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KANSAS STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE

2002

TURFGRASS RESEARCH

Report of Progress 894

K-State Turfgrass Researchers

Researchers at Kansas State University are dedicated to improving turf quality in Kansas. Turfgrass research is conducted at field centers in Manhattan and Wichita. Members of the K-State turf team and their responsibilities are:

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FOREWORD

There is no rest for weary turfgrass managers in Kansas. In 2001, many of us were brought to our knees, literally -- it allowed for a better view of winter-damaged zoysiagrass, brown patch- infested tall fescue, or anthracnose-stricken creeping bentgrass.

K-State's turfgrass research team is growing. We have four faculty in horticulture and one in plant pathology who dedicate their research efforts to improving turfgrass in Kansas. We also have balance, with work addressing fundamental turfgrass management problems like water management, stand establishment, weed control, and disease management. We are also striving to provide balance in serving needs across the industry including golf course superintendents, lawn care operators, and athletic field managers. Kansas turf industry members should be proud of the support they've provided for the K-State research program. You have helped make the program strong, and we'll only get stronger.

This publication contains results of projects done throughout 2001 by K-State turfgrass researchers. Keep this research report handy -- it can be useful all year long. We also make this information available on our web site at: *www.oznet.ksu.edu/horticulture*. You can see many of these projects in progress on August 1, 2002 at the Kansas Turfgrass Field Day at the Rocky Ford Research Center in Manhattan.

As always, we're interested in hearing your ideas about future research projects. Many of our projects start as ideas that arise from people like you. Speak up! We'd love to hear what you're thinking.

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TITLE: Water Savings and Performance of Four Turfgrasses under Deficit Irrigation

OBJECTIVES: To evaluate the performance of zoysiagrass, bermudagrass, tall fescue and Kentucky bluegrass at varying levels of deficit irrigation; determine seasonal water requirements for each of these species; and determine minimum water requirements for maintenance of acceptable visual quality.

PERSONNEL: Jinmin Fu, Jack Fry, and Bingru Huang

SPONSORS: Turf Producers International

INTRODUCTION:

Turfgrass water use rates often exceed natural precipitation, and during extended periods without rainfall, restrictions may be imposed limiting the amount of water that can be applied to turf areas. As such, researchers have sought to identify turf species and cultivars that have good drought resistance and irrigation management techniques to reduce water inputs.

Turf managers overseeing installation of new golf courses, housing developments, and other turf areas are commonly report to government administrators how much irrigation water will be required to maintain an acceptable quality landscape. Sod producers also face growing concerns regarding water requirements to allow satisfactory harvest and sale of turf. Determining the amount of water required to maintain acceptable quality of various turfgrass species throughout the growing season in the transition zone would be of benefit to Kansas turfgrass managers.

MATERIALS AND METHODS:

The experiment was conducted using an automated, mobile rainout shelter (180 m^2, 1936 ft^2) at the Rocky Ford Turfgrass Research Center at Manhattan, KS. 'Meyer' zoysiagrass, 'Midlawn' bermudagrass, 'Falcon II' tall fescue and 'Brilliant' Kentucky bluegrass were sodded in spring 2000 in plots measuring 5.9 by 1.8 m (19.3 by 5.9 ft) to represent whole plots in a split-plot design with three replications. Sub-plots consisted of irrigation levels of 20, 40, 60, 80, and 100% evapotranspiration (ET) applied twice weekly through a metered, hand-held hose.

Turf was mowed twice weekly, just before plots were watered, at 6 cm (2.4 inches). Nitrogen from urea (46-0-0 NPK) was applied at 49 kg ha^{-1} (1 lb N/1000 ft^2) for tall fescue and Kentucky bluegrass in May and September, and bermudagrass and zoysiagrass received an equivalent level of N in May and June.

Data were collected on soil water content, turf quality, ET, relative leaf water content (RWC), and leaf electrolyte leakage (EL).

Treatment effects were determined by analysis of variance according to the mixed procedure of the Statistical Analysis System. Variation was partitioned into grass species, deficit irrigation level, and treatment duration (sampling time). Treatment means were separated by a least significant difference test ($P = 0.05$).

RESULTS:

Soil water content decreased below that of turf receiving 100% ET beginning at 8 d of treatment for Kentucky bluegrass and zoysiagrass receiving 20% ET (Table 1). At 25 d, Bermuda (20% ET) and tall fescue (20 and 40% ET) had lower soil water levels than turf receiving 100% ET. Irrigation at 40% ET reduced soil water content of bermudagrass, tall fescue and zoysiagrass to below the level of turf in 100% ET plots beginning at 40, 25 and 15 d into treatment, respectively. At 60% ET, soil under bermudagrass and zoysiagrass was drier than that receiving 100% ET beginning at 40 d. Generally, compared to Kentucky bluegrass and zoysiagrass, tall fescue and bermudagrass had higher soil water contents at a given irrigation level.

Table 1. Soil water content (v/v) of four species in response to deficit irrigation at Manhattan, KS in 2001.

Species	%ET	Days of treatment								
		8	15	25	40	46	53	60	81	95
Bluegrass	20	23.3 d[1]	19.9 b	19.2 c	16.2 b	15.0 b	17.4 b	14.4 c	16.2 b	16.0 c
Bluegrass	40	29.6 c	22.2 ab	26.5 ab	21.1 a	20.1 a	21.9 a	18.5 b	22.6 a	23.8 b
Bluegrass	60	31.1 bc	25.3 a	24.4 b	21.7 a	21.4 a	21.5 a	18.6 b	21.9 a	23.2 b
Bluegrass	80	32.4 ab	25.5 a	26.7 ab	22.2 a	22.5 a	23.9 a	19.6 ab	23.9 a	25.7 ab
Bluegrass	100	33.7 a	26.8 a	30.2 a	24.0 a	23.4 a	23.2 a	20.8 a	24.7 a	26.5 a
Tall fescue	20	29.5 b	24.8 a	24.4 b	22.9 b	22.1 b	22.6 c	21.4 b	22.9 c	21.8 b
Tall fescue	40	29.9 b	26.3 a	26.0 b	25.2 b	23.9 b	25.5 bc	22.9 b	25.1 bc	24.0 b
Tall fescue	60	32.9 a	27.9 a	29.4 a	28.2 ab	27.9 a	28.3 ab	26.6 a	29.6 a	28.4 a
Tall fescue	80	32.3 a	29.3 a	30.0 a	29.7 a	29.2 a	29.9 a	27.4 a	30.9 a	30.7 a
Tall fescue	100	32.1 a	28.2 a	29.6 a	27.2 ab	28.1 a	28.8 ab	26.1 a	27.6 ab	29.4 a
Bermuda	20	30.9 b	27.5 a	23.2 b	22.4 ab	22.0 ab	22.0 b	19.9 c	20.8 c	22.1 b
Bermuda	40	32.5 ab	27.6 a	27.1 a	22.8 ab	22.2 ab	22.3 ab	20.9 bc	27.7 ab	23.6 b
Bermuda	60	32.8 ab	27.6 a	26.4 ab	22.0 b	20.7 b	21.6 b	20.6 bc	25.0 b	24.6 b
Bermuda	80	33. a	29.0 a	28.4 a	23.6 ab	23.0 ab	23.8 ab	22.0 b	30.1 a	29.5 a
Bermuda	100	34.6 a	30.2 a	28.6 a	25.9 a	25.6 a	26.4 a	24.8 a	30.3 a	29.0 a
Zoysia	20	26.9 b	26.2 b	15.8 c	12.2 d	14.5 c	11.6 d	10.2 e	13.8 c	12.3 d
Zoysia	40	32.9 a	24.7 b	20.4 b	17.3 c	16.0 bc	17.5 c	14.2 d	20.2 b	15.9 c
Zoysia	60	31.4 a	25.6 b	23.7 ab	20.2 bc	19.2 ab	19.7 bc	17.1 c	19.2 b	20.3 b
Zoysia	80	32.0 a	26.8 b	26.6 a	22.7 b	22.0 a	25.8 a	20.2 b	25.9 a	26.5 a
Zoysia	100	34.1 a	31.9 a	27.0 a	27.1 a	22.2 a	23.0 ab	23.2 a	25.9 a	25.6 a

[1] Means within column in a given species followed by the same letters are not significantly different (*P*=0.05).

Kentucky bluegrass and tall fescue had similar ET rates, as did bermudagrass and zoysiagrass (Table 2). Deficit irrigation reduced evapotranspiration of each species during the entire experimental period. Minimum irrigation amounts required between 4 June and September to maintain a level of quality equal to turf receiving 100% ET ranged from 220 mm (8.7 in.) for bermudagrass to 552 mm (21.7 in.) for Kentucky bluegrass.

Kentucky bluegrass quality was lower than that of turf receiving 100% ET beginning at 10 DAT at 20% ET; at 22 DAT at 40% and 60% ET; and at 51 DAT at 80% ET (Table 3). Tall fescue experienced a similar reduction in quality compared to turf irrigated at 100% ET, beginning 44 DAT at 20% ET and 51 DAT at 40% ET. Bermudagrass quality declined below the 100% ET treatment beginning at 51 DAT at 20% ET. Zoysiagrass quality began to decline relative to the 100% ET level beginning at 22 DAT at 20%, 40% and 60% ET.

Leaf relative water content (LRWC) of Kentucky bluegrass receiving 20%, 40% and 60% ET was equivalent to that receiving 100% ET until 9, 22, and 38 DAT, respectively (Table 4). Tall fescue irrigated at 20% and 40% ET had a significantly lower LRWC beginning at 22 and 66 DAT, respectively. LRWC dropped below that of turf irrigated at 100% ET beginning at 66 DAT for bermudagrass receiving 20% ET and at 22 DAT for zoysiagrass receiving 20% and 40% ET. Irrigation level (% of ET) where < RWC was maintained at the same level turf receiving 100% ET was 100% for Kentucky bluegrass, 60 % for tall fescue, 40 % for bermudagrass and 80 % for zoysiagrass (Table 5).

Irrigation level (% of ET) where turf quality was maintained at the same level turf receiving 100% ET is 100% for Kentucky bluegrass, 60 % for tall fescue, 40 % for bermudagrass and 80 % for zoysiagrass (Table 5). In Kentucky bluegrass, any reduction in irrigation below 100% ET resulted in higher levels of EL, indicating that some stress and injury to leaves had occurred. In tall fescue and zoysiagrass, any reduction in ET below 60% caused significantly higher levels of EL. Irrigation had to drop to 40% ET in bermudagrass before EL was lower than turf receiving irrigation at 100% ET.

Table 2. Evapotranspiration (ET) rates of four turfgrass species, and minimum irrigation amounts required to maintain quality equivalent to turf receiving irrigation at 100% ET.

Species	ET (mm)*		Minimum irrigation (mm)	
	Daily	Total	Daily	Total
Kentucky bluegrass	5.58 a	552 a	5.58 a	552 a
Tall fescue	5.68 a	562 a	3.73 b	370 b
Bermudagrass	4.11 b	407 b	2.22 d	220 d
Zoysiagrass	3.94 b	390 b	3.29 c	326 c

Means followed by the same letters within a column are not significantly different (P = 0.05) based on a LSD test.

Table 3. Turf quality of four species in response to deficit irrigation at Manhattan, KS in 2001.

		Turf Quality										
		Days of Treatment										
		10	15	22	32	37	44	51	65	72	80	92
Bluegrass	20	6.0 b[1]	5.7 b	3.3 c	2.0 c	1.3 d	1.0 d	0.8 e	0.7 d	0.7 c	0.7 d	1.0 e
Bluegrass	40	8.0 a	7.7 a	5.0 b	3.0 c	3.3 c	2.7 c	2.3 d	1.3 d	1.7 c	2.3 c	2.3 d
Bluegrass	60	8.0 a	8.0 a	5.7 b	4.3 b	4.3 b	4.7 b	3.7 c	2.7 c	3.3 b	2.7 c	3.3 c
Bluegrass	80	7.7 a	8.0 a	7.7 a	6.3 a	6.0 a	6.0 a	5.7 b	4.0 b	5.3 a	4.7 b	4.7 b
Bluegrass	100	8.0 a	8.0 a	8.0 a	6.7 a	6.7 a	7.0 a	7.0 a	5.0 a	6.0 a	5.7 a	5.7 a
Tall fescue	20	8.0 a	8.0 a	7.7a	7.0 a	7.0 a	6.7 b	6.0 c	5.0 c	5.0 b	4.7 c	5.0 b
Tall fescue	40	8.0 a	8.0 a	7.7 a	7.7 a	7.7 a	7.3 ab	7.0 b	6.0 b	6.0 ab	5.7 bc	6.0 b
Tall fescue	60	7.7 a	8.0 a	8.0 a	8.0 a	7.7 a	8.0 a	8.0 a	6.7 ab	7.0 a	7.0 a	7.3 a
Tall fescue	80	8.0 a	8.0 a	7.7 a	8.0 a	7.7 a	8.0 a	8.0 a	7.0 a	7.0 a	6.7 ab	7.3 a
Tall fescue	100	7.8 a	7.8 a	8.0 a	7.7 a	8.0 a	8.0 a	8.0 a	7.0 a	7.0 a	7.3 a	7.7 a
Bermuda	20	7.0 a	8.0 a	7.3 a	7.7 a	7.0 a	6.7 a	6.0 b	5.3 c	5.0 a	4.7 c	4.7 b
Bermuda	40	7.0 a	8.0 a	8.0 a	7.3 a	7.3 a	7.7 a	6.7 b	6.0 bc	5.7 a	5.7 ab	5.3 ab
Bermuda	60	7.3 a	8.0 a	8.0 a	7.3 a	7.7 a	7.7 a	6.7 b	6.3 ab	6.0 a	5.3 bc	6.0 a
Bermuda	80	6.7 a	8.0 a	8.0 a	7.0 a	7.3 a	7.0 a	7.0 a	6.3 ab	5.7 a	6.0 ab	5.7 ab
Bermuda	100	7.3 a	8.0 a	8.0 a	7.3 a	7.3 a	7.0 a	7.0 a	6.8 a	6.0 a	6.5 a	6.0 a
Zoysia	20	7.7 a	7.7 a	5.3 c	4.0 c	2.3 d	2.7 c	2.0 d	2.0 d	2.3 e	1.3 d	2.3 d
Zoysia	40	7.3 a	8.0 a	7.0 b	5.0 bc	4.3 c	3.7 c	3.7 c	4.0 c	4.0 d	3.0 c	4.3 c
Zoysia	60	7.3 a	8.0 a	7.0 b	6.0 b	5.0 b	6.0 b	5.0 b	5.7 b	5.7 c	5.0 b	6.0 b
Zoysia	80	7.7 a	8.0 a	8.0 a	8.0 a	8.0 a	8.0 a	7.7 a	8.3 a	8.7 b	7.7 a	7.7 a
Zoysia	100	7.7 a	8.0 a	8.0 a	8.3 a	8.0 a	9.0 a	8.3 a	8.7 a	9.0 a	7.7 a	8.0 a

[1] Means within column in a given species followed by the same letters are not significantly different (*P*=0.05).

Table 4. Leaf relative water content (%) of four turfgrass species in response to deficit irrigation levels of 20 to 100% of potential evapotranspiration (ET) at Manhattan, KS in 2001.

Species	Irrigation (ET%)	Days of treatment				
		9	22	38	66	93
Bluegrass	20	71.95 b[1]	73.09 c	55.90 d	41.86 c	53.51 d
Bluegrass	40	84.95 a	81.82 b	66.66 c	54.36 b	62.59 c
Bluegrass	60	81.26 a	84.08 ab	68.75 c	56.04 b	73.03 b
Bluegrass	80	81.56 a	85.42 ab	77.49 b	64.11 a	80.40 a
Bluegrass	100	82.88 a	86.95 a	82.62 a	65.22 a	86.19 a
Tall fescue	20	82.80 a	83.48 b	77.94 b	67.70 d	80.59 b
Tall fescue	40	83.21 a	81.27 b	81.97 a	74.72 c	85.24 b
Tall fescue	60	86.59 a	89.23 a	82.46 a	79.15 b	93.00 a
Tall fescue	80	84.71 a	88.03 a	85.64 a	83.28 a	92.61 a
Tall fescue	100	85.64 a	87.58 a	83.66 a	84.47 a	93.49 a
Bermuda	20	83.25 b	90.45 bc	83.22 a	63.28 b	64.92 b
Bermuda	40	85.95 ab	90.27 bc	86.13 a	64.49 b	68.40 a
Bermuda	60	88.30 a	95.18 a	87.82 a	66.47ab	72.36 a
Bermuda	80	85.59 ab	89.59 c	84.50 a	68.00 a	70.03 a
Bermuda	100	86.72 ab	93.56 ab	85.57 a	67.94 ab	74.64 a
Zoysia	20	80.44 a	77.77 b	65.57 d	46.30 c	57.14 c
Zoysia	40	80.63 a	80.36 b	72.58 c	63.48 b	64.55 b
Zoysia	60	81.05 a	84.88 a	80.69 b	67.58 b	78.36 a
Zoysia	80	80.97 a	86.08 a	88.63 a	83.70 a	81.53 a
Zoysia	100	78.51 a	87.10 a	90.70 a	84.05 a	84.43 a

[1] Means within column and a given species followed by the same letters are not significantly different (*P*=0.05).

Table 5. Irrigation level (% of ET) where turf quality, leaf relative water content (LRWC), and electrolyte leakage (EL) were maintained at the same level as turf receiving 100% ET for four turfgrass species at Manhattan, KS in 2001.

Species	Visual quality	LRWC	EL
Kentucky bluegrass	100	80	100
Tall fescue	60	60	40
Bermudagrass	40	40	40
Zoysiagrass	80	80	60

TITLE: Growth and Physiological Responses of Zoysiagrass and Tall Fescue to Deficit Irrigation.

OBJECTIVES: To evaluate the influence of deficit irrigation upon growth and carbon metabolism in tall fescue and zoysiagrass.

PERSONNEL: Jinmin Fu, Jack Fry and Bingru Huang

SPONSOR: Turf Producers International

INTRODUCTION:

Water availability for use in irrigating green spaces becomes limited when concerns over water shortages arise. Deficit irrigation, or application of water at levels less than potential evapotranspiration (ET), can be used as a water conservation tool. The influence of deficit irrigation on shoot and root growth and carbon metabolism in turfgrasses has not been reported. Research on growth and physiological responses of zoysiagrass and tall fescue to deficit irrigation would helpful to identify drought resistance cultivars and to manage turfgrasses.

MATERIALS AND METHODS:

The experiment was conducted using an automated, mobile rainout shelter (180 m^2, 1936 ft^2) at the Rocky Ford Turfgrass Research Center at Manhattan, KS. The study was set up as a split-plot design, with turfgrass species as the whole plot and irrigation levels as the sub-plot. ‘Meyer’ Zoysiagrass and ‘Falcon II” tall fescue were sodded in spring 2000 in 5.9 by 1.83 m (19.3 by 5.9 ft) whole plots. Sub-plot irrigation levels were 20, 40, 60, 80, and 100% of ET applied twice weekly. Each plot was bordered by metal edging to minimize lateral movement of water upon application. Turf was mowed twice weekly at 6 cm (2.4 inches). Nitrogen was applied at 49 kg ha^{-1} (1 lb N/1000 ft^2) for tall fescue in May and September, and zoysiagrass received an equivalent level of N in May and June.

Data were collected on shoot vertical elongation rate, tiller density, canopy net photosynthesis, leaf-level net photosynthesis, and water use efficiency. Treatment effects were determined by analysis of variance according to the mixed procedure of the Statistical Analysis System. Variation was partitioned into grass species, deficit irrigation level, and treatment duration (sampling time). Treatment means were separated by a least significant difference test ($P = 0.05$).

RESULTS:

Tall fescue receiving 20% and 40% ET had a significantly lower canopy vertical growth rate (CVAR) than that receiving 100% ET, beginning at 30 DAT (Fig. 1). Zoysiagrass receiving 20%, 40% and 60% ET had a significantly lower CVAR, beginning at 19 DAT. However, CVAR of zoysiagrass receiving 60% ET recovered to the level of turf receiving 100% ET near the end of study. Irrigation at 20% ET reduced turf plant density of tall fescue to below the level of turf irrigated at 100% ET beginning 44 DAT (Fig. 2). Zoysiagrass receiving 20% and 40% ET had a significantly lower plant density than turf at 100% ET during most of the study period.

Canopy net photosynthesis of tall fescue irrigated at 20% ET was reduced to below that of turf receiving 100% ET beginning at 44 DAT (Fig. 3). Zoysiagrass irrigated at 20, 40 or 60% ET had a lower CNP than that at 100% ET during most of experimental period. Irrigation levels of 20% and 40% ET reduced whole plant respiration compared to turf receiving 100% ET beginning at 44 DAT for tall fescue and at 30 DAT for zoysiagrass (Fig. 4). However, irrigation at 60% ET reduced whole plant respiration of zoysiagrass beginning at 44 d, but did not affect tall fescue whole plant respiration compared to turf receiving 100% ET. Tall fescue leaf-level photosynthesis when irrigated at 60% ET or above was equivalent to turf receiving 100% ET (Fig. 5). However, zoysiagrass irrigated at 60% ET or less had lower leaf level photosynthesis rates than turf irrigated at 100% ET.

Water use efficiency is an indicator of the amount of water lost through ET relative to the amount of carbon fixed. In general, zoysia had higher WUE levels than tall fescue at a given irrigation level, especially at irrigation levels above 40% ET (Fig. 6). Irrigation at 20% and 40% ET reduced WUE for zoysiagrass during most of the experimental period.

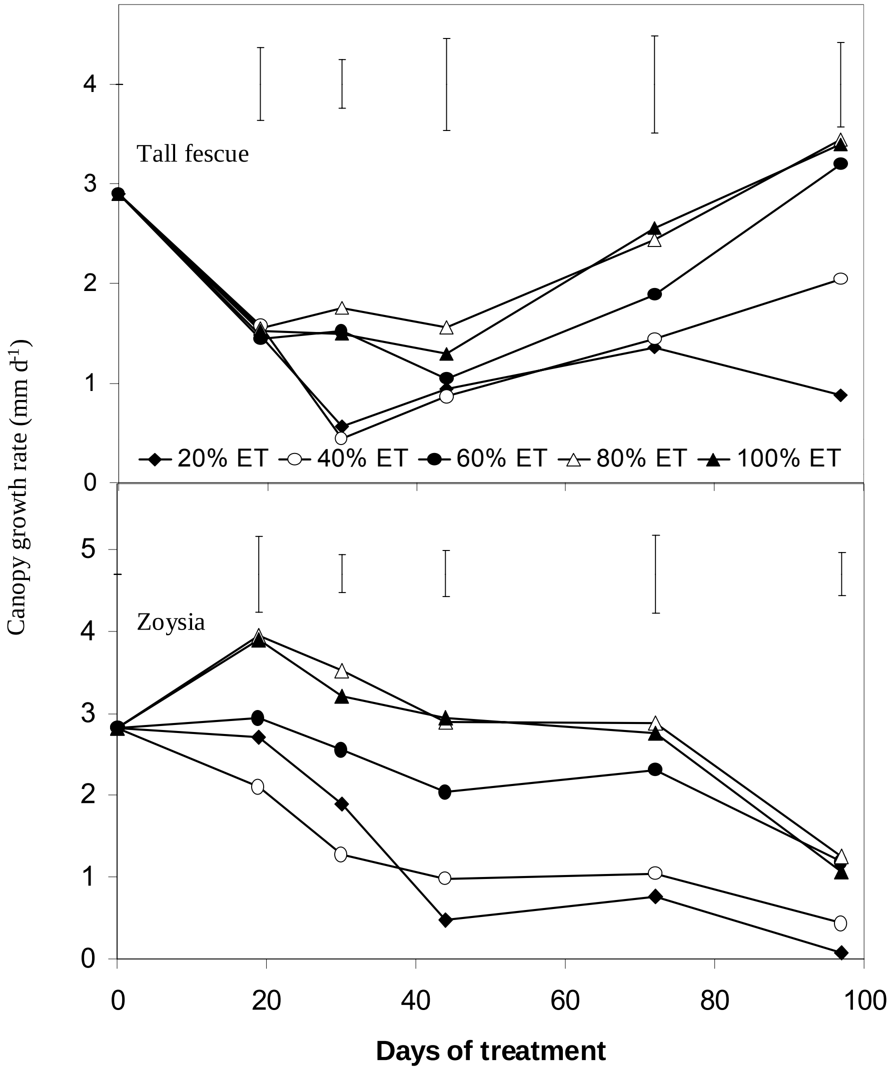

Fig. 1 Canopy growth rate of tall fescue and zoysia grass in response to deficit irrigation. Vertical bars are LSD values (*P=0.05*) for treatment comparisons within a grass species and at a given day of treatment

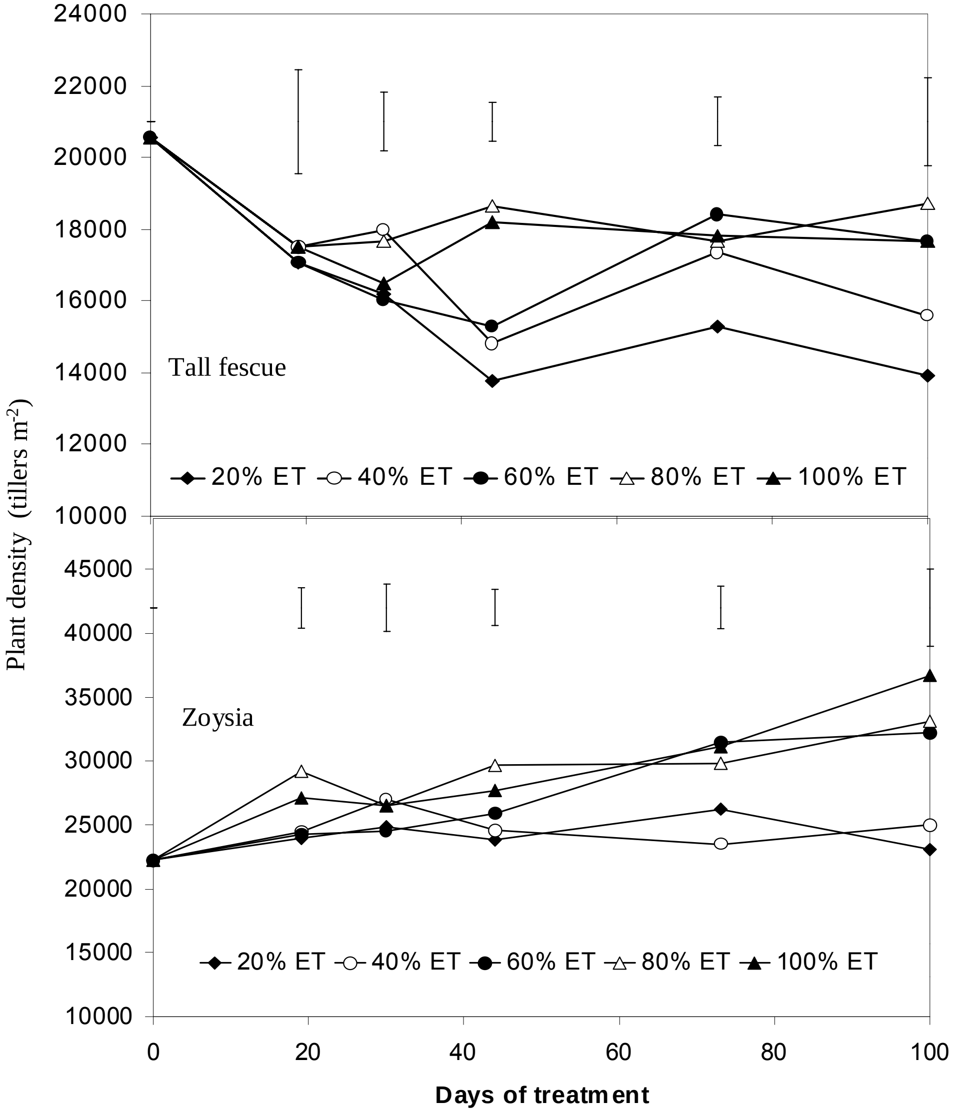

Fig. 2 Plant density of tall fescue and zoysia grass in response to deficit irrigation. Vertical bars are LSD values (*P=0.05*) for treatment comparisons within a grass species and at a given day of treatment

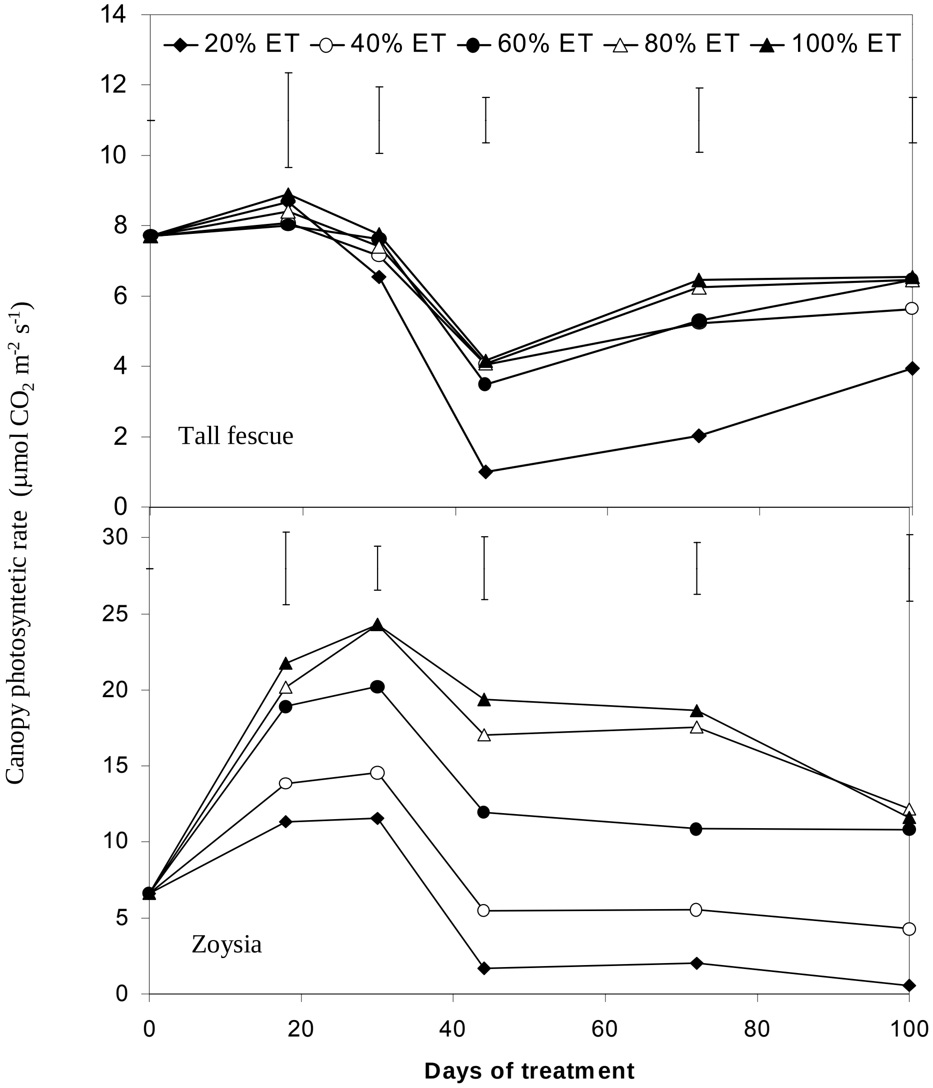

Fig. 3 Canopy photosynthetic rate of tall fescue and zoysia grass in response to deficit irrigation. Vertical bars are LSD values (*P=0.05*) for treatment comparisons within a grass species and at a given day of treatment

