	5.7	5.0	5.7	5.9
J-37	S	6.0	4.7	7.0	5.7	6.3	5.7	5.7	5.7	6.0	5.8
J-36	S	6.0	5.0	4.3	6.0	6.3	5.0	5.3	5.0	5.3	5.5
Meyer	V	5.3	7.0	5.0	5.3	7.3	6.0	4.7	4.3	4.7	5.4
Miyako	V	4.0	5.0	8.3	3.3	4.7	5.7	6.0	6.3	5.7	5.3
Zenith	S	6.0	5.7	4.0	6.3	7.0	5.0	4.7	3.7	5.0	5.3
J-14	V	5.3	4.0	7.7	5.0	4.7	4.7	5.7	5.3	6.0	5.2
Korean Common	S	5.0	4.7	7.7	4.3	4.7	4.0	4.7	4.3	4.7	4.4
Z-18	V	5.0	5.0	6.7	4.0	4.0	5.0	4.7	4.0	4.7	4.4
ZEN-500	S	5.3	5.3	5.0	4.7	5.0	3.7	4.0	4.0	4.3	4.3
De Anza	V	3.0	6.0	8.0	2.7	3.0	3.7	5.0	5.0	5.7	4.2
HT-210	V	5.3	5.0	1.0	3.0	3.3	3.7	4.3	4.7	5.0	4.0
Victoria	V	4.0	6.0	6.0	2.7	3.7	3.7	4.0	4.3	5.7	4.0
LSD[2]		1.1	1.1	1.3	1.2	1.8	1.5	1.2	1.2	1.5	0.8

[1]All attributes were rated visually on a 0 to 9 scale, 9 = best, or least damage.
[2]To determine statistical differences among entries, subtract one entry's mean from another's. A statistical difference occurs when this value is larger than the corresponding LSD value.

TITLE: Effects of Irrigation Frequency, Clipping Removal, and Fungicide Application Strategies on Development of Rhizoctonia Brown Patch in Tall Fescue.

OBJECTIVE: To evaluate potential cultural and chemical management strategies for the most efficacious control of Rhizoctonia brown patch for a typical Kansas tall fescue home lawn.

PERSONNEL: Derek Settle, Jack Fry, and Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation, Ryan Lawn and Tree

MATERIALS AND METHODS:

Tall fescue plots were established at the Rocky Ford Turfgrass Research Center in Manhattan, KS in September 1997. An Olathe slit seeder was used to plant a turf-type tall fescue blend at a rate of 7 lbs / 1000 sq ft in three directions. Prior to the summer1998, the tall fescue received a total of 6 lbs of nitrogen in the form of urea, with 1 lb N/ 1000 sq ft applied in Sept, Oct, Mar, Apr, May, and June. The experimental design was a split-split plot with three replications. The whole plots measured 28 ft x 50 ft and consisted of two irrigation schedules: 1) 100% atmometer estimated evapotranspiration (ET) applied daily and 2) 100% ET applied on Mon, Wed, and Fri (MWF). Pop-up gear-driven heads were used to deliver water to plots; total water applied each week among the two irrigation regimes did not differ. The ET rate also was adjusted for rainfall; however, a minimum run-time of 3 minutes was maintained each day to allow for an entire pass of the irrigation system over a whole plot to remove dew.

The split plots measured 14 ft x 50 ft. Cutting height was 3 inches, and either clippings were returned with a standard 21-inch mulching mower or removed with the same 21-inch mower with the bagger attached.

Subplots were 10 ft x 10 ft and consisted of the following fungicide treatment strategies: no fungicide, preventive, curative, and predictive weather model (Table 1). Fungicides were applied to turf with a CO_2-powered sprayer at 20 psi using 8004 flat fan nozzles in water equivalent to 2 liters/200 sq ft Visual quality ratings were made weekly for each fungicide plot on a 0-9 scale, where 0=dead turf and 9=optimum color, density, and uniformity. Disease incidence was quantified by estimating the visual % plot damage weekly during a brown patch outbreak. Weekly photographs of a randomly selected and permanently marked area within the no- fungicide plots and preventive Heritage plots were taken with a Canon AF-1 35 mm camera beginning in the last week in June. A hue saturation model developed by Dr. Steven Wiest then was used to compare the scanned digitized photos with the visual ratings of percent plot damage. Additionally, 4-inch-diameter soil cores were taken randomly at four times within no-fungicide and preventive Heritage plots. Numbers of grass tillers were counted, and then total plant mass in each soil core was dried for 48 hrs at 80 C and weighed. Percent total tissue nitrogen of four repeated samples taken within the no-fungicide and Heritage treatments was determined by the KSU Soil Testing Laboratory.

RESULTS:

A severe brown patch outbreak began on 3 July and peaked on 13 July, with a mean of 60% blighting in the control plots. Eleven hours of leaf wetness preceded the 3 July event, and varyious levels of mycelium could be observed from 7 July through 15 July. Furthermore, the daily minimum temperature remained above 21C from 3-14 July, and all but 5 and 14 July were preceded with 10 hours or more of the necessary leaf wetness.

No significant difference in brown patch injury or turf quality was observed between the daily and MWF irrigation regimes. Although we have observed that daily irrigation reduces brown patch injury in perennial ryegrass at fairway height, this may not be the case in tall fescue under lawn conditions. The taller canopy may influence the turf microclimat, such that irrigation has less direct effect upon dew and fungal growth.

Visual quality also was not significantly different among the irrigation treatments throughout the summer. However, mulched plots displayed superior quality when compared to bagged plots on 10, 13, 20, and 30 July. Significantly better color also was observed on 13 July and 3 August in plots where clippings were returned. Tissue analysis confirmed that shoots of turf in mulched plots contained more nitrogen, (2.6% for mulched vs. 2.3% for bagged plots). Tall fescue canopy height also was significantly taller in mulched versus bagged plots (10 vs. 8.8 cm, respectively) at 1 week after mowing.

All fungicide treatments were significantly different from the control plots and each other. No interactions among treatments occurred, so an entire-season summary could be made for each fungicide treatment using area under the disease progress curve (logAUDPC). The Heritage treatment provided nearly 98% control of brown patch when applied at 0.2 oz / 1000 sq ft every 35 days (Fig. 1). This is significant because application of this low rate is recommended every 14 days. The curative program reduced the total brown patch by 50 % compared to the control plots. The plots were sprayed at first sign of symptoms on 3 July and again on 28 July when brown patch activity began increasing. The model developed in Maryland did not predict leaf wetness events and was late in predicting an accurate application date. The model also predicted an additional spray on 28 August when no brown patch activity was observed. The curative fungicide treatment required the fewest number of treatments, whereas the model required the most (Table 1). Excellent quality was maintained throughout the summer in the Heritage plots, and the curative treatment maintained acceptable quality for a home lawn. Heritage-treated turf had greater tiller density and greater total dry weight of verdure after the brown patch infection period. However, on 7 August, pythium blight was noticed in the Heritage treatment and was not influenced by either irrigation or mowing treatments.

Cost of each product was determined for each spray per 1000 sq ft and multiplied by the number of applications necessary (Table 1). Cost of the curative Daconil Ultrex program was the most economical at $2.47 / 1000 sq ft, because it required the fewest number of sprays. Cost of the preventive Heritage was more than double that of the curative at $12.75 / 1000 sq ft, but only $0.87 greater than the cost of the Daconil Ultrex weather model. The predictive model proved expensive because it overpredicted and, thus, required the greatest number of applications.

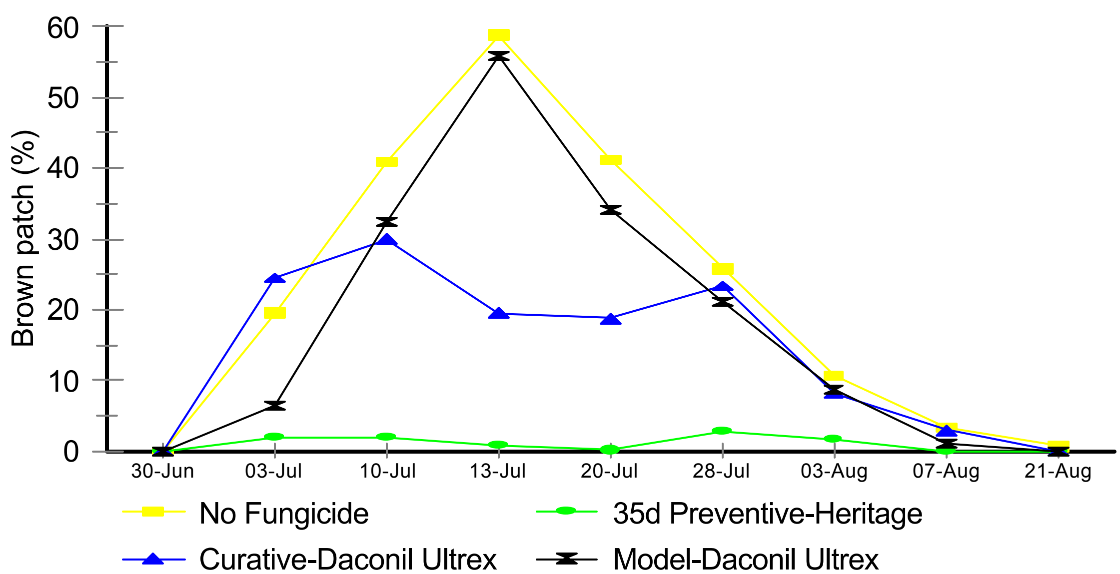
The preventive Heritage treatment best meets the study's objective of providing the most efficacious control of brown patch for a home lawn. The curative approach was economical, but requires daily scouting and an understanding of the environmental conditions conducive to brown patch. By far the most economical strategy was not spraying at all. Although turf quality declined to an unacceptable level during the infection period, it recovered completely by mid-August.

Table 1. Fungicide treatments and associated strategy, total number of sprays required for season, and visual rating on 13 July for tall fescue study at Manhattan, KS in 1998.

Treatment/ Strategy	Formulation/ Rate/1000 sq ft	No. Sprays	Cost/1000 sq ft Total/1000 sq ft	13 July % Brown Patch
No Fungicide/ None	___	0	$ 0.00/ $ 0.00	59a***
Heritage/ Preventive 35d	50 WG/ 0.2 oz	3	$ 4.25/ $12.75	1c
Daconil Ultrex/ Curative**	82.5 SDG/ 3.8 oz	2	$ 2.47/ $ 4.94	20b
Daconil Ultrex/ Weather Model*	82.5 SDG/ 3.8 oz	4	$ 2.47 $11.88	56a

*Predictive model uses the previous day's minimum temperature and average relative humidity.
**Curative trt. sprayed as needed when brown patch increased from previous week's rating.
***Means followed by the same letter are not significantly different at P=0.05.

Figure 1. Effects of fungicide treatment strategies for control of brown patch on tall fescue , Manhattan, KS, 1998.



TITLE: Influences of Irrigation Frequency, Poling, and Nitrogen Rates on Brown Patch in Perennial Ryegrass

OBJECTIVE: To evaluate effects of irrigation frequency, poling, and nitrogen rates on perennial ryegrass quality and brown patch infection.

PERSONNEL: Derek Settle, Jack Fry, and Ned Tisserat

SPONSORS: Heart of America Golf Course Superintendent's Association, Kansas Golf Course Superintendent's Association, Golf Course Superintendent's Association of America

INTRODUCTION:

Frequent irrigation often is cited as enhancing turfgrass fungal diseases, such as brown patch, caused by *Rhizoctonia solani*. However, work done at K-State over the past several summers has demonstrated that daily irrigation significantly reduced brown patch blighting compared to a Monday, Wednesday, Friday irrigation schedule. A new poling treatment applied to half of each irrigation whole plot was begun to investigate the hypothesis that daily irrigation reduces brown patch by removing dew and plant exudate (guttation fluid) much in the same way that physical poling of golf course greens by superintendents reduces fungal disease intensity. Additionally, four increasing yearly amounts of sulfur-coated urea were applied beginning in March 1998 to assess effects on brown patch severity.

MATERIALS AND METHODS:

The study was conducted in the summer of 1998 on a perennial ryegrass blend established during fall, 1997 at the Rocky Ford Turfgrass Research Center, Manhattan, KS. The ryegrass was maintained at ½ inch fairway height by mowing three times weekly. No fungicide was applied to the study. Plots were laid out in a split-split plot design. Whole plots were 28 ft x 42 ft and consisted of two irrigation schedules: 1) 100% atmometer-estimated evapotranspiration (ET) daily and 2) 100% ET on Mon, Wed, and Fri (MWF). Pop-up, gear-driven, Nelson 6000 irrigation heads were used to deliver water to plots. Evapotranspiration was estimated using atmometers, and data were input into a model developed specifically for ryegrass mowed at 0.5 inches. Daily irrigation was scheduled to replace 100% of the previous day's ET; likewise, plots irrigated on MWF received the sum of ET since the last irrigation. Plots in both regimes received the same amount of water. Evapotranspiration and irrigation were adjusted for rainfall, but a minimum run-time of 3 minutes was maintained each day to allow for an entire pass of the irrigation system over a whole plot to remove dew. Irrigation regimes began on May 19 and ended on September 30, 1998.

Subplots 14 ft x 42 ft split the whole plots in half lengthwise, and a poling treatment was applied daily at 7 a.m. with a 10 ft long, flexible, fiberglass rod.

Sub-subplots were 10 ft x 10 ft and consisted of four increasing annual rates of nitrogen (N) fertilizer: 1) 2 lbs / 1000 sq ft, 2) 4 lbs / 1000 sq ft, 3) 6 lbs / 1000 sq ft, and 4) 8 lbs / 1000 sq ft (Table 1). Nitrogen was applied as sulfur-coated urea.

Visual quality ratings were done weekly for each fertilizer plot on a 0-9 scale, where 0=dead turf and 9=excellent color and density. Separate ratings were taken to estimate turf cover, because establishment at the lower N rates was retarded. Disease incidence was quantified by estimating the percentage plot damage by brown patch. In addition, a permanent marker was located randomly within each of the nonpoled, 8 lbs N / 1000 sq ft sub-subplots, so that photographs could be taken to monitor the changes in color during the decline and recovery of perennial ryegrass during a brown patch outbreak. A Canon AF-1 35 mm camera containing 100 ASA film took slides once a week during the summer beginning in the last week of June. A hue saturation model developed by Dr. Steven Wiest then was used to compare the scanned digitized photos with the visual ratings of percent plot damage.

RESULTS:

A total of 580 mm of ET occurred, based upon atmometer estimate. Because of rainfall, 90 mm of water was subtracted from the daily ET calculations, reducing the total amount applied by 15%.

Weather conditions for brown patch were ideal by the end of June, with nighttime temperatures remaining above 21C (70F) and periods of high relative humidity brought on by periods of rain on 28 to 29 June and 6 and 9 to 11 July. Brown patch symptoms were observed first on 3 July, and maximum blighting occurred by 13 July (Fig. 1).

Analysis of visual brown patch damage showed no difference between daily versus MWF irrigations. Analysis of digital images of brown patch data indicated that daily irrigation significantly reduced brown patch compared to the MWF schedule in plots fertilized at the high N rate and given no poling. Additionally, a high level of correlation was found between the visual plot damage ratings and the green hue digital image data.

Poling daily at 7 a.m. was effective in reducing brown patch across all four N treatments compared to nonpoled plots. Poling reduced brown patch by up to 20%, with the greatest reduction observed in plots receiving 8 lbs N / 1000 sq ft and MWF irrigation.

As N rate increased, so did brown patch. On all rating dates, except 30 July, the order from highest to lowest plot damage was 8>6>4>2 lbs N / 1000 sq ft per year. On 13 July, 55, 45, 30, and 28 % blighting occurred across the four decreasing N regimes.

