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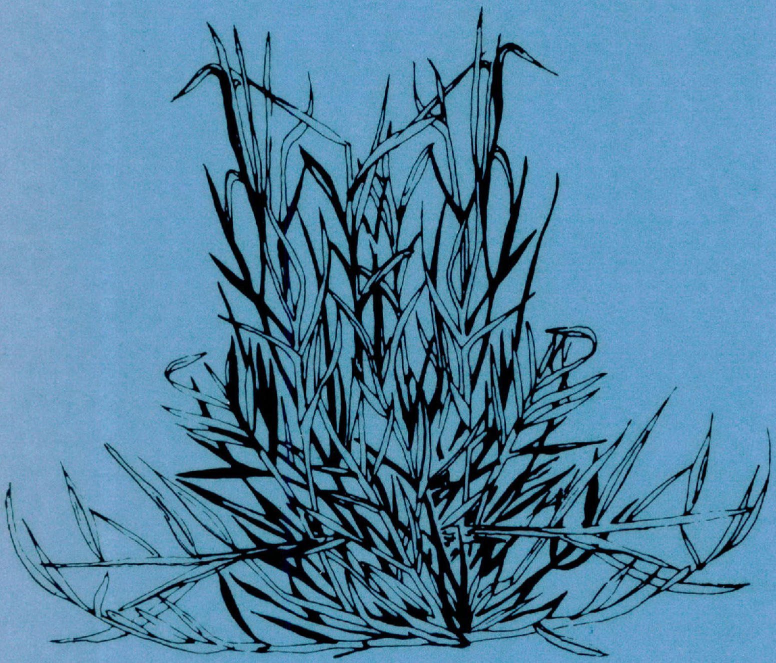

Texas Turfgrass Research — 1983

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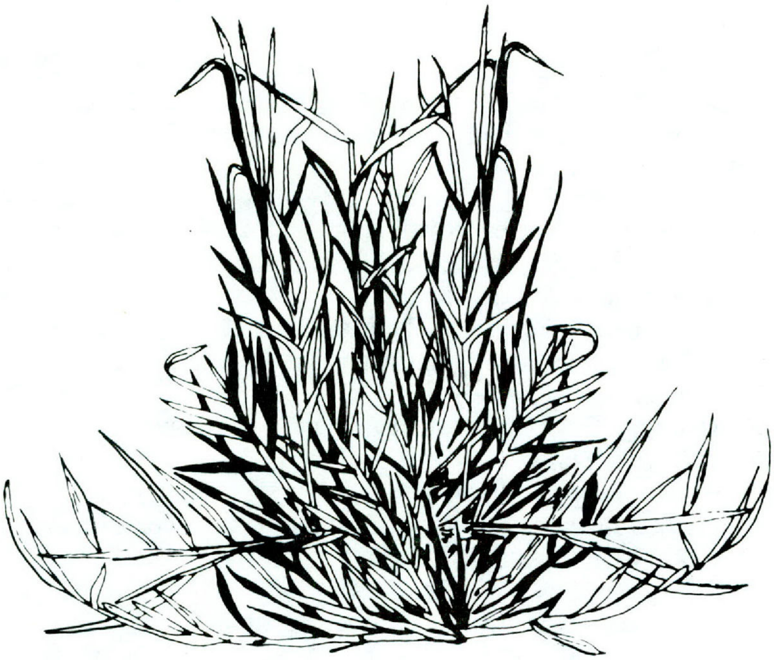

Texas Turfgrass Research — 1983

Contents

Turfgrass Usage In Texas

Size and Contributions

Turfgrasses for functional, recreational, and aesthetic uses cover approximately 3.2 million acres in Texas. The annual expenditure for establishment and maintenance of these turfs is estimated at approximately $840 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 will be 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 due to increased energy costs. 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, reseach 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 reseach 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 the quality of life.

WEATHER SUMMARY

SUMMARY OF MONTHLY TEMPERATURE AND PRECIPITATION PATTERNS FOR THE DALLAS AREA *.

	TEMPERATURE (MEAN MONTHLY F)			PRECIPITATION (INCHES)		
MONTHLY	1982-83	AVERAGE 1973-83	DEPARTURE FROM AVE.	1982-83	AVERAGE 1973-83	DEPARTURE FROM AVE.
JUNE,1982	78.1	79.4	-1.3	4.6	3.8	+0.8
JULY	81.9	84.5	-2.6	2.4	2.3	+0.1
AUGUST	85.2	83.2	+2.0	0.5	1.8	-1.3
SEPTEMBER	70.2	75.0	-4.8	1.2	3.5	-2.3
OCTOBER	63.1	65.2	-2.1	3.5	3.9	-0.4
NOVEMBER	53.2	53.7	-0.5	4.4	2.0	+2.4
DECEMBER	46.8	45.4	+1.4	4.3	1.8	+2.5
JANUARY,1983	42.0	39.9	+2.1	2.6	2.4	+0.2
FEBRUARY	46.3	45.6	+0.7	1.4	1.9	-0.5
MARCH	53.1	55.6	-2.5	3.7	3.2	+0.5
APRIL	59.4	63.3	-3.9	0.5	3.4	-2.9
MAY	68.4	71.1	-2.7	5.4	5.8	-0.4

*Measured at the Texas Agricultural Experiment Station, Coit Road, Dallas, Texas.

Summary of monthly temperature and precipatation patterns for the College Station Area*.

Month	Temperatures Monthly 1982 Max.	Min.	Ave.	1933-61 Ave.	Departure	Precipitation(inches) 1982	1933-61 Ave.	Departure
January	61.9	37.6	49.8	51.1	-1.35	1.44	2.86	-1.42
Feburary	63.3	38.8	51.1	54.6	-3.55	2.26	2.93	-0.67
March	73.0	49.1	61.1	61.6	-0.5	2.40	2.67	-0.27
April	78.0	56.1	67.1	68.2	-1.15	4.67	3.73	+0.94
May	83.0	63.5	73.3	68.2	+5.05	5.98	4.44	+1.54
June	91.1	69.0	80.1	75.6	+4.45	2.00	3.72	-1.72
July	95.3	72.8	84.2	84.5	-0.3	3.58	2.88	+0.7
August	96.5	72.6	84.6	84.8	-0.2	2.93	2.56	+0.37
September	91.8	65.2	78.2	79.4	-0.9	3.18	3.30	-0.12
October	79.2	55.6	67.4	70.7	-3.3	6.89	2.84	+4.05
November	69.6	48.8	59.2	59.1	+0.1	4.09	2.31	+1.78
December	66.6	42.2	54.4	53.6	+0.8	2.13	3.50	-1.37

*Measured at the Texas A&M Turf Farm Station, College Station, Texas.

Acknowledgment of Research Support

A substantial portion of the research results reported herein could not have been accomplished without the grant support and the equipment, chemical, and plant material contributions from foundations, associations, and companies within the turfgrass industry. Thus, it is only appropriate that these very important contributions be recognized. The specific granting agency is acknowledged at the end of the appropraite progress report being supported. In addition, general grants for support of the field laboratory operation were provided by the *Texas Sod Producers Association* and the *Texas Turfgrass Association.*

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. Through their cooperation, the available operating monies can be utilized primarily for employment of personnel needed to maintain the experimental plots. Their assistance is gratefully acknowledged. Vital major donations of equipment have been given by *Goldthwaites of Texas, Jacobsen Manufacturing Company, The Toro Company, Watson Distributing Company,* and *Yazoo Manufacturing Company.* A complete summary of the companies that have given donations of equipment, chemicals, and materials is listed on the facing page.

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 A&M University turfgrass research and teaching programs.

Equipment

Billy Goat Co. –CS
Brookhollow Golf Club –CS
Bunton Co. –CS
Champions Golf Club –CS
Dow Chemical USA –D
Chemical & Turf Speciality Co. –CS, D
FMC Corporation –CS
Goldthwaites of Texas –CS
Jacobsen Manufacturing Co. –CS
O.M. Scott & Sons –CS, EP
Ryan Division, OMC Lincoln –CS
The Toro Co. –CS, D, EP
Watson Distributing Co. –CS
Yazoo Manufacturing Co. –CS

Fertilizer, Pesticides, and Chemicals

Agricultural Products, Inc. –EP
Aquatrols Corp. of America –CS, D
BASF Wayandotte Corp. –CS
BFC Chemicals, Inc. –CS
Chemagro Agricultural Div. of Mobay –CS, D
Cheveron Chemical Co. –CS, EP
CIBA–Geigy Corporation
Agricultural Division –CS, D
Diamond Shamrock Corporation –CS, D
Dow Chemical Co. –D
E. I. DuPont de Nemours & Co., Inc. –CS
Elanco Products Co., a Division
of Eli Lilly –CS, D
Estech, Inc. –CS
Great Salt Lake M&M Corporation –EP
Hercules Incorporaed –CS
LESCO Products –CS, D
Milwaukee Sewerage Commission –CS
3M Company –CS
MAAG Agrochemicals –CS
Mallinkrodt, Inc. –CS, D
Monsanto Co. –CS, D, EP
PBI/Gordon Corporation –CS, EP
Rhone–Poulenc, Inc.,
Agricultural Division –CS, EP
Rohm & Haas Company –CS
Stauffer Chemical Co. –CS
Tuco Products, Division of the
Upjohn Co. –CS
Velsicol Chemical Corporation –CS

Seed and Sod

A.G. SOD –EP
Douglas W. King Co., Inc. –CS
Harpools Seed, Inc. –D
International Seeds, Inc. –CS
Lofts Pedigreed Seed, Inc. –CS
Milberger Turf Farms –CS, D
Northrup King & Co. –CS
O.M. Scott & Sons –CS
Pickseed West, Inc. –CS
Southern Turf Nurseries, Inc. –CS
Southwest Hydromulchers –D
Turf Seed, Inc. –CS, D

Soil Amendments

McMaster's –CS

Urban Water Conservation Research at Lubbock, 1982

Summary

Studies initiated in 1981 to evaluate water losses from sprinklers were continued in 1982. Commercially available lawn sprinklers (rotating, traveling, buried head, impact, ring, oscillating) and a drip hose were evaluated in the studies. As in 1981, the water losses in 1982 at night were found to be 50 percent of those obtained during midday. Lawns should be irrigated between midnight and 8 a.m. to make the most efficient use of applied water.

Water losses from a group of ten buried head sprinklers in 1982 were less than 1/3 of those obtained from a single buried head in 1981. Although many homeowners use single buried head sprinklers in Lubbock, they should be discouraged because of the high water loss.

Losses from the ring sprinkler are apparently higher when it is operated at a higher pressure. Data from the impact, rotary, traveling, and oscillating sprinklers in 1982 were similar to those obtained in 1981. Losses of applied water ranged from 5-20 percent at night to 15-30 percent during the day.

More of the water applied with the drip irrigation hose was lost than expected. Possible causes include higher temperatures due to the black tarp and polyethylene line with emitters which applied water as spray rather than droplets.

