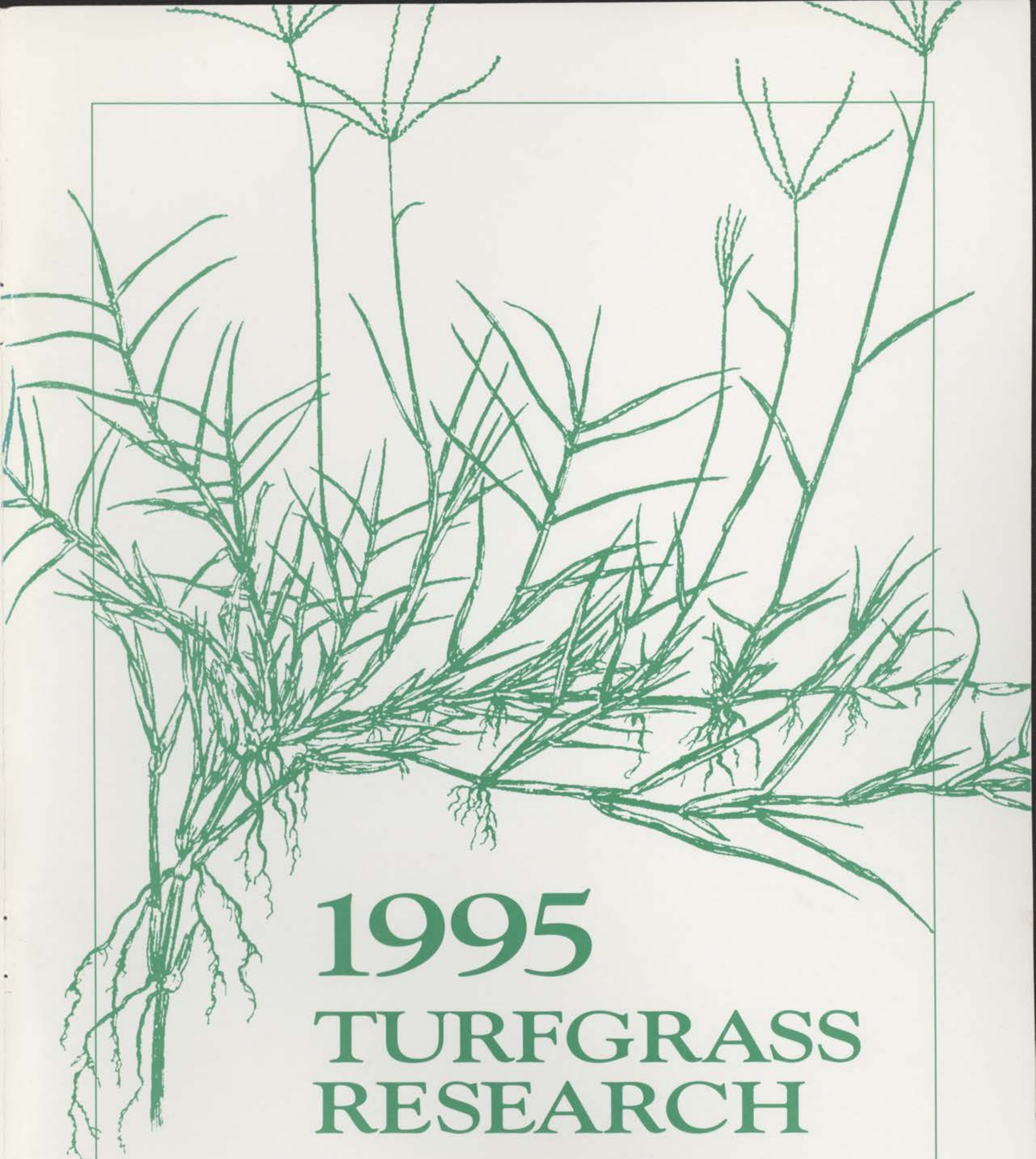

1995 TURFGRASS RESEARCH

Report of Progress 738

Agricultural Experiment Station, Kansas State University, Marc A. Johnson, Director

FOREWORD

Searching for the answers to commonly asked questions regarding turfgrass management in Kansas -- that's the focus of the turf researchers at K-State. Which creeping bentgrass or tall fescue variety will perform well in our harsh climate? Are there any new buffalo, zoysia, or bermuda varieties that will do well in Kansas? How much water does turf use in a growing season? What are the benefits of deep, infrequent irrigation? Which fungicides will provide the best disease control? Which herbicides are most effective in controlling weeds?

These are just a few of the questions for which answers are provided in the 1995 edition of the Turfgrass Research Report. Some studies were started recently, and preliminary results are presented. Others reflect several years of results and are winding down. A lot of effort goes into compiling this information -- take some time to review the results.

We have always known that turfgrass had tremendous value in Kansas, both environmentally and financially. In 1995, the monetary value of the turf industry in Kansas will be documented when the results of a comprehensive survey by the Kansas Agricultural Statistics are released this summer. Over $73,000 was required to complete this project, with contributions coming from the Kansas State Board of Agriculture, the Kansas Turfgrass Foundation, and several organizations representing the Kansas turf industry. To date, the contribution of turfgrass has been hard to estimate. With other commodities, it is relatively easy to count bushels and calculate profits. Determining the value of home lawns to the state is a much more difficult task. After the results are available, our worth relative to other agronomic and horticultural commodities will be established.

The studies outlined herein are expensive to conduct. Once again, the turf industry provided most of the funding for our work. Because so much time and energy goes into these projects, it is imperative that we conduct research that is valuable to you. Let us know if you have an idea. Sometimes we need help identifying the most important problems related to turfgrass management in Kansas. Your support is sincerely appreciated. We look forward to a prosperous 1995 research year.

The K-State Turf Group

Personnel Associated with the K-State Turfgrass Program

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TITLE: Biological and Genetic Diversity in *Ophiosphaerella herpotricha*, a Cause of Spring Dead Spot of Bermudagrass

OBJECTIVES: To investigate diversity in this fungus and to determine when it actively colonizes bermudagrass.

PERSONNEL: Kevin McCann and Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation, Heart of America Golf Course Superintendents Association

MATERIALS AND METHODS:

Research is being conducted on *Ophiosphaerella herpotricha*, a cause of spring dead spot of bermudagrass. This fungal disease can be serious in intensively managed bermudagrass, and effective chemical and cultural controls are not available.

To further investigate the biological and genetic diversity of the fungus, numerous plots at three golf course sites were sampled in May, 1994. Approximately 600 soil cores were taken. The roots were washed and plated on selective media. *O. herpotricha* cultures were grown in shake culture and freeze-dried. Currently, DNA is being extracted from the mycelium, and a series of test using the polymerase chain reaction (PCR) is being performed. DNA primers, used in the PCR, allow testing for the presence of the fungus on bermudagrass roots. Comparisons of the genetic relatedness of each fungal clone can be made through comparisons of the unique, DNA band patterns.

At the Wichita Horticulture Research Center, we are looking at growth of the fungus on bermudagrass roots throughout the year. Three distinct patches are sampled every month in a radial pattern (from the center of the patch extending beyond the symptomatic area). This sampling may show when the fungus is actively colonizing bermudagrass roots.

RESULTS:

Results in Wichita indicate that the fungus is found only in the symptomatic area. Cultures of the fungus from bermudagrass roots and PCR, which specifically amplifies the DNA of *O. herpotricha*, are providing information on the temporal and spatial growth of the fungus. Results to date indicate that each patch is caused by a single clone, that groups of patches tend to be clonal in nature, and that several clones are found at each site.

TITLE: Preventive Fall Fungicide Applications for Control of Yellow Patch on Creeping Bentgrass

OBJECTIVE: To determine whether fall fungicide applications will help suppress development of yellow patch disease of creeping bentgrass.

PERSONNEL: Ned Tisserat

SPONSORS: Heart of America Golf Course Superintendents Association, Ciba, Rhone-Poulenc, PBI Gordon, Miles, Hoechst-AgroEvo, Kansas Turfgrass Found.

MATERIALS AND METHODS:

Fungicides were applied to a creeping bentgrass ('Cohansey') putting green with a history of yellow patch at the Orchards golf course in Lawrence, Kansas. Applications were made on Nov 2, 1994 just as symptoms of yellow patch were developing. Fungicides were applied in 4 liters of water per 240 sq ft at 20 psi with flat fan nozzles using a CO_2 backpack sprayer. Treatment plots were 6 X 10 ft and replicated four times. The fungicides were not watered in after application. Disease severity ratings were made on Nov 15, 1995 and Mar 20, 1995.

RESULTS:

The winter of 1994-1995 was relatively mild, and yellow patch severity on the putting green was low to moderate. All fungicides suppressed yellow patch development 2 wks after application (Table 1). By Mar 20, all fungicides except Aliette plus Fore and Chipco 26019 continued to suppress yellow patch development. The Chipco 26019 application initially gave good control, but was not persistent in early spring. Application of Sentinel caused a slight discoloration of the turf during the winter months and slowed spring green-up. Results indicate that fungicide applications in fall will suppress yellow patch development.

Table 1. Effect of fall fungicide applications on yellow patch disease.

		% Plot Area Damaged		# Patches	
Treatment	Rate/1000 ft^2	15 Nov	20 Mar	15 Nov	20 Mar
No fungicide		13.8a[1]	25.5a	4.3a	5.0a
Aliette 80WP + Fore 80WP	4 + 8 oz	3.3b	16.3ab	1.3b	4.0a
Chipco 26019 50DG	4 oz	0b	6.8ab	0b	2.5ab
Banner 1.1EC	4 fl oz	4.3b	1.3b	1.0b	0.3b
Polyoxorim 2.2WP	4 oz	0.3b	0b	0.3b	0b
Polyoxorim 11.25WP	.8 oz	0.8b	1.8b	0.3b	0.5b
Prostar 70WG	1.4 oz	0.5b	0b	0.3b	0b
Prostar 70WG	2.8 oz	0.8b	0b	0.3b	0b
Lynx 25DF	1 oz	0.5b	0b	0.3b	0b
Bayleton 25DF	2 oz	2.0b	1.3b	0.8b	1.3b
Bayleton 25DF	4 oz	2.5b	0b	0.8b	0b
Sentinel 40WG	0.33 oz	1.0b	0b	0.8b	0b

[1]Means not followed by the same letter are significantly different (P = 0.05) by Fischer's Protected LSD test.

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

OBJECTIVE: To determine whether fall fungicide applications will help suppress development of large patch disease of zoysiagrass caused by *Rhizoctonia solani*.

PERSONNEL: Ned Tisserat

SPONSORS: Heart of America Golf Course Superintendents Association, Ciba, Rhone-Poulenc, PBI Gordon, Miles, Hoechst-AgrEvo,Kansas Turfgrass Foundation

MATERIALS AND METHODS:

Fungicides were applied to zoysiagrass ('Meyer') at the Alavamar golf course in Lawrence , Kansas. A single fungicide application was made on 20 Sept 1994 just as symptoms of large patch were developing. Fungicides were applied in 4 liters of water per 240 sq ft at 20 psi with flat fan nozzles using a CO_2 backpack sprayer. Treatment plots were 6 X 10 ft and replicated three times. The fungicides were not watered in after application. Disease severity ratings were made on 13 Oct, 1994 and 19 Apr, 1995.

RESULTS:

The fall of 1994 was relatively mild and dry. Large patch severity was low in all plots. Plots treated with Aliette plus Fore or Eagle had slightly higher levels of large patch; however, none of the fungicide-treated plots differed significantly from the nontreated plot in disease severity.

Zoysiagrass was very slow to break winter dormancy, and large patch severity in mid April was low. April ratings were taken just as the turfgrass was beginning new growth. The patches were not active (bordered by yellow margins) when ratings were taken, suggesting that most of the damage had occurred the previous fall. Disease development in plots was sporadic, leading to large within-treatment variations. Nevertheless, plots treated with Lynx (both rates), Pennstar, Bayleton at 4 oz,and Prostar at 2.8 oz had little or no disease . Plots treated with Banner and Polyoxorim (2.2 WP at 4 oz) also had low disease severity. In contrast, plots treated with either rate of Aliette plus Fore had a high level of large patch.

These results support the hypothesis that a single fungicide application in the fall will suppress large patch development through late fall and early spring. Plots will be monitored through May to determine how persistent the treatments will be.

Table 1. Preventive fungicide applications for control of large patch disease of zoysia

Treatment	Rate/1000 ft^2	% Plot Area Damaged 13 Oct	19 Apr
No fungicide	--	5.0[1]	25.5
Aliette 80 WP + Fore 80 WP	2 + 4 oz	8.3	43.3
Aliette 80WP + Fore 80WP	4 + 8 oz	5.0	43.6
Polyoxorim 11.25 DF	0.8 oz	5.0	20.0
Chipco 26019 50DG	4 oz	0.0	16.7
Eagle 40 WP	0.6 oz	11.7	10.0
Polyoxorim 2.2 WP	4 oz	1.7	5.7
Banner 1.1EC	4 fl. oz	0.0	5.0
Prostar 70WG	1.4 oz	0.0	5.0
Bayleton 25DF	2 oz	0.0	5.0
Prostar 70WG	2.8 oz	3.3	3.3
Pennstar 75 WP	8 oz	5.0	1.7
Lynx 25DF	1 oz	0.0	0.0
Lynx 25 DF	2 oz	5.0	0.0
Bayleton 25DF	4 oz	1.7	0.0
LSD (P=0.05)*		6.8	20.0

[1]A single fungicide application was made on 20 Sept 1994; ratings taken on 13 Oct 1994 and 19 Apr 1995.

*If the difference between the means of two treatments is larger than the LSD, they are significantly different.

TITLE: Control of Crabgrass in Cool-Season Turf with Preemergence Herbicides

OBJECTIVE: To determine the efficacy of various preemergence herbicides in a Kentucky bluegrass turf.

PERSONNEL: Ward Upham and Jack Fry

SPONSORS: Daru, Monsanto, and Sandoz Chemical Companies

MATERIALS AND METHODS:

A Kentucky bluegrass turf, located at the KSU Rocky Ford Turfgrass Research Center near Manhattan, KS, was used for this study. The experimental area had been overseeded for several years with crabgrass, resulting in a high level of infestation. Treatments were applied on 4/13/94, with second applications (where appropriate) on 6/8/94. Weather conditions were 65°F, sunny, and wind at 11 mph for the former date and 73°F, sunny, and wind at 7 mph for the latter date.

Liquid treatments were applied with a backpack CO_2 sprayer equipped with 8004 flat fan nozzles and calibrated to deliver 60 GPA (1.4 gal/1000 ft^2)at 35 psi. Granular treatments were hand applied with a shaker bottle.

Plot size was 1 x 2 meters, and the experimental design was a randomized complete block with four replications. Data were collected on percent of plot covered with crabgrass at 8, 12, and 16 WAT (weeks after treatment). Crabgrass had not appeared before 8 WAT and was fading out by 20 WAT. Phytotoxicity was rated at 1 and 2 WAT.

Data were subjected to analysis of variance, and means were separated using the Waller-Duncan Bayesian $\underline{k}$ ratio $\underline{t}$ test ($\underline{k}$ = 100, P = 0.05).

RESULTS:

Crabgrass Control: The 8 WAT (week after treatment) rating did not show any significant differences among treatments because of the paucity of crabgrass. The 12 WAT rating showed significant crabgrass control by each chemical but no significant differences among chemicals (Table 1). By 16 WAT, differences began to show among different herbicides.

Phytotoxicity to Seedling Ryegrass: On August 17th, the study area was sprayed with Round-up. A repeat application was made 2 weeks later to ensure total kill of existing turf. The area was scalped and then seeded with PHD perennial ryegrass on Sept 9 using an Olathe slit-seeder. Seedling emergence was rated on Sept 23. No significant phytotoxicity was caused by chemical carryover.

Table 1. Preemergence control of crabgrass with selected herbicides on a Kentucky bluegrass turf in Manhattan, KS - 1994.

Treatment	Rate (lbs ai/A)	Percent of Plot Covered with Crabgrass				Phytotoxicity to Seedling Turf
		8 WAT	12 WAT	16 WAT	18 WAT	
Team/Fert 1.15G	1.5 (2 apps)	0.3	0.8	4.3	8.3	9.0
Team/Fert 1.15G	2.0	0.0	1.8	13.8	32.5	9.0
Team/Fert 1.15G	3.0	0.0	0.8	7.0	13.8	8.5
Ronstar 2G	3.0	0.3	3.0	12.0	13.8	8.5
Ronstar 50WP	3.0	0.3	2.0	6.3	6.3	8.5
Dimension 1EC	0.5	0.0	2.5	7.0	7.5	9.0
Dimension 1EC	0.25 (2 apps)	0.0	0.0	0.3	1.3	9.0
Dimension 0.072G	0.25	0.3	2.0	5.0	5.8	8.5
Dimension 0.072G	0.13 (2 apps)	0.3	1.3	3.8	5.0	9.0
Barricade 65WDG	0.5	0.0	3.5	14.5	20.0	9.0
Barricade 65WDG	0.65	0.3	2.3	10.8	16.3	9.0
Barricade 65WDG	0.75	0.0	0.3	2.8	4.5	8.5
Pendimethalin 60WP	1.5 (2 apps)	0.8	2.0	8.8	8.8	8.7
Check	--------	3.3	30.0	60.0	73.7	8.7
MSD*	--------	NS	10.9	13.8	17.2	NS

*If the difference between the means of two treatments is larger than the MSD, they are significantly different.

TITLE: Control of Crabgrass in Cool-Season Turf with Preemergence Herbicides Applied at Nontraditional Times

OBJECTIVE: Determine the efficacy of various preemergence herbicides applied at nontraditional times in a tall fescue turf.

PERSONNEL: Ward Upham and Jack Fry

SPONSORS: Sandoz, Monsanto

MATERIALS AND METHODS:

A tall fescue turf, located at the KSU Rocky Ford Turfgrass Research Center near Manhattan, KS, was used for this study. Herbicides, treatment dates, and application rates are given in Table 1.

Treatments were applied with a backpack CO_2 sprayer equipped with 8004 flat fan nozzles and calibrated to deliver 60 GPA (1.4 gal/1000 ft^2) at 35 psi. Plot size was 1 x 2 meters, and the experimental design was a randomized complete block with three replications.

Plots were examined for crabgrass starting in May, 1994. Crabgrass was rated by making a visual estimation of the percent of plot covered with crabgrass. Crabgrass did not begin to invade until July, with plots being rated on 7/15, 7/29, and 8/12 of 1994.

Data were subjected to analysis of variance, and means were separated using the Waller-Duncan Bayesian $\underline{k}$ ratio $\underline{t}$ test ($\underline{k} = 100$, $P = 0.05$).

RESULTS:

On all three rating dates, the control plots and the Sept application of Pre-M plots had significantly more crabgrass than all other treatments. However, no differences were noted *between* the Control and the Sept Pre-M plots. No significant differences occurred among the remaining treatments for any date except for the March application of Pre-M, which proved to be less effective for the 7/29 rating date only.

Table 1. Percent crabgrass control with various preemergence herbicides applied at non-traditional times at Manhattan, KS - 1994.

Treatment*	Rate (lbs ai/A)	Date of Application	Crabgrass Control**		
			July 15	July 29	August 15
1: Check	----	----	2.3	8.7	16.7
2: Barricade	0.49	Sept. 28	0.0	0.0	0.0
3: Barricade	0.65	Sept. 28	0.0	0.0	0.3
4: Barricade	0.75	Sept. 28	0.0	0.0	0.0
5: Pre-M	1.5	Sept. 28	2.0	7.0	11.7
6: Dimension	0.38	Sept. 28	0.0	0.3	1.3
7: Barricade	0.49	October 25	0.0	0.0	0.0
8: Barricade	0.65	October 25	0.0	0.0	0.0
9: Barricade	0.75	October 25	0.3	0.0	0.0
10: Barricade	0.49	March 1	0.0	0.0	0.0
11: Barricade	0.65	March 1	0.0	0.0	0.0
12: Pre-M	1.5	March 1	0.7	3.7	5.0
13: Dimension	0.38	March 1	0.0	0.0	0.3
14: Barricade	0.49	April 1	0.0	0.0	0.0
15: Barricade	0.65	April 1	0.0	0.3	0.0
16: Pre-M	1.5	April 1	0.0	0.3	1.7
17: Dimension	0.38	April 1	0.0	0.0	0.0
MSD***			1.3	2.6	6.3

* Rating a visual estimate of the percent of plot covered with crabgrass.