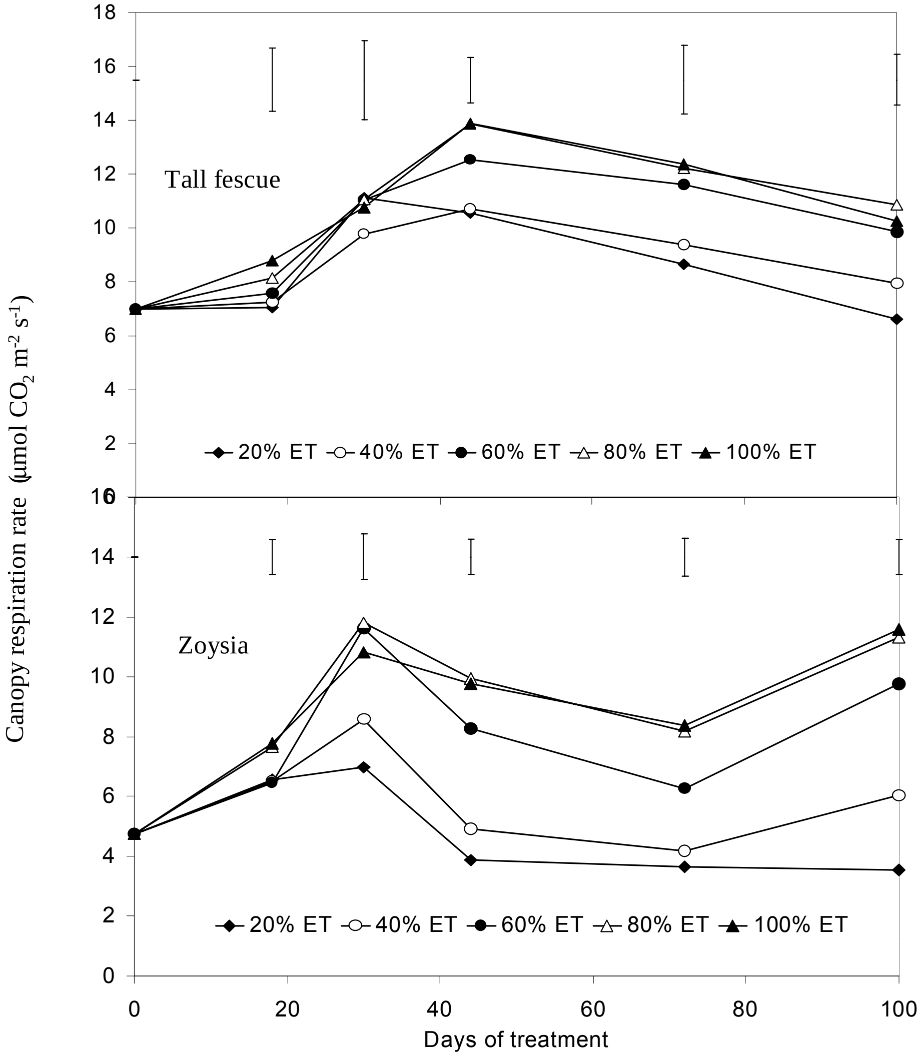

Fig. 4 Canopy respiration rate of tall fescue and zoysia grass in response to deficit irrigation. Vertical bars are LSD values (*P=0.05*) for treatment comparisons within a grass species and at a given day of treatment

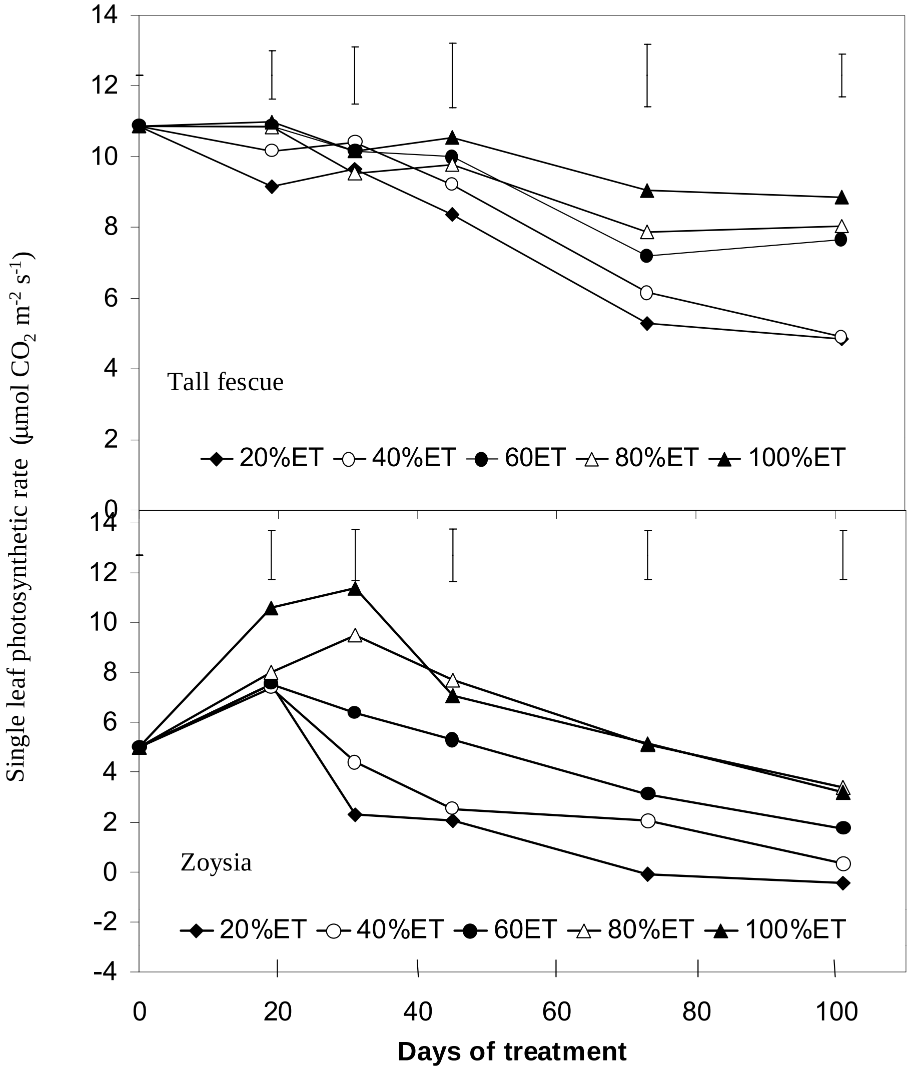

Fig. 5 Single leaf photosynthetic rate of tall fescue and zoysia grass in response to deficit irrigation. Vertical bars are LSD values (*P=0.05*) for treatment comparisons within a grass species and at a given day of treatment

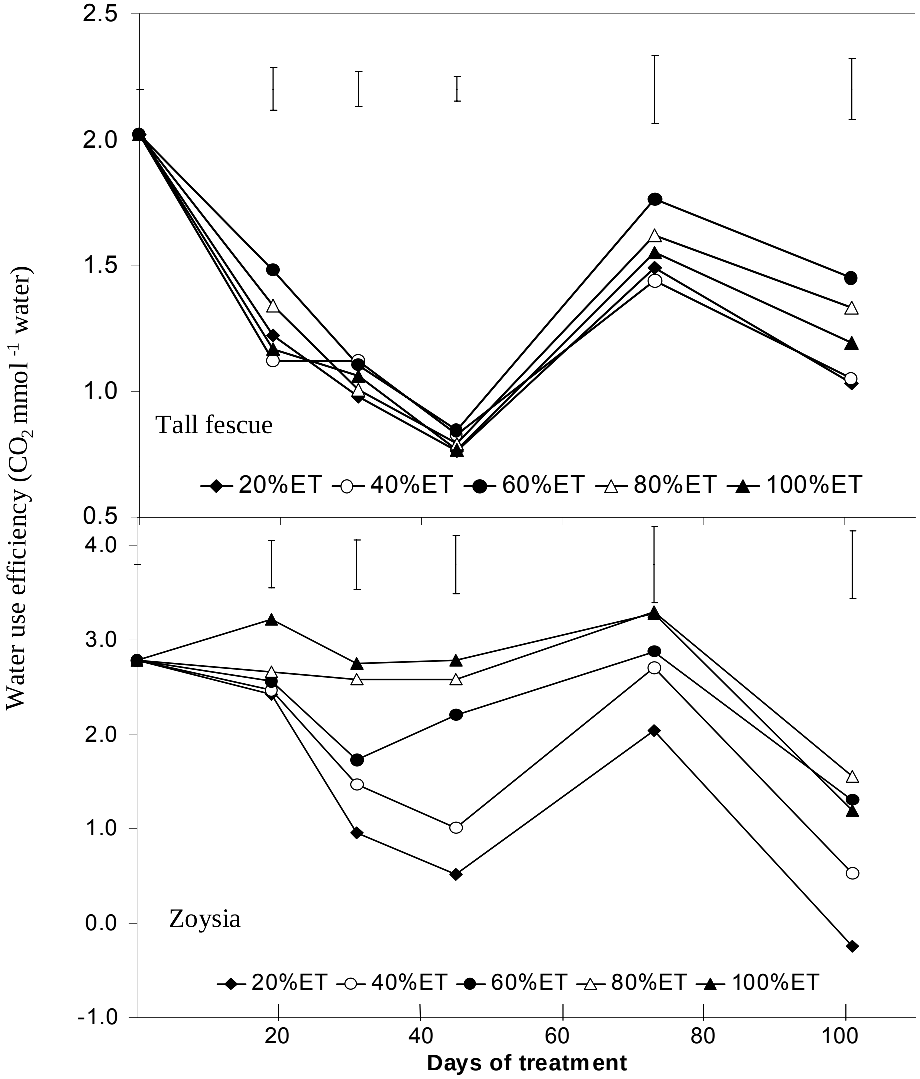

Fig. 6 Water use efficiency of tall fescue and zoysia grass in response to deficit irrigation. Vertical bars are LSD values (*P=0.05*) for treatment comparisons within a grass species and at a given day of treatment

TITLE: Factors Affecting Establishment of Seeded Zoysiagrass in Perennial Ryegrass Turf

OBJECTIVE: To determine the best management practices for converting an existing ryegrass fairway to a seeded zoysiagrass stand.

PERSONNEL: Alan Zuk and Jack Fry

SPONSOR: Golf Course Superintendents Association of America & Kansas Golf Course Superintendents Association

INTRODUCTION:

Many golf course fairways throughout the transition zone of the United States are planted to perennial ryegrass (*Lolium perenne* L.). However, maintaining perennial ryegrass has become uneconomical for many golf courses because of high water costs and its susceptibility to many diseases. Warm season grasses have lower evapotranspiration (ET) rates and better drought resistance characteristics than perennial ryegrass. Zoysiagrass (*Zoysia japonica* Steud.), in particular, has been shown to have ET rates 19% lower than perennial ryegrass. Converting perennial ryegrass fairways to zoysiagrass by seed may be problematic because perennial ryegrass may have an allelopathic effect on zoysiagrass. Allelopathy is defined as “any direct or indirect harmful effect by one plant (including microorganisms) on another through the production of chemical compounds that escape into the environment” (Rice, 1974).

There is little information regarding allelopathy and other factors that may influence the establishment of seeded zoysiagrass in an existing stand of perennial ryegrass. Hence, our research goal is to determine the best management practices for converting an existing ryegrass fairway to a seeded zoysiagrass stand.

MATERIALS AND METHODS:

“Zenith” zoysiagrass seedbed conversion trials were established in 1999 and 2000 at the Rocky Ford Turfgrass Research Center in Manhattan, KS. Soil was a Chase silt loam (fine, montmorillonitic, mesic Aquic Arquidolls), pH 7.2. Data were collected for three seasons from the first trial, and for two seasons from the second trial. Before seeding, both trial areas were core-aerified and verticut. Cores were spaced 4 inches apart with length ranging from 0.5 -1.5 inches. After aeration, the test site was verticut to a depth of 1/8 inch in four directions: north to south, east to west, and two diagonal passes. Good seed to soil contact is essential to keep the seed in place. However, zoysiagrass seed is photodormant and must not be covered too deep at planting.

Test one. On 18 June 1999, “Zenith” zoysiagrass seedbed treatments were seeded at 1 lb/1000 ft^2 into an existing stand of “Alliance” blend perennial ryegrass. We evaluated the following seedbed preparation treatments: 1) untreated (control); 2) glyphosate (Roundup) at 3 qts/a; 3) scalping (scalping continued until zoysia tillering was noticed; 4) mefluidide (Embark Lite) at 2.5 qts/a; 5) trinexapac-ethyl (Primo) at 1.5 qts/a; and 6) Primo and scalped. All chemical treatments were applied with a CO$_2$ sprayer at 35 psi.

A trafficking treatment was included to simulate the effects of foot and cart traffic should a superintendent decide to leave the course open during the establishment phase. Trafficked treatments were rolled 12 times per week with a 400 lb smooth power roller that exerted 1.1 kg/cm^2 static pressure. Trial areas were mowed at fairway height (9/16 inch) three times per week. Plots measuring 4 by 8 ft were arranged in a split-plot, randomized complete block design with three replications. Traffic vs no traffic treatments were the whole plot and the seedbed preparations the sub-plot. After seeding, Tee Time 12-30-7 with Siduron was applied at 3.3 lb/1000 ft^2 for preemergent weed control. The test area was irrigated three times daily in 7-minute intervals to keep the seed moist. After germination, watering was reduced to twice daily in 10-minute intervals. Upon tillering, irrigation was changed to one, 21-minute interval per day. Ten weeks after seeding, irrigation was applied to favor zoysia by irrigating only when zoysia wilting was noticed. Urea was applied at 1 lb N/1000 ft^2 in June and August during each growing season.

A modification of the vertical point quadrant was used to attain percent zoysia coverage within each treatment plot. The vertical point quadrant was constructed of a PVC frame with an internal monofilament grid spaced on 100-mm centers. The grid was placed over the entire plot to estimate zoysia coverage per treatment. The presence of any part of a zoysia seedling under an intersection was recorded as a “hit.” To determine percent coverage, we divided the number of hits by the number of intersections on the grid.

Test two. On 10 June 2000, “Zenith” zoysiagrass seedbed treatments were seeded at 1 lb/1000 ft^2 into an existing stand of “Alliance” blend perennial ryegrass. The same establishment practices mentioned in test one were used in test two. However, the traffic and plant growth regulator treatments were eliminated and two seedbed stripping treatments were added. We evaluated the following seedbed preparation treatments: 1) untreated (control); 2) glyphosate (Roundup) at 3 qts/a; 3) scalping (scalping continued until zoysia tillering was noticed; 4) three strips per plot measuring 3 inches by 7 ft were seeded at 2 lb/1000 ft^2 ; and 5) six strips per plot measuring 3 inches by 7 ft were seeded at 2 lb/1000 ft^2. The seeding strips were created by placing a precut plywood stencil over the entire plot, treating with glyphosate at 3 qts/a, followed by seeding. Plots measuring 4 by 7 ft were arranged in randomized complete block design with three replications. Seedbed preparation treatment plots were evaluated for visual quality on a 0-9 scale weekly throughout each growing season. The analysis of variance (ANOVA) procedure was used to analyze the data. Means were separated using Tukey’s Studentized Range (HSD).

RESULTS:

The control and plant growth regulator treatments scored the highest quality ratings during the first season of the first cultural study because the existing ryegrass in these treatments remained relatively undisturbed (Table 1). The Roundup and scalped treatments scored the lowest quality ratings. Trafficking reduced quality in all treatment plots when compared to non-trafficked treatments. As in the first cultural study, the Roundup and scalped treatments also scored the lowest quality ratings during the first season of the second cultural study (Table 2). The two stripped treatments scored low quality ratings because of the dead seeding strips that ran the length of the treatment plot that remained visible for both years. The control treatment scored the highest quality ratings because the seedbed remained relatively undisturbed other than mowing during the test.

Table 1. Turfgrass quality six weeks after planting: Cultural test one.

Treatment	Year					
	1999		2000		2001	
	Traffic	No Traffic	Traffic	No Traffic	Traffic	No Traffic
Control	6.66[1]	6.92	6.87	6.13	5.33	6.58
Scalped	2.42	3.25	5.13	5.87	5.00	6.08
Embark Lite	5.58	6.50	6.27	6.27	5.58	7.08
Primo	6.75	7.25	6.80	6.33	5.67	6.00
Primo plus scalped	2.92	4.50	6.33	5.87	5.17	5.33
Roundup	0.00	0.00	1.20	5.00	2.25	5.42

[1] Based on weekly visual ratings on a 0-9 scale throughout the growing season.

Table 2. Turfgrass quality six weeks after planting: Cultural test two.

Treatment	Year	
	2000	2001
Control	6.6[1]	6.6
Scalped	2.5	5.8
Three Strips	4.4	4.8
Six Strips	3.0	4.1
Roundup	1.2	7.1

[1] Based on weekly visual ratings on a 0-9 scale throughout the growing season.

Percent Zoysiagrass Coverage

Trafficking treatments reduced zoysia coverage in all plots compared to nontrafficked treatments (Table 3). The Control had the highest quality ratings during the first year of cultural test one, but also had the lowest percent coverage of all nontrafficked treatments. Roundup treatment yielded the highest percent zoysia coverage, even though it had the lowest quality rating during the first season. Only 20% of pure live seed (PLS) produced a zoysia seedling in the Roundup treatment (PLS is percent purity times percent germination). Roundup produced nearly full coverage after two seasons, due to lack of competition from a ryegrass canopy. The scalped treatment yielded the highest zoysia coverage of all nonchemical treatments because more photosynthetically active radiation was able to reach the seedbed during the first 8 weeks.

Table 3. Percent zoysiagrass coverage: Cultural test one.

Treatment	Year					
	1999		2000		2001	
	Traffic	No Traffic	Traffic	No Traffic	Traffic	No Traffic
Control	1[1]	5	0.2	8	0.5	6
Scalped	6	10	6	59	4	75
Embark Lite	5	2	4	10	1	10
Primo	1	4	0.3	11	0.1	14
Primo plus scalped	5	12	4	42	3	41
Roundup	23	75	44	99	49	98

[1] Represents average percent zoysiagrass coverage per treatment in October of each respective year.

Table 4. Percent zoysiagrass coverage: Cultural test two.

Treatment	Year	
	2000	2001
Control	0.5[1]	0.7
Scalped	9	18
Three Strips	66	52
Six Strips	46	54
Roundup	84	100

[1] Represents average percent zoysiagrass coverage per treatment in October of each respective year.

As in the first cultural study, the control treatment yielded the lowest percent zoysia coverage and the Roundup treatment yielded the highest (Table 4). After two years, the stripped treatments produced a significantly higher percent coverage than the scalped treatment. Again, the scalped treatment yielded the highest percent zoysia coverage of all non-chemical treatments.

These data indicate that traffic will reduce turfgrass quality when attempting to establish zoysiagrass by seed in an existing perennial ryegrass canopy. Perhaps a golf course superintendent could avoid this dilemma by seeding one side of the fairways while asking members to play on the unseeded area during establishment. After two to three years, the other side could be seeded.

Turfgrass quality will be reduced during the establishment phase. However, the lower cost of converting by seed rather than sodding in addition to avoiding lost revenue by leaving the course open during the establishment phase would be appealing especially to courses on a limited budget.

Scalping may be the easiest and least expensive method to convert perennial ryegrass to zoysiagrass by seed. A superintendent can avoid the cost of chemicals and achieve nearly full coverage in three years by simply scalping the seeded area three times per week until zoysiagrass tillering is noticed (six to eight weeks) and watering to favor the zoysiagrass after establishment.

The reason for the low germination rate in the control treatment (20% PLS) may be an environmental effect such as shading, washout, or wind scattering of the seed. It may also be an allelopathic effect caused by phenolic acid in perennial ryegrass.

TITLE: Allelopathy of Perennial Ryegrass Leaves and Roots on 'Zenith' Zoysiagrass Seedlings

OBJECTIVES: To evaluate zoysiagrass seedling development when planted in soil amended with perennial ryegrass leaves and roots.

PERSONNEL: Alan Zuk and Jack Fry

SPONSORS: Golf Course Superintendents Association of America & Kansas Golf Course Superintendents Association

INTRODUCTION:

Research has shown that perennial ryegrass (*Lolium perenne* L.) can have an allelopathic influence on the germination and growth of several plant species such as white clover (*Trifolium repens* L.), nodding thistle (*Carduus nutans* L.), raddish (*Raphanus sativus*), lettuce *(Lactuca sativa* L.) and alfalfa (*Medicago sativa L.*). There is some evidence that zoysiagrass (*Zoysia japonica* Steud.) may also be susceptible to the allelopathic effects of ryegrass. This may pose a problem to a homeowner or golf course superintendent planning to establish zoysiagrass by seed in an existing ryegrass stand, or in an area previously planted to ryegrass.

MATERIALS AND METHODS:

A standard greenhouse potting mixture was placed in square, 4 x 4 in. pots, each 3.5 in. deep. Potting soil was amended to a 1.2 in. depth with 0, 2.3%, 11.7%, or 23.3 % (by dry wt.) fresh or glyphosate-killed (GK) perennial ryegrass leaves or roots. Ryegrass was grown in the greenhouse in sand prior to harvesting. GK ryegrass was treated with a labeled rate of herbicide 10 days prior to harvest. At harvest, ryegrass leaves and roots were severed from crowns. Leaves and roots were cut into segments ranging from 2 to 5 mm long and mixed uniformly with the potting mix in Ziploc bags. Twenty 'Zenith' zoysiagrass seeds were placed on the soil surface in each pot. Pots were arranged in a completely randomized design in a growth chamber set at 30/25^{O} C (day/night) with a 16 hour photoperiod. Each treatment was replicated four times. Pots were watered twice daily to provide a total of 5 mm water day $^{-1}$. Pots were rearranged daily to minimize edge effects in the growth chamber. Zoysiagrass seedlings were allowed to grow for 30 days before harvesting. Data include seedling and tiller number, leaf area and weight, and root area, length and dry weight. The test was conducted twice under identical conditions. Data from each test are presented separately.

RESULTS:

<u>Shoot growth</u>. Zoysiagrass seedling numbers were reduced in pots amended with 11.7% and 23.3% GK ryegrass leaves in Study I (Table 1). In Study II, fresh roots at 11.7% and 23.3% reduced seedling numbers, as did fresh leaves at all three levels. GK leaves incorporated at 23.3% also reduced seedling numbers. In Study I, tiller numbers were reduced in soil amended with 23.3% fresh roots or 11.7% fresh leaves (Table 1). In Study II, tiller numbers were reduced by all ryegrass amendments except GK roots at 2.3% and 23.3%. In Study I, only fresh leaves inhibited zoysiagrass leaf area (Table 1). In Study II, all ryegrass treatments except GK roots (2.3%) reduced leaf area. A similar pattern occurred for ryegrass effects on leaf weight in Studies I and II.

<u>Root growth</u>. Root area was not affected by ryegrass amendments in Study I (Table 2). In Study II, all treatments reduced root area except fresh or GK roots at 2.3%. Root length was reduced by only fresh leaves (11.7%) in Study I (Table 2). In Study II, root length was reduced by GK roots at 23.3% and all levels of fresh and GK leaves. Root weight results mimicked results observed for root length in both studies.

Table 1. Seedling number and shoot growth responses of 'Zenith' zoysiagrass 30 days after seeding into soil amended with fresh or glyphosate-killed (GK) perennial ryegrass leaves or roots in two separate studies.[1]

		Seedling (no. pot^{-1})		Tillers (no. pot^{-1})		Leaf area (cm^2 pot^{-1})		Leaf dry wt. (mg pot^{-1})	
Treatment		Study 1	Study 2	Study 1	Study 2	Study 1	Study 2	Study 1	Study 2
Control 0%		11.5 abc[2]	16.0 ab	37.5 abc	41.0 a	27.9 ab	38.9 a	150 a	138 a
Fresh roots	2.3%	11.3 abcd	11.5 bcd	31.3 abcd	26.8 bc	25.5 abc	20.9 b	123 ab	86 b
	11.7%	11.8 abc	10.3 cd	27.5 abcde	22.8 bc	15.2 bc	15.3 bcd	88 ab	63 bc
	23.3%	7.5 e	11.0 cd	20.8 def	20.8 bc	19.4 abc	7.2 cdef	98 ab	29 cde
GK roots	2.3%	12.0 ab	17.0 a	33.3 abcd	39.3 a	29.4 ab	31.9 a	155 a	130 a
	11.7%	8.8 bcde	12.5 abcd	23.3 cde	20.3 bcd	18.6 abc	14.6 bcd	98 ab	61 bcd
	23.3%	9.3 bcde	16.3 ab	26.8 abcde	29.8 ab	15.9 bc	17.9 bc	98 ab	81 b
Fresh leaves	2.3%	13.0 a	10.3 cd	40.5 a	17.0 cde	27.4 ab	11.4 bcdef	163 a	45 bcde
	11.7%	8.3 cde	5.0 e	13.0 e	7.0 e	8.3 cf	1.8 e	30 b	7 e
	23.3%	9.5 bcde	7.8 de	26.8 abcde	9.0 de	25.2 abc	2.1 f	113 ab	7 e
GK leaves	2.3%	11.3 abcd	12.8 abd	38.3 ab	26.5 bc	35.7 a	12.9 bcde	178 a	45 bcde
	11.7%	8.0 de	12.8 abc	24.5 bcde	21.0 bc	23.2 abc	6.0 def	118 ab	19 de
	23.3%	7.8 e	8.0 cde	26.0 abcde	8.3 e	23.1 abc	2.6 ef	133 a	8 e

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[1] Twenty seeds were planted on a potting soil medium that had been amended with plant parts to a 3-cm depth.

[2] Means followed by the same letter in a column are not significantly different ($P \leq 0.05$).

Table 2. Root area, length, and dry weight of 'Zenith' zoysiagrass 30 days after seeding into soil amended with fresh or glyphosate-killed (GK) perennial ryegrass leaves or roots.[1]

		Root area (cm^{-2} pot^{-1})		Root length (cm pot^{-1})		Root dry wt. (mg pot $^{-1}$)	
	Treatment	Study1	Study 2	Study 1	Study 2	Study 1	Study 2
Control	0%	43.8 abc[2]	13.7 b	406.7 abc	201.3 b	43 ab	16 b
Fresh roots	2.3%	51.3 ab	6.5 bc	384.1 abc	116.5 bcd	48 ab	8 bc
	11.7%	22.3 bc	5.8 c	281.7 abcd	111.3 bde	26 abc	8 cb
	23.3%	20.0 bc	3.9 c	148.2 bcd	39.6 cdef	21 abc	3 c
GK roots	2.3%	44.1 abc	26.3 a	285.1 abcd	395.1 a	45 ab	39 a
	11.7%	22.4 bc	5.7 c	239.0 abcd	122.4 bc	25 abc	8 cb
	23.3%	67.7 a	4.9 c	463.0 a	102.0 cdef	58 a	6 c
Fresh leaves	2.3%	45.3 abc	3.9 c	447.2 ab	81.0 cdef	48 ab	5 c
	11.7%	8.4 c	0.7 c	66.5 d	13.7 f	5 c	0.6 c
	23.3%	22.9 bc	0.7 c	161.9 bcd	14.9 f	17 bc	0.8 c
GK leaves	2.3%	41.2 abc	3.2 c	301.9 abcd	66.9 cdef	48 ab	4 c
	11.7%	21.0 bc	1.9 c	140.0 cd	31.9 def	23 abc	2 c
	23.3%	33.1 abc	1.5 c	308.0 abcd	24.8 ef	34 abc	2c

[1] Twenty seeds were planted on a potting soil medium that had been amended with plant parts to a depth of 3 cm.

[2] Means followed by the same letter in a column are not significantly different ($P \leq 0.05$).

TITLE: Suppression of Annual Bluegrass Seedheads using Plant Growth Regulators

OBJECTIVE: To evaluate various timing options for annual bluegrass seedhead suppression with commonly used plant growth regulators.

PERSONNEL: Matthew J. Fagerness

LOCATION: Wamego Country Club

INTRODUCTION:

Suppression of annual bluegrass seedheads is a regular practice in management of cool-season golf course turf. Use of ethofumesate (Prograss) for control of annual bluegrass can effectively suppress annual bluegrass seedheads but use of this herbicide is not cost effective for many golf courses. Plant growth regulators (PGRs), applied in spring, represent an alternative for suppressing seedheads without otherwise damaging existing annual bluegrass. This experiment was designed to compare PGRs traditionally used for annual bluegrass seedhead suppression with those that may be used alternatively.

MATERIALS AND METHODS:

All PGRs were applied to a perennial ryegrass/ Kentucky bluegrass fairway with a history of annual bluegrass pressure. Two application timings were in place: 1) two weeks prior to maximum seedhead emergence (23 April 2001), and 2) at the time of maximum seedhead emergence (7 May 2001). Plots were 5 by 5 ft and treatments were replicated four times. All PGR treatments were applied in a volume equivalent to 40 gallons per acre. PGR treatments at each application timing included ethephon (Proxy) at 3.4 or 6.8 lb ai/a, trinexapac-ethyl (Primo) at 0.09 lb ai/a, mefluidide (Embark) at 0.13 or 0.06 lb ai/a, and paclobutrazol (Trimmit) at 0.13 lb ai/a. Subsequent evaluation of PGR efficacy was by evaluation of percent seedhead suppression in nontreated and treated plots through May 2001.

RESULTS:

PGRs applied at the later of the two timings were not yet effective at the first rating date, since late treatments were applied on that date. Seedhead suppression was least with either Primo or Trimmit, substantiating their reported weakness in suppressing annual bluegrass seedheads. However, both Proxy and Embark were effective at either applied rate and for either of the two application timings (Table 1). Seedhead suppression at or above 70% is deemed sufficient to significantly improve the quality of turf infested with annual bluegrass. Both of these PGR materials show great promise as tools for managing existing annual bluegrass in cool-season golf course turf. No applied PGRs detrimentally impacted turf quality.

Table 1. Plant growth regulator effects on annual bluegrass seedhead suppression.

		Rating Date			
PGR Treatment	Rate	May-7-01	May-16-01	May-23-01	May-29-01
		-----------------% seedhead suppression------------------			
Nontreated		0	3	0	0
Proxy (early)	3.4 lb a.i./a	75	55	47	57
Proxy (early)	6.8 lb a.i./a	83	78	70	67
Primo (early)	0.09 lb a.i./a	30	33	52	43
Embark (early)	0.13 lb a.i./a	75	78	78	73
Embark (early)	0.06 lb a.i./a	70	62	77	58
Trimmit (early)	0.13 lb a.i./a	17	48	65	45
Proxy (late)	3.4 lb a.i./a	2	28	63	73
Proxy (late)	6.8 lb a.i./a	10	60	80	90
Primo (late)	0.09 lb a.i./a	0	35	55	48
Embark (late)	0.13 lb a.i./a	0	40	73	77
Embark (late)	0.06 lb a.i./a	8	58	73	77
Trimmit (late)	0.13 lb a.i./a	10	53	75	52
LSD (P=.05)		19	35	27	30

TITLE: Use of Traditional and Split Season Applications of Preemergence Herbicides for Control of Goosegrass

OBJECTIVE: To evaluate various timing options for goosegrass control with commonly used preemergence herbicides.