Since a black plastic tarp, rather than a surface comparable to a lawn, was used to collect the water in the sprinkler evaporation studies, the data obtained represent qualitative rather than quantitative comparisons of sprinklers. However, where the sprinklers were operated the same way both years, the data were comparable.

Comparison of three different irrigation regimes on water use efficiency in turf was continued in 1982. The data obtained support those obtained in 1981 in that the infrequent heavy irrigations resulted in the highest quality turf for the longest period of time for the amount of water used. More information is needed concerning the criteria for initiating irrigations before recommendations can be made to the homeowner.

To determine if differences in water requirements exist among turfgrass species, zoysiagrass, tall fescue, bermudagrass and buffalograss were established under a portable rainout shelter. Irrigation water requirements during the establishment period were [zoysiagrass (4.8 in.) = tall fescue (4.8 in.) > bermudagrass (2.7 in.) > buffalograss (1.2 in.)]. Total water requirement (irrigation + soil water) also differed [tall fescue (7.2 in.) > zoysiagrass (6.7 in.) > bermudagrass (4.5 in.) > buffalograss (3.6 in.)]. It should be emphasized that these water requirements were those necessary to maintain quality turf during the establishment period and may not be related to the relative requirements during a normal growing season following establishment.

The growth regulator studies initiated in 1981 were continued in 1982. The growth regulators in 1981 had no residual effect on turf in 1982. Of the chemicals applied in 1982, Embark treatments were shorter and produced significantly less wet and dry weight than the controls, but the trend did not continue. It appears that future studies of growth regulators should include multiple applications.

PR 4147

Identifying Genetic Variation in Root Systems of Turfgrasses

V. G. Hickey and M. C. Engelke

Introduction

Water Quality and availability are major focal points in the present-day agricultural and urban communities and are expected to be greater concerns in the future. the urban community presently utilizes about 15% of the total annual water consumption in this nation. Of this portion, estimates exceed 60% (9% of total) being used for urban landscapes, i.e., turf and ornamental plantings. A 33% increase in water useage is projected by the year 2000 with primary increases directed toward industrial and municipal use (Carter, 1980).

Increasing demands on a finite water supply dictate that research must be directed to reducing dependency on water, and increasing the efficiency of water use, especially in plant materials utilized in our urban landscapes. The soil provides physical support for the plant, and in addition, serves as a water reservoir. The volume of the water reservoir available to the plant is directly related to the depth and distribution of the root system. If the rooting system of a plant can be extended, the plant has a larger volume of water available. This type of plant will be a more efficient user of natural water supplies simply by having access to it. Such plants can harvest water from throughout the total soil profile. Plant root depth and distribution are greatly influenced by factors such as soil texture, pH, fertility, and moisture content. The depth of a turf's root system also is influenced by cultural practices such as irrigation duration and frequency, fertilization, and height of mowing. Close, frequent mowing results in a shallow root system. A plant's maximum biological limit for growth is defined by its genetic composition. Hurd (1960) reported genetic variability exists for rooting depth in wheat. Jordan and Miller (1980) demonstrated genetic variation in root distributions among sorghum genotypes.

This study was designed to develop a technique from which large numbers of plant materials could be evaluated for variability in root depth, distribution, and rate of development.

Materials and Methods

Polyethylene tubing, 3 ml thickness, 3.2 cm in diameter, was cut to 70 cm lengths. One end was heat sealed and perforated for drainage. This clear tube was then filled with 1000 g (+/−20 g) of fine washed sand, 97% which passed U.S. sieve size no. 30. Polyvinyl chloride pipe (PVC), 4.5 cm diameter, was cut to 62 cm lengths. The sand filled tube was then inserted inside the PVC pipe. A wire grid was positioned in one end of the PVC pipe to provide bottom support and unrestricted drainage. The entire tube assembly was tapped slightly to pack the sand to form a column of sand 62 cm in length. Three species of turfgrass were selected for study of rooting characteristics: St. Augustinegrass *(Stenotaphrum secundatum* (Walt.) Kuntze), buffalograss *(Buchloe dactyloides* (Nutt.) Engelm.), and zoysiagrass *(Zoysia japonica* (Steud)).

Six tillers having four emerged leaves with the fifth leaf just emerging were selected from each clone in the study. The tillers were prerooted in flats of moist sand which were covered with clear polyethylene to maintain high humidity and reduce dessication. On the 12th day, the three most uniform tillers were selected for each cultivar, and carefully transplanted to sand tubes. After planting, the tubes were transferred to a controlled environment chamber and placed at an angle of approximately 30 degrees from vertical to promote root growth along the lower inside of the plastic tube. The tubes were arranged in a randomized complete block design with three replications. The plant material was grown at 29 degrees C with a 16 hour photoperiod using cool white florescent lamps. Plants were watered to prevent more than the top 1 cm of sand from drying.

Plants were not fertilized or clipped during the duration of the study. Daily root growth was observed along the lower surface of the clear tubing. Root lengths were measured from the intersection of crown and sand. At the termination of the study, the tube was split and the sand was washed away from the root system. The moist root system was cut into 10 cm length segments, air dried and weighed. Number of major roots was counted at the crown, 5, 10, and 20 cm intervals. A log transformation was applied to the length data, after which it was analyzed as a nested design. Data is presented only for the extreme values for differences between clones within a specie.

Results

Statistical differences in root lengths existed among species after 18 days of growth (Table 1). St. Augustinegrass roots averaged 25% deeper than buffalograss roots, with the zoysiagrass roots 6% deeper than the buffalograss after 18 days. As a specie, St. Augustinegrass achieved a greater total root length and rate of elongation than did zoysiagrass or buffalograss. The variability present among clones within a specie for rooting depth appears greatest among the zoysiagrass clones (Table 2). Zoysiagrass clone 1047 was the deepest rooting clone after 80 days. After 49 days, St. Augustinegrass clone 309.01 achieved no additional root length. This would suggest certain genotypes have a maximum length they will attain. A similiar pattern exists for both clones of buffalograss, although their total depth is considerably less than either the St. Augustinegrass or zoysiagrass. Differences existed between species and between clones of a specie in amount of root mass produced per 10 cm segment of soil profile (Table 3). The tillers examined in this study produced different numbers of major roots in the various levels of soil profile (Table 4).

Data collected in this study indicate that genetic variability exists within the root systems of turfgrasses, and that this technique warrants further study for use in identification and selection of turfgrass root systems. However, this must be considered preliminary data, and further years of testing are necessary to validate this information.

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Table 1. Mean root length of 4 St. Augustinegrass, 3 zoysiagrass and 2 buffalograss clones grown in tubes of sand.

Days, num.	Zoysiagrass		St. Augustinegrass		Buffalograss	
	------------length, log transformed, or actual,cm-------					
	Trans.+	Act	Trans.	Act.	Trans.	Act
11	4.60a*	10.0	4.67a	10.70	4.56a	9.6
18	4.81b	12.2	4.97a	14.4	4.75b	11.5
28	5.12b	16.7	5.42a	22.5	4.97b	14.4
39	5.35b	21.0	5.75a	31.4	5.11c	16.5
49	5.46b	23.5	5.85a	34.7	5.22c	18.4
70	5.53b	25.2	5.90a	36.5	5.26c	19.2
80	5.58b	26.5	5.92a	37.2	5.27c	19.4

*Means within the same row followed by the same letter are not significantly different at the .05 level, determined by a paired t-test.
+Trans.= Log Transformed, Act.= Actual in cm.

Table 2. Mean lengths of six turfgrass clones grown in tubes of sand.

Days, Num	Zoysiagrass clone 1077		Zoysiagrass clone 1047		St. Augustinegrass clone 309.01		St. Augustinegrass clone 337.04		Buffalograss clone 1388		Buffalograss clone 1319.2	
	-----------------length, log transformed, or actual,cm------------------											
	Trans.+	Act.	Trans.	Act.	Trans.	Act.	Trans.	Act.	Trans.	Act.	Trans.	Act.
11	4.68a*	10.7	4.69a	10.7	4.86a	12.9	4.70a	11.0	4.93a	13.8	4.20b	6.7
18	4.73b	11.3	5.02b	15.1	5.12a	16.9	4.97a	14.0	5.10a	16.4	4.40b	8.1
28	4.98b	14.5	5.53a	25.2	5.57a	26.0	5.52a	19.4	5.39a	21.9	4.57b	9.7
39	5.21b	18.3	5.95a	38.4	5.86a	35.1	5.79a	26.0	5.49a	24.3	4.73b	11.3
49	5.27b	19.4	6.17a	47.8	5.98a	39.5	5.91a	30.5	5.57a	26.2	4.87b	13.0
70	5.31b	20.2	6.33a	56.1	5.98a	39.5	5.94a	33.7	5.60a	27.2	4.92b	13.7
80	5.36b	21.3	6.39a	59.6	5.98a	39.5	5.95a	36.1	5.61a	27.3	4.92b	13.7

*Means within the same specie and same row followed by the same letter are not siignificantly different at the .05 level determined by a paired t-test.
+Trans.=Log Transformed, Act.=Actual in cm.

Table 3. Mean dried root weight of six clones of turfgrass.

Root length from crown	Zoysiagrass ---clone----		St. Augustinegrass ------clone-------		Buffalograss ----clone---	
	1077	1047	309.01	337.04	1388	1319.2
	----------Wt/10 cm segment,mg.----------					
1-10	93ab*	71abc	116a	48bc	34c	58bc
11-20	33a	50a	57a	48a	19a	36a
21-30	8a	54a	29a	19a	6a	0a
31-40	0b	36a	23ab	16ab	0b	0b

*Means in the same row followed by the same letter are not significantly different at the 5% level by the Duncan Multiple Range Test.

Table 4. Mean number of major root intersections of three species of turfgrass.

Distance from crown ,cm	Zoysiagrass -----clone-------		St. Augustinegrass ------clone------		Buffalograss ----clone----	
	1077	1047	309.01	337.04	1388	1319.2
	----------number/intersection----------					
crown	5.3a*	2.0b	2.0b	1.0b	2.0b	2.0b
5	5.0a	2.0b	2.0b	1.0b	1.3b	1.7b
10	3.0b	2.0a	1.3a	1.0a	1.3a	1.0a
20	0.7a	1.3a	1.0a	1.0a	1.0a	0.7a

*Means in the same row followed by the same letter are not significantly different at the 5% level by the Duncan Multiple Range Test.

PR 4148

Spring Transition Enhancement of Winter Overseeded Bermudagrass Turfs

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

Introduction

There are two periods of transition on overseeded greens. The first period is in the fall during conversion of the permanent base bermudagrass to the temporary overseeded cool season grass species. The second, and perhaps more critical transition, is in the spring as the cool season species begins to decline and the base bermudagrass turf breaks dormancy. In the past, many different techniques have been used by practioners to promote even transition from one grass species to another. The ideal spring transition would result in no visual change in turfgrass quality from the cool season grass to the bermudagrass.

The purpose of this study was to determine the most desirable cultural technique or combination of techniques to achieve uniform spring transition. This study is part of a three-year investigation that is required to assess the effects of year-to-year weather variations.