** Check = no herbicide applied

*** MSD = minimum significant difference

TITLE: Postemergence Control of Crabgrass in Cool-Season Turf with Dimension Herbicide

OBJECTIVE: To determine the efficacy of Dimension as a postemergence herbicide for the control of immature crabgrass in a perennial ryegrass turf.

PERSONNEL: Ward Upham and Jack Fry

SPONSOR: Monsanto

MATERIALS AND METHODS:

A perennial ryegrass turf, located at the KSU Rocky Ford Turfgrass Research Center near Manhattan, KS, was used for this study. Herbicides and application rates are given in Table 1.

Liquid treatments were applied with a backpack CO_2 sprayer equipped with 8004 flat fan nozzles and calibrated to deliver 60 GPA (1.4 gal/1000 ft^2) at 35 psi. The granular treatment was hand applied with a shaker bottle, with each plot receiving three coatings by using three different patterns (north-south, east-west, and diagonal) to ensure uniformity. Plot size was 1 x 2 meters, and the experimental design was a randomized complete block with four replications.

Treatments were applied to a mature perennial ryegrass turf maintained at 3/4 in. Crabgrass at the time of spraying (7/12/94) was at the 1- to 4-leaf stage. Conditions at the time of application were 85°F, sunny, and wind approximately 6 mph. A very light application of irrigation water was made on 7/13/94 to help activate the granular Dimension.

Data were subjected to analysis of variance, and means were separated using the Waller-Duncan Bayesian k ratio t test (k = 100, P = 0.05).

RESULTS:

Phytotoxicity: No significant phytotoxicity was observed for any rating date.

Crabgrass Control:

14 DAT (days after treatment): Dimension G and Acclaim provided significant control of crabgrass. Dimension EC appeared to be slower acting and did not significantly reduce crabgrass populations this soon after herbicide application. However, no significant differences occurred among chemical treatments.

30 and 60 DAT: Each chemical treatment was significantly better than the Check, but no differences occurred among treatments for either rating date.

Table 1. Postemergence crabgrass control with Dimension at Manhattan, KS - 1994.

Treatment	Rate (lbs ai/A)	Number of Crabgrass Plants per Plot		
		14 DAT*	30 DAT	60 DAT
1: Check**	----	22.7	21.3	13.0
2:Dimension EC	0.63	8.0	2.3	1.5
3: Dimension G	0.38	4.8	4.3	5.0
4: Acclaim EC	0.18	1.8	1.5	1.0
MSD***	-----	15.4	13.8	4.6

* DAT = Days after Treatment

** Check = no herbicide applied

*** MSD = minimum significant difference

TITLE: Suppression of Bermudagrass in Cool-Season Turf with Turflon Ester and Acclaim

OBJECTIVE: To determine the efficacy of Turflon Ester and Acclaim for the suppression of bermudagrass in a perennial ryegrass turf.

PERSONNEL: Ward Upham and Jack Fry

SPONSOR: Dow Chemical Company

MATERIALS AND METHODS:

A perennial ryegrass turf, located at the KSU Rocky Ford Turfgrass Research Center near Manhattan, KS, was used for this study. Two 'Midfield' bermudagrass plugs were placed in each 1 by 2 meter ryegrass plot on 6/10/94. Plugs were 4 in. in diameter and were taken by using a cup cutter.

Treatments were started 2 wks after plug insertion and repeated every 4 wks until a total of four treatments had been applied. Treatment dates were 6/24, 7/22, 8/19, and 9/16. Applications were made with a backpack CO_2 sprayer equipped with 8004 flat fan nozzles and calibrated to deliver 60 GPA (1.4 gal/1000 ft^2) at 35 psi.

Plot size was 1 x 2 meters, and the experimental design was a randomized complete block with four replications. Data were collected on area covered by measuring the maximum North-South and East-West coverage of each plug. Areas of the two plugs in each plot were then averaged and this average compared to the initial average size of the same two plugs. Initial size measurements were taken on 6/24 immediatly before the first treatment. Subsequent ratings were taken at 2, 4, 6, 8, 10, 12, and 14 WAT (weeks after treatment). Phytotoxicity ratings of the bermudagrass plugs were also taken on these same rating dates, if any differences were discernible among treatments.

Data were subjected to analysis of variance, and means were separated using the Waller-Duncan Bayesian k ratio t test (k = 100, P = 0.05).

RESULTS:

Phytotoxicity: Ratings taken 2 wks after a treatment (i.e., ratings taken at 2, 6, 10, and 14 wks after the initial treatment) showed more damage than those ratings taken 4 wks after a treatment (4, 8, and 12 wks after the initial treatment) (Table 1). The first group will be called the 2WAT group and the second the 4WAT group.

All ratings taken for the 2WAT group showed every chemical treatment causing significant damage to the bermudagrass. The Acclaim + Turflon Ester treatment caused significantly more damage to the bermuda than any other treatment on the 2, 6, and 14 WAT rating periods.

Ratings taken for the dates in the 4WAT group showed significant recovery of color from each treatment date.

Area: The Acclaim + Turflon Ester treatment resulted in a decrease in area for every rating date except for 4 WAT. Both the Acclaim and the Turflon Ester treatments caused a significant reduction in the spread of the bermuda as compared to the control plot but did not actually reduce the size of the area infested as compared to the size of the initial infestation.

Obviously, repeat treatments are needed to suppress bermuda. The Acclaim + Turflon Ester treatment caused such extensive damage that the bermuda appeared close to death by the end of September.

Table 1. Phytotoxicity* on bermudagrass with Turflon Ester and Acclaim at Manhattan, KS - 1994.

Treatment	Rate (lbs ai/A)	2 WAT**	4 WAT	6 WAT	10 WAT	14 WAT
Control	-----	9.0	8.5	9.0	9.0	9.0
Turflon Ester	1.00	5.5	7.5	5.0	6.5	5.2
Acclaim	0.38	5.5	7.3	3.5	6.0	4.0
Turflon Ester + Acclaim	0.38 1.00	4.0	4.5	2.5	3.7	2.0
MSD**	-----	1.0	1.9	0.8	2.2	1.0

* Phytotoxicity ratings on a 0 to 9 scale with 9 = no damage and 0 =completely brown. There was no discernible phytotoxicity at 8 and 12 WAT.
** WAT = Weeks after Treatment
*** MSD = Minimum Significant Difference

Table 2. Percent increase in area covered by bermudagrass plugs treated with Turflon Ester and Acclaim at Manhattan, KS - 1994*.

Treatment	Rate (lbs ai/A)	2 WAT**	6 WAT	8 WAT	10 WAT	12 WAT	14 WAT
Control	-----	61.7	627.1	703.4	893.1	1215.8	1170.7
Turflon Ester	1.00	20.3	139.6	195.4	111	156.3	54.6
Acclaim	0.38	-10.2***	87.4	51.6	11.9	29.1	13.1
Turflon Ester + Acclaim	0.38 1.00	-19.8	-18	-42.5	-77.5	-53.8	-78.5
MSD****	-----	29.4	134.5	158	187.7	828.1	698.1

* No significant differences occurred among treatments for the 4 WAT period.
** WAT = Weeks after Treatment
*** Negative numbers indicate a decrease in the size of the area covered by bermudagrass.
**** MSD = Minimum Significant Difference

TITLE: Drought and Salinity Tolerances of Buffalograsses, Bermudagrass, and Zoysiagrass

OBJECTIVES: 1) To etermine the relative tolerances to drought and salinity of the three basic types of buffalograsses (diploid, tetraploid, and hexaploid) and compare them to locally adapted bermudagrass ('Midlawn') and zoysiagrass ('Meyer'); 2) If differences are found, to determine why or what mechanisms the tolerant grasses use to survive. This may help in management and in development of new, more tolerant turfgrasses.

PERSONNEL: Ken Marcum and Hongfei Jiang

INTRODUCTION:

Drought stress is one of the most important problems facing turfgrass managers in Kansas and in other water-short regions. Salinity or water quality problems are also important throughout the western U.S. and in certain areas of Kansas. However, knowledge is limited concerning the relative tolerances to these stresses among the important warm-season turfgrasses of Kansas. Also, little is known about how turfgrasses tolerate drought or salinity.

MATERIALS AND METHODS:

'Midlawn' bermudagrass; 'Meyer' zoysiagrass; and 'Buffalawn', 'Prairie', and 'AZ143' buffalograsses were compared for drought and salinity tolerance in these experiments. The three buffalograsses represented the three basic genetic types: diploid, tetraploid, and hexaploid, respectively. Grasses were grown hydroponically in a greenhouse. This was done to reduce interferences of other environmental factors. Other factors, such as soil water content, temperature, and diseases, can interact with and affect relative drought and salinity tolerance.

Salinity stress was achieved by slowly increasing the salt (NaCl) level of the growth solutions, and drought stress by slowly increasing high-molecular-weight polyethylene glycol (PEG). PEG creates drought stress by reducing the availability of water to the roots.

Drought and salinity injury was recorded as the percent of leaf firing, relative to green, healthy leaf, at five levels of stress: 0, 0.4, 0.8, 1.2, and 1.5 MPa osmotic potential (equal to 86, 173, 260, and 326 mM NaCl, or 0, 7.5, 14, 21, and 27 dS m^{-1}). This would be equivalent to mild, moderate, severe, and very severe stresses, respectively.

A number of adaptive responses to stress were measured, to shed light on how turfgrasses survive these stresses. These included root growth, plant osmotic adjustment, leaf sodium and potassium concentrations, relative water content, leaf salt secretion, and leaf glycinebetaine concentration.

RESULTS:

Turf quality decreased (percent leaf firing increased) with increasing drought and salinity stress (Figures 1 & 2). Under severe drought stress, the most tolerant grasses were Meyer zoysia, followed by Midlawn bermuda. The buffalograsses were less tolerant to drought, with AZ143 being the most and Buffalawn the least tolerant. Under severe salinity stress, the same trend was evident. Meyer and Midlawn were most tolerant, with the buffalograsses much less so. Under salinity, the order of tolerance in the buffalograsses was reversed, i.e., Buffalawn was most tolerant and AZ143 was least.

Total root weight was measured at the end of the experiment and compared between plants under no stress and plants under severe stress (Table 1). For the three buffalograsses, root weight did not change under drought stress, but decreased under salinity stress, relative to the control. In bermudagrass, root growth increased under drought stress, but did not change under salinity stress, relative to the control. Root growth did not change with stress in zoysiagrass. An increase in rooting under stress may be an adaptation mechanism to improve efficiency of plant water uptake.

All grasses adjusted osmotically under both drought and salinity stress (Figure 3). As drought or salinity stress increases, the osmotic potential of a soil decreases. In turn, the plant must lower its osmotic potential in step with that of the soil (osmotic adjustment) in order for water uptake to occur. Under drought stress, bermudagrass osmotically adjusted to a higher level than the other grasses.

Sodium (Na^+), a main constituent of salt, is toxic to plants. Under salinity stress, plants must control Na^+ uptake to prevent toxicity. AZ143, the most salt-sensitive grass, accumulated Na^+ to a high level under severe salinity stress (Figure 4).

Some salt-tolerant plants are known to have leaf salt glands, which secrete excess sodium and other salts out of the leaf to prevent toxicity. Salt glands have been reported to occur in bermudagrass and zoysiagrass. Evidence also was found for Na^+ secretion in Buffalawn buffalograss (Table 2). Though not statistically significant, there appeared to be a trend toward Na^+ secretion in the other buffalograsses.

In summary, the grasses studied reacted similarly to drought and salinity stress. The most tolerant grasses were Midlawn bermudagrass and Meyer zoysiagrass. Buffalograsses were more sensitive, with Buffalawn being most tolerant to salinity, and AZ143 being most tolerant to drought. Tolerance to salinity was related to Na^+ exclusion/secretion by salt glands.

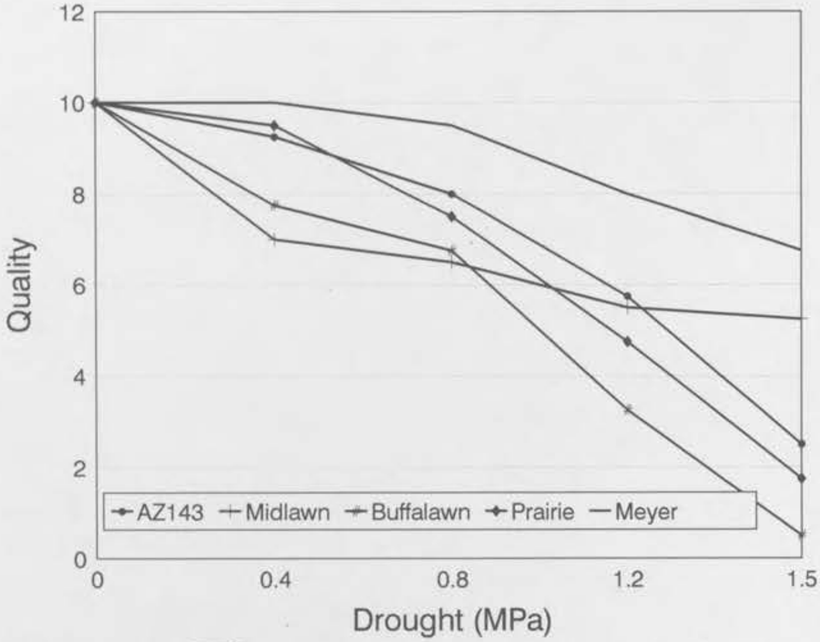

Figure 1. Turf quality under drought stress (1 = dead, 10 = total green).

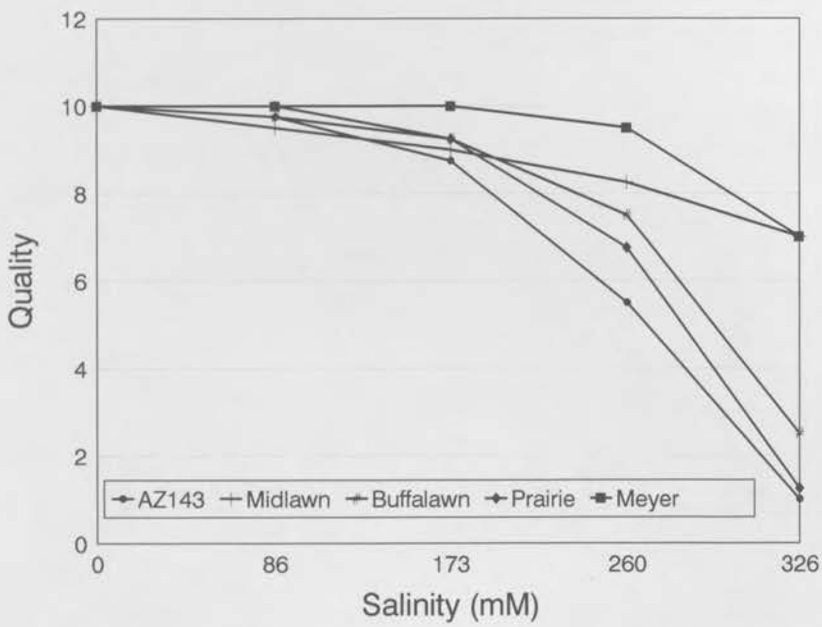

Figure 2. Turf quality under salinity stress (1 = dead; 10 = total green).

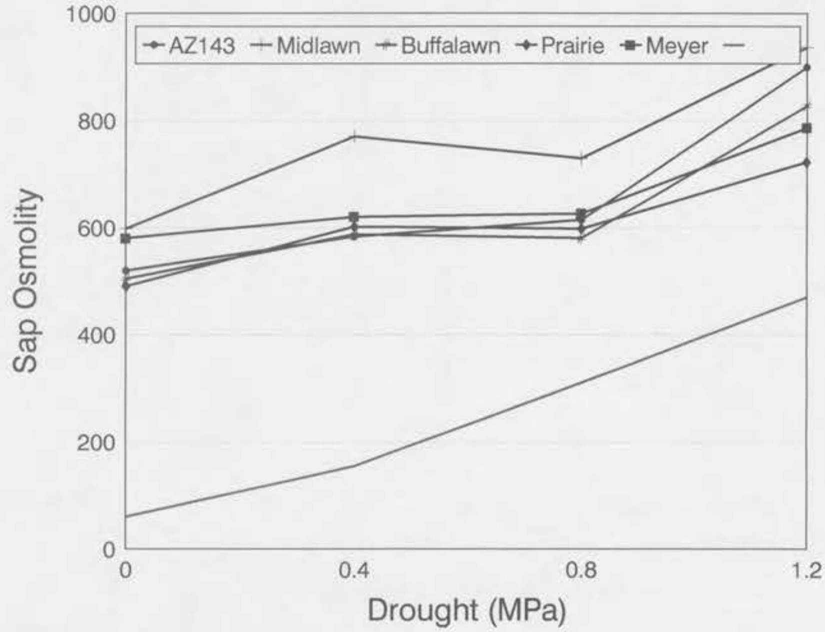

Figure 3. Osmotic adjustment under drought stress.

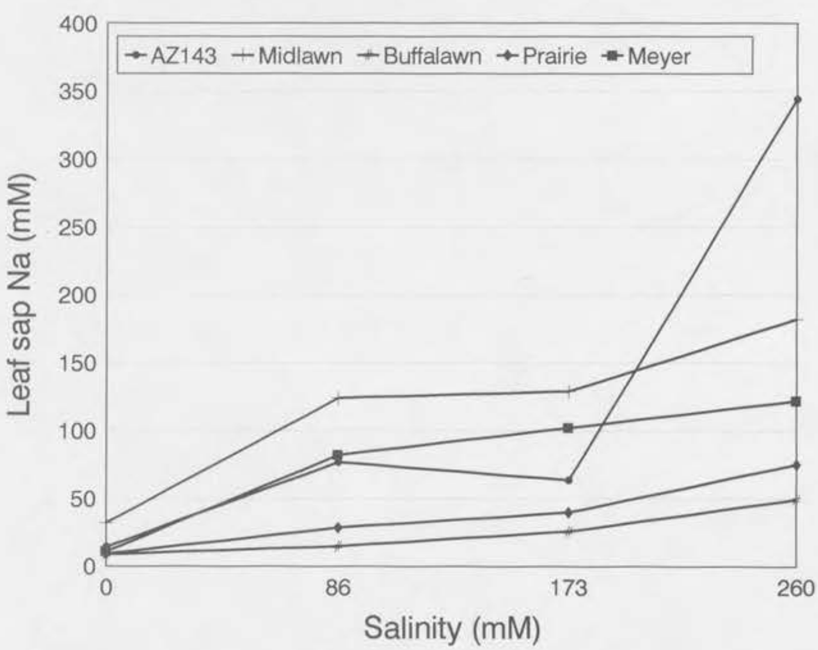

Figure 4. Leaf sodium (Na) under salinity stress.

Table 1. Total root weight (gm) without stress, under drought stress (1.2 Mpa), and under salt stress (260mM salinity).

Grass	Control	Drought	Salinity
Buffalawn	0.82 a[1]	0.71 ab	0.41c
Prairie	0.76 ab	0.92 a	0.52 b
AZ143	1.02 a	1.30 a	0.46 b
Midlawn	0.26 b	0.75 a	0.44 b
Meyer	0.65 a	0.75 a	0.46 a

[1]Means followed by a different letter are significatnly different at the 5% level of probability.

Table 2. Leaf sodium and potassium (mM g^{1} leaf dry weight) secretion under salinity stress.

Grass	Potassium	Sodium
Buffalawn	9.0	67.8*
Prairie	2.5 .	10.5
AZ143	13.7*[1]	29.1
Midlawn	9.1	67.1*
Meyer	5.7	76.1*

[1]Asterisks denote significance at the 5% level of probablity for secretion of ions.

TITLE: Drought Avoidance and Tolerance of Turfgrasses in Kansas

OBJECTIVES: To determine the evapotranspiration (ET) rates, rooting characteristics, and drought tolerance of buffalograss, bermudagrass, zoysiagrass, and tall fescue.