Best turf quality occurred at the 8 lbs N / yr rate until 3 July, when brown patch activity began (Fig.2). Turf in this treatment then exhibited unacceptable quality from 13 July until 21 August. Unacceptable quality ratings occurred only on 13 and 22 July in plots receiving 2 or 4 lbs N / 1000 sq ft / yr. Similarly, cover in plots treated at 8 lbs N / 1000 sq ft / yr was greater than in the other three fertilizer treatments on 10 July but by 30 July fell below 85% and did not recover above 90% until 21 August. On 7 August, turf receiving 2, 4, and 6 lbs N / 1000 sq ft / yr had significantly greater cover than that receiving the high rate of 8 lbs N/ 1000 sq ft / yr.

All plots were recovered fully by the end of August. The brown patch outbreak at Rocky Ford in the summer of 1998 resulted in the most blighting that had been observed in any of the previous 10 years or more.

Table 1. Annual fertilizer treatments and monthly applications (pounds) for perennial ryegrass study at Manhattan, KS in 1998.

*Nitrogen/ 1000 sq ft/yr	April	May	June	September	October	November
2	–	–	–	–	1	1
4	1	–	–	1	1	1
6	1	1	1	1	1	1
8	1.5	1	1	1.5	1.5	1.5

*Sulfur-coated urea applied with a shaker can on the 1st of each month specified.

Figure 1. Effects of four nitrogen rates on brown patch disease in a fairway perennial ryegrass study at Manhattan, KS in 1998.

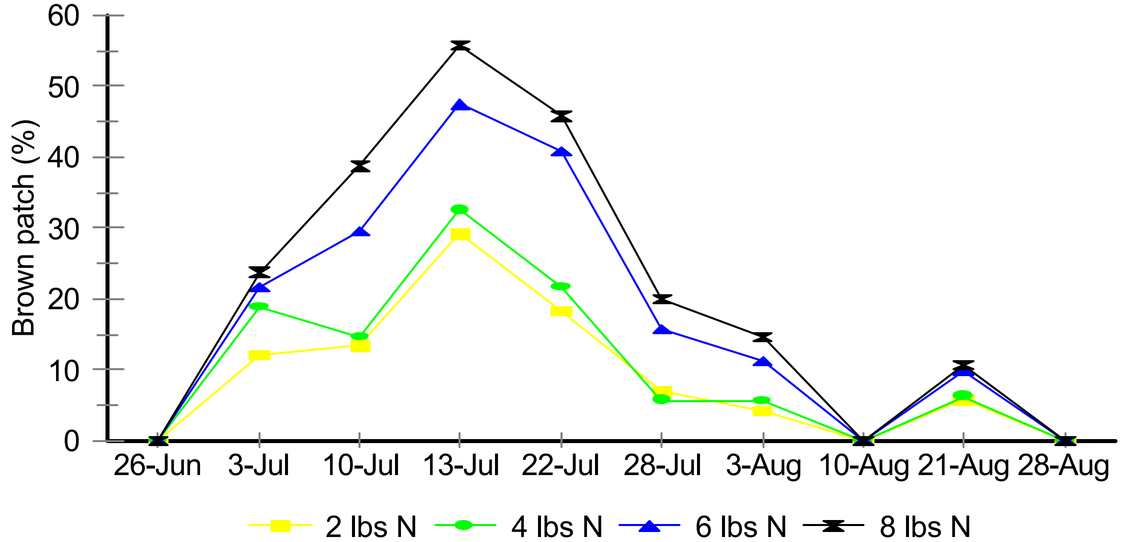
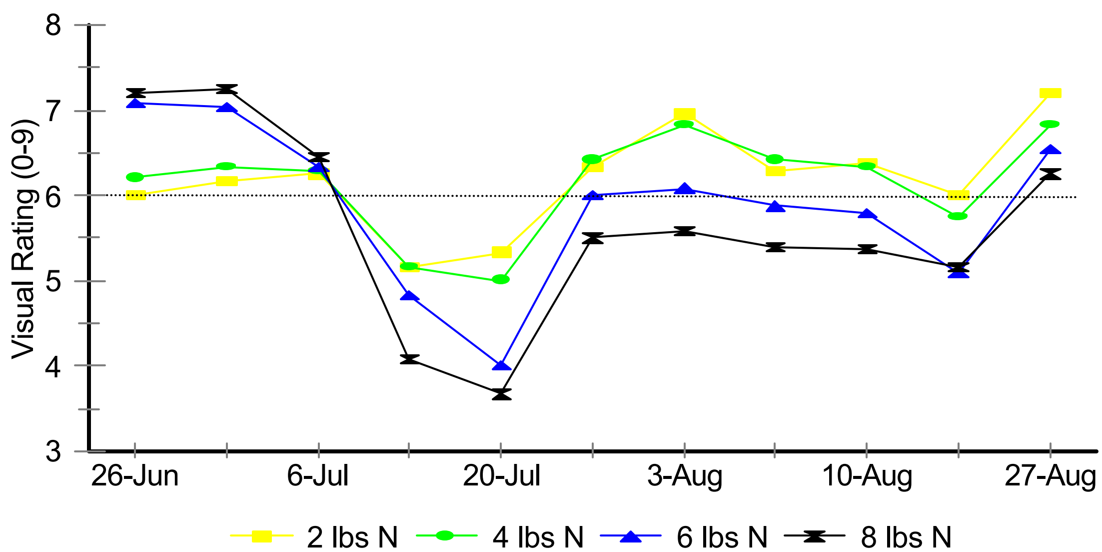


Figure 2. Perennial ryegrass quality as affected by N rate at Manhattan, KS in 1998. A rating > 6 was considered acceptable.



TITLE: Dollar Spot Susceptibility and Fungicide Programs for Four Creeping Bentgrass Cultivars.

OBJECTIVES: To evaluate bentgrass cultivars for susceptibility to disease and to investigate the effectiveness of fungicide management regimes for influence on turf quality, applications required, and active ingredient applied.

PERSONNEL: Derek Settle, Jack Fry, and Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation and Kansas Golf Course Superintendent's Association

INTRODUCTION:

No other turfgrass disease persists throughout the year as dollar spot does. Superintendents apply more fungicides to putting greens per unit area than to any other area of the golf course. Dollar spot is directly responsible for the majority of fungicide sprays, and therefore, costs golf courses more to control than any other disease. Cultivar selection, fungicide selection, and application strategy (preventive vs. curative) are all important choices that can impact annual budget considerations needed to control dollar spot. In some instances, recent "superior performing" bentgrass cultivars have been incorporated into greens without enough attention given to their disease susceptibility. A decision to replace a standard bentgrass variety such as Penncross with a newer improved bentgrass variety actually could require increased fungicide expenditures for a golf course superintendent.

MATERIALS AND METHODS:

The study was conducted in the summer of 1998 on a USGA green at Rocky Ford Turfgrass Research Center, Manhattan, KS. Bentgrass was mowed daily at 5/32 inch, irrigated with 3 to 5 mm of water daily, and received a season total of 5 lbs N / 1000 sq ft. The experimental design was a split plot with three replications. Whole plots consisted of four creeping bentgrass cultivars: L-93, Crenshaw, Penncross, and Providence. Subplots were 3.3 x 7.2 ft and consisted of five fungicide treatments. Fungicides were applied at various intervals depending on treatment from 1 June to 25 September at the manufacturers' recommended rates (Table 1). The treatments included: 1) No fungicide; 2) Chipco GT every 14 days; 3) Chipco Aliette Signature + Chipco GT every 14 days 4) Prostar + Bayleton every 28 days; 5) Heritage + Bayleton every 28 days; and 6) Chipco GT as needed when the number of dollar spots per plot increased from previous week's numbers in at least two of the three replicates. Fungicides were applied in water equivalent to 2 liters/288 sq ft with a CO_2-powered backpack sprayer equipped with 8004 nozzles at 20 psi. Weekly visual ratings were made of each fungicide subplot on a 0-9 scale, where 6=acceptable quality. Dollar spot numbers were counted and recorded for all plots weekly beginning at first appearance on 18 May and continuing until 24 September. Brown patch was evaluated as the percentage of each plot damaged beginning when it was observed first on 10 July and continuing until 24 September. No interactions occurred between fungicide treatments and cultivars, so the log+1 area under the disease progress curve (logAUDPC) was used to sum all weekly data within each cultivar over the entire season.

RESULTS:

The weather during the summer of 1998 was marked with repeated rain events during the growing season and generally still conditions at night, which allowed large amounts of dew and plant exudates to accumulate. Because of this situation, dollar spot began to appear in May, approximately 1 month earlier than had been observed in 1997, and continued well into December.

Among the nontreated plots, Crenshaw nearly always displayed 100 times the number of dollar spots that were recorded for the other three cultivars (Fig. 1). In fact, the sum of all dollar spots of L-93, Penncross, and Providence still would have been fewer than Crenshaw alone in the nontreated plots on any individual date. L-93, Penncross, and Providence did not differ in dollar spot susceptibility.

By late June and into the first 2 weeks of July, rain repeatedly occurred and night temperatures remained >21 C (70 F), providing ideal hot and humid conditions for brown patch. The first brown patch episode in 2 years on the green at Rocky Ford was preceded by 10 hours of leaf wetness on 8 July and was recorded 10 July 1998. Susceptibility to brown patch also was significantly different among cultivars. The lack of interactions between cultivar and fungicide treatment allowed data summary within cultivar. Crenshaw exhibited the greatest susceptibility to brown patch and was significantly different from Providence, followed by Penncross and L-93 with the least susceptibility. After mycelium and characteristic brown patches with smoke rings were observed on 9 and 10 September, combined means of all treatments were determined. Plot damage ratings were Crenshaw = 21%, Providence = 19%, L-93 = 10%, and Penncross = 9%.

All fungicide treatments significantly reduced dollar spot when compared to the no fungicide plots (data not shown). However, Chipco GT applied curatively was ineffective in reducing brown patch and was not significantly different than the untreated bentgrass plots. The best brown patch treatments were the 28-day preventive Prostar + Bayleton and Heritage + Bayleton combinations, which were significantly better than 14-day preventive Chipco GT and Chipco GT + Aliette Signature treatments. For dollar spot, Chipco GT alone and in combination with Aliette Signature provided the best control. Chipco GT applied curatively did not differ significantly from the 28-day preventive Prostar + Bayleton and Heritage + Bayleton fungicide strategies in preventing dollar spot.

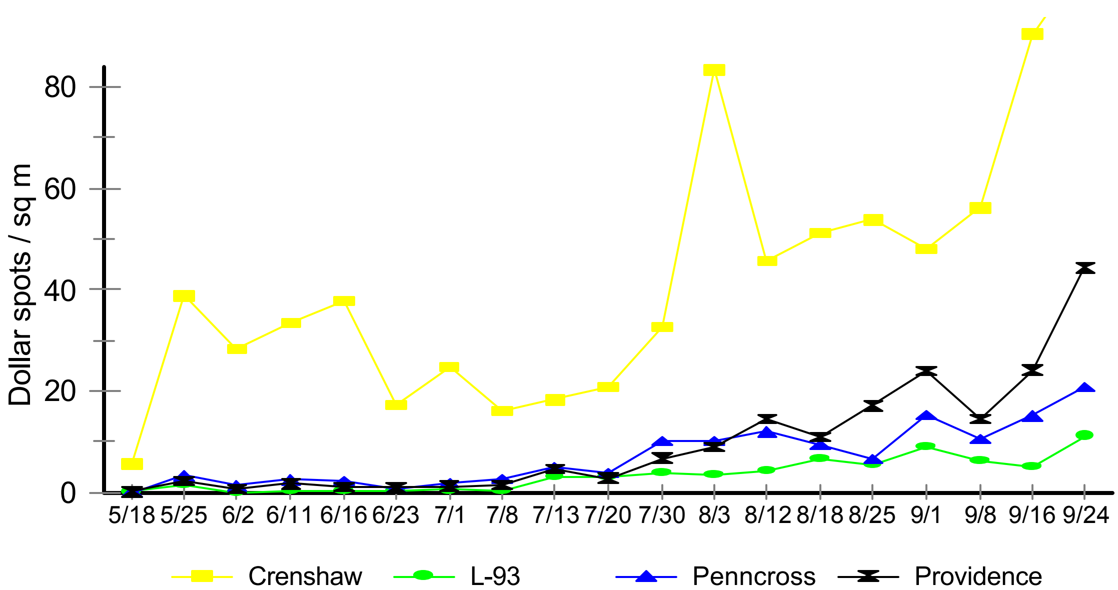
Far less active ingredient could be applied with a single product such as Chipco GT without tankmixing, but brown patch was not controlled with curatively spraying and turf quality was not acceptable for golf course greens. Crenshaw required seven Chipco GT curative sprays during the 1998 season, (two more than required by L-93, Penncross, and Providence), which was a direct consequence of its high susceptibility to dollar spot. Significantly, a curative program required only five applications, whereas 10 were needed on the 14-day preventive Chipco GT program. This curative strategy also reduced the amount of active ingredient applied by 50%. The Chipco GT + Aliette Signature resulted in 6 times more active ingredient applied for Crenshaw and >8 times more active ingredient applied for the remaining three cultivars than the Chipco GT curative program.

Table 1. Fungicide treatments, formulations, rates, and dollar spot and brown patch logAUDPC summary on a bentgrass green in Manhattan, KS in 1998.

Treatment	Formulation	Rate/ 1000 ft sq	logAUDPC* Dollar Spot	logAUDPC* Brown Patch	Total Sprays Required
No Fungicide	—	—	2.8a	2.4a	—
Chipco GT	2F	4 fl oz	0.9c	1.1b	10
Aliette Sig. + Chipco GT	80 WP 2 F	40 oz 4 fl oz	1.1c	1.1b	10
Prostar + Bayleton	50 WP 25 WG	40 oz 1 oz	1.7b	0.6c	5
Heritage + Bayleton	50 WG 25 WG	0.2 oz 1 oz	1.8b	0.3c	5
Chipco GT	2F	4 fl oz	1.6b	2.1a	7,5,5,5***

*Significant at the 0.01 probability level.
**Applied as needed when the number of dollar spots per plot increased from previous week's numbers in at least two of the three replicates.
***Required total number of sprays for 1998 on Crenshaw, L-93, Penncross, and Providence respectively.

Figure 1. Susceptibility to dollar spot disease of four creeping bentgrass cultivars in non-fungicide-treated plots at Manhattan, KS in 1998.



TITLE: Preventive Fungicide Applications for Control of Dollar Spot and Rhizoctonia Brown Patch on Creeping Bentgrass

OBJECTIVE: To evaluate various fungicides for control of dollar spot and brown patch on creeping bentgrass

PERSONNEL: Derek Settle, Jack Fry, and Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation, Heart of America Golf Course Superintendents Associa- tion, Novartis, Rhone Poulenc, AgrEvo, Zeneca, Bayer, Rohm & Haas, and BASF

MATERIALS AND METHODS:

Fungicides were evaluated on established stands of Cobra and Cohansey bentgrass on a sand-based putting green at the Rocky Ford Turf Research Center, Manhattan, KS. The turf was mowed at 0.16 in, irrigated as needed, and fertilized with 4 lb N/1000 sq ft annually. Applications were made at 2- to 4-week intervals beginning on 22 May and continuing through 28 August. Fungicides were applied in water equivalent to 2.7 gal/1000 sq ft with a CO_2-powered backpack sprayer with 8003 TeeJet nozzles at 30 psi. Plots were not irrigated after applications. Plots were 5 ft X 6 ft and arranged in a randomized complete-block design with three to four replications. Plots were rated every week for the number of dollar spot infection centers and the percentage plot area damaged by brown patch.

RESULTS:

Both brown patch and dollar spot were severe on Cobra bentgrass from late July through early August (Table 1). All fungicides reduced dollar spot and brown patch severity throughout the experiment. Plots treated with Confidential B, Confidential A + Confidential C, or Eagle + Heritage sustained only minor disease injury during the experiment. No phytotoxicity was noted with any fungicide applications.

Table 1. Control of brown patch and dollar spot on Cobra bentgrass by fungicides, Manhattan, KS, 1998.