Research Procedure

A seven-year-old Tifdwarf bermudagrass (*Cynodon* spp.) green was overseeded October 27, 1981, with Loretta perennial ryegrass (*Lolium perenne* L.). The plot size was 3 x 6 feet (0.9 x 1.8 m) in a randomized block design of three replications. Until initiation of the transition treatments, the entire area was mowed at 0.25 inch (6 mm) and maintained under typical greens conditions including irrigation as needed to prevent visual wilt. Transition enhancement techniques were initiated on 4-12-82 as follows:

Vertical Cutting Schedule	Nitrogen Rate (lb N/1000 sq. ft./growing month)	Mowing Height (inch)
None	2.0	0.25
"	2.0	0.15
"	1.0	0.25
"	1.0	0.15
Weekly	2.0	0.25
"	2.0	0.15
"	1.0	0.25
"	1.0	0.15
Twice Weekly	2.0	0.25
"	2.0	0.15
"	1.0	0.25
"	1.0	0.15

Both vertical cutting treatments were light and were accomplished using a powered walking-type unit. The blades were spaced 0.625 inch (1.6 cm) apart and adjusted to penetrate the turf approximately 0.2 inch (0.5 cm). The mower blades did not come in contact with the soil.

The fertilizer treatments were applied using a walking, drop-type spreader. Ammonium sulfate (21-0-0) was the nitrogen source. The higher nitrogen rate was applied weekly at 0.5 lb of actual N/1000 sq. ft. (0.25 kg/are). The lower nitrogen rate was applied bimonthly at 0.5 lb of actual n/1000 sq. ft. (0.25 kg/are).

The two mowing heights 0.25 inch (6 mm) and 0.15 inch (4 mm) were attained using a 22 inch (56 cm) walking-type greensmower. Both treatment areas were mowed 6 days per week with the clippings removed.

Assessment of turf responses included the percent of total turf cover and the percent visible bermudagrass shoots. Visual ratings of color were based on 9 = best and 1 = poorest. Rating dates for this study were May 5, May 19, and June 3, 1983.

Results

The 1982-83 results are based on a somewhat late initiation of transition treatments, but sustained bermudagrass shoot growth was also late even though shoot greenup was quite early. The following observations were made:

1. The most rapid transition to bermudagrass was promoted by the higher nitrogen rate and lower mowing height treatments. The frequency of vertical cutting did not seem to have an effect on bermudagrass recovery. As one might predict, the slowest bermudagrass recovery was produced by the combined treatments of no vertical cutting, lower nitrogen fertility, and higher mowing height.
2. Total plant cover was most affected by the frequency of vertical cutting. A semi-weekly vertical cutting regime was excessive at the depth setting used and resulted in decreasing plant cover throughout the transition period.

   The weekly and monthly vertical cutting treatments resulted in the most dense cover throughout the study.
3. Color of the overseeded turf was enhanced only by the higher nitrogen rate. The vertical cutting and the mowing height treatments showed no significant effect on verdure (green shoots below the cutting height) of the turf.

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PR 4149

1982 Bermudagrass Cultivar Characterizations

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

The need for bermudagrass *(Cynodon* spp.) cultivars characterized by low water use, less energy and labor costs in mowing, and in minimum nitrogen requirement has dictated a reassessment of the commercially available and near release bermudagrass selections. Results generated from these characterizations also will provide detailed background information concerning the available germplasm which may be of value in future breeding programs. The turfgrass characteristics under evaluation include the plant morphology, nitrogen fertility requirement, cold hardiness, water use rate, wear tolerance, and resistance to diseases and insects. This 1982 Progress Report includes seasonal evaluations of turfgrass quality and spring greenup.

This is the fourth year in a six-year study. A minimum of six continuous years is required to obtain reliable field evaluations of turfgrass cultivars. Thus, final conclusions concerning adaptation and performance of these bermudagrass cultivars cannot be made until the termination of this study.

Research Procedure

Nineteen bermudagrass *(cynodon* spp.) cultivars were planted in 1978 on a modified loamy and root zone at the TAMU Turfgrass Field Laboratory. The plot size is 5 x 15 feet (1.5 x 4.5 m), in a randomized block design of three replications. Sixteen of the cultivars were planted by sprigging, while Tifdwarf was sodded and both Arizona Common and NK 78098 were seeded. The plots are mowed twice weekly at 0.75 inch (1.9 cm) with clippings returned. In 1979 and 1980, the cutting height was 1.0 inch (2.5 cm). Irrigation is applied as needed to prevent visual wilt.

During 1979 and 1980 the entire area was fertilized at a rate of 0.5 lb nitrogen/1000 sq. ft./growing month (0.25 kg/are). Since 1981, three subplot nitrogen fertility differentials have been super-imposed across the cultivars at rates of 0.25, 0.5 and 0.75 lb of nitrogen/1000 sq. ft./growing month (0.12, 0.25, 0.37 kg/are). Phosphorus and potassium are applied as needed based on an annual soil test.

The use of preemergence herbicides or preventive insecticide/fungicide programs are avoided in this cultivar study. The pesticides are applied only as needed to prevent a complete loss of stand. To date, this has not been necessary. Such an approach gives a better opportunity to obtain data concerning the relative susceptibilities of the cultivars to disease causing pathogens and to insects.

Results

1982 Turfgrass Quality - The comparative seasonal performances of 19 bermudagrass cultivars are shown in Table 1. Visual estimates of turfgrass quality are based on two primary components: (a) uniformity of color, shoot density, and leaf texture, and (b) a high shoot density. Cultivars receiving a rating above 5.0 represent reasonable good quality. No significant disease susceptibility differentials were observed during the growing season. In the case of insects, the activity of the southern mole cricket *(Scapteriscus acletus)* was very evident by extensive tunneling in the bare alleyways surrounding the individual cultivar plots. No thinning of turfs within the plots was evident that could be attributed to feeding activity. However, Tifdwarf bermudagrass uniformity was noticably disrupted during the September period due to mounding activity of the southern mole cricket. It is possible that the adverse effects were obvious in the case of Tifdwarf because of its low growth habit and that similar degrees of upheaval were occurring in other cultivars. Perhaps more specific observations concerning differential effects among cultivars will become apparent in upcoming years.

After four years, the two bermudagrass cultivars, Tifgreen and Tifdwarf which are best adapted to closely mowed greens conditions, ranked first and fourth, respectively, in overall turfgrass quality. Both possess a very high shoot density, which increases the potential for thatch formation.

Also ranking high were Santa Ana, Tifway, Sunturf, Tiffine, and Midiron. These cultivars are used on sports fields, fairways, and quality lawns. Tifway is widely used for these purposes, while Sunturf and Tiffine have fallen into disuse. Two of these, Santa Ana and Midiron, are relatively recent releases.

Santa Ana, a southern California release from UC Riverside, continues to perform very well in these Texas tests and shows good promise for use on sports fields and recreational areas.

Midiron, a Kansas State University release, possesses very good low temperature hardiness which can be important in the Northern portions of Texas during severe winters.

Midway, also developed at Kansas State University, possesses superior low temperature hardiness. It ranked quite high during the first three full growing seasons, but has declined in turfgrass quality during the fourth year. The specific cause of this decline is not known, thus it will be important to carefully observe this cultivar during the fifth and sixth years to fully assess its future potential for Texas.

Ormond ranked very high during the first two growing seasons but has now declined substantially in quality. It is a Florida developed cultivar which was once widely used in that state, but now has decreased in importance due to bermudagrass mite susceptibility.

The two seeded bermudagrasses, NK 78098 and Arizona Common, ranked lowest with Texturf 1 F also ranking quite low. All three cultivars possess a low shoot density which was a significant factor in their low overall turfgrass quality. The deterioration of Arizona Common during the growing season, when mowed at the 0.75 inch (1.9 cm) cutting height, was particularly evident even in comparison with the other seeded cultivar NK 78098.

The within season variation in turfgrass quality for most bermudagrass cultivars was similar in terms of relative ranking with other cultivars. In contrast, Santa Ana possessed low turfgrass quality during spring-early summer but continued to improve through the September period when it was top ranked. Sunturf, Tiffine, Ormond, and Texturf 10 tended to have a similar seasonal variation in turfgrass quality. All reached their highest turfgrass quality during the period of extreme summer stress, particularly heat. Except for Midway and Ormond, these same cultivars tend to be quite late in spring greenup.

Four Year Turfgrass Quality Summary - Trends in seasonal turfgrass quality of the 19 bermudagrass cultivars over the second, third, and fourth full growing seasons after establishment are summarized in Table 2. All cultivars showed a general decrease in quality and performance when comparing the second through fourth years, with the relative decree of decrease varying considerably among the cultivars.

It is evident when comparing the 1980 evaluations with those of 1982 that the capability to sustain quality turfs over a period of years varies considerably among the cultivars. Tifgreen, Santa Ana, Tifway, and Tifdwarf not only had relatively high initial rankings, but also have been able to sustain a higher quality than the other fifteen cultivars. A second grouping of cultivars (Sunturf, Tiffine, Midiron, and Everglades) rank somewhat lower than the top four after 4 years, but are still sustaining an acceptable level of turfgrass quality (above 5.0). In contrast, the two seeded bermudagrasses which initially ranked relatively high have shown a drastic deterioration, especially Arizona Common.

Cultivars which exhibited substantial changes in relative ranking include the following: Everglades ranked quite high the second year but has since declined substantially in quality during the subsequent two years and Ormond ranked quite high in the second and third years but declined sharply during the fourth year. It will remain to be seen if this deterioration continues through the fifth and sixth years.

Spring Greenup Summary - The ability of cultivars to achieve early spring greenup can be important where early spring use is needed. A typical example would be baseball fields. One should not assume that cultivars possessing a rapid spring greenup rate also possess good low temperature hardiness.

It should be indicated that early spring nitrogen fertilization is a cultural technique that can be used to stimulate early spring greenup. The assessments made in this study were conducted under a uniform cultural program, including nitrogen fertilization. Thus, the data represent the inherent genetic characteristic of each individual cultivar. These summary assessments are based on statistical analyses made for the years 1980, 1981, and 1982. From three to six ratings were made during the thirty day period following March 10. The number of ratings varied depending on the rate of greenup.

The spring greenup rates of the 19 bermudagrass cultivars have been assessed at College Station, Texas, for the past three years (Table 3). Ranking very early in spring greenup were Pee Dee, Tifdwarf, Arizona Common, Midiron, Tifgreen, and NK 28098. In contrast Santa Ana, Tifway, U-3, and Sunturf ranked very late in spring greenup. The remainder of the nine cultivars ranked intermediate in this characteristic.

New Bermudagrass Entries - Three newly released bermudagrass cultivars were vegetatively planted into the Bermudagrass Cultivar Characterization study in June of 1982. Included were Midmow released from Kansas State University, Tifway II released from the USDA Tifton Georgia Station, and Vamont released from Virginia Polytechnic Institute and State University. It is far too early in the assessment process to report initial observations concerning these new entries. In the future they will be maintained under the same cultural regime and nitrogen differentials previously described. Quantitative evaluations of these three new cultivars will be presented in future annual Progress Reports.