PERSONNEL: Yaling Qian and Jack Fry

SPONSORS: City of Wichita, Kansas Water Resources Research Institute, Kansas Golf Course Superintendents Association

INTRODUCTION:

Drought resistance has two components, avoidance and tolerance. Turfgrasses may avoid drought by developing a deep root system to tap water deep in the soil or by possessing morphological and physiological features that reduce evapotranspiration (ET). Plants exhibiting drought tolerance can tolerate exposure to low levels of available soil water. Information is needed on ET rates, rooting characteristics, and drought tolerance of warm-season turfgrasses commonly used in Kansas.

MATERIALS AND METHODS:

Study 1 - ET Measurements: Actual ET of 'Prairie' buffalograss, 'Midlawn' bermudagrass, 'Meyer' zoysiagrass, and 'Mustang' tall fescue was measured using weighing lysimeters filled with fritted clay. Lysimeters were set in sleeves in 20 x 20 ft turf plots arranged in a randomized complete block design with three replications. Three warm-season turfgrasses were maintained at a height of 1.75 in. and tall fescue at 2.5 in. Lysimeters were weighed at 0800 hrs on 62 days during the summers in 1993 and 1994.

Study 2 - Determination of Rooting: 'Midlawn' bermudagrass, 'Prairie' buffalograss, 'Meyer' zoysiagrass, and 'Mustang' tall fescue were established in 1992 at the Rocky Ford Turfgrass Research Center in 20 x 20 ft plots and arranged in randomized complete block design with four replications. Root distribution was determined by sampling cores from field plots in Aug 1993 and 1994. Three cores were removed from each turf plot. After roots were washed, total root length and root length density (RLD) at 0-12, 12-24, and 24-36 in. were determined.

Study 3 - Determination of Drought Tolerance: The previously described turf species were well established in 8 in.-diameter by 10-in. deep PVC containers filled with field silt loam soil. A liquid quick-release fertilizer was applied at a rate of 1 lb N/1000 ft^2. Turf was mowed as in study 1, and watered to prevent drought. After 4 mos. of optimum growing conditions, soil was watered to saturation and drained to field capacity. The bottom of each container was sealed, and a drought period began. Every 3-4 days, data were collected on ET, soil moisture content, and turf quality. When soil water content reached about 8%, soil was returned to field capacity. Grasses were rated on their percent recovery 4 to 8 wks after rewatering.

RESULTS:

Study 1 - Mean daily ET of tall fescue was highest, whereas bermudagrass and buffalograss exhibited the lowest ET. Zoysiagrass had an intermediate daily ET.

Study 2 - The highest RLD for all species was observed at the 0 to 12-in. depth (Table 2). In 1993, of roots sampled to a 36-in. depth, 36% were located in the surface 12-in. for tall fescue, bermudagrass, and buffalograss, whereas 47% of the total roots for zoysiagrass were observed between 0 to 12 in. At the 12- to 24-in. depth, RLD of zoysiagrass was lower than that of all other grasses. At 24 to 36 in., RLD of tall fescue was higher than that of other warm-season grasses, and RLD of bermudagrass was higher than that of zoysiagrass.

In 1994, 65% of the roots were located at 0 to 12 in. for tall fescue and bermudagrass, 55% for buffalograss, and 78% for zoysiagrass (Table 2). At 12 to 24 in., tall fescue and buffalograss had more roots than bermudagrass and zoysiagrass. At 24 to 36 in., RLD of tall fescue was higher than that of the three warm-season grasses, and RLD of bermudagrass and buffalograss was higher than that of zoysiagrass.

Study 3 - Because tall fescue had a relatively high ET rate, soil moisture content dropped more quickly with that species than with other warm-season grasses. After 25 days of drought, soil moisture decreased to about 8%. Nearly 45 days passed before soil moisture content under warm-season grasses reached 8%. Regression analysis of turf quality on soil moisture content showed that quality was not affected until the soil moisture content reached a critical point. Critical soil moisture levels were 16% for buffalograss, 19% for bermudagrass, 21% for zoysiagrass, and 20% for tall fescue. All species were brown and dormant when the soil moisture reached 8%. Two weeks after rewatering, buffalograss showed the highest recovery rate, followed by zoysiagrass and bermudagrass (Table 3). Tall fescue exhibited the lowest recovery rate.

CONCLUSION:

Among the four grasses studied, tall fescue had the highest ET rate and least ability to tolerate low soil moisture content. However, tall fescue possessed the most extensive root system and a great ability to absorb water deep in the soil. Zoysiagrass had an intermediate ET rate and drought tolerance and the shallowest roots. Therefore, the drought resistance of zoysiagrass was inferior to that of the other grasses. Buffalograss and bermudagrass had low ET rates, relatively deep roots, and excellent drought tolerance characteristics.

Table 1. Evapotranspiration (ET) of four turfgrasses at Manhattan, KS.

Species	Mowing Height (in)	1993 ET (in/day)* Mean	1993 ET (in/day)* Range	1994 ET (in/day)** Mean	1994 ET (in/day)** Range
Tall fescue	2.5	0.26 a***	0.15 - 0.40	0.27 a***	0.05 - 0.47
Zoysiagrass	1.75	0.24 b	0.13 - 0.34	0.22 b	0.04 - 0.31
Buffalograss	1.75	0.20 c	0.10 - 0.24	0.20 c	0.04 - 0.29
Bermudagrass	1.75	0.19 c	0.09 - 0.26	0.20 c	0.04 - 0.30

*ET was measured on 23 dates between 10 June and 2 Sept, 1993.
**ET was measured on 39 dates between 1 June and 20 Aug, 1994.
***Means not followed by the same letter in a column are significantly different.

Table 2. Root length density and total root length of four field-grown turfgrass species at Manhattan, KS.

		1993				1994			
		Root Length Density (in/in^3)				Root Length Density (in/in^3)			
	Mowing	Depth (in)			Total Root	Depth (in)			Total Root
Species	Ht. (in)	0-12	12-24	24-36	Length (in)	0-12	12-24	24-36	Length (in.)
Tall fescue	2.5	0.56 a*	0.31 a	0.33 a	283 a	1.80	0.53 a	0.42 a	659 a
Bermudagrass	1.75	0.42 b	0.25 a	0.19 b	204 b	0.74	0.20 b	0.19 b	271 b
Buffalograss	1.75	0.42 b	0.28 a	0.16 bc	202 b	0.84	0.47 a	0.22 b	364 b
Zoysiagrass	1.75	0.42 b	0.17 b	0.09 c	165 b	1.09	0.20 b	0.11 c	333 b

*Means not followed by the same letter in a column are significantly different

Table 3. Recovery of four pot-grown turfgrasses after severe drought in the greenhouse.

Species	Recovery (%) 4 Weeks after Rewatering	Recovery (%) 8 Weeks after Rewatering
Tall fescue	2.5 c*	10 d
Zoysiagrass	12.5 b	30 c
Bermudagrass	8 bc	50 b
Buffalograss	5 a	80 a

*Means not followed by the same letter in a column are significantly different

TITLE: Field Performance of Warm-Season Turfgrasses under Deficit Irrigation

OBJECTIVE: To evaluate turf response to deficit irrigation in the field.

PERSONNEL: Yaling Qian and Jack Fry

SPONSORS: City of Wichita, Kansas Water Resources Research Institute, Kansas Golf Course Superintendent's Association, Heart of America Golf Course Superintendent's Association

INTRODUCTION:

Deficit irrigation refers to water applied to turf in amounts less than the potential evapotranspiration (ET). Turfgrass species differ markedly in their response to reduced irrigation. Research is needed to compare the responses of field-grown warm-season turfgrasses and tall fescue to deficit irrigation in Kansas.

MATERIALS AND METHODS:

The study site was at the Rocky Ford Turfgrass Research Center in Manhattan. 'Mustang' tall fescue, 'Prairie' buffalograss, 'Midlawn' bermudagrass, and 'Meyer' zoysiagrass were established in 20 x 20 ft plots in 1992. Warm-season grasses were mowed twice weekly at 1.75 in. and tall fescue was mowed at 2.5 in. weekly. Three 3.3 x 3.3 ft subplots in each plot received weekly irrigation at 0, 50, or 100% of Penman-Monteith estimated ET from June to Aug 31 in 1994. Turf quality was rated weekly on a 0 to 9 scale with 9 = optimum. Leaf wilt symptoms were rated weekly on a 0 to 9 scale, with 0 = total leaf firing and 9 = no drought symptoms.

RESULTS:

No drought occurred in June and July because of periodic precipitation. From Aug 4 to 24, drought was observed. Turf quality and wilt scores at the end of this period are summarized in Tables 1 and 2. Without watering, zoysiagrass was the first to show wilt, followed by tall fescue and bermudagrass. Zoysiagrass leaf-firing was significant, and its quality declined to 2.8. Bermudagrass and tall fescue did not maintain acceptable turf quality because of the drought symptoms. Buffalograss did not wilt, and turf quality was acceptable without irrigation. When irrigated at 50% of estimated ET, zoysiagrass did not maintain acceptable quality, but bermudagrass and tall fescue did.

Table 1. Mean visual turf quality (9 = best) after a 3-week drought during summer, 1994.

Grass	Irrigation Level 100%	50%	0%
Buffalograss	6.8 b*	6.6 b	6.0 a
Bermudagrass	7.2 ab	7.4 a	5.6 a
Tall fescue	8.0 a	7.8 a	5.3 a
Zoysiagrass	8.0 a	4.5 c	2.4 b

*Means not followed by the same letter in a column are significantly different.

Table 2. Mean wilt score (9 = best) after a 3-week drought during summer, 1994.

Grass	Irrigation Level 100%	50%	0%
Buffalograss	8.6 a*	8.6 a	8.1 a
Bermudagrass	7.6 b	7.3 b	5.9 b
Tall fescue	8.1 a	7.4 b	5.4 b
Zoysiagrass	8.0 ab	4.5 c	2.5 c

*Means not followed by the same letter in a column are significantly different.

TITLE: Estimation of Turfgrass Evapotranspiration (ET) Using Atmometers and an Empirical Model

OBJECTIVES: To compare actual turf ET to ET estimated from atmometers and an empirical model.

PERSONNEL: Yaling Qian, Jack Fry, Steve Wiest, and Ward Upham

SPONSORS: City of Wichita, Kansas Water Resources Research Institute, Kansas Golf Course Superintendents Association

INTRODUCTION:

Weather stations commonly accompany the installation of new irrigation systems. An empirical model usually is included that will provide a daily estimate of turf ET. Information is needed on the accuracy of these ET models and other ET estimators for irrigation guidance in Kansas.

MATERIALS AND METHODS:

Actual ET of 'Prairie' buffalograss, 'Midlawn' bermudagrass, 'Meyer' zoysiagrass, and 'Mustang' tall fescue was measured using weighing lysimeters filled with fritted clay. Lysimeters were set in sleeves in 20 x 20 ft turf plots arranged in randomized complete block design with three replications. The three warm-season turfgrasses were maintained at a height of 1.75 in.and tall fescue at 2.5 in. Lysimeters were weighed at 0800 hrs on 4 days weekly during the summers of 1993 and 1994. An evaporation pan and Bellani plates (4) were installed near the experimental area. Water loss from these atmometers was measured at the same time that actual ET was determined. Climatological data were recorded at a weather station adjacent to the experimental area, so that ET could be estimated using a Penman-Monteith empirical model.

RESULTS:

Black Bellani plate evaporation was correlated most closely with measured turf ET ($R^2 = 0.61$ to 0.87), followed by class A pan evaporation ($R^2 = 0.51$ to 0.79), and Penman-Monteith-estimated ET ($R^2 = 0.35$ to 069) (Figs. 1 to 4).

Turfgrass ET estimates are derived from atmometers and empirical models under the assumption that water is not limiting. However, turf ET declines nonlinearly with time since the last irrigation lengthens. Hence, ET estimates provided by atmometers or empirical models should be used as an additional tool that the landscape manager integrates with knowledge of soil characteristics, cultural practices, etc. in determining irrigation need. Our results suggest that in a humid environment, such as that of eastern Kansas, better estimates of turfgrass ET are provided by atmometers such as the Bellani plate and class A pan than the Penman-Monteith model. However, use of any of these tools to guide turf irrigation will provide better results than irrigation by intuition or on a set schedule, as is often practiced.

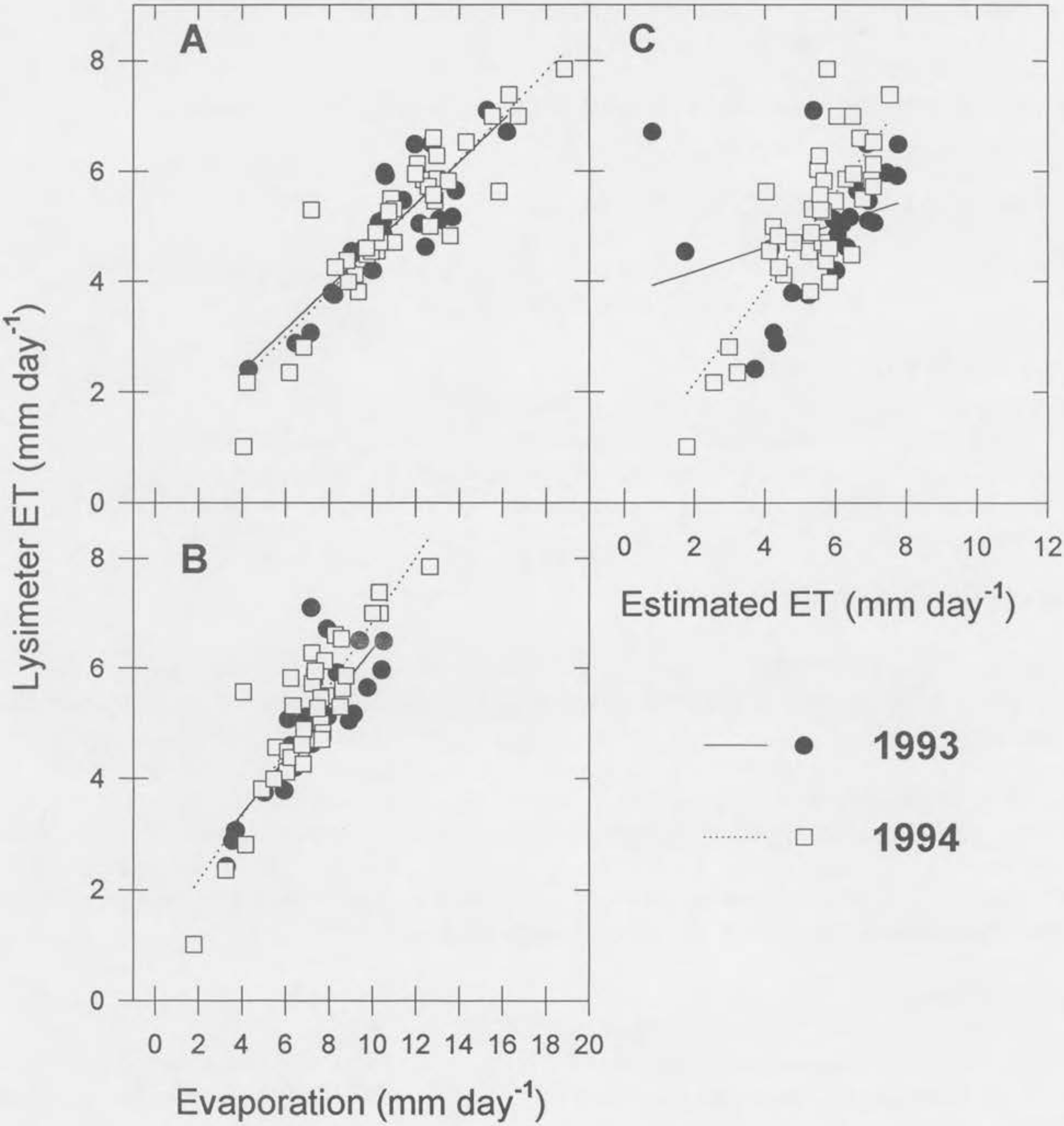

Fig. 1. Bermudagrass lysimeter ET vs.: (A) Bellani plate evaporation (1993, y = 0.88 + 0.38x, R^2 = 0.76; 1994, y = 0.64 + 0.39x, R^2= 0.87); (B) class A pan evaporation (1993, y = 1.34 + 0.5x, R^2 = 0.68; 1994, y = 1.05 + 0.58 x, R^2 = 0.78); and (C) Penman-Monteith-estimated ET (1993, y = 1.81 + 0.54x, R^2 = 0.42; 1994, y = 0.47 + 0.86x, R^2 = 0.63).

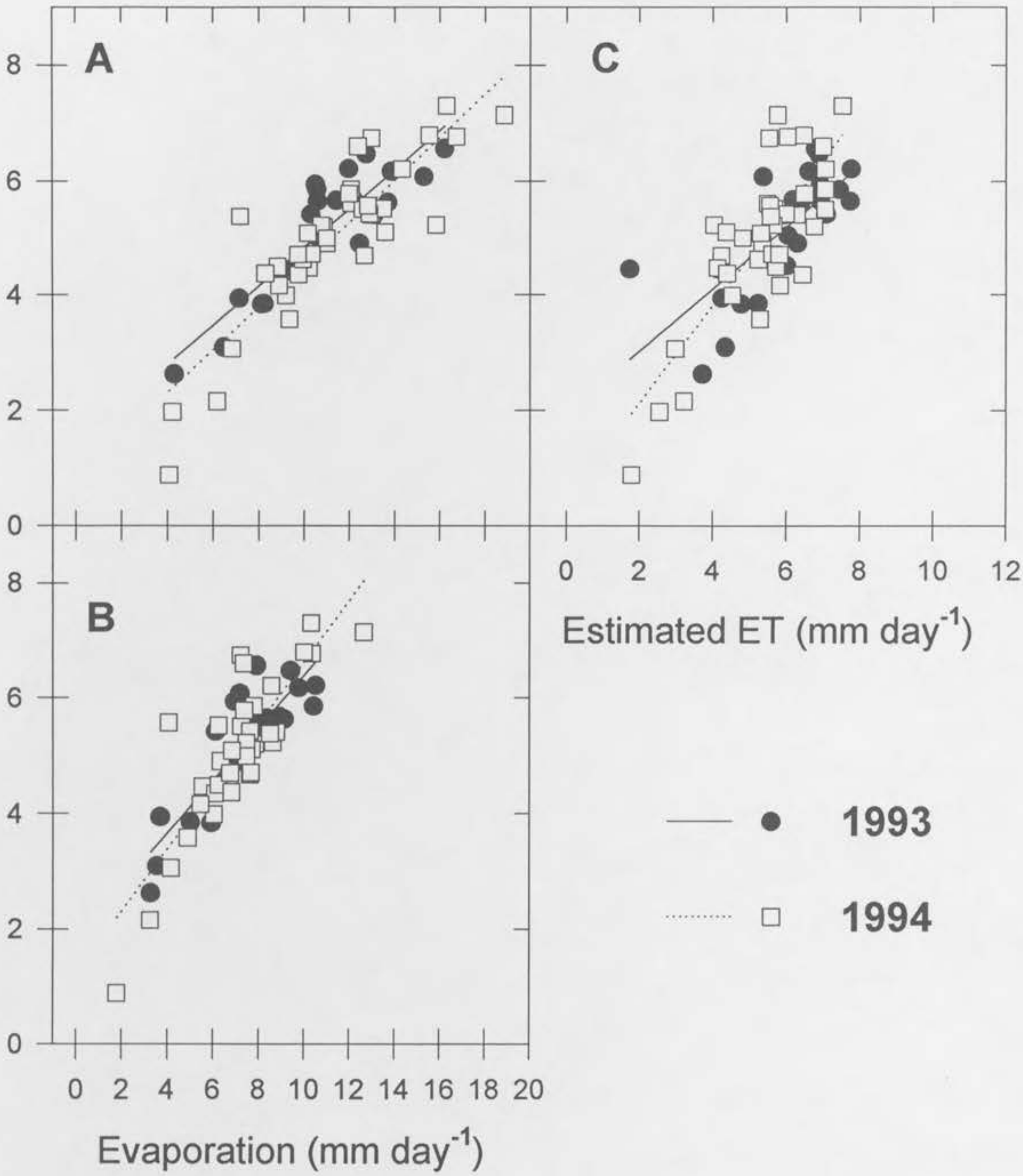

Fig. 2. Buffalograss lysimeter ET vs.: (A) Bellani plate evaporation (1993, y = 0.87 + 0.38x, R^2 = 0.80; 1994, y = 0.79 + 0.37x, R^2 = 0.83); (B) class A pan evaporation (1993, y = 1.84 + 0.46x, R^2 = 0.72; 1994, y = 1.22 + 0.54x, R^2 = 0.76); and (C) Penman-Monteith-estimated ET (1993, y = 1.95 + 0.54x, R^2 = 0.54; 1994, y = 0.43 + 0.85x, R^2 = 0.66).