	Spray Interval	21 Jul[a]		28 Jul		7 Aug		20 Aug	
Treatment and Rate/1000 sq ft	days	Brown Patch[b]	Dollar Spot[c]	Brown Patch	Dollar Spot	Brown Patch	Dollar Spot	Brown Patch	Dollar Spot
Control		27.5 a	21.8 a	50.0 a	40.8 a	27.5 a	92.5 a	47.5 a	74.5 a
Confidential A 0.28 fl oz	14	0.0 c	2.8 bc	0.0 c	4.3 b	0.0 c	1.5 b	1.3 c	0.5 c
Confidential A 0.42 fl oz	14	0.0 c	0.8 c	0.0 c	4.5 b	0.0 c	2.5 b	0.0 c	1.3 c
Confidential B 0.14 oz	14	0.0 c	0.0 c	0.0 c	0.0 b	0.0 c	0.0 b	0.0 c	0.0 c
Confidential B 0.21 oz	14	0.0 c	0.0 c	0.0 c	0.0 b	0.0 c	0.8 b	0.0 c	0.0 c
Confidential A 0.42 fl oz + Confidential C 0.11 fl oz	14	0.0 c	0.0 c	0.0 c	0.0 b	0.0 c	1.3 b	0.0 c	0.5 c
Confidential A 0.28 fl oz +Confidential C 0.14 fl oz	14	0.0 c	0.8 c	0.0 c	0.0 b	0.0 c	0.5 b	0.0 c	0.5 c
Aliette Signature 80WG 4 oz + Chipco GT 2 SC 4 fl oz	14	3.8 c	1.3 c	11.3 b	1.8 b	3.0 bc	1.3 b	6.8 bc	0.0 c
Confidential B 0.275 oz	28	0.0 c	0.3 c	0.0 c	0.0 b	0.8 bc	2.8 b	2.5 bc	0.0 c
Confidential A 0.52 fl oz	28	0.0 c	2.0 bc	0.0 c	4.0 b	0.0 c	13.3 b	0.0 c	7.8 b
CGA 279202 50 WG 0.1 fl oz +Banner MAXX 1.2 MC 1 oz	28	15.0 b	5.8 bc	17.5 b	0.0 b	7.5 b	2.5 b	17.5 b	0.8 c

Bayleton 50DF 0.25 oz + Heritage 50WP 0.2 oz	28	0.0 c	8.0 b	0.0 c	8.0 b	0.0 b	14.8 b	0.0 c	1.0 c
Eagle 40WP 0.6 oz + Heritage 50WP 0.2 oz	28	0.0 c	2.5bc	0.0 c	0.0 b	0.0 b	3.0 b	0.0 c	0.8 c

[a]Fungicides for the 14-day interval were applied on 17 and 31 Jul and 14 Aug; those on the 28-day schedule were applied on 17 Jul and 14 Aug.
[b] Mean percentage plot area damaged by brown patch. Means not followed by the same letter are significantly different (P = 0.05) by Fisher's LSD.
[c]Mean number of dollar spot infections/plot.

Both brown patch and dollar spot were severe on Cohansey bentgrass from late July through early August. In general, most fungicides except CGA 279202 and Confidential A significantly reduced dollar spot severity. However, only Confidential B gave consistently acceptable levels of dollar spot control (< 10 spots/plot) throughout the testing period. Applications of Aliette Signature + Daconil Ultrex, Confidential A, Confidential B, and CGA 279202 consistently reduced brown patch severity. Overall, applications of Confidential B at 14- or 21-day intervals resulted in the greatest suppression of both diseases.

Table 2. Control of brown patch and dollar spot on Cohansey bentgrass by fungicides, Manhattan, KS, 1998.

	Spray Interval	21 Jul[a]		30 Jul		7 Aug		20 Aug	
Treatment and rate/1000 ft^2	days	Brown Patch[b]	Dollar Spot[c]	Brown Patch	Dollar Spot	Brown Patch	Dollar Spot	Brown Patch	Dollar Spot
Control		26.7 a	91.0 a	36.7 ab	136.0 b	76.7 a	228.0 ab	86.7 a	86.7 a
Thalonil Zn 4.1F 6 fl oz	14	10.0 a	40.7 b-e	8.3 bc	85.7 cd	46.7 a	131.3 c	26.7 cde	57.7 bc
Aliette Signature 80WDG 4 oz + Chipco GT 2SC 4 fl oz	14	30.0 a	5.7 de	41.7 ab	46.0 de	43.3 a	23.0d	40.0 bcd	1.7 d
Aliette Signature 80WDG 4 oz + Daconil Ultrex 82.5 SDG 3.8 oz	14	1.7 a	18.3 cde	1.7 c	27.0 ef	1.7 b	46.0 d	5.0 de	27.0cd
Confidential A 0.28 fl oz	14	5.0 a	64.3 ab	0.0 c	190.0 a	0.0 b	175.7 bc	0.0 e	35.3 c
Confidential B 0.14 oz	14	0.0 a	0.0 e	2.3 c	5.0 ef	1.7 b	3.3 d	0.0 e	0.0 d
CGA 279202 50WG 0.1 oz	14	14.0 a	53.7 abc	5.0 c	141.7 b	1.7 b	168.0 bc	15.0 cde	85.3 ab
Bayleton 50DF .25 oz + Thalonil 90WP 1.7 oz	21	10.0 a	21.0 b-e	16.7 abc	0.0 f	40.0 a	39.0 d	41.7 ab	7.7 d
Lynx 45WP 0.28 oz + Thalonil 90WP 1.7 oz	21	1.0 a	0.3 e	0.0 c	0.3 f	40.0 a	24.7 d	36.7 bcd	7.7 d
Eagle 40WP 0.6 oz + Thalonil 90WP 1.7 oz	21	17.3 a	24.0 b-e	0.0 c	0.0 f	56.7 a	1.7 d	63.3 ab	0.0 d
Confidential A 0.52 fl oz	21	0.0 a	49.3 b-d	0.0 c	115.3 bc	0.0 b	249.3 a	10.0 e	103.7a
Confidential B 0.275 oz	21	0.0 a	0.0 e	0.0 c	0.0 f	1.3 b	15.7 d	0.0 e	4.3 d

[a]Fungicides for the 14-day interval were applied on 17 and 31 Jul and 14 Aug; those on the 21-day schedule were applied on 24 Jul and 14 Aug.
[b] Mean percentage plot area damaged by brown patch. Means not followed by the same letter are significantly different (P = 0.05) by Fisher's LSD.
[c]Mean number of dollar spot infections/plot.

TITLE: Effects of Aerification and Fungicide Application on the Development of Summer Patch Disease in Mystic Kentucky Bluegrass

OBJECTIVE: To evaluate aerification and fungicide treatments for their effects on summer patch disease in Kentucky bluegrass maintained under golf course fairway conditions.

PERSONNEL: Henry Wetzel III and Jack Fry

SPONSORS: Bayer, ISK Biosciences, Novartis, Rohm & Haas, and Zeneca

MATERIALS AND METHODS:

This was the last year of a 3-year study. Turf was a 5-year-old stand of Mystic Kentucky bluegrass growing at the Rocky Ford Turfgrass Research Center, Manhattan, KS. The design was a randomized complete block with four replications, and the treatment structure was a split plot with the whole plot (120 sq ft) receiving fungicide and the subplot (60 sq ft) receiving aerification. Aerification was done in October 1997 and March 1998 with a Ryan Greensair equipped with 0.37 in.-diam. hollow tines. Aerification cores were verticut to return soil back into plots, and remaining thatch was raked and discarded. Whole plots had been innoculated in March, 1997 at 10 random locations each with 0.18 oz. of oat kernels infested with a single *Magnaporthe poae* isolate collected from the experimental area in the previous year. Turf was mowed 3 days each week at a 0.75-inch height with a reel mower and received 3.0 lb. N/1,000 sq ft/yr.. Irrigation was applied to prevent stress. Fungicides (Table 1) were applied on 28 April, 27 May, and 23 June 1998 in 2.2 gal H20/1,000 sq. ft. with a pressurized (36 psi) CO_2 backpack sprayer equipped with three flat-fan TeeJet 8010 nozzles. Fungicides were not watered in following treatment. Dimension and Trimec Classic were applied in May, 1998 for preemergence and postemergence broadleaf weed control, respectively. Merit 0.5 G was applied in May 1998 for preventive control of white grubs.

Severity of summer patch disease was assessed visually as a percent of plot area blighted by *M. poae* on a 0 to 100% scale where 0 = no blighting and 100 = entire plot blighted. Turfgrass blight ratings exceeding 5.0% were considered unacceptable disease control. Turf quality was assessed on a 0 to 10 scale, with 0 being completely brown or dead turf; 8 being minimum acceptable quality for golf course fairway turf; and 10 being optimum turf density and greenness. Data were analyzed using the SAS PROC MIXED procedure, and significantly different treatment means were separated using the least squares means for Fisher's protected LSD procedures at the P = 0.05 level.

RESULTS:

Disease control among treatments was generally similar regardless of aerification treatment (data not shown). However, on several rating dates, disease blighting was greater in the aerified control (mean of 47 %) vs. the nonaerified control (mean of 36 %). This suggests that where no fungicide treatment is employed, aerification may exacerbate summer patch disease.

On the first four rating dates, all fungicides suppressed disease compared to the nontreated control (Table 1). On 26 August, Sentinel- and Eagle-treated plots exhibited blight levels > 10%, whereas turf treated with Heritage or Bayleton had < 5% blighting. A similar ranking of fungicide treatments was observed on 3 September.

Nontreated turf had unacceptable quality throughout the summer (Table 2). Heritage and Bayleton provided acceptable turf quality throughout the summer, whereas quality of Eagle-treated turf dropped below this level on 12 August. Sentinel provided acceptable quality until 26 August.

In an area where summer patch has been a recurring problem, fungicides were required to maintain turf quality through the summer. As long as a fungicide was employed, aerification had little effect on blighting or turf quality. Where no fungicide was used, however, aerification seemed to increase disease blighting. All fungicides suppressed summer patch, but Heritage and Bayleton provided superior disease suppression and turf quality.

Table 1. Summer patch ratings on Mystic Kentucky bluegrass at Rocky Ford Turfgrass Research Center, Manhattan, KS, 1998.

		Plot Area Blighted (%)					
Treatment and Rate per 1000 sq ft	Dates Applied	29 July	5 Aug	12 Aug	19 Aug	26 Aug	3 Sept
Eagle 40WP 1.2 oz	1 May + 27 May + 23 Jun	2.1 b[1]	5.0 b	5.7 b[1]	7.9 b	17.4 b	12.5 b
Sentinel 40WG 0.33 oz	1 May + 27 May + 23 Jun	1.5 b	3.5 b	4.6 b	8.0 b	11.8 bc	9.8 bc
Heritage 50WG 0.4 oz	1 May + 27 May + 23 Jun	0.0 b	0.1 b	0.0 b	0.5 b	0.5 d	0.2 c
Bayleton 50DF 2.0 oz	1 May + 27 May + 23 Jun	0.2 b	0.5 b	2.3 b	3.0 b	4.7 cd	4.5 bc
Control	–	11.9 a	23.7 a	33.2 a	44.4 a	54.7 a	42.5 a

[1]Means followed by the same letter are not significantly different according to the LSD procedure at P=0.05. Less than 5% plot area blighted would be considered commercially acceptable control of summer patch disease.

Table 2. Turf quality of Mystic Kentucky bluegrass at Rocky Ford Turfgrass Research Center, Manhattan, KS, 1998.

		Turf Quality					
Treatment and Rate per 1000 sq ft	Dates Applied	29 July	5 Aug	12 Aug	19 Aug	26 Aug	3 Sept
Eagle 40WP 1.2 oz	1 May + 27 May + 23 Jun	8.4 b[1]	8.1 a	7.7 a[1]	7.4 b	6.7 c	6.9 c
Sentinel 40WG 0.33 oz	1 May + 27 May + 23 Jun	9.1 ab	8.6 a	8.5 a	8.0 ab	7.7 bc	7.7 bc
Heritage 50WG 0.4 oz	1 May + 27 May + 23 Jun	9.5 a	9.2 a	9.0 a	9.1 a	9.2 a	9.5 a
Bayleton 50DF 2.0 oz	1 May + 27 May + 23 Jun	9.2 ab	9.1 a	8.5 a	8.3 ab	8.0 b	8.2 b
Control		6.4 c	5.6 b	5.3 b	4.4 c	4.2 d	5.0 d

[1]Means followed by the same letter are not significantly different according to the LSD procedure at P=0.05. Turf quality was assessed on a 0 to 10 scale, with 0 being completely brown or dead turf; 8 being minimal acceptable quality for golf course fairway turf; and 10 being optimum turf density and greenness.

TITLE: Preventive Fungicide Applications for Control of Gray Leaf Spot on Perennial Ryegrass

OBJECTIVE: To evaluate various fungicides for control of gray leaf spot on perennial ryegrass

PERSONNEL: Ned Tisserat and Jack Fry

SPONSORS: Kansas Turfgrass Foundation, Heart of America Golf Course Superintendent's Association, Novartis, Zeneca, Bayer, Rohm & Haas, BASF, and Manhattan Country Club

MATERIALS AND METHODS:

The experiment was conducted on an established ryegrass fairway at the Manhattan Country Club, Manhattan KS. The ryegrass was maintained at 0.5 in. mowing height, irrigated as needed, and fertilized with 4 lb N/1000 sq ft per year. Fungicides were applied in water equivalent to 2.2 gal/1000 sq ft on 11 Aug with a CO_2-powered backpack sprayer with 8003 flat fan nozzles at 30 psi. Plots were not irrigated after applications. Plots were 6 ft X 10 ft and arranged in a randomized complete-block design with four replications. Plots were rated on 4 Sept for the percent plot area blighted by gray leaf spot.

RESULTS:

Gray leaf spot was not present in the fairway plots at the time of fungicide application, but it was observed at a low levels (<5% area blighted) in the perennial ryegrass rough mowed at 1 in. Weather immediately following the fungicide applications was hot and dry. No gray leaf spot was detected in any plots at 4 days after application. No further ratings were taken until 24 days after application. On 4 Sept, severe blighting was present in the untreated plots (Table 1). Although most fungicides reduced the severity of gray leaf spot, only applications of Heritage and CGA 272902 gave aesthetically acceptable (<10% blighting) levels of control. Heritage at .4 oz provided almost complete control of gray leaf spot.

Table 1. Control of gray leaf spot on perennial ryegrass, Manhattan, KS, 1998.

Treatment and rate/1000 sq ft	% Plot Blighted
Control	80.0a*
Eagle 40WP 0.6 oz	67.5ab
Bayleton 50DF 0.5 oz	63.8b
BASF 505 50DF 0.14 oz	47.5c
Sentinel 40WG 0.33 oz	31.3d
Daconil Ultrex 82.5WG 3.8 oz	23.8d
Fungo 50WP 2 oz	23.8d
CGA 279202 50WG 0.1 oz	7.5e
Heritage 50WG 0.2 oz	6.5e
Heritage 50WG 0.4 oz	0.5f

*Means not followed by the same letter are significantly different (*P*=0.05) by Fisher's LSD test.

TITLE: Preventive Fall Fungicide Applications for Control of Rhizoctonia Large Patch Disease of Zoysiagrass

OBJECTIVE: To evaluate the effectiveness of preventive fungicide applications for the control of large patch of zoysiagrass.

PERSONNEL: Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation, Heart of America Golf Course Superintendent's Association, Novartis, Rhone Poulenc, AgrEvo, Zeneca, Bayer, Rohm & Haas, BASF, and The Cleary's Corporation

MATERIALS AND METHODS:

Fungicide plots were established on Meyer zoysiagrass fairways at the Highlands and Alvamar golf courses in Hutchinson and Lawrence, KS, respectively. Turfgrass was mowed at 0.5 inches, irrigated as needed, and fertilized with approximately 1.5 lb N/1000 sq ft annually. Twelve fungicide treatments were applied in water equivalent to 2.2 gal/1000 sq ft on 24 September in Lawrence and 29 September 1998 in Hutchinson with a CO_2 backpack sprayer with 8003 TeeJet flat fan nozzles at 30 psi. Treatment plots were 10 X 12 ft and replicated four times in a randomized complete block design. Plots were not irrigated after fungicide applications. The percentage plot area diseased was recorded on 23 and 27 April, 1999 in Hutchinson and Lawrence, respectively, after zoysiagrass resumed spring growth.

