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Texas Turfgrass Research—1986

The Texas Agricultural Experiment Station
Neville P. Clarke, Director
The Texas A&M University System
College Station, Texas

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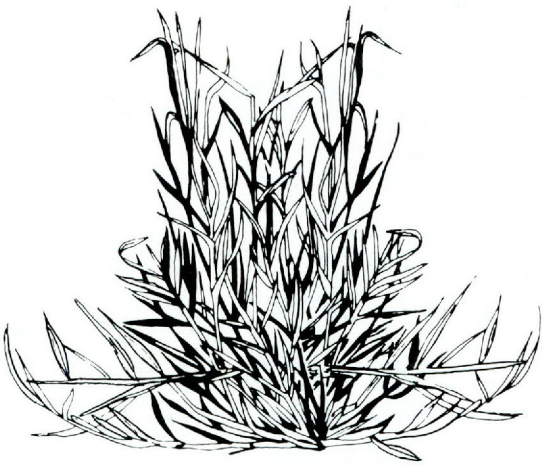

Texas Turfgrass Research—1986

Contents

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Turfgrass Usage in Texas

Size and Contributions

Turfgrasses for functional, recreational, and aesthetic uses cover approximately 3.4 million acres in Texas. The annual expenditure for establishment and maintenance of these turfs is estimated at approximately $960 million. In another perspective, turfgrasses are maintained for over 2 million homeowners. In addition, turfs are used on grounds surrounding businesses, industries, schools, churches, institutional facilities, and public buildings as well as for parks, sports grounds, golf courses, cemeteries, military installations, and roadsides. The significance of turfs cannot be measured simply in terms of size or monetary value. Even more important may be the contribution toward (1) functional benefits such as soil stabilization against water erosion, control of dust blowing problems, heat dissipation, noise abatement, glare reduction, atmospheric pollution control and prevention of visual pollution; (2) low cost recreational and sport surfaces for physical activities contributing to human health and also for sports where spectator entertainment is involved; and (3) ornamental beauty and aesthetic benefits that contribute to mental health and a more favorable environment for social interaction among peoples, especially in densely populated urban areas. Thus, there are many facets to the contributions of turfs in providing a favorable quality of life.

Projected Changes and Research Needs

Energy and non-renewable resources are increasing concerns as supplies become more limited and costs increase. Thus, it is imperative that turfgrass cultivars and cultural practices be developed that have a more simple, lower cost maintenance requirement and yet retain their very valuable functional role in providing a favorable quality of life for productive, harmonious human activities. Of most concern will be changes toward lower water and energy requirements. An associated concern is the potential for continued concentrations of people in urban areas combined with less frequent mobility to outlying recreational and resort areas. This will result in an even greater intensity of use on parks, sports grounds, and related green belt areas in the immediate vicinity of urban centers. This increased use will place even greater stresses on the turfgrasses utilized on these sites. Thus, research is needed to develop improved cultivars and cultural practices which will enable these turfgrasses to survive intense use and satisfy the functional, recreational, and aesthetic needs of people living in this concentrated urban setting.

The turfgrass problems and research needs of the residents of Texas are great and very diverse. The pool of fundamental knowledge is very small compared to the traditional agricultural commodity areas. It is critical that improvements be made in terms of turfgrass species and cultivars so that they can be maintained at a lower intensity of culture, particularly in terms of water and energy resources. These research contributions must be achieved at this time before demands for these resources become so limiting that restrictions are imposed which will drastically impair the use of turfgrasses; thus, in turn, creating a decline in our quality of life.

Acknowledgement of Research Support

A substantial portion of the research results reported herein could not have been accomplished without grant support and contributions of equipment, chemicals, and plant materials from foundations, associations and companies within the turfgrass industry.

Of special note is the major grant commitment of the United States Golf Association. Over $100,000 annually are being granted to Drs. Beard, Engelke, and Horst for the development of minimal maintenance, water conserving turfgrasses and cultural systems.

In addition, general grants for support of the Turfgrass Field Laboratory operations were provided by the Texas Golf Association. Texas Sod Producers Association, Texas Turfgrass Association, Bermudagrass Research Committee of Dallas, and Bent Research Inc. of Dallas. There are also grants provided for specific research objectives. In this case, the specific granting agency is acknowledged at the end of the appropriate Progress Report being supported.

Numerous turfgrass equipment manufacturing firms and suppliers have provided equipment, chemicals, seed, and allied materials that are so vital to the continuing operation of the turfgrass research facilities. Due to their donations, operational monies can be utilized primarily for employment of personnel needed to maintain the experimental plots. Their assistance is gratefully acknowledged. A complete summary of the companies that have given donations of equipment, chemicals, and materials is on the following page.

Vital major donations of equipment have been given by Goldthwaites of Texas, Jacobsen Manufacturing Company, the The Toro Company, Watson Distribution Company, and Yazoo Manufacturing Company.

Donations Acknowledged

Recognition is given to those who have generously provided equipment and materials during the past two years to aid in development of the Texas Agricultural Experiment Station turfgrass research and Texas A&M University turfgrass teaching programs.

Equipment

Billy Goat Co.—C
Briggs and Stratton Corp.—C
Brookhollow Golf Club—C, D
Bunton Co.—C
Champions Golf Club—C
Chemical & Turf Speciality Co.—C, D
Dow Chemical USA—D
Everest Interscience, Inc.,—E
FMC Corp.—C
Goldthwaites of Texas—C
Jacobsen Manufacturing Co.—C
John Deere—C, D
O.M. Scott & Sons—C, E
Rainbird Sprinkler Corp.—C, D, E
Ryan Division, OMC Lincoln—C, D
Snapper Power Equipment—C
Strittmatter Irrigation—D
The Toro Company—C, D, E
Thompson Irrigation—D
TXI—D
Warren's Turf Nursery—D
Watson Distributing Co.—C, D
Yazoo Manufacturing Co.—C

Seed, Sod, and Spriggs

A. G. Sod—E
Coastal Turf Nursery—C, D
Douglas W. King Co., Inc.—C
Harpools Seed, Inc.—D
International Seeds, Inc.—C, D
Jim Lincoln Corp.—D
Lofts Pedigreed Seed, Inc.—C, D
Milberger Turf Farms—C, D
Northrup King & Co.—C, D
O.M. Scott & Sons—C
Pickseed West, Inc.—C, D
Quality Turf—D
Southern Turf Nurseries, Inc.—C
Turf Seed, Inc.—C
Winrock Grass Farm—C, D

C = College Station
D = Dallas
E = El Paso

Soil Amendments

McMaster's—C

Fertilizers, Pesticides, and Chemicals

American Cyanamid Corp.—C.
Aquatrols Corp. of America—C
ATT—D
BASF Wyandotte Corp.—C
Chevron Chemical Co.—C
CIBA-Geigy Corp. Agricultural Division—C, D, E
Diamond Shamrock Crop.—C, D
Dow Chemical Co.—C, D
E.I. DuPont de Nemours & Co. Inc.—C, D
Elanco Products Co., a Division of Eli Lilly—C, D, E
Estech, Inc.—C
Hoechst-Roussel Agri-Vet Co.—C
LESCO Products—C, D, E
Milwaukee Sewerage Commission—C
Mallinckrodt, Inc.—C, D
Mobay Chemical Corp.—C, D
Monsanto Co.—C, D, E
Nelson Plant Food—C
PBI/Gordon Corp.—C, E
Rhone-Poulenc, Inc., Agricultural Division—C, D, E
Sandoz—C, D
Stauffer Chemical Co.—C
Union Carbide Agricultural Products Co., Inc.—C, D
W.A. Cleary Corp.—C

Other Cooperators

Abbott Laboratories—D
Bentgrass Research, Inc.—D
Dallas Parks and Recreation Dept.—C, D
El Paso Country Club—E
El Paso Parks and Recreation Dept.—E
Fort Worth Parks and Recreation Dept.—D
Plano Parks and Recreation Dept.—D
Richardson Parks and Recreation Dept.—D
Texas A&M University Golf Course—C
Texas Golf Association—C
USGA—C, D, E

Leaf Blade Stomatal Characterizations and Potential Evapotranspiration Rates of 12 Cool-Season, C-3 Turfgrasses

R.L. Green, J.B. Beard, and D.M. Casnoff

Introduction

Stomata is a term that describes pores or "openings" on the leaf blade surface. They comprise only about one percent of the total leaf blade surface area, but perform an essential role in photosynthesis by serving (1) as the major entry point into the leaf for atmospheric CO_2 and (2) as the exit point for the transpiration of H_2O which is the major driving force for water movement within the plant. Stomata open and close by the movement of adjacent specialized cells, called guard cells. Thus, the water status within a plant is influenced by stomata size, shape, and distribution and the plant's control of stomatal disposition (i.e. opening and closing). A study of evapotranspiration of St. Augustinegrass showed that under adequately watered conditions, 20 to 30 percent of actual evapotranspiration rate was controlled by resistance of the leaf epidermis and stomata disposition; evapotranspiration was influenced to a greater extent by aerodynamic resistance and resistance to air mass exchange within the turf canopy (Johns et al., 1983).

No research has been conducted specifically on stomatal frequencies and/or their association with the water use rates of cool-season turfgrasses. This information will be helpful in determining if stomatal traits should be considered in the development of new cool-season turfgrasses with reduced water use rates. The objectives of this study were (1) to characterize the stomatal densities of 12 cool-season turfgrasses (nine species) and (2) to characterize their associated potential evapotranspiration (PET) rates under non-limiting soil moisture conditions and uniform cultural practices in a controlled environmental simulation chamber.

Materials and Methods

The 12 cool-season turfgrasses characterized in this study include annual bluegrass; chewings fescue; Penncross creeping bentgrass; Waldina hard fescue; Bensun, Majestic, and Merion Kentucky bluegrass; Manhattan II perennial ryegrass; Sabre rough bluegrass; sheep fescue; and Kentucky 31 and Rebel tall fescue. Three replicates of each turfgrass were established and grown under greenhouse conditions in plastic containers, 21 cm diam and 21 cm deep, filled with fritted clay. Turfs were mowed at a 5-cm cutting height and fertilized biweekly with a complete nutrient solution at a rate equivalent to 0.25 kg N are^{-1} (0.25 lb N 1000 sq. ft.) per growing month. The grasses were grown until turf coverage was complete and uniform.

One week before stomatal and water use rate determinations, the turfs were transferred from the greenhouse to a growth chamber and preconditioned in conditions similar to the environmental simulation chamber; day and night temperatures were 22°C (72°F), photoperiod (day length) was 14 hours, and PAR radiation was 500 μE m^{-2} sec^{-1}.

Following preconditioning, the turfs were mowed, immediately sampled for stomatal characterization, and then placed in the environmental simulation chamber for water use rate determinations. Four of the youngest, fully expanded leaf blades were excised from each turf canopy. Two adaxial (upper) and two abaxial (bottom) leaf blade surface impressions were made by first painting a thin layer of polyvinal solution over one surface of each leaf blade and then gently removing the dried plastic impression and mounting it on a microscope slide for analysis (Rice et al., 1979). Each impression was placed under a microscope with a 20x occular and the stomata counted within a 1-cm^2 grid which was placed within a 10x eyepiece. Two to three locations on each leaf blade impression were counted.

Immediately following excision of leaf blades for stomatal characterization, turfs were placed in a controlled environmental simulation chamber to characterize water use rates under uniform temperature, relative humidity, light, photoperiod, and wind speed conditions. Day and night temperature was 22°C (72°F), dewpoint was 12°C (approximately 53% relative humidity), photoperiod was 14 hours, and PAR radiation was 1,080 μE m^{-2} sec^{-1}. Potential evapotranspiration was determined for each pot using mini-lysimetry technique and the water balance method as described in previous work by Johns (1980) and by Kim (1983). This method involved determining the weight of water lost in a 24-hour period by calculating the difference between the initial and final weight of each mini-lysimeter (fully turfed pots).

Results

Significant differences in stomatal density were found among the cool-season turfgrasses on both the adaxial (upper) and abaxial (bottom) surfaces. Density of stomates was greater on the adaxial than abaxial surface for all 12 turfgrasses. Previous work with 10 warm-season perennial turfgrasses found the same difference in stomatal density between the two leaf blades surfaces (Casnoff et al., 1985). Turfgrasses highest for adaxial stomatal density include Waldina hard fescue and Penncross creeping bentgrass, while the lowest included Merion Kentucky bluegrass and Kentucky 31 tall fescue. Turfgrasses highest for abaxial surface stomatal density included Penncross creeping bentgrass and annual bluegrass, while the lowest included Sabre rough bluegrass, chewings fescue, sheep fescue, and Waldina hard fescue. Adaxial and abaxial stomatal densities of the cool-season turfgrasses are considerably lower than those found in a study of 10 warm-season perennial turfgrasses (Casnoff et al., 1985). The stomatal densities of the cool-season turfgrasses ranged from 17 to 51 per mm^2 on the adaxial surface and from 0 to 25 per mm^2 on the abaxial surface, while warm-season turfgrasses had much higher stomatal densities ranging from 108 to 468 per mm^2 on the adaxial surface and from 84 to 348 per mm^2 on the abaxial surface.

No relationship was found between an increase in the potential evapotranspiration rate and a higher stomatal density. Potential evapotranspiration rate was found to be negatively correlated with the stomatal densities found on the abaxial side of the leaf in a collection of 10 warm-season perennial turfgrasses (Casnoff et al., 1985). Further, it was found that stomatal size (length and width) was positively correlated with stomatal density. Conversely, Johns et al. (1983), investigating the resistances to evapotranspiration from a St. Augustinegrass turf canopy, concluded that manipulation of stomatal size or frequency would not be a major factor in a breeding program designed to develop water conserving turfgrasses to be grown under irrigated conditions. Data from this research similarly suggest that manipulation of stomatal characteristics would not significantly reduce water use rates in cool-season turfgrasses. Manipulation of turf canopy characteristics, such as density, leaf size and orientation, and growth rate may provide a more beneficial approach to water conservation.

Acknowledgment

A major portion of this investigation has been made possible by a grant from the United States Golf Association Green Section.

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PR-4513

Root Characteristics of 'Seaside' Bentgrass Compared with Seaside Plants which Survived High soil Temperatures

V.G. Lehman and M.C. Engelke

Introduction

Cool-season turfgrasses such as creeping bentgrass (*Aqrostis palustris* Huds.) require intensive cultural inputs to provide a high quality turf in the southern United States. Temperature and moisture extremes are among the important environmental factors which affect turf quality during stress.

A fundamental objective of the Texas Agricultural Experiment Station/United States Golf Association bentgrass breeding project is the development of cultivars which possess heat tolerance. Such cultivars would significantly reduce the amount of maintenance required to maintain high quality turf. A greenhouse study was conducted to select individual plants with heat tolerance and incorporate them into the breeding programs at Dallas.

Materials and Methods

'Seaside' creeping bentgrass (*Agrostis palustris* Huds.) was planted in a heated greenhouse bench (Engelke et al. 1985) on 11 Feb. 1985 at a seeding rate of 0.25 kg/are (0.5 lb/1,000 ft^2). The seedlings were maintained at a cutting height of 1.3 cm and fertilized with Peters® 20-20-20. The plants were sub-irrigated when the moisture level dropped beneath the 20 cm depth, as sensed by mercury tensiometers. The heat bench was subdivided into 98, 15 x 15 cm grids, to aid in selecting the best plants. A single plant was selected from each grid prior to raising the soil temperature of the bench. These plants formed the base population used as a standard for Seaside. From 12 to 23 June 1985, the soil temperature was gradually raised to 40°C and maintained. By 10 July 1985, an excess of 95 percent of plants in the bench had entered dormancy or died from the heat treatment. A single superior plant was selected from each grid based on its relative growth response. These plants were designated as 'Seaside-RHT' (Root Heat Tolerance).

Following selection, each plant was transplanted to an individual container, fertilized, and maintained in the greenhouse to promote maximal growth. On 15 Aug. 1985, single tillers of 23 randomly selected clones each of Seaside and Seaside-RHT with three leaves trimmed to 2.5 cm, with 1 root (maximum 1.3 cm length) were transplanted to minirhizotrons for a comparison of root characteristics. The minirhizotrons consisted of a clear polyethylene sleeve, 60 cm in length, filled with coarse graded sand (97% of which passed U.S. sieve size no. 30, vibrated to a uniform density, and maintained at a 30 degree angle inside a PVC tube. Heavy weight (17.3 kg) germination-blotter paper was placed around each plantlet on the sand surface to aid in maintaining moisture during establishment. Three g of Osmocote® (14-14-14) fertilizer were mixed in with the sand for each tube to provide nutrients during the study. Bimonthly applications at label rate of metalaxyl were made for *Pythium* sp. control. The minirhizotrons, maintained in the greenhouses, were misted three times daily until plants were established, then watered daily thereafter.

Root lengths were measured weekly by marking the depth of the longest root on the polyethylene sleeve. At the termination of the study, numbers of tillers and major root adventitious intersections per 10 cm depth of soil were counted. The roots were washed, cut into 10 cm segments, and placed in an approximate 0.025 percent sodium hypochlorite solution. Root area was measured using the model AM2 Delta T Leaf Area Meter® (Delta-T Devices LTD, 128 Low Road, Burwell, Cambridge, England). Data were analyzed as plants nested within populations, arranged in a randomized block design with four replications, using SAS GLM with least-square means procedures (SAS Institute, Inc., Box 8000, Cary, N.C. 27511). Frequency distribution analysis for differences between populations was conducted using chi-square tests (Steel and Torrie, 1980.)

Results

The RHT population consistently averaged deeper roots throughout the study. However, no significant differences were detected in mean root lengths between the two populations (Table 1). Significant differences existed in depth of rooting among plants within and between each population at study termination (Figure 1). Sixty-five percent of the plants from RHT population exceeded the average depth of the Seaside population. In addition, the maximum depth achieved by any plant in the RHT group exceeded the depth of Seaside by 26% (592 mm vs. 508 mm) (Figure 1). This shift in rooting depth would suggest the character may be related to heat tolerance in roots. Broadsense heritability, calculated with the sums of squares from plants within populations as genetic variance, was 0.17. Frequency distribution analysis indicated more Seaside-RHT plants with root systems in the 50-60 cm depth (Figure 2). Using the mean (439 mm) of Seaside-RHT as a selection cutoff, 11 plants of Seaside-RHT had a mean greater than the population mean (47% of the population). Only 7 plants (30%) of the Seaside had a mean greater than that of the mean of RHT. The data presented suggest that selection of plants for heat tolerance will result in populations with deeper roots.

When data for root areas were analyzed, the means were not significantly different at any depth. However, a distinct shift occurred in root distribution as the total mass of roots was shifted deeper in the profile. As an example, 41 percent of the root area of RHT was below 20 cm, whereas 31 percent of Seaside was below this depth (Table 2). Significant differences did occur among plants within each population at the 50-60 cm soil depth. One particular clone from RHT had a significantly larger root area (Figure 3). Frequency distribution analysis indicated the populations did not differ in root area until the depth reached 30 cm. Below the 30 cm depth, there were significantly more Seaside-RHT plants with a greater area than Seaside plants (Figure 4). The differences in frequency distributions in root area suggests, as did the root length data, that selection for heat tolerance indirectly selected a population with increased root area.

Table 1. Mean root length of Seaside bentgrass and of Seaside-RHT selected for heat toleance.

	Week									
Population	1	2	3	4	5	6	7	8	9	10
	Length (mm)									
Seaside	73*	124	160	189	219	257	279	301	325	402
Seaside-RHT	83	135	176	202	231	276	304	328	356	439
CV	42	31	29	26	26	23	22	23	23	21
SE	2.4	3.0	3.6	3.7	4.3	4.4	4.8	5.3	5.8	6.7

* A least squares means analysis was used to test for significant differences between populations. Means for each week between populations were not significantly different at the 0.05 probability level.