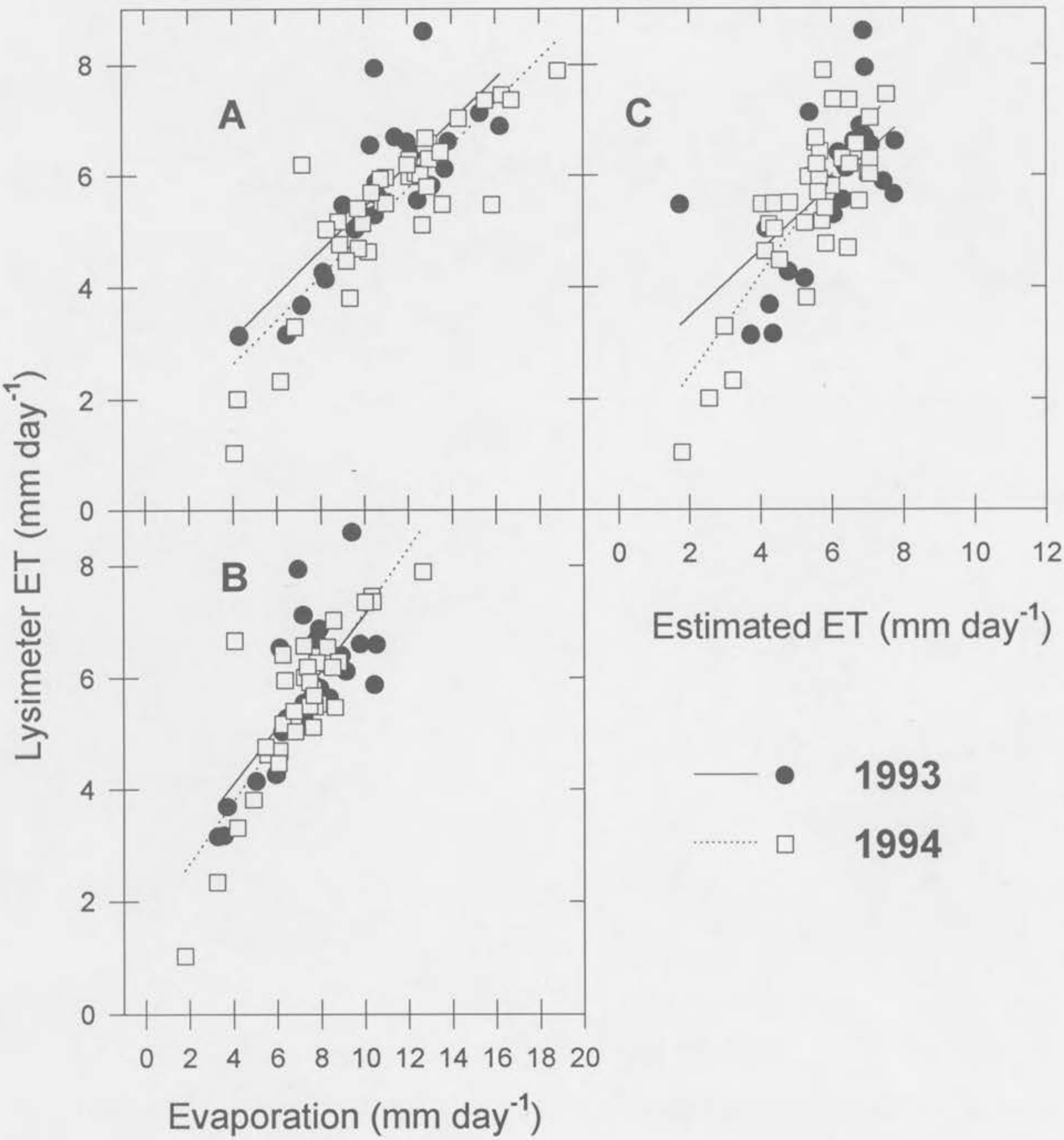

Fig. 3. Zoysiagrass lysimeter ET vs.: (A) Bellani plate evaporation (1993, y = 1.54 + 0.39x, R^2 = 0.61; 1994, y = 1.08 + 0.39x, R^2 = 0.75): (B) class A pan evaporation (1993, y = 2.08 + 0.51x, R^2 = 0.55; 1994, y = 1.52 + 0.57x, R^2 = 0.71); and (C) Penman-Monteith-estimated ET (1993, y = 2.31 + 0.62x, R^2 = 0.39; 1994, y = 0.64 + 0.89x, R^2 = 0.65).

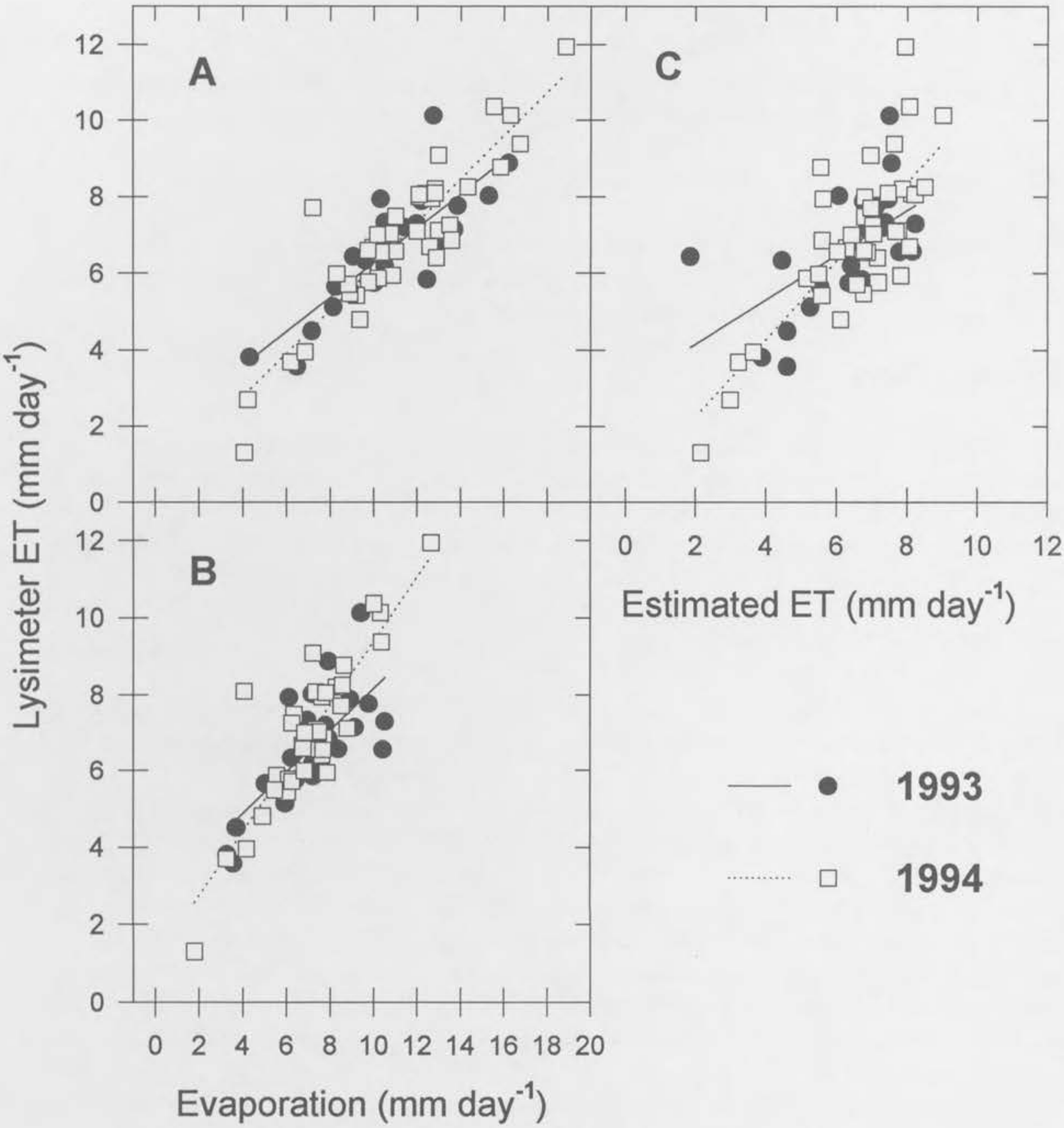

Fig. 4. Tall fescue lysimeter ET vs.: (A) Bellani plate evaporation (1993, y = 1.32 + 0.50x, R^2 = 0.69; 1994, y = 0.50 + 0.57x, R^2 = 0.87); (B) Class A pan evaporation (1993, y = 2.56 + 0.58x; R^2 = 0.54; 1994, y = 1.07 + 0.82x, R^2 = 0.79) and (C) Penman-Monteith-estimated ET (1993, y = 2.96 + 0.59 x, R^2 = 0.35; 1994, y = 0.20 + 1.02x, R^2 = 0.69).

TITLE: Effect of Irrigation Frequency on the Drought Resistance of 'Meyer' Zoysiagrass

OBJECTIVE: To determine the effect of irrigation frequency on zoysiagrass rooting and turf performance during a subsequent drought.

PERSONNEL: Yaling Qian and Jack Fry

SPONSORS: City of Wichita, Kansas Water Resources Research Institute, Heart of America Golf Course Superintendents Association, Professional Grounds Management Society of Kansas City

INTRODUCTION:

Recommendations for turf irrigation traditionally have been to water deeply and infrequently to encourage deep rooting and create a drought-tolerant plant. However, with the increasing competition for water resources, more frequent irrigation with less water has been recommended by some practitioners. Limited research has been done to address the effects of irrigation frequency on turfgrass rooting and response to a subsequent drought.

MATERIALS AND METHODS:

The study was done in 1993 and repeated in 1994. 'Meyer' zoysiagrass was sodded on a loam soil retained in 12 PVC containers measuring 36-in. deep and 10-in. in diameter. A field loam soil was packed firmly to provide a 2.2 ft^3 in each container.

Before irrigation treatments began, grasses in all containers were watered daily until roots reached a 7- to 8-in. depth. One lb N/1000 ft^2 from a soluble fertilizer was applied. After roots reached that depth, turf in six of the containers was watered daily and that in the other six was watered at the first indication of leaf rolling. Irrigation was applied to equal cumulative daily evapotranspiration, which was determined by weighing three well-watered minilysimeters maintained under the same conditions and adjacent to the 12 containers. All containers received the same amount of water. Irrigation treatments continued for 3 mos. During this period, turf was mowed weekly at 2 in. with clippings collected. Data were collected weekly on turf quality and vertical growth rate.

After about 3 months of irrigation treatments, turf in all containers was subjected to a dry-down period. On the day that irrigation ceased, leaf osmotic potential at full turgor was measured with a vapor pressure osmometer to compare effects of two irrigation treatments during the previous 3 months on osmotic adjustment.

During the dry-down period, weekly data were collected on turf quality and growth rate, leaf water potential, and volumetric soil moisture content. To allow determination of volumetric soil moisture content at different depths by time domain reflectometry (TDR), holes to accommodate TDR probes were drilled in the side of PVC containers at 6, 12, 20, and 28 in. depths. Two 6-in. or 9-in.-long stainless steel rods were installed horizontally at each depth. After 55 days of drought, turf was rewatered, and recovery was rated 1 wk later.

RESULTS:

During the irrigation period, irrigation treatment had no effect on turf quality (Table 1). Frequently irrigated zoysia exhibited a 25% to 40% faster growth rate than infrequently irrigated turf. During dry-down, quality of zoysiagrass that had been irrigated frequently declined more rapidly than that of infrequently watered turf. After 55 days without water, mean quality of turf that had been watered infrequently was 5.3 to 5.7, whereas that of turf watered frequently was 4.0 to 4.1. During dry-down, infrequently irrigated turf exhibited a faster growth rate than frequently irrigated turf.

One to 4 days after the drought period began, leaf water potential of turf irrigated infrequently was lower than that of frequently watered turf because of osmotic adjustment during the previous 3 mos (Fig. 1). At 31 to 41 days without water, leaf water potential was higher in turf that had been watered infrequently, suggesting that the turf was under less stress.

After 53 days without irrigation, soil at 20- and 28-inch depths under previously infrequently-irrigated turf showed lower volumetric water content than soil under previously frequently-irrigated turf (Table 2). Infrequent irrigation had encouraged deep rooting that resulted in drier soil at these depths.

Clearly, infrequent irrigation promotes zoysiagrass rooting and aids in the development of a plant more physiologically prepared for oncoming drought.

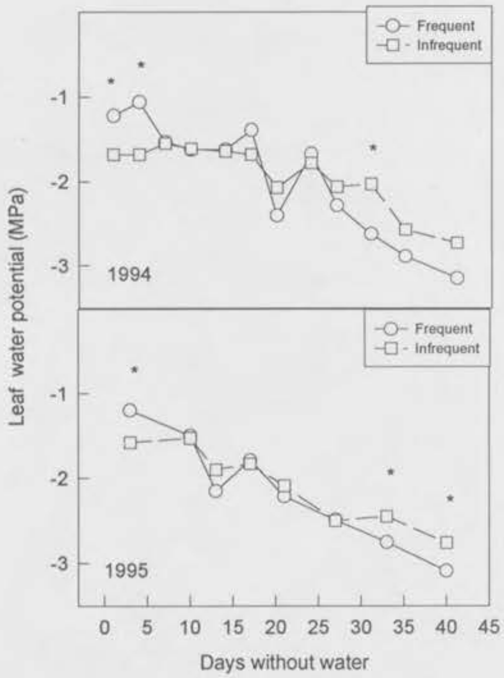

Figure 1. Influence of prestress irrigation on zoysiagrass leaf water potential during a dry-down. * denotes significant treatment difference ($P < 0.05$).

Table 1. Quality and growth rate of 'Meyer' zoysiagrass during and subsequent to irrigation treatment, leaf osmotic potential during irrigation, and recovery after drought.

		During Irrigation			During Drought		During Recovery
		Mean Quality	Weekly Growth	Osmotic** Potential at Full Turgor	Quality***	Weekly Growth**	Quality
Irrigation		(9 = best)	(cm)	(bar)	(9 = best)	(cm)	(9 = best)
1994	Frequent	8.9	5.0 a	---	4.0 b	---	5.0 b
	Infrequent	8.8	4.0 b	---	5.3 a	---	6.2 a
1995	Frequent	8.8	4.8 a	12.2	4.1 b	3.7 b	5.0 b
	Infrequent	8.8	3.4 b	15.1	5.7 a	5.0 a	6.5 a

*In 1994, the irrigation treatment lasted for 92 days. In 1995, the irrigation lasted for 103 days.

**Only 1995 data available.

***Quality during first 3 weeks of dry-down.

****Means not followed by the same letter in a column are significantly different.

Table 2. Soil moisture content (%) at the end of 53 days of drought after irrigation of zoysiagrass daily (frequent) or at leaf roll (infrequent) for 3 months.

	1994		1995	
Depth (in)	Frequent	Infrequent	Frequent	Infrequent
0-6	9.3	9.6	10.1	10.4
12	12.7	12.4	11.9	12.4
20	16.9	14.7	21.4	19.0*
28	18.7	15.1*	21.8	19.6*

*Means in a row significantly different.

TITLE: Plant Growth Regulator Effects on Water Use of Tall Fescue

OBJECTIVE: To determine the effects of plant growth regulators on turfgrass drought avoidance mechanisms, rooting depth and density, and evapotranspiration (water use).

PERSONNEL: Hongfei Jiang and Ken Marcum

SPONSORS: Kansas Turfgrass Foundation, Ciba-Geigy

INTRODUCTION:

Water is often a limiting factor in turfgrass maintenance across the country, especially as competition for limited water resources increases. Therefore, it is important to develop new management strategies to reduce turfgrass water use and increase drought tolerance. Besides reducing the expense of mowing by reducing growth rate, plant growth regulators may be able to reduce water use as well.

MATERIALS AND METHODS:

Tall fescue 'Kentucky 31' was grown in weighing lysimeters filled with fritted clay evenly mixed with 10 g kg^{-1} slow release Osmocote fertilizer (17-6-10). Grasses were grown until densely established prior to application of plant growth regulators.

Plant growth regulators used in this experiment were: Embark (mefluidide, PBI Gordon); Ethrel (ethephon, Rhone-Poulenc); Primo (trinexapac-ethyl, Ciba-Geigy); TGR (paclobutrazol, O.M. Scott & Sons, Inc.); and Cyto-gro (cytokinin, Clifford Sales and Marketing). They were applied once at the manufacturer's recommended rates.

Water use was measured over a 58-day period following treatment, using the water balance method. Lysimeters were brought up to field capacity, weighed, and reweighed following a growth period to measure water loss.

RESULTS:

Water use of tall fescue was reduced significantly by Embark, Ethrel, and Primo within 4 days after application (Table 1). Thereafter, water use of tall fescue treated with Embark, Ethrel, and Primo were significantly lower than that of the control on 11, 12, and 7 measurement dates, respectively. Cyto-gro and TGR did not significantly affect water use on any date. Embark, Ethrel, and Primo show promise in reducing water use of tall fescue. However, Ethrel severely reduced rooting depth and density of tall fescue in previous experiments. Deep rooting is an important drought-tolerance trait, allowing plants to mine water from deep in the soil profile during water shortages. However, Embark and Primo had minimal effect on roots and should be better candidates for reducing water use in turfgrass.

Table 1. Effects of plant growth regulators on tall fescue water use (ET).

Days after Applic.	Control	Cytogro	TGR	Embark	Ethrel	Primo
3	3.00	3.00	3.12	3.01	2.63	2.77
4	3.70	3.72	3.43	2.97*	3.06*	2.89*
5	2.00	2.05	2.13	1.83	1.74	1.85
6	3.29	3.25	3.05	2.42*	2.54*	2.37*
7	3.58	3.58	3.61	2.90	2.75	2.79
8	3.04	3.11	3.04	2.85	2.54	2.58
9	3.72	3.66	3.56	3.24	2.87*	2.83*
11	6.48	6.68	6.36	5.36	5.00*	5.00*
14	9.10	9.63	8.97	7.83	6.94*	6.89*
19	9.34	9.64	9.47	8.19	6.87*	7.44
21	4.41	4.66	4.48	5.20	3.37	3.56
34	5.05	5.30	5.38	3.85*	4.55	4.94
36	6.04	6.25	6.30	4.33*	5.03*	5.45
39	5.51	5.76	5.47	3.92*	4.61	4.98
42	10.28	10.53	10.26	6.81*	8.21*	8.31*
44	7.94	8.42	8.54	5.68*	6.51*	7.66
47	5.59	5.94	5.84	4.12*	4.92	5.64
50	6.61	7.04	6.80	4.89*	5.97*	5.97*
52	5.29	5.28	5.63	3.97*	4.61*	5.01
54	5.32	5.35	4.88	4.04*	4.42*	4.88
58	7.38	7.37	7.35	5.46*	6.19*	6.56*
Mean	5.72	5.90	5.76	4.58*	4.65*	4.88*

* ET of treatment was significantly (P=0.05) lower than that of control, according to Fischer's LSD.

TITLE: Safety of Preemergence Herbicides Applied in the Buffalograss Seedbed

OBJECTIVE: To screen 15 preemergence herbicides for damage to buffalograss and weed control efficacy when applied in the seedbed.

PERSONNEL: Jack Fry
R. Gaussoin, R. Masters, and D. Beran, Univ. of Nebraska

MATERIALS AND METHODS:

One study was done at the Rocky Ford Turfgrass Research Center in Manhattan, KS, and two studies were done at the Univ. of Nebraska Turfgrass Research Center in Mead, NE in 1994. Weed pressure was light in Kansas and moderate to severe in Nebraska. At all sites, buffalograss was seeded at 1.5 lbs/1,000 ft^2. Herbicides listed in tables were applied over burrs within 2 days of planting. Irrigation was applied to maintain a moist seedbed. Plots were rated for buffalograss coverage, seedling number and vigor, and buffalograss and weed coverage as described in table footnotes.