RESULTS:

No large patch was evident at either location before or after fungicide application in the fall. However large patches were present in nontreated areas as zoysiagrass broke winter dormancy. This indicated that much of the infection occurred between fall dormancy and resumption of zoysiagrass growth in the spring. Applications of Heritage, Bayleton, RH 0753, and Prostar gave excellent control (< 5 % blighting) of large patch at both locations (Table 1). Penstar also gave excellent control at Alvamar. These results are consistent with previous experiments and indicate that a single fungicide application in fall is effective in suppressing large patch disease through the fall and winter dormancy. These fungicides also appeared to be suppressing further progression of the disease in mid- to late April. However, the development of small, active patches in these treatments indicated that an additional spring application may be required for disease suppression during May.

Table 1. Control of Rhizoctonia large patch disease of zoysiagrass in Kansas, 1998.

Treatment and Rate per 1000 sq ft[1]	% Plot Damaged Alvamar	Highlands
Heritage 50 WP 0.4 oz	1.5 a	0.8 a
RH 0753 2SC 0.5 fl oz	3.0 a	0.8 a
Bayleton 50WP 1.0 oz	3.0 a	1.3 a
Penstar 75WP 16 oz	3.3 a	–
Prostar 70WP 2.2 oz	4.5 a	3.0 ab
Triton 2 SC 2 fl oz	7.5 ab	3.0 ab
CGA 279202 50 WDG 0.2 oz plus Banner MAXX 1.1E 1 fl oz	12.5 ab	22.5 c
Cleary's 3336 50 WP 4 oz	13.3 ab	21.3 c
BASF 505 50 DF 0.18 oz	13.8 ab	7.0 b
CGA 279202 50 WDG 0.25 oz	20.0 b	22.5 c
BASF 500 2.09 EC 0.375 fl oz	-	7.5 b
No fungicide	33.8 c	21.3 c

[1]Fungicides applied on 24 and 29 September and rated on 27 and 23 April at Alvamar and Highlands country clubs, respectively.

TITLE: Geographic Distribution and Genetic Diversity of Three *Ophiosphaerella* Species that Cause Spring Dead Spot of Bermudagrass

OBJECTIVE: To assess the genetic diversity of these fungi through the use of molecular biology techniques

PERSONNEL: Henry Wetzel III and Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation, Heart of America Golf Course Superintendent's Association, United States Golf Association, and the Golf Course Superintendent's Association of America

MATERIALS AND METHODS:

The distribution and genetic diversity of three *Ophiosphaerella* spp. that cause spring dead spot of bermudagrass was studied by systematically sampling three golf courses, two in Oklahoma and one in Kansas..

The AFLP technique was used to investigate inter- and intraspecific genetic diversity in the three species. A single, selective, PCR primer-pair combination (EAA/MCA) was used to differentiate issolates into distinct groups representing the three *Ophiosphaerella* species.

RESULTS:

Of 513 isolates collected, 445 were *O. herpotricha*, 47 were *O. korrae*, and 21 were *O. narmari*. These included the first report *of O. narmari* in North America and the first finding of *O. korrae* in the Great Plains region on bermudagrass.

Isolates of *O. narmari* exhibited more similarity to *O. herpotricha* than to *O. korrae*. A majority of the *O. herpotricha* and *O. narmari* isolates collected at Afton, OK (Oklahoma) were distinct haplotypes, suggesting that genetic recombination was occurring within the population. Conversely, multiple isolates recovered representing the same haplotypes in *O. narmari* and *O. herpotricha* also suggested that asexual propagation was occurring. The genetic diversity among *O. herpotricha* isolates collected from Afton was not distinctly different from that of isolates collected throughout the southern United States. In contrast, isolates of *O. narmari* from Afton were distinct from those collected in Australia, where it is the major cause of spring dead spot. The genetic diversity in *O. korrae* was markedly different than that of the other two species. The population at the Afton course was dominated by just a few haplotypes, and these were nearly identical to isolates collected throughout western and northern North America and Australia (one isolate only). However, *O. korrae* also showed a strong geographic segregation. Isolates collected over a wide geographic region in southeastern United States were only distantly similar to other North American isolates.

TITLE: *Cyclocephala* in Kansas: 1998 Flight Patterns and Species Distributions

OBJECTIVES To identify the species of *Cyclocephala* in Kansas and to determine flight activities with special emphasis on peak flight activity as a tool to predict the timing of preventative grubacide applications.

PERSONNEL: Bob Bauernfeind

SPONSOR: Kansas Turfgrass Foundation

COOPERATORS:

Various people who operated blacklight traps: Alan Zuk (Rocky Ford Superintendent); Cliff Dipman (Manhattan Country Club superintendent); Bill Wood (Jewel County CEA, ret.); Byron Hale (Decatur County CEA); Craig Poe (Oakley - 4-H'er); Lawrent Buschman (Garden City, Southwest Research-Extension Center); Mark Olney and Darryl Kennedy (City of Liberal Parks Dept., and Willow Tree Golf Course Superintendent, respectively); Robert Pohl (Pohl's Garden and Nursery, Great Bend); Tom Auerbach (Grove Park Golf Course - Ellinwood); John Cauthorn (Medicine Lodge Golf Course); Mike Daratt (Wichita HRC Field Tech.), Brian Kaiser (KOCH Industries, Wichita); and Joe Knickerbocker (Independence Nursery and Garden Center).

INTRODUCTION:

White grubs are the most serious insect pests of high-maintenance turfgrass in Kansas. They are the larval stages of beetles in the family Scarabaeidae. Perhaps the most commonly recognized scarab beetles are May and June beetles, which, in late spring through summer, are attracted to lights during evening hours. Although white grub larvae of these June beetles are capable of causing damage to turf, the white grub larvae of "masked chafers" are considered (by turf entomologists throughout the United States) to be the primary pests of high maintenance turfgrass.

Cyclocephala species have a 1-year developmental cycle. Eggs deposited during June and July hatch in 1-2 weeks, and the larvae rapidly develop and become (for the most part) mature 3rd instar larvae prior to the onset of cooler/cold weather in the fall. During this developmental period, annual grubs will feed on grass root systems. Depending on grub population levels and the condition/vigor of the turfgrass, turf may be damaged and killed when grubs have attained their most damaging stage/size in late August through September and into October.

Research has shown that the development of annual grubs can be traced back to the flight activities of the chafers responsible for egg production. Thirty to 40 days after peak flights of chafers occur, all grubs will have hatched from eggs, and 90% of them will be in their 1st or 2nd developmental stages/instars. This is an ideal time to monitor for grubs (their presence and numbers) and apply preventative grubacide treatments, if deemed necessary. Small grubs are extremely susceptible to insecticides and will not yet have caused significant damage to the root systems of the turfgrass upon which they feed.

MATERIALS AND METHODS:

Two types of blacklight traps were used to monitor chafer flights: General Purpose Blacklight Traps (O.B. Enterprises, Inc.) and UL40 Bug Zappers (DeJay Corporation). The electric grids of the UL40 traps were deactivated, and the traps were fitted with funnels and collecting cans. The traps were run over a 3-month period (May 1 - Aug. 1), during which first catches of the year could be recorded as well as flight peaks.

For the most part, collections were made on a daily basis. Specimens were placed in alcohol-filled specimen containers or in plastic sacks that were stored in freezers. Dated samples eventually were brought to Kansas State University, where chafer numbers were determined and species identified.

RESULTS: The following tables summarize the 1998 work:

Table 1. *Cyclocephala* flight activities in Kansas, 1998.

Trapping Site	First Chafer	Flight Peak	Trapping Site	First Chafer	Flight Peak
Independence	6/03	6/23	Medicine Lodge	6/10	7/04
ondondery	6/07	6/28	Ellinwood	6/12	6/27-28
Rocky Ford	6/09	6/19	Oberlin	6/18	7/12-13
Manhattan CC	6/09	6/28	Oakley	6/19	7/12
Colbert Hills	6/09	6/28	Mankato	6/21	7/10
Great Bend	6/09	6/28	Garden City	6/21	7/13
Wichita (HRC)	6/09	7/2-5	Liberal	6/30	7/12
Wichita (KOCH)	6/09	7/2-5			

The earliest chafer activities for 1998 began on June 3 at Independence. This southeast typically has been “the earliest”; thus, peak flights have occurred earliest there. Chafer flights began at most other sites a week later, and their peaks occurred during the last week of June. The exception was at Rocky Ford, where the light was unplugged on the evening of June 28. Thus, the highest chafer count was on 6/19, although the trends for the evenings before and after indicated that June 28 probably was the peak night. The onsets of flight activities were latest at the Mankato, Oberlin, Oakley, Garden City, and Liberal trapping sites, and peak flights occurred well into July.

Table 2. *Cyclocephala* Distribution in Kansas, 1998.

Trapping Site	Total No. Chafers	Number per Species *lurida*	*pasadenae*	*longula*	*borealis*
Colbert Hills	2,328	2,152	171	0	5
Londondery	4,429	4,215	211	0	3
Rocky Ford	7,443	5,669	1,761	0	13
Manhattan CC	1,376	1,233	142	0	1
Mankato	7,238	4,193	3,045	0	0
Oberlin	3,502	39	3,463	0	0
Oakley	26,118	0	26,118	0	0
Garden City	17,308	257	17,049	0	2
Liberal	4,855	205	4,551	0	0
Great Bend	3,669	1,847	1,798	24	0
Ellinwood	6,662	3,074	3,494	94	0
Medicine Lodge	8,108	2,753	4,739	616	0
Wichita (HRC)	3,376	2,315	975	368	0
Wichita (KOCH)	1,816	1,102	98	616	2
Independence	1,192	782	65	0	345

Cyclocephala lurida and *C. pasadenae* again were the predominant species in Kansas; the former was a more eastern species, and the latter a more western species. Of interest was *C. longula*'s being somewhat clustered in the southcentral area of the state. Again, *C. borealis* was most prevalent at the Independence site with a scattered few (as usual) collections at the Manhattan sites. The two each recorded from Wichita and Garden City were the first ever over the 4 years of trapping at those sites.

TITLE: Crabgrass Control with Pre- and Postemergence Herbicides

OBJECTIVE: To evaluate pre- and postemergence herbicides for crabgrass control

PERSONNEL: Jack Fry

SPONSORS: BASF, Dow, and Rohm &Haas

INTRODUCTION:

Crabgrass is one of the primary summer turf weeds in Kansas, and turf managers are always interested in the ability of pre-and postemergence herbicides to control this weed.

MATERIALS AND METHODS:

Turf was predominantly perennial ryegrass, but the south 1/3 of the plot area was Kentucky bluegrass. The area at the Rocky Ford Turfgrass Research Center, Manhattan, KS was managed to favor weed encroachment. This was accomplished by seeding the area during fall, 1997 with approximately 1 lb of smooth crabgrass seed/1,000 sq ft. Turf also was scalped to about a 1-inch height when it reached 3 to 4 inches tall. Irrigation was applied to keep the soil moist during the period in which a flush of crabgrass germination was expected.

The initial preemergence application of herbicides was made on May 5. However, the Drive G formulation was not received until May 8 and was applied on that date. Sequential preemergence applications and application of postemergence herbicides were done on June 30. At this time, crabgrass in the area had from 1 to 5 tillers. Liquid herbicides were applied at 66 gal/acre using a CO_2-powered backpack sprayer. Granular herbicides were applied with a shaker bottle.

Plots measured 1 by 2 meters and were arranged in a randomized complete block design with three replicates. Data were analyzed using PROC GLM in SAS, and means were separated using the Duncan-Waller Least Significant Difference test.

RESULTS:

Crabgrass pressure was severe, but variability in crabgrass encroachment from north to south (opposite of the way blocks were laid out) resulted in relatively high LSD values on all rating dates. On June 26, no significant differences occurred among treated and nontreated plots.

On 10 July, treatments with less crabgrass cover than untreated plots included Team Pro (1.5 + 1.5 or 2.0), Dimension 1 EC (0.38 or 0.25 + 0.125), Dimension FG (0.25), and Pendimethalin 60W (1.5 + 1.5 or 3.0).

On 9 September, the nontreated plots had nearly 80% crabgrass coverage. Treatments that had significantly less crabgrass than the nontreated were Team Pro 0.86G (1.5 + 1.5), Dimension 1 EC (0.38 and 0.25 + 0.125), Dimension FG (0.25), Barricade 65 WDG (0.65), Pendimethalin 60 W (1.5 + 1.5), and Dimension 1 EC (post, 1.0). Treatments that resulted in < 10% crabgrass cover (which would be considered the commercially acceptable limit by many) were Team Pro 0.86G (2.0), Dimension 1 EC (0.38), and Pendimethalin 60W (1.5 + 1.5).

Drive applied preemergence in the dry flowable formulation or in the granular formulation had no effect on crabgrass coverage. Postemergence applications of Drive DF yellowed and stunted crabgrass, but it recovered.

Table 1. Crabgrass cover in turfgrass treated with pre- or postemergence herbicides in 1998 at Manhattan, KS.

Herbicide	Form	Rate (lb. a.i./A)[1]	Crabgrass (% of Plot) June 26	July 10	Sept 9
1. Team	0.86 G	1.5 + 1.5	1	6	47
2. Team Pro Fert.	0.86 G	2.0	1	2	6
3. Pendimethalin Fert.		0.86 G	1.5 + 1.5	3	3043
4. Pendimethalin Fert.		0.86 G	2.0	2	2645
5. Dimension		0.10 G	0.38	17	5073
6. Barricade	0.22 G	0.5	1	14	37
7. Dimension		1 EC 0.38	0	3	10
8. Dimension		1 EC 0.25 + 0.125	2	5	23
9. Dimension Fert.	FG	0.25	2	7	28
10. Dimension Fert.	FG	0.125 + 0.125	2	38	48
11. Barricade	65 WDG	0.6	1	12	17
12. Pendimethalin	60 W	3.0	0	1	33
13. Pendimethalin	60 W	1.5 + 1.5	0	2	6
14. Fert. Blank			3	27	47
15. Drive	75 DF	0.5	10	48	68
16. Drive	75 DF	0.75	3	37	58
17. Drive	0.57 G	0.5	5	27	47
18. Drive	0.57 G	0.75	8	70	100
19. Drive	75 DF	0.5	20	58	75
20. Drive	75 DF	0.75	5	19	48
21. Drive	0.57 G	0.5	14	50	75
22. Drive	0.57 G	0.75	14	52	75
23. Dimension		1 EC 1.0	9	10	17
24. Untreated			7	42	78
LSD[2]			10	34	46

[1]Initial treatments made on May 5, 1998. Sequential treatments were applied on June 30, 1998. Treatments 1 through 18 were applied preemergence. Treatments 19 to 23 were applied post-emergence on June 30 (crabgrass with 2 to 5 tillers).

[2]To determine statistical differences among entries, subtract one entry's mean from another's. A statistical difference occurs when this value is larger than the corresponding LSD value.

TITLE: Seasonal Changes and Cultivar Variations in Shoot and Root Growth of Creeping Bentgrass

OBJECTIVE: To investigate seasonal changes and genetic variations in root growth and turf quality

PERSONNEL: Xiaozhong Liu and Bingru Huang

SPONSORS: Golf Course Superintendent Association of America, Kansas Turfgrass Foundation, and Alfred Sloan Foundation

MATERIALS AND METHODS:

The experiment was conducted on a USGA green at the Rocky Ford Turfgrass Research Center, Manhattan, KS in two growing seasons from May to October during 1997-1998. Four cultivars, Crenshaw, Penncross, Providence, and L-93, were examined. Grasses were maintained following typical management practices used on Kansas golf courses with 5/32 inch of mowing height and irrigation on alternate days to replace 100% daily water loss. Turf quality was evaluated visually and estimated using a multispectral radiometer (MSR 16). Root growth was monitored at different soil depths and different times of the year with a minirhizotron imaging system.