Table 1. Comparative Turfgrass Quality of 19 Bermudagrass Cultivars in 1982 at College Station, Texas

Cultivar	Visual Turfgrass Quality (9 - best; 1 - poorest)				
	May	June	Sept.	Nov.	Seasonal Avg.
Tifgreen	6.3	6.5	6.3	4.7	6.0 a[1]
Santa Ana	4.3	5.7	7.2	6.3	5.9 a
Tifway	5.7	5.7	6.2	5.8	5.8 a
Tifdwarf	5.7	5.8	5.0	6.5	5.7 ab
Sunturf	5.3	4.8	6.0	4.8	5.3 abcd
Tiffine	4.8	5.2	6.2	4.8	5.3 abcd
Midiron	4.7	5.7	5.8	4.7	5.2 abcd
Everglades	4.8	4.7	5.2	5.2	5.0 bcde
Pee Dee	5.7	5.0	4.3	4.3	4.8 cde
Midway	4.2	4.3	5.8	4.2	4.6 cdef
Ormond	3.8	4.5	5.3	4.5	4.5 cdef
FB 119	4.8	4.7	4.8	3.3	4.4 def
Bayshore	4.3	5.2	4.5	3.5	4.4 def
Texturf 10	2.8	3.7	5.8	5.2	4.4 def
Tiflawn	4.5	4.0	4.7	3.8	4.3 ef
U-3	3.8	4.8	4.0	4.3	4.3 ef
Texturf 1F	3.3	4.5	3.7	4.0	3.9 fg
NK 78098	2.8	3.7	3.3	2.7	3.1 g
Common (Arizona)	2.0	2.5	1.8	1.7	2.0 g

[1]Values joined by the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 2. Trends in the Seasonal Turfgrass Quality of 19 Bermudagrass Cultivars Over The First Four Years College Station, Texas

Cultivar	Average Seasonal Turfgrass Quality[1] 2nd Year 1980	3rd Year 1981	4th Year 1982
Tifgreen	6.7	5.9	6.0
Santa Ana	6.8	6.0	5.9
Tifway	7.2	5.4	5.8
Tifdwarf	5.6	6.2	5.7
Sunturf	6.7	6.1	5.3
Tiffine	5.8	5.1	5.3
Midiron	6.3	5.3	5.2
Everglades	7.4	4.8	5.0
Pee Dee	4.5	5.3	4.8
Midway	6.3	6.4	4.6
Ormond	7.4	6.6	4.5
FB 119	6.6	4.5	4.4
Bayshore	6.4	5.3	4.4
Texturf 10	6.3	5.0	4.4
Tiflawn	5.7	5.1	4.3
U-3	5.3	4.4	4.3
Texturf 1 F	5.6	4.5	3.9
NK 78098	6.0	4.9	3.1
Common (Arizona)	6.4	3.5	2.0

[1]Visual estimates of turfgrass quality with 9 - best and 1 - poorest.

Table 3. Comparative Spring Greenup of 19 Bermudagrass Cultivars. College Station, Texas

Relative Ranking	Cultivar
Early	Pee Dee Tifdwarf Common (Arizona) Midiron Tifgreen NK 28098
Intermediate	Ormond Midway Tiffine Everglades FB 119 Texturf 1 F Bayshore Tiflawn Texturf 10
Late	Sunturf U-3 Tifway Santa Ana

PR 4150

Buffalograss Germ Plasm Diversity and Development for Semi-Arid Turf

M. C. Engelke, and V. G. Hickey

Buffalograss *(Buchloe dactyloides* (Nutt) Engelm.) is a warm-season perennial grass species native to the United States Great Plains area. It is an important range grass, and is one of a few native species which has considerable potential for use as an amenity grass that requires low energy inputs amd minimal maintenance. Its range of distribution extends from Canada to Mexico.

Relatively little effort has been put forth in developing improved buffalograss varieties. Only four cultivars are commercially available ('Texoka', 'Sharps Improved', 'Commanche' and a common type). All four were developed for improved forage characteristics. Beard et al. (1982) observed genetic variability among the four for leaf width, internode diameter, and competitive ability. It is a slow growing turf requiring only occasional mowing. Under adverse conditions such as minimal maintenance, buffalograss is highly competitive with other species. Buffalograss spreads by fine textured stolons which form a relatively loose, open turf. This characteristic, at least in commerical cultivars, precludes sod production as a means of effective distribution. In addition, seed are borne by the staminate plant (female) near the ground surface in multi-caryopsis burs. Seed production per unit area is low, and the harvest process is difficult. Freshly harvested seed are dormant, requiring special seed treatment procedures to stimulate germination (See Hickey, et al. PR 4169, this report).

Few insects have been reported on buffalograss. The low maintenance requirements, moderate-to-good wear tolerance, drought tolerance, and persistence of buffalograss indicated good potential for use on athletic fields and recreation areas where supplemental irrigation is not feasible. The species has potential for use in numerous landscape situations where introduced species have been employed previously.

A buffalograss collection was made throughout the southern Great Plains in 1981 in order to assemble additional germplasm of the species. No previous extensive collection has been made, nor has any specific effort been put forth to specifically identify germplasm or plant types with improved turfgrass characteristics. The collection was made in cooperation with the United States Department of Agriculture, Soil Conservation Service, Southern Region. Arnold Davis, Regional Plant Material Specialist, Cliff Williams, State Resource Conservationist, Richard Heiser, Plant Materials Specialist, USDA, SCS, Temple, Texas, and David Lorenz, Manager Plant Materials Center, Knox City, Texas provided the leadership within SCS. They were instrumental in coordinating the productive efforts put forth by the District Conservationists from as far south as Jim Hogg County in south Texas, and north into central Nebraska.

A space plant nursery was established December 20, 1981 from approximately 2" plugs of individual buffalograss plants. The initial planting included 93 clones, collected from 43 locations with no replication. Only 66 (81%) survived the winter; of these, 15 started spring growth as early as March 3. Numerous agronomic characteristics were monitored throughout the growing season. Considerable variation was noted for growth habit and plant type based on their relative internode length, physical length of longest stolon, leaf type, and color. Leaf color ranged from green to grey with intervening shades of blue. Under drought stress, numerous leaves tended to curl, whereas leaves of many other accessions remained straight. Variation within the collection for vegetative density, sex, flowering habit, and flowering density indicate progress should be possible for improvement in reproductive characteristics such as seed production and possibly sod production. Growth rates and turf quality were quite variable according to the area of plot coverage and relative density in August, and November, 1982.

Mites, of yet an unknown species - suspect is a Eriophyid (Crocker-personal communication) - differentially infested the entire population under field conditions. The mite inoculum source was traced to surrounding grain sorghum fields. Plants were evaluated and rated on a scale where 1 = heavy mite damage and 9 = no damage. Although no plants were totally free of the mite, several appeared to support relatively low populations of the mite and expressed less damage. The plant materials utilized in this planting were directly from the material received from the Plant Materials Center, and the purity of each accession was in question. Therefore, each of the plants was regenerated from a single stolon under greenhouse conditions to ensure a pure (uniform) genotype. Some plants within this collection as well as others have demonstrated their ability to produce both pistillate and staminate flowers (males and females). Based on the information collected in this initial planting, an additional planting was made from seed lots collected by SCS personnel. The 1983 planting consisted of approximately 15 plants of each of 60 entries. This expanded germplasm planting has also been complemented by numerous other collections made over the past 3 years. In total the 1983 collection consists of nearly 1400 individual plants for which numerous agronomic and turf characteristics will be recorded. The variability evident in the initial planting shows considerable promise in the availability of necessary genetic diversity to develop improved turf-type buffalograsses for use in domestic and industrial turf sites.

Literature Cited

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PR 4151

Centipedegrass Variety Performance in North Texas

M. C. Engelke and V. G. Hickey

Centipedegrass *(Eremochloa ophiuroides* (Munroe.) Hack.) is a warm season turfgrass introduced into the United States from China in 1916. The species has been restricted in its utility throughout the southern United States due to its generally slow establishment rate, limited seed availability, poor winter hardiness, and limited adaptation to acidic, high moisture soils (Beard, 1973).

In recent years, efforts have been put forth to select and develop varieties adapted to marginal environmental conditions. Specific emphasis has been directed toward cold hardiness, late season color retention, rapid establishment, early spring greenup, and adaptation to a broad range of soil pH.

Materials and Methods

In August 1981, a randomized complete block, three replicate planting of 20 centipedegrass experimental varieties (EXPERVARS) was established in an Austin silty clay soil (fine-silty, carbonetic, thermic, Entic Haplustolls) with a pH ranging from 7.7 to 8.3 at the TAES-Dallas center. Water infiltration rates of less than 0.1 inches per hour are common in these soils. The plots measuring 4.5 m^2(49 ft^2) were established from a single 2 inch greenhouse pot planted in the center of the plot area. The potted material had been previously grown under similiar greenhouse conditions to ensure uniformity of material. The nursery was irrigated to prevent wilt, and received the equivalent of 97.6 kg/ha (2#/1000 ft^2) of soluble nitrogen applied in May and July of 1982. The plots were mowed weekly to maintain a height of cut at 5 cm (2 inch).

Results and Discussion

The winter of 1981/82 was considered particularly severe for the Dallas/Fort Worth area with low temperature readings of -13'3 C (8° F) occurring on two consecutive nights in February, The last frost of the year occurred on March 6, with the first sign of greenup among the varieties occurring March 9, 1982 in AC 20 (Ent#14, an Alabama entry) (Table 1.). Notes were taken throughout the spring and early summer to identify the date of greenup and general performance of each of the acessions. CT171 (#2) from Tifton, Georgia was the latest to green. The Tifton lines demonstrated the poorest winter survival at Dallas. Only one of the three replicates of CT181 and CT171 (#1 and 2) survived the winter, and only two of the three plots of CT178 (#5) ad Common (#8) survived. On 27 April the percentage of plot greenup was estimated based on the size of the plot present in the fall of 1981. The areas range from less than 1% (CT171) to as much as 58.3% (AC44).

Following the spring and summer growth of 1982, the percent of plot coverage was estimated in the fall of 1982, which reflected the amount of growth present for each of the entries. AC44 (#16) had demonstrated the most growth, followed closely by several of the other Alabama selections. Of the Georgia selections, CT172A (#3) demonstrated the most growth. Fall color was assessed on November 5, prior to onset of winter dormancy. CT171 (#2) and PI414363 (#11) appeared to retain the most color. On 17 November the first killing frost was experienced on the plots. The 19 November note on frost damage identified several expervars which were susceptible to the frost (1 = most damage), while other entries demonstrated considerably less damage. The winter of 1982/1983 was milder as none of the accessions completely entered into dormancy, i.e. green tissue was evident on all entries throughout the winter months.

The information presented here is based on a single year of performance and should not be considered as a recommendation as to the utility or adaptation of any of the experimental varieties. Further testing of the experimental varieties of centipedegrass is essential to fully assess the adaptability and utility of the species in the North Texas area.