RESULTS:

Herbicides that did not reduce buffalograss seedling number, vigor, or coverage compared to untreated turf were imazethapyr (0.06 lb/A) and simazine (1.0 lb/A) (Tables 1 to 3). Imazameth (0.06 lb/A kg/ha) reduced buffalograss coverage compared to untreated plots 6 and 10 weeks after germination (WAG) in Kansas, but enhanced coverage in Nebraska. Pronamide (1.0 lb/A) reduced buffalograss coverage at 6 WAG in Kansas, but coverage was equivalent to that of untreated plots by 10 WAG, and no other deleterious effects were observed. Imazethapyr provided 72% and imazameth 86% annual grass control in Nebraska. Simazine and pronamide provided < 34% annual grass control. All aforementioned herbicides except pronamide provided excellent control of broadleaf weeds. Imazethapyr enhanced buffalograss coverage by 63% over weed-infested, untreated plots at 10 WAG in Nebraska.

Table 1. Effects of 15 preemergence herbicides on buffalograss seedling number and vigor 2 weeks after germination (WAG) at Manhattan, KS and Mead, NE in 1994.

Herbicide	Rate	Seedlings KS	Seedlings NE1	Seedlings NE2	Seedling Vigor*
	lb/A	----------------no./m^2------------------			
Imazethapyr (Pursuit)	0.06	216	100	97	7.4
Imazameth (Cadre)	0.06	165	70	62	3.8
DCPA (Dacthal)	10.5	12	8	1	2.2
Simazine (Princep)	1.0	156	68	46	5.1
Pronamide (Kerb)	1.0	94	42	42	5.0
Dithiopyr (Dimension)	0.5	9	2	2	1.5
Prodiamine (Barricade)	0.75	50	12	1	2.5
Pendimethalin (Pre-M)	2.0	0	14	12	2.5
Bensulide (Presan)	7.5	70	10	20	4.3
Siduron (Tupersan)	12.0	0	13	28	2.0
Oxadiazon (Ronstar)	2.0	68	39	41	3.9
Benefin (65%)+ trifluralin (35%) (Team)	2.0	103	24	42	4.1
Oryzalin (Surflan)	1.5	1	0	13	0.3
Benefin (50%) + oryzaline (50%) (XL)	2.0	27	6	3	1.6
Untreated	---	163	42	80	5.9
MSD**		74	74	74	1.6

*Seedling vigor represents mean over all locations. Vigor was rated visually on a 0 to 9 scale, where 0 = dead plants and 9 = most vigorous.

*If the difference between the means of two treatments in a column is larger than the MSD, they are significantly different.

Table 2. Effects of 15 preemergence herbicides on buffalograss coverage 6 and 10 WAG at Manhattan, KS and Mead, NE in 1994.

		Buffalograss Coverage (%)*					
		6 WAG			10 WAG		
Herbicide	Rate	KS	NE1	NE2	KS	NE1	NE2
	lb/A	%					
Imazethapyr (Pursuit)	0.06	45	53	48	95	64	70
Imazameth (Cadre)	0.06	10	40	9	46	54	16
DCPA (Dacthal)	10.5	10	3	1	63	6	3
Simazine (Princep)	1.0	36	20	29	93	22	43
Pronamide (Kerb)	1.0	25	6	15	80	9	30
Dithiopyr (Dimension)	0.5	1	1	0	5	2	0
Prodiamine (Barricade)	0.75	12	2	0	59	3	0
Pendimethalin (Pre-M)	2.0	1	4	1	5	11	1
Bensulide (Presan)	7.5	12	4	7	54	7	10
Siduron (Tupersan)	12.0	1	2	8	18	4	16
Oxadiazon (Ronstar)	2.0	18	7	10	89	9	23
Benefin (65%) + trifluralin (35%) (Team)	2.0	13	5	3	81	6	6
Oryzalin (Surflan)	1.5	0	0	0	6	0	0
Benefin (50%) + oryzalin (50%) (XL)	2.0	6	3	1	13	4	3
Untreated	---	46	2	16	89	3	31
MSD**		12	12	12	21	21	21

*Buffalograss coverage was rated visually on a 0 to 100% scale.

**If the difference between the means of two treatments in a column is larger than the MSD, they are significantly different.

Table 3. Effect of 15 preemergence herbicides on weed coverage 6 and 10 WAG at Mead, NE in 1994.

		Weed Coverage*			
		6 WAG		10 WAG	
Herbicide	Rate	NE1	NE2	NE1	NE2
	lb/A	%			
Imazethapyr (Pursuit)	0.06	21	0	28	1
Imazameth (Cadre)	0.06	9	0	14	0
DCPA (Dacthal)	10.5	24	22	36	34
Simazine (Princep)	1.0	38	2	49	5
Pronamide (Kerb)	1.0	59	26	66	31
Dithiopyr (Dimension)	0.5	23	4	30	9
Prodiamine (Barricade)	0.75	40	2	51	5
Pendimethalin (Pre-M)	2.0	18	4	28	8
Bensulide (Presan)	7.5	48	54	60	69
Siduron (Tupersan)	12.0	21	41	24	51
Oxadiazon (Ronstar)	2.0	31	8	45	15
Benefin (65%) + trifluralin (35%) (Team)	2.0	46	18	55	28
Oryzalin (Surflan)	1.5	2	4	8	5
Benefin (50%) + oryzalin (50%) (XL)	2.0	30	13	40	16
Untreated	---	54	31	74	40
MSD**		17	18	17	18

*Weed coverage was rated visually on a 0 to 100% scale.

**If the difference between the means of two treatments in a column is larger than the MSD, they are significantly different.

TITLE: The Use of Mulching Mowers to Recycle Tree Leaves: Effects on Tall Fescue Lawn Quality

OBJECTIVES: To determine if mulching with leaves of two different tree species is detrimental/beneficial to turfgrass quality, thatch accumulation, and soil fertility.

PERSONNEL: Ken Marcum

SPONSORS: Modern Distributing/Toro and Kansas Turfgrass Foundation

INTRODUCTION:

Yard debris accounts for a large part of landfill volumes in most major cities. In many areas, including Missouri,disposing of yard debris through traditional means (city landfills) is now illegal. To eliminate the need for grass clipping disposal, recycling or mulching mowers have been developed. Research has shown that the proper use of mulching mowers to recycle grass clippings may not reduce turf quality, may not result in thatch accumulation, and provides nutrients to the turf under conditions of low fertility.

However, little is known about the effects on turfgrass of recycling tree leaves with mulching mowers. Tree leaves differ from turfgrass clippings in the amount of nutrients which they contain and in the ease with which they decompose. When whole tree leaves are left on the turf over winter, the turf stand can be reduced. Data are needed to determine if mulching tree leaves into turfgrass 1) decreases turf quality, b) increases thatch, c) enhances earthworm activity, and d) affects soil organic matter and nutrient status. Finally, effects of leaf type (large-coarse, sycamore; small-fine, oak) are being examined.

MATERIALS AND METHODS:

Leaves of sycamore and oak were collected and dried in the fall of 1993 and 1994 prior to mulching into a K-31 tall fescue turf planted during the spring of 1993 at Rocky Ford Turfgrass Research Center. Two rates of dry leaves of each of the two species were used: 25 and 50 kg per 1000 ft^2. The rates approximated depths of 3 and 6 in., respectively. Plots are 3 ft X 12 ft in size. Leaves were mulched into plots with a Toro 37 in. mid-size recycling mower with 14 HP engine on Nov 15, 1993 and again on Nov 25, 1994. Nitrogen was applied at two rates to the plots during both years: a low rate of 2 lbs N/1000 ft^2 (all in fall) or a high rate of 4 lbs N/1000 ft^2 (3 lb in fall, 1 in spring). There are 10 treatments (2 tree species X 2 mulch rates + control X 2 N rates) and 3 replications.

Turf quality (density + color) is being rated periodically. At the end of the study, thatch accumulation will be measured as compared to control, as well as earthworm activity in the soil profiles. Effects of mulching on soil organic matter percent also will be determined in the soil profiles. Fertility status of the soil of the various treatments will be determined, along with nutrient concentrations of turf leaves. The experiment will continue for at least 2 years, with mulching treatments applied each fall.

RESULTS:

Turf quality ratings were taken on Dec 21, 1993; May 16, June 10, and July 27, 1994; and Apr 19, 1995.

Data for the first two ratings was presented in last year's report. For the first (December) rating, nitrogen had no statistically significant effect. In general, quality declined with increasing mulching rate for both leaf types. This was expected, because the leaves (brown in color) had not had time to decompose and were still just below the turfgrass canopy.

For the following spring (May 16, 1994), the effect of nitrogen was statistically significant. Again, turfgrass quality declined with increasing rate of leaf mulch for both tree species. However, quality declined less when plots were fertilized with the high N rate (4 lbs /1000 ft^2).

This same trend could be seen during the summer rating on June 10, 1994 (Table 1). Increasing mulching rates tended to reduce quality under both N rates, but quality was generally higher under high N relative to low N. By July 27, the effect of N on quality was not noticeable, though higher rates of leaf mulch still tended to reduce quality.

Evidently, the extra nitrogen aided in decomposition of the leaf mulch. Leaf mulch has a relatively low nitrogen content relative to grass clippings and would be expected to tie up nitrogen as it decomposed. The extra nitrogen may have prevented this.

Table 1. Effect of tree leaf mulching on turfgrass quality, rated June 10, 1994.

Low N	Quality
Control	7.3
Sycamore 25 kg/1000	7.0
Sycamore 50 kg/1000	6.7
Oak 25 kg/1000	6.7
Oak 50 kg/1000	6.0
High N	**Quality**
Control	7.3
Sycamore 25 kg/1000	7.3
Sycamore 50 kg/1000	7.0
Oak 25 kg/1000	6.7
Oak 50 kg/1000	6.3
MSD*	1.4

*If the difference between two means is larger than the MSD, they are significantly different.

Table 2. Effect of tree leaf mulching on turfgrass quality, rated July 27, 1994.

Low N	Quality
Control	6.7
Sycamore 25 kg/1000	7.3
Sycamore 50 kg/1000	6.0
Oak 25 kg/1000	5.7
Oak 50 kg/1000	5.7
High N	**Quality**
Control	6.0
Sycamore 25 kg/1000	6.3
Sycamore 50 kg/1000	6.0
Oak 25 kg/1000	7.0
Oak 50 kg/1000	5.7
MSD*	1.5

*If the difference between two means is larger than the MSD, they are significantly different.

Table 3. Effect of tree leaf mulching on turfgrass quality, rated April 19, 1995.

Low N	Quality
Control	6.3
Sycamore 25 kg/1000	5.7
Sycamore 50 kg/1000	5.3
Oak 25 kg/1000	6.3
Oak 50 kg/1000	6.0
High N	**Quality**
Control	6.7
Sycamore 25 kg/1000	6.7
Sycamore 50 kg/1000	7.0
Oak 25 kg/1000	6.7
Oak 50 kg/1000	6.3
MSD*	1.0

*If the difference between two means is larger than the MSD, they are significantly different.

TITLE: Factors Affecting the Use of Sodding vs. Seeding and Hydroseeding in the Midwest

OBJECTIVE: To determine: 1) the relative use of sodding, seeding, and hydroseeding by the turfgrass industry in the midwest; 2) the relative amounts spent on the three options; and 3) what criteria the turfgrass industry uses in deciding whether to sod, seed, or hydroseed.

PERSONNEL: Ken Marcum and Alan Stevens

SPONSOR: Turfgrass Producers International

MATERIALS AND METHODS:

This report is the result of an in-depth survey of contractors, landscapers, and turfgrass managers within the five-state area of the midwest (Kansas, Missouri, Colorado, Nebraska, and Oklahoma). Over 5,000 surveys were sent out, and to date, 1254 have been returned and analyzed (see Table 1 for breakdown by occupation).

We wanted to answer a number of questions through this survey, including:

1) How much does the turfgrass industry spend annually, by occupation, on turfgrass planting/maintenance?
2) What percentage of grass is planted by sodding/hydroseeding/seeding, by occupation?
3) What factors are considered most important when considering whether to sod/hydroseed/seed?
4) What types of areas are considered most favorable for planting by sodding/hydroseeding/seeding?

RESULTS:

The big spenders in the turfgrass industry are golf courses and highway establishment (Table 2). Grounds maintenance (large-scale commercial and residential), real estate developers, and landscape contractors also are large spenders. Schools and athletic fields, on the other hand, spend less on turfgrass planting and maintenance, on average.

Within the turfgrass industry, landscapers (landscape architects and landscape contractors) use the most sod in comparison to seed or hydroseed, over 40% (Table 3). These operations also spend relatively large amounts on turfgrass maintenance. The largest spenders, golf courses and roadside establishment, use a medium amount of sod (31 and 26%, respectively); golf courses rely most heavily on seed (72%). Though roadside establishment also uses predominately seed, it is the highest user of hydroseed (15%). The four lowest spenders (schools, athletic fields, lawn maintenance - residential and small commercial, and parks) also use the lowest percentages of sod (14, 17, 24, and 23%, respectively). Surprisingly, roadside establishment uses a relatively large amount of sod (31%), evidently on erosion-prone areas.

Golf courses and grounds maintenance (large-scale commercial and residential), though being large spenders, use relatively little sod, relying heavily on seed instead. Also, very little hydroseeding is used by these groups (less than 4%).

What are the factors most important in influencing the decision of whether to sod, seed, or hydroseed? We surveyed each of the 12 occupational groups, asking them to rank 14 factors by their relative importance. Data are presented as averages across all occupational groups (Table 4). In all cases, two factors were paramount: size of the area and visual impact of the area.

Availability of irrigation also was ranked a major decisive factor by all occupational groups. Intended use of area ranked highly with golf course superintendents and somewhat highly for parks and schools. Quality needed in an area was ranked as a factor of middle importance across all occupations.

Cost, including labor, equipment, chemicals, fertilizer, and materials (grass), ranked low as a prioritizing factor, though cost of materials (grass) was the highest of these. Cost is not considered as important as other factors, such as size of area, visual impact, intended use, and availability of irrigation in influencing the decision to sod, seed, or hydroseed.

Table 1. Relative numbers and percentages of responses in various occupations.

Occupation	Number	Relative %
Real estate developer	39	3.1
General contractor	178	14.2
Nursery landscaper	100	8.0
Landscape contractor	191	15.3
Golf course superintendent	281	22.5
Lawn maintenance	272	21.8
Grounds maintenance	212	17.0
Schools	277	22.2
Parks	218	17.4
Athletic fields	351	28.1
Roadside establishment	108	8.6
Landscape architect	89	7.1
Total number	1254	

Table 2. Relative percentages of responses, by occupation, in each spending category (planting and/or maintenance of turfgrass only per year). Categories are: 1) \$0-\$10,000; 2) \$10,001-\$50,000; 3) \$50,001-\$100,000; 4) \$100,001-\$500,000; 5) over \$500,000.

Occupation	1	2	3	4	5
Real estate developer	21	26	16	29	8
General contractor	26	39	11	17	7
Nursery landscaper	25	34	23	13	4
Landscape contractor	14	38	19	20	8
Golf course superintendent17	18	13	41	10	
Lawn maintenance	26	36	17	17	4
Grounds maintenance	17	29	19	25	10
Schools	57	18	9	12	4
Parks	32	25	14	20	9
Athletic fields	43	21	13	17	6
Roadside establishment	20	24	9	22	24
Landscape architect	32	20	20	14	14
Total number	685	614	336	481	189

Table 3. Percentage of total grass planted in an average year by sodding, seeding, and hydroseeding, according to industry.

Industry	Sod	Seed	Hydroseed
Landscape architect	46.4	42.1	11.5
Landscape contractor	41.9	52.0	5.5
Nursery landscaper	34.1	61.2	4.7
Roadside establishment	31.2	58.0	11.4
General contractor	30.1	52.6	17.3
Grounds maintenance	29.6	66.8	3.6
Real estate developer	29.2	56.0	14.8
Golf course superintendent	25.6	72.3	2.0
Lawn maintenance	24.0	72.2	2.7
Parks	22.7	71.1	6.2
Athletic fields	17.3	77.3	4.5
Schools	14.1	80.8	3.9

Table 4. Average ratings of factors most important to consider when deciding whether to plant by seeding, hydroseeding, or sodding, across all occupations. The lower the number, the higher the importance.

Category	Rating
Size of area	3.9
Visual impact of area to be planted	4.1
Intended use of turf area	5.2
Irrigation available	5.6
Slope of area	5.6
Season of planting	5.6
Quality needed	5.6
Cost of materials (grass)	6.0
Survival of grass stand	6.0
Time required until turf is established & looks good	6.8
Convenience of installation	6.8
Cost & availability of labor	7.1
Cost of equipment	8.7
Cost of chemicals (herbicides, fertilizer)	8.8

TITLE: National Tall Fescue Cultivar Trial

OBJECTIVE: To evaluate commercial and experimental tall fescue genotypes under Kansas conditions.

PERSONNEL: John Pair, Ward Upham, and Ned Tisserat

SPONSOR: USDA National Turfgrass Evaluation Program (NTEP)

INTRODUCTION:

Tall fescue is the best adapted, cool-season turfgrass for use in the transition zone because of its greater drought and heat tolerance. Although tall fescue has few serious insect and disease problems, it possesses a rather coarse leaf texture because it lacks stolons and has only very short rhizomes. Efforts to improve tall fescue cultivars include selection for finer leaf texture, good mowing quality, a rich green color, and better sward density, while maintaining good stress tolerance characteristics.

MATERIALS AND METHODS:

Wichita:

A trial of 65 cultivars and experimental numbers was established on Sept 10, 1987 in Wichita. Plots were maintained at 4 lbs N/1000 sq ft per year, mowed at 2½ in. with clippings removed, and irrigated to alleviate stress. Team (Balan/Treflan) was applied in April and June to prevent crabgrass growth. This trial was terminated after 4 years, and a summary was published in 1994. A new national trial was initiated on Sept 24, 1992 containing 95 cultivars and experimental numbers and was given the same management.

Manhattan:

A trial consisting of 103 cultivars and experimental numbers was seeded at the Rocky Ford Turfgrass Research Center near Manhattan during the fall of 1992. The turf was mowed at a height of 3 inches,and fertility maintained at 3 lbs N/1,000 ft^2/yr. Irrigation was applied as needed to prevent drought stress. Turf quality was rated visually, where 0 = brown turf; 6 = acceptable quality; and 9 = optimum color, density, and uniformity.

RESULTS:

Wichita:

Initial seedling vigor was rated to determine the dwarfness or tallness of the various selections which is obscured by mowing. It is quite apparent that this trial includes a number of new dwarf types. Based on very preliminary data, good initial performance was rated on cultivars Rebel, Jr., Bonsai Plus, Micro DD, Silverado, Cochise, Pixie, Duke, Lancer, and Guardian. Experimental numbers also rated high were GEN-91, ZPS-E2, PST-5LX, PST-59D, 2 PS-ML, 1TR-90-2, Pick 90-10, MB-21-92, and MB-23-92 (Table 1).

During 1994, early summer density was rated in June and visual quality was rated from April through September (Table 2). Greatest density was noted on ATF-006, ATF-007, ISI-AFA, MB-21-92, Micro DD, PST-5PM, Pick 90-12, and WXI-208-2. Better than average density occurred in Bonsai Plus, Duke, GEN-91, ISI-AFE, Lancer, Lexus, MB-24-92, MB-25-92, PST-5LX, PST-RDG, Pixie, Rebel Jr.,Rebel-3D, STU-1, SR4000, Silverado, SPS-E2, ZPS-J3, and ZPS-VL. Rated highest in best overall quality for the season were ISI-AFA, MB-25-92, Pick 90-12, ATF-007, Cochise, MB-21-92, MB-23-92, PST-5LX, PST-RDG, PST-5PM, Lancer, Lexus, Finelawn, Petite, GEN-91, MB-24-92, Pixie, Rebel Jr., ZPS-ML, ZPS-VL, Rebel 3-D, Tomahawk, Pick 90-6, and Pick 90-10. Good quality at the end of the season was found for cultivars Avanti, Aztec, Bonanza, Bonanza II, Bonsai, Bonsai Plus, Cochise, Duke, Eldorado, Excaliber, Finelawn 88, Finelawn Petite, Guardian, Lancer, Leprechaun, Lexus, Monarch, Pixie, Rebel Jr., Rebel-3D, Safari, Shenandoah, Silverado, Tomahawk, Trailblazer II, Twilight, Vegas, and Virtue.