PERSONNEL: Matthew J. Fagerness

LOCATION: Manhattan Country Club

INTRODUCTION:

Goosegrass control is a regular practice in management of golf course turf but can be complicated by the lack of effective products and herbicide breakdown in mid- to late summer. More aggressive use of stronger residual herbicides like prodiamine (Barricade) or dithiopyr (Dimension) can overcome these problems but may create risk for fall overseeding. However, split applications of such herbicides may reduce risk of injury to overseeded cool-season turf by reducing the applied rate of herbicide nearer to overseeding. Additionally, split applications may extend the window of herbicide control for weaker materials like pendimethalin (Pendulum) and help reduce the need for summer applications of postemergence materials like fenoxaprop (Acclaim Extra). This experiment was designed to compare traditional fall or spring full rate applications of common preemergence herbicides with split fall/late spring applications.

MATERIALS AND METHODS:

Herbicides were applied to a perennial ryegrass fairway with a history of goosegrass pressure. Fall applications were made 4 December 2000; full rate spring applications were made 22 March 2001; and late spring split applications were made 29 May 2001. The front half of the split application program in fall was presumed to be more than adequate to last until the second half of the split in late spring. Plots were 5 by 5 ft and were replicated four times. All herbicide treatments were applied in a volume equivalent to 40 gallons per acre. Herbicide treatments included Barricade at 0.65 lb ai/a in fall or early spring and at 0.32 +0.32 lb ai/a in fall/late spring. Similar treatments were used for Dimension and Pendulum with respective full rates of 0.5 and 3 lb ai/a (Table 1). Subsequent evaluation of herbicide efficacy was by estimation of percent goosegrass pressure in nontreated and treated plots throughout summer 2001.

RESULTS:

Goosegrass pressure was not tremendous in the test area but the visual disruptiveness of this weed allows for very little tolerance of it. Barricade effectively controlled goosegrass, regardless of application timing. Dimension performed at a similar level, although split applications resulted in the best control by the end of summer. Heaviest goosegrass pressure existed in areas treated with Pendulum, which was not effective in controlling goosegrass. However, split applications of Pendulum resulted in less goosegrass pressure than a full rate in fall or spring, suggesting the split application program still has merit for this herbicide. Results demonstrated that Barricade or Dimension may offer best control of goosegrass, in addition to options such as oxadiazon (Ronstar), while the use of Pendulum, even with split applications, may still require the use of a postemergence herbicide to get acceptable goosegrass control.

Table 1. Preemergence herbicide timing effects on goosegrass.

		Rating Date		
Herbicide Treatment	Rate	Aug-3-01	Aug-31-01	Oct-4-01
		-----------------% goosegrass------------------		
Nontreated		6	7	6
Barricade (fall)	0.65 lb a.i./a	2	2	1
Barricade (spring)	0.65 lb a.i./a	1	2	1
Barricade (fall+spring)	0.32 lb a.i./a+ 0.32 lb a.i./a	1	1	1
Dimension (fall)	0.5 lb a.i./a	4	7	6
Dimension (spring)	0.5 lb a.i./a	1	3	4
Dimension (fall+spring)	0.25 lb a.i./a+ 0.25 lb. a.i./a	2	1	2
Pendulum (fall)	3 lb a.i./a	6	12	13
Pendulum (spring)	3 lb a.i./a	9	17	17
Pendulum (fall+spring)	1.5 lb a.i./a+ 1.5 lb. a.i./a	4	7	7
LSD (P=.05)		4	6	6

TITLE:	Annual Bluegrass Control in Dormant Zoysiagrass
OBJECTIVE:	To evaluate various selective and nonselective herbicides for control of annual bluegrass in a dormant stand of Meyer zoysiagrass
PERSONNEL:	Matthew J. Fagerness and Ben Blackmore
SPONSOR:	Griffin LLC
LOCATION:	Rocky Ford Turfgrass Research Center, Manhattan

INTRODUCTION:

Winter annual weed control can be facilitated in dormant warm-season turfgrasses by virtue of being able to use herbicides that would be lethal to cool-season grasses if applied in late fall or early spring. In addition, expanded herbicide options are available in warm-season turfgrasses because of their tolerance to materials that are toxic to cool-season species. This study was established to compare possible control options for annual bluegrass, one of the most prevalent winter annual grassy weeds in dormant warm-season turfgrasses.

MATERIALS AND METHODS:

All herbicides were applied to fully dormant Meyer zoysiagrass on 4 December 2001. At that time, annual bluegrass pressure ranged from 15 to 35% in terms of total plot space occupied. Plots were 5 by 10 ft and were replicated four times. All herbicide treatments were applied in a volume equivalent to 40 gallons per acre. Herbicide treatments were: rimsulfuron (TranXit) at 0.5, 1, or 2 oz/a plus nonionic surfactant at 0.25%, simazine (Princep) at 0.5, 1, or 2 lb ai/a, atrazine at 2 lb ai/a, Roundup Pro Dry at 6 lb ae/a, and pronamide (Kerb) at 1 lb ai/a. Subsequent evaluation of herbicide efficacy was done by estimating percent injury to annual bluegrass at several rating dates in spring 2002.

RESULTS:

Levels of injury observed in nontreated plots are a function of the level of activity in *Poa annua* at the time ratings were taken, rather than as a result of herbicide effects. All herbicides effectively controlled annual bluegrass relative to the nontreated control, except Princep at the 0.5 lb rate. The absence of other noteworthy differences among treatments indicates that all applied treatments showing comparable control of annual bluegrass are reasonable options for this annual weed in dormant zoysia. Cost considerations are therefore highly relevant in selecting an ideal material for annual bluegrass control in zoysia and other dormant warm-season turfgrasses.

Table 1. Herbicide effects on annual bluegrass injury in dormant zoysiagrass.

		Weeks after Herbicide Application			
Herbicide Treatment	Rate	13	14	16	18
		-----------------% annual bluegrass injury------------------			
Nontreated		43	50	48	46
Tranxit + 0.25%NIS	0.5 oz/a	78	88	93	93
Tranxit + 0.25%NIS	1 oz/a	63	84	88	88
Tranxit + 0.25%NIS	2 oz/a	85	93	94	96
Simazine	0.5 lb a.i./a	48	59	51	46
Simazine	1 lb a.i./a	70	83	84	85
Simazine	2 lb a.i./a	78	85	89	88
Atrazine	2 lb a.i./a	78	78	78	74
Roundup Pro Dry	6 lb a.e./a	95	99	98	99
Kerb	1 lb a.i./a	75	90	94	99
LSD (P=.05)		27	24	27	32

TITLE:	Use of Plateau for Annual Grass and Broadleaf Weed Control in Native Grasses
OBJECTIVE:	To evaluate various rate and timing options for weed control in a golf course native grass area.
PERSONNEL:	Matthew J. Fagerness
SPONSOR:	BASF
LOCATION:	Colbert Hills Golf Course, Manhattan

INTRODUCTION:

Weed control is a necessary practice in native grass areas, especially during their establishment and after spring burning, when increased sunlight penetration to the ground and elevated soil temperatures can stimulate weed germination. Broadleaf herbicides may effectively control dicot weeds in native grass areas but grassy weeds may still be a problem. Herbicides like imazapic (Plateau) have extensive label information for use in native grasses and effectively control both grassy and broadleaf weeds in native areas. This experiment was designed to evaluate different rates of application for Plateau in controlling an assortment of weeds in a native grass area.

MATERIALS AND METHODS:

All Plateau treatments were applied to a native grass area with a history of strong weed pressure. The stand had been established from seed in spring 2000 and was burned four weeks prior to initiation of the experiment. Grasses in the stand included big and little bluestem, blue grama, and sideoats. Applications were made on 21 May 2001 to all treated plots and a sequential application (to one treated area only) was made four weeks later. Plots were 5 by 10 ft and were replicated four times. All Plateau treatments were applied in a volume equivalent to 40 gallons per acre and included a surfactant to increase absorption into treated weeds. Rates included 0.032, 0.064, and 0.095 lb ai/a for single applications while the split application treatment rates were both at 0.032 lb ai/a. Subsequent evaluation of herbicide efficacy looked at both percent weed control and percent injury to the native grass stand through July 2001.

RESULTS:

No significant injury was observed in the native grasses, as a result of Plateau treatments. While no significant weed control was observed at the earliest rating date, Plateau did an excellent job of controlling weeds in treated plots by the end of the experiment. These results suggest that patience may be critical in evaluating the performance of this herbicide in native grass areas. Controlled weeds included summer annual broadleaf weeds such as marestail and annual grasses like foxtail. Because Plateau has extensive labeling for safe use in both existing and newly seeded native grass areas, this herbicide may prove a useful tool for management of such areas on golf courses. Future research will further investigate Plateau efficacy in a variety of native grass areas, which are becoming common components of Kansas golf courses.

Table 1. Plateau effects on weed control in a native grass stand.

		Rating Date		
Herbicide Treatment	Rate	May-28-01	Jun-13-01	Jul-24-01
		-------------% weed control---------------		
Nontreated		13	11	19
Plateau	0.032 lb a.i./a	8	70	85
Plateau	0.064 lb a.i./a	24	75	89
Plateau	0.095 lb a.i./a	23	45	89
Plateau	0.032 lb a.i./a+ 0.032 lb. a.i./a	19	61	93
LSD (P=.05)		16	24	15

TITLE:	Use of Sulfonylurea Herbicides for Control of Cool-Season Grasses and Broadleaf Weeds in Buffalograss
OBJECTIVE:	To evaluate various rate and timing options for weed control in established buffalograss.
PERSONNEL:	Matthew J. Fagerness
SPONSOR:	Syngenta
LOCATION:	Rocky Ford Turfgrass Research Center, Manhattan

INTRODUCTION:

Weed control is a necessary but often difficult practice in buffalograss areas, especially with buffalograss sensitivity to phenoxy type herbicides like 2,4-D. Development of herbicides in the sulfonylurea family have shown promise in buffalograss for controlling both broadleaf weeds and perennial cool-season grasses like volunteer tall fescue. Examples of such herbicides are chlorsulfuron (Corsair, Telar) and metsulfuron-methyl (Manor), both of which have demonstrated excellent safety to buffalograss. This experiment was designed to compare how different sulfonylurea herbicides, some with variable rates of application, controlled weeds in established buffalograss.

MATERIALS AND METHODS:

All treatments were applied to an established buffalograss area with several featured varieties. Varieties were not deemed an issue in the performance of the experiment so were not considered independently. The stand had been established from sprigs in 1999 and had a history of solid weed pressure, mainly from dandelion and volunteer tall fescue. Initial applications were made on 24 April 2001 to all treated plots while sequential applications (to two treated areas) were made six weeks later. Plots were 5 by 10 ft and were replicated four times. All herbicide treatments were applied in a volume equivalent to 40 gallons per acre and included a surfactant to increase absorption into treated weeds. Herbicides included the experimental CGA-362 at rates of 5 g ai/a + 5 g ai/a (sequential), 10 g ai/a + 10 g ai/a (sequential), 15 g ai/a, or 20 g ai/a, and Corsair at 2 oz/a. Subsequent evaluation of herbicide efficacy looked at both percent weed control and percent buffalograss greenup through July 2001.

RESULTS:

Applied sulfonylurea herbicides significantly controlled weeds as soon as 2 weeks after initial application, with control at or near 100% by the conclusion of the experiment (Table 1). These results suggest that recovery of weeds from observed injury is unlikely and that weed control is sufficiently persistent. Some delayed buffalograss greenup was observed with all treatments, suggesting a slight injurious effect of applied herbicides (Table 2). However, such effects were not persistent and were scarcely noticeable by 4 weeks after initial applications were made. Results suggested that sulfonylurea herbicides may be excellent tools for managing a broad biological spectrum of annual and perennial weeds in established bufflaograss and may represent an expansion of herbicide options for this species.

Table 1. Sulfonylurea herbicide effects on weed control in established buffalograss.

		Rating Date			
Herbicide Treatment	Rate	May-10-01	May-23-01	Jun-21-01	Jul-24-01
		--------------------% weed control---------------------			
Nontreated		0	0	0	0
Corsair	2 oz./a	60	86	86	94
CGA-362	5+5 g a.i./a	53	78	81	96
CGA-362	10+10 g a.i./a	61	79	95	99
CGA-362	15 g a.i./a	63	89	94	96
CGA-362	20 g a.i./a	73	83	94	100
LSD (P=.05)		10	11	13	4

Table 2. Sulfonylurea herbicide effects on buffalograss greenup.

		Rating Date			
Herbicide Treatment	Rate	May-10-01	May-23-01	Jun-21-01	Jul-24-01
		--------------------% greenup---------------------			
Nontreated		70	89	100	100
Corsair	2 oz./a	53	79	98	100
CGA-362	5+5 g a.i./a	61	89	94	100
CGA-362	10+10 g a.i./a	58	86	92	99
CGA-362	15 g a.i./a	58	83	98	98
CGA-362	20 g a.i./a	51	84	100	100
LSD (P=.05)		8	9	5	3

TITLE:	Use of Traditional and Split Season Applications of Preemergence Herbicides for Control of Crabgrass
OBJECTIVE:	To evaluate various timing options for crabgrass control with commonly used preemergence herbicides.
PERSONNEL:	Matthew J. Fagerness
LOCATION:	John C. Pair Horticultural Research Center, Wichita

INTRODUCTION:

Crabgrass control is a regular practice in management of fine turf but can be complicated by herbicide breakdown in mid- to late summer. More aggressive use of stronger residual herbicides like prodiamine (Barricade) or dithiopyr (Dimension) can overcome this problem but may create risk for fall overseeding. However, the possibility of using split applications of such herbicides may reduce the risk of injury to overseeded cool-season turf by reducing the applied rate of herbicide nearer to overseeding. Additionally, split applications may extend the window of herbicide control for weaker materials like pendimethalin (Pendulum) and help reduce the need for summer applications of postemergence materials like fenoxaprop (Acclaim Extra). This experiment was designed to compare traditional fall or spring full rate applications of common preemergence herbicides with split fall/late spring applications.

MATERIALS AND METHODS:

All herbicides were applied to a bare ground area with a history of strong crabgrass pressure. Fall applications were made 4 December 2000; full rate spring applications were made 22 March 2001, and late spring split applications were made 29 May 2001. The front half of the split application program in fall was presumed to be more than adequate to last until the second half of the split in late spring. Plots were 5 by 5 ft and were replicated four times. All herbicide treatments were applied in a volume equivalent to 40 gallons per acre. Herbicide treatments included Barricade at 0.65 lb ai/a in fall or early spring and at 0.32 +0.32 lb ai/a in fall/late spring. Similar treatments were used for Dimension and Pendulum with respective full rates of 0.5 and 3 lb ai/a (Table 1). Subsequent evaluation of herbicide efficacy was by estimating percent crabgrass pressure in nontreated and treated plots throughout summer 2001.

RESULTS:

Not surprisingly, all herbicides were effective when crabgrass pressure was rated in late June. However, as summer progressed, significant herbicide breakdown was observed with spring-only applications of all three herbicides and with the fall-only application of Pendulum. Split applications of all three herbicides increased crabgrass control but effects were most pronounced with Pendulum. Pendulum is the most cost effective but also has the weakest residual activity of the three herbicides tested in this experiment so increased control with split applications showed tremendous promise for future use of this herbicide. Use of split applications of Pendulum, or full or split applications of Barricade or Dimension may offer viable alternatives to postemergence herbicides for control of escaped crabgrass in Kansas turfgrasses.

Table 1. Preemergence herbicide timing effects on crabgrass.

		Rating Date			
Herbicide Treatment	Rate	Jun-29-01	Aug-1-01	Aug-30-01	Sep-26-01
		-----------------% crabgrass------------------			
Nontreated		38	70	65	88
Barricade (fall)	0.65 lb a.i./a	1	3	6	6
Barricade (spring)	0.65 lb a.i./a	3	10	34	19
Barricade (fall+spring)	0.32 lb a.i./a+ 0.32 lb a.i./a	1	1	3	1
Dimension (fall)	0.5 lb a.i./a	3	8	9	8
Dimension (spring)	0.5 lb a.i./a	1	10	11	23
Dimension (fall+spring)	0.25 lb a.i./a+ 0.25 lb. a.i./a	0	1	1	3
Pendulum (fall)	3 lb a.i./a	5	31	55	48
Pendulum (spring)	3 lb a.i./a	5	19	46	53
Pendulum (fall+spring)	1.5 lb a.i./a+ 1.5 lb. a.i./a	3	6	15	14
LSD (P=.05)		11	17	27	20

TITLE: Effects of Glyphosate Formulations on Zoysiagrass Greenup

OBJECTIVE: To evaluate the effects of glyphosate on zoysia greenup, when applied during the early spring greenup phase.

PERSONNEL: Matthew J. Fagerness

SPONSOR: Syngenta

LOCATION: Rocky Ford Turfgrass Research Center, Manhattan

INTRODUCTION:

Weed control in warm-season grasses is often facilitated by the ability to apply a nonselective material like glyphosate (Roundup Pro, Touchdown Pro) when the turf is still dormant. However, weather conditions often force practitioners to push the calendar limit, beyond which such applications are no longer deemed safe to the turf. Traditionally, it is recommended that glyphosate applications only be made to fully dormant warm-season grasses like zoysia. This experiment was designed to investigate the effects of such applications during the early greenup phase and determine both the incidence of injury and time required for recovery.

MATERIALS AND METHODS:

All glyphosate treatments were applied to an established Meyer zoyisagrass area, which had roughly 30% greenup at the time of application. Applications were made on 24 April 2001 to all treated plots. Plots were 5 by 10 ft and were replicated four times. All glyphosate treatments were applied in a volume equivalent to 30 gallons per acre. Herbicides included both Roundup Pro and Touchdown Pro, each applied at 16, 32, or 64 oz/a. Subsequent evaluation of herbicide efficacy was done by evaluating percent zoysiagrass greenup through early June 2001.

RESULTS:

As expected, applied glyphosate had an immediate detrimental effect on zoysia greenup (Table 1). Reduced greenup initially was as high as 50%. However, by two weeks later, evidence of recovery was present, with greenup in plots treated with the low rate of Roundup Pro equivalent to the nontreated control plots. By the conclusion of the experiment, recovery equivalent to the nontreated was also evident for both Roundup Pro and Touchdown Pro at 32 oz/a. Results suggested clearly that glyphosate applications too late into the greenup stage were detrimental but that recovery was possible if applied rates were not excessive. Therefore, it is suggested that applications made during very early greenup (<20%) may be possible without inducing prolonged zoysia injury. However, it is also suggested that such an application only be made under extreme circumstances, such as those where weed pressure is unusually high, to avoid unnecessary injury and accompanying visual discoloration to the turf.

Table 1. Glyphosate effects on zoysia greenup.

		Rating Date		
Herbicide Treatment	Rate	May-10-01	May-23-01	Jun-5-01
		---------------% greenup-----------------		
Nontreated		63	86	95
Roundup Pro	16 oz./a	24	53	63
Roundup Pro	32 oz./a	24	54	80
Roundup Pro	64 oz./a	14	28	44
Touchdown Pro	16 oz./a	36	74	86
Touchdown Pro	32 oz./a	23	56	78
Touchdown Pro	64 oz./a	16	15	29
LSD (P=.05)		9	14	19

TITLE: Use of Commercial and Consumer Herbicides for Control of Dandelion.

OBJECTIVE: To evaluate various herbicides for dandelion control in cool-season turfgrasses.

PERSONNEL: Matthew J. Fagerness

SPONSORS: Dow, Bayer

LOCATION: Rocky Ford Turfgrass Research Center, Manhattan

INTRODUCTION:

Dandelion control is a necessary practice in many turfgrass settings, ranging from golf course turf to home lawns. Many products exist for such control but some are only available for commercial applications. These experiments were designed to evaluate both commercial and consumer broadleaf herbicides for their effects on dandelion, one of the most common perennial broadleaf weeds in turf.

MATERIALS AND METHODS:

All treatments were applied to established tall fescue areas with a solid history of heavy dandelion pressure. Applications of commercial grade herbicides were made on 11 April 2001 while consumer grade materials were applied 10 September 2001. Plots were 5 by 10 ft for the commercial herbicide experiment and 5 by 5 ft for the consumer herbicide experiment. All herbicide treatments were applied in a volume equivalent to 40 gallons per acre. Commercial herbicides included Lontrel T&O at 0.5 or 1 pint/a and Confront at 1 or 2 pints/a. Consumer herbicides included All-in-One Concentrate at 3 oz/1000 ft^2, WeedBGon Concentrate at 5 oz/1000 ft^2, and Weedstop concentrate at 4 oz/1000 ft^2. Herbicide efficacy was evaluated by estimating percent dandelion control for several weeks after herbicide application in each experiment.

RESULTS:

Applied commercial herbicides significantly controlled dandelion but required several weeks before maximum effect was observed (Table 1). The highest level of control achieved with commercial herbicides was about 80%, perhaps reflecting the greater degree of difficulty in controlling dandelion in spring vs. fall. However, considering the high level of dandelion pressure in the test area, control from commercial materials was deemed very good. Consumer materials also performed well, controlling dandelion nearly 90% one month after applications were made (Table 2). Greater dandelion control was observed in the consumer herbicide experiment with either WeedBGon or Weedstop than with All-in-One. Results confirmed that available commercial and consumer herbicide products can effectively control dandelion but that greater control may be achievable when herbicides are applied in the fall.

Table 1. Commercial herbicide effects on dandelion control in established tall fescue.

		Rating Date		
Herbicide Treatment	Rate	Apr-25-01	May-10-01	May-23-01
		---------------% weed control----------------		
Nontreated		15	10	5
Lontrel T&O	0.5 pt./a	35	76	81
Lontrel T&O	1 pt./a	53	81	83
Confront	2 pt./a	38	68	63
Confront	1 pt./a	38	73	71
LSD (P=.05)		32	42	36

Table 2. Consumer herbicide effects on dandelion control in established tall fescue.

		Rating Date			
Herbicide Treatment	Rate	Sep-20-01	Sep-25-01	Oct-4-01	Oct-12-01
		--------------------% weed control---------------------			
Nontreated		6	0	0	0
All-in-One Conc.	3 oz./1000 sq. ft.	21	44	60	78
WeedBGon Conc.	5 oz./1000 sq. ft.	54	65	85	89
Weedstop Conc.	4 oz./1000 sq. ft.	51	55	83	88
LSD (P=.05)		18	13	7	7

TITLE: Host Preference of the Stunt (*Tylenchorynchus spp.*) and Ring (*Criconomella spp.*) Nematodes among Cool and Warm Season Turfgrasses Grown in a Sand-based Rootzone mix.

OBJECTIVES: To evaluate host preference of root feeding phytoparasitic nematodes commonly present in sand-constructed golf putting greens.

PERSONNEL: Derek Settle, Tim Todd, Jack Fry, Ned Tisserat

SPONSORS: Plant Pathology Departmental Graduate Research Assistantship

MATERIALS AND METHODS:

A greenhouse study was conducted beginning 22 June and ending 21 November 2001. The experiment design was a completely randomized block with two nematode treatments x eight turfgrass species x three replications (total of 48 pots). Half of the pots of each turfgrass species received a mixed population of stunt and ring nematodes, and the remaining half did not. Four cool-season turfgrasses were chosen: (i) creeping bentgrass 'Crenshaw'; (ii) Kentucky bluegrass 'Caliber'; (iii) a perennial ryegrass blend 'Charger II', 'Manhattan II', 'Chaparral'; and (iv) a turf-type tall fescue blend 'Tomahawk', 'Apache II', 'Coronada', 'Safari', 'Barlexas', and 'Tar Heel'. Similarly, four warm-season turfgrasses where chosen: (i) Bermuda 'Midlawn'; (ii) buffalo; (iii) St. Augustine 'Raleigh'; and (iv) zoysia 'Meyer'.

Nematode Inoculation

Nematode infested soil was collected from a creeping bentgrass green at Highlands Country Club, Hutchinson, KS during April 2001. Pots were PVC cylinders having a 4-inch diameter and 6-inch depth. Pots were filled with 750 cm^3 of steamed sand-silt soil obtained from the Hutchinson, KS site and washed sod was planted on April 29, 2001. Prior to planting, sod pieces (4-inch diameter cores) were verified to be nematode-free.

On June19-22, stunt and ring nematodes were extracted from the refrigerated soil using a light sucrose technique with centrifugation. Phytoparasites were placed in 1 liter of water and aliquots of 40 cm^3 were delivered to inoculate a pot with nematodes using a large syringe without a needle. On June 22, sod pieces were bunched together by hand, exposing roots around the edge of each pot and the syringe was emptied directly to the rhizosphere around the perimeter of each pot. Initial inoculated pot populations were 480 stunt and 185 ring per 100 cm^3 soil in treatments with nematodes. Turfgrass pots without nematode inoculation were also bunched together but were not inoculated. Following inoculation all pots were lightly top-dressed with steamed root zone mix and watered in.

Measurements

Pots were clipped at 1-inch height each month and total clippings from each pot were dried and weighed. At experiment end roots from each pot were harvested, dried and weighed. After 5 months, nematode populations were extracted from each pot (21 November 2001). Three 3-cm-diameter soil plugs were randomly taken from each pot to a depth of 15 cm, providing 100 cm^3 soil. A remaining 100-g aliquot of soil was weighed, dried, and re-weighed to determine each sample's soil moisture content, and allow standardization of lance population per 100 g dry soil.

RESULTS:

Stunt

The number of stunt declined during the experiment. Unfortunately, all final populations were lower than the initial inoculum levels of 480 per 100 cm^3, reflecting a high amount of stunt mortality that occurred during the experiment. Therefore, stunt host preference cannot be determined in this experiment.

Ring

<u>Host preference</u>

Ring nematodes (per 100 g dry soil) showed no host preference among the eight turfgrass hosts and a final population of 254 ring was measured across all inoculated hosts and was different than the uninoculated controls (3). Unlike the stunt populations, the ring populations increased from the initial inoculum level of 185 ring per 100 cm^3 soil.

<u>Kansas turfgrass</u>

Ring nematode populations did not negatively affect any of the turfgrass species grown in the state of Kansas. Importantly, growth of warm season grasses adapted to the Kansas transition zone were not affected by ring nematode parasitism; buffalo, ‘Midlawn’ bermuda, and ‘Meyer’ zoysia.

<u>St. Augustine</u>

Unexpectedly, several plant biomass measurements were reduced in nematode inoculated pots of the St. Augustine host. Ring populations in St. Augustine was 263 for inoculated versus 8 for uninoculated. Stunt were not a factor with virtually no populations in St. Augustine turf, ranging from 0 to 12 among all St. Augustine pots sampled.

The growth of St. Augustine was reduced by the ring nematode populations. Initially, during the first three months of the experiment dry clipping weight was not influenced by ring presence and a total of 12.6 g was harvested, whether inoculated or uninoculated (Fig. 1). The final two months of clippings were reduced by 32 percent in pots inoculated with ring nematodes; 13.6 versus 19.9 g dry weight (Fig. 1). Greatest effect to St. Augustine was found in the rhizosphere, with ring nematodes reducing root biomass by 50 percent (7.0 versus 14.1 g dry weight; Fig. 1). Finally, the total plant dry weight harvested during the experiment was reduced 29 percent by ring nematode parasitism (33.3 g versus 46.8 g; Fig. 1).

Previously, ring nematodes have been found to reduce total plant fresh weight of St. Augustine and Centipede turfgrass. A damage threshold of 500 ring per 100 cm^3 soil has been estimated for St. Augustine turfgrass. The results of this experiment suggest that the damage threshold for St. Augustine may be lower than previously thought; approximately 250 ring per 100 cm^3 soil.

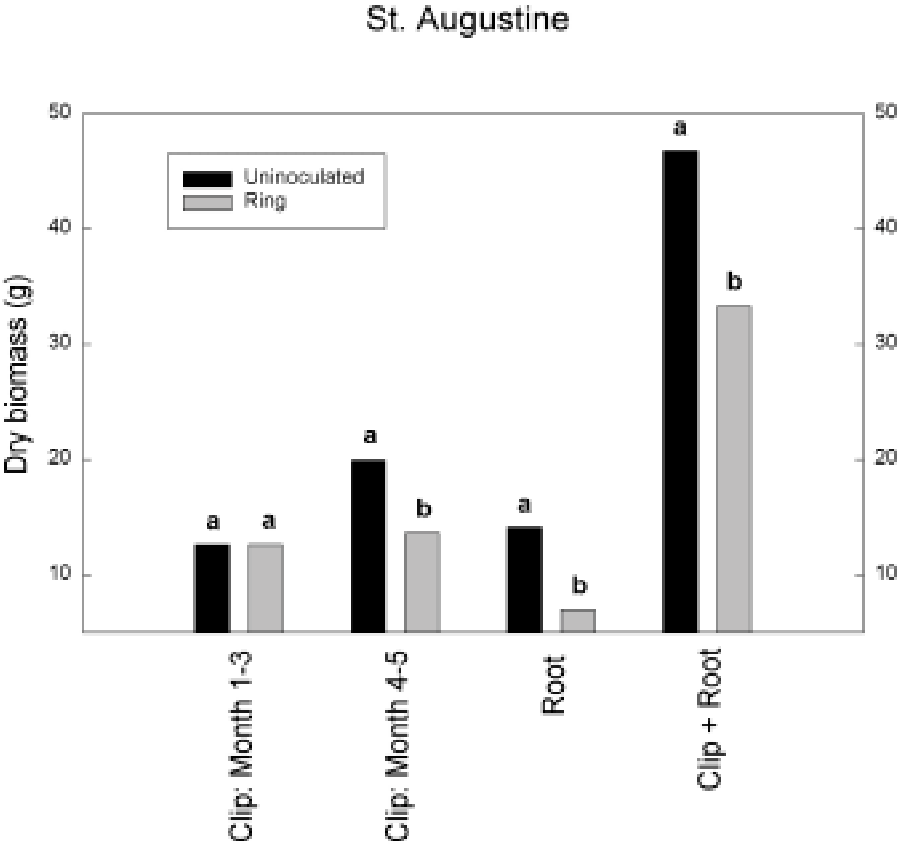

Figure 1. Effect of ring nematode parasitism on St. Augustine growth ($P<0.05$) in a greenhouse study in 2001.

TITLE: Host Preference of the Stunt (*Tylenchorynchus sp.*) Nematode among Cool and Warm Season Turfgrasses Given Two Soil Temperatures.

OBJECTIVES: To evaluate host preference of the stunt nematode while maintaining both optimum and sub-optimum soil temperatures for turfgrass host growth.

PERSONNEL: Derek Settle, Tim Todd, Jack Fry, and Ned Tisserat

SPONSORS: Plant Pathology Departmental Graduate Research Assistantship

INTRODUCTION:

The purpose of this experiment was to determine if nematode host preference is influenced by soil environmental conditions. Two soil temperatures were chosen to provide near optimum root growth for either a warm- or cool-season turfgrass. Nematode host preference studies are normally conducted in the greenhouse, and time of year may affect results as lighting and temperature vary according to the season. For example, extended high soil temperatures can decrease growth and vigor of cool-season turfgrasses, such as creeping bentgrass and Kentucky bluegrass. Our hypothesis was that the soil temperature that allows greatest root growth of a compatible host would coincide with the most favorable temperature for stunt nematode population growth.

MATERIALS AND METHODS:

A greenhouse study was conducted beginning 2 November 2000 and ending 18 April 2001. The experiment design was a completely randomized block with eight turfgrass species (four cool-season and four warm-season) x two soil temperature treatments x three replications (total of 48 pots). Pots were clipped at 1-inch height weekly, watered to pot-capacity every third day, and fertilized using a Peters 10-20-10 liquid formulation to provide 0.25 lb N per 1000 ft^2 bimonthly.