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TABLE 1. CENTIPEDEGRASS VARIETY EVALUATION AND PERFORMANCE TRIALS AT TAES-DALLAS 1981/1982.

EXPERVAR	ENT #	%SURVIVAL[1] APR 27	DATE[2] GREENUP	%GREENUP APRIL 27	%COVER NOV 5	COLOR[3] NOV 5	FROST[3] NOV 19	SOURCE
CT181	1	33	82.0	2.0	5.0	3.0	2.0	TIFTON,GA
CT171	2	33	90.0	0.0	5.0	7.0	1.5	TIFTON,GA
CT172A	3	100	71.7	3.3	30.0	4.0	3.0	TIFTON,GA
CT180	4	100	69.7	19.7	13.3	5.0	4.0	TIFTON,GA
CT178	5	67	72.5	6.0	3.0	6.0	3.0	DALLAS,TX
CT177	6	100	85.3	3.3	4.7	4.0	2.7	TIFTON,GA
CT169	7	100	69.7	23.3	20.0	4.0	3.3	TIFTON,GA
COMMON	8	67	73.3	7.5	10.0	3.5	2.7	TIFTON,GA
CT173	9	100	74.3	2.0	8.3	5.0	3.0	TIFTON,GA
CT179	10	100	73.7	16.0	15.0	4.0	2.7	TIFTON,GA
PI414363	11	100	70.3	50.0	26.7	7.0	3.7	EXPERIMENT,GA
AC12	12	100	70.7	37.0	11.7	3.0	3.0	AUBURN,AL
AC17	13	100	69.0	26.7	20.0	6.0	3.3	AUBURN,AL
AC20	14	100	68.7	40.0	43.3	4.0	2.7	AUBURN,AL
AC26	15	100	69.0	28.3	41.7	5.3	4.0	AUBURN,AL
AC44	16	100	70.3	58.3	45.0	5.0	4.3	AUBURN,AL
AC71	17	100	69.7	48.3	30.0	5.3	3.0	AUBURN,AL
AC91	18	100	73.7	3.7	4.3	4.7	2.3	AUBURN,AL
AC106	19	100	70.0	45.0	41.7	6.3	3.7	AUBURN,AL
DALCT1208	20	100	71.7	10.0	41.7	5.7	4.0	GREENVILLE,TX

[1] Percentage of the plots which survived, i.e. 33 = 1 out of 3 plots survived
[2] Indicates Julian date, i.e. 68 = March 9.
[3] Based on 1 to 9, where 9 = best performance, for Frost, 1 = severe damage

PR 4152

Comparison of Perennial Ryegrass and Rough Bluegrass Mixtures for Overseeding Home Lawns

M. C. Engelke and J. W. Nolan

Common bermudagrass *(Cynodon dactylon* L.Pers) is the most widely used lawn turfgrass within the Dallas-Fort Worth area. Winter dormancy occurs by mid-November and spring green-up normally occurs in mid-April. During dormancy, homeowners are faced with an unappealing brown turf with sporadic patches of green winter annual weeds. Overseeding of dormant bermudagrass with cool season turfgrasses will improve the appearance and utility of the home lawn. This study examined several variables which influence the performance of cool season grasses overseeded on common bermudagrass turf. The performance of perennial ryegrass *(Lolium perenne* L. var. Regal) and rough bluegrass *(Poa trivialis* var. Sabre) were evaluated in pure stand, in mixtures of various percentages and seeding rates, for establishment, uniformity and coverage.

Research Procedure

Four seeding rates were used with seven different mixtures of perennial ryegrass and rough bluegrass to overseed a lawn area of common bermudagrass at the Texas Ag. Exp. Stn., Dallas. Seeding rates for monocultures of perennial ryegrass and rough bluegrass are as follows:

Seeding rates:

Composition of seeding mixtures were set at 100%, 90%, 75%, and 50% for each specie on a pure live seed basis yielding seven different treatment combinations per seeding rate. Three replicatons were used in a randomized complete block design. Prior to planting, the area was mowed to 2.5 cm height with clippings collected. The treatments were seeded on 16 Oct. 1980. The seed was mixed with sand and hand sown within a 1.8m x 1.2m (6' x 4') plywood planting frame. Multiple irrigations were applied daily to move seed through the thatch and initiate germination. After emergence, mowing height was maintained at 5 cm. Plots were fertilized with ammonium nitrate at a rate of .9 kg on 25 Nov. 1980. No pesticides were applied prior to establishment or at any time during the study.

Germination was scored on a 1-9 basis which reflected the percentage of the plot which was green with 1=10% or less; 9=90% or more. Uniformity reflected coverage and was closely related but not identical to germination notes. Uniformity was rated on a 1-9 scale with 1= large bare areas and 9= even distribution and density.

Density counts were taken 10 Dec. 1980 by counting the number of plants in each of three randomly selected samples/plot of 25 plants and is expressed as the total number of tillers per 25 plants.

	Perennial ryegrass	Rough bluegrass
4X	4.9 kg/are (10.0 lbs/100 ft^2)	0.91 kg/are (2.0 lbs/1000 ft^2)
2X	2.4 kg/are (5.0 lbs/1000 ft^2)	0.74 kg/are (1.5 lbs/1000 ft^2)
X	1.2 kg/are (2.5 lbs/1000 ft^2)	0.45 kg/are (1.0 lbs/1000 ft^2)
0.5X	0.6 kg/are (1.25 lbs/1000 ft^2)	0.22 kg/are (0.5 lbs/1000 ft^2)
# Seeds/kg	500,535	5,600,700

Germination and uniformity date were analyzed as a factorial experiment with seeding rates (4 levels), mixture composition (7 levels), and sampling date (4 levels) as main effects. Plant density and tillering capacity were subjected to similar analysis with rate and mixture composition as main effects.

Results

Statistical analysis of germination data indicates highly significant differences among seeding mixtures and seeding rates (Table 1). Germination scores were significantly higher at higher seeding rates. Within each mixture varying the seeding rates generally resulted in significantly different scores with exceptions between the 2X and X rates within four of seven seeding mixtures.

The predominately ryegrass mixtures were superior to mixtures in which rough bluegrass predominated. This trend was generally apparent at each seeding rate for all mixtures, with larger differences occurring at higher seeding rates.

A statistically different interaction was detected between seeding rates ad mixtures for all characteristics studies. One component of this interaction is due to the behavior of various seed mixtures within the 2X seeding rate. While germination scores generally decreased or remained the same as the ryegrass percentage of the mix was reduced, scores increased for the 75/25% mixture and 25/75% mixture within the 2X rate. A second factor, the magnitude of the difference in performance between seeding mixtures was generally reduced at lower seeding rates due to the generally poor performance of these treatments for both species.

Rough bluegrass in monoculture was much slower to develop coverage than perennial ryegrass under the same conditions. Germination scores for rough bluegrass at the 4X rate were 1.7, 3.3, 4.0, and 6.7 for the 11/13, 11/20, 12/1, and 1/9 sample dates, respectively. Scores for perennial ryegrass at the 4X seeding rate were 6.0, 7.3, 7.7, ad 8.7 for these same dates, indicating more rapid germination and development of perennial ryegrass.

Overall means of germination scores were 2.9, 3.6, 4.2, and 5.8 (LSD (.05=0.41) for 11/13, 11/20, 12/1, and 1/9 samples dates, respectively. A highly significant rate X date interaction was detected for germination scores. This may be a result of the relationship between population density and tillering capacity. Correlation coefficents (r) between plot density measurements (at 12/10/80) and average tiller counts on 12/11/80 and 1/23/81 were = -0.61** and -0.78**, respectively. Tiller counts increased 69% between sampling dates for the high seeding rate and 252% for the low seeding rate (Figure 1). This suggests that plot coverage showed a greater increase over time at lower seeding rates due to tillering than did high density populations which had greater coverage initially. Density ratings differed significantly between the 4X, 2X, and X seeding rates. The two low rates were not statistically different for density although germination scores differed. Mixtures containing at least 90% ryegrass had significantly greater density counts. Density counts generally correspond to the percentage of ryegrass for the mixture treatments. Tiller counts showed the opposige trend: more tillering as rate decreased and the ryegrass percentage decreased.

Uniformity ratings were closely correlated (r=0.97**) with germination scores. Treatments with greater density were also more uniform; however, treatments containing a high proportion of rough bluegrass compared more favorably to predominantely ryegrass mixes for uniformity than for germination (Table 2). Sample means for seeding mixture differed significantly between 100/1 and 75/25% treatments whereas no statistical difference was detected for germination. Again, a significant interaction was detected between rate and mixture but no interaction existed between those effects and sampling date. Statistically significant differences were detected between sampling dates as the plots established.

Rough bluegrass did not contribute substantially to the performance of overseeded mixtures under the conditions of this test.

Treatment combinations with the same rate of perennial ryegrass, such as 4X-50/50% and 2X - 100/0% treatments, behaved similarly on germination and uniformity scores. When the ryegrass percentage decreased to 10%, rough bluegrass of the 4X rate improved scores over pure ryegrass stands at the .5X rate. Poor establishment and slow development characterized rough bluegrass development. Perennial ryegrass will achieve superior results quickly and easily for the homeowner when overseeded on dormant or semi- dormant common bermudagrass turf, with little ground preparation. Home lawn overseeding does not require the density resulting from the 4X seeding rate. Our observations indicate that the 2X seeding rate is adequate for home lawn overseeding.

Table 1. Germination ratings of overseeded mixtures of perennial ryegrass and rough bluegrass at four seeding rates(T).

	Seeding Rate				
Mixture percent §	4X	2X	X	0.5X	mean
100/0	7.4 (#¶)	5.6	4.9	3.3	5.3
90/10	7.2	5.7	4.5	2.8	5.2
75/25	7.2	6.2	4.5	2.8	5.0
50/50	6.0	4.3	3.8	2.5	4.2
25/75	5.2	4.7	3.1	1.8	3.7
10/90	5.1	3.0	2.7	1.7	3.1
0/100	3.9	2.0	2.1	1.3	2.3
mean	6.0	4.5	3.6	2.3	4.1

(T)Germination scored on 1-9 scale with 1=10% or less; 9=90% cover.
Seeding rates:

	Perennial ryegrass	Rough bluegrass
4X	4.9 kg/are (10.1 lbs/1000 ft^2)	0.91 kg/are (2.0 lbs/1000 ft^2)
2X	2.4 kg/are (5.0 lbs/1000 ft^2)	0.74 kg/are (1.5 lbs/1000 ft^2)
X	1.2 kg/are (2.5 lbs/1000 ft^2)	0.45 kg/are (1.0 lbs/1000 ft^2)
0.5X	0.6 kg/are (1.25 lbs/1000 ft^2)	0.22 kg/are (0.5 lbs/1000 ft^2)
# seeds/kg[1]	500,535	5,600,700

#Means are the average of four sample dates: 11/13, 11/20, 12/1, and 1/9.
¶LSD(.05)=0.83 for individual means, 0.31 for rate means and 0.41 for mixture means.
§percent based on pure live seed count.