Manhattan:

Cultivars were rated for quality each month from March through October. The 10 top-performing cultivars during 1994 were Lexus, Vegas, Finelawn Petite, Twilight, Rebel-3D, Trailblazer II, Kittyhawk, Micro DD, Bonsai Plus, and Leprechaun (Table 3). Lexus had the highest rating of any cultivar or experiment. Six cultivars had an average quality rating that was less than acceptable. These were K-31, Aquara, Anthem, Arid, Falcon, and Aztec. K-31 was consistently at the bottom of the list.

The best experimental numbers were MB-22-92, PST-59-D, Pick 90-12, PST-RDG, Pick 90-6, Pick C11, GEN-91, Pick 90-10, ATF-007, and MB-21-92. The only experimental number that rated less than acceptable was PSTF-LF.

Table 1. Preliminary performance of tall fescue cultivars at Wichita, KS, 1993 [1].

Cultivar or Accession No.	Vigor 4/5/93	Genetic Color	Visual Quality					
			4/5/93	5/1/93		6/14/93	9/3/93	Average
Falcon II	7.2	7.8	8.2	7.8	DG	7.8	7.7	7.8
Marksman	6.3	8.3	7.7	7.8	DG	8.0	7.7	7.8
Micro DD	5.8	8.2	7.7	7.8	DG	7.5	7.0	7.5
GEN-91	6.7	8.2	7.3	7.8	DG	8.3	6.3	7.4
Silverado	6.5	7.8	7.7	7.8		7.5	7.5	7.6
Apache II	6.0	8.3	7.0	7.8	T,DG	7.7	7.5	7.5
Cochise	7.3	8.2	8.0	7.8	DG	7.5	6.7	7.5
Bonsai Plus	6.5	8.2	7.5	7.7		8.2	6.8	7.5
Pixie	6.8	7.3	7.5	7.7	DG	7.7	8	7.7
Lancer	6.2	8.0	7.2	7.7	DG	7.3	7.7	7.5
Coyote	5.3	7.5	7.2	7.7	DG,F	8.2	7.5	7.6
Duster	5.7	8.2	7.0	7.7		7.7	6.7	7.3
Emperor	6.2	8.2	7.0	7.7	DG	7.8	7.8	7.6
Pick 90-10	5.3	8.8	6.8	7.7	DG,T	7.5	7.2	7.3
PST-5LX	5.3	8.5	7.2	7.7	DG,W	7.7	7.7	7.6
Rebel, Jr.	6.5	7.7	8.0	7.7		7.8	7.8	7.8
ISI-AFA	6.5	7.7	8.0	7.5		7.8	7.5	7.7
PST-5VC	6.8	7.3	7.8	7.5		7.7	6.7	7.4
Duke	7.5	6.8	7.5	7.5	M	7.7	7.5	7.5
Guardian	7.2	7.3	7.8	7.5		7.7	7.2	7.5
KWS-DSL	6.7	7.2	7.7	7.5		7.7	7.2	7.5
SFL	6.8	7.7	7.0	7.5	T,W	7.5	7.0	7.2
MB-25-92	6.0	7.7	7.7	7.5		7.5	7.5	7.5
403	7.3	7.2	7.5	7.3		7.2	7.3	7.3
Pick CII	6.8	7.8	7.5	7.3	DG	7.2	6.8	7.2
Pick 90-6	4.5	8.3	7.2	7.3	DG,W	8.2	6.7	7.3
Alamo	6.8	7.5	7.2	7.3		7.7	7.2	7.3
WXI-208-2	7.2	7.5	7.2	7.3		7.5	7.2	7.3
Rebel-3D	6.8	7.7	7.3	7.3	C	7.8	7.5	7.5
SR 8200	6.7	7.3	7.0	7.3	T	7.3	7.3	7.2
Lexus	5.5	8.5	7.2	7.3	DG,T,W	8.3	7.3	7.5
Finelawn Petite	6.3	7.8	7.5	7.3	DG	7.8	6.8	7.3
Vegas	6.5	7.8	7.0	7.2	DG	7.3	7.0	7.1
Leprechaun	6.7	7.5	7.2	7.2		7.2	7.2	7.2
MB-22-92	6.2	7.5	7.2	7.2	DG	7.7	7.3	7.3
PST-5STB	7.3	7.0	6.8	7.2		7.5	6.0	6.9
ZPS-VL	5.3	8.7	7.2	7.2		8.0	7.0	7.3
BAR Fa 0855	7.8	7.0	7.2	7.2		7.2	6.7	7.1
Pick 90-12	5.8	8.3	6.8	7.2	DG	7.8	7.5	7.3
Bonanza II	7.0	6.8	7.5	7.2	M	7.3	6.8	7.2

Table 1. Preliminary performance of tall fescue cultivars at Wichita, KS, 1993 [1].

Cultivar or Accession No.	Vigor 4/5/93	Genetic Color	Visual Quality					
			4/5/93	5/1/93		6/14/93	9/3/93	Average
Bonanza	7.5	6.5	7.5	7.0		6.8	6.8	7.0
ISI-CRC	7.8	6.8	7.7	7.0		7.2	6.5	7.1
ATF-006	6.5	7.5	7.2	7.0	T,W	8.0	7.5	7.4
Virtue	7.3	7.2	7.5	7.0		7.2	7.2	7.2
ISI-ATK	7.3	6.7	7.5	7.0		7.3	6.8	7.1
FA-19	6.8	7.5	7.3	7.0	W	7.7	6.8	7.2
Tomahawk	6.7	7.3	7.2	7.0	T	7.8	7.7	7.4
PST-5PM	6.5	7.5	6.5	7.0	T,W	7.5	7.2	7.0
Coronado	5.5	8.0	7.2	7.0	T,W	7.7	7.3	7.3
ATF-007	6.2	7.8	6.8	7.0		7.8	7.5	7.3
Twilight	7.7	8.3	7.7	7.0		7.7	7.3	7.4
Titan II	7.5	6.8	7.3	7.0	LG	6.8	7	7
STU-1	7.0	6.7	7.7	7.0		7.3	7.2	7.3
Eldorado	7.2	6.7	7.7	6.8		7.0	7	7.1
Houndog V	7.2	7.3	7.7	6.8	T	8.0	7	7.4
SR 8400	7.3	7.2	7.5	6.8		7.2	7.3	7.2
Kittyhawk	7.2	6.5	7.2	6.8		6.8	6.2	6.7
Monarch	6.7	6.8	7.5	6.8	LG	7.0	6.5	6.9
Aztec	7.2	7.0	7.3	6.8		6.8	6.7	6.9
OFI-TF-601	6.3	7.2	7.2	6.8	T,LG	7.3	7.3	7.1
Jaguar 3	6.5	7.5	7.0	6.8		7.7	7.5	7.2
PST-5DX w/endo.	6.8	7.3	7.0	6.8	T	7.2	7.0	7.0
BAR Fa 2AB	7.0	7.2	6.8	6.8		7.5	7.5	7.1
Bonsai	3.5	8.5	6.2	6.8		7.8	6.8	6.9
SR 8210	6.5	7.5	6.8	6.8		7.7	7.0	7.1
Montauk	6.5	7.0	6.7	6.8		7.3	6.8	6.9
BAR Fa 214	5.7	7.0	7.2	6.8	W	6.7	6.3	6.7
Alamo	7.2	7.2	7.5	6.8	T	7.3	6.8	7.1
M-2	7.5	7.3	7.8	6.7		6.8	6.5	6.9
Austin	7.7	6.2	7.2	6.7	LG	6.2	6.3	6.6
Safari	8.0	6.5	7.3	6.7	LG	6.7	7.2	7.0
PRO-9178	6.8	7.5	6.7	6.7		7.2	7.3	7.0
PSTF-401	7.5	6.5	6.8	6.7	LG	6.7	7.0	6.8
CAS-MA21	7.0	6.7	7.2	6.7		6.8	6.3	6.7
FA-22	7.3	6.2	7.2	6.7	LG	6.7	6.5	6.7
Finelawn 88	7.0	7.2	6.8	6.5	T	6.7	7.3	6.8
Phoenix	8.3	6.0	7.2	6.5	LG,C	6.3	6.7	6.7
Excaliber	5.7	7.2	6.3	6.5	T	7.5	6.7	6.7
Trailblazer II	8.2	7.0	7.5	6.5		7.0	7.3	7.1
Cafa101	7.8	6.5	7.3	6.3	C	6.7	6.7	6.7
CAS-LA20	6.3	7.2	6.5	6.3	T,W	6.7	6.2	6.4

Table 1. Preliminary performance of tall fescue cultivars at Wichita, KS, 1993 [1].

Cultivar or Accession No.	Vigor 4/5/93	Genetic Color	Visual Quality				
			4/5/93	5/1/93	6/14/93	9/3/93	Average
PSTF-LF	7.0	6.3	7.0	6.3 LG	6.7	6.8	6.7
Shenandoah	7.3	6.0	7.3	6.3 LG	7.0	6.8	6.8
MB-24-92	5.3	8.0	6.0	6.2 T,DG	7.5	7.2	6.7
Arid	8.0	4.7	6.7	6.2 LG	6.2	6.3	6.3
Evergreen	7.7	6.3	7.2	6.2 C,LG	6.3	5.5	6.3
SR 8300	7.8	6.8	6.5	6.0 T	6.5	6.8	6.4
Avanti	7.8	6.5	7.0	6.0 LG	7.2	7.3	6.9
Olympic II	8.0	5.8	7.5	5.7 LG	6.5	6.2	6.5
Astro 2000	8.2	6.0	7.3	5.7 LG,C	6.7	6.3	6.5
	7.8	6.2	7.3	5.7 LG	5.8	6.3	6.3
PSTF-200							
Falcon	8.3	5.3	7.0	5.3	6.3	5.5	6.0
Anthem	9.0	4.8	6.0	5.0 LG,C	5.3	5.3	5.4
KY-31 no endo.	8.7	4.0	6.0	4.3 LG,C	4.7	4.3	4.8
KY-31 w/endo.	8.8	4.3	6.0	4.0 C,LG	4.3	4.3	4.6

[1/] Established Sept. 24, 1992 at 4.6 lbs. seed per 1,000 sq. ft. Ratings based on scale of 0-9 w/9 = best vigor, darkest green and highest quality.
LG = Light green, DG = Dark green, T = Thin, W = Weedy, C = Coarse.

Table 2. Performance of fescue cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Density 6/20/94	Quality					
		4/17/94	5/10/94	7/26/94	8/24/94	9/16/94	Avg.
ISI-AFA	7.7	8.5	8.0	7.8	7.8	7.8	8.0
MB-25-92	7.3	8.0	8.3	7.8	8.2	7.8	8.0
Pick 90-12	7.7	8.0	7.8	8.0	8.2	7.8	8.0
ATF-007	8.2	7.8	8.2	8.2	8.2	7.2	7.9
Cochise	6.7	7.8	7.8	7.5	8.2	7.5	7.8
Falcon II	7.5	7.8	8.2	7.3	8.0	7.5	7.8
Marksman	6.8	7.8	7.3	7.5	8.0	8.3	7.8
PST-5PM	7.7	8.0	7.7	7.5	8.2	7.8	7.8
Coronado	7.3	8.0	8.2	7.5	7.8	7.3	7.8
Emperor	7.3	7.8	7.7	7.8	7.7	8.0	7.8
Jaguar 3	7.2	8.0	8.0	7.7	7.3	8.2	7.8
Finelawn Petite	6.2	8.0	7.5	7.0	8.2	7.8	7.7
GEN-91	7.2	8.0	7.8	7.3	7.7	7.5	7.7
Lancer	7.0	7.5	7.5	7.5	8.0	7.8	7.7
Lexus	7.2	7.8	8.0	7.2	7.8	7.5	7.7

Table 2. Performance of fescue cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Density 6/20/94	Quality 4/17/94	5/10/94	7/26/94	8/24/94	9/16/94	Avg.
MB-24-92	7.2	7.5	7.5	7.7	8.2	7.7	7.7
Pixie	7.3	7.8	7.7	8.0	7.3	7.5	7.7
Rebel Jr.	7.3	7.5	7.8	8.2	7.7	7.5	7.7
Coyote	7.0	8.0	8.3	7.0	7.8	7.3	7.7
ZPS-VL	7.2	7.7	8.0	7.5	7.5	7.7	7.7
Pick 90-6	7.0	7.5	8.0	7.2	7.7	7.5	7.6
PST-5LX	7.2	7.7	7.7	7.0	8.2	7.7	7.6
Rebel-3D	7.3	7.8	7.2	7.3	8.2	7.7	7.6
Tomahawk	6.7	7.8	7.3	7.5	7.7	7.8	7.6
CAS-LA20	6.8	7.7	7.5	7.2	7.8	7.3	7.5
Houndog V	7.2	7.3	7.7	7.3	7.7	7.5	7.5
Duster	6.8	8.0	7.7	7.3	7.2	7.2	7.5
Alamo	6.5	8.0	7.7	7.5	7.3	7.2	7.5
Pick CII	6.7	7.3	8.0	7.7	7.5	7.2	7.5
PRO-9178	6.8	7.7	6.7	7.3	8.0	7.7	7.5
PST-5STB	6.7	8.2	7.5	6.8	7.3	7.8	7.5
Silverado	7.2	7.8	7.0	7.5	7.7	7.7	7.5
SR 8400	7.2	7.7	7.5	6.8	7.7	7.7	7.5
Twilight	6.3	7.5	7.2	7.7	7.5	7.5	7.5
WXI-2	7.5	7.8	7.5	7.3	7.7	7.3	7.5
403	6.8	7.3	7.5	7.3	7.7	7.2	7.4
BAR Fa 0855	7.0	7.7	7.0	6.8	7.7	7.7	7.4
BAR Fa 2AB	7.0	7.7	7.7	7.2	7.2	7.2	7.4
Excaliber	6.2	7.5	7.8	7.2	7.3	7.3	7.4
Apache II	5.8	7.3	7.5	7.3	7.5	7.5	7.4
PST-5DX	7.0	7.3	7.3	7.0	7.7	7.7	7.4
SFL	6.5	7.3	7.3	7.3	7.7	7.2	7.4
SR 8210	6.8	7.3	7.3	7.3	7.7	7.5	7.4
ATF-006	7.5	7.7	7.5	7.0	7.2	7.2	7.3
ISI-ATK	6.3	7.0	7.2	7.8	7.5	7.2	7.3
SIU-1	7.3	7.5	7.3	7.2	7.5	7.2	7.3
Bonanza II	6.3	7.0	7.0	7.2	7.5	7.3	7.2
Bonsai	6.3	7.3	7.3	7.8	6.7	7.0	7.2
CAS-MA21	6.0	7.2	7.5	6.7	7.3	7.2	7.2
Duke	7.2	7.7	7.2	7.0	7.3	7.0	7.2
FA-19	6.8	7.3	7.0	6.5	7.7	7.3	7.2
Guardian	7.0	7.3	7.2	6.8	7.7	7.0	7.2
KWS-DSL	6.5	7.5	7.2	7.2	7.0	7.3	7.2
Micro DD	7.5	7.5	7.7	7.3	7.2	6.3	7.2
OFI-TF-601	6.8	7.5	7.0	6.7	7.3	7.7	7.2
Vegus	6.7	7.3	7.5	7.3	6.8	7.2	7.2
Virtue	6.5	7.2	7.2	7.0	7.2	7.5	7.2

Table 2. Performance of fescue cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Density 6/20/94	Quality 4/17/94	5/10/94	7/26/94	8/24/94	9/16/94	Avg.
Bonsai Plus	7.2	7.2	7.2	7.5	6.8	6.7	7.1
Eldorado	6.0	7.5	7.0	6.7	7.2	7.0	7.1
MB-22-92	6.8	7.3	7.5	7.0	6.5	7.2	7.1
Monarch	6.5	7.2	7.0	7.5	7.3	6.7	7.1
PST-5VC	7.0	7.3	7.0	6.0	7.7	7.7	7.1
Safari	6.2	7.0	6.8	7.3	7.0	7.5	7.1
Trailblazer II	6.7	7.5	7.0	7.2	6.7	7.2	7.1
Bonanza	6.2	6.5	6.8	6.7	7.3	7.5	7.0
Alamo	6.5	7.5	6.5	7.2	6.7	7.0	7.0
Leprechaun	6.8	6.7	7.3	7.2	6.8	7.2	7.0
Avanti	5.5	7.2	6.3	6.8	7.0	7.3	6.9
ISI-CRC	6.2	6.8	6.2	7.2	7.3	7.0	6.9
Austin	6.0	7.0	6.5	6.7	6.8	6.8	6.8
BAR Fa 214	6.7	6.2	6.7	7.0	7.2	7.2	6.8
Cafa 101	6.7	7.2	7.0	7.0	6.7	6.3	6.8
Kittyhawk	6.5	7.2	6.8	6.7	6.8	6.7	6.8
PSTF-LF	6.2	6.7	7.0	6.7	6.7	7.0	6.8
SR 8200	6.3	6.7	6.3	6.8	7.2	7.0	6.8
Aztec	6.2	7.3	6.2	6.3	6.8	7.0	6.7
Finelawn 88	5.8	6.5	6.3	6.7	7.2	7.0	6.7
Montauk	6.7	6.8	6.7	6.5	6.7	7.0	6.7
Shenandoah	6.7	7.0	6.3	6.3	7.0	7.0	6.7
FA-22	6.5	6.7	6.7	6.5	6.7	6.5	6.6
KS Supreme	6.3	6.3	6.7	7.2	6.3	6.7	6.6
PSTF-401	6.3	6.7	6.3	6.5	7.0	6.3	6.6
SR 8300	5.3	6.8	6.5	6.5	6.3	6.8	6.6
M-2	6.5	7.0	7.2	6.8	5.7	5.7	6.5
Titan II	6.5	6.5	6.0	6.8	6.7	6.7	6.5
Olympic II	5.7	6.3	6.3	6.5	6.7	6.3	6.4
Evergreen	5.7	6.3	6.2	6.0	6.7	6.5	6.3
Phoenix	5.7	5.8	5.3	6.0	7.3	6.8	6.3
PSTF-200	5.7	6.2	5.7	6.7	6.5	6.5	6.3
Astro 2000	5.7	6.3	5.8	6.0	6.3	6.5	6.2
Arid	6.5	6.2	5.3	6.7	6.3	6.0	6.1
Falcon	5.5	6.0	6.2	5.7	5.3	6.0	5.8
Anthem	4.7	5.0	5.0	5.0	5.7	5.3	5.2
Ky-31 no endo.	4.7	4.7	4.3	5.0	5.3	4.7	4.8
Ky-31 w/endo.	4.3	4.7	4.3	4.3	4.7	4.3	4.5

[1] Established September 24, 1992. Quality ratings based on a scale of O-9 w/9 = best density, color.and visual quality.

Table 3. Performance of tall fescue cultivars at Manhattan, KS, 1994.