RESULTS:

The 1998 results reported here in general were consistent with the results from 1997 that were reported in 1998 Turfgrass Research. However, turf quality decline during the summer was more severe in 1998 than in 1997.

A decline in turf visual quality occurred beginning in early July in all four cultivars (Fig. 1), and quality was lowest in late August. Turf quality recovered in October in all cultivars. Root growth and production ceased by late July, and severe root dieback occurred in all cultivars in July and August. New roots were regenerated in October.

From June to September, L-93 had higher quality than Penncross. L-93 had the highest green leaf biomass (Fig. 2) and photosynthetic efficiency, Providence and Crenshaw were intermediate, and Penncross ranked the lowest.

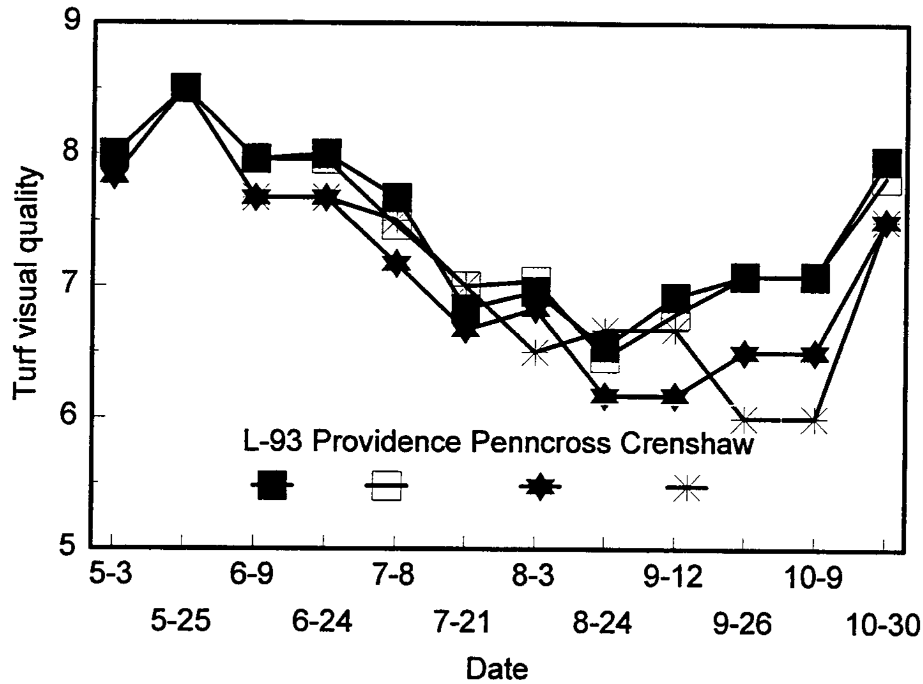


Figure 1. Seasonal changes in turf quality for four cultivars of creeping bentgrass, Manhattan, KS, 1998.

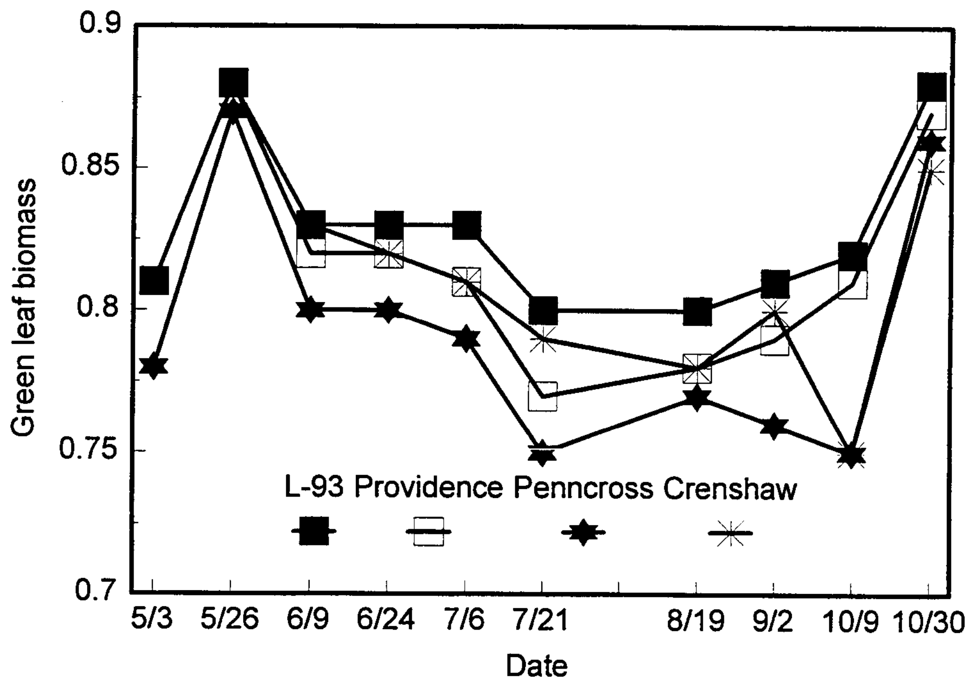


Figure 2. Seasonal changes in the amount of green leaves for four cultivars of creeping bentgrass, Manhattan, KS, 1998.

TITLE: Effects of Mowing Height and Irrigation on Creeping Bentgrass

OBJECTIVE: To study the effects of cultural practices on turf and root growth in creeping bentgrass

PERSONNEL: Xiaozhong Liu and Bingru Huang

SPONSORS: Golf Course Superintendent's Association of America, Kansas Turfgrass Foundation, and Alfred Sloan Foundation.

MATERIALS AND METHODS:

The experiment was conducted on a USGA green at the Rocky Ford Turfgrass Research Center, Manhattan, KS in two growing seasons from May to October during 1996-1998. Penncross and Crenshaw creeping bentgrasses were examined in this study. Two irrigation and two mowing height treatments were applied, beginning in June 1997 and May 1998. Mowing height treatments were 5/32 inch and 1/8 inch. Irrigation regimes included watering daily (replace 100% daily ET) or every other day. Turf quality was evaluated visually and estimated using a multispectral radiometer (MSR 16). Root growth was monitored at different soil depths and different times of the year with a minirhizotron imaging system.

RESULTS:

The results in 1998 discussed here were consistent with those from 1997 that were reported in 1998 Turfgrass Research.

Turf maintained similar quality when irrigated daily or on alternate days during the entire growing season for both cultivars. Irrigation daily or on alternate days had no effect on rooting. The results indicated that irrigation on alternate days at 100% ET was sufficient to maintain bentgrass quality in our area.

Mowing at 1/8 inch caused severe declines in turf quality (Fig. 1) and root growth because of reduced leaf area, green leaf biomass, and photochemical efficiency, especially during summer months. Low mowing reduced rooting depth and accentuated root dieback. Raising mowing height to 5/32 inch improved turf quality in the summer.

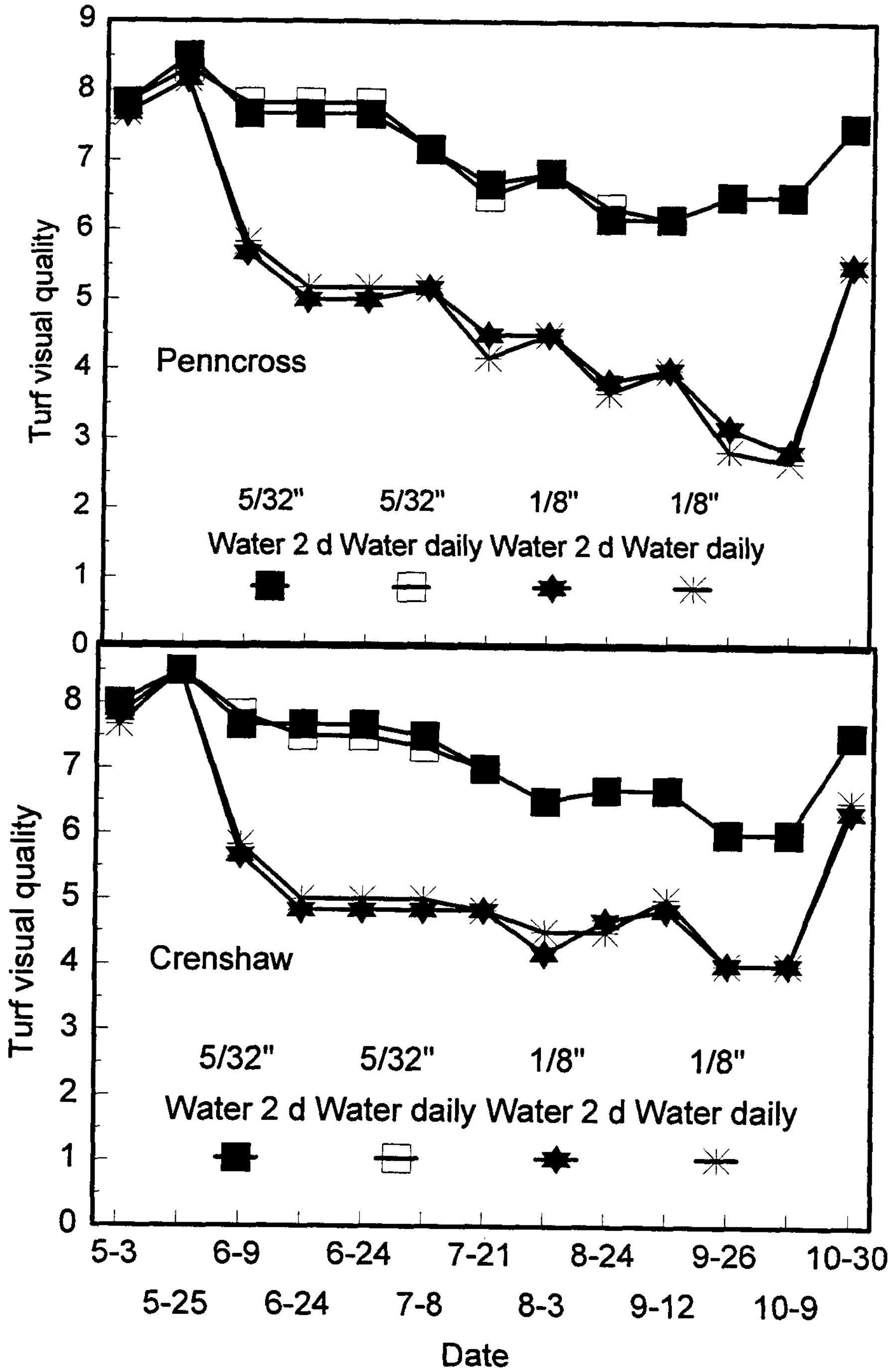


Figure 1. Effects of mowing height and irrigation on turf quality of Penncross and Crenshaw creeping bentgrass, Manhattan, KS, 1998.

TITLE: Major Soil Factors Associated with Summer Declines of Turf and Root Growth in Creeping Bentgrass

OBJECTIVE: To investigate major environmental factors contributing to summer bentgrass decline

PERSONNEL: Xiaozhong Liu and Bingru Huang

SPONSORS: Golf Course Superintendent's Association of America, Kansas Turfgrass Foundation, and Alfred Sloan Foundation

MATERIALS AND METHODS:

The experiment was conducted on a USGA green at the Rocky Ford Turfgrass Research Center, Manhattan, KS in 1997-1998. Crenshaw was maintained by typical management practices used on Kansas golf courses with height of 5/32 inch and irrigation daily or on alternate days to replace 100% daily water loss.

Soil temperature was monitored at 1-hr intervals at 2, 4, and 6 inches from the soil surface using thermocouples and a CR-10 data logger. Soil oxygen status and soil moisture were measured biweekly at 0.5, 2, and 6 inches with an oxygen diffusion meter and time domain reflectometer, respectively.

RESULTS:

Soil temperature, especially in the surface 2 inches, showed dramatic changes during the growing season (Fig. 1) and reached a maximum decline in July. This corresponded to a period of severe decline in turf quality and root death. Daily maximum temperatures reached 32, 30, and 27 C, at 2, 4, and 6 inches, respectively, during July. These were much higher than the optimum temperature required for creeping bentgrass shoot and root growth (18 to 24 C).

Oxygen diffusion rate remained at a constant level (about 1.5 μg cm^{-1} min^{-1}) in all treatments during the entire growing season. This oxygen level is sufficient for root growth and activity.

Plants were well-watered by irrigating daily or on alternate days. Soil moisture contents ranged from 18 to 30% in the thatch layer, and 14 to 20% at 2 and 6 inches from June to September, which were not limiting to shoot and root growth (Fig. 2).

Summer declines in turf quality and root growth of creeping bentgrass at a low mowing height were associated mainly with high soil temperatures.

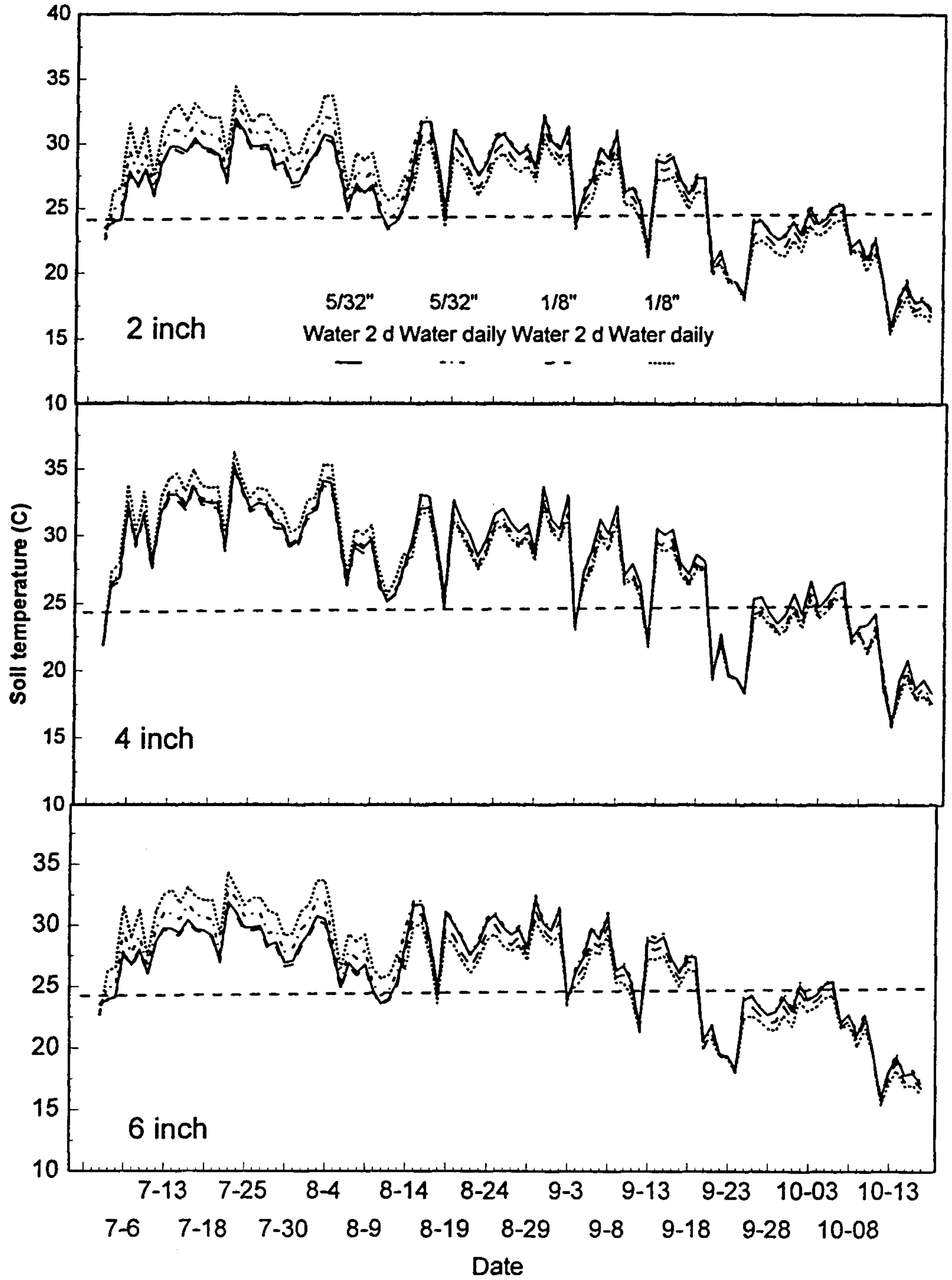


Figure 1. Changes in soil temperature at different soil depths in creeping bentgrass plots in Manhattan, KS, 1997. The horizontal dotted lines indicate the upper limit of the optimum temperature range for root and shoot growth in creeping bentgrass.