Table 2. Uniformity ratings of overseeded mixtures of perennial ryegrass and rough bluegrass at four seeding rates (T).

Mixture percent §	Seeding Rate 4X	2X	X	0.5X	mean
100/0	7.1 (#¶)	4.9	5.0	2.9	5.0
90/10	6.4	5.3	4.2	2.2	4.5
75/25	5.9	5.2	3.5	2.5	4.3
50/50	4.4	3.8	3.9	2.2	3.6
25/75	4.6	4.0	2.8	1.5	3.2
10/90	5.0	2.4	2.2	1.5	2.8
0/100	4.4	1.8	1.5	1.1	2.2
mean	5.4	3.9	3.3	2.0	3.6

T Uniformity scored on 1-9 scale, 9=best.
Seeding rates:

	Perennial ryegrass	Rough bluegrass
4X	4.9 kg/are (10.0 lbs/1000 ft^2)	0.91 kg/are (2.0 lbs/1000 ft^2)
2X	2.4 kg/are (5.0 lbs/1000 ft^2)	0.74 kg/are (1.5 lbs/1000 ft^2)
X	1.2 kg/are (2.5 lbs/1000 ft^2)	0.45 kg/are (1.0 lbs/1000 ft^2)
0.5X	0.6 kg/are (1.25 lbs/1000 ft^2)	0.22 kg/are (0.5 lbs/1000 ft^2)
# seeds/kg[1]	500,535	5,600,700

#Means are the average of four sample dates: 11/13, 11/20, 12/1, and 1/9.

¶LSD(.05)=0.83 for individual means, 0.31 for rate means and 0.41 for mixture means.

§percent based on pure live seed count.

[1]Metcalfe, D. S. 1973 in M. E. Heath et al. (eds.). Forages, pp. 69-70. Iowa State University Press, Ames, Iowa.

PR 4153

Developing Fine Texture Turf-Type Tall Fescue for the Southern United States

M. C. Engelke and V. G. Hickey

Tall fescue *(Festuca arundinacea* Schreb.) is a widely adapted cool season turfgrass with tolerance to variable soil pH and drainage, heat, drought diseases and insects. In comparison to most of our warm-season turfgrasses, it has good shade tolerance and excellent wear tolerance. Tall fescue has only been utilized as a turf species within the past ten years (Murray and Powell, 1979), so most cultivars available were selected for forage characteristics. Few tall fescue cultivars are commercially available. Since the first turf-type tall fescue cultivar, 'Rebel', was released in 1980, several other cultivars have emerged on the market. Nearly all are products of breeding and improvement programs located in more temperate regions of the U.S.

Even though tall fescue appears marginally adapted to the Southern U.S., considerable genetic diversity exists for improved heat and drought tolerance. In 1980, a concentrated breeding and selection program was initiated by the Texas Agricultural Experiment Station at Dallas, to develop a turf type tall fescue specifically for the adverse environmental conditions of the South. Specific characteristics targeted for improvement were leaf texture, heat tolerance, insect and disease resistance and growth habit.

Materials and Methods

Over 400 accessions of tall fescue were obtained from the USDA-ARS Plant Introduction System. Thirty-six plants each of 200 accessions were planted three replications of a space plant nursery in 1981. From this initial base population, 250 plants survived drought conditions and a severe white grub infestation in 1981. Of these, 19 plants were further selected for leaf texture, summer color and persistence. These plants were transplanted to two crossing blocks on 1 m centers, designated Da18101 and Da18102.

Da18101 includes 7 parents selected specifically for leaf texture and uniform flowering habit. Da18102 contains 12 parents selected for summer color and general persistence. The plants selected for each crossing block are of various origins and include plant material from France, Germany and the United States. On 5 June 1982, leaf area measurements were made on each crossing block and the original base population to determine progress of selection for improved leaf texture. The first leaf below the flag leaf was measured on six tillers per plant with a Lambda Inst. Corp. Leaf Area Meter, model T.T. 3000. Data was analyzed as a nested design, with Duncan's Multiple Range mean separation test performed.

Results

Considerable improvement in leaf area resulted in Da18101 when plants were selected for fine leaf blade (Table 1). Our experience suggests that more improvement may be made in tall fescue for fineness of leaf texture. The first synthetic seed lot from Da18101 and Da18102 were planted in turf trials at the Dallas Exp. Stn. in Sept. 1982. Further evaluation for improvement in heat tolerance and turf quality is planned.

Literature Cited

Murray, J. J. and J. B. Powell. 1979. Turf. In: R. C. Buckner and L. P. Bush. Tall Fescue. Agronomy 20: 293-306. Am. Soc. of Agron., Madison, Wis.

Table 1. Mean leaf area of two tall fescue crossing blocks selected specifically for fine leaf texture and of the base parent population.

Source	Plants	Leaf Area
	# of clones	cm2
Dal8101	7	9.8b*
Dal8102	12	11.7a
Parent population	69	12.2a

*Means followed by the same letter are not significantly different at the .05 level of probability by the Duncan's Multiple Range Test.

PR 4154

Kentucky Bluegrass Cultivar Evaluation and Performance in Texas

M. C. Engelke and V. G. Hickey

Introduction

Kentucky bluegrass *(Poa parantensis* L.) is the most important and widely used turfgrass (Beard, 1973). The species, introduced from Eurasia, is a cool-season grass which is well adapted to the cool humid climates of the United States, and performs quite well at higher altitudes in the subtropical regions (Turgeon, 1980). According to Beard (1973), considerable variability exists within the genus for agronomic characters such as color, texture, shoot density, growth habit, adaptation, cultural requirements and disease resistance. The species is a long-lived perennial which has demonstrated good drought tolerance and fair heat tolerance for summer climates of the temperate regions. However, Kentucky bluegrass generally lacks sufficient heat and drought tolerance to persist under the more intense summer heat and moisture stress typical of the tropics and subtropics.

Considerable research has been directed to improving the performance and persistence of Kentucky bluegrass through genetic manipulaton and plant breeding in both the academic and private sectors of the turf industry. A national testing program has been developed under the direction of Mr. Jack Murray, USDA, ARS, Beltsville, MD which enables side-by-side comparison of the new experimental varieties (EXPERVARS) with commercially available cultivars to enhance the information available on regions of adaptation and utilization.

Materials and Methods

The 1980 National Kentucky bluegrass test consisted of 84 entries of advanced expervars and commercially available cultivars. The replicated test was established at two locations in the Dallas/ Fort Worth Area. The test at the Texas Agricultural Experiment Station-Dallas was established on 10 Oct. 1980 in 4' X 6' plots. The randomized complete block design with three replications was imposed on an Austin silty clay soil (fine-silty, carbvonetic, thermic, Entic Haplustolls), pH between 7.8 and 8.2 in the turfgrass field nursery under full sun. The second test was established 14 Oct. 1980 under an 80% shade canopy in the rough area adjacent to number 3 fairway at Colonial Country Club in Fort Worth. Shade was provided by a mature stand of Pecan *(Carya illinoensis* Koch) trees growing on Frio silty clay soil (fine, mixed, thermic Cumulic Haplustolls). Plots measured 4' X 6' with three replications.

Cultural practices imposed on both tests would be considered minimal. Soluble nitrogen (3#/1000 sq ft) was applied in three applications between September and April of each year. The areas were mowed at weekly intervals to maintain 3" height-of-cut during the active growing season. The shade trial was irrigated to prevent wilt. The TAES-Dallas trial was allowed to enter summer dormancy in both 1981 and 1982 to monitor persistence and drought recovery under the hot-arid climate of North Texas.

Results and Discussion

Considerable differences in performance existed among cultivars in full sun (Table 1) and under shade (Table 2). Of greatest interest is the level of variability present among the various cultivars for each of the characteristics observed. Only those cultivars which were in the most desirable statistical grouping are identified. The number of statistical groups determined by Duncan's

Multiple Range means separation test for each of the traits supports the existence of genetic variation. Additionally, the number of cultivars within the top group are indicated for each of the traits.

Twenty-seven cultivars were similar in their performance for turf uniformity in January 1982 and by June, sufficient growth and development occurred to include 63 similar cultivars in the top group (Table 1). Overall, little change occurred in degree of plot coverage, with a slight improvement from January to June. Considering the months for which turf quality was reported, a distinct decline was noted from May to August, with only 4 cultivars performing superior to the others, i.e. Baron (Ent#17), Aspen (28), America (38), and Midnight (56).

Genetic color was assessed in February, March, and May, with a greater range in color expression noted in March, and higher color ratings in May. A leaf spot *(Helminthosporium* spp.) infestation identified 22 cultivars as having some acceptable level of resistance, whereas, little differences were noted in occurrence of leaf rust *(Puccinia* spp.), however, 5 cultivars were noted to be more susceptible.

The greatest difference among cultivars was noted for the degree of persistance under heat and moisture stress. The observations were based on the amount of green tissue present on 23 Aug. 1982, following a period of 46 days with a trace or no precipitation nor supplemental irrigation provided. The average daily temperature averaging 84.5 degrees F, with extremes between 71 degrees and 101 degrees F. The plots were irrigated with 2" of water per week beginning August 24, with drought recovery and regrowth being monitored at 7 and 14 days. America (38), and Midnight (56) rated the highest for heat tolerance or summer performance without supplemental irrigation, the cultivar did not respond as noticably to late summer moisture as many of the others. Two weeks following the initial irrigation, five cultivars stood out as superior types. They were Wabash (9), S-21 (12), America (38), A20-6 (50), and I-13 (53).

The overall performance ratings of the national Kentucky bluegrass trial under full sun in the adverse north central Texas climate is characterized by identifying those cultivars which were consistently among the best performers (#A's). Those cultivars most frequently in this category (10 or more A's) includes America (38), Glade (2), Adelphi (1), Bono (35), Majestic (44), Charlotte (49), A20-6 (50), Midnight (56), Bristol (66), and Admiral (77).

The performance ratings of the cultivars under shade with supplemental irrigation are presented in Table 2. Of the 84 cultivars, 13 were consistently superior (5 A's) under local conditions. Although, America (38) rated high under full sun (Table 1), and provided good quality and uniformity in the spring of the year (Table 2), it appears to lack shade tolerance in comparison to numerous other cultivars.

This report contains data for only 1982 and will be combined with previous information in the final report to be published in the near future. All information presented here has been submitted for evaluation in the National Testing Program.

The trials were established in Texas primarily to assess the heat and drought tolerance of these cultivars. With the exception of the Panhandle of Texas, and higher elevations of the subtropics, Kentucky bluegrasses are not considered adapted nor are they recommended for the Southern United States.

Literature Cited

Beard, J. B. Turfgrass: Science and Culture. Englewood Cliffs, N.J. Prentice-Hall, Inc. 1973, 658 pages.

Turgeon, A. J. Turfgrass Management. Reston, VA, Prentice-Hall, Inc. 1980, 391 pages.

Table 1. 1982 Means Table for the 1980 National Kentucky Bluegrass Test Under Full Sun at TAES-Dallas.