Cultivar	Green-up[1]	Color[2]	Visual Quality[3] May	July	September	Average
Lexus	6.0	7.7	7.7	7.0	7.7	7.4
MB-22-92	5.7	7.0	7.7	6.7	7.3	7.2
PST-59-D	6.7	6.7	7.7	7.0	7.0	7.2
Pick 90-12	6.7	6.3	7.3	7.0	7.3	7.2
PST-RDG	6.0	7.0	7.7	7.0	6.7	7.1
Pick 90-6	6.3	7.3	7.7	7.0	6.7	7.1
Pick CII	6.7	7.3	8.0	6.3	7.0	7.1
GEN-91	6.0	8.0	7.3	6.7	7.3	7.1
Pick 90-10	6.0	7.7	7.7	6.7	6.7	7.0
Vegas	6.7	6.7	7.7	6.7	6.7	7.0
ATF-007	5.7	7.3	7.3	6.7	7.0	7.0
MB-21-92	6.0	6.7	7.0	6.7	7.3	7.0
ISI-AFA	6.3	7.3	7.3	6.7	7.0	7.0
Finelawn Petite	6.0	7.7	7.3	6.3	7.3	7.0
MED 2-8-12	5.7	6.0	7.7	6.3	6.7	6.9
403	7.0	7.0	7.3	6.7	6.7	6.9
ZPS-VL	5.7	6.3	8.0	6.0	6.7	6.9
MED 2-3-19	6.0	7.0	7.0	6.7	7.0	6.9
SR 8400	6.3	6.3	7.0	6.3	7.3	6.9
MED 2-7-11	6.3	6.3	7.3	6.3	7.0	6.9
Twilight	6.0	7.7	7.3	6.3	7.0	6.9
ZPS-ML	6.0	7.3	7.3	6.3	7.0	6.9
Rebel-3D	6.3	7.3	7.7	6.0	6.7	6.8
Trailblazer II	6.0	7.0	6.7	6.7	7.0	6.8
SIU-1	6.7	7.0	6.7	6.7	7.0	6.8
Kittyhawk	7.0	7.0	6.7	7.0	6.7	6.8
Micro DD	6.0	7.0	6.7	6.7	7.0	6.8
KWS-DSL	6.3	7.0	6.7	7.0	6.7	6.8
WXI-208-2	6.3	7.7	7.3	6.3	6.7	6.8
Bonsai Plus	6.0	6.7	7.3	6.3	6.7	6.8
Leprechaun	6.0	6.7	7.0	6.3	7.0	6.8
Montank	6.3	6.7	6.7	6.7	6.7	6.7
PSTF-401	7.0	7.3	6.7	6.7	6.7	6.7
CAS-MA21	6.7	6.7	6.7	6.7	6.7	6.7
PST-5LX	5.7	6.7	7.3	6.7	6.0	6.7
ISI-AFE	6.7	7.0	7.0	6.3	6.7	6.7
SR 8010	6.7	6.7	6.3	6.7	7.0	6.7
SR 8200	6.0	7.0	6.7	6.3	7.0	6.7
Virtue	6.3	7.0	7.0	6.7	6.3	6.7
ISI-CRC	6.7	7.0	6.3	6.7	7.0	6.7
Cochise	6.3	6.0	7.0	6.7	6.3	6.7

Table 3. Performance of tall fescue cultivars at Manhattan, KS, 1994.

Cultivar	Green-up[1]	Color[2]	Visual Quality[3] May	July	September	Average
ATF-006	5.7	5.0	7.0	6.7	6.3	6.7
BAR Fa 2AB	6.3	6.7	6.3	6.7	7.0	6.7
J-1048	6.3	6.3	7.3	6.3	6.3	6.7
Pixie	6.0	7.0	6.7	6.3	6.7	6.6
MED 10-3-3	5.3	6.7	6.7	6.0	7.0	6.6
Lancer	6.3	7.0	6.7	6.3	6.7	6.6
SFL	6.7	6.7	6.7	6.7	6.3	6.6
Silverado	6.3	6.3	6.7	6.7	6.3	6.6
CAS-LA20	6.3	6.7	7.0	6.7	6.0	6.6
MB-25-92	6.0	7.3	6.7	6.3	6.7	6.6
PRO-9178	6.0	6.7	6.7	6.3	6.7	6.6
PST-5PM	6.0	5.7	7.0	6.3	6.3	6.6
FA-22	6.0	6.3	6.3	7.0	6.3	6.6
Tomahawk	6.3	6.7	7.3	6.0	6.3	6.6
ZPS-J3	6.3	7.0	6.3	6.3	7.0	6.6
ITR-90-2	5.7	6.7	7.0	5.7	6.7	6.4
PST-5VC	6.0	6.7	6.7	5.7	7.0	6.4
Austin	6.3	6.7	6.7	6.7	6.0	6.4
MED 10-6-8F	6.0	6.7	6.3	6.3	6.7	6.4
MB-23-92	5.7	6.7	7.0	6.3	6.0	6.4
OFI-TF-601	6.7	7.0	6.3	6.3	6.7	6.4
Duke	6.3	6.3	6.3	6.3	6.7	6.4
M-2	6.3	7.0	7.0	6.3	6.0	6.4
MED 10-4-3	6.7	6.0	6.7	6.3	6.3	6.4
SR 8210	6.0	7.3	6.3	6.0	7.0	6.4
PST-5DX w/endophytes	6.3	6.0	6.7	6.3	6.3	6.4
PST-5STB	6.0	5.7	7.3	6.0	6.0	6.4
Bonsai	5.7	7.0	7.0	6.0	6.3	6.4
Bonanza II	6.0	6.0	6.3	6.7	6.3	6.4
Avanti	7.0	6.7	6.3	6.0	7.0	6.4
Eldorado	6.7	7.3	6.7	6.3	6.3	6.4
Rebel, Jr.	6.3	6.3	7.0	6.0	6.3	6.4
MB-24-92	6.0	6.3	6.0	6.3	6.7	6.3
PSTF-200	6.7	7.0	6.0	6.7	6.3	6.3
Cafa101	6.3	6.0	6.0	6.7	6.3	6.3
FA-19	5.7	6.7	6.0	6.0	7.0	6.3
Finelawn 88	6.7	6.0	6.0	6.7	6.3	6.3
ISI-ATK	7.0	6.3	6.3	6.0	6.7	6.3
MED 10-5-4	6.7	6.0	6.3	6.0	6.7	6.3
SR 8300	6.0	6.0	6.3	6.3	6.3	6.3
Astro 2000	6.3	7.0	5.7	6.7	6.3	6.2

Table 3. Performance of tall fescue cultivars at Manhattan, KS, 1994.

Cultivar	Green-up[1]	Color[2]	Visual Quality[3] May	July	September	Average
Olympic II	6.7	6.3	5.7	6.7	6.3	6.2
Safari	6.3	7.0	5.7	6.0	7.0	6.2
Phoenix	7.0	6.0	5.7	6.7	6.3	6.2
Guardian	7.0	6.0	6.3	6.3	6.0	6.2
MED 2-9-3	6.3	5.7	6.3	6.0	6.3	6.2
ZPS-E2	6.0	6.0	6.0	6.3	6.3	6.2
Shenandoah	6.3	6.7	6.0	6.3	6.3	6.2
BAR Fa 0855	7.0	7.0	6.0	5.7	6.7	6.1
Monarch	6.0	6.0	5.7	6.7	6.0	6.1
MED 10-7-2	6.3	6.7	5.7	6.0	6.7	6.1
Bonanza	6.7	6.3	6.3	6.3	5.7	6.1
BAR Fa 214	5.7	6.3	5.7	6.3	6.3	6.1
MED 2-1-25	6.7	5.3	6.0	6.0	6.0	6.0
PSTF-LF	6.7	6.7	5.7	6.3	5.7	5.9
Aztec	6.0	6.7	5.7	6.0	6.0	5.9
Aquara	7.0	6.0	5.3	6.3	6.0	5.9
Falcon	7.7	5.3	6.0	5.7	5.7	5.8
Arid	7.7	5.3	5.3	6.3	5.7	5.8
Anthem	8.0	6.0	5.3	6.3	5.7	5.8
Aquara	7.7	5.0	5.3	6.0	5.7	5.7
K-31 no endophytes	8.3	4.3	5.0	5.3	5.0	5.1
K-31 w/endophytes	8.0	4.3	5.0	5.3	4.0	4.8

[1] Green-up rated visually, with 9 = darkest green and 0 = brown.
[2] Color rated visually, with 9 = darkest green and 0 = brown.
[3] Quality rated visually, with 9 = best and 0 = brown turf.

TITLE: National Bentgrass Cultivar Trial

OBJECTIVE: To evaluate commercial cultivars and experimental numbers of bentgrass for performance in Kansas.

PERSONNEL: John C. Pair, Jack Fry, and Ward Upham

SPONSORS: USDA National Turfgrass Evaluation Program

INTRODUCTION:

For many years 'Penncross' has been considered the elite cultivar for use on golf greens in cool regions of the U.S. In recent years, however, several new cultivars have been introduced, and the evaluation of experimental selections continues through this USDA trial.

This study compares 21 cultivars and experimental numbers for performance in Kansas. The planting at Manhattan is evaluated under putting green conditions. The Wichita trial is maintained at fairway height.

MATERIALS AND METHODS:

Wichita:

Twenty-one cultivars and experimental numbers were established in the fall of 1993. Fertility level was at 4 lbs N/1000 sq ft per season. Cutting height was at a fairway height of 1 inch with clippings removed. Fungicides Daconil at 3 oz/1000 sq ft and Fungoflo at 2 oz/1000 sq ft were alternated for disease control.

Manhattan

Cultivars were seeded in fall 1993 on a sand-based putting green at the Rocky Ford Turfgrass Research Center. Turf was mowed 6 days weekly at 5/32 in. A total of 5 lbs N/1000 sq ft was applied in 1994. Irrigation was applied as needed to prevent stress. Turf quality was rated visually, where 0 = dead turf; 7 = acceptable quality for a putting green; and 9 = optimum color, density, and uniformity. Seedling vigor and turf genetic color were rated on the same scale, where 0 = no vigor or brown turf and 9 = optimum vigor or dark green.

RESULTS:

Wichita:

Best seedling vigor was apparent for Exeter and Seaside, followed by Providence, PRO/CUP, and Penncross (Table 1). Best winter color was seen on BAR As 493 and Exeter. Genetic color (darkest green) was rated highest on 18th Green, Cato, G-2, Tendez, Bar Ws 42102, and ISI-At-90162. Visual quality was rated highest on Southshore, Penneagle, Crenshaw, DF-1, and Providence. Following closely with excellent quality in mid-summer were Lopez, Penncross, and Cato.

Manhattan:

Quality ratings for cultivars were variable over months. Crenshaw exhibited the highest mean quality rating and was the top performer between July and September. Providence, L-93, and A-4 also ranked near the top for seasonal mean quality. Poorest mean quality scores were received by Tendenz and Seaside. Seedling vigor scores were highest for Pro/Cut, Crenshaw, Regent, Southshore, and Seaside. Best genetic color was observed for 18th Green, DG-P, L-93, and Lopez.

Table 1. Performance of bentgrass cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Seedling Vigor 1/5/94	Winter Color 1/5/94	Genetic Color 5/20/94	Quality (0 - 9 w/9 = best)					
				4/22/94	5/27/94	6/28/94	7/30/94	8/26/94	9/30/94
18th Green	3.7	3.0	8.0	7.8	8.0	8.2	5.0	4.0	6.7
BAR As 493	6.7	8.3	6.3	5.3	6.2	6.8	5.0	3.7	6.3
Bar Ws 42102	5.3	5.2	7.7	7.5	7.7	6.8	5.0	4.7	6.5
Cato	4.0	5.0	8.2	8.3	8.2	8.7	7.2	5.5	7.3
Crenshaw	6.0	5.0	7.0	6.3	7.5	8.2	7.3	6.3	8.3
DF-1	6.0	4.3	6.7	6.5	7.0	7.3	7.0	6.0	8.0
Exeter	8.7	8.2	5.7	4.0	6.0	4.7	5.3	3.3	5.3
G-2	5.5	6.8	7.8	7.2	7.8	8.7	5.0	4.0	6.8
G-6	5.7	5.7	7.7	7.3	8.2	8.3	5.0	3.3	6.5
ISI-At-90162	3.3	6.0	7.5	7.2	6.5	5.0	2.7	2.0	3.7
Lopez	6.0	6.3	7.2	6.3	7.3	7.5	6.8	6.8	7.8
OM-At-90163	4.7	6.3	7.2	6.0	6.3	5.8	4.0	2.7	5.3
PRO/CUP	7.0	6.3	7.0	5.7	7.8	7.8	5.8	4.3	7.0
Penncross	7.0	5.7	7.0	6.2	7.0	7.7	7.0	6.8	7.8
Penneagle	6.7	5.3	7.0	6.3	7.3	8.2	7.3	7.5	8.5
Providence	7.3	6.0	7.2	5.7	7.8	8.5	6.8	5.3	8.0
SR 7100	5.7	6.7	6.7	6.3	6.3	6.8	3.7	3.0	5.3
Seaside	8.3	5.3	5.0	4.2	6.3	5.3	4.7	4.0	5.3
Southshore	6.3	5.0	7.0	6.2	7.5	7.5	7.0	7.3	8.7
Tendez	4.7	4.7	7.7	6.5	6.3	4.7	2.7	1.7	3.0
Trueline	6.2	6.0	7.2	6.3	7.5	7.7	6.3	5.7	7.5

[1] Established Sept. 15, 1993. Maintained at fairway height of ½ in.

Table 2. Quality of creeping bentgrass cultivars at Manhattan, KS in 1994.

Cultivar	Quality*					
	May	June	July	August	Sept.	Mean
Pro/Cut	6.7	6.0	7.0	7.0	6.3	6.6
Providence	6.7	6.3	7.3	7.3	6.7	6.9
Crenshaw	6.7	6.0	7.7	8.7	8.3	7.5
Trueline	6.3	5.7	7.0	6.7	6.3	6.4
Regent	6.3	6.0	7.0	7.3	6.0	6.5
Cato	6.3	6.0	6.7	7.3	7.0	6.7
Syn 92-1-93	6.3	6.3	6.7	8.0	7.7	7.0
Pennlinks	6.3	6.3	7.0	7.0	5.7	6.5
Southshore	6.0	5.7	7.0	7.7	6.7	6.6
SR1020	6.0	5.3	6.3	6.7	6.0	6.1
L-93	6.0	6.3	6.7	7.7	7.7	6.9
BAR WS 42102	5.7	5.7	7.0	7.3	6.7	6.5
Syn-1-88	5.7	5.3	6.0	6.7	6.0	5.9
A-4	5.7	6.3	7.0	7.3	8.0	6.9
Syn 92-2-93	5.7	5.7	6.3	7.3	7.7	6.5
MSUEB	5.7	5.7	6.3	6.3	6.0	6.0
Penncross	5.7	5.7	6.0	6.3	5.7	5.9
Lopez	5.3	5.7	6.0	6.3	6.0	5.9
ISI-AP-89150	5.0	5.0	6.0	6.7	7.0	5.9
BAR AS 493	5.0	5.0	6.0	6.3	5.7	5.6
18th Green	4.7	5.7	6.0	5.7	5.3	5.5
A-1	4.7	5.7	6.0	6.7	7.0	6.1
DG-P	4.7	5.3	6.0	6.3	6.3	5.7
G-2	4.3	5.0	5.7	6.3	5.7	5.4
Syn 92-5-93	4.3	5.3	6.0	6.3	6.0	5.6
Seaside	4.3	4.3	6.0	5.3	4.7	4.9
G-6	4.0	5.3	5.3	6.0	6.0	5.3
Tendenz	3.0	4.0	4.7	4.7	5.0	4.3
LSD**	2.1	2.3	2.5	1.6	1.6	1.6

*Turf quality was rated visually on a 0 to 9 scale where 9 = optimum quality and 7 = acceptable for a putting green.

**If the difference between two cultivar means is larger than the LSD value, they are significantly different.

Table 3. Seedling vigor and genetic color of creeping bentgrass at Manhattan, KS in 1994.

Cultivar	Seedling Vigor*	Color
Pro/Cut	7.0	7.3
Providence	6.0	7.7
Crenshaw	6.3	7.7
Trueline	6.0	7.3
Regent	6.3	6.7
Cato	6.0	7.3
Syn 92-1-93	6.0	7.7
Pennlinks	6.0	7.0
Southshore	6.3	7.0
SR1020	5.0	6.7
L-93	6.0	8.3
BAR WS 42102	5.0	7.7
Syn 1-88	4.7	7.3
A-4	5.3	7.3
Syn 92-2-93	5.3	6.3
MSUEB	5.3	7.3
Penncross	5.7	7.7
Lopez	4.3	8.0
ISI AP-89150	5.0	8.0
BAR AS 493	4.7	7.0
18th Green	4.7	8.7
A-1	4.7	7.3
DG-P	4.7	8.0
G-2	4.3	7.3
Syn 92-5-93	4.3	7.3
Seaside	6.3	6.7
G-6	4.3	6.7
Tendenz	3.3	7.3
LSD**	3.0	0.8

*Seedling vigor and genetic color were rated visually on 0 to 9 scales, where 0 = no vigor or brown turf and 9 = optimum vigor or dark green.

**If the difference between two cultivar means is larger than the LSD value, they are significantly different.

TITLE: National Fineleaf Fescue Cultivar Trial

OBJECTIVE: To evaluate commercial and experimental fineleaf fescue genotypes under Kansas conditions and provide that data to the National Turfgrass Evaluation Program.

PERSONNEL: Ward Upham

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Fineleaf fescues include a number of species such as Chewings, Creeping Red, Hard, and Sheep fescues. These grasses have a finer leaf texture than Kentucky bluegrass. They prefer cool weather and have better shade tolerance than grasses normally grown in this state. Fineleaf fescues are not well adapted to Kansas conditions if grown in full sun because of summer heat stress and disease problems that cause thin turf during hot weather.

MATERIALS AND METHODS:

A trial consisting of 60 cultivars and experimental numbers was seeded at the Rocky Ford Turfgrass Research Center near Manhattan during the fall of 1993. The turf was mowed at a height of 3 in. and fertility maintained at 3 lbs N/1000 sq ft/yr.

Irrigation was applied as needed to prevent drought stress. Turf quality was rated visually, where 0 = brown turf; 6 = acceptable quality; and 9 = optimum color, density, and uniformity.

RESULTS:

Cultivars were rated for quality each month from March through October. The cultivars that had an average quality rating of 6.0 or above included Shademaster II, Brittany, Jasper, Seabreeze, and Scaldis. Those that had an average rating of less than 5.5 were Reliant II, Flyer, Jamestown, Spartan, Molinda, Common Creeping, Rondo, Pamela, and Cascade.

Experimental numbers with a rating of 6.0 or above were PST 4VBENDS, ZPS-4BN, PST-4DT, MB61-93, PST-44D, NJF-93, MB65-93, MB63-93, ISI-FC-62, MB64-93, ZPS-MG, AND WX3-FF54. Those with a rating of less than 5.5 included PST-4ST, SR 3100, MB83-93, BAR UR 204, MED 32, FO 143, AND 67135.

A rating of 6.0 or above is considered acceptable quality.

Table 1. Performace of fineleaf fescue cultivars at Manhattan, KS, 1994.

Cultivar		Visual Quality			
	Green-up	May	July	September	Average
PST 4VBENDS	8.3	7.7	7.0	6.3	7.0
Shademaster II	5.7	8.0	7.0	5.3	6.8
ZPS-4BN	7.3	7.3	6.7	6.3	6.8
PST-4DT	8.0	7.0	7.0	6.0	6.7
MB61-93	6.3	6.7	6.7	6.0	6.4
PST-44D	7.3	6.7	6.3	6.3	6.4
NJF-93	6.3	7.3	6.3	5.7	6.4
MB65-93	7.0	6.7	6.7	5.7	6.3
Brittany	6.7	6.3	6.3	6.3	6.3
MB63-93	7.0	6.7	6.0	6.0	6.2
ISI-FC-62	6.0	6.3	6.7	5.3	6.1
Jasper	7.3	6.3	6.7	5.3	6.1
MB64-93	7.3	6.3	7.0	5.0	6.1
Seabreeze	6.3	6.3	7.3	4.7	6.1
ZPS-MG	7.0	6.0	6.3	5.7	6.0
Scaldis	5.0	6.3	5.7	6.0	6.0
WX3-FF54	5.0	6.3	6.3	5.3	6.0
Victory (E)	6.3	5.7	6.3	5.7	5.9
Brigade	6.3	5.7	6.3	5.7	5.9
SR 5100	6.0	5.7	6.3	5.7	5.9
Bridgeport	7.0	6.3	5.7	5.7	5.9
TMI-3CE	5.7	6.0	6.0	5.7	5.9
WX3-FFG6	6.0	6.7	6.0	5.0	5.9
Pick 4-914	6.3	6.0	5.7	5.7	5.8
CAS FR13	7.0	7.0	5.7	4.7	5.8
Discovery	4.7	6.0	5.7	5.7	5.8
MB66-93	7.0	6.0	6.3	5.0	5.8
Banner II	5.7	6.0	6.0	5.3	5.8
Jamestown II	5.3	6.0	6.0	5.3	5.8
PRO 92/20	5.7	6.0	6.0	5.0	5.7
PRO 92/24	5.7	5.7	6.0	5.3	5.7
BAR Frr 42DB	6.7	5.7	6.3	5.0	5.7
Shadow E	7.0	7.0	5.7	4.3	5.7
Aruba	6.3	7.0	6.0	4.0	5.6

Table 1. Performace of fineleaf fescue cultivars at Manhattan, KS, 1994.