Turfgrass

The four cool-season turfgrass species were: (i) creeping bentgrass ‘Crenshaw’, (ii) Kentucky bluegrass ‘Caliber’, (iii) a perennial ryegrass blend ‘Charger II’, ‘Manhattan II’, ‘Chaparral’, and (iv) a turf-type tall fescue blend ‘Tomahawk’, ‘Apache II’, ‘Coronado’, ‘Safari’, ‘Barlexas’, and ‘Tar Heel’. The four warm-season turfgrasses were: (i) bermuda ‘Midlawn’, (ii) buffalo, (iii) St. Augustine ‘Raleigh’, and (iv) zoysia ‘Meyer’. All sod pieces, except St. Augustine, were obtained from existing mature turf stands at the Rocky Ford Research Center, Manhattan, KS. St. Augustine sod pieces were grown by propagating from stock greenhouse material. Pots were established with 750 cm^3 nematode-containing soil and washed sod on November 2, 2000. Prior to planting, circular sod pieces (4-in. diameter) were verified to be stunt-free, only residual populations of spiral nematodes persisted after all soil had been removed.

Nematode

Stunt (*Tylenchorynchus spp*.) nematode contaminated soil was collected from a sand-based nursery green of established creeping bentgrass at Highlands Country Club, Hutchinson, KS, on October 10, 2000. Initial populations of nematodes (number/100 cm^3 homogenized soil) were relatively high for stunt, moderate for ring and low for other phytoparasitic nematodes: 850 stunt, 125 ring, 35 spiral, 10 lance, and 10 sheath.

Temperature

One of two soil temperatures was maintained in each individual 4 by 6 inch pot by embedding a U-shaped segment of epoxy-coated copper tubing (0.3 cm i.d.) in the soil with both ends protruding through bottom drain holes. Beneath the greenhouse bench, each pot's copper tubing was connected to a rubber hose that circulated either warmed or chilled water and consisted of i) 70 °F, and (ii) 85 °F. Each temperature system was unique and consisted of an in-line water pump, a thermostat, and a 50 gallon reservoir fitted with either an L-shaped heating element or an in-line water chiller. Following a 2-month grow-in period, soil temperature treatments began on 18 February 2001 and lasted 10 weeks.

Measurements

At weekly intervals, each individual pot was assessed for visual quality (0-9, 9 = best), percent turfgrass cover, and dry clipping weight. Finally, roots from each pot were harvested, dried and weighed. Following soil temperature initiation, live nematode populations were quantified twice at week 4 and 10 by a light sucrose extraction of 75 g soil. A sub-sample of approximately 100 g fresh soil from each pot was taken to calculate soil moisture, allowing nematode populations to be standardized per 100 g dry soil.

RESULTS:

After four weeks of soil temperature initiation, stunt nematodes preferred the cool-season creeping bentgrass host with a soil temperature of 85 °F over all other treatments (Fig.1). By week 10, stunt nematodes preferred creeping bentgrass and the warm-season zoysia hosts receiving an 85 F soil temperature (Fig. 1). At 85 °F, stunt populations in bentgrass fell considerably from 1543 to 569, and at the same time populations for zoysia more than doubled from 165 to 384 (Fig.1). Populations in Kentucky bluegrass at 85 °F had also increased, from 163 to 347, but the population was not different from non-host turfgrasses, such as tall fescue (Fig.1).

When final plant biomass of each treatment was compared, soil temperature was found to have a significant effect on the dry root weight of all four cool-season turfgrasses. The temperature of 85 °F, when compared within each cool-season species, reduced root biomass compared to 65 °F. For example, bentgrass roots weighed 1.7 grams at 65 °F versus 0.6 grams at 85 °F soil temperature. Soil temperature had no effect on root biomass within each warm-season species. Interestingly, clippings harvested were higher among all turfgrasses receiving an 85 °F soil temperature versus 65 °F. One exception was perennial ryegrass, where total clippings were the same regardless of soil temperature.

Visual quality and percent pot coverage of creeping bentgrass was similar among the two soil temperature treatments throughout the study period.

SUMMARY:

The stunt nematode preferred a warm soil temperature of 85 °F when creeping bentgrass was the host, and showed a similar trend with Kentucky bluegrass and warm-season zoysia. However, the host preference of stunt nematodes parasitizing creeping bentgrass was reduced substantially following 10 weeks of warm soil temperature; likely due to a measured reduction in root biomass at 85 °F. The initiation of bentgrass root mortality may have been caused by the warm soil temperature, high nematode populations, or a combination of the two. A future greenhouse study will include pots without nematodes as controls, to determine which effect(s) are directly responsible for bentgrass root decline.

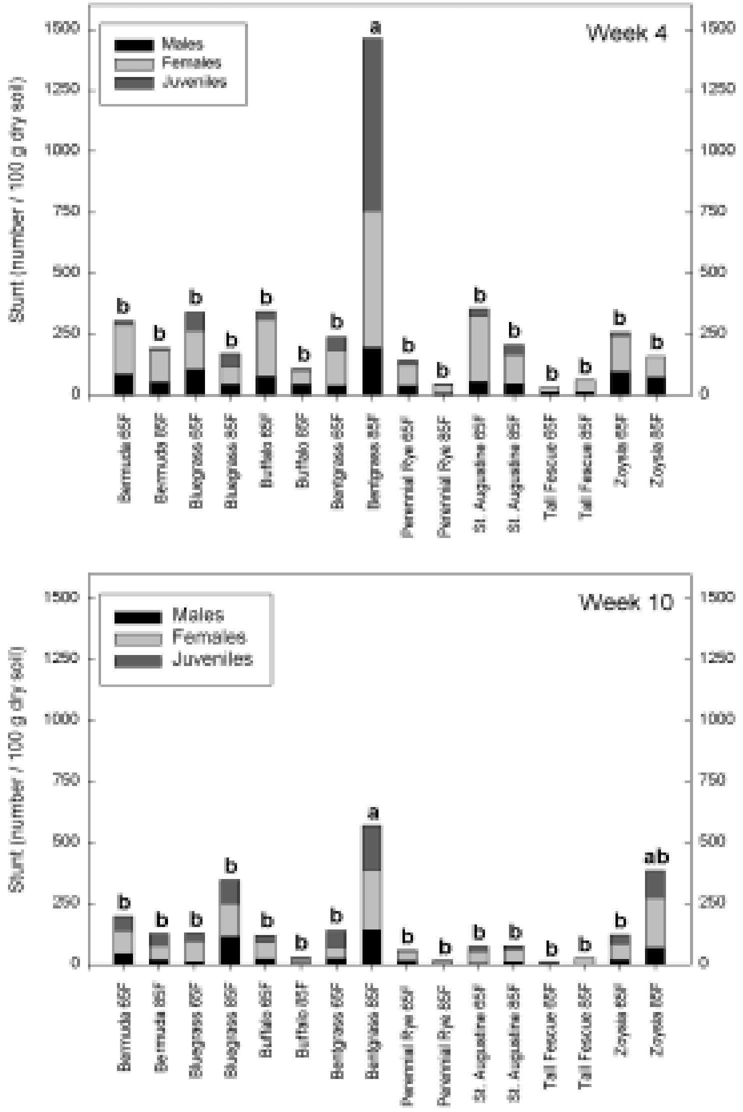

Figure 1. A greenhouse stunt nematode host preference test of four cool and four warm season turfgrasses given two soil temperatures at Manhattan, KS in 2000 (P=0.05).

TITLE: Host Preference of the Spiral (*Helicotylenchus spp.*) and Ring (*Criconemella spp.*) Nematodes Among Cool- and Warm-Season Turfgrasses Grown in a Silt-loam Soil.

OBJECTIVES: To evaluate host preference of root feeding phytoparasitic nematodes commonly present in Kansas soils

PERSONNEL: Derek Settle, Tim Todd, Jack Fry, and Ned Tisserat

SPONSORS: Plant Pathology Departmental Graduate Research Assistantship

INTRODUCTION:

Information is needed to evaluate root-feeding nematodes and their relationship with turfgrass. Nematicide recommendations to control nematodes rely on known minimum population thresholds in the soil, above which damage to plant host is likely. Population thresholds that have been set for nematode damage on cool season turfgrasses in the transition zone are at best educated guesses. In general, visible reduction in turf quality from nematode parasitism occurs mainly in the southern United States where primarily warm-season turfgrasses are grown.

The spiral and ring nematodes are two of the most frequently identified nematodes in Kansas soils. The spiral nematode has been associated with summer dormancy of Kentucky bluegrass in Wisconsin, and fading-out of Kentucky bluegrass in Nebraska. The ring nematode has been associated with bermudagrass decline in the South.

MATERIALS AND METHODS:

A greenhouse study was conducted beginning in June and ending in October 2000. The experiment was a completely randomized block design with two nematode treatments x eight turfgrass species x three replications, for a total of 48 pots. Half of the turfgrass species were planted in a silt-loam soil with a mixed population of spiral and ring, and the remaining half was planted in the same soil that had been steamed to kill the nematode populations. Four cool-season species selected for study were: (i) creeping bentgrass ‘Crenshaw’, (ii) Kentucky bluegrass ‘Caliber’, (iii) a perennial ryegrass blend of ‘Charger II’, ‘Manhattan II’, and ‘Chaparral’, and (iv) a turf-type tall fescue blend of ‘Tomahawk’, ‘Apache II’, ‘Coronado’, ‘Safari’, ‘Barlexas’, and ‘Tar Heel’. Four warm-season species where also selected: (i) bermuda ‘Midlawn’, (ii) buffalo, (iii) zoysia ‘Meyer’, and (iv) St. Augustine ‘Raleigh’.

Chase silt-loam soil was obtained from an area of established Kentucky bluegrass at the Rocky Ford Research Center, Manhattan, KS. All soil was mixed to homogenize the existing number of nematodes (160 spiral and 105 ring per 100 cm^3), then half the soil was steamed at 170 °F for 120 minutes to provide nematode-free soil for the non-infested soil treatment.

All sod pieces, except St. Augustine, were obtained from existing mature turf stands at the Rocky Ford Research Center. St. Augustine sod pieces were grown by propagating from stock greenhouse material. Each sod piece measured 8 by 11 in. with a depth of approximately 2 in., and all existing soil nematodes were washed off with a jet of water lasting 5 minutes. Washed sod pieces were then planted in individual 3-gallon containers filled with either nematode-infested or non-infested soil.

During the study period, nematode populations were monitored monthly by a light sucrose extraction of 100 cm^3 soil samples. The technique separates nematodes into clear water for microscopic identification and counting from aliquots of soil by flotation and centrifugation. Four 3-cm-diameter soil plugs were randomly taken from each pot to a depth of 15 cm, providing 100 cm^3 soil. A remaining 100 g aliquot of soil was weighed, dried, and re-weighed to determine each sample's soil moisture content, and allow standardization of lance population per 100 g dry soil. Sod given nematode-infested soil was compared visually to sod given non-infested soil to check for any possible plant pathological effects.

All turfgrass was treated on three separate occasions with the fungicide iprodione, Chipco GT (4 oz 1000 ft^{-2}), due to Rhizoctonia brown patch development in creeping bentgrass. An insect growth regulator, Precision, was applied every 14 to 21 days for preventive control of fungus gnats and thrips. Pots were watered as needed, and fertilized weekly with Peters 10-20-10 liquid fertilizer and clipped three days a week at 1-inch height. Greenhouse temperature was maintained at 90/80 °F day/night. However, midday temperatures exceeded 100 °F during summer's hottest periods of July and August, and reduced visual quality of all cool season turfgrass.

RESULTS:

Spiral

At no time during the greenhouse study were there any visible differences between turf in spiral-free soil and sod grown in spiral-infested soil. Nevertheless, numbers of spiral nematodes did exceed published damage thresholds (350-400/100 cm^3) for Kentucky bluegrass, perennial ryegrass, tall fescue, and zoysia on one or more months (Fig. 1).

Best host was Kentucky bluegrass and perennial ryegrass in August (Fig. 1). In September, high populations of spiral were again found in perennial ryegrass and bluegrass, as well as zoysia and tall fescue. In October, perennial ryegrass had high spiral populations (Fig. 1).

Among cool-season grasses, perennial ryegrass was the best host for spiral nematodes, where high levels of spiral nematode populations were present in each month of the study (Fig. 1). Surprisingly, Kentucky bluegrass, a reported excellent host of spiral nematodes, did not support high populations throughout the summer (Fig. 1). Among warm-season turfgrasses, zoysia was the best host for spiral nematodes (Fig. 1.).

Ring

Ring nematode numbers never exceeded reported damage thresholds (generally > 1,000 per 100 cm^3). In September, bermuda and zoysia were the best hosts for the ring nematode (Fig. 1). Both grasses exhibited a rapid drop in nematode levels on the October sampling date (Fig. 1), possibly indicating onset of dormancy.

CONCLUSIONS:

Both spiral and ring nematodes displayed differing host preference among four cool- and four warm-season turfgrasses. Spiral tended to prefer cool-season grasses with greatest populations occurring in perennial ryegrass on October 1, whereas ring tended to prefer warm-season grasses with greatest populations occurring in bermuda and zoysia on September 1 (Fig. 1). Interestingly, zoysia was the only turfgrass in which high populations of both ring and spiral nematodes occurred.

Contrary to current information, the minimum damage threshold for spiral nematodes parasitizing Kentucky bluegrass, perennial ryegrass, and zoysia was not supported in this study.

Importantly, time of sampling affected host preference status of both spiral and ring nematodes. Sampling of nematode populations to determine host preference should be timed to coincide with optimum plant growth conditions for the host in question. Alternatively, a phytoparasitic nematode-host relationship may be best understood by sampling at regular intervals throughout the growing season. For example, Kentucky bluegrass is an excellent host of the spiral nematode, and yet spiral nematode populations parasitizing bluegrass fell significantly following August 1 (Fig. 1), a time in which high greenhouse temperatures during the summer caused Kentucky bluegrass to decline visibly. Similarly, zoysia's spiral nematode populations dropped dramatically in October (Fig. 1); possibly indicating the onset of dormancy.

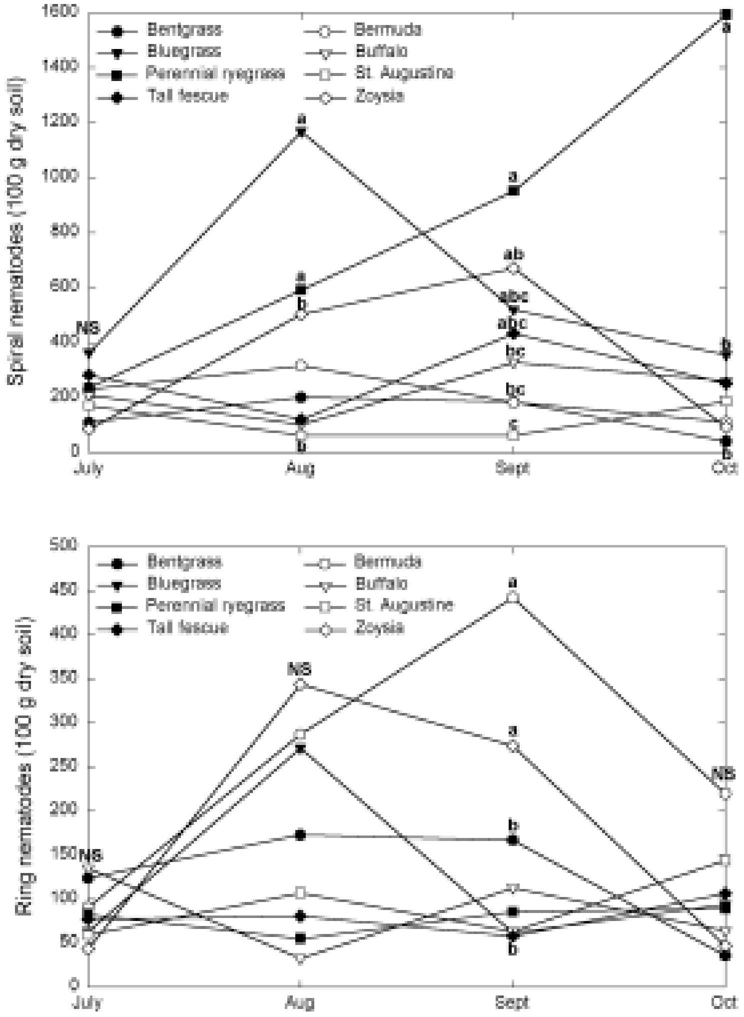

Figure 1. Ring and spiral nematodes in cool- and warm-season turfgrasses, Manhattan, KS.

TITLE:	Preventive Fungicide Applications for Control of Brown Patch and Dollar Spot on Creeping Bentgrass in 2001
OBJECTIVE:	To determine efficacy of various fungicides in the control of brown patch and dollar spot on creeping bentgrass.
PERSONNEL:	Derek Settle, Jack Fry and Ned Tisserat
SPONSORS:	Aventis Corporation, Bayer Corporation, BASF Corporation, Dow AgroSciences (plus former Rohm & Haas products) and Syngenta Corporation

MATERIALS AND METHODS:

Fungicides were evaluated on an established stands of ‘A-4’ and ‘Cobra’ creeping bentgrass on a sand-based putting green at the Rocky Ford Turf Research Center, Manhattan, KS. The turf was mowed to a height of 0.16 in., irrigated as needed, and fertilized with 4 lb N/1000 ft^2 annually. Applications were made at 2- or 4-wk intervals beginning in May and continued through Sep. Fungicides were applied with a CO_2-powered backpack sprayer with 8003 TeeJet nozzles at 20 psi in water equivalent to 2.7 gal/1000 ft^2. Plots were not irrigated after applications. Plots were 5 by 6 ft and arranged in a randomized complete-block design with four replications. Plots were rated weekly for the number of dollar spot infection centers and the percentage plot area damaged (foliar necrosis) by brown patch.

RESULTS:

Dollar spot was active throughout the summer, but was most intense in June, and in late Aug through early Sep. On the cultivar A-4, all fungicides except Daconil Ultrex and Fore Rainshield provided visually acceptable levels of control through the growing season. Brown patch occurred from 23 July through 13 Aug and on 30 Aug through 5 Sep. All fungicides significantly reduced brown patch AUDPC values as compared to untreated plots. Chipco 26GT and Chipco 26GT + Chipco Aliette Signature provided the best overall turf quality through the summer. On the cultivar Cobra, all fungicide treatments were effective in suppressing dollar spot throughout the summer. No phytotoxicity was observed.

Table 1. Fungicide efficacy on 'A-4' creeping bentgrass

Treatment and rate/1000 ft^2	Spray interval (days)	Dollar spot (number infection centers/plot) 10 Jun	Dollar spot (number infection centers/plot) 5 Sept	Dollar spot (AUDPC)[1]	Brown patch 5 Sept (% plot area area blighted)	Brown patch (AUDPC)
No fungicide	-	64.0 a	132.5 a	575.0 a	57.5 a	208.7 a
Chipco GT 2SC 4 fl oz	14	8.3 d	0.0 e	13.3 d	3.5 d	6.5 de
Daconil Ultrex 82.5 DG 3.2 oz	14	7.3 d	76.5 b	175.0 bc	30.0 b	49.0 cde
Eagle 40WP 0.6 oz	14	0.0 d	0.0 e	4.8 d	22.5 bc	25.0 de
Eagle 40WP 1.2 oz	28	0.0 d	0.0 e	6.3 d	10.3 bcd	9.9 de
Fore Rainshield 80WP 8 oz	14	33.5 bc	52.5 bc	145.1 bc	1.3 d	11.4 de
Fore Rainshield 80WP 6 oz	14	30.0 c	58.8 bc	187.1 b	13.8 bcd	35.6 cde
XF00059 Manhandle 6G 4 lb	28	8.8 d	0.0 a	11.0 d	55.0 a	87.5 bc
Banner MAXX 1.2MEC 0.5 fl oz	14	5.7 d	1.3 de	6.9 d	52.5 a	108.8 b
Bayleton 50DG 0.5 oz	14	0.0 d	0.0 e	5.6 d	30.0 b	64.0 bcd
Chipco Aliette Signature 80WDG 4 oz + Chipco 26GT 2SC 4 fl oz	14	6.0 d	0.0 e	8.5 d	1.8 d	2.6 e
Chipco Aliette Signature 80WDG 4 oz + Daconil Ultrex 82.5DG 3.2 oz	14	11.0 d	33.0 cd	58.1 bc	6.8 cd	30.4 cde

[1] Area under disease progress curve (AUDPC). Means not followed by the same letter within the same column are significantly different (P=0.05) by Fisher's protected LSD.

Table 2. Fungicide efficacy on 'Cobra' creeping bentgrass

Treatment and rate/1000 ft2	Spray interval (days)	Dollar spot (number infection centers/plot)		Dollar spot Area under the Disease progress curve[1]		Brown patch (% plot area blighted)
		2 Jul	12 Sept	AUDPC I (4 Jun-16 Jul)	AUDPC II (23 Jul-12 Sept)	11 Sept
No fungicide	-	32.3 a	39.8 a	139.1 a	184.0 a	6.3 a
Lynx 45 WP	14	0.0 b	0.0 b	5.1 b	0.0 b	0.0 b
Compass 50WG 0.05 oz + Lynx 45WP 0.556 oz	14	0.0 b	0.0 b	0.0 b	0.0 b	0.0 a
Bayleton 50WG 0.5 oz	14	0.0 b	0.0 b	9.5 b	0.0 b	3.0 a
Compass 50WG 0.15 oz + Bayleton 50WG 0.5 oz	14	0.0 b	0.0 b	0.0 b	0.0 b	0.0 a
Compass 50WG 0.15 oz	14	0.0 b	0.0 b	0.0 b	0.5 b	0.0 a
Honor (BAS 505) 50WG 0.2 oz	14	0.0 b	0.0 b	2.0 b	0.0 b	0.0 a
Honor 50WG 0.2 oz	28	0.0 b	0.0 b	0.0 b	3.3 b	0.0 a
Honor 50WG 0.0 oz + Daconil Ultrex 82.5DG 3.2 oz	14	0.0 b	0.0 b	0.8 b	0.0 b	0.0 a
BAS 510 0.13 oz	14	0.0 b	0.0 b	5.2 b	1.3 b	0.8 a
BAS 510 0.18 oz	28	0.0 b	0.0 b	3.0 b	0.0 b	11.8 a
Banner MAXX 1.2MEC 0.5 fl oz + Heritage 50DG 0.2 oz	14	0.0 b	0.0 b	0.0 b	0.0 b	0.0 a

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[1] Area under disease progress curve (AUDPC). Means not followed by the same letter within the same column are significantly different (P=0.05) by Fisher's LSD.

TITLE: Dollar Spot and Brown Patch Incidence in Creeping Bentgrass as Affected by a Plant Defense Activator and Biostimulants

OBJECTIVE: To evaluate the potential for using the plant defense activator acibenzolar-S-methyl (ASM) in combination with 12 biostimulants for reducing dollar spot *(Sclerotinia homoeocarpa* F.T. Bennett) and brown patch (*Rhizoctonia solani* Kuhn) in creeping bentgrass.

PERSONNEL: Joon Lee, Jack Fry, and Ned Tisserat

SPONSORS: Kansas Turfgrass Foundation, Green Releaf, Plant Health Care, Roots, PBI Gordon, Sustane, Grigg Bros., Harmony Products

INTRODUCTION:

There is interest in identifying cultural practices that may reduce fungicide requirements of creeping bentgrass putting greens. Such practices currently under consideration include the use of biostimulants and other fungicide alternatives.

MATERIALS AND METHODS:

The study was done on a blend of 'Crenshaw' and 'Cato' creeping bentgrass at the Rocky Ford Turfgrass Research Center on a sand-based green. Turf was mowed 6 days weekly at 5/32 inch. Irrigation was applied daily to deliver approximately 0.2 inch water. A 20-0-10 fertilizer was applied to the entire study area at 1 lb N/1000 ft^2 in April, May, September, and October, and at 0.5 lb N/1000 ft^2 in June, July, and August. The study design was a split-plot. Whole plots were either treated or not treated with the plant defense activator acibenzolar-S-methyl at 1 oz/a in 2 gal per 1000 ft^2 every 14 days beginning on 5 May 2000 and 20 April 2001. Whole plots measured 14 by 21 ft. Sub-plots were the biostimulant treatments, and were 3 by 7 ft. Biostimulants were applied according to label directions:

1. Urea (46-0-0): Rate = 0.1 lb N/1000 ft^2 every 2 weeks
2. Roots 1>2>3 premix with bacillus complex: soil enhancing microbes with 1.4% K_2O, 2.0%, P_2O_5, 2.2% chelated iron. Rate = Premix at 6 oz of product/1000 ft^2. Bacillus complex added to the tank mix at 1.5 oz of product/1000 ft^2 every 2 weeks.
3. Roots 1>2>3 premix with Standup: applied at 6 oz of product/1000 ft^2; Standup added to the tank mix to apply 6 oz product/1000 ft^2 every 2 weeks.
4. Aminoplex: N-3%, fermentation products- 45%, natural plant and organic extracts-21% and inert material-31%. Rate = 3 oz/1000 ft^2 every 2 weeks.
5. Colonize T & O: applied the rate of 0.01 lb/1000 ft^2 every 2 weeks.
6. Compete Plus : A dry, water dispersible soil inoculant that contains numerous strains of beneficial rhizosphere bacteria and fungi including selected species of bacillus, streptomyces and pseudomonas bacteria and trichoderma fungi. Rate = 0.04 lb/1000 ft^2 every 2 weeks.
7. Flexx (3-0-20): Humic and fulvic acids derived from solubilized leonardite, cold water sea kelp extract, *Ascophylum nodosum*, amino acids, 18 vitamins and soluble Yucca plant extract. Rate = 0.16 lb/1000 ft^2 every 2 weeks.

8. Turf Vigor (9-3-6): Applied at a rate of 18 oz/1000 ft^2 every 2 weeks. It is composed of Kelp, 9-3-6 NPK, 6 specific bacillus strains with unique phyto hormone production capabilities and micronutrient package (including 0.1% Fe).
9. 710-132 -Microbial Fungicide. Rate = 5 oz/1000 ft^2 every 2 weeks. It is composed of Kelp, small NPK, 1 baccilli strain and micronutrient package (including 0.1% Fe).
10. Focus Liquid: 4.8% Kelp extract, 35.4% humic/fulvic acid, 1.4% chelated iron and 58.4% inert. Rate = 8 oz/1000 ft^2 in Mar-Apr, May-June (5/12), July-Aug(7/7), Sept.-Oct(9/15).
11. Focus 15G: 7% N (urea), 5.3% humic/fulvic acid, 0.7% kelp extract, 0.17% organo-modified siloxane surfactant and 0.04% iron derived from EDTA. Applied at 4 lb/1000 ft^2 in early spring(5/12), mid-summer(7/7), and early fall(10/13).
12. Launch: 74.3% manure extract, 1.2% kelp (*Ascophyllum nodosum*) extract, 9% humic/fulvic acid, 0.35% chelated iron and 15.15% inerts. Applied every 4 weeks at 32 fl oz/1000 ft^2.
13. Bolster: 2.0% Sulfur, 5.0% Iron, plant food sources derived from ferrous sulfate, 2.0% solubilized seaweed and 4.0% humic acids from leonardite. Applied 3.0 oz/1000 ft^2 every 2 weeks.

RESULTS:

Dollar spot infection centers were reduced by 38% with ASM, but levels were > 1,000 per m^{-2} at their peak in August 2000. None of the biostimulant-treated turf had reduced dollar spot or brown patch levels compared to turf receiving biweekly applications of soluble N at 0.1 lb N/1000 ft^2 every 2 weeks (Table 1). Turf quality was unacceptable through most of the study period regardless of treatment (Table 2).

Table 1. Dollar spot in a Crenshaw-Cato creeping bentgrass blend as influenced by biostimulants at Manhattan, KS in 2000 and 2001.

Treatment[2]	Application Interval (days)	AUDPC[1] 2000	AUDPC[1] 2001
Urea control	14	9354 e	167 de
Root 1>2>3 premix with bacillus complex	14	10802 abcde	232 bcde
Roots 1>2>3 premix with standup	14	12293 a	301 ab
Aminoplex	14	11976 ab	200 bcde
Colonize T & O	14	11603 abc	244 bcde
Compete Plus	14	12329 a	357 a
Flexx	14	11902 ab	210 bcde
Turf Vigor	14	10191 bcde	157 ef
710-132 Microbial Fungicide	14	9819 cde	179 cde
Focus Liquid	48	11445 abcd	278 abc
Focus 15G	48	11477 abcd	268 abcd
Launch	28	12058 ab	264 abcd
Bolster	14	11619 abc	243 bcde

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[1] Area under the disease progression curve (AUDPC) represents counts of *S. homeocarpa* infection centers each year as follows: 10 May to 14 Sept., 200; 23 May to 20 Sept., 2001. AUDPC is expressed as number of infection centers x day.

[2] All treatments were applied according to label instructions. Urea was applied to provide N at 0.10 lb N/1,000 ft^2 every 2 weeks in addition to routine fertilization described in methods.

[3] Means followed by the same letter are not significantly different ($P < 0.05$) according to a F-LSD mean separation test.

Table 2. Quality of a Crenshaw-Cato creeping bentgrass blend as influenced by biostimulants at Manhattan, KS in 2000 and 2001.

	Turf Quality[1]									
	2000					2001				
Treatment[2]	May	June	July	Aug	Sep	May	June	July	Aug	Sep
Urea control	5.2	5.2	5.3 a[3]	4.0 ab	5.5 a	7.0ab	6.0	6.6	6.4ab	5.7
Roots 1>2>3 premix with bacillus complex	5.2	5.1	4.8 d	3.4 cd	4.0 c	6.4ab	6.0	6.5	6.3abc	5.3
Roots 1>2>3 premix with standup	4.9	5.4	4.9 cd	3.4 cd	4.0 c	6.4ab	5.8	6.6	6.1abcd	5.0
Aminoplex	4.8	5.0	4.9 d	3.6 bcd	4.2 bc	6.5ab	6.4	6.7	6.4a	5.3
Colonize T&O	5.0	4.7	4.9 bcd	3.4 cd	4.1 bc	6.5ab	6.1	6.5	5.9bcd	5.1
Compete Plus	4.7	4.5	4.7 d	3.3 cd	4.0 c	6.3b	5.8	6.3	5.8cd	5.1
Flexx	5.0	4.9	4.9 d	3.4 cd	4.1 c	6.6ab	6.0	6.6	6.3abc	5.0
Turf Vigor	4.7	5.1	5.2 ab	4.1 a	5.3 a	7.0a	6.2	6.4	6.2abc	5.7
710-132 Microbial Fungicide	5.3	5.4	5.2 abc	3.8 abc	4.6 b	6.7ab	6.2	6.7	6.5a	5.2
Focus Liquid	5.3	5.0	4.9 d	3.3 cd	3.9 c	6.4ab	5.9	6.4	5.7d	4.9
Focus 15G	5.1	4.9	5.2 ab	3.4 cd	4.0 c	6.6ab	5.9	6.5	5.9bcd	5.3
Launch	5.1	4.9	4.9 cd	3.2 d	4.1 bc	6.3b	5.9	6.5	6.1abcd	5.0
Bolster	5.1	4.7	5.0 bcd	3.3 cd	4.0 c	6.3b	6.2	6.7	6.3abc	5.1
	NS[3]	NS					NS	NS		NS

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[1] Turf quality was rated visually on a 0 to 9 scale, where 0 - dead turf, 7 = acceptable putting green quality, and 9 = optimum color and density.

[2] All treatments were applied according to label instructions. Urea was applied to provide N at 2.5 kg ha^{-1} in addition to routine fertilization described in methods.

[3] Means followed by the same letter in a column are not significantly different ($P < 0.05$) according to a F-LSD mean separation test.

[4] NS, not significant.