		UNIFORM[1]		COVER[2]		QUALITY[1]			COLOR[1]			DISEASES[1]		DROUGHT[2]			
NAME	ENT	JAN	JUN	JAN	MAR	MAY	JUNE	AUG	FEB	MAR	MAY	LSPT	RUST	PERFORM	REC1	REC2	#A's
Adelphi	1	4.3A*	7.7A	76.7A	73.3A	6.0A	6.3A	3.7	5.3A	8.7A	7.0A	3.3A	7.7A	31.7	30.0	41.7	10
Glade	2	5.0A	7.7A	83.3A	80.0A	7.3A	6.7A	2.0	5.3A	7.0A	7.7A	4.0A	6.3A	25.0	7.0	10.0	11
Birka	3	4.0	6.3A	78.3A	78.3A	7.3A	5.7A	2.0	5.7A	6.7A	6.3A	3.3	5.0A	12.3	3.7	7.3	9
Monopoly	4	4.3A	7.7A	83.3A	81.7A	6.0A	3.0	2.0	5.7A	6.3	5.7	2.7	7.3A	15.0	25.0	41.7	7
Ram-1	5	3.7	6.0A	68.3A	61.7A	6.0A	6.3A	2.7	5.7A	6.7A	8.3A	3.3	7.3A	26.7	8.7	8.7	9
Fylking	6	3.3	6.7A	70.0A	75.0A	6.3A	3.0	1.0	4.3	6.0	7.3A	3.3	7.3A	4.0	2.7	5.3	6
Cheri	7	3.0	6.0A	71.7A	73.3A	6.0A	6.3A	3.7	5.0A	6.0	6.7A	2.7	5.0A	35.0	10.7	15.0	8
243	8	3.3	6.7A	65.0A	70.0A	5.3	6.0A	3.7	6.3A	7.3A	7.3A	6.0A	2.7	40.0	18.3	31.7	8
Wabash	9	3.7	7.7A	80.0A	81.7A	5.7A	5.3	3.3	5.3A	5.3	4.3	3.3	7.3A	30.0	26.7	50.0A	7
Nugget	10	2.7	5.3	46.7	41.7	3.7	6.0A	2.0	4.3	4.7	7.7A	1.7	4.3A	15.0	13.3	13.3	3
239	11	4.7A	6.7A	78.3A	88.3A	6.3A	4.7	1.7	4.0	6.7A	5.3	4.7A	6.3A	8.3	15.7	35.0	8
S-21	12	2.7	5.7	41.7	45.0	5.0	4.7	1.7	6.0A	6.0	5.7	1.7	6.7A	11.7	35.0	48.3A	3
PSU-190	13	4.0	7.3A	80.0A	76.7A	6.3A	6.3A	2.3	5.0A	5.3	6.3A	3.3	6.0A	21.7	13.3	45.0	8
PSU-150	14	3.0	7.0A	68.3A	73.3A	5.7A	6.0A	3.0	5.7A	7.0A	7.0A	2.3	6.3A	28.3	10.0	33.3	9
PSU-173	15	3.0	5.7	56.7A	70.0A	5.3	6.3A	3.3	5.0A	6.7A	7.3A	2.3	7.7A	30.0	12.3	22.7	7
Kimono	16	3.7	6.7A	76.7A	76.7A	6.7A	5.7A	3.3	5.7A	6.3	7.0A	3.0	5.7A	41.7	10.0	18.3	8
Baron	17	3.7	6.0A	61.7A	48.3	5.0	6.3A	4.7A	4.7	6.0	6.7A	3.3	6.7A	51.7	30.3	31.7	6
Enmundi	18	4.0	5.7	71.7A	80.0A	6.7A	6.7A	2.3	5.3A	7.3A	7.3A	3.0	7.0A	28.3	7.0	11.7	8
Plush	19	3.7	6.7A	75.0A	81.7A	5.0	5.7A	3.3	5.0A	6.3	5.7	2.3	5.7A	36.7	5.3	20.0	6
Parade	20	5.0A	6.7A	86.7A	81.7A	7.3A	4.7	2.3	5.7A	6.3	6.0	4.3A	5.0A	15.0	10.3	10.0	8
Trenton	21	5.3A	7.7A	86.7A	89.7A	6.7A	5.0	1.7	4.3	7.0A	5.3	4.7A	4.7A	11.7	4.3	6.7	8
Rugby	22	6.0A	8.0A	81.3A	86.3A	5.7A	5.0	1.3	3.7	5.3	5.7	4.7A	5.7A	5.0	9.7	10.0	7
SV-01617	23	4.0	8.3A	81.7A	81.7A	7.3A	3.7	1.0	5.3A	6.0	6.7A	3.3	7.0A	6.7	3.0	5.0	7
Banff	24	5.3A	7.7A	85.0A	88.3A	6.7A	4.3	1.0	4.7	6.7A	6.0	4.0A	7.0A	5.0	10.3	15.0	8
Dormie	25	2.3	5.3	45.0	53.3	4.0	5.0	1.3	6.0A	6.3	6.7A	2.7	5.3A	10.0	20.0	23.3	3
Holiday	26	3.7	5.7	63.3A	70.0A	6.0A	4.7	2.7	5.0A	6.7A	7.3A	3.0	5.0A	25.0	10.3	16.7	6
Geronimo	27	3.3	6.0A	63.3A	80.0A	6.0A	4.7	1.3	4.7	7.3A	6.0	1.7	5.0A	10.0	11.0	15.1	6
Aspen	28	3.0	6.3A	68.3A	65.0A	5.3	5.7A	5.0A	5.3A	6.7A	7.3A	3.3	5.7A	43.3	21.7	28.3	9
MIM-18011	29	3.3	6.3A	55.3A	66.7A	6.0A	5.3	3.0	5.0A	6.3	6.7A	2.7	5.0A	30.0	13.7	18.3	7
CEBVB3965	30	3.3	5.3	63.3A	70.0A	5.3	6.0A	2.3	5.0A	6.3	7.0A	2.3	4.0	26.7	4.7	11.7	5
Touchdown	31	3.7	6.7A	68.3A	76.7A	5.7A	5.0	1.0	5.3A	5.7	6.7A	4.0A	3.0	9.0	4.3	8.3	7
Welcome	32	4.0	5.7	71.7A	76.7A	5.3	5.3	1.7	5.0A	5.7	7.3A	2.7	6.0A	13.3	3.7	6.7	5
WW Ag 463	33	6.0A	7.0A	61.3A	86.0A	6.0A	5.0	1.7	4.0	5.7	5.7	4.7A	6.3A	13.3	5.0	23.3	7
WW Ag 480	34	3.0	6.3A	46.7	70.0A	5.0	6.7A	3.3	4.3	5.7	6.7A	3.0	5.7A	26.7	36.7	43.3	5
Bono	35	4.7A	7.7A	73.3A	76.7A	6.0A	5.7A	1.0	5.3A	6.3	6.7A	4.3A	5.7A	11.7	6.0	7.7	10
Kenblue	36	3.0	6.7A	66.7A	78.3A	5.7A	5.3	1.7	5.3A	5.3	5.7	2.7	6.0A	10.7	6.7	36.7	6
Harmony	37	4.3A	6.3A	65.0A	66.7A	5.0	5.7A	3.0	6.0A	5.3	6.7A	3.3	6.7A	20.0	6.7	15.7	8
America	38	4.3A	7.3A	78.3A	73.3A	3.3	7.0A	6.3A	4.0	6.7A	7.3A	2.0	6.0A	70.0A	46.7A	73.3A	12
Vanessa	39	3.3	5.7	65.0A	68.3A	5.3	5.7A	1.3	4.7	5.0	7.7A	1.7	4.3A	13.3	7.0	11.7	5
Mosa	40	4.0	5.7	60.0A	65.0A	5.7A	5.3	1.7	5.0A	6.0	6.0	1.7	5.7A	10.0	11.7	14.0	5
Cello	41	2.7	5.3	63.3A	71.7A	5.7A	5.3	2.3	5.7A	6.7A	6.3A	3.3	4.3A	18.3	11.7	15.0	7
WW Ag 478	42	4.0	6.7A	66.7A	80.0A	6.0A	5.7A	2.7	5.0A	6.3	7.3A	4.0A	7.0A	16.7	3.7	4.7	9
Piedmont	43	2.0	6.3A	60.0A	78.3A	6.7A	5.0	3.0	6.0A	7.0A	5.0	3.3	5.3A	30.0	18.3	26.7	7
Majestic	44	3.7	6.0A	65.0A	76.7A	6.3A	5.7A	3.3	5.0A	7.0A	7.7A	4.3A	5.3A	26.7	5.3	7.3	10