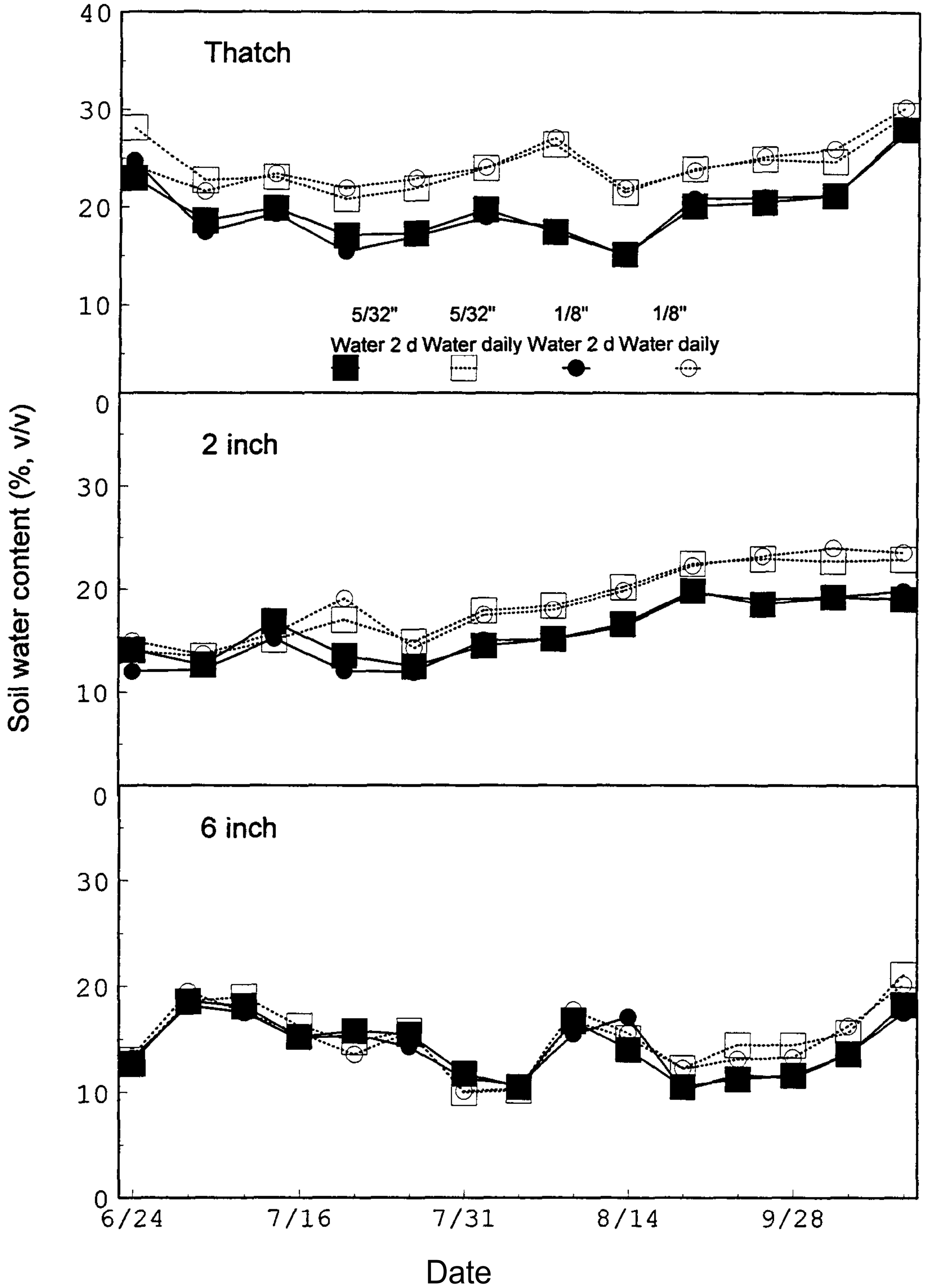


Figure 2. Changes in soil moisture at different soil depths in creeping bentgrass plots, Manhanttan, KS, 1997.

TITLE: Creeping Bentgrass Responses to Increasing Temperatures

OBJECTIVE: To determine responses of turf quality, root growth, and carbohydrate metabolism to increasing temperatures.

PERSONNEL: Bingru Huang

SPONSORS: Kansas Turfgrass Foundation

MATERIALS AND METHODS:

Penncross creeping bentgrass was grown in a mixture of sand and fritted clay contained in polyvinyl chloride tubes in growth chambers at Kansas State University. Turf was mowed daily to a 3-4 mm height with an electric clipper, watered daily, and fertilized weekly with nutrient solution.

Plants were exposed sequentially for 20 d to air temperatures of 20, 24, 30, 34, and 38 C.

Turf quality was rated visually based on color, uniformity, and density on a 0 to 9 scale where 0 = worst quality, 6 or above = acceptable, and 9 = best quality. Canopy net photosynthetic rate and respiration rate of whole plants were determined. Root dehydrogenase activity was measured with the TTC reduction technique. Total nonstructural carbohydrate content of shoots was measured.

RESULTS:

Turf quality (Fig. 1), root dry weight (Fig. 2), and activity (Fig. 3) declined as temperature increased to 30 C and above. Turf quality declined to below an acceptable level at 34 and 38 C.

Canopy rate of photosynthesis (a process producing carbohydrate or food for plant growth) declined significantly as temperature was elevated to 30 C or higher; photosynthesis rate dropped to almost zero at 38 C (Fig. 4). Whole-plant rate of respiration (a process consuming carbohydrate or food for energy production) increased as temperature increased from 20 C to 34 C and then decreased at 38 C (Fig. 4). Respiration rate was higher than photosynthesis rate when temperature increased to 34 and 38 C. Carbohydrate availability in shoots decreased as temperature increased to 30 C and above (Fig. 5).

The results indicated that 30 C was a critical temperature leading to declines in turf quality and root growth of creeping bentgrass cultivars. Turf quality decline when temperature exceeded 30 C was related to the imbalance between carbon production and carbon consumption processes and reduced carbohydrate availability.

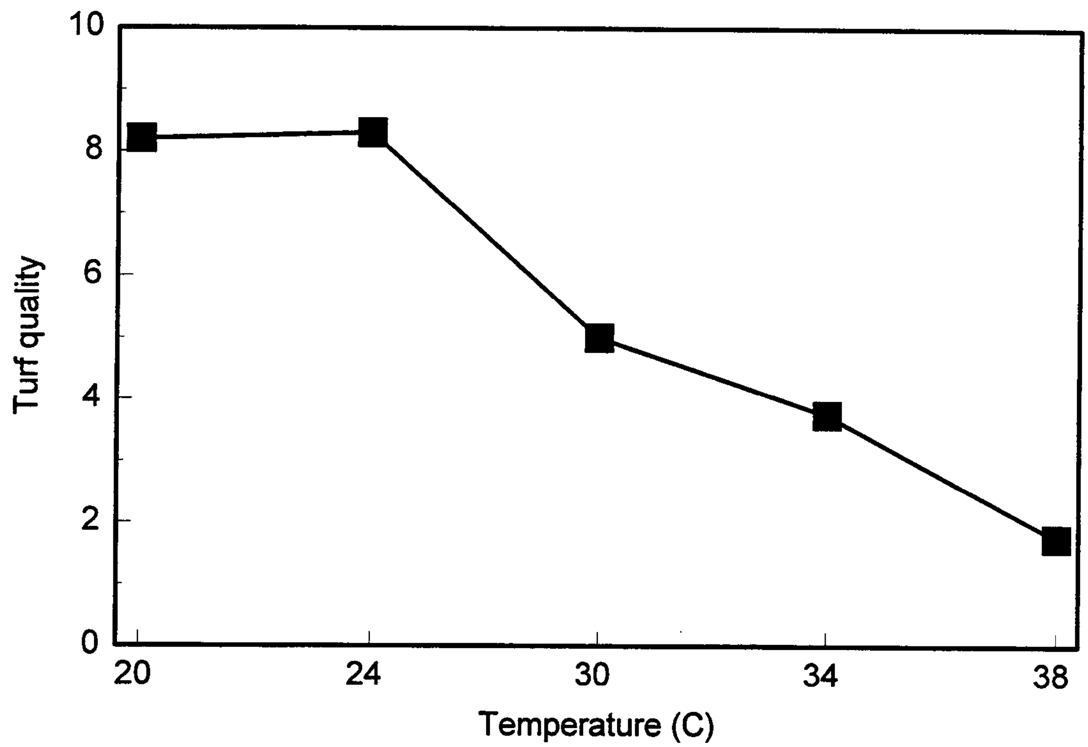


Figure 1. Turf quality of Penncross creeping bentgrass as affected by increasing temperatures.

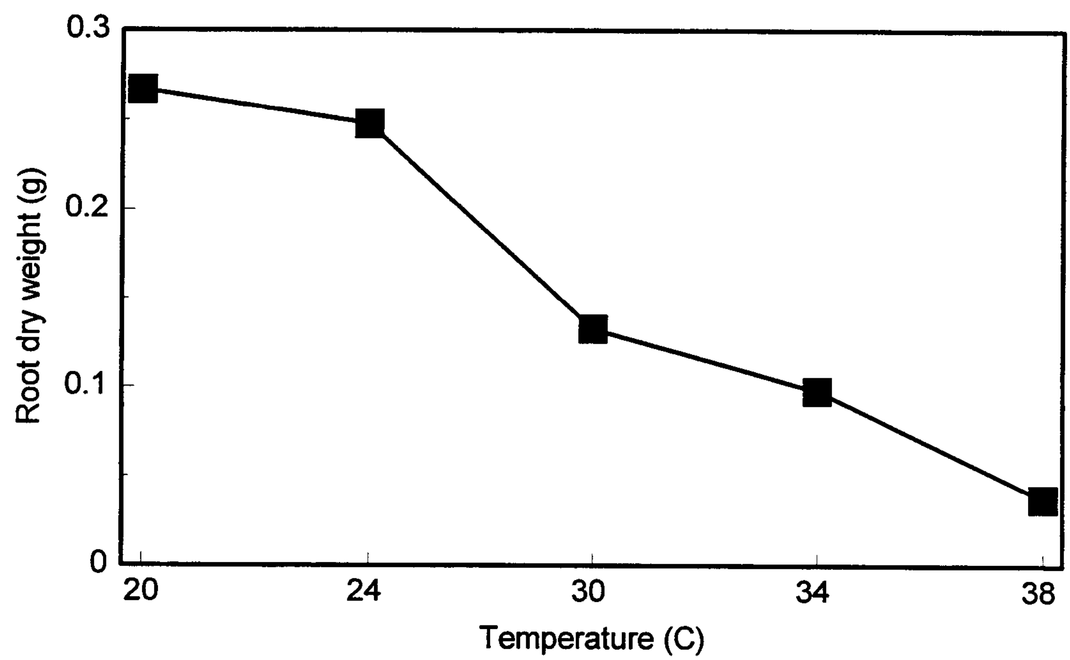


Figure 2. Root dry weight of Penncross creeping bentgrass as affected by increasing temperatures.

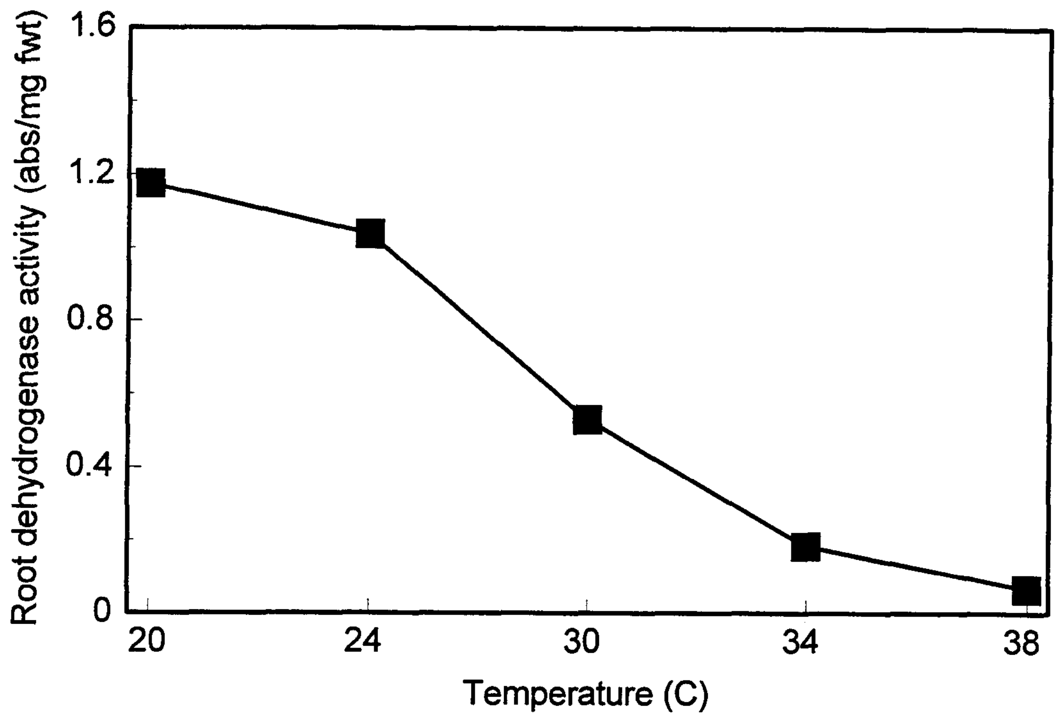


Figure 3. Root activity of Penncross creeping bentgrass as affected by increasing temperatures.

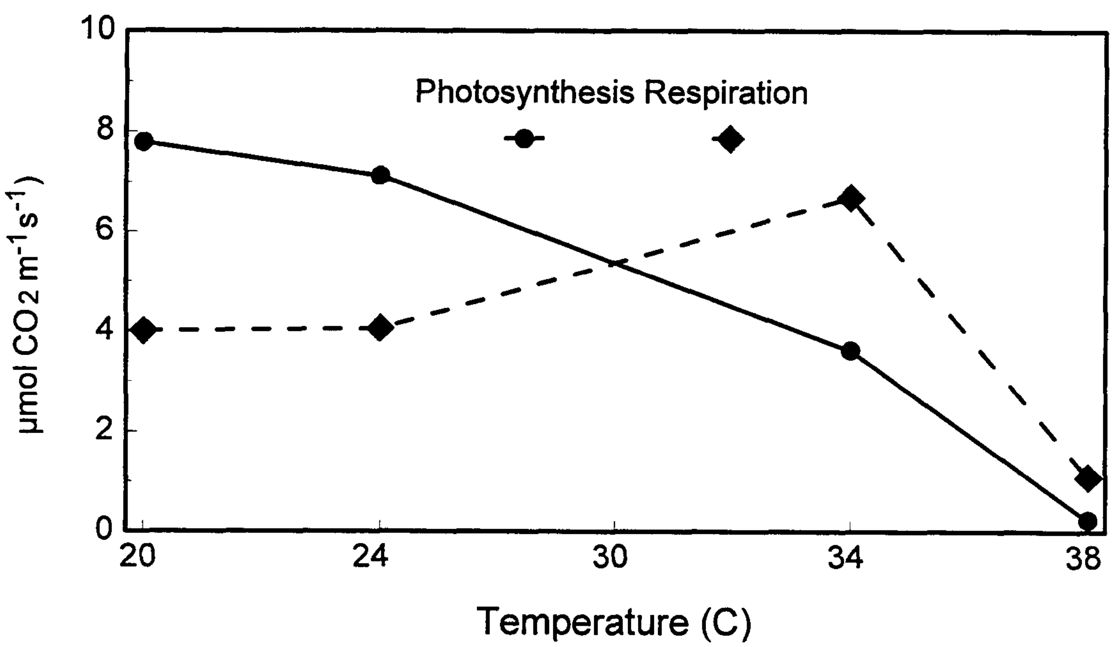


Figure 4. Photosynthesis and respiration rate of Penncross creeping bentgrass as affected by increasing temperatures.