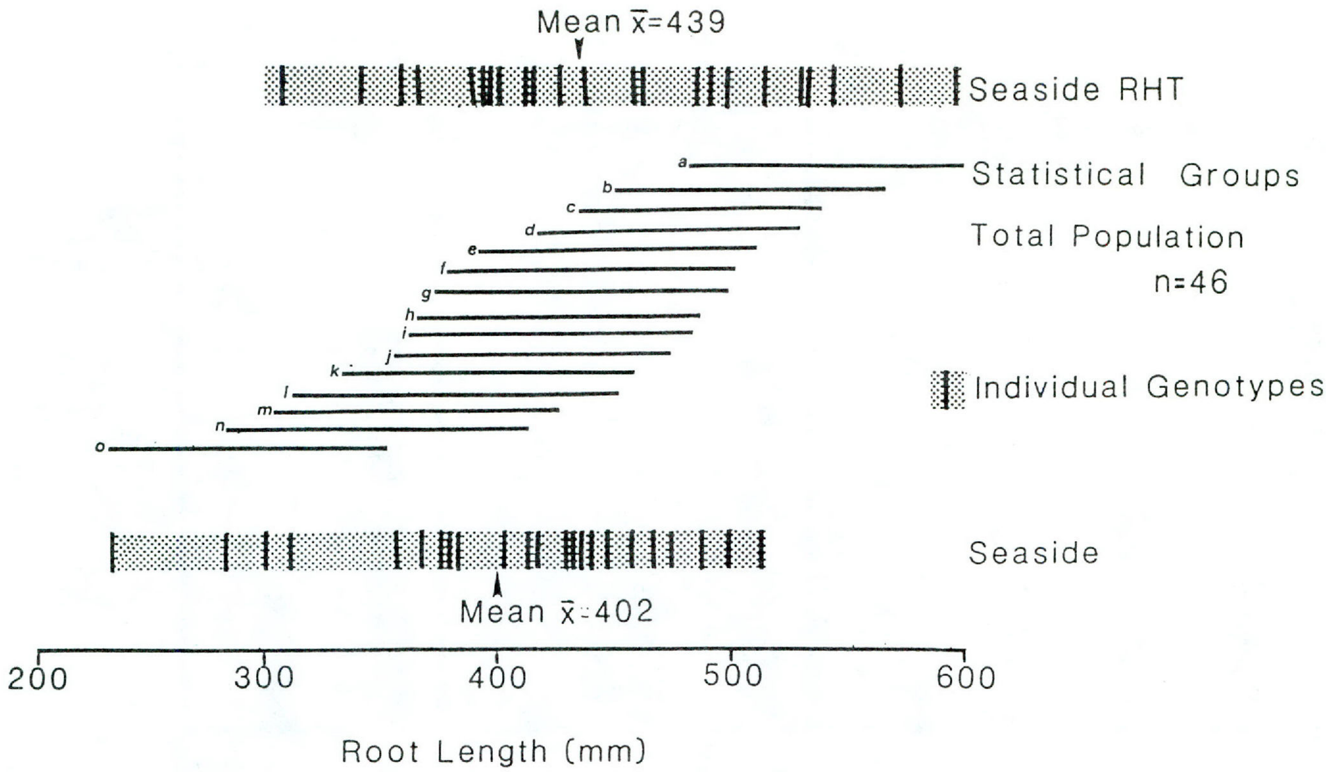

Figure 1. Mean root length of individual plants from Seaside bentgrass and from a population selected for heat tolerance (Seaside RHT).

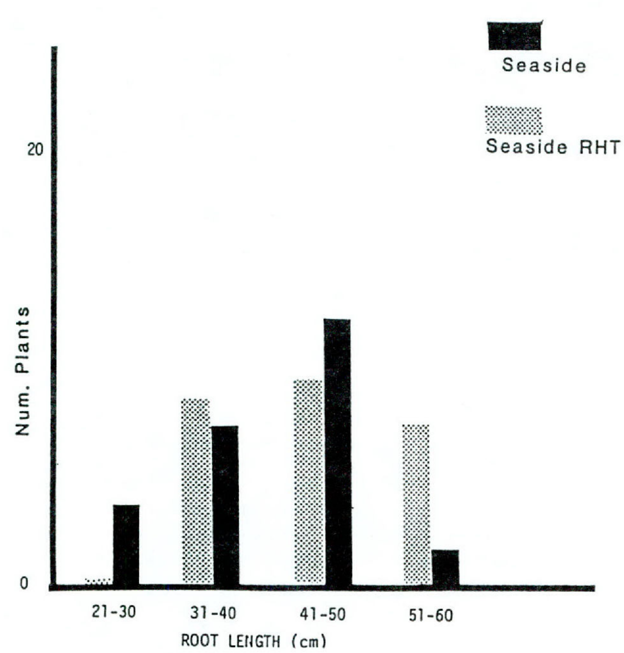

Figure 2. Frequency distribution of maximum root length from an unselected base population of Seaside bentgrass and a population selected for heat tolerance (Seaside RHT). The distributions of maximum root lengths in Seaside RHT were significantly different from those of Seaside (chi-square, P = 0.05).

Table 2. Distribution of roots throughout the soil profile for Seaside and Seaside-RHT.

Population	Depth (cm) from surface 0-10	0-20	0-30	0-40	0-50	0-60
	% of total root area					
Seaside	41.3	68.4	84.7	93.4	97.7	99.9
Seaside-RHT	36.6	58.9	79.6	90.3	97.4	100.0

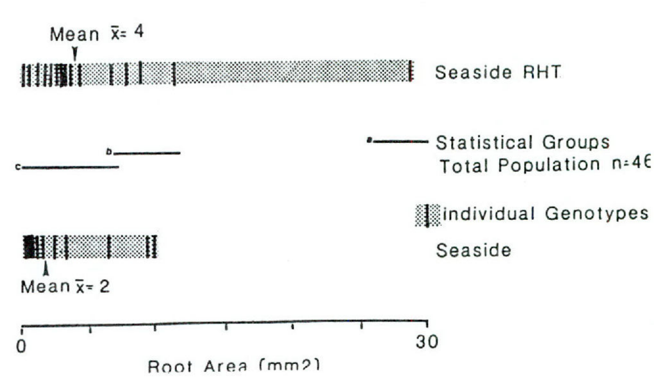

Figure 3. Mean root area of individual plants from Seaside and Seaside RHT bentgrass at the 50-60 cm soil depth.

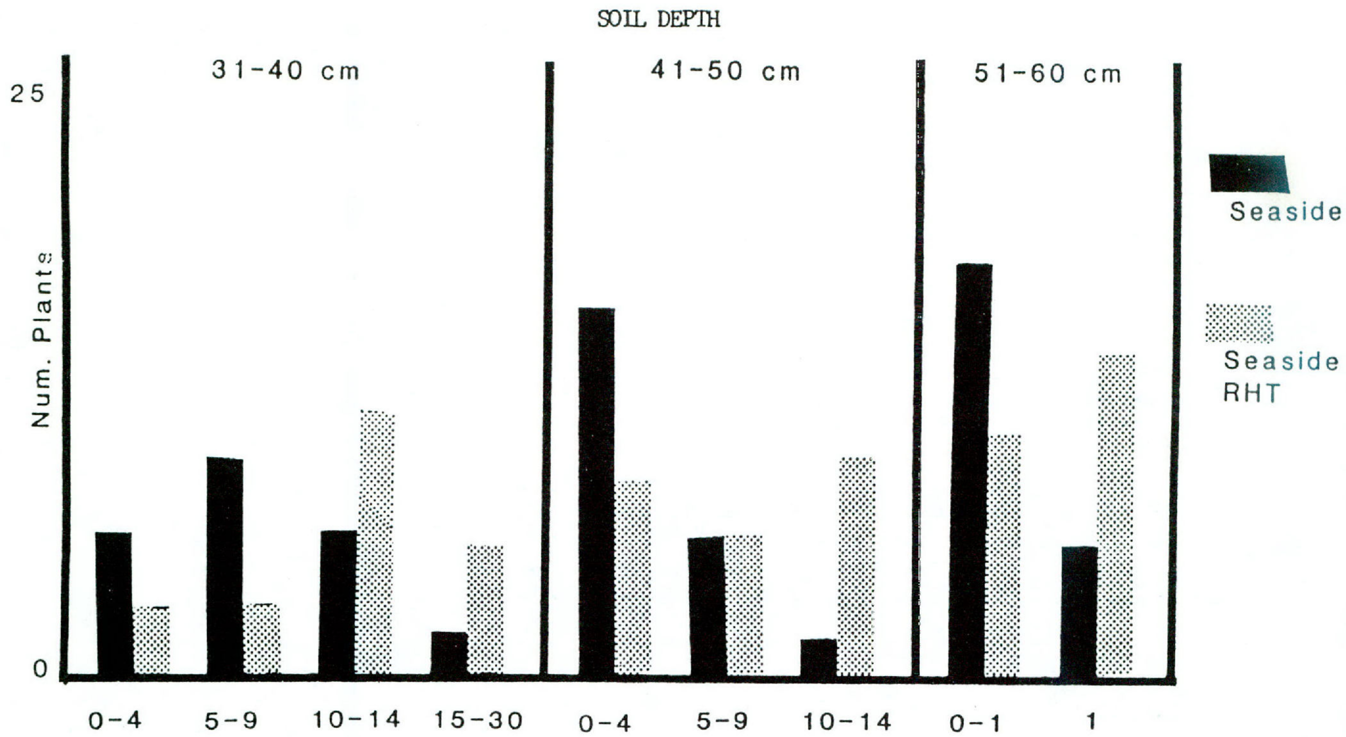

Figure 4. Frequency distribution of mean root area from 31-60 cm in depth from Seaside bentgrass and population selected for heat tolerance (Seaside RHT). The distributions differed significantly (chi-square, P = 0,05).

Table 3. Mean root number of Seaside bentgrass and of Seaside-RHT selected for heat tolerance.

Population	Depth (cm) 10	20	30	40	50	60
	Number					
Seaside	19*	11	6	3	1	0
Seaside-RHT	19	12	8	5	3	1.
CV	40	46	63	73	120	260
SE	0.8	0.6	0.5	0.3	0.3	0.1

* A least squares means analysis was used to test for significant differences between populations. Means for each number between populations were not significantly different at the 0.05 probability level.

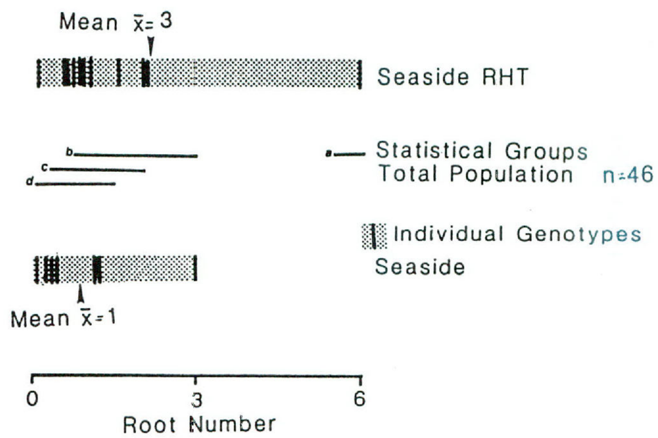

Figure 5. Mean root number of individual plants from Seaside and Seaside RHT at the 50-60 cm soil depth.

No significant differences existed between populations for root area at any depth (Table 3). Significant differences existed in root number between plants within and between populations at the 50-60 cm depth (Figure 5) and frequency distribution analysis indicated that more plants in Seaside-RHT had more roots at the lower soil profile (Figure 6).

Shoot-root growth relationships are frequently viewed as source-sink relationships. Examination of total tiller number (as source) revealed that mean tiller number of Seaside-RHT ($\overline{X} = 43$) and Seaside ($\overline{X} = 38$) were not significantly different, although significant differences existed among plants both within and between populations (Figure 7).

This preliminary research indicates that selection for heat tolerance has shifted root characters. Testing of additional plants from the same two populations is currently in progress.

Acknowledgment

This investigation was partially supported by a grant from the United States Golf Association (Golf House, Far Hills, N.J. 07931) and Bentgrass Research, Inc. (Colonial

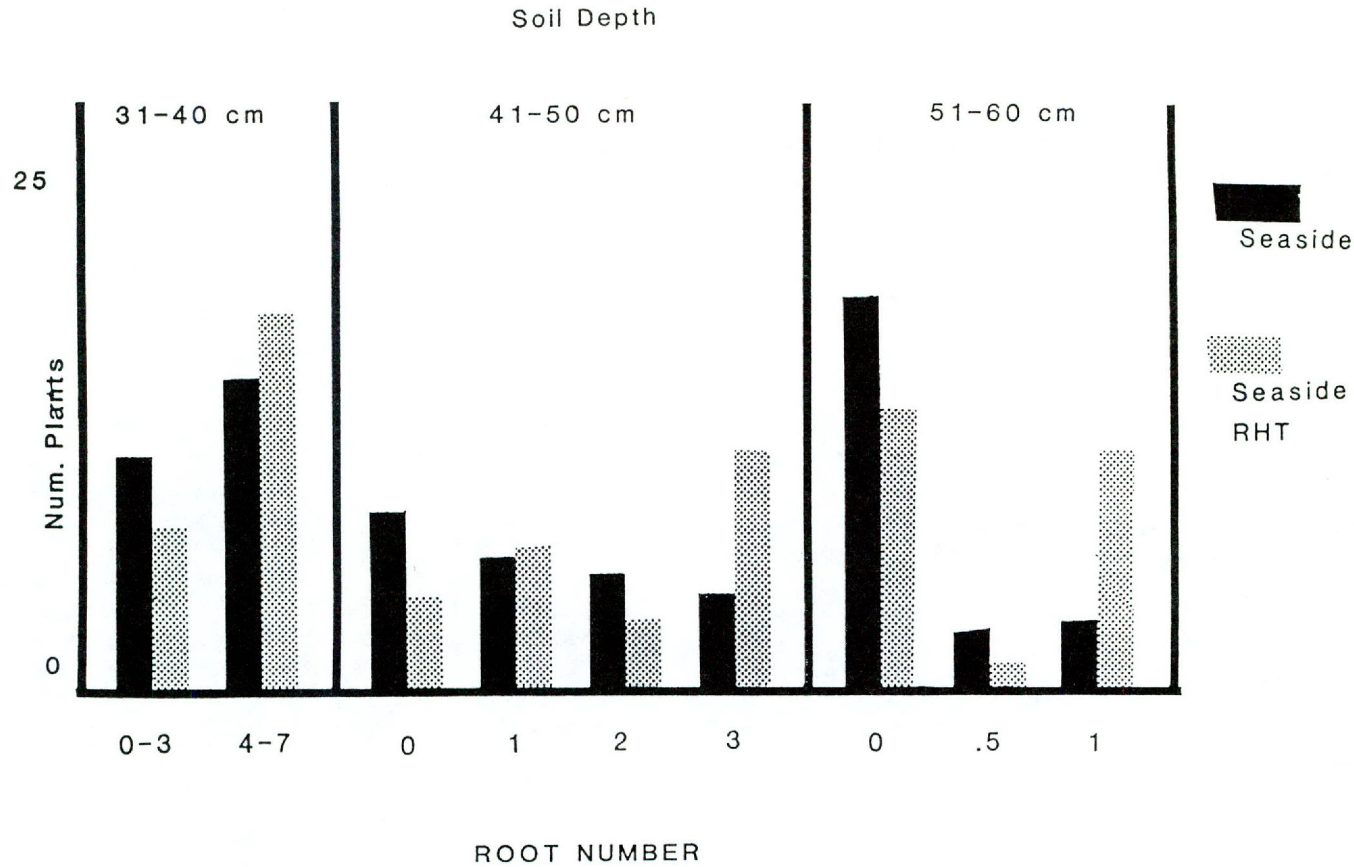

Figure 6. Frequency distribution of mean root number from 30-60 cm in depth from Seaside bentgrass and population selected for heat tolerance (RHT). The Seaside RHT distribution of mean root number was significantly different from those of Seaside (chi-square, P = 0.05).

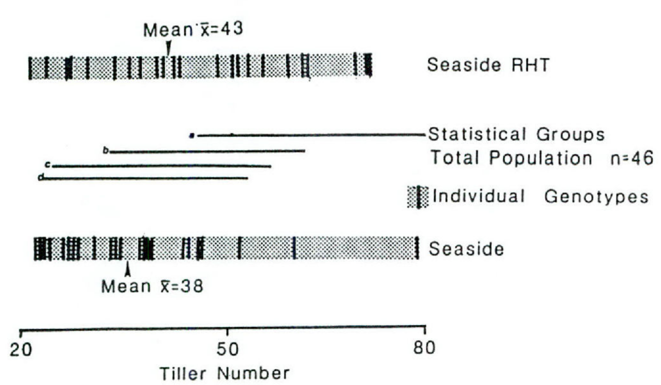

Figure 7. Mean tiller number of individual plants from Seaside bentgrass and of Seaside RHT, a population selected for heat tolerance.

Country Club, 3735 Country Club Circle, Fort Worth, Texas 76109).

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1985 Centipedegrass Cultivar Characterizations: College Station, Texas

R.L. Green, J.B. Beard, and J.R. Walker

Introduction

Centipedegrass (*Eremochloa ophuiroides* Munro. Hack.) was introduced into the United States in 1916 from China. It is a medium-textured, stoloniferous, warm-season, perennial grass with a prostrate growth habit and slow vertical shoot growth rate. Centipedegrass has high drought resistance (current research indicates that it ranks only behind zoysiagrass and bermudagrass among the major warm-season turfgrasses for drought resistance), and excellent heat hardiness, but poor cold hardiness. It is a low cultural intensity turfgrass, but has poor recuperative potential. Centipedegrass is best adapted to full sun but will tolerate low amounts of shade. Centipedegrass is typically found in moist, acid, sandy soils, with low fertility. Studies at Texas A&M University have shown satisfactory turfs of centipedegrass can be produced on soil with a pH up to 8.4.

Interest in minimal maintenance turfgrasses, including centipedegrass, has been increasing over the past few years. Georgia Common, Oklawn, and Tennessee Hardy have been evaluated at the Texas A&M Turfgrass Research Field Laboratory for 6 consecutive years as of 1985. Three experimental cultivars from Auburn University were added to the study in 1983 and were fully established in 1984. One of these experimental cultivars, AC-17, was officially released by the Alabama Experiment Station of Auburn University in 1983 as AU Centennial. Typically, a minimum of 6 years of assessment is required to obtain a more complete, reliable field evaluation of turfgrass cultivars. Final conclusions concerning the overall adaptation and performance of these centipedegrass cultivars cannot be made until this period of observation is completed.

Materials and Methods

Three commercially available centipedegrass cultivars were planted in September, 1979. Tennessee Hardy and Oklawn were sprigged, while Georgia Common was seeded. Subsequently, three vegetatively propagated selections from Auburn University were added to this study in 1983: AC-26, AC-44, and AC-17. The cultivars were planted in a modified loamy sand at the Texas A&M University Turfgrass Field Research Laboratory in College Station, Texas. Three replications of each grass were planted in a randomized complete block design. Plot size was 5 x 8 ft (1.5 x 2.4 m) with 18-inch (0.45 m) alleyways. The turfs were mowed twice weekly with a rotary mower at a 1.5 in. (3.8 cm) cutting height with the clippings removed. During 1985, the pH was maintained in a range of 7.9 to 8.2 with timely applications of sulfur throughout the growing season. Nitrogen was applied at a rate of 0.5 lb/1000 sq. ft. (0.25 kg are^{-1}) per growing month. Phosphorus and potassium were applied as needed based on soil tests, and irrigation was applied as needed to prevent visual wilt. No pesticides were applied in 1985 and no disease or insect damage symptoms were observed.

Results

A summary of 1985 centipedegrass cultivar seasonal turf quality ratings and spring greenup is shown in Table 1. Seasonal averages for turf quality show that all six cultivars produced an acceptable turf (5.0 being the minimum value for an acceptable turf) and that there were no differences in quality among the cultivars under College Station, Texas conditions. These findings are

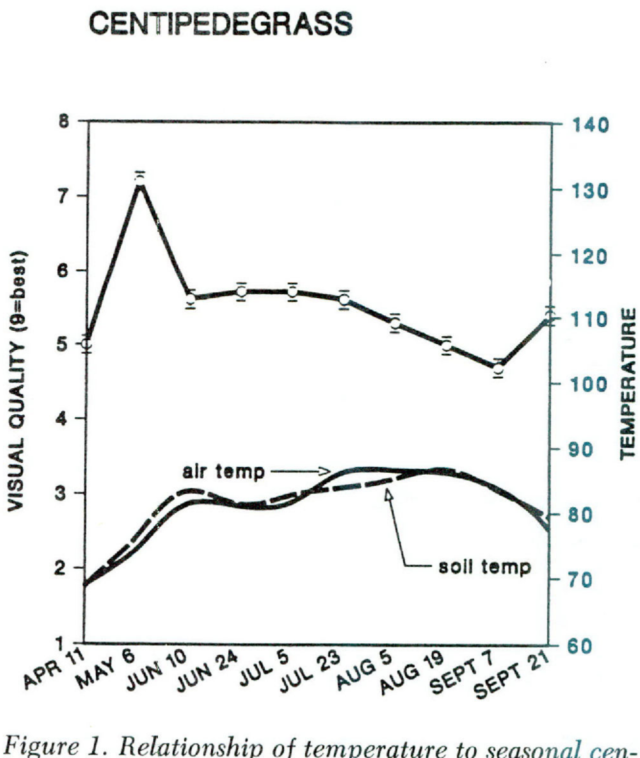

Figure 1. Relationship of temperature to seasonal centipedegrass turfgrass quality.