TITLE:	Creeping Bentgrass Disease Incidence as Affected by Cultivar, a Plant Defense Activator, and Organic Fertilizers
OBJECTIVES:	Our objectives were to evaluate the influence of bentgrass cultivar, the plant defense activator acibenzolar-S-methyl (ASM), and organic fertilizers on dollar spot
AUTHORS:	Joon Lee, Jack Fry, and Ned Tisserat
SPONSORS:	Kansas Turfgrass Foundation, Nature Safe, Roots

INTRODUCTION:

More fungicides are applied per unit area to creeping bentgrass putting greens than any other turf area. Golf course superintendents are interested in identifying ways to reduce fungicide inputs in bentgrass.

MATERIALS AND METHODS:

The study was done during 2000 and 2001 at the Rocky Ford Research Center on a sand-based USGA green. Turf was mowed six days weekly at 5/32 inch. Irrigation was applied to deliver approximately 0.2 inch water each day. Plot design was a split-strip plot. Whole plots were the bentgrass cultivars (Crenshaw, L-93, Penncross, and Providence) and measured 24 by 7.2 ft. Subplots were the plant activator (treated or untreated) and were 24 by 3.6 ft. Strip plots were fertilizer treatments (see Tables). The plant activator (acibenzolar-S-methyl, Syngenta's Actigard) was applied at 1 oz/a in 2 gal of water/1000 ft^2 every 14 days beginning 5 May 2000 and 20 April 2001. Fertilizers were applied each year at 1 lb N/1000 ft^2 in April, May, and September, and at 0.5 lb N/1000 ft^2 in June, July, and August. Data were collected weekly on turf quality, dollar spot number, and brown patch. Turf quality was rated visually on a 0 to 9 scale where 0 = dead turf; 7 = acceptable quality for a putting green; and 9 = optimum color, density, and uniformity. Dollar spot was counted using a 27-cm-diam. template randomly tossed two times per plot. Values were then converted to number of spots per square meter. Brown patch was rated visually using a 0 to 100% scale. Dollar spot and brown patch data were analyzed using Area Under the Disease Progress Curve, which allows comparison of treatments using a whole-season data summary.

RESULTS:

Crenshaw had up to 15 times the number of dollar spot infection centers counted in other cultivars; L-93 was most resistant (Table 1). Acibenzolar-S-methyl applied every 14 d at 1 oz/1000 ft^2 reduced dollar spot by 18 to 41% across all cultivars. In most instances, organic fertilizers did not suppress dollar spot or brown patch compared to urea (Table 2). In all cultivars except L-93, application of selected organic fertilizers resulted in up to 56% higher dollar spot levels compared to urea. Quality of turf in all fertilizer treatments was less than acceptable through most of the two-year study (Table 3).

Obviously, higher quality would have been observed if fungicides had been applied. None of the fertilizers resulted in higher quality ratings than urea-treated turf in either year. Selection of disease-resistant cultivars is more important than fertilizer selection in managing dollar spot in creeping bentgrass. Acibenzolar-S-methyl may be a tool golf course superintendents could use to reduce fungicide inputs on putting greens.

Table 1. Dollar spot in four creeping bentgrass cultivars as influenced by the plant defense activator acibenzolar-S-methyl (ASM) at Manhattan, KS.

	AUDPC[1]			
Treatment	Crenshaw	L-93	Penncross	Providence
Untreated	12884 a[2]	1415 a	2414 a	2798 a
ASM	10923 b	1161 a	1830 b	1986 b

[1] Area under the disease progression curve (AUDPC) represents counts of *S. homoeocarpa* infection centers each year as follows: 10 May to 14 Sept., 200; 23 May to 20 Sept., 2001.
AUDPC is expressed as number of infection centers x day. Means are of data combined from 2000 and 2001.

[2] Means followed by the same letter in a column are not significantly different ($P < 0.05$).

Table 2. Dollar spot in four creeping bentgrass cultivars as influenced by nitrogen source at Manhattan, KS in 2000 and 2001.

N Source	Analysis (N-P-K)	AUDPC[1]							
		Crenshaw		L-93		Penncross		Providence	
		2000	2001	2000	2001	2000	2001	2000	2001
Milorganite	6-0.9-0	10093 c[2]	1056 d	692 a	94 a	1832 ab	89 b	1117 abc	247 b
Nature Safe	8-1.3-4.2	12507 a	1975 a	1308 a	85 a	1719 ab	214 ab	2737 a	553 a
Nature Safe	10-0.9-6.6	11415 b	1995 a	1207 a	100 a	1868 ab	148 b	1191 abc	510 a
Roots Turf Food	15-1.3-6.6	10117 c	1545 c	1173 a	293 a	1818 ab	213 ab	1585 c	438 a
Sustane	10-0.4-1.7	8918 d	1594 bc	1119 a	236 a	2446 a	95 b	2027 abc	447 a
Sustane with Iron	5-0.9-3.3	10481 c	1838 ab	1366 a	257 a	2325 ab	484 a	2344 ab	659 a
Urea	46-0-0	10072 c	1529 c	1238 a	165 a	1668 b	270 ab	1758 bc	394 a

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[1] Area under the disease progression curve (AUDPC) represents counts of *S. homoeocarpa* infection centers each year as follows: 10 May to 14 Sep, 2000; 23 May to 20 Sep, 2001. AUDPC is expressed as number of infection centers x day.

[2] Means followed by the same letter in a column are not significantly different ($P < 0.05$) according to a Fisher's Protected LSD mean separation test.

Table 3. Influence on N Source on quality of four creeping bentgrass cultivars at Manhattan, KS in 2000 and 2001.

		Quality[1]									
		Crenshaw		L-93		Penncross			Providence		
		2000		2000		2000		2001	2000		2001
Nitrogen Source	Analysis (N-P-K)	June	July	May	June	May	June	May	June	Aug	May
Milorganite	6-0.9-0	3.2 b[2]	4.7 bc	5.6 b	5.6 c	5.4 bc	5.2 c	5.5 c	5.8 c	4.7 bc	5.2 b
Nature Safe	8-1.3-4.2	3.4 b	4.5 c	5.9 b	6.4 b	5.0 c	5.8 ab	6.7 a	5.1 c	4.5 c	6.4 a
Nature Safe	10-0.9-6.6	3.8 ab	4.7 bc	6.1 b	6.3 bc	5.4 bc	5.8 ab	6.3 a	5.5 ab	4.6 bc	6.8 a
Roots Turf Food	15-1.3-6.6	4.8 a	5.3 a	6.2 ab	6.8 ab	5.9 ab	6.1 ab	6.3 ab	6.4 a	4.9 b	6.5 a
Sustane	10-0.4-1.7	3.3 b	4.9 ab	6.1 b	6.1 bc	5.4 bc	5.0 c	5.7 bc	5.3 bc	4.7 bc	6.1 a
Sustane with Iron	5.0-9-3.3	3.6 ab	4.9 ab	6.0 b	6.4 b	5.5 bc	5.3 bc	6.6 a	5.0 c	4.8 bc	6.5 a
Urea	46-0-0	4.8 a	5.2 ab	7.0 a	7.3 a	6.3 a	6.4 a	6.5 a	6.1 ab	5.3 a	6.7 a

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[1] Turf quality was rated visually on a 0 to 9 scale, where 0 = dead turf, 7 = acceptable putting green quality, and 9 = optimum color and density.

[2] Means represent the average of two rating dates per month. Means followed by the same letter in a column are not significantly different ($P < 0.05$) according to a Fisher's Protected LSD mean separation test.

TITLE:	Aggressiveness of *Ophiosphaerella korrae* Isolates from two Genetically Distinct Populations to Bermudagrass.
OBJECTIVE:	Determine the distribution, genetic diversity and aggressiveness of two populations of *O. korrae.*
PERSONNEL:	F.B. Iriarte , N. A. Tisserat, J.D. Fry , D.L. Martin and T. C. Todd.
SPONSOR:	United States Golf Association (USGA)

INTRODUCTION:

Spring dead spot (SDS) is a serious disease of bermudagrass. It is more severe in intensively managed turf . Symptoms of the disease occurs as circular patches of bleached, dead grass ranging from few inches to several feet in diameter. Disease occurs after very cold winters when bermudagrass breaks dormancy. Fungi associated with the disease include *Ophiosphaerella herpotricha, O. korrae* and *O. narmari*. *O. herpotricha* is the primary pathogen in Kansas and Oklahoma, whereas *O. korrae* is associated with the disease in Mississippi, Alabama, Virginia, North Carolina, Georgia, and Tennesse. *O. narmari* is the principal cause of SDS in Australia and California. Amplified Fragment Length Polymorfisms analysis (AFLP) revealed that *O. korrae* isolates from the southeastern United States (‘southern’) clustered into a clade that was distinct from isolates collected in Kansas and Oklahoma (‘northern’). We are studying whether these two populations differ in temperature optima for growth and most importantly if ‘northern’ and ‘southern’ *O. korrae* isolates have differences in aggressiveness.

MATERIALS AND METHODS:

In vitro studies

Nineteen ‘southern’ and 12 ‘northern’ *O. korrae* isolates were grown in PDA plates at 25 and 30 °C . Four replicate plates of each isolate (treatment) were included . Treatments and replications were completely randomized in the respective temperature – incubator, and the experiment was repeated Radial growth was evaluated after the 15th day.

Greenhouse studies

Five-month-old Midlawn (resistant) and Tifgreen (susceptible) bermudagrass cultivars were inoculated with sterile oats or oats colonized with isolates of *O. herpotricha*, *O. narmari*, *O korrae* ’southern’and *O. korrae* ‘northern’. Inoculated turf was maintained for a month in greenhouse and then taken to cold room for 30 days for acclimation. Turf was then frozen at –4 °C for two hours. After a month in greenhouse turf was evaluated for recovery.

RESULTS:

In vitro studies

On average, 19 southern isolates exhibited faster (P = 0.0001) radial growth than 15 northern isolates on potato dextrose agar at 25 °C and 30 °C. The difference between 'southern' and 'northern' was more evident at 30 °C.

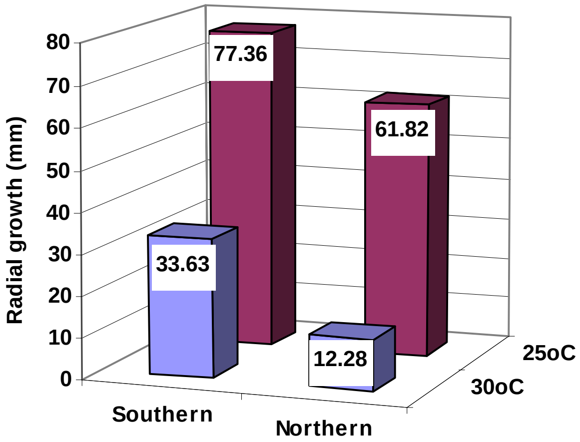

Figure 1. Radial growth of *Ophiosphaerella korrae* isolates on Potato dextrose agar after 15 days.

Greenhouse studies

In general, *O. herpotricha* was the most aggressive pathogen, follow by *O. korrae* 'southern' isolates . Recovery of bermudagrass inoculated with *O. narmari* , *O. korrae* 'northern' isolates were not statistically different from plants amended with sterile oats.

Plants inoculated with the *O. korrae* 'southern' isolates exhibited greater shoot mortality (P≤ 0.05) than plants inoculated with *O. korrae* 'northern' isolates. No difference in shoot mortality among resistant and susceptible cultivars was detected. These results suggest there are regional differences in aggressiveness of *O. korrae* isolates. Additional studies with a large number of isolates within each population of *O. korrae* ('northern' and 'southern') are currently under way to support this hypothesis.

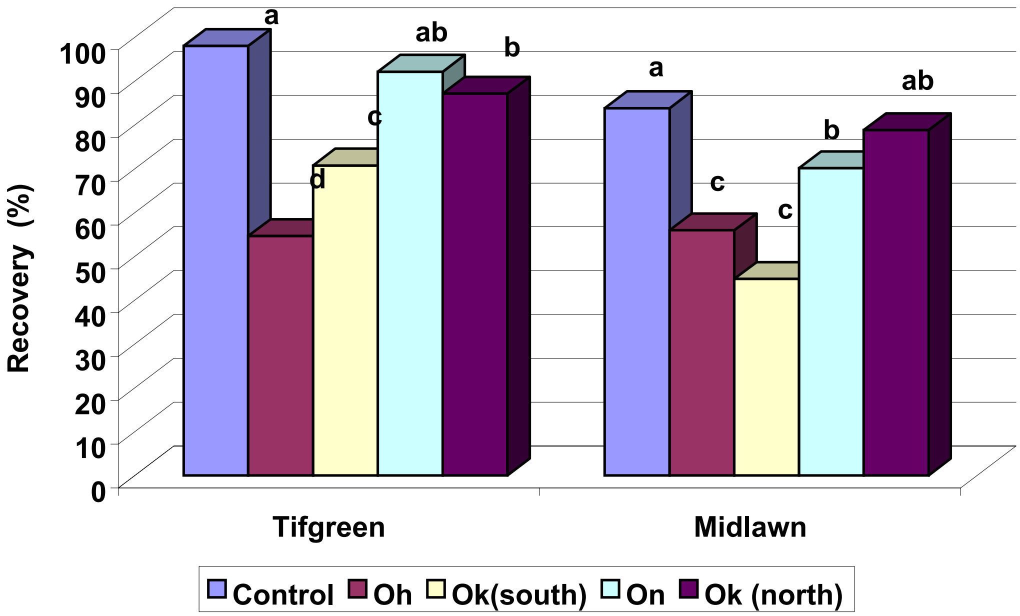

Figure 2. Shoot survival of inoculated Tifgreen and Midlawn after 30 days of recovery period post- freezing at –4°C.

TITLE:	Lance Nematode (*Hoplolaimus galeatus*) Population Effects in Creeping Bentgrass given Mowing and Irrigation Cultural Practices.
OBJECTIVES:	Evaluate contribution of phytoparasitic nematodes to midsummer creeping bentgrass decline
PERSONNEL:	Derek Settle, Tim Todd, Jack Fry, and Ned Tisserat
SPONSORS:	Plant Pathology Departmental Graduate Research Assistantship

INTRODUCTION:

Summer decline of creeping bentgrass maintained as golf greens is frequently reported throughout the Transition Zone. The cool season grass is especially vulnerable during Kansas's hottest months, July and August. Cultural management decisions by golf course superintendents are especially critical during hot temperature extremes because creeping bentgrass growth is retarded and recovery following damage can be slow. Current trends in golf course putting green management generally enhance ball roll speed, and include low clipping heights and reduced nitrogen input by 'spoon-feeding' liquid fertilizer applications. The direct or indirect effects of such management decisions are not fully known.

Phytopathogenic nematodes are frequent inhabitants of golf greens. Golf green construction with sand provides good drainage and aeration, creating an ideal environment for turfgrass root growth and microscopic round worms known as nematodes. Parasitic root-feeding nematodes of several genera are common inhabitants of creeping bentgrass golf greens in Kansas.

The purpose of this research was to determine if high lance nematode populations exacerbate summer creeping bentgrass decline across a range of cultural management strategies. Previous research at Kansas State University indicated that summer nematode populations in creeping bentgrass golf greens peak during July, and that lance population densities exceeding 300 per 100 cm^3 of soil can cause visible leaf necrosis.

MATERIALS AND METHODS:

An existing field area with natural phytoparasitic nematode populations ranging from 0 to 1000 or more per 100 cm^3 was identified in June 2000. Lance nematode populations predominated with periodic occurrence of four other genera, *Criconemella* (ring), *Paratrichodorus* (stubby-root), *Hemicycliophora* (sheath), and *Helicotylenchus* (spiral).

The location measured 7 by 24 m (24 by 79 ft), and was an established push-up sand constructed creeping bentgrass research green, which was seeded in fall1996 at the Rocky Ford Turfgrass Research Center, Manhattan, KS. Treatments and measurements begain in June and ended in September 2001. Cultural treatments of bentgrass cultivar, irrigation and clipping height were applied in a randomized strip-strip plot design with three replications. Four bentgrass cultivars were located in strips 2 by 7 m (6.5 by 24 ft), and consisted of; i) Crenshaw, ii) L-93 iii) Penncross, and iv) Providence. Each cultivar was split by two daily mowing heights, i) 1/8 inch, and ii) 5/32 inch. Irrigation treatments, measuring 3.5 x 8 m (11.5 by 26 ft), split whole blocks and consisted of i) automatic every-other-day irrigation (1.2 in. wk^{-1}), or ii) every-other-day irrigation plus mid-day hand watering every 24h (2.4 in. wk^{-1}).

Each individual plot consisted of cultivar x clipping height x irrigation treatments, and lance nemtodes were monitored by averaging two sub-samples taken approximately 1 m apart within each of the 48 plots, which where were 2 m^2 (43 ft^2) in area. The total sample grid represented 96 potential *H. galeatus* population sites (Fig. 1), and was sampled monthly by obtaining three 2-cm cores to a depth of 15 cm. Soil cores from each sampling site were combined, and a 75 g fresh sample was removed for nematode extraction by a light sucrose flotation technique. A remaining 100 g aliquot of soil was weighed, dried, and re-weighed to determine each sample's soil moisture content, and allow standardization of lance population per 100 g dry soil.

Creeping bentgrass quality was monitored from nematode sampled plots monthly using weekly visual quality average (0 = worst and 9 = best) and multispectral radiometry (MSR) (Cropscan, Rochester, MN) at turfgrass canopy light reflectance wavelengths of 661, 813 and 935nm. Reflectance MSR data was used for calculations that included; leaf area index (LAI = R_{935} / R_{661}), green leaf biomass expressed as normalized vegetation difference index (NDVI = (R_{935} - R_{661}) / (R_{935} + R_{661})), and canopy color index (CI = 1 / R_{661}). Photosynthesis was measured with an Li-6400 portable gas analyzer (Licor, Lincoln, NE).

Bentgrass received a total of 5 lb N 1000 ft^{-2}. Preventive applications of Heritage and Bayleton (0.2 and 2 oz 1000 ft^{-2}) fungicides occurred every 28 days from June through September to target brown patch and dollar spot. Supplemental applications of Chipco GT (4 oz 1000 ft^{-2}) to the entire area were needed in June and September due to Crenshaws' high susceptibility to dollar spot. No insecticides were applied to the area. Environmental data was monitored by the Rocky Ford Research Center weather station.

RESULTS:

In July, lance nematode populations were negatively correlated with visual quality (r = -0.20, P = 0.06), MSR reflectance at 815 nm (r = -0.17, P = 0.09), and calculated indices of CI (r = -0.22, P = 0.03), LAI (r = -0.20, P = 0.05), NDVI (r = -0.19, P = 0.06). As lance populations increased from 0 to 1000, visual quality was reduced by 0.7 (an 8% reduction on a 9-point visual scale).

By August, cultural practices influenced lance population dynamics, and increasing populations were negatively correlated with photosynthesis (r = -0.28, P = 0.005).

Cultivar

Lance nematodes preferred Penncross with a population of 671, 42-62% greater than Crenshaw, L-93 or Providence.

Clipping Height

Reducing clipping height from 5/32 to 1/8 inch reduced lance nematode populations (503 versus 405), but did not significantly alter damage relationships.

Irrigation

Plots that received supplemental, daily irrigation between 1200 and 1400 hr averaged 240% more second stage juveniles (P=0.10) and exacerbated visual decline 10 fold compared to plots that were irrigated every other day alone.

SUMMARY:

This study suggests that current lance population thresholds required for damage to creeping bentgrass is likely higher than previously thought. For example, when lance populations greater than 700 were not considered in the correlation analysis, the relationship between visual quality and lance populations vanished, indicating very dense populations of lance are required for damage. Although lance nematodes contributed to visual creeping bentgrass decline, the effect was slight.

Importantly, high lance populations in combination with the certain cultural practices may exacerbate damage or reduce visual quality below acceptable levels. For example, in July supplemental irrigation (midday hand watering) exacerbated lance damage. Further, clipping at 1/8 inch reduced July visual quality from 7.4 to 6.1 in plots with no lance populations (y-intercept), and a 0.71 visual quality decline in areas of dense lance populations would result in unacceptable visual quality for the low 1/8 inch height, while 5/32 inch would remain acceptable (> 6).

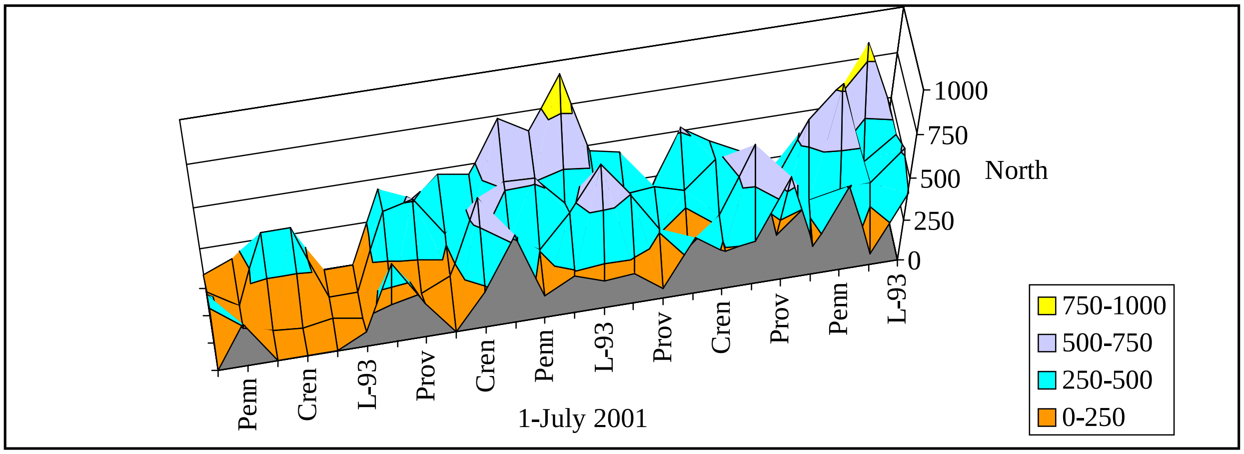

Figure 1. Lance nematode populations (no. / 100 g dry soil) from 96 sites sampled in strip plots of four creeping bentgrass cultivars (Crenshaw, L-93, Penncross, Providence) at Manhattan, KS.

TITLE: Effect of Clipping Height and Soil Temperature on Host-Parasite Relationships of *Hoplolaimus galeatus* on Creeping Bentgrass.

OBJECTIVES: To evaluate if lance nematode damage to creeping bentgrass is linked to stressful cultural and environmental conditions.

PERSONNEL: Derek Settle, Tim Todd, Jack Fry, and Ned Tisserat

SPONSORS: Plant Pathology Departmental Graduate Research Assistantship

INTRODUCTION:

Compared to warm season turfgrasses, little information exists on pathogenic effects root feeding nematodes may have on cool season turfgrass. Previous research found dense lance nematode populations correlated with visual decline and foliar necrosis of creeping bentgrass putting greens during midsummer in Kansas. The current greenhouse experiment was designed to explore the hypothesis that physiological plant stressors, in addition to high lance nematode populations, are necessary for observable nematode symptoms to occur in creeping bentgrass. Previous field observations of a naturally infested lance nematode research green during midsummer at Manhattan, KS suggested increasing lance populations were correlated with visual decline at 1/8 and not 5/32 inch clipping height. Low clipping heights in combination with high summer soil temperatures have been shown to cause greatest physiological decline of creeping bentgrass under field conditions. A turfgrass plant with low carbon reserves may suffer increased susceptibility to phytoparasitic nematode feeding. Therefore, lance nematode parasitism of creeping bentgrass may be of particular importance in the Transition Zone.

MATERIALS AND METHODS:

A greenhouse study was conducted November 2000 through April 2001. The experiment design was a completely randomized block with four harvest dates x two nematode treatments (inoculated versus uninoculated) x two soil temperature treatments (70 °F or 90 °F) x two clipping heights (1/8 inch or 1/4 inch) x three replications, for a total of 96 pots (24 pots per harvest date). Pots were clipped flush with upper edge every Mon., Weds., and Fri. with hand operated grass shears, which resulted in a 1/8 inch height. Similarly, clipping level with a PVC spacer ring attached to the pot lip produced the 1/4 inch clipping height. Pots were watered to pot-capacity every third day, and fertilized bimonthly using Peters 10-20-10 liquid formulation to provide 0.25 lb N 1000 ft^{-2}.

Creeping bentgrass cultivar A-4 sod pieces were obtained from an established research green, seeded the fall of 1999 at the Rocky Ford Research Center, Manhattan, KS. Prior to planting, the circular sod pieces (4- inch diameter) were washed to remove all soil and were verified nematode-free. Pots measuring 4 inches in diameter and 6 inches deep were established with 750 cm^3 steamed sand-silt root zone mix collected from the same field research green that provided the sod.

Nematode Inoculation

Lance (*Hoplolaimus galeatus*) inoculum was prepared by obtaining lance infested soil from a Penncross area of the research green. Approximately 50 gallons of soil was processed using a sucrose extraction technique that utilizes sucrose flotation with centrifugation and resulted in a final total of 100,000 lance nematodes that were placed into 2 liters of water. A large needle-less syringe was used to deliver 40 cm^3 lance inoculum or water filtrate to each pot full of soil on 23 March 2000. Following inoculation, pots were lightly top-dressed with steamed root zone mix and watered in. Initial lance nematode inoculated pot populations were 2000 per pot or 267 lance per100 cm^3.

Soil Temperature

One of two soil temperatures was maintained in each individual pot by embedding a U-shaped segment of epoxy-coated copper tubing (0.3 cm i.d.) in the soil with both ends protruding through bottom drain holes. Each pot’s copper tubing was connected to a rubber hose that circulated either warmed (90 °F) or chilled (70 °F) water. Each temperature system was unique and consisted of an in-line water pump, a thermostat, and a 50-gal reservoir fitted with either a L-shaped heating element or an in-line water chiller. Following the grow-in period, soil temperature treatments began in November 2001 and were applied for 12 weeks.

Measurements

Monthly, each individual pot was given three measurements: visual quality (0-9, 9 = best), percent turfgrass cover and dry plant weight. Live nematode populations were quantified monthly from pots assigned to one of four harvest dates. A sub-sample of approximately 50 g fresh soil from each pot was taken and dried to calculate soil moisture, and also allowed nematode populations to be standardized per 100 g dry soil.

RESULTS:

Lance populations

Across the four monthly harvest dates, active lance nematode populations (per 100 g dry soil) were found to generally increase from 125 to 241. However, the soil temperature of 90 °F caused a gradual decline of lance populations by the final two harvest dates when compared to 70 °F (159 versus 323 P=0.08, and 141 versus 276 P=0.04).

Bentgrass decline

Treatments of 90 °F soil temperature and 1/8 inch clipping alone or in combination caused greatest bentgrass decline, reducing visual quality, percent cover, and dry plant weight. For example, at the final harvest date best quality (8) and percent cover (100%) were observed at the 1/4 inch height x 70 °F soil temperature combination compared to the 1/8 inch x 90 °F combination (1.2 and 12% respectively).

Nematode effect

Bentgrass maintained at 1/8 inch was reduced 32% by lance nematode feeding, whereas bentgrass at 1/4 inch height was not (Fig. 1). This agrees with preliminary field data from the Research Center in 2000, which indicated high lance nematode populations may contribute to bentgrass decline when clipped at 1/8 inch (Fig. 2). It is probable that lower clipping heights, known to reduce root biomass, concentrate phytoparasitic nematode feeding to fewer roots. For example, at final harvest date, lance populations were similar at 1/8 and 1/4 inch clipping heights (204 and 214) when expressed per 100 g dry soil, but increase considerably at 1/8 inch when lance are expressed per g dry plant weight (204 / 0.61 = 334 versus 214 / 1.15 = 184).

SUMMARY:

This greenhouse study confirms that lance nematode parasitism can be tolerated for extended periods by creeping bentgrass with little visible effect. However, a golf course superintendent that chooses bentgrass putting green clipping heights lower than the standard 5/32 inch may increase the potential for bentgrass decline if and where high populations of lance nematodes exist. Current thresholds, expressed per 100 cm^3, may not be accurate for creeping bentgrass during summer, and instead lance number per dry root weight could give a better representation of the actual parasitic nematode pressure that a creeping bentgrass plant ‘sees’.

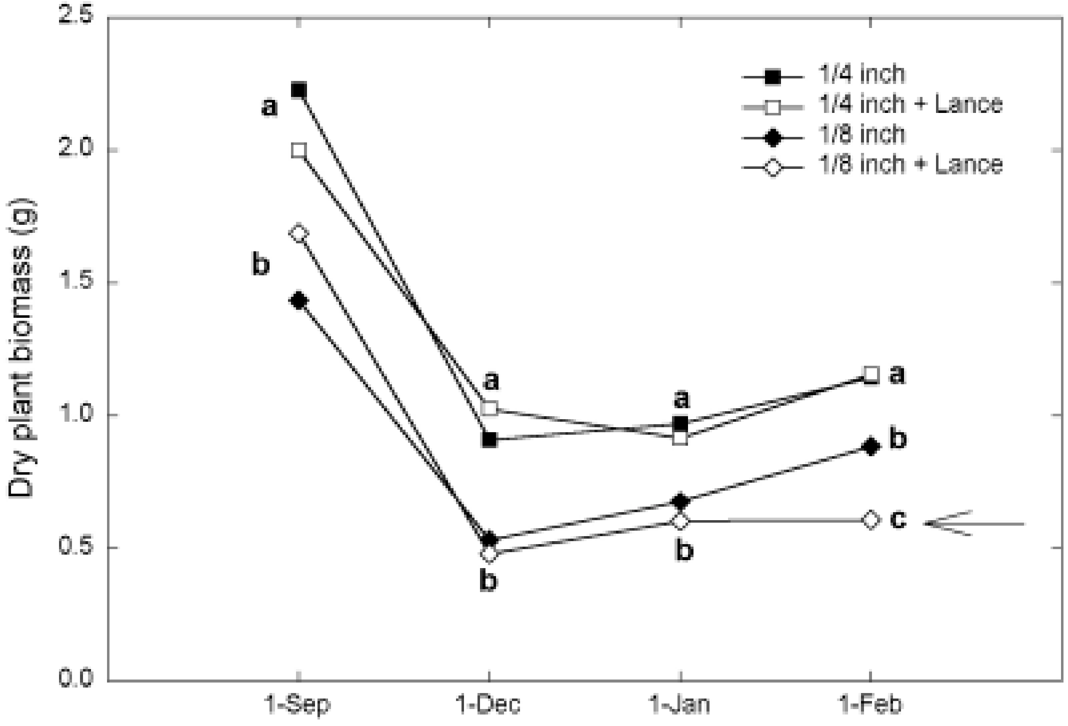

Figure 1. Arrow indicates negative effect of clipping height and lance nematode parasitism to A-4 creeping bentgrass plant weight in a greenhouse experiment at Manhattan, KS in 2001 (P=0.07).