Cultivar		Visual Quality			
	Green-up	May	July	September	Average
WVPB-STCR-101	7.0	6.3	5.3	5.3	5.7
Tiffany	6.0	6.3	5.7	4.7	5.6
Nordoz	5.3	5.7	6.3	4.7	5.6
MB82-93	6.3	5.7	6.0	5.0	5.6
MB81-93	6.3	6.0	5.0	5.7	5.6
Dawson	6.3	6.7	5.7	4.3	5.6
Aurora/Endophyte	5.3	6.0	6.0	4.7	5.6
EcoStar	6.7	5.7	6.3	4.7	5.6
Medina	7.0	6.3	5.3	5.0	5.6
Darwin	6.0	6.0	6.3	4.3	5.6
Reliant II	5.7	5.0	5.7	5.7	5.4
Flyer	5.7	7.0	5.3	4.0	5.4
Jamestown	6.3	5.3	6.3	4.7	5.4
PST-4ST	6.3	6.7	5.3	4.0	5.3
SR 3100	5.3	5.3	5.7	5.0	5.3
MB83-93	5.3	5.0	6.0	5.0	5.3
Spartan	7.7	5.7	6.0	4.0	5.2
BAR UR 204	6.0	5.7	6.0	4.0	5.2
Molinda	6.7	5.3	5.7	4.3	5.1
Common Creeping	6.3	6.3	5.7	3.3	5.1
MED 32	6.3	5.0	5.7	4.3	5.0
Rondo	5.7	6.3	5.3	3.3	5.0
FO 143	6.0	5.3	5.0	4.0	4.8
Pamela	6.3	5.7	5.3	3.3	4.8
Cascade	7.3	6.0	5.7	2.3	4.7
67135	7.0	3.7	3.3	4.0	3.7

TITLE: National Buffalograss Cultivar Trial

OBJECTIVE: To evaluate the performance of 22 buffalograss cultivars and experimental selections under Kansas conditions.

PERSONNEL: John C. Pair and Yaling Qian

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Bufffalograss is the only native species used for turfgrass in Kansas. Its heat and drought tolerance and the introduction of many new selections have aroused considerable interest in growing buffalograss in low maintenance turf situations. In addition, both seeded and vegetative types are now available but not yet fully evaluated. Evaluation was done in Wichita and Manhattan.

MATERIALS AND METHODS:

Wichita:

As part of the National Turf Evaluation Program sponsored by USDA, 22 selections were established on July 1, 1991. All entries, even seeded types previously sown in the greenhouse, were plugged on 1-ft centers. Fertilizer was lightly incorporated at the rate of 1 lb N/1000 sq ft as 13-13-13 prior to planting. A preemergent herbicide, XL granules containing Surflan and Balan, was applied at 100 lbs/acre (2.12 lbs/1000 sq ft) on July 2 after planting. In 1994, Dimension was applied preemergence on April 14 . Plots were maintained under a low fertility regime of 1 lb N/1000 sq ft per season and moderate drought stress with only occasional irrigation.. Plots were split with mowing heights of 1½ and 3 in. and clippings returned.

Manhattan:

Cultivars were plugged in June 1991. In 1994, fertilizer was applied in July to provide 1 lb of N/1000 sq ft. Turf was mowed weekly at 2.5 in. No irrigation was applied. Turf quality was rated on a 0 to 9 scale based on overall appearance, where 9 = optimum quality. Quality components were color, density, sex expression, plot coverage, and turf vigor. Grass green up was rated in May on a 0 to 9 scale, with 9 = best. Wilt was rated in September on a 0 to 9 scale, where 0 = brown and 9 = no wilt.

RESULTS:

Wichita:

Data were taken on genetic color, density, and visual turf quality. Preliminary data indicate darker green color on Plains, NE84-609, NTDG-1, and Bison (Table 1). Selections rated superior in density included AZ143, Buffalawn, NE84-315, NE84-436, NE85-378, and NTDG-2. NE84-609 was rated highest quality under a mowing height of 1.5 inches. Cultivars that appeared to have above average turf quality when mowed at 3 inches were Bison, Plains, NE 84-609, NTDG-4, Sharp's Improved, and Texoka.

Some herbicide injury occurred when Trimec was applied on August 7, 1993. Although the temperature was below 85°F on the day of application, it rose to near 90°F on the following day. The response appeared to be varietal, and NE84-45-3, AZ143, Highlight 25, Prairie, and Plains were most affected, but all recovered from injury in a few days. NE85-378 was largely unaffected.

Manhattan:

Highest green-up scores in the spring were given to NE-84-315 (Table 2). Highest seasonal mean turf quality was observed for NE 84-436, Buffalawn, and NE 85-378, followed by Texoka, NTDG-4, AZ 143, NTDG-3, and NE 84-609. Most resistant to wilt was Highlight 15, followed by Buffalawn, Highlight 4, and Prairie.

Table 1. Performance of buffalograss cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Spring Green-up 4/22/94	Genetic Color 6/15/94	Density 6/15/94	Quality 6/15/94	Quality 7/23/94	Quality 9/30/94	Quality Average
Mowed at 1.5 in.							
AZ143	7.3	7.0	8.3	7.3	5.5	7.1	6.6
Topgun(BAM101)	6.0	7.3	7.5	7.3	7.2	7.3	7.3
Plains(BAM202)	7.7	8.0	6.5	7.5	7.8	7.3	7.5
Bison	7.7	8.0	5.7	7.2	7.5	6.8	7.1
Buffalawn	3.7	6.0	8.0	6.8	7.2	7.3	7.1
Highlight 4	3.0	6.2	6.3	6.7	6.0	6.3	6.3
Highlight 15	4.0	6.0	6.8	6.5	6.5	6.6	6.5
Highlight 25	3.3	5.5	5.8	6.0	5.3	5.7	5.7
NE 84-45-3	5.7	7.5	7.8	6.8	6.7	7.1	6.9
NE 84-315	6.8	7.3	8.5	7.5	6.5	7.5	7.2
NE 84-436	7.8	7.0	8.5	7.5	6.7	7.6	7.2
NE 84-609	7.2	7.3	7.7	7.7	8.0	7.8	7.8
NE 85-378	7.0	7.5	8.3	7.5	6.7	7.5	7.2
NTDG-1	6.5	7.8	7.5	7.5	7.3	7.4	7.4
NTDG-2	6.8	7.5	8.2	7.3	6.3	7.3	7.0
NTDG-3	6.7	7.2	7.8	7.3	6.8	7.3	7.2
NTDG-4	6.5	6.8	7.8	7.3	6.5	7.2	7.0
NTDG-5	6.5	7.5	7.7	7.5	6.7	7.3	7.1
Prairie	6.3	6.0	7.2	6.5	6.8	6.8	6.7
Rutger's	3.0	6.3	7.2	7.0	7.0	7.1	7.0
Sharp's Improved	7.3	7.7	6.7	7.5	7.3	7.2	7.3
Texoka	7.0	7.0	7.3	7.2	7.5	7.3	7.3
Mowed at 3 in.							
AZ143	7.3	7.0	8.3	7.0	5.7	4.7	5.8
Topgun(BAM101)	6.0	7.3	7.5	7.3	7.3	6.0	6.9
Plains(BMA202)	7.7	8.0	6.5	7.2	7.7	6.5	7.1
Bison	7.7	8.0	5.7	7.0	7.7	7.2	7.3

Table 1. Performance of buffalograss cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Spring Green-up 4/22/94	Genetic Color 6/15/94	Density 6/15/94	Quality 6/15/94	Quality 7/23/94	Quality 9/30/94	Quality Average
Buffalawn	3.7	6.0	8.0	7.3	7.0	6.0	6.8
Highlight 4	3.0	6.2	6.3	6.5	6.3	5.7	6.2
Highlight 15	4.0	6.0	6.8	6.7	6.2	5.0	5.9
Highlight 25	3.3	5.5	5.8	6.3	5.0	4.7	5.3
NE 84-45-3	5.7	7.5	7.8	6.7	6.7	4.7	6.0
NE 84-315	6.8	7.3	8.5	7.5	6.0	5.7	6.4
NE 84-436	7.8	7.0	8.5	7.0	6.5	5.8	6.4
NE 84-609	7.2	7.3	7.7	7.7	7.7	8.7	8.0
NE 85-378	7.0	7.5	8.3	7.3	6.0	6.8	6.7
NTDG-1	6.5	7.8	7.5	7.3	7.2	5.7	6.7
NTDG-2	6.8	7.5	8.2	7.3	6.5	6.0	6.6
NTDG-3	6.7	7.2	7.8	7.3	6.8	5.7	6.6
NTDG-4	6.5	6.8	7.8	7.5	7.0	6.5	7.0
NTDG-5	6.5	7.5	7.7	7.0	6.3	6.5	6.6
Prairie	6.3	6.0	7.2	6.8	6.0	7.0	6.6
Rutger's	3.0	6.3	7.2	6.7	6.8	6.0	6.5
Sharp's Improved	7.3	7.7	6.7	7.0	7.5	7.0	7.2
Texoka	7.0	7.0	7.3	7.0	7.3	6.7	7.0

[1] Established on July 1, 1991.

Table 2. Turf quality, green-up, and wilting resistance for buffalograss at Manhattan, KS, 1994.

Cultivar	Quality						Green-up	Wilt
	May	June	July	August	September	Mean		
NE 84-315	5.0	8.0	6.7	5.0	3.3	5.6	5.3	4.3
NE 84-609	3.3	7.3	8.7	6.0	5.3	6.1	2.3	5.7
NE 84-436	4.7	7.7	8.7	7.0	5.7	6.7	3.7	4.0
NE 84-453	4.3	5.7	6.3	2.3	3.3	4.4	3.7	3.3
NE 85-378	4.7	8.3	8.0	6.7	5.3	6.6	4.3	5.0
Buffalawn	2.0	7.3	8.0	7.7	8.3	6.7	1.0	7.0
AZ 143	5.0	7.0	8.0	6.3	4.7	6.2	4.3	3.7
Highlight 4	2.0	3.7	5.7	3.7	4.3	3.9	1.0	7.0
Highlight 15	2.0	6.7	5.7	6.7	6.0	5.4	1.0	7.3
Highlight 25	2.3	7.3	7.0	5.7	5.7	5.6	1.0	6.7
Prairie	3.0	7.0	6.3	5.3	5.0	5.3	1.7	7.0
Rutgers	2.3	6.0	6.3	5.0	5.0	4.9	1.0	6.3
Sharps Imp*	3.7	6.3	7.7	6.0	5.7	5.9	3.7	5.3
NTDG-1*	4.0	7.0	7.7	5.0	5.0	5.4	3.0	5.0
NTDG-2*	4.0	6.7	7.0	5.0	4.3	5.7	3.3	3.7
NTDG-3*	4.0	6.3	7.3	6.7	6.7	6.2	3.3	5.0
NTDG-4*	4.3	7.3	8.3	6.0	5.7	6.3	2.7	4.3
NTDG-5*	5.0	7.3	7.3	6.3	4.0	6.0	3.7	4.0
Bison*	3.3	6.7	7.0	6.0	6.3	5.9	3.0	5.7
Bam 101*	3.7	6.3	7.0	5.0	4.7	5.3	3.3	4.3
Bam 202*	3.0	6.3	6.3	4.7	4.3	4.9	3.7	5.7
Texoka*	4.7	7.3	8.0	6.3	5.7	6.4	4.0	6.0
MSD	0.7	1.6	2.0	2.6	2.6	1.1	0.8	1.0

*Indicates seeded types. All others must be established vegetatively.

**If the difference between two cultivar means is larger than the MSD value, they are significantly different.

TITLE: National Zoysiagrass Cultivar Trial

OBJECTIVE: To evaluate 24 cultivars and experimental numbers under Kansas conditions.

PERSONNEL: John C. Pair and Ned Tisserat

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Zoysiagrass is one of the hardiest warm-season turfgrass species grown in the transition zone. In addition to common Korean zoysiagrass (Zoysia japonica), few cultivars have been introduced that offer advantages of more rapid establishment and higher turf qualities. As water restrictions increase, this drought-resistant species may again become a popular choice, especially if more attractive cultivars are available.

MATERIALS AND METHODS:

Twenty-four selections, including the standard Meyer (Z-52) were provided by USDA-NTEP for evaluation. All were established from vegetative plugs on June 11, 1991 on 12 inch centers. Fertilizer was incorporated prior to planting at the rate of 1 lb N-P-K/1000 sq ft as 13-13-13. An additional application of fertilizer containing Atrazine was made in September. Mowing was at 1 inch with clippings returned.

RESULTS:

Preliminary data indicated that DALZ 8512 had the most rapid establishment and covered plots in 11 months. Atrazine injury occurred on JZ-1, Belair, Korean Common, and TGS-B10. Winter injury was apparent on Belair, Emerald, DALZ 8501, DALZ 8502, DALZ 8508, DALZ 8701, and JZ-1, perhaps partially because of the phytotoxicity of Atrazine for certain cultivars. Early spring green-up was particularly good on TC 5018, Sunburst, Belair, CD259-13, Korean Common, and TGS-W10 .

Vigorous selections that established quicker than Meyer in addition to DALZ 8512 were El Toro, DALZ 8514, GT 2047, CD 259-13, CD 2013, TC 5018, and TC 2033 (Table 1). Selections with highest quality ratings were Belair, Meyer, TC 2033, CD 2013, Emerald, and TC 5018, followed by DALZ 8512, DALZ 8507, DALZ 8508, DALZ 8516, GT 2004, and Sunburst.

Table 1. Performance of zoysiagrass cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Green-up 4/26/94	Quality 5/27/94	6/29/94	7/30/94	8/31/94	9/30/94	Average
Belair	8.3	7.7	7.7	8.0	8.2	7.5	7.8
CD259-13	8.3	6.8	7.5	7.7	7.3	6.5	7.2
CD2013	7.0	6.8	7.5	7.3	7.8	7.8	7.5
DALZ8501	3.0	5.3	5.0	6.3	6.5	7.0	6.0
DALZ8502	3.3	5.7	8.0	7.5	7.3	7.7	7.2
DALZ8507	6.3	6.5	7.8	7.3	7.5	7.2	7.3
DALZ8508	4.7	6.2	7.3	7.3	7.8	8.0	7.3
DALZ8512	7.3	6.5	7.8	8.0	7.3	7.2	7.4
DALZ8514	6.0	6.0	7.7	7.2	7.5	7.3	7.1
DALZ8516	5.0	5.3	8.0	7.8	7.5	7.8	7.3
DALZ8701	2.3	4.7	4.7	5.5	5.5	5.3	5.1
DALZ9006	3.3	6.0	6.5	7.0	7.7	7.7	7.0
El Toro	6.0	5.7	8.0	7.2	7.5	7.0	7.1
Emerald	4.7	7.2	8.2	7.8	7.7	7.8	7.7
GT2004	6.0	6.2	7.0	7.2	8.0	8.0	7.3
GT2047	7.3	6.5	6.5	6.8	6.3	6.8	6.6
JZ-1 lot #A89-1	7.7	4.7	5.7	5.3	5.0	6.0	5.3
Korean Common	8.0	5.7	5.3	5.7	5.3	5.7	5.5
Meyer	7.7	7.5	7.7	7.8	8.7	8.2	8.0
Sunburst	8.7	6.7	7.8	6.8	7.5	7.5	7.3
TC2033	5.7	7.0	8.0	7.3	8.0	8.7	7.8
TC5018	8.7	6.7	7.2	8.2	7.7	7.7	7.5
TGS-B10	7.7	6.5	7.0	7.5	7.7	6.5	7.0
TGS-W10	8.0	6.0	6.8	7.0	6.8	6.8	6.7

[1] Established on June 11, 1991. Quality based on a scale of 0 - 9 w/9 = best green-up and visual turf quality.

TITLE: National Bermudagrass Cultivar Trial

OBJECTIVE: To evaluate both seeded and vegetative cultivars and experimental numbers for performance under Kansas conditions.

PERSONNEL: John C. Pair and Ned Tisserat

SPONSORS: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Greater hardiness and finer quality of new bermudagrass introductions have once again aroused the interest of turfgrass managers in this wear-resistant and low water-demand turf species. The development of hardy seeded types provides greater winter survival than available with Arizona common. New vegetative cultivars with spring dead spot resistance and greater sod strength offer more choices for both sod growers and consumers.

MATERIALS AND METHODS:

A national turf evaluation program (NTEP) cultivar trial, coordinated by USDA and consisting of 26 selections, was established on June 23, 1992. Entries included 16 seeded types and 10 vegetative selections. Four miscellaneous KSU clones also were included. Plots were maintained at 4 lbs actual N/1000 sq ft and mowed at 1 in. with clippings removed. Qualities rated included color, texture, and visual quality from May to September and spring green-up in April. In subsequent years, resistance to spring dead spot will be evaluated.

RESULTS:

In preliminary observations during the first season, highest quality ratings were given to vegetative types Midlawn, Midway, and Tifway, although the latter is not expected to be hardy in Kansas. The highest rated seeded type was OKS 91-11, which also exhibited early green-up, as did J-27 and Guymon. Darkest green color occurred on OKS91-11, Tifway, STF-1, and Midway, followed closely by Midlawn. Finest texture was rated on FHB-135 (a very refined Florida introduction of doubtful hardiness). Midiron and Midlawn continued to exhibit excellent hardiness and early green-up (Table 1). Hardiness of bermudagrass really was not tested under the conditions of the past winter.

In 1994, improved cultivars continued to outperform Arizona Common with the highest overall quality given to Tifway and Midlawn followed by Midfield and Midiron, all vegetative types. Highest rated seeded types were OKS 91-11, J-7, Guymon, and 90173. Earliest green-up occurred on J-27 and 90173. Miscellaneous clones A-7 and A-12 also excelled in early spring green-up and overall quality.

Table 1. Performance of bermudagrass cultivars at Wichita, KS, 1994.[1]

Cultivar or Accession No.	Spring Green-up 4/22/94	Quality				
		5/31/94	7/27/94	8/25/94	9/30/94	Average
Seeded entries						
Arizona Common	3.7	5.3	6.5	5.2	5.7	5.7
Cheyenne	2.7	4.7	6.8	4.7	5.4	5.4
FMC 1-90	3.0	5.3	7.0	5.1	5.8	5.8
FMC 2-90	3.0	4.8	7.2	5.0	5.7	5.7
FMC 3-91	2.7	5.3	5.7	4.6	5.2	5.2
FMC 5-91	3.7	6.2	7.0	5.6	6.3	6.3
FMC 6-91	3.0	6.0	7.8	5.6	6.5	6.5
Guymon	7.3	7.0	7.2	7.2	7.1	7.1
J-27	7.7	7.3	7.5	7.5	7.4	7.4
J-912	4.0	6.5	6.7	5.7	6.3	6.3
OKS 91-1	3.0	6.0	6.5	5.2	5.9	5.9
OKS 91-11	6.0	7.5	7.7	7.1	7.4	7.4
Sahara	2.7	4.8	5.7	4.4	5.0	5.0
Sonesta	3.0	5.7	6.0	4.9	5.5	5.5
Sundevil	5.0	6.2	6.7	5.9	6.3	6.3
90173	6.7	6.8	7.2	6.9	7.0	7.0
Vegetative entries						
A-7	7.7	8.0	8.2	7.9	8.0	8.0
A-12	8.0	7.7	8.0	7.9	7.9	7.9
Arizona Common	2.7	3.7	5.2	3.8	4.2	4.2
E-7	6.7	8.0	8.2	7.6	7.9	7.9
FHB-135	5.0	6.3	7.2	6.2	6.6	6.6
Midfield	5.3	8.0	8.0	7.1	7.7	7.7
Midiron	7.0	7.7	7.8	7.5	7.7	7.7
Midlawn	6.7	7.8	8.7	7.7	8.1	8.1
STF-1	5.0	7.7	8.2	6.9	7.6	7.6
TDS-BM1	6.0	7.3	7.8	7.1	7.4	7.4
Texturf 10	4.0	4.7	6.8	5.2	5.6	5.6
Tifgreen	5.7	7.2	7.3	6.7	7.1	7.1
Tifway	5.0	8.0	9.0	7.3	8.1	8.1

[1] Established on June 23, 1992.

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