Table 1. Summary of 1985 seasonal turfgrass quality ratings and spring greenup rates for six centipedegrass cultivars. College Station, Texas.

Cultivar	Visual Estimates of Turfgrass Quality†												Percent Spring Greenup
	3/28	4/11	5/6	6/10	6/24	7/5	7/23	8/5	8/19	9/7	9/21	Seasonal Average	
AU Centennial (AC-17)	5.7ab*	5.3a	7.0a	5.3a	5.7a	5.6a	6.0a	6.0a	5.0a	5.3a	5.7a	5.7a	93a¶
Georgia Common	4.7ab	5.3a	7.3a	5.3a	5.7a	5.7a	5.7a	5.7a	5.7a	4.7a	5.7a	5.6a	73ab
Oklawn	6.0a	5.7a	8.0a	6.0a	6.0a	5.7a	5.3a	5.0a	4.3a	4.7a	5.0a	5.6a	97a
Tennesee Hardy	4.0b	4.3a	6.7a	5.7a	6.0a	5.7a	5.3a	5.3a	5.7a	4.7a	5.7a	5.4a	50b
AC-26	6.0a	5.0a	7.7a	5.7a	5.3a	6.0a	5.7a	5.0a	4.7a	4.3a	5.7a	5.5a	93a
AC-44	4.7ab	4.3a	6.7a	5.3a	5.7a	5.7a	5.7a	5.0a	4.7a	4.3a	5.0a	5.2a	92a
Average§	5.2bcd	5.0cd	7.2a	5.6bc	5.7b	5.7b	5.6b	5.3bc	5.0cd	4.7d	5.4bc		

* Means followed by the same letter within the same column are not significantly different, Duncan's Multiple Range Test, alpha = 0.05.

† Visual quality means are avweraged over three replications. Visual quality ratings are based on a 1 to 9 scale: 1 = poor, 9 = best, 5 = accetable.

¶ Spring greenup means are averaged over three replications. Spring greenup ratings are based on a 1 to 100 percent scale.

§ Average of all cultivars for each rating date. Averages followed by the same letter are not significantly different, Duncan's Multiple Range Test, alpha = 0.05.

similar to those reported in 1984 (1). Dates of rating the visual overall turfgrass quality of the cultivars varied significantly over the growing season (Figure 1). Cultivars rated highest in turf quality between May 6 and July 23 of 1985, with rating dates before and after this period equally lower.

The centipedegrass cultivar spring greenup rate varied significantly. Oklawn, AC-26, AU Centennial, and AC-44 had a significantly earlier spring greenup rate than Tennessee Hardy, with Georgia Common ranking intermediate. It is interesting to note that in 1984 (1), Oklawn had a longer fall color retention than Georgia Common, which in turn had a longer fall color retention than Tennessee Hardy. It appears that spring greenup and fall color retention are related among these six centipedegrass cultivars; that is those cultivars with longer fall color retention are also those cultivars that greenup sooner in the spring.

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PR-4515

1985 Zoysiagrass Cultivar Characterizations: College Station, Texas

R.L. Green, J.B. Beard, and J.R. Walker

Introduction

Zoysiagrasses (*Zoysia* Willd.) are warm-season C-4 perennial turfgrasses that produce a dense, wear resistant sod. They are the most drought resistant warm-season turfgrass, mainly due to a high level of physiological drought tolerance. Among the commonly used warm-season turfgrasses, *Zoysia japonica* tolerates the widest range of high and low temperatures. Zoysiagrasses are best adapted to full sun but will tolerate low to moderate shade. Their greatest cultural limitation is a slow rate of establishment. Generally, two growing seasons are required to establish a full cover when planted from sprigs. Much current research on zoysiagrass is directed toward the development of cultural practices and/or cultivars that establish full coverage more rapidly.

Two cultivars included in this study are relatively recent developments. El Toro is a *Zoysia japonica*, developed at the University of California at Riverside. Belair, a *Z. japonica*, was developed by the USDA-ARS in Beltsville, Maryland. This data represents the sixth consecutive year of evaluation for three cultivars but only 1 to 2 years for the newly released cultivars. In addition, the extensive *Rhizoctonia* brown patch problem has only recently developed. Typically, a minimum of 6 years of assessments is required to obtain a more complete, reliable field evaluation of turfgrass cultivars. Final conclusions concerning the overall adaptation and performance of these zoysiagrass cultivars cannot be made until additional observations are completed.

Materials and Methods

Three commercially available cultivars were included in this study: Emerald, Meyer, and FC 13521. They were planted by sprigging in August of 1979. El Toro was planted by sprigging in June of 1983 with Korean Common and Belair being planted by seed and sprigging, respectively, in July of 1984. The soil was a well-drained, modified loamy sand with a pH of 8.0 located at the Texas A&M Turfgrass Field Research Laboratory in College Station, Texas. The plot size was 5 x 15 feet (1.5 x 4.5 m) in a randomized complete block design with three replications.

The turfs were mowed twice-weekly with a triplex reel mower at a 1-inch (2.5 cm) cutting height with the clippings removed. A subplot fertility system was stripped across the cultivars at rates of 0.25, 0.50, and 0.75 lb of nitrogen per 1000 sq ft (0.12, 0.25, and 0.37 kg N/are^{-1}) per growing month. Phosphorus and potassium were applied as needed based on an annual soil test. Sulfur was applied at a rate of 10 lb. S/1000 sq ft (5 kg S/are^{-1}) per growing month to maintain the soil pH below 8.0. Irrigation was applied as needed to prevent visual wilt. No pesticides were needed or applied during 1985.

The cultivars were evaluated at approximately 15-day intervals, June 10 through September 21 and were evaluated for percent spring greenup on March 28. In the fall of 1985, a mild outbreak of brown Patch (*Rhizoctonia solani* Kuhn) occurred on the zoysiagrass cultivars. The plots were rated for disease severity and resultant turf quality, but no significant differences were found, although Meyer tended to be less effected.

Results

Visual estimates of turfgrass quality for the six zoysiagrass cultivars during the 1985 growing season are shown in Table 1. Concerning the seasonal averages for turf quality: most cultivars produced a reasonably acceptable turf. Emerald (F_1 hybrid of *Z. japonica x Z. tenuifolia*) and FC 13521 (*Z. matrella*), ranked better than the *Z. japonica* cultivars, Belair, El Toro, Korean Common, and Meyer. In 1984, Meyer and Emerald had the highest seasonal average for quality (1), while in 1983, Emerald and FC 13521 had the highest seasonal average for quality (2). The important point to remember is that all zoysiagrass cultivars produced an acceptable turf and differences in quality between them were small and frequently not significant.

The turf quality of the zoysiagrasses changed significantly during the season (Figure 1). The June 10 through July 23 ratings were significantly greater than the August 5 through September 21 ratings. Warmer air temperatures during mid to late summer caused the reduction in turfgrass quality. Individual cultivars did not rank the same within each rating date. Thus, for comparisons it is more representative to assess a cultivar's performance for the entire season.

There was a significant increase of turfgrass quality due to the increased amounts of nitrogen applied, during

Table 1. Summary of 1985 zoysiagrass cultivar characterizations for seasonal visual turfgrass quality and spring greenup rate. College Station, Texas.

Zoysiagrass Cultivar	Visual Estimates of Turfgrass Quality†								Seasonal Average	Percent Spring Greenup¶
	6/10	6/24	7/5	7/23	8/5	8/19	9/7	9/21		
Emerald	7.0 a*	7.0 a	7.3 a	7.2 a	6.1 a	4.7 a	3.3 a	4.3 a	5.9 a	75 b
FC 13521	6.0 a	6.8 ab	6.8 ab	7.0 a	5.6 a	4.4 a	4.2 a	5.9 a	5.8 ab	57 b
Meyer	5.6 a	5.2 ab	5.1 b	5.3 a	5.0 a	4.7 a	4.9 a	5.9 a	5.2 abc	73 b
Belair	5.7 a	6.0 ab	6.0 ab	5.4 a	4.0 a	4.3 a	3.8 a	5.2 a	5.1 bc	100 a
Korean Common	5.0 a	5.4 ab	6.2 ab	5.2 a	5.1 a	4.6 a	4.0 a	4.7 a	5.0 c	100 a
El Toro	4.9 a	4.8 b	4.8 b	5.8 a	5.2 a	4.3 a	4.1 a	5.7 a	4.9 c	70 b
Average§	5.7 b	5.9 ab	6.09 a	6.0 a	5.2 c	4.5 d	4.1 e	5.3 c		

* Means followed by the same letter within the same column are not significantly different, Duncan's Multiple Range Test, alpha = 0.05.

† Visual quality means are the average of all three replications and three N fertility rates. Visual quality ratings are based on a 1 to 9 scale: 1 = poor, 9 = best, with 5 = minimum acceptable turf quality for lawns.

¶ Spring greenup means are the average of all three replications and three N fertility rates. Spring greenup ratings are based on a 1 to 100 scale: 100 = 100 percent green cover.

§ Average of all cultivars for each rating date. Averages followed by the same letter are not significantly different, Duncan's Multiple Range Test, alpha = 0.05.

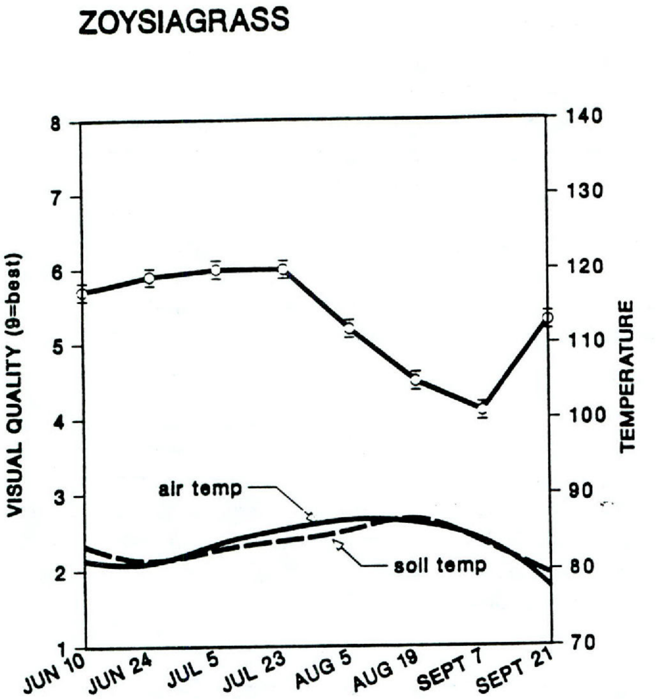

Figure 1. Relationship of temperature to seasonal zoysiagrass turfgrass quality.

the 1985 growing season. However, the differences in magnitude for turfgrass quality between the three nitrogen levels was less than 1 rating unit. Thus, the practice of using a higher level of nitrogen fertilization, such as 0.75 lb N/1000 sq ft per growing month, is questionable.

These data indicated that Belair and Korean Common greened up significantly sooner in the spring than the remaining four cultivars (Table 1). These two cultivars also were the most recently established (1984). Since newly planted turfs tend to greenup earlier than mature turfs, several additional year's observations are needed before drawing final conclusions regarding comparative spring greenup rates.

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PR-4516

1985 St. Augustinegrass Cultivar and Selection Characterizations Including Shade Adaptation: College Station, Texas

W.G. Menn, J.B. Beard, K.S. Kim, and P.H. Vermeulen

Introduction

St. Augustinegrass (*Stenotaphrum secundatum* Walt. Kuntze) continues to be a popular lawn grass, especially in the southern two-thirds of Texas. This popularity is probably due to its availability, reasonable cost, rapid establishment, and good shade adaptation. However, St. Augustinegrass is not free of potential problems. St. Augustinegrass decline (SAD) virus, Rhizoctonia brown patch, gray leaf spot, downy mildew, chinch bugs, and lack of cold hardiness are all reasons for developing improved cultivars of this species. During the past 10 years, a large number of selections have been screened by Drs. Toler, Beard, Crocker, and Grisham for possible release as improved cultivars of St. Augustinegrass. The best six selections have been placed in a state-wide evaluation program for the past 3 years.

This report presents preliminary comparisons of (1) turf qualities and percent greenup among the six near-release selections and four commercially available cultivars of St. Augustinegrass; (2) turf quality among commercially available cultivars and three selections of St. Augustinegrass under the natural shade condition; and (3) turf establishment rates of two selections and seven cultivars of St. Augustinegrass under the environmental conditions in College Station, Texas. Typically, a minimum of 6 years of assessments is required to obtain reliable field evaluations of turfgrass cultivars. No final conclusions concerning the overall performance can be made until this period of observation is completed.

Materials and Methods

The three St. Augustinegrass characterization studies included in this progress report are located at the Texas A&M Turfgrass Field Research Laboratory in College Station, Texas. The experimental area (except for the

Shade Study) consisted of a 10-inch (25 cm) deep modified sand root zone overlaying a 4-inch (10 cm) diameter ADS flexible plastic drainage system. The entire area received a preplant application of 13-13-13 fertilizer at a rate of 1.5 lbs each of N, P_2O_5 and K_2O per 1000 sq ft (0.73 kg are^{-1}). This fertilizer was also applied at the same rate for the spring and fall applications. This was followed with monthly applications of ammonium sulfate (21-0-0) at a rate of 1.0 lb of N per 1000 sq ft (0.49 kg are^{-1}) The initial soil pH was found to be 8.4. Due to the sodium content of the irrigation water, several applications of sulfur were necessary to maintain the soil pH below 8.0. Irrigation was applied as needed to prevent visual wilt. The turfs were maintained at a 2-inch (5.0 cm) clipping height by weekly mowing with a self-propelled, walk-behind rotary mower. Clippings were removed.

Visual estimates of turf quality were made on a biweekly basis. A scale of 1 to 9 was used to depict the degree of quality. Any rating value below 5.0 would indicate an unacceptable turf for lawn use. No significant differentials in disease or insect injury were noted during the 1985 growing season. Percent greenup ratings were made visually on a biweekly basis from March through May.

Experimental Selection Study

Ten St. Augustinegrasses (Tables 1 and 2) were sprigged into 6 x 10 ft (1.8 x 3.0 m) plots on October 19, 1982, with full turf establishment achieved in May of 1983. The experimental design involved four replications arranged in a randomized block. Four of these are commercially available cultivars, while the remaining six are experimental selections. Each was propagated in the greenhouse from a single node in February of 1982.

Shade Study

Shade plots were established by sprigging in September of 1984 on a 4-inch (10 cm) sand modified root zone. Shade was provided by mature post oak trees that surround the site. The 5 x 5 ft (1.5 x 1.5 m) plots were arranged in a randomized complete block design with three replications. Four cultivars and three selections (Table 3) were evaluated for turf quality five times during the growing season from July through September. The plot maintenance and the turf quality rating methods were the same as those previously described.

Cultivar Study

A new St. Augustinegrass cultivar characterization study area was established during the summer of 1985. Seven cultivars and two selections were sprigged on June 3, 1985, and their percent establishment coverage was rated visually on a biweekly basis from August through September. The maintenance program for this study was the same as described earlier.

Results

Turf quality is a composite assessment determined by a number of Turf plant characteristics. Color, shoot density, leaf texture, stem diameter, and growth habit are all considered when assigning values for the quality of a turf.

Experimental Selection Study

As shown in Table 1, SATX 8262, SATX 8308, and SATX 8231 showed significantly higher quality turfs than several of the commercially available cultivars. SATX 8203, which showed very high quality turf in 1984, produced very poor quality in 1985 mainly due to the cold damage during the winter of 1984 and subse-

Table 1. Seasonal comparisons of turf quality among six near-release St. Augustinegrass selections and four commercially available cultivars. College Station, Texas (1985).

St. Augustine-grass Selection or Cultivar	Visual Estimate of Turfgrass Quality† 4/11	5/6	7/6	7/17	8/5	9/19	Seasonal Mean (April to Sept.)
SATX 8262	6.3 a*	8.0 ab	5.0 a	6.0 a	5.8 a	6.0 ab	6.2 a
SATX 8208	6.8 a	9.0 a	5.2 a	5.5 a	4.6 a	5.3 ab	6.0 a
SATX 8231	4.8 ab	7.3 abc	4.5 a	4.8 a	4.5 a	5.8 ab	5.3 ab
Texas Common	5.3 ab	7.3 abc	4.4 a	4.6 a	4.6 a	4.8 b	5.1 ab
Floralawn	3.0 bc	4.3 d	5.2 a	5.3 a	5.0 a	4.8 b	4.6 b
SATX 8218	3.0 bc	5.3 cd	4.6 a	5.0 a	5.0 a	4.3 b	4.5 b
Floratam	3.5 bc	4.8 cd	4.6 a	4.8 a	4.8 a	4.5 b	4.5 b
Raleigh	4.8 ab	6.0 bcd	4.0 a	4.0 a	4.1 a	3.8 b	4.4 b
SATX 8203	1.0 c	4.3 d	3.8 a	4.1 a	4.5 a	7.8 a	4.2 b
SATX 8202	3.0 bc	4.0 d	4.8 a	4.6 a	4.5 a	4.3 b	4.2 b

† Rating scale based on 9 = best and 1 = poorest; a 5.0 represents the minimal acceptable turf quality for lawns.

* Means followed by the same letter in a column are not significantly different at the 5% level of Duncan's Multiple Range Test.

Table 2. Comparative percent greenup of six near-release St. Augustinegrass selections and four commercially available cultivars. College Station, Texas (1985).

St. Augustine-grass Selection or Cultivar	Percent Greenup 3/11	3/27	4/11	5/16	Spring Mean (March to May)
SATX 8208	32.5 a*	80.0 a	92.5 a	100.0 a	76.3 a
SATX 8262	26.3 ab	72.5 ab	85.0 ab	99.0 a	70.7 b
Texas Common	16.3 bcd	62.5 bc	78.8 b	99.5 a	64.3 c
Raleigh	17.5 bc	58.8 cd	66.3 c	92.5 a	58.8 d
SATX 8231	5.0 de	50.0 de	60.0 cd	96.3 a	52.8 e
Floratam	15.0 bcd	43.8 ef	51.3 de	98.8 a	52.2 ef
Floralawn	16.3 bcd	45.0 ef	48.8 e	98.8 a	52.2 ef
SATX 8202	12.5 cd	40.0 ef	45.0 e	97.5 a	48.8 ef
SATX 8218	11.3 cde	33.8 f	43.8 e	98.5 a	46.8 ef
SATX 8203	1.0 e	6.3 g	22.5 f	58.8 b	22.1 f
Mean	15.4	49.3	59.4	94.0	

* Means followed by the same letter in a column are not significantly different at the 5% level of Duncan's Multiple Range Test.

Table 3. Seasonal turf quality comparisons of three St. Augustinegrass selections and three commercially available cultivars under natural post oak shade conditions. College Station, Texas (1985).

St. Augustine-grass Selection of Cultivar	Visual Estimate of Turfgrass Quality† 7/5	8/5	8/19	9/2	9/19	Seasonal Mean (July to Sept.)
Texas Common	6.0 a*	6.7 a	7.0 a	5.0 a	7.0 a	6.3 a
SATX 8262	5.7 a	5.0 a	6.3 a	4.3 a	5.7 a	5.4 a
SATX 8208	4.7 a	5.3 a	5.3 a	4.3 a	5.3 a	5.0 a
Raleigh	3.7 a	3.3 a	4.0 a	2.7 a	4.0 a	3.5 a
Seville	3.7 a	3.3 a	3.7 a	2.3 a	3.7 a	3.3 a
SATX 8203	3.0 a	3.7 a	3.7 a	2.3 a	3.3 a	3.2 a
Floratam	1.0 b	1.0 b	1.0 b	1.0 b	1.0 b	1.0 b
Mean	4.0	4.0	4.4	3.1	4.3	4.0

† Rating scale based on 9 = best and 1 = poorest; a 5.0 represents the minimal acceptable turf quality for lawns.
* Means followed by the same letter in a column are not significantly different at the 5% level of Duncan's Multiple Range Test.

quent slow recovery. It should be noted, however, that SATX 8203 showed the highest quality rating at the end of the season (September rating). Among the commercially available cultivars, Texas Common also ranked the highest during the previous two consecutive years.