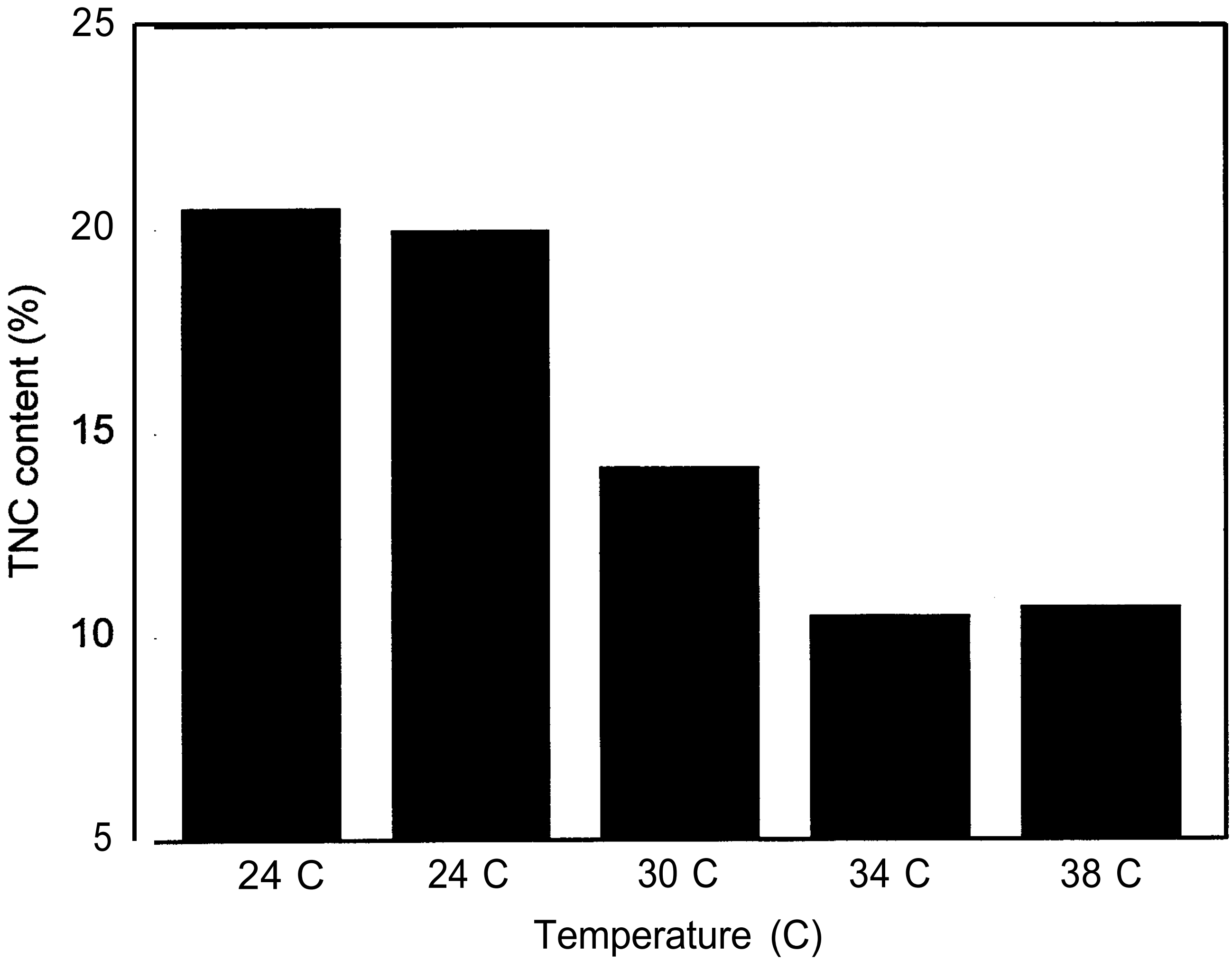


Figure 5. Shoot carbohydrate content of Penncross creeping bentgrass as affected by increasing temperatures.

TITLE: Effects of Root-Zone Temperature Modification on Turf Growth and Carbohydrate Accumulation in Creeping Bentgrass

OBJECTIVE: To determine whether turf quality, root growth, and carbohydrate availability of creeping bentgrass could be improved by reducing root-zone temperatures

PERSONNEL: Qingzhang Xu, Bingru Huang, and Jack Fry

SPONSORS: United States Golf Association, and Kansas Turfgrass Foundation

MATERIALS AND METHODS:

Penncross and L-93 creeping bentgrass were grown in a mixture of 10% profile and 90% sand in polyvinyl chloride tubes in growth chambers at Kansas State University. Turf was mowed daily at a 3-4 mm height.

To examine effects of differential shoot/root temperatures on shoot and root growth, four differential air/soil temperature regimes were imposed: a) 20/20 C; b) 35/20 C; c) 20/35 C; and d) 35/35 C. Root-zone temperature was controlled by maintaining the soil medium in water baths.

Turf quality was rated visually using the scale from 0 to 9, with 9 being the best and 0 the worst. Rates of photosynthesis and respiration were measured to calculate the daily ratio of carbon consumption to production.

RESULTS:

Turf quality of both cultivars declined when only roots (20/35 C) or both shoots and roots (35/35 C) were exposed to high temperatures, but to a greater extent for Penncross. Reducing root temperature to 20 C while shoots were maintained at 35 C improved turf quality to a level similar to the turf grown at low shoot and root temperatures (20/20 C) for both cultivars (Fig. 1).

Grasses grown under low shoot/root (20/20 C) or low root temperature (35/20 C) had larger and active root systems (Fig. 2) than those grown under high root (20/35 C) or high shoot/root (35/35 C) temperature conditions.

Grasses grown under low shoot/root temperatures consumed about 50% of the carbon produced during a day. High root or shoot temperature increased carbon consumption relative to production (Figs. 3 and 4). The amount of carbon consumed per day was 2 to 10 times higher than that produced under high shoot/root temperatures, which could lead to carbohydrate starvation.

High root, shoot, or shoot/root temperatures reduced carbon supply to roots, which may cause a decline in root growth (Fig. 5). These results suggested that cultural practices that can reduce soil temperature in summer would improve turf quality and root growth, and any cultural practices that help conserve carbohydrates or stimulate carbohydrate production, would enhance heat tolerance of creeping bentgrass.

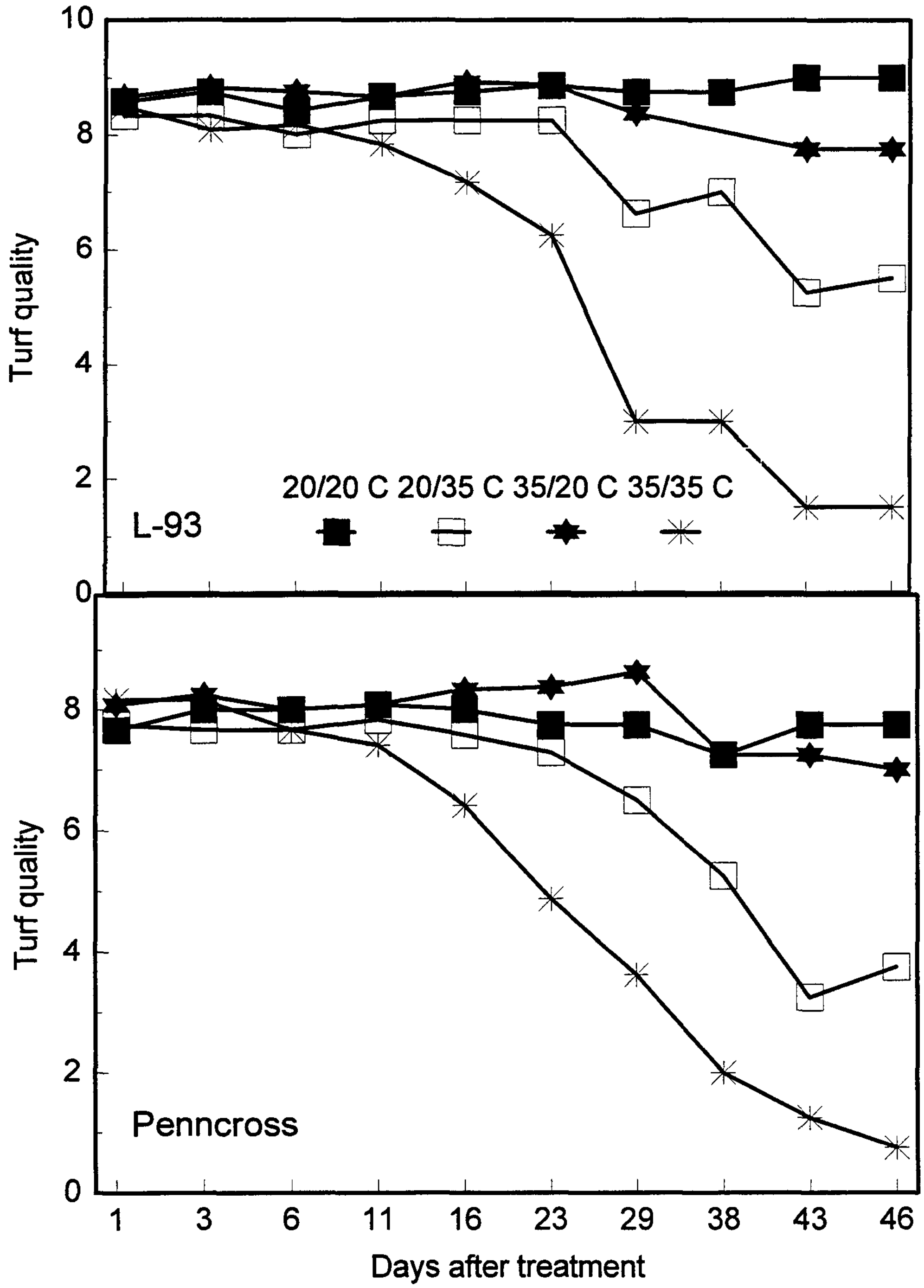


Figure 1. Effects of differential shoot/root temperatures on turf quality of L-93 and Penncross creeping bentgrass.

Figure 2. Effects of differential shoot/root temperatures on root growth of Penncross and L-93 creeping bentgrass mowed daily or on alternate days.

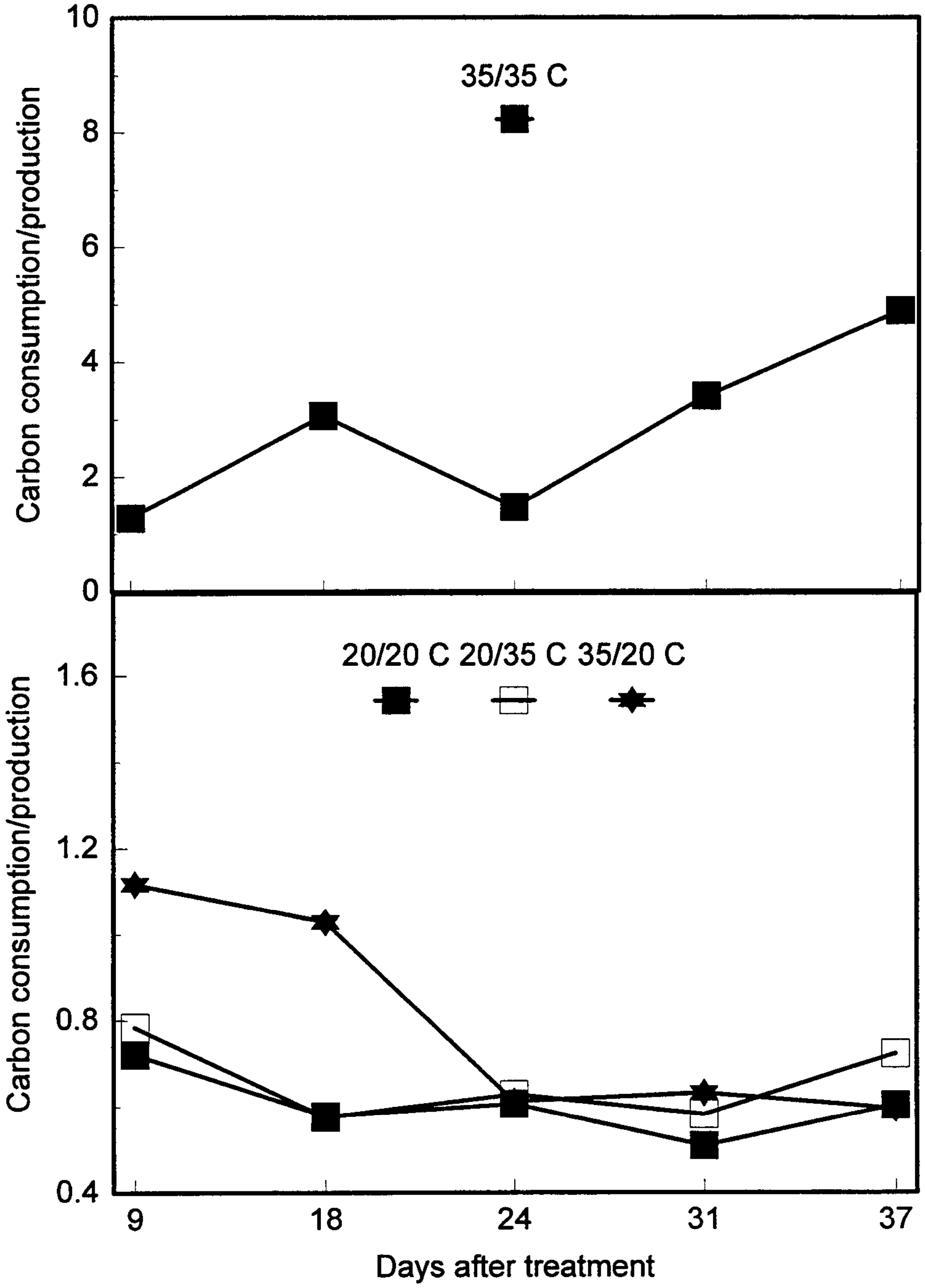


Figure 3. Effects of differential shoot/root temperatures on the balance between carbon consumption and production for L-93 creeping bentgrass.