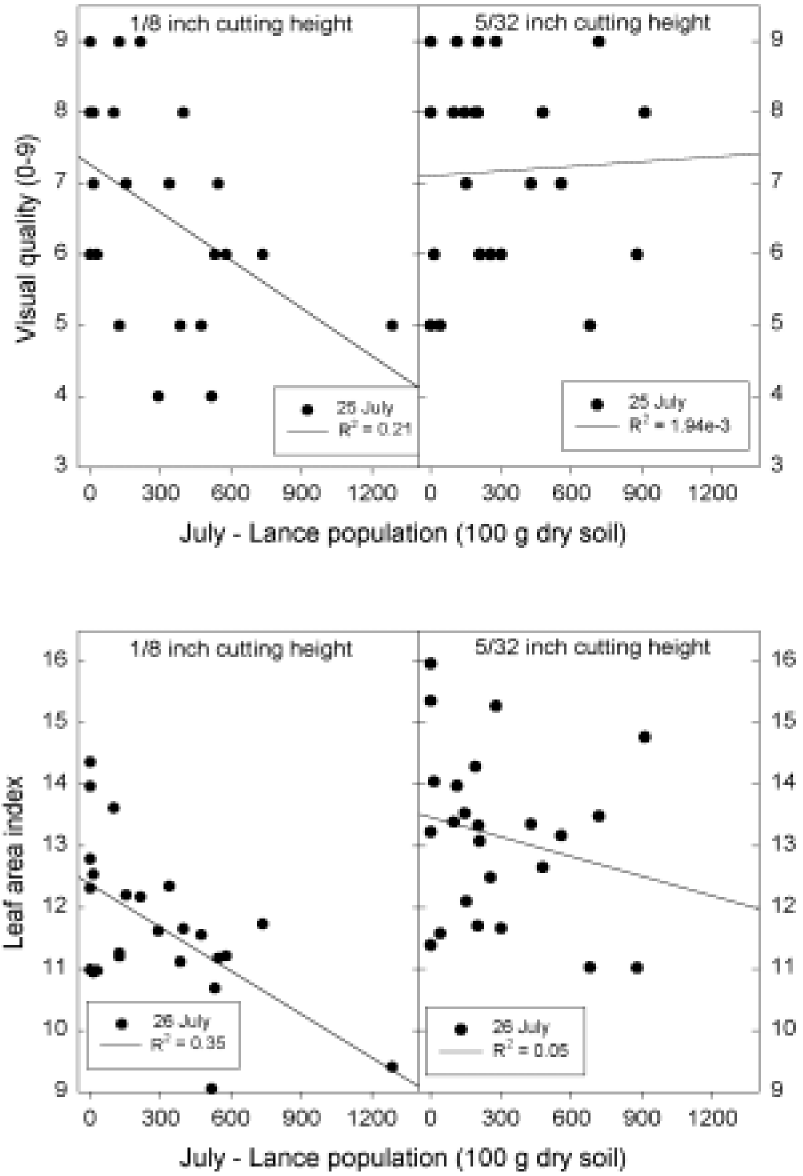

Figure 2. Increasing lance nematode populations reduced creeping bentgrass quality indicators at 1/8 inch clipping height across four bentgrass cultivars (Crenshaw, L-93, Penncross, and Providence) at the Rocky Ford Research Center, Manhattan, KS in 2000.

TITLE: Determining the Lance Nematode (*Hoplolaimus galeatus*) Damage Threshold Level to Creeping Bentgrass Using Field Microplots.

OBJECTIVES: Refine current damage threshold level of lance nematodes parasitizing creeping bentgrass putting greens in Kansas

PERSONNEL: Derek Settle, Tim Todd, Jack Fry, and Ned Tisserat

SPONSORS: Plant Pathology Departmental Graduate Research Assistantship

INTRODUCTION:

Much of today's turfgrass-nematode information is limited to warm season turfgrass species that predominate the Southern United States. Phytoparasitic nematodes are consistently associated with the roots of cool season creeping bentgrass grown on sand-based putting green root zone mixtures, but little is known about their physiological effects on the turfgrass. Much of our current information was developed from correlations between turfgrass decline or injury and corresponding high population levels of specific nematodes. Specific nematode-turfgrass damage threshold levels (minimum number of nematodes per 100 cm^3 soil, above which damage is likely) are compiled in a turfgrass pathology reference book (Couch, H. B. 1995. Diseases of Turfgrasses. Krieger Publishing Co., Malabar, FL. 421 p.). However, whether high nematode populations innately damage cool season turfgrasses is not clear, because dense populations can be discovered without visible decline.

The lance nematode, *Hoplolaimus galeatus,* is a common inhabitant of Kansas putting greens, and is a relatively large nematode that possesses a robust stylet. Lance nematode densities greater than 150 per 100 cm^3 have been estimated as the damage threshold level for creeping bentgrass putting greens. However, field studies that introduce and monitor discrete treatments of nematode populations among cool season turfgrass species are needed to verify current threshold values. The damage threshold level is very important environmentally, because it allows integrated pest management of nematodes. An incorrect damage threshold level can lead to unnecessary nematicide use and associated risks.

MATERIALS AND METHODS:

Microplot construction

The field experiment was conducted on a push up constructed sand-silt research putting green at the Rocky Ford Research Center, Manhattan, KS, from 2000 through 2001. Experimental design was a randomized complete block with 5 replications with 4 levels of initial lance nematode populations per 100 cc of root zone mix: i) control = 0, ii) ½X = 125, iii) 1X = 250, and iv) 2X = 500. The microplots (nematode cages) were constructed using 12- in.-diameter PVC pipe cut and installed 15 in. deep, encompassing the entire root zone to the clay base. The microplots centers were spaced 1 m (3.3 ft) apart and the entire PVC sleeve was buried with the upper edge visible and flush with the existing bentgrass putting surface, allowing normal maintenance. The sand-silt root zone mix was removed from each microplot, mixed to ensure homogeneity, steamed at 80 °C for 90 minutes and then returned.

Lance Inoculation

Lance (*H. galeatus*) inoculum was prepared by obtaining lance infested soil from a Penncross area of the bentgrass research green. Approximately 100 gallons of soil was processed using a sucrose extraction technique, and resulted in 87,500 lance nematodes that were placed into 1.75 liters of water. Check plots received 50 ml each of nematode-free filtrate, and mixed inoculum of 50 *H. galeatus* per ml was delivered in 50, 100, and 200 ml amounts (2209, 4418, and 8835 nematodes) to provide ½, 1 and 2X population levels on 6 June 2000. Treatment levels (100 cm^3 $soil^{-1}$) were calculated for a soil volume inoculated to an initial 2.5 cm depth. Twelve-inch-diameter A-4 creeping bentgrass sod, originally established from seed the fall of 1998 at the site, was washed and applied to each microplot surface following nematode inoculation. Each microplot was topdressed with sand as needed to establish and maintain a flush installation with the surrounding putting green, and ensured the same clipping height.

Data Collection

Population levels of *H. galeatus* were collected every-other month by removing two 1.5 cm diameter by 16 cm deep cores for nematode extraction as previously described. A sub-sample of approximately 50 g fresh soil from each pot was taken to calculate soil moisture, allowing nematode populations to be standardized per 100 g dry soil. Creeping bentgrass quality was monitored monthly using mean weekly visual quality ratings (0 = worst, and 9 = best) and multispectral radiometry (MSR) (Cropscan, Rochester, MN) at turfgrass canopy light reflectance wavelengths of 661, 813 and 935nm. MSR reflectance data was used for calculations that included; leaf area index ($LAI = R_{935} / R_{661}$), green leaf biomass expressed as normalized vegetation difference index ($NDVI = (R_{935} - R_{661}) / (R_{935} + R_{661})$), and canopy color index ($CI = 1 / R_{661}$). Photosynthesis was measured monthly with an Li-6400 portable gas analyzer (Licor Inc., Lincoln, NE). Electrolyte leakage of roots was determined by removing a 2.5 by 16 cm core from each plot in June and September of 2001. Clean fresh roots were soaked in 20 ml deionized water for 24 h, roots were then killed by autoclaving for 2 h, to allow comparison of living:dead root electrolyte leakage ratio. Electrical conductivity (uS sec^{-1}) was measured at each interval, followed by the calculation[(24 h fresh / 2 h autoclave) x 100 = % electrolyte leakage].

Each year, bentgrass received a total of 5 lbs N 1000 ft^{-2}. Preventive applications of Heritage and Bayleton fungicides (0.2 and 2 oz 1000 ft^{-2}, respectively) occurred every 28 days from June through September to target brown patch and dollar spot. Supplemental applications of Chipco GT (4 oz 1000 ft^{-2}) to the entire area were needed in June and September due to A-4's high susceptibility to dollar spot. No insecticides were applied to the area. Environmental data was monitored by the Rocky Ford Research Center weather station.

RESULTS:

Lance nematode populations (per 100 g dry soil) were successfully established and have increased to high densities in microplots (Fig. 1). Beginning in December 2000 lance population densities climbed to levels greater than the minimum 150 thought necessary for damage. Correlation of data compiled from July 2000 to February 2002 was significant for visual quality ($r^2 = 0.04$, $P = 0.05$), but not for canopy reflection or photosynthesis. Visually, a 10% reduction in quality (0-9 scale) occurred as lance populations increased to 800. Surprisingly, root electrolyte leakage increased as lance populations increased in June 2001 (Fig. 2). In contrast to visual quality, lance nematode-root leakage correlation was strong ($r^2 = 0.41$, $P = 0.01$).

SUMMARY:

The microplot field study results indicate that currently published lance damage threshold levels in creeping bentgrass are likely underestimated. For example, although physiological root leakage greater than 50% was correlated with lance populations over 150 during mid-summer, visual differences were very slight. Visual quality of the A-4 creeping bentgrass remained acceptable (> 6), without decline throughout the 2001 summer regardless of lance parasitism.

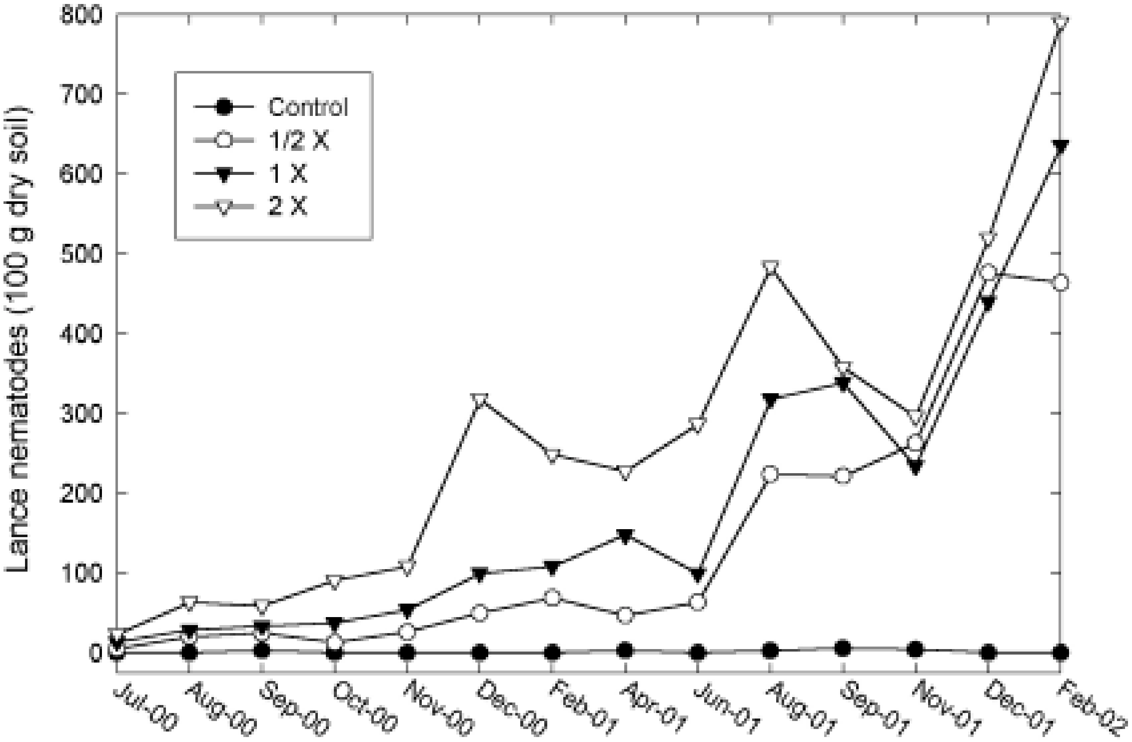

Figure 1. Four levels of lance nematode populations inoculated to A-4 creeping bentgrass microplots at the Rocky Ford Research Center, Manhattan, KS from 2000 thru 2002.

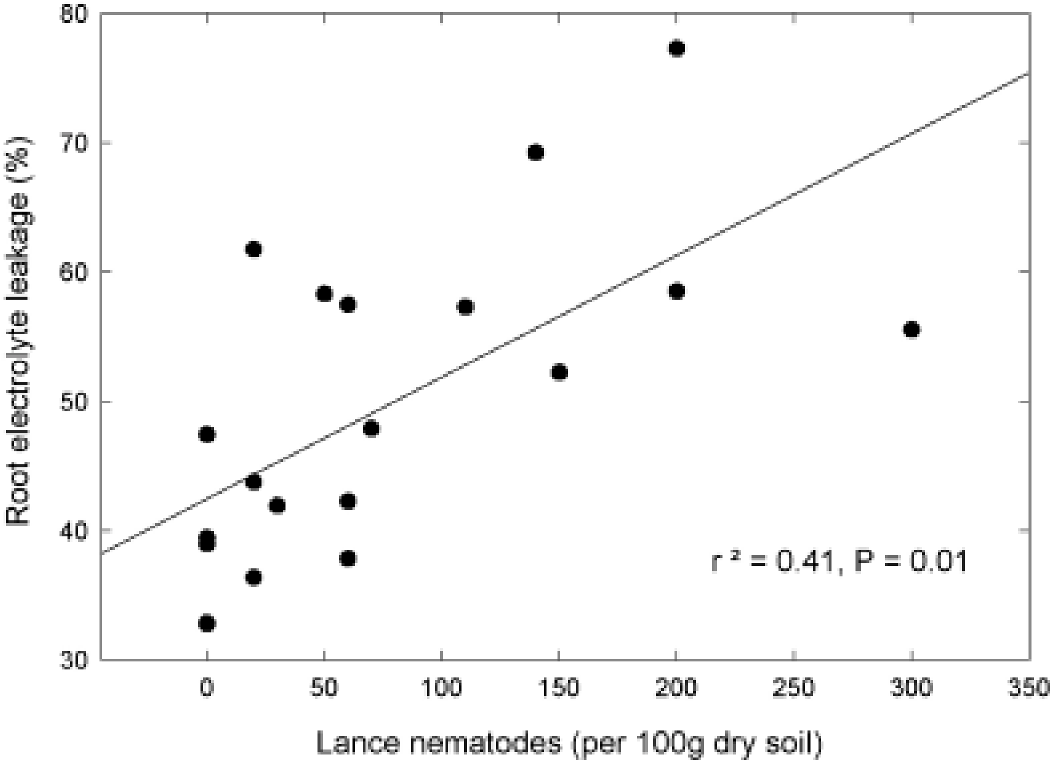

Figure 2. Increasing lance nematode populations increase root electrolyte leakage of A-4 creeping bentgrass in microplots at the Rocky Ford Research Center, Manhattan, KS, during June, 2001.

TITLE:	Bentgrass Cultivar Evaluation for Putting Greens
OBJECTIVE:	Evaluate new and standard putting green cultivars for use on putting greens in Kansas.
PERSONNEL:	Jack Fry
SPONSOR:	National Turfgrass Evaluation Program

INTRODUCTION:

Interest continues in new bentgrasses that are available for use on putting greens. In this test, 29 cultivars were evaluated.

MATERIALS AND METHODS:

We seeded 26 creeping bentgrass and 3 velvet bentgrass cultivars in September 1998 at 1.5 lb/1000 ft^2 at the Rocky Ford Research Center in Manhattan. A total of 4.5 lb N/1000 ft^2 was applied. Mowing was done 6 days weekly at 5/32 inch. Insecticides were applied as needed. Fungicides were applied after an initial dollar spot outbreak. Plots were rated for leaf texture, and quality from May through October. All ratings were made on a 0 to 9 scale, where 0 = worst; 9 = best.

RESULTS:

Leaf Texture

Cultivars with significantly coarser leaf texture ratings compared to the top ranking cultivars were Providence, Brighton, Crenshaw, Penncross, Backspin, and Pennlinks (Table 1).

Turf Quality

No significant differences in cultivar quality occurred for any rating month, or for the overall quality mean (Table 1). This was due, in part, to variable performance of cultivars across replications.

Table 1. Leaf texture and quality of creeping bentgrass cultivars at Manhattan, KS in 2001.

		Quality				
Cultivar	Texture	May	Jun	Aug	Oct	Mean
Penn G-6	7.3[1]	7.0	6.3	8.3	7.0	7.2
Penn A-1	8.3	7.3	5.7	7.7	7.7	7.1
ABT-CRB-1	8.0	6.0	7.7	7.7	5.7	6.8
PST-A2E	7.3	6.3	6.7	7.7	6.3	6.8
Penn G-1	8.0	5.7	7.3	7.3	6.3	6.7
SYN 96-3	7.7	6.0	6.0	8.0	6.7	6.7
L-93	6.3	7.0	5.3	7.7	6.3	6.6
Providence	7.0	6.0	7.3	7.3	5.7	6.6
Century	7.3	6.3	6.3	7.3	5.7	6.4
Imperial	7.3	6.3	6.3	7.7	5.3	6.4
Penn A-2	8.0	6.7	5.7	7.3	6.0	6.4
SYN 96-1	8.3	6.0	5.7	7.7	6.3	6.4
Bengal (BAR AS 8FUS2)	7.7	6.3	5.7	7.3	5.7	6.3
Brighton (SRX 1120)	6.7	5.7	6.7	7.0	5.7	6.3
SR 1119	7.3	6.0	6.0	6.7	6.3	6.3
SRX 1NJH	7.0	6.7	5.3	7.0	6.3	6.3
SYN 96-2	8.0	6.3	6.0	7.3	5.3	6.3
Crenshaw	6.7	5.7	6.3	7.3	5.3	6.2
Penn A-4	7.0	5.3	6.7	6.7	6.0	6.2
Pick CB 13-94	7.3	6.3	5.7	7.3	5.3	6.2
BAR CB 8US3	7.3	5.0	6.0	7.7	5.3	6.0
SR 7200	7.7	6.0	6.0	6.7	5.3	6.0
SRX 1BPAA	7.0	5.7	5.7	7.0	5.7	6.0
ISI AP-5	7.7	6.0	5.3	7.0	5.3	5.9
Penncross	6.3	5.3	6.0	6.7	5.7	5.9
Vesper (Pick MVB)	7.3	6.0	6.0	6.3	5.3	5.9
Backspin	6.7	5.3	6.0	7.0	5.0	5.8
Bavaria	7.0	5.3	5.0	7.3	5.3	5.8
Pennlinks	6.3	5.3	5.0	6.0	5.3	5.4
LSD	*1.4*[2]	*NS*[3]	*NS*	*NS*	*NS*	*NS*

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[1] Ratings based on a scale of 0-9 with 9 = best texture and quality.

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

[3] NS = no statistical difference for this rating month.

TITLE: Fineleaf Fescue Cultivar Trial

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

PERSONNEL: Alan Zuk

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Fineleaf fescues are a shade tolerant cool season grass with a slow, nonaggressive growth habit but a high density upon establishment. Blade width is usually narrower than 2 mm. Leaf curling often occurs during dry periods, which can cause a wiry texture. They also do not tolerate wet, poorly drained soils, are susceptible to summer heat stress and various diseases, have a fair wear tolerance, and a fair to poor recuperative potential. Fineleaf fescues are better adapted to northern climates and often are thinned severely by our hot summers.

MATERIALS AND METHODS:

Seventy nine fineleaf fescue cultivars were seeded at the Rocky Ford Turfgrass Research Center in September 1998. The trial was mowed at 3 inches and fertilized with 3 lbs N/1000 ft^2 per year. Seedling vigor, spring, summer and fall density and quality from April thru October were visually rated on a 0 to 9 scale, 9 = best. Analysis of variance (ANOVA) was used to analyze the data . Means were separated using the Waller-Duncan K-ratio t test.

RESULTS:

Forty one cultivars had an average genetic color rating of 8 or higher, including Pathfinder, Florentine, PST-4FR, Cindy Lou ISI F, ABT- CHW-2, and Rose ASC 087 (Table 1). Eleven cultivars had an average genetic leaf texture rating of 8 or higher, including SRX 3961, Scaldis II AHF, Oxford, MB-82, ABT- HF-3, and Eureka II ISI F. Forty seven cultivars had an average spring density rating of 8 or higher, including Eureka II ISI F, Pick FF A-97, ABT-CR-2, Attila E, ABT-HF-4, and ABT-HF1. Thirty three cultivars had an average summer density rating of 8 or higher, including Cindy Lou ISI F, Oxford, Shademark, SRX 52961, Bighorn, and ABT-CHW-2. Seventy two cultivars had an average fall density rating of 8 or higher, including 4001, Shademark, BAR CHF 8 FUS2, Heron, ABT-CR-2, and ABT-CR- 3. Two cultivars had an average mean quality rating of 8 or higher, including Navigator ISI F and 4001.

Table 1. Performance of fineleaf fescue cultivars under lawn conditions at Manhattan, KS in 2001.

						Quality[1]						
Cultivar	Genetic Color	Leaf Texture	Spring Density	Summer Density	Fall Density	May	June	July	Aug.	Sept.	Oct.	Mean
Navigator ISI F	8.7	6.0	9.0	8.3	9.0	8.7	8.3	7.0	7.3	8.7	8.7	8.1
4001	7.3	7.3	8.7	8.7	9.0	8.0	7.7	7.3	7.3	8.7	9.0	8.0
Nordic E	7.0	7.3	8.7	9.0	9.0	8.3	7.7	7.0	7.3	8.3	9.0	7.9
ABT-CR-2	8.7	6.0	9.0	8.3	9.0	8.7	7.7	7.7	7.0	8.0	8.0	7.8
Jasper II	8.7	6.7	8.7	8.3	9.0	8.3	8.0	6.7	7.3	8.3	8.3	7.8
Pick FF A-97	7.3	7.0	9.0	8.7	9.0	8.0	7.7	7.0	7.3	8.0	8.7	7.8
MB-63	8.3	7.0	8.0	8.0	9.0	7.7	7.7	6.7	6.7	8.7	8.3	7.6
PST-4FR	9.0	6.3	8.3	8.0	9.0	8.3	7.3	6.3	6.7	8.3	8.3	7.6
Stonehenge AHF	7.0	7.7	8.7	8.7	9.0	7.3	7.0	6.7	7.0	8.3	8.7	7.5
Attila E	7.3	7.7	9.0	8.7	9.0	7.7	7.0	6.7	7.0	7.7	9.0	7.5
Shademark	8.3	6.0	8.7	8.3	9.0	7.7	7.7	6.7	6.3	8.3	8.3	7.5
Bridgeport	7.7	6.7	8.0	8.3	9.0	7.3	7.3	6.3	7.3	8.3	8.0	7.4
ABT-CR-3	8.7	5.7	8.3	7.7	9.0	7.3	7.7	6.0	7.0	8.0	8.0	7.4
BAR CHF 8 FUS 2	8.0	7.3	8.3	8.3	9.0	7.3	7.7	6.7	6.3	8.0	8.3	7.4
Reliant II	7.0	7.3	8.3	8.0	9.0	7.3	7.0	7.0	6.7	7.7	8.7	7.4
SR 5210 SRX 52L	8.0	6.3	8.7	8.3	8.7	7.7	8.0	5.7	7.0	8.0	8.0	7.4
Longfellow II	8.3	6.3	7.3	8.3	9.0	7.7	7.3	6.3	7.0	8.0	7.7	7.3
Cindy Lou ISI F	9.0	6.0	8.3	8.3	8.7	8.0	8.0	6.3	6.7	7.3	7.7	7.3
Magic	8.3	6.7	7.7	7.7	9.0	7.0	6.3	7.0	7.3	8.0	8.0	7.3
ABT-HF-2	7.3	7.3	8.7	7.3	9.0	7.7	7.0	6.3	6.7	7.3	8.3	7.2
PST-4HM	8.0	7.3	8.7	8.7	9.0	8.0	7.3	6.0	6.0	8.0	8.0	7.2

						Quality[1]						
Cultivar	Genetic Color	Leaf Texture	Spring Density	Summer Density	Fall Density	May	June	July	Aug.	Sept.	Oct.	Mean
PST-EFL	8.0	6.0	8.0	8.0	9.0	7.3	8.0	5.7	6.3	7.3	8.3	7.2
ABT-CHW-1	8.3	7.3	7.7	8.3	8.7	6.7	7.0	5.7	7.0	8.0	8.7	7.2
Wrigley ACF 092	7.7	7.7	8.0	8.0	8.7	7.0	7.0	6.3	6.3	7.7	8.0	7.1
Scaldis	7.3	8.0	8.3	8.3	8.3	7.3	7.0	6.3	6.3	7.7	7.7	7.1
Heron	7.3	7.3	7.7	7.7	9.0	7.3	7.3	4.7	7.0	7.7	8.3	7.1
Sandpiper	7.7	7.0	8.0	8.0	9.0	7.3	7.0	6.3	6.3	7.3	8.0	7.1
Treazure E	7.3	6.7	7.3	7.7	8.3	6.3	7.0	5.7	7.0	8.3	8.0	7.1
Pathfinder	9.0	6.0	8.0	7.7	8.3	7.0	7.3	6.0	5.7	7.7	8.3	7.0
SRX 52961	8.7	5.3	8.3	8.0	9.0	8.0	8.0	5.3	5.7	7.7	7.3	7.0
Culombra	7.7	7.0	8.7	8.3	8.7	8.3	6.7	5.7	6.3	7.3	7.7	7.0
ABT-HF1	7.0	7.3	9.0	7.7	8.0	8.7	7.0	5.3	6.3	7.0	7.3	6.9
SRX 3961	7.3	9.0	8.7	8.3	8.3	7.3	7.7	5.7	6.0	7.3	7.3	6.9
Salsa	8.0	6.3	8.0	7.7	8.3	7.7	7.7	5.7	5.3	7.0	8.0	6.9
Eureka II ISI F	7.3	8.0	9.0	7.3	8.7	7.7	6.7	5.7	6.0	7.3	8.0	6.9
Shademaster II	8.3	6.0	8.0	7.7	8.7	7.0	8.3	5.0	5.3	7.0	8.3	6.8
Ambassador	8.3	7.3	7.7	7.3	8.7	7.0	7.0	5.7	6.0	8.0	7.3	6.8
PST-47TCR	8.0	6.0	8.0	7.7	8.7	7.7	7.3	5.0	5.7	7.0	7.7	6.7
Discovery	7.7	8.0	8.0	7.7	8.3	6.7	6.7	6.0	6.0	7.0	8.0	6.7
ABT-HF-4	6.7	8.0	9.0	8.7	8.7	7.3	6.7	6.3	5.7	6.7	7.7	6.7
ABT-CHW-2	8.7	6.7	7.3	8.0	8.7	6.7	7.0	5.7	6.0	7.0	7.7	6.7
Pick FRC A-93	8.0	7.0	7.7	7.0	8.7	7.7	6.7	5.0	6.0	7.3	7.3	6.7

						Quality[1]						
Cultivar	Genetic Color	Leaf Texture	Spring Density	Summer Density	Fall Density	May	June	July	Aug.	Sept.	Oct.	Mean
PST-4MB	6.0	6.3	8.7	7.7	9.0	7.3	6.0	5.3	6.3	7.3	7.3	6.6
ABT-HF-3	6.7	8.3	8.7	8.0	9.0	7.3	6.7	5.3	5.7	7.3	7.3	6.6
MB-82	7.7	8.3	7.3	7.3	8.3	7.0	7.0	5.7	5.7	6.3	8.0	6.6
Hardtop BAR HF	7.0	7.7	8.7	7.3	8.7	7.3	6.0	5.0	5.7	7.3	8.0	6.6
BAR CF 8 FUS 1	8.3	6.3	8.0	6.7	8.3	7.3	6.7	5.3	5.3	7.0	7.3	6.5
DGSC 94	7.7	6.0	8.7	7.3	8.3	7.3	8.0	5.0	5.3	6.3	6.7	6.4
Rose ASC 087	8.7	5.0	6.3	7.3	8.3	6.3	7.0	6.0	5.3	6.3	7.7	6.4
Minotaur	6.0	7.3	8.3	7.7	8.3	7.0	6.7	6.3	5.7	6.0	7.0	6.4
SR 3200	7.0	7.3	8.3	7.7	8.7	7.0	6.0	5.7	6.0	6.3	7.7	6.4
Rescue 911	8.0	8.0	8.3	7.3	8.3	7.3	6.7	5.3	5.3	6.7	7.0	6.4
ABT-CHW-3	8.3	7.0	6.7	6.7	7.7	7.0	5.7	5.3	6.0	7.0	7.3	6.4
ASC 082	7.7	6.7	8.3	7.3	8.7	7.3	7.0	4.3	6.0	6.0	7.3	6.3
Bighorn	6.0	7.7	7.7	8.0	8.7	7.0	6.3	5.0	6.0	6.3	7.0	6.3
Silhouette Pick	8.3	6.7	6.0	7.0	7.7	6.3	6.3	5.0	5.7	7.3	7.0	6.3
Brittany	8.3	6.0	7.0	7.0	8.7	6.7	5.6	5.3	5.7	7.0	7.3	6.3
SR 5100	7.3	6.0	6.7	7.3	8.0	6.7	5.7	5.0	6.0	6.7	7.3	6.2
Quatro	7.0	7.7	7.7	8.0	8.0	6.7	6.3	5.0	5.3	6.3	7.3	6.2
ASR 049	8.7	6.3	6.7	6.7	8.3	6.7	6.7	5.3	4.3	6.3	7.7	6.2
Jamestown II	8.3	6.0	6.0	6.7	8.0	5.7	5.7	5.7	5.0	7.0	7.3	6.1
Scaldis II AHF	7.7	9.0	8.3	7.7	8.0	7.3	6.3	4.7	5.0	6.0	7.0	6.1
Defiant	6.7	7.7	8.3	6.3	8.0	7.3	6.3	5.3	4.3	6.0	7.0	6.1
Intrigue	8.0	7.7	6.0	6.3	8.7	5.0	5.3	4.7	5.3	7.0	7.7	5.8

						Quality[1]						
Cultivar	Genetic Color	Leaf Texture	Spring Density	Summer Density	Fall Density	May	June	July	Aug.	Sept.	Oct.	Mean
SR 6000	6.7	5.7	7.7	7.7	8.0	6.7	5.0	4.7	5.0	6.0	7.3	5.8
Common Creeping	7.7	5.7	7.7	6.0	8.7	6.7	6.3	4.7	4.7	5.7	6.7	5.8
BAR SCF 8 FUS 3	7.7	6.7	7.3	7.0	8.0	6.7	7.0	5.0	4.3	5.0	6.0	5.7
Shadow II	8.3	5.7	5.0	6.0	6.7	5.3	5.7	4.7	4.7	6.0	7.0	5.6
Dawson E+	8.0	6.3	7.0	5.7	7.3	6.0	6.7	4.3	4.3	5.0	6.3	5.4
ASC 172	8.3	6.0	7.3	6.7	8.3	6.3	5.3	4.7	4.7	5.3	6.3	5.4
Banner III	8.0	6.7	5.7	5.7	7.3	5.3	5.7	4.7	4.3	5.7	6.3	5.3
Seabreeze	8.0	5.7	5.7	5.0	7.0	5.3	5.3	3.7	3.0	5.3	6.7	4.9
ACF 083	8.3	7.7	4.7	5.7	6.3	4.7	5.3	4.3	3.7	5.3	5.7	4.8
LSD Value[2]	0.9	1.6	2.4	3.3	4.2	3.3	3.3	3.7	3.0	2.6	3.3	2.3

[1] Quality rated on a scale of 0 - 9 w/9 = best.

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

TITLE: Perennial Ryegrass Cultivar Trial

OBJECTIVE: Evaluate new and standard ryegrass cultivars for performance in Kansas

PERSONNEL: Joon Lee and Jack Fry

SPONSOR: National Turfgrass Evaluation Program

INTRODUCTION:

Perennial ryegrass continues to be widely used in the Midwest for golf course fairways and tees and sports turfs, despite concerns about disease susceptibility. There is interest in identifying cultivars that are resistant to grey leaf spot, brown patch, and phythium, while at the same time possessing good resistance to environmental stresses.