In terms of greenup, SATX 8208 and SATX 8262 showed the earliest recovery (Table 2). By the end of March, SATX 8208 and SATX 8262 Produced over 75% greenup, while SATX 8203 had less that 10% greenup. Floratam and Floralawn showed very poor greenup during March and April; however, they produced over 98% greenup in early May.

Shade Study

In the Shade Adaptation Study (Table 3), Floratam failed completely. No significant differences in turf quality were found among the other six entries due to variability in vegetative establishment among the

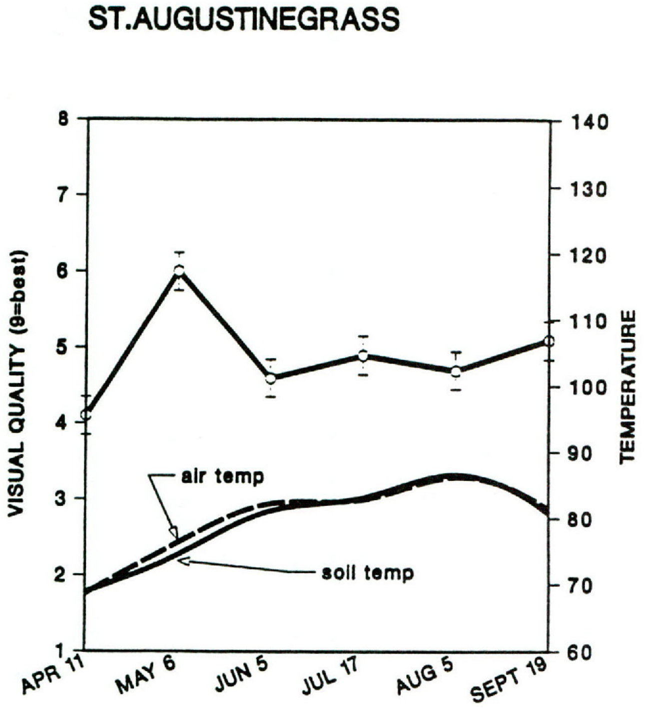

Figure 1. Relationship of temperature to seasonal St. Augustinegrass turfgrass quality.

replications. However, Texas Common, SATX 8262, and SATX 8208 ranked better than the remaining three. This assessment represents only the first year's data, with further investigations planned to obtain detailed results concerning shade adaptation.

Cultivar Study

Most of the cultivars showed over 90% establishment after 3.5 months of growth. Only SATX 8262 showed slow establishment. However, it had achieved about 90% coverage at the end of the growing season. Even though there were no significant differences among the entries, Floratam and Floralawn consistently ranked faster in establishment than the other entries.

Acknowledgement

This study was partially supported by a grant from the Texas Sod Producers Association.

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PR-4517

1985 Tall Fescue Cultivar Characterizations Under Post Oak Tree Shade: College Station, Texas

W.G. Menn, J.B. Beard, and J.R. Walker

Introduction

Tall fescue (*Festuca arundinacea* Schreb.) is well adapted to the transitional climatic regions of the United States. It is one of the most wear tolerant, heat hardy, and drought resistant of the cool season turfgrasses. With improvements in heat hardiness, tall fescue could become better adapted to the cooler portions of the warm-humid climatic regions of the South. The interest in tall fescue increased substantially in the Northern and Eastern portions of Texas at the same time that the turf-type tall fescue cultivars were being developed. Since tall fescue has good shade adaptation and is established by seeding, it it well suited to rapid turf renovation and repair under shade stress conditions.

The investigation of cultivars under post oak shade is 3 years old. Typically, a miminum of 6 years of assessments is required to obtain reliable field evaluations of turfgrass cultivars. Final conclusions concerning the overall adaptation and performance of these tall fescue cultivars cannot be made until this period of observation is completed.

Materials and Methods

All cultivars were planted in November, 1982, by seeding at a rate of 9 lbs/1,000 sq ft (4.4 kg are^{-1}) on a modified Lufkin fine sandy loam. A randomized complete block design of three replications was used with a plot size of 5 x 7 ft (1.5 x 2.1 m). The turfs were mowed weekly with a rotary mower at a 2-inch (5 cm) cutting height with the clippings removed. Nitrogen was applied at a rate of 1 lb N/1,000 sq ft (0.5 kg are^{-1}) per growing month from October through March. Potassium was applied once in early spring and again in early fall at a rate of 1 lb K/1,000 sq ft (0.5 kg are^{-1}), based on soil tests. Phosphorus was not needed based on soil tests. Irrigation was applied as needed to prevent visual wilt. Pesticides were not applied during the 1985 growing season nor were any disease or insect damage symptoms observed.

Results

Visual estimates of turf quality were based on two primary components: (a) uniformity of appearance and (b) shoot density. The rating scale was 9 = best and 1 = poorest with a rating of 5.0 or above representing acceptable performance for lawns.

After several years of growth in the warm, humid climate of College Station, differences among the tall fescue cultivars decreased considerably. There were no statistical differences among cultivars at any one rating date. When comparing seasonal averages (Table 1); however, slight differences were noticed. Rebel and Jaguar remained the top ranked tall fescue cultivars in terms of turf quality, followed closely by Falcon, Adventure, and Houndog. During the previous 3 years of evaluation, Rebel has consistently ranked at or near the top in turf quality and performance. Of the 14 cultivars evaluated, Brookston and Galway have been consistently ranked near the bottom in terms of turf quality ratings taken over the past 3 years. In summary, under post oak tree shade conditions with adequate moisture, including irrigation as needed, all 14 tall fescue cultivars included in this study produced an acceptable turf cover. A comparison of ratings taken throughout the year showed the best turf quality across the tall fescues was observed during May and June, which is consistent with data collected in previous years.

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Table 1. Summary of 1985 seasonal turfgrass quality ratings of 14 tall fescue cultivars grown under post oak shade. College Station, Texas.

Tall Fescue Cultivar or Selection	Visual Estimates of Turfgrass Quality†										
	Jan. 22	Feb. 25	Apr. 11	May 24	July 5	July 23	Aug. 8	Aug. 19	Sept. 7	Sept. 21	Seasonal Average
Rebel	5.7	6.0	6.0	7.7	7.3	6.7	6.3	6.3	6.7	7.0	6.6 a*
Jaguar	6.0	6.3	6.3	8.0	6.7	6.3	6.3	6.0	6.3	7.0	6.5 a
Falcon	5.5	5.8	6.7	7.7	7.0	6.3	6.3	5.7	6.3	7.0	6.4 ab
Adventure	5.2	5.8	6.7	7.7	7.3	6.3	5.7	6.0	6.0	6.3	6.3 ab
Houndog	5.3	5.5	6.0	7.7	6.7	7.0	6.3	6.0	6.0	6.0	6.3 ab
Marathon	5.2	5.7	6.3	7.7	6.3	6.0	5.3	5.7	5.7	6.3	6.0 abc
Olympic	5.3	5.7	5.7	7.7	5.7	5.7	5.3	5.0	6.3	6.7	5.9 abc
Clemfine	5.2	5.8	6.0	7.0	6.7	6.0	5.7	5.0	5.3	6.3	5.9 abc
Alta	5.0	5.3	6.0	7.0	6.3	6.0	5.7	5.0	5.7	6.0	5.8 abc
Kentucky 31	4.8	5.3	5.3	7.3	6.0	6.0	5.3	5.3	6.0	6.3	5.8 abc
Kenwell	4.8	5.0	6.0	7.7	5.7	6.0	6.0	4.7	5.7	6.0	5.8 abc
Mustang	5.0	5.5	5.0	7.3	6.3	5.7	5.3	5.0	5.7	6.3	5.7 abc
Brookston	4.5	4.8	5.3	7.7	5.7	5.3	6.0	5.3	6.0	5.7	5.6 bc
Galway	4.7	5.5	5.7	7.0	5.0	5.3	4.7	5.0	5.0	5.7	5.4 c
Averages											

† Turfgrass quality estimates were based on a scale of 9 = best and 1 = poorest; with 5.0 being the minimal acceptable quality.

* Values followed by the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

PR-4518

Morphological and Physiological Plant Parameters of Bermudagrass Cultivars with Low Nitrogen Requirements

S.I. Sifers and J.B. Beard

Introduction

There is a major need to develop minimal maintenance turfgrass cultivars that can sustain quality, functional turfs. No data are available to indicate which plant growth characteristics might be used to identify bermudagrass (*Cynodon* spp.) selections adaptable to low nitrogen stresses. The objectives of this investigation were (1) to develop baseline data concerning the minimum acceptable nitrogen nutritional levels and (2) to describe the anatomical and/or morphological characteristics associated with low nitrogen stress tolerant bermudagrass cultivars that might be utilized in a breeding program.

Materials and Methods

Four *Cynodon* cultivars—Midway, Tifgreen, Texturf 10, and FB-119—were maintained at three nitrogen fertility levels in the greenhouse. Ten bi-weekly observations of shoot height, internode length, number of stolons, shoot dry weight, turfgrass quality, and leaf tissue nitrogen content were made and then the nitrogen treatments were terminated, followed by five bi-weekly observations of the same plant parameters to develop baseline data concerning the minimum acceptable nitrogen nutritional level for these four bermudagrass cultivars. The morphological and physiological characteristics associated with low nitrogen stress tolerance were then assessed statistically.

Results

Significant differences in morphological characteristics occurred both when nitrogen was supplied and when nitrogen was withdrawn. *Cynodon dactylon* cultivars were more suitable for low or minimal nitrogen maintenance than were the *Cynodon* hybrids. Shoot height, root-rhizome mass to shoot mass ratio, and the length of the third youngest internode of lateral stems were characteristics useful in predicting bermudagrasses with a minimal nitrogen requirement. The minimum nitrogen level recommended for these cultivars to sustain viability is 0.25 lb/1,000 sq. ft. (0.125 kg N a^{-1}) per growing month. Of the cultivars assessed, Texturf 10 was the best turf for low nitrogen stressed environments followed by FB-119. These cultivars appear to have a mechanism which allows them to sustain growth with low levels of nitrogen and to partition the available nitrogen in a manner that sustains both root-rhizome and shoot growth.

Acknowledgment

A major portion of this investigation has been made possible by a grant from the United States Golf Association Green Section. Two additional studies are now underway that address more specific aspects of these two research objectives concerning the physiological basis of minimal maintenance turfgrasses.

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PR-4519

Criteria for Visual Prediction of Low Water Use Rates of Bermudagrass Cultivars

S.I. Sifers, J.B. Beard, and K.S. Kim

Introduction

One of the key components in a water conservation strategy is the selection of turfgrass species and cultivars possessing low water use rates. Investigations utilizing the water balance method with mini-lysimeters indicated significant differences in evapotranspiration rates occur at both the interspecies and intraspecies levels under both nonlimiting soil moisture and progressive water stress conditions (2). Evapotranspiration rates did not show large relative changes whether maintained under uniform or optimum cultural practices. However, all turfgrass species exhibited higher evapotranspiration rates when maintained at their optimum nitrogen fertility and cutting height (3). This was attributed to a more rapid vertical leaf extension rate. Those turfs with a low leaf extension rate, high shoot density, low leaf area, and prostrate growth habit tended to have low evapotranspiration rates (1, 2, 3, 4, 5). This investigation was undertaken to assess the validity and relative accuracy of a technique utilizing those plant parameters for visually estimating evapotranspiration rates of turfs; thus, providing a rapid method to screen thousands of clonal turfgrass plantings under field conditions.

Materials and Methods

This study was conducted on field plots, established in 1978 at the TAMU Turfgrass Field Research Laboratory in College Station, which contained 24 bermudagrass (*Cynodon* spp.) cultivars in three replications. They have been maintained at a cutting height of 1 inch (2.5 cm) and have received 1 lb N/1,000 sq. ft. (0.5 kg are^{-1}) per growing month, as well as irrigation as needed to prevent visual wilt. No visual disease or insect injury symptoms were evident at the time of the evapotranspiration evaluations.

The evapotranspiration measurements were accomplished using the water balance method with minilysimeters. At the same time these measurements were taken, visual ratings of predicted comparative evapotranspiration rates were made on both the turfs in the mini-lysimeters and the turfs in the field plots. Visual parameters used were canopy orientation, leaf extension, leaf width, and leaf/shoot density. These parameters were combined into a high canopy resistance—low leaf area concept, with the basic underlying premise that turfs with prostrate canopy orientation, low leaf extension rates, narrow leaf widths, and high shoot densities would have low evapotranspiration rates. The visual estimates made by four observers (J. B. Beard, M. C. Engelke, G. L. Horst, and S. I. Sifers) were averaged and statistically compared to the actual evapotranspiration rates measured by the previously mentioned water balance method utilizing mini-lysimeters.

Results

The visual estimates correlated at a 75% accuracy level with the actual evapotranspiration rates with a range among observers of 83% to 62%. The observers were 81% accurate in identifying the six bermudagrass cultivars with the highest actual evapotranspiration rate and 81% accurate in identifying the six cultivars with the lowest actual evapotranspiration rate.

In summary, visual assessment using the high canopy resistance—low leaf area concept offers a rapid, economical approach for screening large numbers of mowed bermudagrass clonal plantings under field conditions for low water use rates. Further testing should be conducted on unmowed bermudagrasses and other turfgrasses to determine if this technique has universal application.

Acknowledgment

A major portion of this investigation has been made possible by a grant from the United States Golf Association Green Section. Additional studies are now underway to evaluate the effectiveness of the prediction technique on other species.

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1985 Bermudagrass Cultivar Characterizations: College Station, Texas

S.I. Sifers, J.B. Beard, K.S. Kim, and J.R. Walker

Introduction

The need for minimal maintenance bermudagrass (*Cynodon* spp.) cultivars has dictated a reassessment of the commercially available bermudagrasses. Results generated from this assessment also will provide detailed background information concerning the available germplasm which may be of value in future breeding programs. Turfgrass characterizations under evaluation consist of the plant morphology, nitrogen fertility requirement, spring greenup rate, cold hardiness, fall low temperature color retention, water use rate, wear tolerance, drought resistance, seedhead production, and resistance to diseases and insects.

This is the seventh year of study for 18 of the 24 cultivars under evaluation. Thus, the data for these cultivars can now be considered reliable field performance evaluations for the conditions under which the study was conducted. Final conclusions concerning the adaptation and performance of the remaining six cultivars cannot be made at this time. This Progress Report discusses the seasonal evaluations of turfgrass quality, evapotranspiration rate, leaf width, shoot density, leaf extension rate, canopy orientation, spring greenup rate, fall low temperature color retention, and seedhead formation.

Materials and Methods

Eighteen of the cultivars were planted in 1978 on a modified loamy sand root zone at the Texas A&M Turfgrass Field Research Laboratory in College Station, Texas. The plots were 6 x 15 ft (1.8 x 4.6 m) arranged in a randomized complete block design of three replications. Tifdwarf was sodded, Arizona Common was seeded, and the remaining original cultivars were planted by sprigging. Additional entries which were sprigged in 1982, were Tifway II, which was released by the USDA from Tifton, Georgia, and Vamont, which was released from the AES of Virginia Polytechnic Institute and State University. Entries sprigged in 1983 were Tifgreen II, which was released by the USDA from Tifton, Georgia, and A-22 and A-29, which were released by the AES of Kansas State University. Tufcote was sprigged in 1984. Evaluations of these later acquisitions are included in this report, but caution should be used in interpretation since the minimum 6-year assessment period is not yet complete.

The turfs were mowed twice weekly with a triplex reel mower at 1 inch (2.5 cm) with clippings removed. Irrigation was applied as needed to prevent visual wilt. During the first 2 years of this study, the entire area was fertilized at a rate of 0.5 lb N/1000 sq ft (0.25 kg are^{-1}) per growing month from April through September. Since 1981, three subplot nitrogen fertility differentials have been superimposed across the cultivars at rates of 0.25, 0.5 and 1 lb N per 1000 sq ft (0.12, 0.25, and 0.50 kg are^{-1}) per growing month. Phosphorus and potassium were applied as needed based on an annual soil test. In 1983, the application timing was changed from monthly to bi-weekly, without changing the annual rate, due to rapid leaching of nutrients through the sandy root zone. This did not completely compensate for the leaching problem. Therefore, the annual rate was doubled in 1984 with the bi-weekly applications resulting in application rates of 0.5, 1.0, and 2.0 lb N/1000 sq ft (0.25, 0.5, and 1.0 kg are^{-1}) per growing month.

The pH of the root zone was monitored monthly. Sulfur was applied as needed to maintain a pH below 8.5. This was necessary due to the high sodium content of the irrigation water.

Use of preemergence herbicides was avoided, while preventive insecticide/fungicide programs were used only as needed to prevent a total loss of stand. Two applications, diazinon on July 1, and chlorpyrifos on August 20, were used in 1985 to combat serious infestations of bermudagrass mites (*Eriophyes cynodeniensis*). No other insecticides or fungicides were used. Visual turf quality ratings were made on a bi-weekly basis throughout the growing season.

Results

Turfgrass Quality Assessments

Visual estimates of turfgrass quality were based on two primary components: (a) uniformity of appearance; and (b) shoot density. The rating scale used was 9 = best and 1 = poorest. A rating of 5.0 or above represented reasonably good quality for use on sports fields and high quality lawns. No significant disease infestations were observed during 1985. Significant weed problems occured on all replications and fertility levels of Tifdwarf and may have affected the quality ratings. This weed infestation was not chemically treated as the Tifdwarf competed successfully except at the lower N level.

The comparative visual ratings of turfgrass quality, as affected by three nitrogen fertility levels, are shown in Table 1. Tifway, Santa Ana, and Tifgreen have consistently rated high in overall quality for the last six years; Midway for the last three years; and Sunturf and Tifdwarf for five of the last six years.

In 1985, all but six cultivars rated satisfactory in terms of turf quality at the high nitrogen fertility rate. Turf

Table 1. Comparative seasonal ratings of turfgrass quality for 24 bermudagrass cultivars, as affected by three nitrogen fertilization rates. College Station, Texas (1985)

Cultivar	Seasonal Averages of Turfgrass Quality†		
	2.0 lb N¶ (1.0 kg N are^{-1})	1.0 lb N¶ (0.5 kg N are^{-1})	0.5 lb N¶ (0.25 kg N are^{-1})
Tifway	5.9 a	5.4 a	5.1 a
U-3	5.7 ab	5.1 ab	4.9 ab
Texturf 1F	5.7 ab	5.3 a	4.9 ab
Ormond	6.0 a	5.1 ab	4.8 ab
Tiffine	5.7 ab	5.1 ab	4.7 abc
Santa Ana	5.7 ab	5.1 ab	4.7 abc
Tifgreen	6.1 a	5.3 a	4.7 abc
Everglades	5.6 ab	5.0 ab	4.7 abc
Pee Dee	5.8 ab	5.1 ab	4.6 abcd
A-22§	5.8 ab	5.0 ab	4.6 abcd
Sunturf	5.6 ab	4.9 abc	4.6 abcd
Tifgreen II§	5.5 ab	5.0 ab	4.6 abcd
Tifdwarf	5.8 ab	4.7 bcd	4.6 abcd
Bayshore	5.6 ab	4.9 abc	4.5 bcd
A-29§	5.5 ab	4.7 bcd	4.5 bcd
Tifway II§	5.7 ab	4.9 abc	4.5 bcd
Midiron	5.3 bc	5.0 ab	4.4 bcde
FB-119	5.2 bc	4.6 bcde	4.2 cdef
Tiflawn	4.7 cd	4.4 cdef	4.1 cdef
Midway	4.6 cd	4.1 defg	3.9 efgh
Vamont§	4.8 cd	3.8 fg	3.7 fgh
Texturf 10	4.8 cd	3.8 fg	3.6 gh
Arizona Common	4.3 d	4.0 efg	3.5 gh
Tufcote§	4.7 cd	3.7 g	3.4 h

† Visual estimates of turfgrass quality based on 9 = best and 1 = poorest.
¶ Per 1,000 sq ft per growing month.
* Means with the same letter in a column are not significantly different at the 5% level in Duncan's Multiple Range Test.
§ Cultivars evaluated for less than six years.

quality differences between nitrogen rates were minimal for a few cultivars, such as Tifway, Arizona Common, and Midway. But, for most cultivars, the turf quality differentials showed a wide variance and a dependency upon the rate of fertilizer applied. As this is the second year for this data presentation, care should be taken in drawing final conclusions. The data do indicate several possible cultivars, such as Texturf 10 and FB-119, as candidates for use in low maintenance situations as they appear not to be as dependent on the higher rates of nitrogen to maintain acceptable quality as are the other cultivars. In contrast, Tifdwarf exhibited a severe decline in turf quality as the nitrogen rate was lowered. This resulted in substantial weed invasion at the lower nitrogen rates that did not occur in any of the other cultivars.