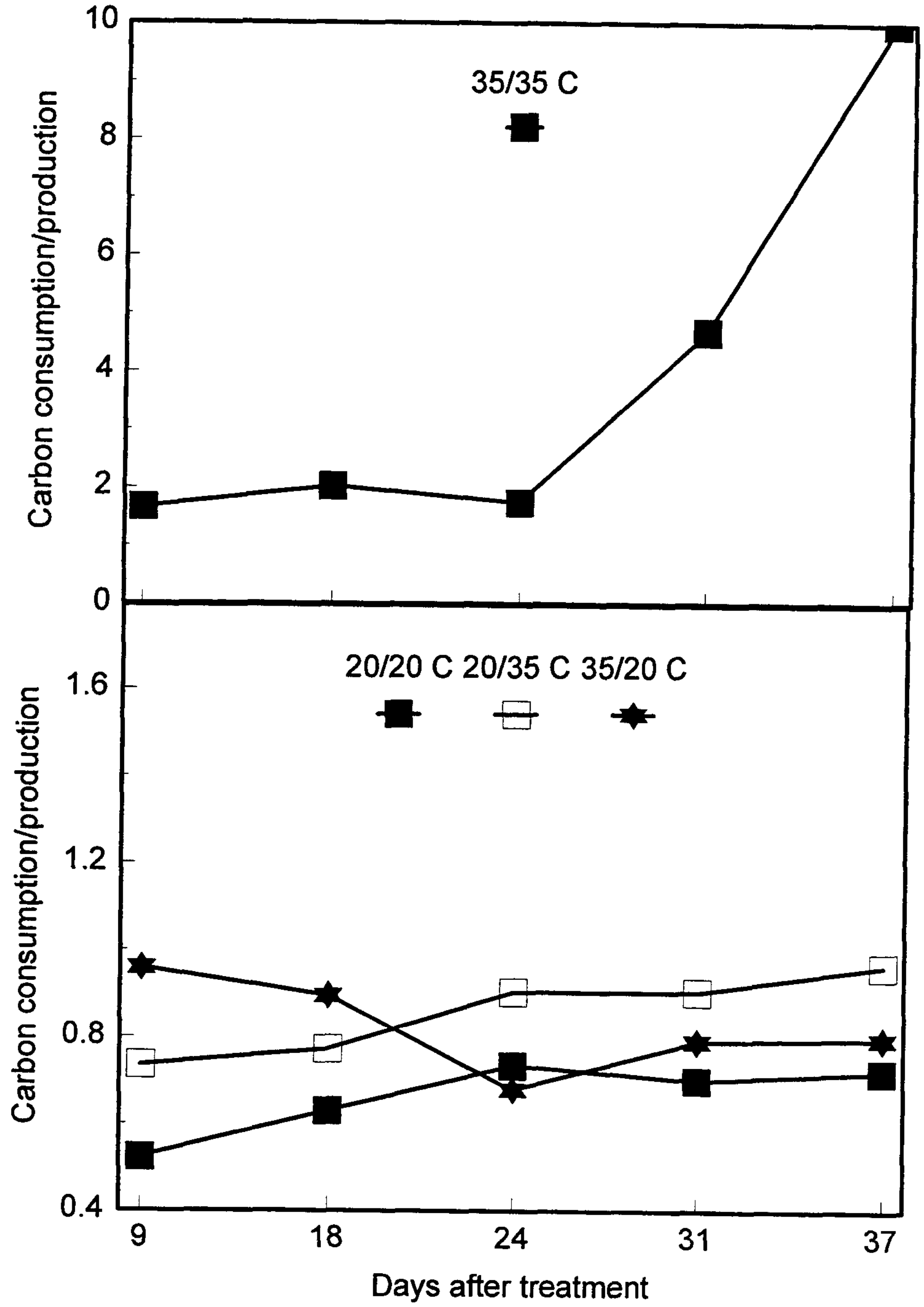


Figure 4. Effects of differential shoot/root temperatures on the balance beween carbon consumption and production for Penncross creeping bentgrass.

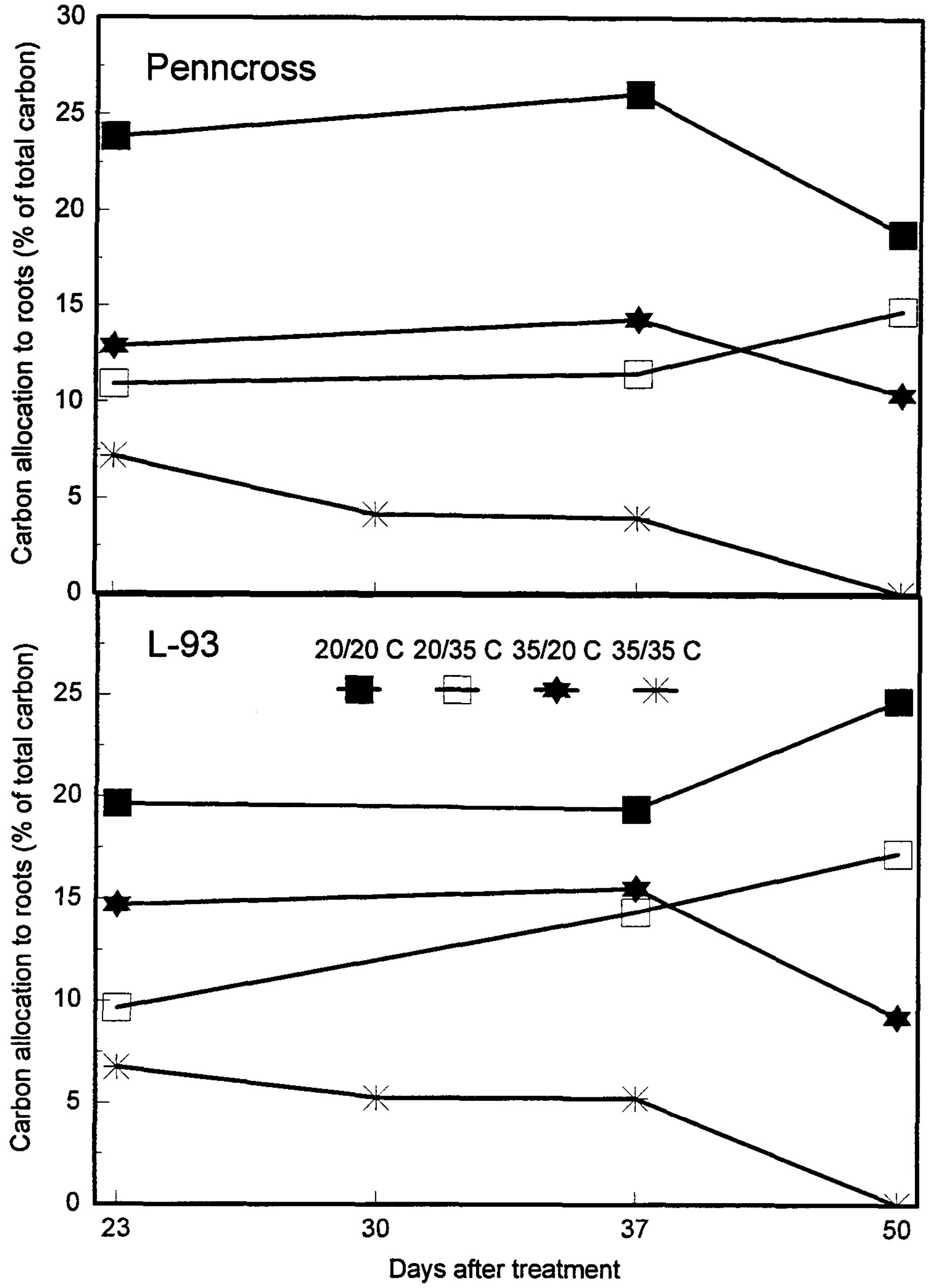


Figure 5. Effects of differential shoot/root temperatures on carbon allocation to roots in Penncross and L-93 creeping bentgrass.

TITLE: Differences in in Physiological Responses of Tall Fescue Cultivars to Drought Stress

OBJECTIVE: To evaluate variation in drought tolerance for tall fescue cultivars representing several generations of turfgrass improvement

PERSONNEL: Bingru Huang

SPONSORS: Kansas Turfgrass Foundation and Kansas Agricultural Experiment Station.

MATERIALS AND METHODS:

Six tall fescue cultivars were examined in this study. Kentucky-31 is a forage-type; Houndog V, Phoenix, and Falcon II are turf-types; and Rebel Jr and Bonsai are dwarf turf-types. Grasses were mowed weekly at 6 cm height and grown in well-watered or drying (nonirrigated) soil for 35 days in a greenhouse at Kansas State University. Photosynthetic efficiency, leaf water status, and root growth were evaluated during drought stress.

RESULTS:

Photosynthetic efficiencies of all six cultivars was similar during 15 d of drought stress. Thereafter, Falcon II, Houndog V, and Kentucky-31 had higher photosynthetic efficiency than Phoenix, Rebel Jr, and Bonsai (Fig. 1).

At 4, 9, 28, and 35 d after drought, Houndog V, Falcon II, Phoenix, and Kentucky-31 maintained higher leaf water content than Rebel Jr and Bonsai (Fig. 2).

Rebel Jr and Bonsai had relatively smaller root systems than other cultivars during drought (Fig. 3).

Drought resistance of dwarf turf-type cultivars Rebel Jr and Bonsai in general was inferior to that of the turf-types (Phoenix, Houndog V, and Falcon II) and the forage-type (Kentucky-31). Falcon II appeared to be more drought resistant than Phoenix but similar to Houndog V and Kentucky-31. High photosynthetic efficiency and water uptake capacity contributed to drought tolerance.

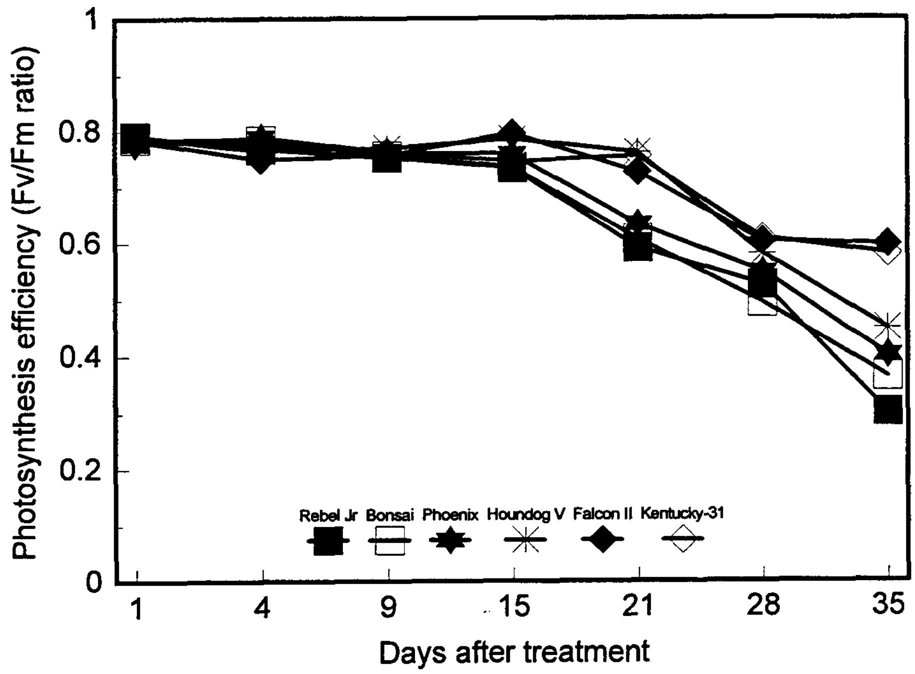


Figure 1. Photosynthetic efficiency of tall fescue cultivars during drought stress.

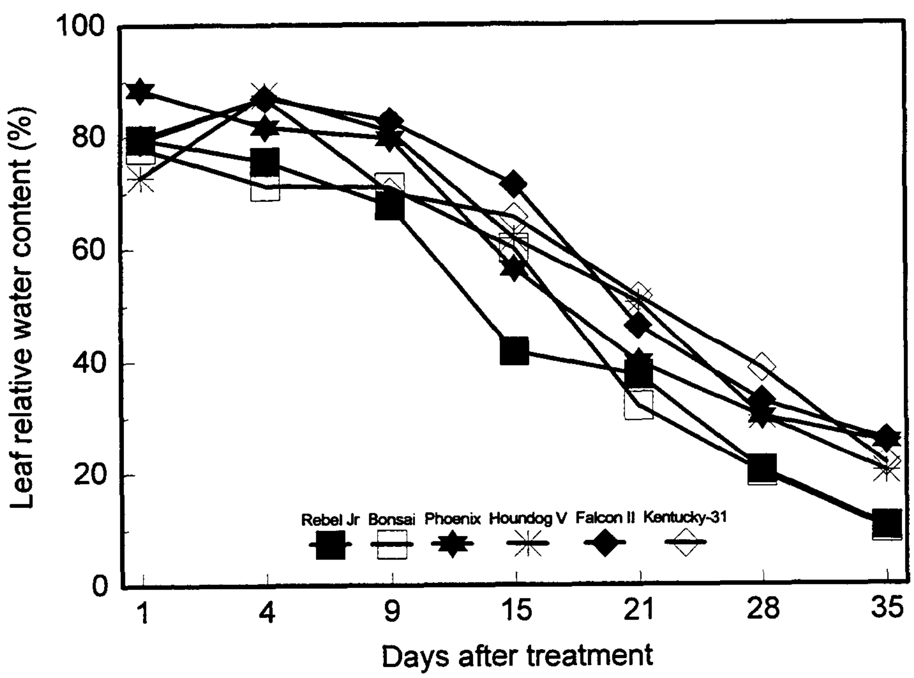


Figure 2. Leaf water content of tall fescue cultivars during drought stress.

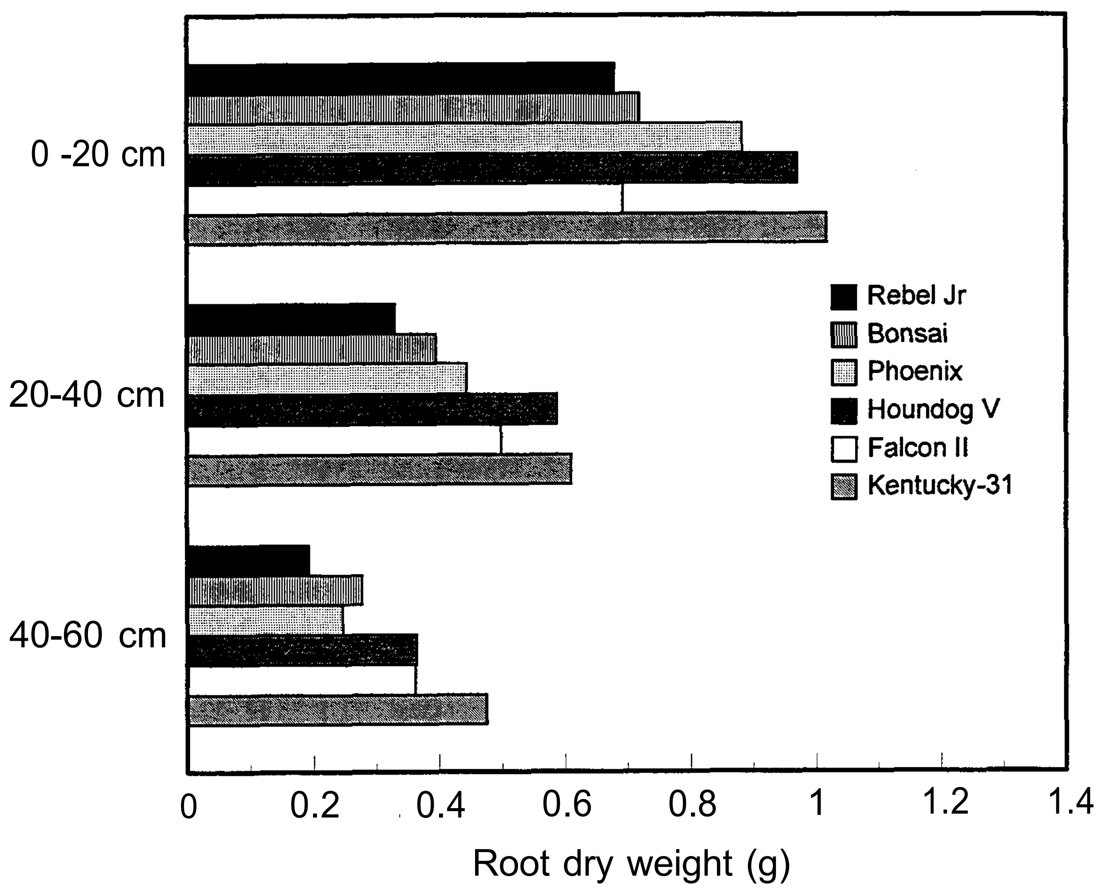


Figure 3. Root dry weight in different soil depths of tall fescue cultivars at 35 d of drought stress.

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Great American Turf (John Deere)
Great Plains Industries
Heart of America GC Supt. Assn.
Highlands Country Club
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ISK Biosciences
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Kansas Agricultural Experiment Stn.
Kansas Golf Course Supt. Assn.
Kansas Golf Association
Kansas Turfgrass Foundation
Manhattan Country Club
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Zeneca

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Note: Trade names are used to identify products. No endorsement is intended, nor is any criticism implied of similar products not mentioned.

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