MATERIALS AND METHODS:

On 17 September 1999, 134 perennial ryegrass entries were planted at the Rocky Ford Turfgrass Research Center. Turf was mowed at 0.5 inch three days weekly, received 1 lb N/1000 ft^2 from urea in September, November, and May, and was irrigated to prevent drought stress. A preemergence herbicide was used in spring 2001; no fungicides or insecticides were used. Turf was rated for visual quality from April to September using a 0 to 9 scale, where 7 = acceptable quality for a golf course fairway or tee.

RESULTS:

Genetic Color

Cultivars in the highest group were Radiant, Roberts-627, MB411, ABT-99-4.834, and Pleasure XL. Those with poorest color ratings were Linn and DP 17-9496.

Leaf Texture

Cultivars that were significantly coarser than all others were Linn and DP 17-9496. All others had similar texture.

Turf Quality

No significant differences occurred among cultivars in any rating month. In general, quality of cultivars after the June rating period was less than acceptable.

Table 1. Genetic color, leaf texture, and quality of perennial ryegrass cultivars at Manhattan, KS in 2001.

			Quality							
Cultivar	Color[1]	Texture	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
ABT-99-4.721	7.7	7.7	7.7	7.3	7.0	5.0	5.7	6.3	6.7	6.5
Pennant II	7.3	7.7	7.3	6.7	7.3	5.7	6.0	6.0	6.3	6.5
PST-2L96	8.0	7.3	7.7	7.3	7.0	5.3	5.0	6.3	7.0	6.5
Churchill	7.7	7.0	7.0	6.3	7.7	6.0	5.7	6.0	6.0	6.4
Pick PR B-97	7.3	7.3	7.0	6.7	6.7	6.0	5.7	6.0	6.0	6.3
SRX 4820	7.7	7.0	7.0	6.3	7.0	6.0	5.7	5.7	6.7	6.3
A5C (ABT-99-4.960)	8.7	6.7	7.7	7.0	7.0	5.7	5.0	5.0	6.3	6.2
Charismatic (LTP 98-501)	8.0	7.3	7.3	6.7	7.7	5.3	5.3	5.3	5.7	6.2
Salinas (PST-2SLX)	8.0	7.7	7.0	7.0	7.0	5.7	5.0	5.3	6.3	6.2
SRX-4RHT	7.7	7.0	7.0	7.3	7.0	5.0	5.0	5.7	6.3	6.2
ABT-99-4.339	7.3	7.3	7.3	7.0	6.3	5.0	5.3	5.3	6.3	6.1
All Star2 (CIS-PR-78)	8.3	7.3	7.0	7.3	6.3	5.3	5.0	5.3	6.7	6.1
MB 413 (ABT-99-4.633)	8.0	6.7	7.0	7.0	6.3	5.3	5.0	6.0	6.0	6.1
MP107	7.7	7.7	7.3	7.0	6.7	5.7	4.7	6.0	5.7	6.1
Nexus	8.7	7.3	7.0	6.7	7.0	5.3	5.3	5.7	6.0	6.1
Palmer III	7.3	7.7	7.0	7.0	6.7	5.0	5.0	5.3	6.7	6.1
Stellar (CIS-PR-72)	7.7	7.3	6.7	7.0	6.7	5.3	5.3	5.3	6.3	6.1
Admire (JR-151)	7.0	7.7	7.0	6.7	6.7	5.0	5.0	5.3	6.0	6.0
Amazing (B1)	7.7	6.7	7.0	6.7	6.7	5.3	5.0	5.0	6.0	6.0
Applaud (Pennington-11301)	8.0	7.3	6.7	6.7	7.0	5.7	5.0	5.0	5.7	6.0
APR 1233	6.7	7.7	7.0	7.0	6.7	5.3	4.7	5.3	5.7	6.0
APR 776	6.7	7.3	6.7	6.7	6.3	5.0	5.0	5.7	6.3	6.0
Charger II	6.0	6.3	6.3	6.0	6.7	5.3	5.3	5.7	6.3	6.0
CIS-PR-75	8.3	7.3	7.0	7.3	6.7	5.0	5.0	5.0	5.7	6.0
LPR 98-144	7.0	7.7	7.3	6.7	6.7	5.3	4.3	6.0	5.7	6.0
Manhattan 3	7.3	8.0	6.7	7.0	6.7	5.0	5.3	5.7	6.0	6.0
MB 410 (ABT-99-4.629)	7.3	7.7	7.0	7.0	6.7	4.7	4.7	5.7	6.3	6.0

			Quality							
Cultivar	Color[1]	Texture	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
MB 412 (ABT-99-4.461)	8.7	7.0	6.7	6.7	6.7	5.0	5.0	5.7	6.3	6.0
Pizzazz	7.7	7.0	7.0	6.7	6.7	5.3	5.3	5.7	5.3	6.0
PST-CATS	7.0	7.0	6.7	6.7	7.0	4.7	4.7	5.7	6.3	6.0
ABT-99-4.115	7.3	7.0	6.7	6.7	6.7	5.3	4.7	5.7	5.7	5.9
APR 1232	6.3	7.3	6.7	6.3	6.3	5.3	5.3	5.3	6.0	5.9
CABO (CIS-PR-80)	8.3	7.0	7.3	7.0	7.0	4.7	4.7	5.0	5.7	5.9
LTP-ME	7.7	7.0	6.7	6.3	6.0	5.3	5.3	5.7	5.7	5.9
Racer	7.7	7.3	6.7	7.0	6.3	5.3	4.7	5.0	6.0	5.9
SRX 4120	6.3	6.7	6.7	6.3	6.3	5.7	5.0	5.0	6.3	5.9
SRX 4801	8.0	7.0	6.7	6.3	6.3	6.0	4.3	5.7	6.0	5.9
UT-1000 (ABT-99-4.709)	7.3	7.0	7.0	7.3	6.7	5.0	5.0	4.7	5.3	5.9
Wilmington	8.3	7.0	7.0	6.7	6.7	5.3	4.3	5.0	6.0	5.9
ABT-99-4.965	7.3	6.7	7.0	7.0	6.3	5.0	4.3	4.7	6.3	5.8
Gator 3 (CIS-PR-85)	7.7	7.3	6.7	7.0	6.0	4.3	5.0	5.3	6.0	5.8
Pick Prngs	7.0	7.7	7.0	7.0	6.7	5.0	4.3	4.7	5.7	5.8
Promise	7.0	6.7	6.7	6.3	6.3	5.0	5.0	5.0	6.0	5.8
PST-2CRR	7.3	7.7	7.0	6.0	6.0	5.3	4.3	5.0	6.7	5.8
R8000	7.7	7.0	7.0	7.0	6.7	4.7	4.3	4.7	6.0	5.8
Superstar (EP57)	7.3	7.3	6.3	6.3	6.3	5.3	5.0	4.7	6.3	5.8
DLF-LDD	7.3	7.0	6.7	6.0	6.3	5.0	5.0	5.3	5.3	5.7
Fiesta 3	7.0	7.3	6.3	6.3	6.3	4.7	5.0	5.7	5.7	5.7
Galaxy (JR-128)	7.0	7.0	6.3	6.0	6.0	5.0	5.3	4.7	6.3	5.7
Majesty	7.3	8.0	7.3	6.7	6.7	3.7	4.0	5.3	6.0	5.7
NJ-6401	7.3	8.0	6.7	7.3	6.7	5.0	4.3	4.7	5.3	5.7
PST-2SBE	7.3	7.0	6.3	6.0	6.0	5.3	5.3	5.0	6.0	5.7
Seville II	7.3	7.3	6.3	5.7	6.3	5.3	4.7	5.3	6.0	5.7
WVPB-R-82	6.0	6.3	6.7	6.0	6.7	5.0	4.7	5.0	5.7	5.7
Calypso II	6.7	7.0	7.0	6.3	6.7	4.7	4.0	5.0	5.7	5.6

			Quality							
Cultivar	Color[1]	Texture	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
Catalina	7.3	7.0	6.3	6.0	6.0	5.0	4.7	5.3	6.0	5.6
Cathedral II	7.0	6.7	6.0	6.0	6.0	5.0	5.3	5.0	6.0	5.6
Jet	7.3	7.0	6.3	5.7	6.0	5.3	5.0	4.7	6.0	5.6
LPR 98-143	6.7	7.0	6.7	5.7	5.7	5.3	5.0	5.0	6.0	5.6
Pick PR 1-94	8.3	6.3	6.3	6.3	5.7	5.3	5.0	4.7	6.0	5.6
Affirmed	7.0	7.0	6.3	5.7	5.7	5.3	5.0	5.0	5.7	5.5
APR 1231	7.0	7.0	6.3	6.3	6.7	4.7	4.0	5.0	5.7	5.5
Brightstar II	8.0	7.3	6.7	6.7	6.0	4.3	4.0	4.7	6.3	5.5
CIS-PR-84	8.7	6.7	6.3	6.7	6.3	4.3	5.0	4.3	5.7	5.5
DP 17-9391	5.7	7.0	6.7	5.7	6.0	5.0	4.7	5.0	5.7	5.5
Edge	6.0	6.5	6.5	6.0	5.5	5.0	5.0	5.0	5.5	5.5
Elfkin	7.0	6.7	6.3	6.0	5.7	4.7	4.3	5.3	6.0	5.5
Extreme (JR-317)	7.3	7.7	6.7	6.3	6.3	4.3	4.7	4.7	5.7	5.5
MB 414 (ABT-99-4.903)	7.7	7.0	7.0	6.7	6.3	4.3	4.3	4.3	5.3	5.5
Mepy	7.7	7.0	6.7	6.7	5.7	4.7	4.7	5.0	5.3	5.5
ABT-99-4.464	6.7	6.7	6.3	6.0	6.0	5.3	4.7	4.3	5.3	5.4
Ascend	7.0	7.0	7.3	6.3	6.7	5.0	4.0	4.0	4.3	5.4
Kokom (CIS-PR-69)	8.0	7.3	7.7	7.3	7.0	3.7	3.7	4.0	4.7	5.4
KOOS R-71	6.7	6.7	6.3	5.7	6.3	4.7	4.3	4.7	5.7	5.4
Line Drive	6.3	7.0	6.0	6.0	5.7	4.7	5.0	4.3	6.0	5.4
Paragon	7.3	6.7	6.0	6.3	5.7	4.7	5.0	5.0	5.3	5.4
Phantom	7.3	6.7	6.7	6.3	6.3	4.7	4.0	4.7	5.3	5.4
Pick MDR	7.0	7.0	6.0	6.7	6.7	4.3	4.3	4.7	5.3	5.4
Prosport (AG-P981)	7.7	7.0	6.3	6.0	5.7	4.7	4.7	5.0	5.3	5.4
PST-2M4	7.3	6.3	6.0	6.0	5.7	4.7	5.0	5.0	5.3	5.4
ABT-99-4.600	6.0	6.0	6.0	5.7	5.7	4.3	5.0	5.0	5.3	5.3
ABT-99.4.815	7.0	7.3	6.0	5.7	5.7	5.0	5.0	4.3	5.3	5.3
Allsport	7.0	6.7	6.3	5.7	5.7	4.7	4.7	4.3	5.7	5.3

			Quality							
Cultivar	Color[1]	Texture	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
Brightstar SLT (PST-2A6B)	7.0	6.3	6.0	6.0	6.0	4.0	4.0	4.7	6.7	5.3
CAS-LP84	7.7	7.0	6.0	6.0	6.0	4.7	4.3	4.7	5.3	5.3
Cutter II (Pick RC2)	7.0	7.0	6.7	6.3	6.3	4.0	4.3	5.0	4.7	5.3
Headstart	6.7	7.7	6.0	6.0	5.7	4.3	4.0	5.3	5.7	5.3
MDP	7.7	6.0	6.0	6.3	5.7	4.7	4.3	4.7	5.3	5.3
Panther	7.0	6.7	6.7	6.3	6.3	4.0	4.0	4.0	5.7	5.3
Pick PR QH-97	8.3	7.0	6.7	6.7	6.3	5.0	3.3	4.3	5.0	5.3
PST-2BR	7.7	7.3	6.0	6.3	6.0	5.0	4.3	4.3	5.0	5.3
WVPB-R-84	6.7	7.0	6.3	6.0	6.0	4.3	4.0	4.7	6.0	5.3
ABT-99-4.625	8.3	6.7	6.3	5.7	5.3	5.0	4.3	4.7	5.0	5.2
BY-100	5.7	7.0	6.3	5.7	6.3	4.7	4.0	4.3	5.0	5.2
DP 17-9069	5.7	6.3	6.3	5.7	6.0	4.3	4.3	4.7	5.3	5.2
Paradigm (APR 1236)	7.3	6.3	6.3	5.3	6.0	4.3	4.0	5.0	5.7	5.2
Pinnacle II (BAR 9 B2)	7.0	7.3	6.3	6.7	6.3	4.0	4.0	4.0	5.3	5.2
ABT-99-4.724	7.3	6.7	5.7	5.0	5.3	4.7	4.7	5.0	5.7	5.1
Affinity	5.7	6.7	6.3	6.3	5.3	4.7	4.0	4.0	5.3	5.1
Divine	7.0	6.7	6.3	6.0	6.0	4.3	3.7	4.3	5.3	5.1
Manhattan (PST-2CRL)	7.3	7.0	6.3	6.0	6.3	4.3	4.0	3.7	5.0	5.1
MP103	7.7	7.0	6.0	6.3	5.3	4.3	4.3	4.3	5.3	5.1
Pleasure XL	8.0	6.7	6.0	5.7	6.0	4.3	4.7	4.3	4.7	5.1
Premier	6.7	7.0	6.0	5.7	5.7	5.0	4.0	4.3	5.0	5.1
PST-2JH	6.7	6.3	6.3	6.0	5.7	4.3	4.3	4.3	5.0	5.1
PST-2LA	7.7	7.0	6.7	6.0	6.0	4.7	3.7	4.0	5.0	5.1
Secretariat	6.7	6.7	6.3	6.0	6.3	4.0	4.0	4.0	5.3	5.1
Yatsugreen	5.3	6.3	5.3	5.0	6.0	4.7	4.7	4.7	5.7	5.1
ABT-99-4.834	8.3	7.3	5.3	5.7	5.7	4.0	4.3	4.3	5.7	5.0
APR 1237	6.7	7.3	5.3	6.0	6.3	3.7	3.3	4.7	6.0	5.0
Buccaneer	5.3	6.3	6.0	5.3	5.7	4.0	4.0	4.3	5.7	5.0

			Quality							
Cultivar	Color	Texture	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
EPD	6.3	6.3	6.0	5.3	5.7	4.7	3.7	4.3	5.7	5.0
MB 411 (ABT-99-4.753)	8.3	7.3	6.3	6.3	6.0	3.7	3.7	4.3	4.7	5.0
MP88	7.7	7.3	6.0	5.7	5.7	4.3	4.3	4.3	5.0	5.0
Passport	7.3	6.3	6.0	6.0	6.0	3.7	4.0	3.7	5.3	5.0
Prowler (APR 777)	6.7	6.7	5.7	5.7	5.7	4.3	4.3	4.3	5.3	5.0
Roberts-627	8.3	7.3	7.0	7.0	7.0	4.0	3.0	3.0	6.3	5.0
DP LP-1	5.7	6.3	6.3	5.3	5.7	3.7	4.0	3.7	5.7	4.9
Exacta	7.7	6.3	5.3	5.0	5.7	4.0	4.3	5.0	5.0	4.9
Pacesetter (6011)	7.3	7.0	6.0	6.3	5.7	3.3	3.7	4.3	5.0	4.9
Radiant	8.7	6.7	6.0	6.0	5.7	4.0	3.7	3.7	5.3	4.9
Skyhawk	7.0	7.7	6.7	6.0	6.3	3.7	3.0	3.7	4.7	4.9
SR 4500	7.3	6.7	5.3	5.7	5.7	4.7	4.3	4.0	4.3	4.9
APR 1234	6.0	6.3	5.3	5.3	5.0	4.0	3.7	4.3	5.7	4.8
DP 17-9496	4.3	5.0	5.3	4.3	5.0	4.7	4.3	4.7	5.3	4.8
Monterey II (JR-187)	7.3	7.0	6.0	6.7	5.7	4.3	3.7	3.7	4.3	4.8
APR 1235	7.0	7.0	5.0	5.3	5.0	4.0	3.7	4.3	5.3	4.7
Barlennium	7.3	6.3	6.0	5.7	5.3	3.7	3.3	4.0	4.3	4.7
EP53	7.0	6.3	6.0	5.0	5.0	4.3	4.0	4.0	4.7	4.7
Pick EX2	6.3	6.3	5.7	5.3	5.3	3.7	3.7	4.0	5.0	4.7
Premier II	7.3	6.7	6.0	6.3	6.3	3.3	3.3	3.3	4.3	4.7
PST-2RT	7.0	6.7	5.7	5.3	5.3	3.7	3.7	3.7	5.0	4.6
ABT-99-4.560	7.7	6.3	5.0	5.3	5.0	4.0	3.0	3.0	5.0	4.3
Linn	4.0	5.0	4.3	4.0	4.3	3.0	3.3	3.3	4.0	3.8
LSD	0.8[2]	2.2	NS[3]	NS	NS	NS	NS	NS	NS	NS

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[1] Ratings based on a scale of 0-9 with 9 = best texture and quality.

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

[3] NS = no statistical difference for this rating month.

TITLE: 2000 National Kentucky Bluegrass Test

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

PERSONNEL: Linda R. Parsons, Jack D. Fry

SPONSOR: USDA National Turfgrass Evaluation Program

INTRODUCTION:

Kentucky bluegrass is a cool-season turfgrass suitable for use in Kansas. Its dark to mid blue-green color and relatively fine texture make an attractive lawn. Its rhizomatous nature contributes to its drought tolerance and allows it to withstand low maintenance conditions. Even though, without care, it may go dormant and turn brown in hot, dry periods, it recovers well from injury and can be considered a water-saving grass. We are interested in evaluating bluegrass cultivars suitable for home lawns, golf course roughs, etc. that tolerate low maintenance conditions and yet retain a dark leaf color, fine texture, disease resistance, and good sward density.

MATERIALS AND METHODS:

On 2 October 2000, we seeded 528 study plots (5 by 5 ft in a 220 by 60 ft grid) in a randomized complete block design at the John C. Pair Horticultural Center in Wichita, KS, with 173 Kentucky bluegrass cultivars and experimental numbers. Seeding rate was 2.0 lb seed/1000 ft^2. Prior to seeding, we incorporated 13-13-13 NPK into the study plots at a rate of 1.0 lb/1000 ft^2. We fertilized the plots twice in 2001 at 1.0 lb N/1000 ft^2. Plots were mowed weekly during the growing season at 2.0 to 2.5 inches and clippings returned. We irrigated as necessary to prevent dormancy and controlled weeds, insects, and diseases only when they presented a threat to the trial. We rated turfgrass performance on a scale of 0=dead turf, 6=acceptable, and 9=optimum measure.

RESULTS:

We evaluated bluegrass establishment rate or percent ground cover 6 weeks after seeding (Table 1). Washington, SRX 26351, GO-9LM9, and Kenblue were the best established at 60–70% cover, respectively; A98-407, CVB-20631, and Chateau were the worst at 20%. By the spring of 2001, percent ground cover had increased substantially throughout most of the test plots. Now PST-1701, Bariris , Pro Seeds - 453, Baronie, and A97-133 rated the highest with 70–73% cover, respectively, and North Star and CVB-20631 the worst with 45% cover. We continued rating the bluegrass throughout the 2001 growing season for quality. Ratings were influenced by degree of coverage and weed infestation as well as turf color, texture, and density. The best overall performers were Langara, A97-1715, Everglade, Pick 113-3, and A97-1330. At summer's end, we again looked at percent ground cover and found that A98-304 and Langara at 99% and Everglade, Freedom II, Impact, and Pro Seeds - 453 at 98% were the best. Arcadia and Pick-232 were the worst at only 73% cover.

Table 1. 2000–2001 performance of Kentucky bluegrass cultivars at Wichita, KS[1].

Cultivar/ Experimental Number	% Establishment 2000	% Living Cover Spring ’01	Quality 2001								% Living Cover Fall ’01
			May	June	July	Aug.	Sept.	Oct.	Nov.	Mean	
Langara*[2]	37	67	4.3	6.7	7.7	7.7	7.3	7.0	6.7	6.8	99
A97-1715	33	55	3.3	6.7	7.0	7.0	7.3	7.0	7.3	6.5	97
Everglade*	40	52	3.0	6.7	7.7	7.7	7.7	6.3	6.7	6.5	98
Pick 113-3	33	63	4.0	7.0	7.3	7.0	7.0	6.3	6.7	6.5	98
A97-1330	33	73	5.7	7.0	7.7	7.0	7.0	5.3	5.7	6.5	93
Pro Seeds - 453	40	70	4.7	6.3	7.0	7.0	7.0	6.0	7.0	6.4	98
BH 00-6002	37	68	4.7	6.7	7.0	7.3	6.3	6.3	5.7	6.3	97
Champagne*	47	63	4.0	6.3	7.3	6.7	7.0	6.0	6.7	6.3	96
PST-B5-89	30	53	3.0	8.0	6.7	6.7	7.3	6.0	6.3	6.3	96
Sonoma*	53	62	4.0	6.3	7.0	6.7	6.7	6.7	6.7	6.3	94
Abbey*	47	62	3.7	6.7	7.7	7.0	6.7	6.0	6.0	6.2	98
A98-139	43	58	3.7	6.3	7.0	6.0	6.7	6.3	7.3	6.2	97
Ba 81-058	40	65	4.3	6.3	6.7	6.3	6.7	7.0	6.0	6.2	93
Impact*	37	60	3.7	6.7	7.0	6.3	7.3	6.0	6.3	6.2	98
Mallard (A97-1439)*	37	60	3.7	7.0	6.7	7.0	6.7	6.0	6.3	6.2	95
SRX 26351	60	58	3.0	7.3	8.3	7.0	6.0	5.3	6.3	6.2	93
A96-451	30	63	4.0	6.3	7.0	6.7	7.0	6.0	6.0	6.1	96
A97-1409	33	63	4.0	7.7	7.0	6.0	6.0	6.0	6.3	6.1	92
Jefferson*	57	68	5.0	6.0	6.7	6.7	6.7	6.0	6.0	6.1	94
Hallmark*	40	68	4.7	7.0	7.3	6.3	6.0	5.7	6.0	6.1	95
Pick 417	37	63	4.0	6.7	6.7	6.7	7.0	6.0	6.0	6.1	93
Unique*	40	62	4.0	6.3	7.0	7.0	6.7	6.0	6.0	6.1	97
A96-427	40	65	4.3	6.3	7.0	6.7	6.3	6.0	6.0	6.1	94
Bariris*	43	70	5.0	6.3	7.0	7.0	6.3	5.3	5.7	6.1	93
Baritone*	33	65	4.3	6.7	6.7	6.3	7.0	5.7	6.0	6.1	97
J-1648	43	48	3.0	5.7	7.0	6.7	7.3	6.0	7.0	6.1	98
J-2695	40	52	3.3	5.7	6.7	7.0	7.0	6.7	6.3	6.1	98
SRX 2284	37	62	4.0	6.7	6.7	7.0	6.7	5.7	6.0	6.1	93
DLF 76-9037	43	63	4.0	7.0	6.3	6.7	6.7	5.7	6.0	6.0	96
A98-304	50	57	3.3	6.3	7.0	7.0	7.0	5.7	6.0	6.0	99
Goldrush*	40	62	4.0	6.7	7.3	7.0	6.3	5.3	5.7	6.0	94
BAR Pp 0566	37	62	4.0	6.7	7.0	6.3	6.3	5.7	6.0	6.0	92
Jewel*	43	60	4.0	5.7	6.7	6.7	6.7	5.7	6.7	6.0	95
A98-183	33	57	3.7	6.0	6.3	6.7	6.7	6.0	6.3	6.0	96
A98-365	30	58	3.3	7.0	7.0	6.3	6.7	5.7	5.7	6.0	96
Alpine*	50	57	3.3	6.3	7.0	6.7	6.3	6.0	6.0	6.0	96
Award*	37	53	3.3	6.0	6.3	6.0	7.0	6.7	6.3	6.0	94

Cultivar/ Experimental Number	% Establishment 2000	% Living Cover Spring ’01	Quality 2001								% Living Cover Fall ’01
			May	June	July	Aug.	Sept.	Oct.	Nov.	Mean	
BAR Pp 0573	37	57	3.7	6.3	6.3	6.0	6.7	6.3	6.3	6.0	93
Baronie*	57	73	5.3	6.3	6.3	6.3	6.7	5.3	5.3	6.0	92
Monte Carlo (A96-402)*	47	58	3.3	7.0	7.0	6.0	6.7	5.7	6.0	6.0	88
PST-731	37	52	3.0	6.3	7.0	6.3	6.7	6.3	6.0	6.0	96
Ascot*	37	55	3.0	6.3	7.0	6.3	6.3	6.0	6.3	5.9	94
Cabernet*	37	62	4.0	6.3	6.3	6.3	6.7	5.7	6.0	5.9	91
H92-203	47	57	3.3	6.7	7.0	6.7	6.0	5.7	6.0	5.9	93
J-1665	40	48	3.0	5.7	6.7	6.7	7.0	5.7	6.7	5.9	97
Liberator*	43	58	3.7	6.3	6.3	6.0	7.0	6.0	6.0	5.9	98
Wellington*	43	60	3.3	6.3	6.7	6.7	6.3	5.7	6.3	5.9	97
J-1420	43	57	3.3	6.3	7.0	6.3	6.3	6.0	5.7	5.9	95
A98-296	40	57	3.7	6.0	6.7	6.3	6.3	6.0	6.0	5.9	91
Freedom II*	37	50	3.0	6.3	6.7	6.0	6.7	5.7	6.7	5.9	98
SI A96-386	27	55	3.7	6.3	6.7	6.7	6.0	5.7	6.0	5.9	96
B3-171	40	60	3.7	6.7	6.7	6.7	6.3	5.0	5.7	5.8	95
B5-45	30	55	3.3	6.3	7.3	6.3	5.7	5.7	6.0	5.8	93
Misty*	37	57	3.3	6.3	6.7	6.3	6.3	5.7	6.0	5.8	93
Shamrock*	40	58	3.7	6.0	7.0	5.7	6.0	5.7	6.7	5.8	90
A97-857	37	52	3.3	5.7	6.3	6.7	6.3	6.0	6.3	5.8	97
DLF 76-9034	40	60	4.0	6.0	6.7	6.3	6.7	5.3	5.7	5.8	94
Royale (A97-1336)*	43	58	3.3	6.3	6.7	7.0	5.7	6.0	5.7	5.8	92
SRX 2114	37	60	4.0	6.3	6.3	6.3	6.3	5.7	5.7	5.8	90
Ba 82-288	33	57	3.3	6.0	6.0	6.7	6.7	5.7	6.0	5.8	93
A98-739	30	57	3.3	6.3	6.0	6.7	6.3	5.7	6.0	5.8	93
Bartitia*	40	58	3.7	6.7	7.0	6.3	5.7	5.3	5.7	5.8	95
Bordeaux*	43	65	4.0	7.3	6.7	5.7	5.3	5.3	6.0	5.8	90
Brooklawn*	37	62	4.0	6.3	6.3	6.0	6.7	5.0	6.0	5.8	93
Chateau*	20	55	3.3	6.3	6.3	5.7	6.7	5.7	6.3	5.8	97
Coventry*	40	62	4.0	6.0	6.0	6.3	6.3	6.0	5.7	5.8	94
Eagleton*	43	60	3.7	6.0	6.7	6.3	6.0	6.0	5.7	5.8	96
PST-108-79	27	53	3.0	6.3	6.3	6.3	7.0	5.3	6.0	5.8	97
PST-B3-170	40	55	3.7	6.3	7.0	6.3	6.3	5.3	5.3	5.8	90
Quantum Leap*	40	53	3.0	7.0	6.3	6.7	6.3	5.3	5.7	5.8	83
Rambo*	40	55	3.0	6.3	7.3	6.3	6.3	5.0	6.0	5.8	93
A98-1275	33	52	3.0	6.3	6.3	6.3	6.3	5.7	6.0	5.7	94
PST-1701	47	72	5.0	5.7	6.0	6.3	6.0	5.7	5.3	5.7	95
Raven*	40	62	4.0	6.3	6.3	6.3	6.0	5.7	5.3	5.7	93
A98-881	47	63	4.0	6.3	6.3	6.3	6.0	5.7	5.3	5.7	95

Cultivar/ Experimental Number	% Establishment 2000	% Living Cover Spring ’01	Quality 2001								% Living Cover Fall ’01
			May	June	July	Aug.	Sept.	Oct.	Nov.	Mean	
Boutique*	30	53	3.7	5.7	7.0	6.3	6.7	4.7	6.0	5.7	85
Brilliant*	37	63	4.0	6.3	6.7	6.3	6.0	5.0	5.7	5.7	89
J-1515	37	52	3.0	6.3	6.0	6.3	7.0	5.7	5.7	5.7	89
Midnight*	33	55	3.3	5.7	6.3	6.0	7.0	5.7	6.0	5.7	96
PST-B5-125	40	60	3.7	6.7	6.0	6.3	5.7	6.0	5.7	5.7	90
PST-H6-150	33	53	3.3	6.0	6.3	6.3	6.0	6.0	6.0	5.7	93
Pp H 6370	40	55	3.3	6.3	6.7	5.7	5.7	6.0	6.3	5.7	92
Rita*	33	55	3.7	6.3	6.3	6.0	6.0	5.7	6.0	5.7	88
Julia*	40	63	4.3	6.0	5.7	6.0	6.3	5.7	5.7	5.7	98
Kenblue*	70	65	4.0	6.3	7.3	6.0	5.3	4.7	6.0	5.7	91
PST-York Harbor 4	30	55	3.3	6.0	6.7	6.3	6.3	5.0	6.0	5.7	96
Washington*	60	63	4.0	6.0	6.7	6.0	5.7	5.3	6.0	5.7	93
B4-128A	33	55	3.3	6.3	6.3	6.0	6.3	5.0	6.0	5.6	93
Chicago II*	37	55	3.3	6.0	6.7	6.3	6.3	5.0	5.7	5.6	87
Everest*	53	53	3.0	5.3	6.0	6.7	6.3	5.7	6.3	5.6	93
H94-293	40	57	3.3	6.3	6.7	6.3	6.7	4.7	5.3	5.6	92
J-2885	50	53	3.3	5.0	6.7	6.3	6.3	5.7	6.0	5.6	93
PST-1BMY	27	57	3.7	6.0	5.7	6.0	6.7	5.3	6.0	5.6	92
PST-1QG-27	33	60	3.7	6.0	6.0	6.7	6.3	5.0	5.7	5.6	97
Wildwood*	47	63	4.0	6.0	6.3	5.7	6.0	5.7	5.7	5.6	93
A98-1028	43	55	3.7	5.3	6.3	5.7	6.3	5.3	6.3	5.6	95
H92-558	37	57	3.7	6.0	6.3	6.0	6.7	5.0	5.3	5.6	88
Pp H 7097	37	57	3.7	5.7	6.7	6.0	6.0	5.3	5.7	5.6	88
Rugby II*	33	55	3.3	6.3	6.7	6.0	6.0	5.3	5.3	5.6	90
Serene*	47	63	4.0	6.7	6.7	5.7	5.7	5.0	5.3	5.6	85
Unknown	30	48	3.0	5.3	6.0	6.0	6.0	6.3	6.3	5.6	93
DLF 76-9032	40	52	3.0	6.0	6.7	6.7	5.7	5.3	5.3	5.5	89
DLF 76-9036	43	55	4.0	5.3	6.0	6.0	6.0	5.7	5.7	5.5	95
J-2890	47	53	3.7	5.3	6.0	6.3	6.3	5.3	5.7	5.5	87
Apollo*	50	65	4.3	5.7	5.7	6.0	5.7	5.7	5.7	5.5	92
B5-144	33	50	3.0	5.3	6.0	6.0	6.0	5.7	6.7	5.5	93
B5-43	27	52	3.3	5.7	6.0	6.3	5.7	5.7	6.0	5.5	87
BAR Pp 0468	27	58	4.0	6.0	6.0	5.7	6.3	5.0	5.7	5.5	90
Baron*	40	53	3.0	6.0	6.3	6.0	6.7	5.0	5.7	5.5	90
IB7-308	30	55	3.7	5.7	6.0	5.7	6.0	5.7	6.0	5.5	88
PST-161	37	62	4.0	6.3	5.7	5.0	6.3	5.7	5.7	5.5	90
Princeton 105*	30	53	3.7	5.3	5.3	6.3	6.3	6.0	5.7	5.5	92
Envicta*	47	58	3.7	5.7	6.3	6.0	6.3	5.0	5.3	5.5	92