As in the previous 7 years, the lowest ranking cultivar was the seeded Arizona Common. Tufcote has not rated satisfactory at any nitrogen level during the 2 years since planting.

Spring Greenup Rate and Fall Low Temperature Color Retention

Early spring greenup is an important characteristic in locations where early use of the turf is anticipated, such as on baseball fields. Assessments made during this study were conducted on turfs maintained under a uniform cultural program and should, therefore, indicate the inherent genetic characteristic of the cultivar in response to the various weather conditions. Data for 1985 are shown in Table 2.

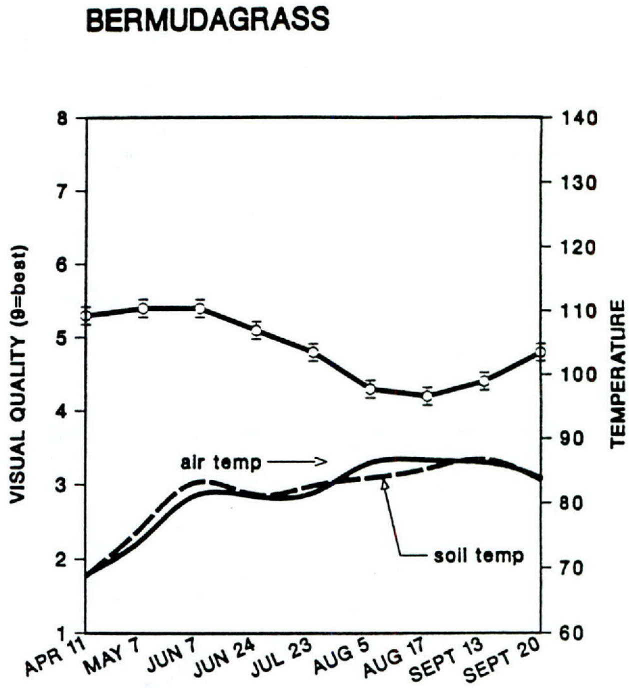

Figure 1. Relationship of temperature to seasonal bermudagrass turfgrass quality.

Analyses of data collected for the past 6 years show a few cultivar variations from year to year, but most cultivars have remained in the same category. Those commercially available cultivars that have consistently shown early greenup are Everglades, Texturf 1F and Tifgreen; while Tiflawn, Tifway, and Tifway II are in the late category. These cultivars have remained in the same category despite considerable variation in the weather.

As with spring greenup, the ability of a turfgrass to retain color longer into the fall is a desirable trait for sports turfs and lawns. Two commercially available cultivars, Tifway and Santa Ana, have exhibited good late fall color retention for the past 4 years. Tifway II and Tifgreen II, based on 3 years of data, are in this category as well. Midiron, Arizona Common, and Midway consistently discolored early in the fall.

Seedhead Formation Tendency

Information on seedhead production is beneficial in several ways. Heavy seed production disrupts normal vegetative growth, interferes with ball roll, is unattractive, and requires more frequent mowing to remove the unsightly seedheads. A cultivar with heavy seed production may actually decline in shoot density and leaf growth for a period of 3 to 5 weeks.

Detailed observations of seedhead characteristics were made in 1983, 1984, and 1985. No differences were evident between the 1984 and 1985 data shown in Table 3. Based on 3 years of data, FB-119, Arizona Common, and Vamont are heavy seedhead producers at all nitrogen fertility levels; while Tifway II, Texturf 10, Texturf 1F, Tifway, Ormond, and Santa Ana are light producers. Based on 2 years of data, Tifgreen II and Tuf-

Table 2. Comparative spring greenup rate and fall low temperature color retention rankings of 24 bermudagrass cultivars. College Station, Texas (1985)

Spring Greenup		Fall Low Temperature Color Retention	
Ranking	Cultivar	Ranking	Cultivar
Early	U-3	Late	Tifway
	Tifgreen		Santa Ana
	Tifgreen II		FB-119
	Everglades		Tifgreen II
	Texturf 1F		Tifway II
	Midiron		Bayshore
	Pee Dee		Tiflawn
	Tiffine		Everglades
Intermediate	Midway	Intermediate	Tifdwarf
	Sunturf		Pee Dee
	Bayshore		Ormond
	A-22		Tiffine
	A-29		Sunturf
	Santa Ana		Vamont
	Ormond		Tifgreen
			U-3
Late	Tifway II	Early	Midway
	FB-119		Tufcote
	Arizona Common		Texturf 1F
	Tiflawn		A-29
	Texturf 10		A-22
	Tufcote		Texturf 10
	Tifway		Arizona Common
	Tifdwarf		Midiron
	Vamont		

cote are heavy seeders, while A-22 and A-29 are light in seedhead production over all nitrogen fertiltiy levels.

Morphological Characteristics

Morphological characteristics were reported in 1981 for 19 bermudagrass cultivars, in 1983 for 22 bermudagrass cultivars, and presented in Tables 4 and 5 are the 1985 data for 24 cultivars. Shoot density, leaf width, leaf extension rate, and, for the first time, canopy orientation. These characteristics can be correlated with the water use rate of turfgrasses as reported by Kim and Beard et al.(7) and the 1985 data shown in Table 6.

Leaf Width. Bermudagrasses possess a relatively fine leaf texture compared to other turfgrasses. The finer textured cultivars tend to be used in high quality, high maintenance turfs and the course textured cultivars in minimal maintenance situations. Narrow leaf width turfs tend to have low evapotranspiration rates (7). Leaf widths reported in Table 4 closely match previous reports.

Shoot Density. A dense turf is able to compete against weed invasion, while the increase in verdure contributes to improved wear tolerance. Also, a high shoot density turf tends to have a low evapotranspiration rate (7). An increase in shoot density has occurred in each of the cultivars over time. The 1985 density counts were completed only on the high nitrogen level portion of each plot which would contribute to significantly higher densities being reported. Common bermudagrass has consistently ranked the lowest of all cultivars.

Leaf Extension. The more rapid the leaf extension rate, the greater the mowing frequency resulting in higher labor and energy costs. Turfgrasses with rapid

Table 3. Comparative seedhead formation of 24 bermudagrass cultivars ranked in increasing order. College Station, Texas (1985)

Relative Intensity of Seedhead Formation	Cultivar
Light	Texturf 10
	Texturf 1F
	A-29
	Midiron
	Ormond
	Tifway
	Santa Ana
	Tifdwarf
	A-22
	Tifway II
Intermediate	Midway
	Bayshore
	Everglades
	Pee Dee
	Tiflawn
	Tifgreen
	U-3
	Tiffine
Heavy	Tifgreen II
	FB-119
	Arizona Common
	Vamont
	Sunturf
	Tufcote

Table 4. The comparative leaf widths and shoot densities of 24 bermudagrass cultivars. College Station, Texas (1985)

Cultivar	Leaf Width (mm)		Cultivar	Shoot Density (dm^{-2})	
Tifdwarf	1.2	fg*	Tifdwarf	340	a
Pee Dee	1.3	fg	Tifway	312	ab
Tifgreen	1.3	fg	Tifgreen II	240	cd
Sunturf	1.3	fg	Tifway II	232	cd
U-3	1.3	fg	Tifgreen	230	cd
Tifway	1.4	efg	Tiflawn	218	cde
Tifway II	1.4	efg	Everglades	208	def
Santa Ana	1.4	defg	U-3	206	def
Tiffine	1.4	defg	Sunturf	206	def
Texturf 1F	1.4	defg	Pee Dee	192	defg
Bayshore	1.5	bcdefg	Tiffine	184	efg
Everglades	1.5	bcdefg	Santa Ana	182	efg
Ormond	1.5	bcdefg	FB-119	176	efgh
Midway	1.6	bcdef	A-22	172	efghi
Tifgreen II†	1.6	bcdef	Ormond	168	fghij
A-29†	1.8	abcd	A-29	160	hij
A-22†	1.8	abcd	Midway	156	hij
Tiflawn	1.9	abc	Midiron	152	hijk
FB-119	1.9	abc	Bayshore	144	hijk
Midiron	2.0	ab	Tufcote	142	hijkl
Arizona Common	2.1	a	Texturf 1F	138	ijkl
Texturf 10	2.1	a	Texturf 10	131	ijkl
Tufcote†	2.2	a	Vamont	120	jkl
Vamont	2.2	a	Arizona Common	112	l

* Means with the same letter in a column are not significantly different at the 5% level in Duncan's Multiple Range Test.
† First year data.

vertical leaf extension rates tend to have high evapotranspiration rates (7). Conversely turfs with slow vertical extension rates tend to have low evapotranspiration rates, but also may have slow rates of lateral growth which could restrict recuperative rates. The comparative leaf extension rates of 24 bermudagrasses are shown in Table 5. Arizona Common was again highest, with Texturf 1F, Everglades, Midiron, Midway, and FB-119 also

Table 5. The comparative leaf extension rates and canopy orientations of 24 bermudagrass cultivars. College Station, Texas (1985)

Cultivar	Leaf Extension Rate† (mm day^{-1})		Cultivar	Canopy Orientation¶	
Tifdwarf	4.9	g*	Tifdwarf	3.0	g
Vamont	7.2	efg	Vamont	3.7	fg
Tifgreen II	7.2	efg	U-3	4.0	efg
Pee Dee	7.6	ef	Pee Dee	4.0	efg
A-29	7.7	ef	Tufcote	4.0	efg
Ormond	8.0	ef	Tiflawn	4.3	defg
Tifway	8.3	def	A-29	4.3	defg
Tifgreen	8.4	de	FB-119	4.3	defg
Santa Ana	8.7	cde	Tifgreen	4.7	cdef
Tifway II	8.8	cde	Tifgreen II	4.7	cdef
Tiffine	8.9	cd	Tiffine	4.7	cdef
U-3	9.2	bcd	Ormond	4.7	cdef
Sunturf	9.3	bcd	Bayshore	4.7	cdef
Tiflawn	9.3	bcd	Everglades	5.0	bcdef
Texturf 10	9.5	bcd	Texturf 10	5.0	bcdef
Bayshore	9.7	abc	Midiron	5.0	bcdef
Tufcote	9.7	abc	Santa Ana	5.0	bcdef
Midway	10.3	abc	A-22	5.0	bcdef
A-22	10.6	abc	Texturf 1F	5.3	bcde
FB-119	10.9	ab	Tifway II	5.3	bcde
Midiron	10.9	ab	Tifway	5.7	abcd
Everglades	11.2	ab	Midway	6.0	abc
Texturf 1F	11.9	ab	Sunturf	6.3	ab
Arizona Common	14.7	a	Arizona Common	7.0	a

† At 2 lb N/1,000 sq ft (1.0 kg N are^{-1}). Average of 24 measurements.
¶ Based on a scale of 0 = horizontal and 9 = vertical. Average of 3 measurements.
* Means with the same letter in a column are not significantly different at the 5% level in Duncan's Multiple Range Test.

Table 6. Comparative evapotranspiration rates of 24 bermudagrass cultivars under non-limiting moisture conditions, 2 lb N/1,000 sq ft (1 kg are^{-1}) per growing month, and 1 inch (2.5 cm) mowing height. College Station, Texas (1985).

Cultivar	Mean for the 1985 Observations (mm day^{-1})	
Bayshore	4.3	h*
Everglades	4.4	gh
Tifdwarf	4.4	fgh
Vamont	4.4	fgh
Midiron	4.4	fgh
Midway	4.5	efgh
Texturf 10	4.5	defgh
Pee Dee	4.6	cdefgh
Tiflawn	4.6	cdefgh
U-3	4.7	bcdefgh
FB-119	4.7	bcdefgh
Tiffine	4.7	bcdefg
Tifgreen II	4.7	bcdefg
Tifway	4.8	bcdefg
A-22	4.8	abcdef
Texturf 1F	4.8	abcdef
Tifway II	4.9	abcde
Tifgreen	4.9	abcd
Arizona Common	5.0	abc
Tufcote	5.0	abc
Ormond	5.0	abc
Santa Ana	5.1	ab
A-29	5.1	ab
Sunturf	5.3	a*

* Means with the same letter in a column are not significantly different at the 5% level in Duncan's Multiple Range Test.

ranking among those with rapid shoot extension rates. Tifdwarf was slowest with an extension rate three times slower than Arizona Common.

Canopy Orientation. This is the first year of reporting for the orientations of the turfgrass canopy. A turf with a canopy completely vertical would be rated as 9, and one with a canopy completely horizontal would be rated as 0. The range of ratings for the 24 bermudagrasses was from 7 for Arizona Common, indicating a near vertical canopy orientation, to a low of 3 for Tifdwarf or a near horizontal growth. Canopy orientation and water use rate under nonlimiting moisture conditions show a close correlation. Bermudagrass turfs with near vertical canopies tend to have high evapotranspiration rates and those with near horizontal canopies tend to have low rates.

Evapotranspiration Rate. This is the first year for inclusion of these data in our annual progress report. Evapotranspiration rates were assessed for 24 bermudagrass cultivars grown under nonlimiting moisture conditions at 2 lb N/1000 sq ft (0.5 kg N are^{-1}) per growing month and a 1-inch (2.5 cm) mowing height. The assessments were made using the water balance method with mini-lysimeters inserted into the turfgrass cultivar plots. One assessment was completed in May and one in June. Means for these assessments are shown in Table 6.

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Comparative Drought Resistances Among Major Warm-Season Turfgrass Species and Cultivars

K.S. Kim, S.I. Sifers, and J.B. Beard

Introduction

More than 50 percent of the water use in urban areas is for the maintenance of landscaping materials which include turfgrass. In Texas alone, there are 3.2 million acres of turf area, and thus the water use by turfgrass is an important water conservation issue in urban areas.

A green lawn area provides an aesthetically pleasing landscape; with a number of functional roles such as evaporative cooling, soil and dust stabilization, safety, and reductions in noise, glare, and air pollution. Without water, turfgrass goes dormant, and may eventually die. A brown turf can add an attractive dimension to landscapes; however, its functional roles such as evaporative cooling, safety, and air pollutant absorption are minimized. Furthermore, dead turf areas may need to be replaced eventually, and probably at a higher cost.

Turf quality ratings (Beard, 1966; Minner and Butler, 1985) and percent shoot recovery (Gaskin, 1966) were the major parameters used to monitor drought resistance of cool-season turfgrasses, mostly at the intraspecific level. They reported intraspecific differences in drought resistance among the turfgrass cultivars (varieties) within species.

Most research on turfgrass drought resistance has been limited to cool-season species. The objective of this study was to evaluate warm-season turfgrass species and cultivars for their comparative drought resistance.

Materials and Methods

During the summer of 1985, eleven turfgrasses for the interspecies study, plus 22 bermudagrass, 6 zoysiagrass, 5 St. Augustinegrass, and 6 centipedegrass cultivars for the intraspecies study, were evaluated for their survival under severe progressive drought stress at the Texas A&M University Turfgrass Research Field Laboratory in College Station, Texas. The turfgrass species and cultivars used are listed in Table 1.

A special site was prepared for this drought study. The root zone consisted of 2 feet (0.6 m) of masonry sand over drain lines with a clay subgrade. The experimental area was divided into 5 subsites for studies involving interspecies, bermudagrass cultivars, zoysiagrass cultivars, St. Augustinegrass cultivars, and centipedegrass cultivars. Each subsite consisted of a randomized block design with four replications. Mature turf plugs 4 inches (10 cm) in diameter were transplanted, 3 feet (0.9 m) apart, from the nearby cultivar characterization plots. The turfs were allowed to root from May to July, or 75 days. Insecticide and nutrient solution were applied during this period. Irrigation was applied by pop-up rotary sprinkler system as needed to prevent visual wilt.

At the end of July, the irrigation was discontinued, and the turfs exposed to progressive drought conditions. Whenever there was a possibility of rain, a plastic cover was installed above the plot area to avoid possible water input. Each turf perimeter was trimmed weekly during this period. Leaf firing was visually assessed daily until the end of the study. The turfs were rewatered 48 days after initiation of the drought stress, and recovery was assessed by the percent green shoot development

Results

Interspecies Study

The shoot recovery and leaf firing of turfgrass species and cultivars during the 1985 drought study are shown in Tables 1 and 2. Shoot recovery represents the relative drought resistances of each grass. Meyer and Emerald zoysiagrasses showed high shoot recovery. Throughout the drought period of 48 days they maintained over 50 percent green shoots. The bermudagrasses also showed high shoot recovery, with the exception of Tifway which showed poor drought resistance. It had 81 percent leaf firing after 34 days of drought and recovered only 46 percent. In contrast, Arizona Common, Tifgreen, and Texturf 10 showed over 95 percent green shoot recovery. Centipedegrass also showed high shoot recovery.

Bahiagrass and seashore paspalum possessed medium drought resistances. Even though they had over 50 percent leaf firing after 34 days of stress, their recovery was over 70 percent after rewatering. Buffalograss also showed medium recovery of 80 percent after over 80 percent leaf firing. St. Augustinegrass had the lowest drought resistance. It exhibited over 90 percent leaf firing, and only 32 percent green shoot recovery.

Bermudagrass Cultivar Study

The highest green shoot recovery among the 22 bermudagrass cultivars was 90 percent by Tiflawn and the lowest was 11 percent in Tifway II. Leaf firing after 34 days of drought stress varied from 100 percent of Tifway II to only 28 percent of Tiffine. Tiflawn, Tiffine, Tufcote, Bayshore, and Texturf 1F showed high green shoot recoveries of over 95 percent. FB-119, Tifgreen II, Midway, U-3, Texturf 10, and Midiron had medium high green shoot recoveries of over 90 percent. Arizona Common, Sunturf, Ormond, Pee Dee, Tifgreen, and

Table 1. Comparative* shoot recovery of warm-season turfgrass observed 18 days after rewetting, following 48 days of drought stress in the summer of 1985. College Station, Texas.

Interspecies	Bermudagrass	St. Augustinegrass	Zoysiagrass	Centipedegrass
High	Very High	High	High	High
Emerald zoysiagrass	Tiflawn	Floralawn	FC 13521	Georgia Common
Meyer zoysiagrass	Tiffine	Floratam	Emerald	Oklawn
Texturf 10 bermudagrass	Tifcote		Meyer	
Tifgreen bermudagrass	Bayshore	Medium	El Toro	Low† (Med.?)
Georgia Common centipedegrass	Texturf 1F	Tx 8262	Belair	AU Centennial
Arizona Common bermudagrass			Korean Common	Tenn Hardy
	Medium High	Low		AC 26
Medium	FB 119	Raleigh		AC 44
Adalayd seashore paspalum	Tifgreen II	Texas Common	All cultivars	
Texas Common buffalograss	Midway		showed over 95%	
Bahiagrass	U-3		green recovery	† Over 70%
	Texturf 10			green recovery
Low	Midiron			
Tifway bermudagrass				
Texas Common St. Augustinegrass	Medium			
	Sunturf			
	Arizona Common			
	Ormond			
	Pee Dee			
	Tifgreen			
	Vamont			
	Medium Low			
	Tifdwarf			
	Everglades			
	Tifway			
	Very Low			
	Santa Ana			
	Tifway II			

* Classification comparisons are valid only within each column.

Table 2. Comparative* leaf firing of warm-season turfgrass observed after 35 days of drought stress during the summer of 1985. College Station, Texas.

Interspecies	Bermudagrass	St. Augustinegrass	Zoysiagrass	Centipedegrass
High	Very High	High	High	High
Texas Common St. Augustinegrass	Tifway II	Texas Common	Korean Common	AU Centennial
Tifway bermudagrass	Santa Ana	Raleigh	Meyer	AC 26
Texas Common buffalograss	Tifdwarf			Tenn Hardy
		Medium	Medium	AC 44
Medium	Medium High	Tx 8262	Belair	
Adalayd seashore paspalum	Tifway			Low
Bahiagrass	Pee Dee	Low	Low	Georgia Common
Georgia centipedegrass	Everglades	Floratam	FC 12521	Oklawn
Tifgreen		Floralawn	El Toro	
	Medium		Emerald	
Low	Tifgreen			
Texturf 10 bermudagrass	Ormond			
Arizona Common bermudagrass	Sunturf			
Emerald zoysiagrass	Arizona Common			
Meyer zoysiagrass	Vamont			
	Midiron			
	FB 119			
	U-3			
	Texturf 10			
	Medium Low			
	Midway			
	Tufcote			
	Bayshore			
	Tifgreen II			
	Tiflawn			
	Texturf 1F			
	Low			
	Tiffine			

* Classification comparisons are valid only within each column.

Vamont showed medium recoveries. Tifway II and Santa Ana had low recoveries, while Tifway, Everglades, and Tifdwarf exhibited medium low recoveries.

St. Augustinegrass Cultivar Study

There were large variations in drought resistance among the five St. Augustinegrass cultivars. Floralawn and Floratam showed high green shoot recovery. They showed less than 50 percent leaf firing after 34 days of drought stress and recoveries of over 90 percent. However, Texas Common and Raleigh showed over 98 percent leaf firing and less than 20 percent recovery. TX 8262 showed medium green shoot recovery. The performance of Floratam and Floralawn was excellent throughout the study in terms of shoot color, turgidity, and uniformity.

Zoysiagrass Cultivar Study

All six zoysiagrass cultivars showed very high recovery from drought stress. Their shoots recovered by over 95 percent after rewatering, even though Korean Common showed over 50 percent leaf firing after 34 days of drought stress. In contrast, El Toro had less than 10 percent leaf firing.

Centipedegrass Cultivar Study

Centipedegrass also showed high shoot recovery from drought stress upon rewatering. All six cultivars showed over 75 percent green shoot recovery; with the recoveries among cultivars not found to be statistically different. Oklawn and Common had less than 50 percent leaf firing after 34 days of drought stress, while AU Centennial had over 70 percent leaf firing.

Acknowledgment

A major portion of this investigation has been made possible by a grant from the United States Golf Association Green Section. Additional follow-up studies are underway in the greenhouse and were conducted for 1986 in the field.

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PR-4522

An Assessment of Herbicides for the Selective Control of Virginia Buttonweed in Texas Common St. Augustinegrass

W.G. Menn, R.L. Duble, J.R. Walker, and J.B. Beard

Introduction

Buttonweed (*Diodia virginiana* L.) is one of the more difficult to control broadleaf weeds found in Southern lawns, especially those containing St. Augustinegrass (*Stenotaphrum secundatum* Walt. Kuntze). Buttonweed is a warm-season perennial that spreads by seed, stolons, and rhizomes. Leaf width is often close to that of St. Augustinegrass and, thus, early diagnosis of an infestation is difficult. Buttonweed is usually well established before a problem is known to exist.

In bermudagrass turf, buttonweed can be controlled selectively by applying sequential combinations of MSMA and 3-Way (or similar compounds) in the spring and summer. However, in St. Augustinegrass turf, when applied alone, the 3-Way product has produced only fair results in controlling this weedy pest.

This study was initiated to evaluate and compare various rates of Imazaquin with some of the more commonly used herbicides for the control of Virginia buttonweed.

Materials and Methods

The site of this study was on a Texas Common St. Augustinegrass lawn at the Beaumont Country Club in Beaumont, Texas. The lawn area was under automatic irrigation and mowed weekly at a height of 2 in. (5 cm). At the time of application, the Virginia buttonweed and St. Augustinegrass were both actively growing. The ten herbicide treatments and rates are shown in Table 1. Each treatment included an amount of a non-ionic surfactant equivalent to 1 quart per acre. All materials were applied on April 8, 1985, using a small, hand-held CO_2

Table 1. Phytotoxic effects of ten herbicides and herbicide mixtures on Texas Common St. Augustinegrass.

Herbicide Treatment	Formulation	Application Rate(s) lb ai/ac	kg ai h^{-1}	Phytotoxicity Rating 3 Weeks After Application†
Imazaquin	1.5 L	0.125	0.14	1.9 abc*
"	"	0.250	0.28	2.0 abc
"	"	0.50	0.56	2.4 ab
Bromoxynil + Dicamba	2E + 4E	1.0 + 0.5	1.12 + 0.56	1.5 bc
Imazaquin + 3-Way	1.5L + 3.96EC	0.125 + 1.2	0.14 + 1.34	3.0 a
"	"	0.250 + 1.2	0.28 + 1.34	2.6 ab
"	"	0.50 + 1.2	0.56 + 1.34	3.0 a
3-Way	3.96EC	1.2	1.34	1.9 abc
Trimec	4.18EC	1.6	1.8	2.3 ab
Imazaquin + Dicamba	1.5L + 4E	0.50 + 0.25	0.56 + 0.28	1.8 bc
Untreated check	- - - - -	- - - - - -	- - - - - -	1.0 c

† Ratings based on 1 = no phytotoxicity and 9 = severe phytotoxicity.
* Values within a column followed by the same letter are not significantly different at the 5% level of Duncan's Multiple Range Test.

Table 2. Effect of various herbicides and herbicide mixtures on the control of Virginia buttonweed in a Common St. Augustinegrass lawn in Beaumont, Texas.

Treatment	Formulation	Application Rate(s) lb ai/ac	kg ai/h	Control Ratings After Application† 3 Weeks	6 Weeks
Imazaquin	1.5 L	0.125	0.14	5.1 bc	4.8 abcd*
"	"	0.250	0.28	4.6 c	4.3 abcd
"	"	0.50	0.56	7.5 ab	7.0 ab
Bromoxynil + Dicamba	2E + 4E	1.0 + 0.5	1.12 + 0.56	3.5 c	2.5 cd
Imazaquin + 3-Way	1.5L + 3.96EC	0.125 + 1.2	0.14 + 1.34	5.4 bc	3.5 bcd
"	"	0.250 + 1.2	0.28 + 1.34	7.1 ab	6.8 abc
"	"	0.50 + 1.2	0.56 + 1.34	8.3 a	8.0 a
3-Way	3.96EC	1.2	1.34	3.6 c	3.0 bcd
Trimec	4.18EC	1.6	1.8	2.9 c	1.5 d
Imazaquin + Dicamba	1.5L + 4E	0.50 + 0.25	0.56 + 0.28	5.1 c	5.3 abcd
Untreated check	- - - - -	- - - - - -	- - - - - -	1.0 d	1.0 d

† Ratings based on 9 = complete control and 1 = no control.
* Values within a column followed by the same letter are not significantly different at the 5% level of Duncan's Multiple Range Test.

pressurized plot sprayer. Spray volume was calibrated to equal 1 gal/1000 sq. ft. (4.1 L are^{-1}) and application pressure was set at 25 psi. Weather conditions at the time of application were an overcast sky, a temperature of 68°F (20°C), and a light variable wind (less than 5 mph).

The individual plot size was 72 sq. ft. (16.7 m) with each treatment arranged in a randomized block design with four replications. Ratings for phytotoxicity of the treatments to Texas Common St. Augustinegrass were made 3 weeks following application (Table 1). Virginia buttonweed control ratings were taken at 3 and 6 weeks after treatment (Table 2).

Results

At the rates applied, there was not a significant amount of phytotoxicity to the St. Augustinegrass caused by any of the herbicide treatments included in this study (Table 1). There was some noticeable leaf discoloration; however, it was not permanent and would probably be tolerable.

The potential for the control of Virginia buttonweed with Imazaquin appears quite promising (Table 2). The control obtained with bromoxynil, dicamba, Trimec, and the 3-Way material was not acceptable. The Imazaquin alone or in combination with 3-Way was the most effective in controlling Virginia buttonweed under the conditions of this study. The combination appeared slightly more effective than Imazaquin applied alone.

It is felt that sequential applications (2 or 3) of the Imazaquin/3-Way combination might be necessary for post-emergent control of Virginia buttonweed. For complete control, applications of the Imazaquin/3-Way combination may need to be coupled with a good pre-emergent herbicide (i.e. Pre-M). At the present, the effectiveness of Pre-M on Virginia buttonweed has not been determined.

In summary, (1) this study indicated that the combination of Imazaquin and 3-Way was significantly more effective in post-emergent control of Virginia buttonweed than any of the other nine treatments evaluated, (2) the effect of sequential applications of Imazaquin on Virginia buttonweed should be evaluated, and (3) the application of Imazaquin in combination with a pre-emergent herbicide for a total control program should be investigated.

Acknowledgment

Appreciation is extended to Beaumont Country Club for providing an area in which to conduct the study. This investigation was partially funded by a grant from LESCO, Inc.

PR-4523

Effects of Nine Imazaquin and MSMA Combinations on the Selective Control of Purple Nutsedge in a Common Bermudagrass Turf

W.G. Menn, S.D. Griggs, K.S. Kim, and J.B. Beard

Introduction

Purple nutsedge (*Cyperus rotundus* L.) has long been recognized as a major weed problem in turf. The ability to effectively control this pest post-emergently has been poor, with methyl bromide fumigation being the only means of erradication. Selective control using multiple applications of MSMA or DSMA in established turf has been only fair; and these materials could not be used on St. Augustinegrass or centipedegrass turfs. The objectives of this study were to evaluate the effects of Imazaquin in terms of (1) purple nutsedge control and (2) Common bermudagrass (*Cynodon dactylon* L. Pers.) selectivity.

Materials and Methods

The site of this study was on the Texas A&M University campus in College Station, Texas on a fairly level lawn area composed of Common bermudagrass. The turf was mowed weekly at a height of 1.25 inches (3.2 cm) and irrigated uniformly as needed to prevent visual wilt, using an automatic sprinkler system. The soil at this location was a Lufkin sandy loam surface, approximately 8 to 10 inches (20 to 25 cm) deep, over a heavy clay hardpan. Soil pH in this area was approximately 8.3 due primarily to a high sodium concentration in the irrigation water.

Imazaquin was applied alone and in combination with MSMA on July 25, 1985. Rates of application are shown in Tables 1 and 2. All materials were applied as a spray using a small, hand-held CO_2 pressurized sprayer. Spray pressure was set at 25 psi and volume was calibrated to equal 1 gal/1000 sq ft (4.1 L). The individual plot size was 30 sq ft (2.8 m^2) with each treatment being replicated three times and arranged in a randomized block design. Air temperature at the time of application was 80°F (28°C) and the wind was calm. The test area was mowed 3 days prior to and 4 days following application, with irrigation being withheld for 2 days following herbicide treatment. Retreatments with selective rates of Imazaquin alone and in combination with MSMA were applied on September 27, 1985; however, an early-season cool front negated any valid results.

Visual ratings for phytotoxicity of the Imazaquin on the bermudagrass were made on August 5 and August 12, 1985 (Table 1). Visual ratings of Imazaquin's effectiveness in controlling purple nutsedge were made on August 12, September 6, September 20, and October 4, 1985 (Table 2).

Results

Concerning the phytotoxic effects of Imazaquin on Common bermudagrass, it was found that the higher rates applied alone and in combination with MSMA produced significant shoot discoloration (Table 1). This was not a permanent effect. Approximately 3 weeks after application, the phytotoxic effects were not noticeable on any of the turfs, except for those treated at the highest rate of Imazaquin (0.75 lb ai/A; 0.84 kg h^{-1}).

When comparing a single treatment of Imazaquin with a similar combination with MSMA, there was a trend toward increased control of the purple nutsedge (Table 2). At the higher rates, there were no long term advantages observed from applying the combination of Imazaquin and MSMA. At the initial rating period, the combination of materials appeared more effective; however, this could have been attributed to the surfactant that had been added to the MSMA. The sample of Imazaquin used in this study contained a statement on the label to the effect that the material already contained a surfactant and, subsequently, none was added to those treatments where Imazaquin was applied by itself. Since this study was conducted, it has been learned that the concentration of wetting agent added to the Imazaquin was too weak to be effective and that additional surfactant should have been added at the time of application.

Sequential application of selected rates was applied, but possibly too late in the growing season to effect a representative response. Additional experiments were conducted in 1986.

Table 1. Phytotoxic effects of nine Imazaquin and MSMA treatment combinations on a Common bermudagrass turf. College Station, Texas.

Treatment	Rate(s) lb a.i./ac (kg a.i. h^{-1})	Rating† Dates 8/5/85	8/12/85
Imazaquin	0.125 (0.14)	2.7 cd*	1.7 c
"	0.25 (0.28)	5.7 ab	3.0 bc
"	0.50 (0.56)	7.0 a	4.3 ab
"	0.75 (0.84)	7.0 a	5.3 a
Imazaquin + MSMA	0.125 + 2.00 (0.14 + 2.24)	3.7 bc	1.0 c
" "	0.25 + 2.00 (0.28 + 2.24)	4.0 bc	1.7 c
" "	0.50 + 2.00 (0.56 + 2.24)	6.7 a	4.3 ab
" "	0.75 + 2.00 (0.84 + 2.24)	6.7 a	4.7 ab
MSMA	2.00 (2.24)	2.0 cd	1.0 c
Untreated check	---	1.0 d	1.0 c

† Ratings based on a scale of 1 = no phytotoxicity and 9 = severe phytotoxicity.
* Values followed by the same letter are not significantly different at the 5% level of Duncan's Multiple Range Test.

Table 2. Effects of nine Imazaquin and MSMA treatment combinations on the control of purple nutsedge in a Common bermudagrass turf. College Station, Texas.

Treatment	Rate(s) lb a.i./ac (kg a.i./h)	Rating† Dates 8/12/85	9/6/85	9/20/85	10/4/85
Imazaquin	0.125 (0.14)	7.3 abc*	2.0 bc	2.7 c	1.7 d
"	0.25 (0.28)	7.3 abc	7.0 a	6.0 b	2.3 cd
"	0.50 (0.56)	6.3 bc	9.0 a	6.7 ab	4.0 bc
"	0.75 (0.84)	5.7 c	3.3 b	7.3 ab	5.3 ab
Imazaquin + MSMA	0.125 + 2.00 (0.14 + 2.24)	9.0 a	2.7 bc	3.0 c	2.7 cd
" "	0.25 + 2.00 (0.28 + 2.24)	8.3 ab	9.0 a	2.7 c	2.7 cd
" "	0.50 + 2.00 (0.56 + 2.24)	8.3 ab	9.0 a	7.3 ab	3.0 cd
" "	0.75 + 2.00 (0.84 + 2.24)	7.3 abc	4.0 b	8.7 a	6.7 a
MSMA	2.00 (2.24)	5.0 c	2.7 bc	1.7 c	1.7 d
Untreated check	---	1.0 d	1.0 c	1.3 c	1.0 d

† Ratings based on a scale of 1 = no control and 9 = complete control.
* Values followed by the same letter are not significantly different at the 5% level of Duncan's Multiple Range Test.

Conclusions

1. At selected rates Imazaquin was significantly more effective than MSMA in post-emergent control of purple nutsedge.
2. Phytotoxic effects of Imazaquin on Common bermudagrass shoots were only of a temporary, three-week duration.
3. Sequential applications of Imazaquin may be necessary for effective control of purple nutsedge.
4. It is suggested that treatments be initiated earlier in the growing season than July 25 to achieve purple nutsedge control through multiple applications.

Acknowledgments

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Control of Southern Chinch Bug in St. Augustinegrass: 1985 Test

Robert L. Crocker

Abstract

Two experimental products (carbaryl 43 percent SL and carbaryl 20 percent F) and carbaryl 80 percent S (all at 4.48, 6.72, and 8.96 kg ai/ha), and chlorpyrifos 0.5G at 1.23 kg ai/ha were applied to caged field plots of St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, turf to control southern chinch bugs, *Blissus insularis* Barber (Hemiptera: Lygaeidae). All materials significantly reduced the population of treated insects; the most effective treatment was the high application rate of carbaryl 43 percent SL, which produced ca. 95 percent mortality. No treatment-related phytotoxicity was detected.

Introduction

St. Augustinegrass is highly favored as a turfgrass throughout the southern United States, especially in the Gulf Coast area. The southern chinch bug, Blissus insularis Barber (Hemiptera: Lygaeidae), is the most destructive pest of St. Augustinegrass throughout most of its cultivated range, especially in its zone of primary adaptation. The insect damages grass stolons by feeding on liquid materials in the stem, using the piercing-sucking mouthparts of its long slender beak. Much of the feeding injury probably is caused by digestive enzymes the insect injects into the plant as part of the feeding process.

The purpose of the present research was to test the field efficacy of several insecticides in controlling the southern chinch bug in St. Augustinegrass.

Materials and Methods

The research was performed according to the methods of Crocker and Simpon (1981). The procedure eliminates insect distributional variation and among-plot insect migration present in open field-plot tests. It also maintains a natural turf environment where the insects can behave normally and where factors such as thatch can affect pesticide availablity (Niemczyk et al. 1977, Sears and Chapman 1979). The experiment included applications of two experimental formulations (carbaryl 43 percent SL and carbaryl 20 percent F), and carbaryl 80 percent S (all at 479.4, 719.0, and 458.7 g ai/ha [4.0, 6.0, and 8.0 lbs ai/A]), chlorpyrifos 0.5G at 131.8 g ai/ha (1.1 lbs ai/A) as a standard, and an untreated control.

On October 3, 1985, unsexed adult test insects were collected using a D-Vac™ model 24 vacuum insect net (D-Vac Co., Riverside, CA) from a field population that was severely damaging St. Augustinegrass in turf plots on the campus of Texas A&M University at College Station. The insects were transported the same day to TAES-Dallas on living St. Augustinegrass stolons. On October 4, the unsexed adults were divided into groups of 50. These insects were placed, 1 group per plot, in 186 cm^2 field plots delimited by the walls of an open-ended metal cylinder (15 cm diameter by ca 16 cm high) embedded in established irrigated St. Augustinegrass turf with minimal thatch on the TAES-Dallas turf plots. Soil in the plots was Austin-Houston type, alkaline montmorillonite clay typical of the Texas blackland prairies. The insects were allowed to settle into the new habitat for 24 hours pretreatment to ensure them an opportunity to assume a natural distribution in the turf. Treatments were applied in the equivalent of 2.5 liters/m^2 final product, by the method of Reinert (1972, 1974) on October 5. Before and immediately after treatment, each field cage was covered by a nylon mesh which permitted air exchange and light passage but which prevented insect escape (Croker and Simpson 1981). Data were collected (by replication) October 7-8.

Statistical analyses of treatment effects were performed using untransformed data, as well as data transformed according to $X_t = (X + 0.375)^{1/2}$, and according to X_t = arc sin (X/100) where X_t is the transformed value and X is the total number of adult chinch bugs recovered from a plot. The transformed and the untransformed data were computer-analyzed using SAS Proc ANOVA, with treatment separations determined by the Waller-Duncan k-ratio t test (SAS Institute, Inc., Cary, NC). Reported means were calculated using untransformed data; reported statistical separations are based on arcsin transformed data.

Results

The results (Table 1) indicate that all treatments significantly ($p = 0.05$) reduced treated populations of southern chinch bugs in St. Augustinegrass. The moderate efficacy of chlorpyrifos in this experiment indicates that organophosphate insecticide resistance may have begun to develop in parts of Texas, although not yet to the extent seen in some parts of Florida (Reinert and Portier 1983). The 43 percent SL formulation of carbaryl was the most effective, yielding better control than the standard, chlorpyrifos, at all tested treatment levels.

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Table 1. Mean numbers of southern chinch bugs per plot following treatment with various insecticides; initial population = 50 adult chinch bugs/ caged plot; 6 replications; Dallas, TX; October, 1985.

Material applied	kg ai per ha*	Mean number of Chinch Bugs/ Plot
Untreated	-	37.0 a**
Carbaryl 20% F	4.5	13.8 b
Carbaryl 80% S	4.5	13.7 bc
Carbaryl 80% S	9.0	12.5 bcd
Carbaryl 80% S	6.7	12.2 bcd
Carbaryl 20% F	9.0	10.3 bcd
Chlorpyrifos 0.5% G	1.2	9.8 cd
Carbaryl 20% F	6.7	8.3 de
Carbaryl 43% SL	6.7	5.3 ef
Carbaryl 43% SL	4.5	4.2 f
Carbaryl 43% SL	9.0	1.8 g

* 1 kg ai/ha = 0.890 lbs ai/A.

** Means followed by the same letter are not significantly different at p=0.05, according to Waller-Duncan k-ratio t test.

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PR-4525

Efficacy of Fungicides for Controlling Rhizoctonia Blight of St. Augustinegrass

P.F. Colbaugh

Abstract

Field tests were used to evaluate commercial and experimental fungicides for controlling Rhizoctonia blight of 'Raleigh' St. Augustinegrass. Fungicides were evaluated for their long-term effectiveness in controlling the disease under conditions of heavy disease pressure. Results of field investigations with 24 fungicide treatment programs one month after application indicate some experimental fungicides gave protection during the 30-day period and encouraged regrowth of infected areas. Most of the fungicides were not effective under the conditions of the study.

Introduction

Four distinct pathogens are attributed to Rhizoctonia blights of turfgrasses; however, only one *Rhizoctonia* sp. (*R. solani*) is thought to occur on Texas common St. Augustinegrasses (2). Cultural practices including heavy fertilization and irrigation are known to increase the incidence and severity of Rhizoctonia brown patch. Field symptoms of the disease can vary greatly depending on cultural management practices and environmental conditions associated with disease outbreaks. Rhizoctonia diseases are initiated by outgrowth of mycelial threads in scattered areas of the turfgrass stand to form circular or roughly circular spots of dead or wilting grass. As the disease progresses, the appearance of mostly circular patterns with occasional irregular patches of affected turf are typical symptoms of the disease (3).