Cultivar/ Experimental Number	% Establishment 2000	% Living Cover Spring ’01	Quality 2001								% Living Cover Fall ’01
			May	June	July	Aug.	Sept.	Oct.	Nov.	Mean	
HV 140	40	53	3.3	6.0	6.3	5.7	6.3	5.7	5.0	5.5	88
J-1513	50	55	3.0	6.0	5.3	6.3	6.3	5.7	5.7	5.5	95
Limerick	37	57	3.3	6.0	5.7	6.0	6.3	5.3	5.7	5.5	98
Marquis*	40	57	3.7	5.0	5.7	5.7	6.3	6.0	6.0	5.5	92
PST-B4-246	33	50	3.0	6.0	6.7	6.0	5.7	5.7	5.3	5.5	90
Pp H 7832	40	62	4.0	6.3	6.7	5.3	5.3	5.3	5.3	5.5	89
BH 00-6003	30	60	4.0	5.7	6.0	5.7	5.7	5.3	6.0	5.5	89
A96-742	33	50	3.3	5.3	6.3	5.7	6.0	5.3	6.0	5.4	90
A96-739	40	55	3.7	5.7	6.0	6.3	6.0	4.7	5.7	5.4	90
A98-407	20	47	3.0	5.3	6.3	6.0	6.3	5.7	5.3	5.4	93
Blue Ridge (A97-1449)*	40	65	4.7	6.0	6.0	5.7	5.0	5.0	5.7	5.4	82
Lily	37	58	3.3	6.3	7.0	5.7	6.0	4.3	5.3	5.4	86
Limousine*	33	55	3.3	6.0	6.0	6.3	5.7	5.3	5.3	5.4	93
BAR Pp 0471	37	55	3.7	5.3	6.3	5.7	6.0	5.0	5.7	5.4	95
Bodacious*	37	52	3.0	5.3	5.7	5.7	6.3	6.0	5.7	5.4	93
Fairfax*	27	58	4.0	5.7	6.3	5.7	6.0	4.7	5.3	5.4	87
HV 238	43	67	4.7	6.0	5.7	5.0	5.3	5.3	5.7	5.4	87
Odyssey*	40	48	3.0	5.7	6.0	5.7	6.3	5.7	5.3	5.4	88
PST-222	37	53	3.3	5.3	5.7	6.3	6.0	5.7	5.3	5.4	93
Pick 453	40	63	4.3	6.7	5.3	6.0	5.7	4.3	5.3	5.4	81
Chelsea*	27	50	3.0	5.7	6.3	5.7	5.7	5.7	5.3	5.3	90
Bedazzled*	43	57	3.3	6.0	5.7	5.7	5.3	5.7	5.3	5.3	85
Blackstone*	33	58	4.0	5.7	5.7	5.3	6.0	4.7	5.7	5.3	86
J-2487	33	50	3.0	5.7	5.3	6.0	6.3	5.0	5.7	5.3	86
PST-1804	43	65	4.3	6.0	6.0	5.3	5.0	5.0	5.3	5.3	92
Showcase*	33	53	3.3	5.7	6.0	6.0	6.3	4.3	5.0	5.2	83
NA-K991	33	57	3.7	5.7	6.3	5.3	5.3	4.7	5.3	5.2	87
J-1838	37	57	3.7	5.7	5.7	5.7	5.7	4.7	5.0	5.1	83
PST-604	33	62	4.0	5.7	4.7	5.3	5.7	5.0	5.7	5.1	87
PST-H5-35	37	48	3.0	5.7	6.0	5.7	6.0	4.3	5.3	5.1	90
SRX OG245	40	55	3.3	6.7	7.0	5.7	4.3	4.3	4.7	5.1	77
Boomerang*	37	53	3.3	5.3	5.3	5.0	5.7	5.0	6.0	5.1	88
Julius*	30	48	3.0	5.7	5.7	5.7	5.7	4.7	5.3	5.1	90
99AN-53	30	48	3.0	5.7	6.0	5.7	5.3	4.7	5.3	5.1	88
GO-9LM9	67	65	4.3	6.0	5.7	5.3	5.0	4.3	5.0	5.1	83
NuGlade*	33	47	3.0	5.0	5.7	6.0	6.0	5.0	5.0	5.1	86
J-1368	37	50	3.3	5.0	5.3	5.3	6.0	5.0	5.3	5.0	85
Moonlight*	33	52	3.7	5.0	5.7	5.3	5.3	5.0	5.3	5.0	79

Cultivar/ Experimental Number	% Establishment 2000	% Living Cover Spring ’01	Quality 2001								% Living Cover Fall ’01
			May	June	July	Aug.	Sept.	Oct.	Nov.	Mean	
J-1880	37	48	3.3	5.0	5.7	5.7	5.7	4.3	5.3	5.0	88
Pp H 6366	43	57	3.3	6.3	6.0	4.7	5.0	4.7	5.0	5.0	87
North Star*	37	45	3.0	5.0	4.7	5.3	5.7	5.3	5.7	5.0	88
SRX 2394	50	52	3.0	5.7	6.3	5.0	5.0	4.7	5.0	5.0	80
A97-1567	40	57	3.7	5.3	5.3	4.7	5.3	4.7	5.3	4.9	85
SRX 27921	43	53	3.3	5.3	6.0	4.7	5.3	4.7	5.0	4.9	85
Total Eclipse*	30	50	3.3	5.3	5.3	5.3	5.3	4.7	5.0	4.9	83
Ba 84-140	27	57	3.7	6.0	4.3	4.7	6.0	4.3	5.0	4.9	87
Ba 83-113	33	52	3.3	5.3	5.0	5.0	5.0	5.0	5.0	4.8	88
Pp H 7929	40	47	3.0	4.7	5.3	5.3	5.7	4.7	5.0	4.8	82
B3-185	33	57	4.0	5.0	4.7	5.0	5.3	4.7	4.7	4.8	77
CVB-20631	20	45	3.0	4.7	5.0	5.3	5.3	5.0	5.0	4.8	87
NA-K992	30	53	3.3	5.7	5.3	4.7	5.3	4.0	5.0	4.8	88
A97-1432	33	53	3.3	5.3	5.3	4.7	5.3	4.0	5.0	4.7	85
Ba 00-6001	27	50	3.3	4.3	5.0	5.3	5.3	5.0	4.7	4.7	88
J-2561	33	48	3.3	4.3	4.3	5.3	5.7	5.0	5.0	4.7	76
Barzan*	23	47	3.0	5.0	5.0	5.0	5.0	4.7	5.0	4.7	86
Pick-232	43	62	4.3	5.3	5.3	4.7	4.3	4.0	4.7	4.7	73
Arcadia*	30	53	3.7	4.7	4.7	5.0	4.7	4.0	4.7	4.5	73
Blue Knight*	33	50	3.3	4.7	4.3	5.0	5.0	4.3	4.3	4.4	82
LSD[3]	*12.6*	*9.7*	*0.9*	*1.4*	*1.8*	*1.6*	*1.5*	*1.6*	*1.3*	*1.1*	*13.4*

[1] Ratings based on a scale of 0-9 with 9=best quality.

[2] Cultivars marked with “*” will be commercially available in 2002.

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

TITLE:	1997 National Bermudagrass Test
OBJECTIVE:	To evaluate seeded and vegetative bermudagrass cultivars under Kansas conditions and submit data collected to the National Turfgrass Evaluation Program.
PERSONNEL:	Linda R. Parsons, Jack D. Fry
SPONSOR:	USDA National Turfgrass Evaluation Program

INTRODUCTION:

Bermudagrass is a popular warm-season turfgrass that is heat and drought tolerant and wear-resistant. Recent introductions of interest are being selected for their improved hardiness and quality. New seeded varieties, in particular, show the potential for improved winter survival. Both seeded and vegetative types need further evaluation to determine their potential use by both sod growers and consumers.

MATERIALS AND METHODS:

During the summer of 1997, we established 18 seeded and 10 vegetative bermudagrass cultivars and experimental numbers at the John C. Pair Horticultural Center in Wichita, KS. Preparation for the study included incorporating 13-13-13 into 84 study plots, each 5 by 5 ft, at a rate of 1 lb NPK/1000 ft^2. We seeded or plugged the plots in a randomized complete block design. We maintained fertility of the plots at 0.5 to 0.75 lb N/1000 ft^2 per growing month. We mowed the plots weekly during the growing season at 1.0 to 1.5 inches and returned clippings. We irrigated as necessary to prevent dormancy and controlled weeds, insects, and diseases only when they presented a threat to the trial. At appropriate times throughout the course of the study, we rated the turfgrass on a scale of 0=dead turf, 6=acceptable, and 9=optimum measure.

RESULTS:

The winter of 2000–2001 was the harshest of this study and provided an excellent opportunity to evaluate the bermudagrass cultivars for hardiness. Wind played a role in influencing winter survival as it caused desiccation. Extreme temperature fluctuations in autumn may have also contributed to winter injury. The high on September 20 was 99 °F and the low on September 21 was 38 °F. Similarly, the high on September 23 was 94 °F and the low on September 26 was 34 °F. Lows in the single digits were recorded on 10 days in December and 2 days in January. The lowest temperature was 0 °F on January 2. Snow cover may have helped to moderate effects of wind and temperature during some of the coldest days in December. On 31 May 2001 we rated the turfgrass for winter injury and percent surviving ground cover. All seeded selections except Riviera (OKS 95-1) exhibited significant winter injury (Table 1). Winterkill on Riviera (OKS 95-1) was negligible and that on Blackjack and Continental (PST-R69C) was moderate; all others exhibited severe injury. Vegetative selections that exhibited very good hardiness were OKC 18-4 and OKC 19-9. Winter injury ratings on Midlawn, Shanghai, and Cardinal were statistically the same as those for the Oklahoma (OKC) selections. Percent surviving ground cover reflected winter injury ratings with seeded cultivar Riviera (OKS 95-1) and vegetative cultivars OKC 18-4 and OKC 19-9 showing the least damage.

Spring green-up and overall turfgrass quality ratings for 2001 also reflected hardiness. Vegetative cultivars OKC 18-4, OKC 19-9, and Midlawn and seeded cultivar Riviera (OKS 95-1) were the earliest to green up. The two best overall performers were vegetative type Midlawn and seeded type Riviera (OKS 95-1). Mean quality ratings for vegetative types OKC 18-4, OKC 19-9, and Shanghai and seeded types Blackjack and Continental (PST-R69C) were statistically the same as those of the two best performers. At summer's end, we looked at turf color and texture and found that vegetative cultivars OKC 18-4, Shanghai, and OKC 19-9 and seeded cultivar Riviera (OKS 95-1) were the darkest green. Vegetative types Cardinal, Midlawn, Tifgreen, and Tifsport (Tift 94) had the finest texture.

The growing season for these bermudagrass cultivars varied from year to year during the 5-year course of this study and was influenced by the severity and duration of cold winter weather. We were able to rate the study for spring green-up as early as April 4 in 1998 and April 26 in 2000 but not until May 14 in 1999 and May 31 in 2001. Similarly, we were able to rate turfgrass quality as late as October 19 and 18 in 1998 and 1999, respectively, but had to stop with our September 26 and 25 ratings in 2000 and 2001, respectively.

We found that, on average, vegetative cultivars Midlawn, OKC 19-9, and Cardinal and seeded cultivar Riviera (OKS 95-1) were the first to green up in the spring (Table 2). We rated overall turfgrass quality regularly during the growing season from 1998 through 2001 and found that the best performer over the course of the study was seeded cultivar Riviera (OKS 95-1) followed by vegetative cultivars Midlawn, OKC 18-4, and Shanghai. Ratings were influenced by degree of coverage and weed infestation as well as turf color, texture, and density.

During the summer of 1997, we looked at seedling vigor of the seeded bermudagrass types. We found Arizona Common, NuMex-Sahara, and Savannah to be the most vigorous, showing the best and most rapid germination.

As consumers seem most interested in dark green, finely textured turfgrass, we looked at these characteristics regularly during the course of our study. We rated turfgrass color annually from 1998 through 2001 and found that Shanghai, OKC 18-4, OKC 19-9, CN 2-9, and Tifway were the darkest vegetative types. Riviera (OKS 95-1) followed these as the darkest colored seeded type. Vegetative cultivars Cardinal, Tifgreen, Midlawn, Tifsport (Tift 94), Tifway, and finally seeded cultivar Riviera (OKS 95-1) averaged the finest textures during the same period.

Table 1. 2001 performance of bermudagrass cultivars at Wichita, KS[1].

							Quality				
Cultivar/ Experimental Number	Seeded/ Vegetative	Winter Injury	% Green	Spring Green-Up	Color	Texture	May	June	Aug.	Sep.	Mean
Midlawn*[2]	V	5.7	65	5.3	6.0	8.0	6.0	5.0	5.7	5.7	5.6
Riviera (OKS 95-1)*	S	7.0	75	5.3	7.0	7.0	6.7	5.3	5.3	5.0	5.6
OKC 18-4	V	6.7	82	6.0	7.3	7.0	6.7	5.7	4.0	5.0	5.3
OKC 19-9	V	6.3	83	5.7	7.0	6.7	6.3	5.0	4.0	5.3	5.2
Shanghai*	V	5.3	67	4.3	7.3	5.0	5.0	4.7	6.0	5.0	5.2
Blackjack*	S	4.7	60	3.7	5.0	6.0	4.7	4.3	6.0	4.7	4.9
Continental (PST-R69C)*	S	4.3	53	4.0	5.0	6.3	4.7	4.3	6.0	4.3	4.8
Cardinal	V	5.0	67	4.3	4.0	8.7	5.0	4.3	4.3	4.0	4.4
Princess*	S	2.3	18	2.3	6.3	7.0	2.3	3.3	6.0	5.3	4.3
Tifsport (Tift 94)*	V	3.7	33	3.3	6.0	8.0	3.3	3.3	5.0	5.0	4.2
Tifgreen*	V	4.0	35	3.3	5.0	8.0	3.3	4.3	4.0	4.0	3.9
Southern Star (J-1224)*	S	3.0	21	2.7	6.0	5.7	3.0	3.0	5.0	4.3	3.8
J-540	S	2.7	11	2.0	6.0	6.0	2.3	3.3	5.0	4.3	3.8
Sundevil II*	S	3.0	16	2.7	5.3	5.0	2.7	3.3	4.7	4.0	3.7
Tifway*	V	2.7	30	2.3	6.0	7.3	2.7	2.7	4.3	5.0	3.7
SW 1-11	S	2.0	10	2.0	5.3	6.0	2.0	2.7	5.7	4.0	3.6
CN 2-9	V	2.3	20	2.0	6.7	6.7	2.0	3.0	4.3	4.3	3.4
Pyramid*	S	2.0	10	1.7	6.0	5.7	2.0	2.7	4.7	4.3	3.4
Savannah*	S	2.3	8	2.0	5.7	5.7	2.0	2.7	4.7	4.3	3.4
Majestic*	S	1.7	7	1.7	5.7	5.7	1.7	2.3	4.0	5.0	3.3
Jackpot*	S	2.0	10	2.0	5.7	5.3	2.0	2.0	4.3	4.3	3.2
NuMex-Sahara*	S	1.7	6	1.3	5.7	5.3	1.7	2.3	4.3	4.3	3.2
Shangri La*	S	1.7	6	1.3	6.0	5.3	1.7	2.0	5.0	4.0	3.2
Mirage*	S	1.7	8	1.3	6.7	5.3	1.7	2.3	4.3	4.0	3.1
Blue-Muda*	S	1.7	3	1.0	5.7	5.3	1.0	2.0	4.3	4.7	3.0
Sydney (SW 1-7)*	S	1.3	4	1.0	6.7	5.0	1.7	1.7	4.0	4.3	2.9
Arizona Common*	S	1.7	5	1.0	5.3	5.3	1.3	1.7	4.7	3.7	2.8
Mini-Verde*	V	3.0	26	2.7	5.0	5.7	2.7	3.7	1.7	1.7	2.4
LSD[3]		*1.8*	*20.8*	*1.5*	*1.0*	*0.8*	*1.6*	*1.5*	*1.2*	*1.2*	*0.9*

[1] Ratings based on a scale of 0-9 with 9=least winter injury, earliest green up, darkest color, finest texture, and best quality.

[2] Cultivars marked with "*" will be commercially available in 2002.

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

Table 2. Summary of bermudagrass cultivar performance at Wichita, KS over the 5-year period 1997–2001[1].

Cultivar/ Experimental Number	Seeded/ Vegetative	Seedling Vigor ’97	Spring Green-Up ’98–’01	Color ’98–’01	Texture ’98–’01	Quality ’98–’01 (October ’98, ’99 only)						
						May	June	July	Aug.	Sep.	Oct.	Mean
Riviera (OKS 95-1)*[2]	S	2.7	6.2	6.6	6.8	6.8	6.5	6.7	6.2	5.7	6.8	6.3
Midlawn*	V	.	7.3	5.8	7.4	6.7	6.3	6.7	5.9	5.6	5.8	6.0
OKC 18-4	V	.	6.0	7.6	6.4	6.5	6.4	6.3	5.2	5.3	5.5	5.8
Shanghai*	V	.	5.3	7.9	4.8	5.8	5.7	5.6	6.1	5.5	5.7	5.6
OKC 19-9	V	.	6.5	6.8	5.8	5.5	5.1	5.4	5.1	5.2	5.3	5.3
Tifway*	V	.	4.2	6.8	7.0	5.2	5.5	6.7	4.8	4.9	6.8	5.3
Cardinal	V	.	6.3	4.3	8.9	6.7	5.7	5.9	4.3	4.2	5.5	5.2
Princess*	S	4.3	2.8	6.4	6.3	4.3	5.2	6.0	5.8	5.5	5.7	5.2
Tifsport (Tift 94)*	V	.	4.4	6.6	7.1	5.0	5.0	6.6	5.0	5.0	5.7	5.1
Blackjack*	S	3.0	3.7	5.5	5.4	4.7	5.3	4.7	5.7	5.1	4.8	5.0
CN 2-9	V	.	4.3	6.8	6.4	4.3	5.3	6.0	4.8	4.7	5.7	4.8
Tifgreen*	V	.	5.3	5.5	7.6	4.6	5.5	5.6	4.5	4.5	4.7	4.8
Southern Star (J-1224)*	S	3.3	3.7	6.1	5.6	4.8	4.8	4.8	5.3	4.8	5.3	4.8
J-540	S	3.7	3.6	6.0	5.6	4.3	5.0	5.0	5.2	4.8	5.2	4.8
Continental (PST-R69C)*	S	1.3	3.8	5.6	5.8	4.3	4.7	4.4	5.3	4.5	4.5	4.6
Majestic*	S	5.0	2.3	5.8	5.4	3.8	4.4	4.9	5.1	5.3	5.5	4.6
SW 1-11	S	4.7	1.7	5.9	6.0	3.2	4.3	4.8	5.8	4.9	5.0	4.5
Pyramid*	S	3.3	2.9	6.1	5.4	3.9	4.4	4.6	4.9	4.9	5.3	4.5
Mirage*	S	5.3	2.6	5.9	5.4	3.8	4.5	4.4	5.0	4.7	5.7	4.5
Sydney (SW 1-7)*	S	3.3	2.5	6.3	5.5	3.7	4.5	4.8	4.8	5.0	4.7	4.4
Blue-Muda*	S	5.3	2.4	5.8	5.3	3.3	4.3	4.8	5.3	4.8	4.8	4.4
Savannah*	S	5.7	3.0	5.8	5.7	4.1	4.5	4.6	4.8	4.2	5.0	4.4
Shangri La*	S	5.3	2.3	5.9	5.3	3.3	4.3	4.7	5.2	4.7	5.3	4.3
NuMex-Sahara*	S	6.3	1.8	5.9	5.2	2.8	4.1	4.6	5.1	4.8	4.8	4.2
Sundevil II*	S	3.3	3.1	5.7	5.1	3.9	4.3	3.9	4.5	4.2	4.2	4.1
Jackpot*	S	5.3	2.1	5.7	5.3	2.8	3.6	3.7	4.7	4.7	4.3	3.8
Arizona Common*	S	6.7	1.3	5.8	5.3	2.3	3.1	3.9	5.0	4.3	5.0	3.7
Mini-Verde*	V	.	3.1	5.9	6.6	3.0	3.8	3.3	2.7	2.7	2.2	2.9
LSD[3]		*3.0*	*0.7*	*0.4*	*0.5*	*1.0*	*0.9*	*0.9*	*0.8*	*0.6*	*0.8*	*0.6*

[1] Ratings based on a scale of 0-9 with 9=earliest green up, darkest color, finest texture, and best quality.

[2] Cultivars marked with “*” will be commercially available in 2002.

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

TITLE: 1997 Buffalograss Test

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

PERSONNEL: Linda R. Parsons, Jack D. Fry

INTRODUCTION:

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

MATERIALS AND METHODS:

During the summer of 1997, we established 9 seeded and 11 vegetative buffalograss cultivars and experimental numbers in 60 study plots (8 by 8 ft) at the John C. Pair Horticultural Center in Wichita, KS. Prior to seeding or plugging the plots, we incorporated 13-13-13 into them at a rate of 1 lb NPK/1000 ft^2. We maintained fertility at 0 to 0.25 lb N/1000 ft^2 per growing month. We mowed the plots weekly during the growing season at 2.5 to 3.0 inches and returned clippings. We irrigated as necessary to prevent dormancy and controlled weeds only when they presented a threat to the trial. At appropriate times during the course of the study, we rated the turfgrass on a scale of 0=dead turf, 6=acceptable, and 9=optimum measure.

RESULTS:

The 2000–2001 winter was the harshest of this study and provided an excellent opportunity to evaluate the buffalograss trial for hardiness. Wind influenced winter survival as it caused desiccation. Extreme temperature fluctuations in autumn may have also contributed to winter injury. The high on September 20 was 99 °F and the low on September 21 was 38 °F. Similarly, the high on September 23 was 94 °F and the low on September 26 was 34 °F. Lows in the single digits were recorded on 10 days in December and 2 days in January. The lowest temperature was 0 °F January 2. Snow cover may have moderated wind and temperature effects during some of the coldest days in December. On 31 May 2001 we rated turfgrass for winter injury and percent surviving ground cover. Vegetative types Legacy (86-61) and Stampede exhibited fairly good hardiness and 378, 91-118, 86-120, Bonnie Brae, and Mobuff were not significantly different from the two best (Table 1). All other selections exhibited significant winter injury although seeded cultivars Bison and Cody suffered the least. Percent surviving ground cover reflected winter injury ratings somewhat with vegetative cultivars Legacy (86-61), 91-118, and Bonnie Brae and seeded cultivar Cody showing least damage.

We continued rating the buffalograss trial during the 2001 growing season, first for spring green-up and then for overall quality and leaf texture. Legacy (86-61), 378, and 91-118 were the earliest vegetative selections to green up and 8907 the earliest seeded selection. We rated quality four times during the course of the summer and found recovery from winter injury to be extremely good in some cultivars. Ratings were influenced by degree of coverage and weed infestation as well as turf color, texture, and density. Best overall quality was found in vegetative types 609, Prairie, and Stampede and then in seeded types Bison, Cody, Sharp's Improved, and Sharp's Improved #2.

Vegetative cultivars 609 and Midget and seeded cultivar Bison showed the finest texture.

The growing season for these buffalograss cultivars varied a bit from year to year during the 5-year course of this study and was influenced by the severity and duration of cold winter weather. We were able to rate the study for spring green-up as early as April 26 in 2000 but not until May 14 in 1999 and May 31 in 2001. Similarly, we were able to rate turfgrass quality as late as October 19 in 1998, but had to stop with our September 21, 26, and 25 ratings in 1999, 2000, and 2001, respectively.

We found that, on average, vegetative types Bonnie Brae, Legacy (86-61), 378, 86-120, and 91-118 were the first to green up in the spring followed by seeded type Cody (Table 2). We rated overall turfgrass quality regularly during the growing season from 1998 through 2001 and found that the best performers over the course of the study were vegetative cultivars 609, UCR-95, and 91-118 and seeded cultivars Sharp's Improved, and Sharp's Improved #2. UCR-95 performed so well during the first four years of this study that even though it suffered the most severe injury during the 2000–2001 winter, never recovered, and rated last for the 2001 growing season, it was still able to rank statistically as one of the top selections in this study.

As consumers seem most interested in dark green, finely textured turfgrass, we looked at these characteristics as well. We found that Prairie, 609, and UCR-95 were the darkest colored vegetative cultivars. BAM-1000, Bison, and Cody were the darkest green seeded cultivars but were significantly lighter than the three darkest vegetative types. Vegetative cultivar Midget had by far the finest texture of the group, although vegetative types 609 and Prairie and seeded types Bison, Sharp's Improved, and Tatanka had good fine textures as well.

Table 1. 2001 performance of buffalograss cultivars at Wichita, KS[1].

Cultivar/ Experimental Number	Seeded/ Vegetative	Winter Injury	% Green	Spring Green-Up	Texture	Quality May	Quality June	Quality Aug.	Quality Sep.	Quality Mean
609*[2]	V	3.3	30	2.7	8.3	2.7	5.3	5.3	6.3	4.9
Prairie	V	3.7	32	2.7	7.7	3.3	5.7	5.0	5.3	4.8
Stampede*	V	6.0	40	5.0	7.7	3.7	6.0	3.7	6.0	4.8
Bison*	S	4.7	40	4.0	7.7	4.7	5.0	4.0	4.7	4.6
Cody*	S	4.7	47	4.3	7.0	4.3	5.3	4.3	4.0	4.5
Sharp's Improved	S	4.0	38	3.7	7.3	4.0	4.7	5.0	4.3	4.5
Sharp's Improved #2	S	4.0	42	4.0	7.0	4.3	5.3	4.0	4.0	4.4
91-118	V	5.7	50	5.3	6.7	4.3	6.0	3.3	3.0	4.2
BAM-1000	S	4.3	32	3.7	7.3	3.7	4.7	4.0	4.0	4.1
Tatanka*	S	4.0	35	3.3	7.3	4.0	5.0	3.3	4.0	4.1
Texoka*	S	4.0	35	4.0	7.3	3.7	4.7	4.0	4.0	4.1
Sharpshooter	S	4.3	43	5.0	7.0	4.0	5.7	3.0	3.0	3.9
378*	V	5.7	42	5.3	6.7	3.7	5.3	4.0	2.0	3.8
8907	S	4.3	43	5.0	7.0	4.0	4.7	3.3	3.0	3.8
86-120	V	5.3	40	5.0	7.3	3.7	5.3	3.3	2.3	3.7
Legacy (86-61)*	V	6.3	57	6.0	7.7	4.3	5.0	3.0	2.3	3.7
Bonnie Brae*	V	5.3	47	5.0	7.0	3.7	4.7	3.3	2.3	3.5
Mobuff	V	5.3	42	4.3	6.7	3.3	4.7	4.0	2.0	3.5
Midget*	V	3.0	28	2.7	8.3	2.3	4.0	3.0	3.7	3.3
UCR-95	V	1.0	4	1.0	7.3	1.0	2.0	2.3	4.3	2.4
LSD[3]		*1.2*	*9.3*	*1.2*	*0.9*	*0.9*	*0.9*	*1.2*	*0.7*	*0.5*

[1] Ratings based on a scale of 0-9 with 9=least winter injury, earliest spring green-up and best texture and quality.

[2] Cultivars marked with "*" were commercially available in 2001.

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

Table 2. Summary of buffalograss cultivar performance at Wichita, KS over the 5-year period 1998–2001[1].

Cultivar/ Experimental Number	Seeded/ Vegetative	Spring Green-Up	Color	Texture	Quality (October '98 only) May	June	July	Aug.	Sep.	Oct.	Mean
609*[2]	V	4.4	7.0	7.8	4.9	5.8	5.6	5.4	6.2	6.3	5.6
Sharp's Improved #2	S	4.8	6.0	7.1	4.8	5.8	5.4	4.8	5.1	6.3	5.2
Sharp's Improved	S	4.7	6.0	7.4	4.8	5.4	5.3	5.1	4.9	6.3	5.1
UCR-95[3]	V	1.8	7.0	7.3	4.7	5.3	6.6	4.6	5.3	6.3	5.1
Cody*	S	5.0	6.0	7.2	4.6	5.8	5.2	4.9	4.7	5.7	5.0
Bison*	S	4.8	6.0	7.4	4.6	5.4	4.9	4.8	4.9	5.7	4.9
91-118	V	5.2	5.3	6.3	5.1	6.3	5.2	4.3	3.9	4.7	4.9
Tatanka*	S	4.2	6.0	7.4	4.3	5.5	5.1	4.7	5.0	6.0	4.9
Prairie	V	3.4	7.3	7.7	3.8	4.8	4.9	4.9	4.9	4.7	4.7
Texoka*	S	4.8	6.0	7.3	4.3	5.1	4.8	4.6	4.5	5.3	4.7
Sharpshooter	S	4.7	5.3	6.6	4.3	5.9	4.6	3.9	3.9	5.3	4.5
BAM-1000	S	4.1	6.0	7.2	4.2	5.1	4.7	4.4	4.0	5.0	4.5
Stampede*	V	4.9	5.7	7.1	4.0	5.1	4.0	3.8	4.6	2.7	4.3
Bonnie Brae*	V	5.8	5.0	6.7	4.3	5.3	4.6	4.3	3.7	3.3	4.3
378*	V	5.3	4.7	6.7	4.5	5.3	4.7	4.0	3.0	4.0	4.2
8907	S	4.7	5.3	6.7	4.0	5.3	4.3	3.8	3.7	4.3	4.2
86-120	V	5.3	4.3	6.8	4.3	5.1	4.2	3.7	3.0	2.7	4.0
Midget*	V	3.2	6.0	8.1	3.6	4.7	3.6	3.7	3.9	4.3	3.9
Legacy (86-61)*	V	5.4	4.7	6.8	4.0	4.7	3.7	3.3	2.4	1.3	3.5
Mobuff	V	4.2	4.3	6.7	3.1	3.9	2.9	2.9	2.4	1.3	3.0
LSD[4]		*0.6*	*0.8*	*0.5*	*0.8*	*0.8*	*1.2*	*0.9*	*0.8*	*1.8*	*0.7*

[1] Ratings based on a scale of 0-9 with 9=earliest spring green up, darkest color, finest texture, and best quality.

[2] Cultivars marked with "*" were commercially available in 2001.

[3] Not recommended for use in Kansas. See text.

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

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