While Rhizoctonia blight attacks virtually all turfgrasses, a few species of turfgrasses are particularly susceptible. In the southern U.S., the disease is often severe on St. Augustinegrass during the fall season. In the northern growing areas, bentgrasses, bluegrasses and tall fescues are attacked from late spring through early fall when growing conditions are warm and excessively moist (3).

Environmental relationships and turf cultural practices have a strong influence on the development of Rhizoctonia blight. Dense canopied turfgrasses receiving high rates of nitrogen fertility followed by excessively moist growing conditions are very susceptible to Rhizoctonia attack. Nitrogen fertilizer promotes lush vegetative growth that the fungus readily attacks. Fertilizer applications in the range of 1# Nitrogen/1000 ft^2 (5 g N/93 m^2) can induce disease outbreaks rapidly if weather conditions are warm and moist during periods that follow. The relationship of outbreaks of Rhizoctonia blight with warm, humid environments is demonstrated by the minor occurrence of the disease in perennially cool environments of the Pacific Northwest (1).

Research undertaken at the Texas A&M University (TAMU) Research and Extension Center at Dallas focused on developing practical measures for controlling Rhizoctonia blight of St. Augustinegrass. Investigations during the 1985 growing season included field experiments with commercial and experimental fungicides for Rhizoctonia disease control. Field tests with fungicides for control of Rhizoctonia brown patch on 'Raleigh' St. Augustinegrass evaluated long-term effectiveness of available and experimental fungicides under conditions of heavy disease pressure.

Materials and Methods

The experimental site was located on the TAMU Research and Extension Center at Dallas property. The site consisted of newly established 'Raleigh' St. Augustinegrass growing on unmodified Blackland clay-loam soil.

Experimental plots were 4 x 3 feet (1.2 x 0.91 m). The plot site consisted of 24 treatments in a randomized block design replicated five times. All sites were irrigated as necessary to prevent visible wilt. The experimental area was fertilized at the rate of 1# Nitrogen/1000 sq ft with 34-0-0 (NPK fertilizer) using a rotary broadcast spreader. Following two applications of fertilizer at 2 week intervals on 22 August 1985 and 6 September 1985, symptoms of the brown patch disease began to appear throughout the St. Augustinegrass nursery.

Foliar applications of fungicides were made on 17 September 1985. Chemicals, formulations, and rates of application used in the study are given in Table 1. Wettable powder formulations were suspended in 1.4 gal (5.3 liters) of water per 1000 sq ft and applied with a hand operated CO_2 sprayer with a delivery of ca 25 psi. Granular applications were made with a hand-pushed, drop spreader. Natural rainfall and heavy night irrigation following the applications of fungicides favored continued disease spread during the weeks that followed.

Table 1. FUNGICIDES AND USE RATES FOR FIELD PLOT EXPERIMENTS FOR CONTROL OF BROWN PATCH OF 'RALEIGH' ST. AUGUSTINEGRASS.

Fungicide		Application Rate	
Common Name	Trade Name	oz a.i./1000 ft$_2$	(g a.i./93 m^2)
thiophanate methyl	Fungo® (50W)	.50	14.17
thiophanate methyl	Fungo® (50W)	1.00	28.35
thiram-cadmium	Kromad® (27.5W)	1.10	31.18
thiram-cadmium	Kromad® (27.5W)	1.65	46.78
thiophanate methyl-mancozeb	Duosan® (60W)	1.80	51.03
thiophanate methyl-mancozeb	Duosan® (60W)	3.00	85.05
phenylbenzamide	MF-654 (50W)	.50	14.17
phenylbenzamide	MF-654 (50W)	1.00	28.35
banodanil-vinclozolin	MF-690 (50W)	1.00	28.35
benodanil-vinclozolin	MF-690 (50W)	1.50	42.52
benodanil-vinclozolin	MF-745 (50W)	1.00	28.35
benodanil-vinclozolin	MF-745 (50W)	1.50	42.52
flutolanil	SN-84364 (50W)	1.00	28.35
flutolanil	SN-84364 (50W)	2.00	56.70
	NC-28410 (40SC)[a]	2.00	56.70
	NC-28410 (40SC)	4.00	113.40
	NC-28410 (40SC)	6.00	170.10
fenpropimorph	Corbel® EF-700	.97	27.56
fenpropimorph	Corbel® EF-700	2.91	82.67
fenpropimorph	Corbel® EF-700	5.83	165.34
pentachloronitrobenzene	PCNB (10G)	10.94	310.14
pentachloronitrobenzene	PCNB (75W)	12.00	340.19
iprodione	Chipco® 26019 (50W)	2.00	56.70
Control		-	-

[a] Common name and chemical formula not available.

Results

A schematic representation of brown patch disease activity on 17 September and 18 October are presented (Figs. 1a-b) with general patterns of disease noted on the two dates. Brown patch in the experimental areas developed from infected loci, expanding into irregular-shaped areas that coalesced. Because of the uneven development of the disease, variability among treatment replications was high in the field experiments. Assessments of disease activity on test plots were made following applications of fungicides and following one month of severe disease pressure in the field. Tabular data of percent diseased areas on the plots, mean values for respective treatments, and differences in mean percent disease on the two dates of observation are presented.

Results of field studies with fungicide treatment programs are presented in Table 2. The range of corrected mean percent diseased areas observed on 18 October (Figure 1b) showed good separation of treatment effects. Corrected data for mean percent disease among treatments was subjected to statistical analysis for determination of significant values. Results obtained with the two experimental fungicides, SN-84364 (2 oz active ingredient [ai]) and NC-28410 (4 oz ai), and Chipco® 26019 at the 2 oz ai rate had greater efficacy than other fungicides used in the study. Chipco® 26019 when used at a 1 oz ai rate in previous field studies, gave effective results for stopping progress of the disease on Texas common St. Augustinegrass, however, disease activity resumed 2 weeks after treatment. These studies indicate that the higher rate of use can be effective for longer periods of disease protection. Treatments with SN-84364 and NC-28410 at the highest rates used in the study gave a significant recovery of diseased turf one month after fungicide application.

Figure 1a. Schematic representation of brown patch disease activity in replicated field studies.[1]

17 September 1985

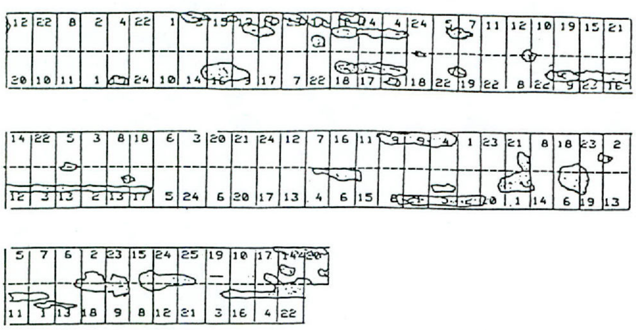
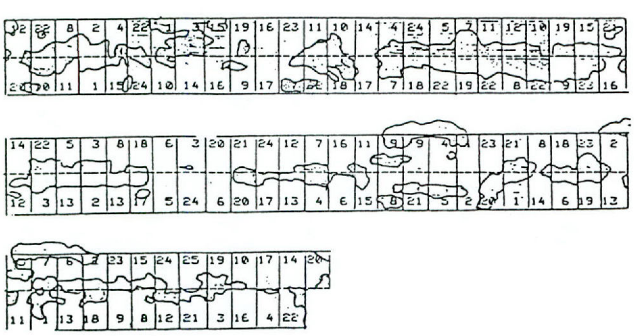


Figure 1b. Schematic representation of brown patch disease activity in replicated field studies.[1]

(One Month Following Application of Fungicides) **18 October 1985**



Circled areas indicate disease activity on dates indicated.

Table 2. FIELD FUNGICIDE EVALUATIONS FOR BROWN PATCH CONTROL ON "RALEIGH" ST. AUGUSTINEGRASS. FALL, 1985.

Treatment Number	Treatment	Application Rate oz a.i./1000 ft²	% Disease: 1 Month[a] After Application
14	SN-84364 50W	2.00	1.6 A
16	NC-28410 40SC	4.00	4.0 A B
24	Chipco 26019	2.00	9.6 A B C
17	NC 28410 40SC	6.00	10.2 A B C
6	Duosan 60W	3.00	15.8 A B C D
12	MF-745 50W	1.50	18.6 A B C D E
11	MF-745 50W	1.00	18.8 A B C D E
13	SN-84364 50W	.50	19.6 A B C D E
10	MF-690 50W	1.50	20.0 A B C D E
4	Kromad 27.5W	1.65	20.0 A B C D E
21	PCNB 10G	10.94	24.4 A B C D E
15	NC-28410 40SC	2.00	25.6 A B C D E
9	MF-690 50W	1.00	25.6 A B C D E
2	Fungo 50W	1.00	26.4 A B C D E
5	Duosan 60W	1.80	28.0 B C D E
23	PCNB 75W	12.00	28.2 B C D E
18	Corbel EF-700	.97	28.8 B C D E
1	Fungo 50W	.50	32.0 C D E
19	Corbel EF-700	2.91	32.2 C D E
3	Kromad 27.5W	1.10	33.4 C D E
20	Corbel EF-700	5.83	33.6 C D E
8	MF-654 50W	1.00	34.2 C D E F
22	Control Not Treated		38.4 D E F
7	MF-654 50W	.50	43.4 E F

[a] % disease represents the mean % disease of five replicates.
[b] Treatment values followed by the same letter are not significantly different.

Statistical separation of percent disease indices is difficult with the spreading nature of the brown patch disease. Although the early symptoms of disease appeared to be uniformly distributed throughout the plot area, contiguous plots to these disease centers were favored for higher levels of disease activity. In these investigations, PCNB 75W fungicide, which is recognized as a standard for controlling Rhizoctonia blights of turf, was less effective than several experimental fungicides used in the study. Also, PCNB appeared to have greater effectiveness as a granular formulation than as a wettable powder formulation for controlling the Rhizoctonia blight disease.

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A New Host for St. Augustine Decline (Panicum Mosaic Virus St. Augustinegrass Decline Strain)

R.W. Toler and J.D. Alexander

St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, is used extensively for private and commercial lawns throughout the southern coastal states, and is vulnerable to a number of diseases and insect pests. St. Augustine decline, caused by the St. Augustine decline strain of Panicum mosaic virus (PMV-SAD) (4,5,6), occurs throughout the St. Augustinegrass-growing area of Texas (7), and Louisiana (2). Damage to St. Augustinegrass lawns from PMV-SAD was estimated to exceed $100 million in the 1970's (3).

Until now, the known host range of PMV-SAD did not include centipedegrass (*Eremochloa ophiuroides*) Anth. nor crowfootgrass (*Dactyloctenium aegyptium*) Anth. However, Holcomb (1) reported virus like mosaic symptoms on centipedegrass and crowfootgrass in a lawn from Hammond, Louisiana in 1985. His preliminary results with agar diffusion serology indicated that both grasses were infected with a virus similar to the Panicum mosaic/St. Augustine decline group. To confirm Holcomb's finding we assayed known PMV-SAD isolates on centipedegrass in Texas.

Materials and Methods

The host and indicators used in this study were 'Common' centipedegrass, Texas 'Common' St. Augustinegrass, and 'German strain R' millet. In addition, three SAD resistant cultivars were tested (Floratam, Raleigh, and Seville). Two sources of PMV-SAD inoculum were used: the original PMV-SAD isolate known as isolate S and the more recently described wild type known as SAD-W. All experiments were repeated and each trial was replicated at least 6 times.

Virus inoculum was prepared using a 1:2 (wt:wt) ratio of infected St. Augustinegrass leaf material to 0.1M, pH 7.0 phosphate buffer, and 1 percent 600 mesh carborunbum. Inoculum was applied to the leaves of the tests plants with an artist-airgun at 7.3 kg/cm^2 Standard agar gel diffusion serology using 0.8 percent agarose, containing 0.85 percent sodium chloride and 0.04 percent, sodium azide was employed.

Table 1. Symptom expression in several grasses inoculated with two isolates of PMV-SAD virus

Host Grass	Isolate SAD-S	Isolate SAD-W
'Common' Centipede	+++[a]	+++
'Common' St. Augustine	+++	+++
'Floratam'[b] St. Augustine	---	---
'Raleigh'[b] St. Augustine	---	---
'Seville'[b] St. Augustine	---	---
'German strain R' Millet	+++	+++

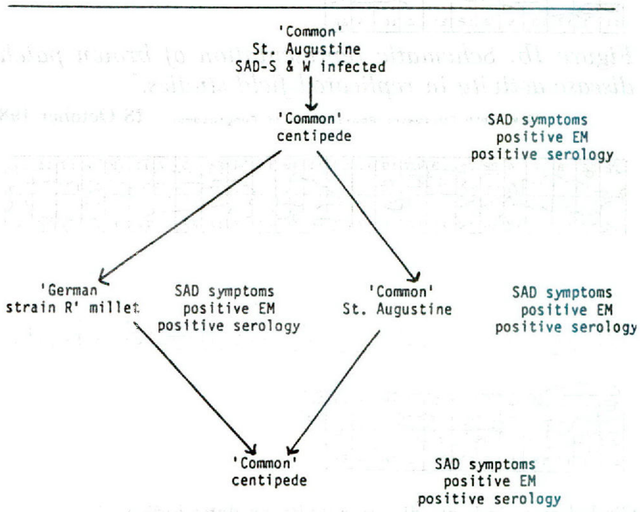
a +++: positive symptoms (chlorosis, mosaic, etc.)
---: no symptoms present

b SAD resistant

Results

Centipedegrass 'Common' cultivar was susceptible to both the S and W isolates of PMV-SAD (Table 1). Typical mottling of the leaves developed 14 to 28 days after mechanical inoculation in each host with each isolate, but the mottling was less intense and the symptoms spread more slowly in centipedegrass than in St. Augustinegrass. The virus was transmitted from SAD-infected centipedegrass to healthy Texas 'Common' St. Augustinegrass and German strain R millet (Figure 1). The virus was also transmitted back to 'Common' centipedegrass and Texas 'Common' St. Augustinegrass from

Figure 1. Flow chart of inoculations.



centipedegrass. The virus failed to infest the resistant St. Augustines. The virus was identified as PMV-SAD serologically in all three hosts. Electron micrographs of infected centipedegrass tissues showed isometric particles consistant with that of PMV-SAD virus infections.

The work by Holcomb indicates that the PMV-SAD occurs naturally in Louisiana. Our findings demonstrate that centipedegrass can be infected by PMV-SAD and that it can be transmitted from St. Augustinegrass or German strain R millet to centipedegrass and from centipedegrass to St. Augustinegrass and the indicator German strain R millet.

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PR-4527

Influence of Irrigation and Nitrogen on Weed Invasion in Bermudagrass and St. Augustinegrass

Paul Graff and Billy Hipp

Irrigation and fertility management are mutually important aspects of maintaining desirable turfgrass quality and stand purity. Irrigation and nitrogen fertilization practices in the Dallas/Fort Worth area range from none to excessive. Guidelines need to be established defining thresholds for minimum watering and fertilization that maximize turf quality in terms of stand purity and foliar density. Excessive water and ferlilizer expense, as well as groundwater pollution by leached nitrates are negative attributes of extravagant management. In contrast, inadequate cover, weed invasion, and poor color and texture can result from neglectful management. As an aid in establishing irrigation and nitrogen application guidelines for North Central Texas, studies were conducted on St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Kuntze] and common bermudagrass [*Cynodon dactylon* (L.) Pers.] at Dallas, Texas. This report presents results of field tests with varying levels of irrigation and N fertilization on subsequent weed invasion in the two turfgrasses.

Materials and Methods

St. Augustinegrass (Texas common) was solid sodded on Austin silty clay soil in the summer of 1982. Several irrigation treatments were initiated in April 1983 and continued through 1985. The data included in this report are for nonirrigated plots and plots that received weekly irrigation equal to one-half the evaporation from a class A pan. This irrigation level is the approximate water use rate by St. Augustinegrass in the Dallas area (2). Irrigation plots were 20 x 20 ft (6.1 x 6.1 m) and each plot was served by an individual underground sprinkler and controller. This irrigation system was used in 1983 and 1984, but a portable system, constructed of PVC pipe and 12 shrub sprinkler heads per plot, was used in 1985. Irrigation applications were metered on each plot in 1985, but were regulated with a timer in 1983 and 1984. Each water level treatment was split to include 0, 2, 4, and 6 lbs N/1000 sq ft (0, 98, 196, and 392 kg/ha) subplots. Nitrogen treatments were applied as ammonium sulfate in two applications (normally May and August). These rates include the recommended levels (4-6 lb N/1000 sq ft) for Texas lawns (1).

Similar studies were initiated on common bermudagrass seeded on Austin silty clay soil in the spring of 1985. Nitrogen treatments were applied on 24 June and 12 August 1985. Irrigation treatments were initiated on 3 July 1985. Bermudagrass irrigation plots were 19 x 12 ft (5.8 x 3.7 m) and nitrogen subplots were 9.5 x 6 ft (2.9 x 1.8 m). Irrigation treatments were metered using a portable sprinkler system consisting of 12 shrub heads per plot.

Plots were evaluated for grass and broadleaf weeds in late-May 1986. Weed densities were obtained by tallying the number of various types rooted within a 4.1 x 4.1 in (10 x 10 cm) wire frame placed at 10 random locations in each fertilizer sub-plot. The four most prevalent weeds in each turf type were selected for separate tally and all other weeds were combined into a single class. Other grasses made up the final tally class. Invasion of St. Augustinegrass by bermudagrass was evaluated separately by visual estimate. While density (plants/sq ft) of sodgrasses is difficult to evaluate, and frequency of common bermudagrass occurrence approached 100 percent in most subplots, dominance (canopy cover/ unit area) varied discretely, making it the preferred index. Data were subjected to analysis of variance to test the effect of irrigation and fertilizer rate on densities or dominance of each weed class. Linear and polynomial regression were used to further examine significant relationships.

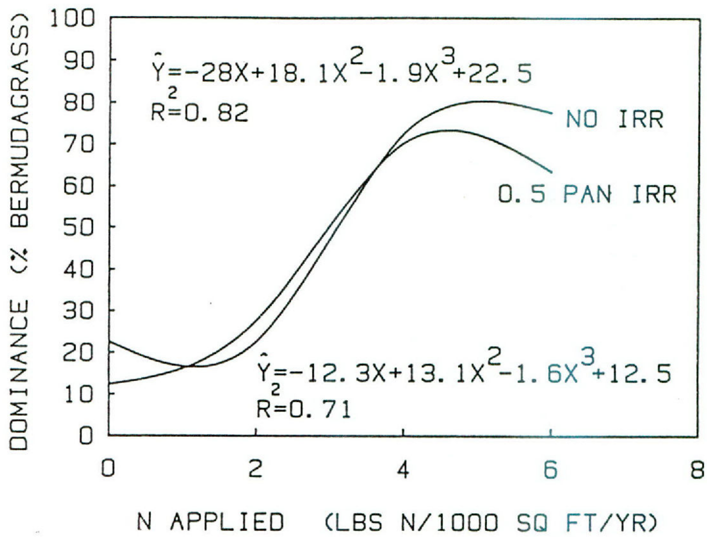

Figure 1. Bermudagrass dominance in a St. Augustinegrass stand with four levels of N fertilization and two irrigation regimes. Upper equation corresponds to nonirrigated treatment.

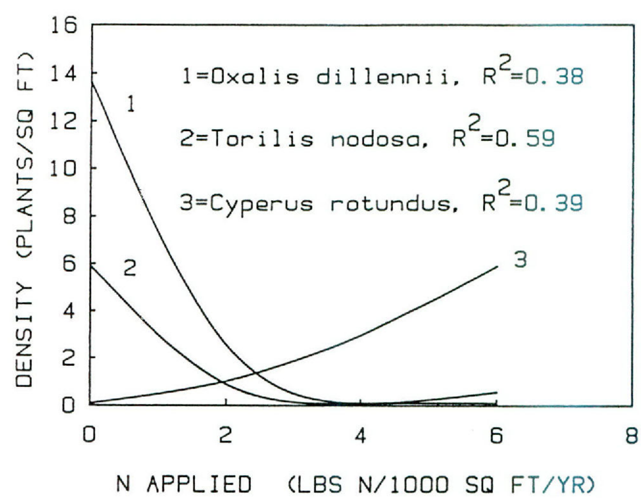

Figure 2. Densities of three weed species in St. Augustinegrass with four levels of N fertilization.

Results and Discussion

The most widespread invader of the St. Augustinegrass was common bermudagrass (Figure 1), with the level of dominance increasing greatly between 2 and 4 lb N. This result was independent of the presence or absence of irrigation application ($R^2 = 0.79$ combining irrigation treatments). Stand dominance by common bermudagrass increased by 53.8 percent between 2 and 4 lb N application rates, but no further increase was noted at the 6 lb N level. Stand dominance levels for common bermudagrass were 17.5, 25.0, 71.3 and 7.0 percent at the 0, 2, 4, and 6 lb N levels, respectively. In early spring 1984 and 1985, the St. Augustinegrass receiving higher N (4-6 lb/1000) was more delayed in its greenup than either the St. Augustinegrass plots receiving no or low (2 lb/1000) N, or the common bermudagrass inherently present from previous invasion. We have also observed a higher percentage of winter kill of St. Augustinegrass receiving higher N (4-6 lb/1000) as compared with that receiving no or low N (2 lb/1000). This winter kill tendency thus delayed spring greenup of plots receiving high N and likely contributed to common bermudagrass gaining advantage and invading these treatments. Little common bermudagrass invasion (17.5% dominance) occurred in the 0-N sub-plots with and without irrigation, however, turf color was poor and texture was coarse.

Yellow woodsorrel (*Oxalis dillenii* Jacq.), knotted hedgeparsley. [*Torilis nodosa* (L.) Gaertn.], and purple nutsedge (*Cyperus rotundus* L.) occurred often enough in the St. Augustinegrass to comprise separate tally classes. Figure 2 shows the response of these three weeds with varying rates of N. Numerous yellow woodsorrel (14.3 plants/sq ft) and knotted hedgeparsley (5.9 plants/sq ft) plants were found at the 0-N level, but densities dropped dramatically at the 2 lb N level, where means were 0.8 and 0 plants/sq ft, respectively. While the total number of yellow woodsorrel and knotted hedgeparsley plants in both irrigation treatments showed a highly-significant ($p = 0.005$), negative response ($R^2 = -0.66$) to fertilizer rate, common bermudagrass dominance was positively correlated ($p = 0.003$, $R^2 = 0.79$) with fertilizer rate, suggesting the possibility that exclusion of these weeds was a function of increased showed bermudagrass invasion. Data analysis, in fact, showed a moderate, negative correlation ($R^2 = -0.42$) of weed density to common bermudagrass dominance, though not statistically significant ($p = 0.11$). Purple nutsedge was not present in the plots receiving no nitrogen, but increased to 1.1 plants/sq ft at the 6 lb N level. Invasion by grasses other than common bermudagrass was not influenced by the presence or absence of irrigation, or by N level in this study.

Small hop clover (*Trifolium dubium* Sibth.) and knotted hedgeparsley were the most prevalent weed species found in the common bermudagrass plots. Other broadleaf weeds and grasses comprised the final two tally classes. Level of N did not significantly ($p = 0.1$) affect weed density in the common bermudagrass plots, though there appeared to be fewer weeds with increased fertilization level. Mean weed densities for 0, 2, 4, and 6 lb N treatments were 3.8, 2.2, 2.1 ad 2.6 plants/sq ft, respectively. Densities of all weed classes except grasses were lower ($p = 0.008$) in irrigated versus nonirrigated plots (Table 1).

A statistical comparison of weed invasion between St. Augustinegrass and common bermudagrass was not made because of the three-year age difference in our stands. However, Table 2 shows the combination of 0.5 pan irrigation plus 4 lb N/1000 sq ft/yr resulted in the lowest weed densities in both grasses.

Conclusions

Results indicate stand purity and foliar density of Texas common St. Augustinegrass and common bermudagrass is a function of both adequate irrigation and proper, though not excessive, fertilization. Results also suggest the combination of 0.5 pan irrigation plus 4 lb N/1000 sq ft/yr in two split applications can reduce broadleaf weed invasion in both grasses. Our observations on St. Augustinegrass emphasize the importance of not fertilizing this grass with N in late fall to prevent winter kill and late greenup which might give invading common bermudagrass an advantage. The dramatic increase in weed occurrence in the common bermudagrass nonirrigated plots could be attributed to lower stand density and resulting ground exposure, providing opportunity for weedy plants more tolerant of moisture stress and surface temperature extremes.

Table 1. Densities (plants/sq ft) of various weed types in bermudagrass under two irrigation regimes.

Weed type	No Irr.	0.5 Pan Irr.	PR > F
Trifolium dubium	5.3	1.2	0.002
Torilis nodosa	4.9	0.4	0.001
Other broadleaf weeds	3.9	0.9	0.003
Grasses	2.3	2.5	0.967

Table 2. Weed densities (plants/sq ft) in St. Augustinegrass and bermudagrass under various irrigation and fertilization regimes.

	No Irr.				0.5 Pan Irr.			
N rate (lb/1000/yr)	0	2	4	6	0	2	4	6
St. Augustinegrass	6.1	2.5	0.9	1.6	3.6	0.4	0.3	1.1
Bermudagrass	4.9	3.1	3.9	4.4	2.6	1.3	0.3	0.8

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PR-4528

The Effect of Perennial Ryegrass Overseeding Rates on Annual Bluegrass Invasion

W.G. Menn and J.B. Beard

Introduction

Annual bluegrass (*Poa annua* L.) is by far the number one cool-season grassy weed problem on most golf courses and resort lawns throughout the South. This is especially true on winter overseeded bermudagrass (*Cynodon* spp.) greens where one or more cool-season turfgrasses are being maintained, while simultaneous annual bluegrass control is being attempted. There have been several chemical approaches attempted to selectively control annual bluegrass in winter overseeded situations.

When perennial ryegrass use for winter overseeding started to increase, seeding rates of 40 to 45 lbs/1,000 sq ft (95 to 106.7 kg are^{-1}) were common. At these higher seeding rates, annual bluegrass was seldom a problem on greens. Through the years seeding rates have decreased to the extent that it is not uncommon for perennial ryegrasses to be overseeded onto bermudagrass greens at rates of 20 to 25 lbs/1,000 sq ft (47.5 to 53.4 kg are^{-1}). At these lower rates, annual bluegrass may become a serious weed problem on overseeded greens that are mowed closely. Thus, this study was conducted to examine the effect of winter overseeding rate and resultant competition on the occurrence of annual bluegrass.

Materials and Methods

The site for this study was a 6,000 sq ft (5.58 are), rectangular shaped, relatively flat experimental green at the Texas A&M Turfgrass Field Research Laboratory in College Station, Texas. Approximately 2/3 of this green consists of a 23-year old stand of Tifgreen bermudagrass (*Cynodon* hybrid) and the remaining 1/3 contains a 19-year old stand of Tifdwarf bermudagrass (*Cynodon* hybrid). This green contains a sand modified root zone having a pH of 8.3.

In preparation for winter overseeding, the entire green was vertically mowed in six directions on September 27, 1985. The fungicide, Captan 50W, was sprayed over the entire area on October 21, 1985, at a rate of 8 oz of product per 1,000 sq ft (30.5 g are^{-1}).

An overseeding of Derby perennial ryegrass (*Lolium perenne* L.) at four seeding rate treatments (Table 1) was accomplished on October 28, 1985. Each seeding rate was replicated three times in randomized strips measuring 6 x 48 ft (2.4 x 19.2 m). Two replications were located on the Tifgreen bermudagrass and one replication on the Tifdwarf bermudagrass. The perennial ryegrass seed applied to each strip plot was worked into the turf by dragging each plot in two directions using a 6 ft x 6 ft (2.4 x 2.4 m) piece of close-pile carpet with the pile side down. Irrigation was applied such that the surface of the turf remained moist during seed germination. After watering for 3 days, the entire area was topdressed with approximately 1/8 inch (0.32 cm) of masonry sand.

During establishment, mowing was accomplished with a triplex, riding greensmower, initially set at a 5/16-inch (0.8 cm) clipping height, and gradually lowered to and maintained at ¼ inch (0.64 cm) throughout the duration of the overseeding study.

Approximately 2.5 months following planting, perennial ryegrass plant counts were taken for each seeding rate to determine the stand density. Plant counts were based on the number of ryegrass plants per 4 sq. in. (25 cm^2) with three random counts being taken within each replication of the four seeding rate treatments.

Annual bluegrass plant counts were made on April 9, 1986, with measurements being based on the number of annual bluegrass plants per 64 sq. in, (400 cm^2).

Results

As mentioned earlier, during the past 15 years overseeding rates for the perennial ryegrasses have been reduced to almost half of the earlier recommended rate. This reduction might be attributed to tighter budgets and/or the intent to cut seed costs. Another contributing factor to the decrease in overseeding rates is the assumption that by lowering seeding rates one has less ryegrass to eliminate in the Spring, thereby enhancing the chances for a smooth Spring transition. Whether or not this assumption is correct is yet to be proven. Studies are underway at Texas A&M University to either prove or disprove this theory, which unfortunately is already being practiced.

Regardless of the reason for reducing overseeding rates, this study evaluated the effects of overseeding rates on annual bluegrass infestation. As might be expected, a higher winter overseeding plant population resulted in a lower incidence of annual bluegrass, while lower seeding rates caused a higher occurence of the weedy pest (Table 1). It appears to have been strictly a competition effect (i.e. the higher the plant density of perennial ryegrass, the greater the likelihood of crowding out the annual bluegrass).

Table 1. The influence of winter overseeding rates of Derby perennial ryegrass on the invasion of annual bluegrass.

Seeding Rate lb/1,000 sq. ft. (kg are^{-1})	Plant Count per sq. in. (5 cm^2) Derby Perennial Ryegrass	Annual Bluegrass
10 (23.7)	7.75 a*	2.00 a
20 (47.5)	13.70 b	1.00 b
30 (71.3)	17.25 c	0.75 bc
40 (95.0)	26.25 d	0.50 c

* Values followed by the same letter are not significantly different at the 0.05 level of Duncan's Multiple Range Test.

In summary, (1) perennial overseeding rates of 35 to 40 lbs per 1,000 sq. ft. (83 to 95 kg are^{-1}) have a marked effect on reducing annual bluegrass populations and (2) lower overseeding rates of 20 lbs or less per 1,000 sq. ft. (47.5 to 53.4 kg are^{-1}) definitely forms a more open turf community that is more conducive to annual bluegrass infestation.

Acknowledgment

This investigation was partially supported by a grant from the Texas Golf Association. A second experiment is planned for the next year.

An Assessment of Cutting Height and Nitrogen Fertility Requirements of Seashore Paspalum

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Introduction

Preliminary assessments indicate that certain seashore paspalum cultivars show promise in Texas as turfgrasses for use in highly saline conditions where bermudagrass growth is impaired (2). Several characteristics in terms of growth and morphology were compared with bermudagrass (1, 2). This is the initial report of an ongoing investigation concerning the cutting height and nitrogen fertility requirements of *Paspalum vaginatum* Sw. Literature references cite the common names of 'Adalåyd', 'Excaliber', 'sand knotgrass', and 'seashore paspalum'. The latter is now more commonly accepted.

Materials and Methods

This investigation was conducted at the Texas A&M Turfgrass Research Field Laboratory in College Station, Texas. The plot area was stolonized on April 26, 1984 at a rate of 10 bushels of sprigs per 1000 sq ft (36 m^3 ha^{-1}). The stolons were provided by Coastal Turf, Inc. Bay City, Texas. The soil was a sand modified fine sandy clay. Prior to planting, the soil was rotary tilled and fumigated with methyl bromide. The soil pH was maintained between 7.0 and 7.8 based upon an annual soil test. The plot size was 6 x 5 ft (1.8 x 1.5 m) with three replications of each treatment. Mowing was twice weekly with clippings removed. The cutting height treatments were 0.5, 1.0, 1.5, and 2.0 inches (1.5,2.5, 4.0, and 5.5 cm, respectively). Nitrogen was applied monthly during the growing season with nitrogen treatments of 0.25, 0.5, 1.0, and 1.5 lbs N/1,000 sq.ft.(13, 25,50, and 75 kg ha^{-1}, respectively) per month. The four cutting heights and four nitrogen fertility levels were imposed in all possible combinations. Phosphorus and potassium were applied as needed based on annual soil tests. Irrigation was applied as needed to prevent visual wilt. Herbicides, fungicides, and insecticides were applied as needed to prevent the serious loss of turf quality and stand. No vertical cutting or other cultivation technique was practiced.

Visual turfgrass quality and shoot density were assessed bi-weekly. The visual quality rating was based upon a 1 to 9 scale with 1 = poor and 9 = excellent. A ranking of 5 was the minimum acceptable turf quality.

Results

Two visual turfgrass quality ratings were made in late 1985. However, these data were not conclusive. The observers noted that quality differences were very difficult to obtain. The highest rating was 5 and lowest was 3. No significant differences were obtained in shoot density measurements affected by nitrogen fertility level. However, the trend indicated that higher shoot densities were associated with the lower mowing heights.

References

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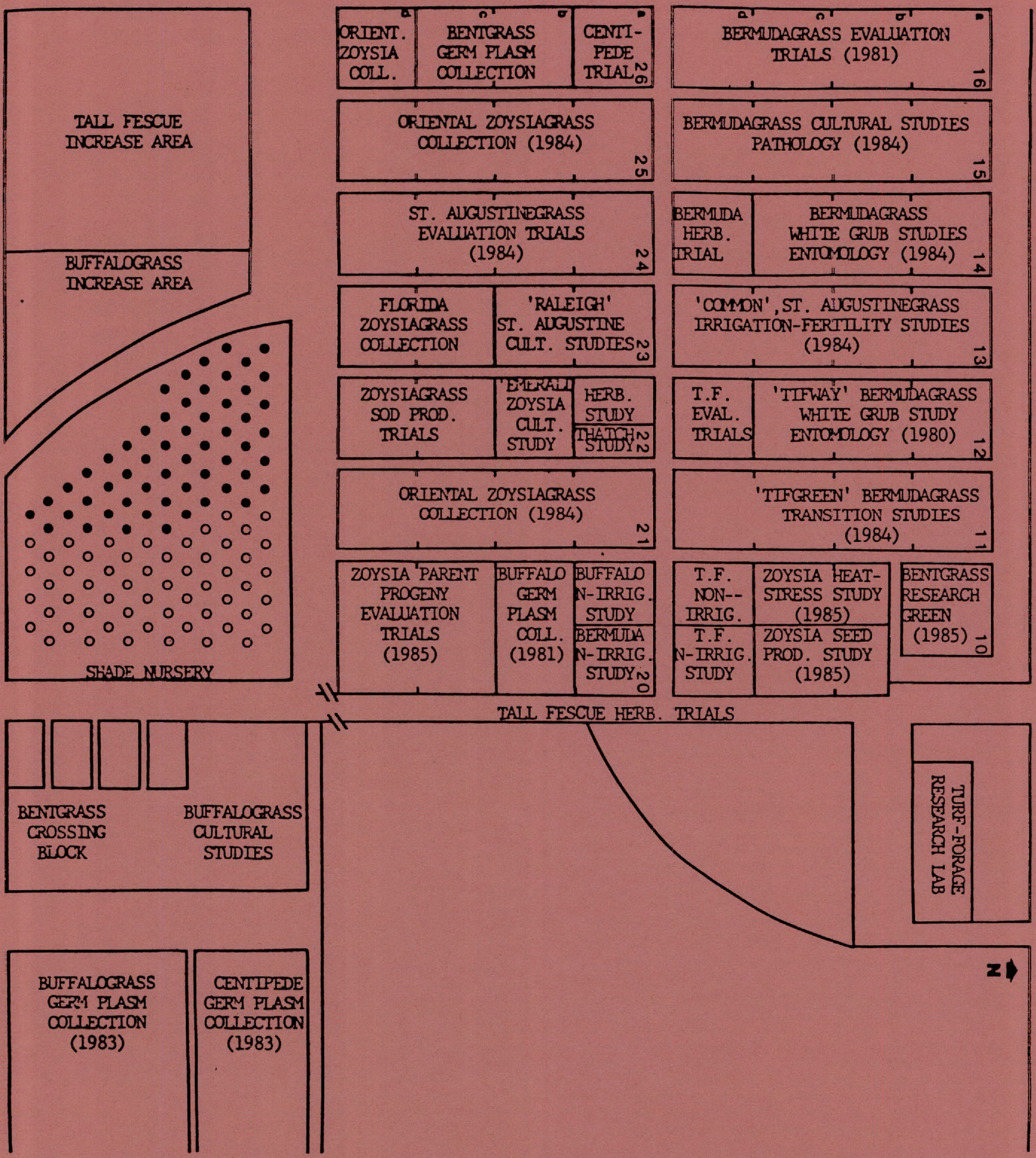

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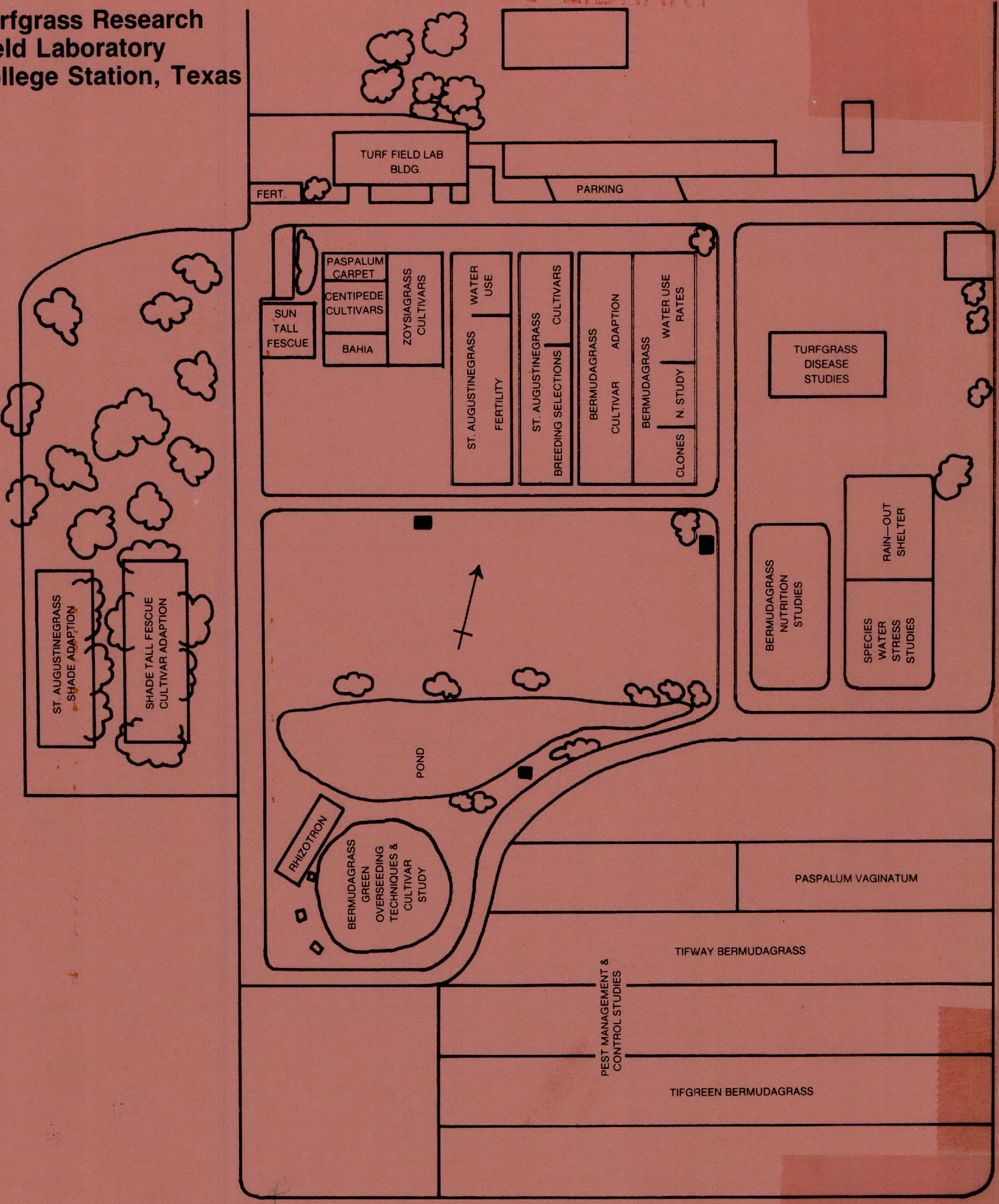

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