Bonnieblue	45	3.3	6.7A	71.7A	65.0A	5.7A	6.0A	2.3	5.7A	6.3	7.0A	3.3	5.7A	11.7	4.0	5.3	8
Vantage	46	3.3	6.3A	48.3	78.3A	6.0A	5.0	2.7	6.0A	6.7A	5.0	2.7	6.7A	16.7	25.0	33.3	6
Merit	47	3.7	7.0A	66.7A	75.0A	5.7A	5.7A	3.3	5.0A	7.3A	6.0	2.7	7.3A	28.3	20.0	26.7	8
Argyle	48	2.3	6.7A	56.7A	70.0A	6.0A	5.7A	1.3	6.3A	7.0A	5.7	2.0	4.7A	11.7	15.0	18.3	8
Charlotte	49	5.7A	7.0A	78.3A	83.3A	8.0A	3.7	1.0	5.3A	6.7A	7.0A	4.3A	7.3A	4.0	2.3	8.3	10
A20-6	50	4.7A	6.0A	68.3A	71.7A	6.7A	6.3A	3.3	4.7	7.3A	6.0	4.0A	6.7A	33.3	51.7A	63.3A	11
A20	51	1.7	5.3	51.7	65.0A	5.3	5.3	3.0	6.0A	6.3	6.0	3.0	4.3A	30.0	40.0A	43.3	4
Victa	52	3.3	4.7	48.3	68.3A	4.7	5.0	1.7	6.0A	6.7A	4.7	3.7	4.0	12.7	15.0	25.0	3
I-13	53	2.7	5.3	70.0A	78.3A	5.0	5.3	3.0	5.7A	6.3	6.3A	3.0	5.7A	40.0	57.7A	65.0A	7
A20-6-A	54	5.0A	6.3A	76.7A	85.0A	6.7A	5.3	3.3	6.0A	7.3A	6.0	5.7A	3.0	38.3	25.0	38.3	8
N535	55	2.7	5.7	37.0	31.7	5.3	5.0	1.3	5.7A	7.3A	6.7A	3.7	7.0A	15.0	13.3	13.3	4
Midnight	56	3.7	7.0A	76.7A	73.3A	5.7A	7.3A	6.3A	5.0A	5.7	8.0A	2.0	5.0A	65.0A	15.0	30.0	10
Shasta	57	4.3A	7.0A	73.3A	73.3A	6.0A	5.3	1.7	5.3A	6.7A	6.7A	3.7	4.7A	18.3	13.3	21.7	9
Columbia	58	5.7A	7.0A	83.3A	76.7A	6.3A	6.0A	1.7	4.3	5.0	5.3	4.0A	5.3A	15.0	8.3	18.3	8
Apart	59	3.7	6.0A	56.7A	68.3A	5.0	3.7	1.3	5.3A	6.3	7.0A	4.7A	6.7A	15.0	10.0	12.3	7
A-34	60	2.7	6.0A	71.7A	75.0A	5.3	5.0	2.0	5.7A	6.7A	6.0	2.3	6.7A	15.0	11.7	23.3	6
Sydsport	61	3.3	5.7	63.3A	66.7A	5.0	5.3	3.7	4.7	6.7A	6.7A	2.7	7.7A	43.3	28.3	43.3	5
MerPP 300	62	3.3	6.3A	61.7A	65.0A	4.0	7.0A	4.3	5.0A	5.3	7.0A	1.7	5.0A	43.3	30.0	38.3	7
MerPP 43	63	3.0	5.7	58.3A	61.7A	5.3	5.7A	1.7	6.3A	7.0A	7.0A	2.7	5.3A	18.3	11.7	19.0	7
Mona	64	6.0A	5.7	78.3A	80.0A	6.7A	6.7A	1.7	3.7	6.0	6.3A	3.7	6.0A	11.7	10.0	18.3	7
Lovegreen	65	3.7	7.7A	73.3A	73.3A	6.0A	5.0	1.7	5.0A	4.3	5.3	2.7	5.0A	11.7	2.7	4.0	6
Bristol	66	3.7	6.3A	63.3A	75.0A	6.3A	6.7A	3.3	5.7A	6.7A	7.3A	4.0A	6.0A	40.0	7.0	30.0	10
Victa	67	4.0	6.0A	65.0A	61.7A	5.7A	5.7A	3.3	5.3A	6.0	6.7A	2.0	4.7A	28.3	20.0	30.0	8
Enoble	68	4.3A	4.3	75.0A	76.7A	5.7A	5.3	1.3	3.7	5.0	6.3A	2.3	7.0A	13.3	5.3	9.0	6
SH-2	69	2.7	5.0	48.3	46.7	3.7	4.0	1.3	6.3A	5.7	6.0	4.3A	4.7A	15.0	26.7	33.3	3
NJ 735	70	4.0	6.7A	71.7A	55.0	6.3A	5.3	2.0	5.7A	6.3	6.0	2.7	7.0A	15.0	4.0	5.7	5
SD Common	71	4.3A	7.3A	7117A	88.3A	6.7A	4.7	1.0	6.0A	6.3	6.0	3.0	6.7A	5.3	5.7	7.7	5
Merion	72	3.3	6.3A	60.0A	73.3A	6.3A	6.7A	1.0	5.0A	6.3	7.0A	2.0	5.0A	6.7	18.3	21.0	8
BA-61-91	73	5.0A	6.7A	71.7A	75.0A	5.7A	7.0A	2.0	4.7	6.3	6.7A	2.0	7.7A	11.7	10.0	10.7	8
Bayside	74	5.0A	7.3A	76.7A	86.7A	7.3A	5.7A	1.0	5.0A	8.0A	6.0	2.7	5.7A	6.7	5.3	8.0	9
225	75	6.7A	8.0A	88.3A	93.0A	7.0A	5.3	1.7	4.3	6.3	6.0	4.3A	5.3A	11.7	5.3	11.7	7
Mystic	76	2.7	6.3A	65.0A	71.7A	5.7A	6.7A	1.7	6.0A	5.7	6.7A	3.0	5.3A	10.3	3.7	6.7	8
Admiral	77	3.7	6.7A	73.3A	86.7A	6.3A	6.3A	2.3	5.7A	7.3A	6.3A	4.3A	5.7A	26.7	13.3	23.3	10
Eclipse	78	3.3	6.3A	56.7A	56.7	5.0	5.7A	3.7	5.3A	6.3	7.3A	1.3	5.3A	36.7	16.7	15.0	6
Escort	79	4.3A	5.7	58.3A	70.0A	5.3	5.0	1.7	5.0A	6.7A	6.0	2.0	4.7A	18.3	10.0	21.7	6
K3-162	80	4.7A	8.0A	83.3A	90.0A	7.3A	5.0	1.0	5.0A	5.0	6.3A	3.0	6.7A	13.3	8.3	10.0	8
K3-179	81	2.3	7.3A	50.0	63.3A	5.7A	5.7A	1.7	4.7	6.3	6.3A	1.0	5.7A	16.7	21.7	43.3	6
K3-178	82	5.3A	7.3A	81.7A	68.3A	6.0A	5.3	1.3	4.3	5.3	6.0	4.3A	5.7A	11.7	8.3	10.0	7
K1-152	83	5.3A	7.0A	85.0A	71.7A	6.0A	5.0A	1.3	3.3	4.0	7.0A	3.7	7.3A	8.3	11.7	13.3	7
Barblue	84	3.7	6.3A	71.7A	66.7A	5.3	4.7	1.3	6.0A	6.7A	7.3A	3.3	6.0A	20.0	4.3	9.0	7
#CULTIVARS w/A's		27	63	74	76	57	41	4	62	35	53	22	79	2	4	5	
# STATIS.GROUPS		8	6	8	9	6	8	7	5	7	7	8	4	15	11	12	
MEAN		3.8	6.4	68.0	72.6	5.8	5.5	2.3	5.2	6.3	6.5	3.2	5.8	21.2	14.2	21.8	
s		1.2	1.2	16.6	15.4	1.3	1.0	1.0	0.7	1.1	1.0	1.0	1.7	10.7	10.9	14.5	
C.V's		31.1	18.1	24.4	21.2	22.0	17.4	42.4	13.9	17.6	15.2	32.9	28.8	50.4	76.6	66.5	

*A's indicate highest statistical group according to Duncan's Multiple range means separation test.
[1]All ratings on 1 to 9 scale, 9 = most desirable in month indicated.
[2]Rating based on % of plot.

Table 2. 1982 Means Table for the 1980 National Kentucky Bluegrass Test Under 80% shade at TAES-Dallas.

	ENT	UNIFORM[1] MAY	COVER[2] JAN	COVER[2] MAY	COVER[2] JUNE	QUALITY[1] JUNE	#A's
Adelphi	1	7.7A*	43.3	73.3A	78.3A	6.7A	4
Glade	2	5.7A	20.0	36.7	45.0A	3.3	2
Birka	3	3.7	7.7	15.0	25.0	2.7	0
Monopoly	4	6.0A	5.3	14.3	13.3	4.0	1
Ram-1	5	8.7A	58.3	61.7A	75.0A	7.3A	4
Fylking	6	6.0A	7.7	21.7	28.3	3.7	1
Cheri	7	8.0A	28.3	48.3A	65.0A	6.7A	4
243	8	6.3A	51.7A	42.3A	51.0A	5.7A	5
Wabash	9	8.3A	85.0A	81.3A	86.7A	7.0A	5
Nugget	10	3.3	8.7	5.7	10.0	2.3	0
239	11	8.3A	60.0A	76.7A	85.0A	7.0A	5
S-21	12	4.0	10.3	35.0	30.7	3.3	0
PSU-190	13	6.0A	16.7	35.0	50.0A	4.7A	3
PSU-150	14	6.3A	18.3	43.3A	48.3A	6.3A	4
PSU-173	15	7.0A	20.0	45.0A	48.3A	6.3A	4
Kimono	16	4.0	5.0	15.0	26.7	4.3	0
Baron	17	5.0A	1.7	8.0	8.3	2.3	1
Enmundi	18	7.3A	51.7A	58.3A	68.3A	6.0A	5
Plush	19	4.0	5.0	16.7	20.0	3.0	0
Parade	20	8.3A	61.7A	71.7A	75.0A	6.7A	5
Trenton	21	7.3A	45.0	66.7A	80.0A	7.0A	4
Rugby	22	8.7A	70.0A	75.0A	76.7A	8.0A	5
SV-01617	23	4.7A	1.7	10.7	16.7	3.3	1
Banff	24	8.7A	63.3A	71.7A	63.3A	8.0A	5
Dormie	25	6.0A	4.0	5.7	16.7	4.3	1
Holiday	26	8.0A	46.7	70.0A	60.0A	6.0A	4
Geronimo	27	2.0	6.3	6.7	5.7	2.3	0
Aspen	28	6.3A	18.3	46.7A	53.3A	6.0A	4
MIM-18011	29	6.7A	25.0	46.7A	45.0A	5.7A	4
CEBVB3965	30	4.3	8.3	17.0	27.0	3.0	0
Touchdown	31	5.3A	8.3	33.7	38.7	3.3	1
Welcome	32	5.3A	3.7	3.7	4.3	3.3	1
WW Ag 463	33	8.3A	53.3A	63.3A	71.7A	6.7A	5
WW Ag 480	34	7.3A	31.7	36.7	45.0A	6.3A	3
Bono	35	2.3	3.7	10.3	4.7	3.3	0
Kenblue	36	6.0A	2.3	19.3	24.3	5.0A	2
Harmony	37	2.7	10.7	21.0	23.3	4.0	0
America	38	5.3A	10.0	38.3A	38.3	5.3A	3
Vanessa	39	3.7	6.0	13.0	17.3	3.0	0
Mosa	40	4.0	8.0	4.7	11.7	2.7	0
Cello	41	5.7A	20.0	43.3A	43.3A	5.3A	4
WW Ag 478	42	5.7A	11.7	10.7	11.7	4.0	1
Piedmont	42	7.3A	16.7	40.0A	30.0	4.3	2
Majestic	44	7.3A	25.7	56.7A	50.0A	5.0A	4
Bonnieblue	45	7.7A	20.0	48.3A	45.0A	5.7A	4
Vantage	46	7.0A	11.7	50.0A	43.3A	5.0A	4
Merit	47	3.0	1.7	8.0	6.7	1.3	0
Argyle	48	5.0A	30.0	46.7A	36.7	4.3	2

Charlotte	49	1.3	2.3	9.0	2.7	2.0	0
A20-6	50	7.0A	40.0	43.3A	70.0A	7.3A	4
A20	51	7.7A	11.7	28.3	43.3A	5.3A	3
Victa	52	7.0A	33.3	48.3A	61.7A	5.0A	4
I-13	53	8.3A	28.3	58.3A	70.0A	7.3A	4
A20-6-A	54	8.0A	70.0A	78.3A	85.0A	7.0A	5
N535	55	6.0A	31.7	46.7A	51.7A	4.3	3
Midnight	56	4.3	31.7	45.0A	51.7A	3.7	2
Shasta	57	7.7A	40.0	70.0A	75.0A	6.3A	4
Columbia	58	8.7A	71.7A	73.3A	71.7A	7.3A	5
Apart	59	2.7	5.3	3.7	11.3	2.0	0
A-34	60	7.0A	36.7	68.3A	60.0A	6.3A	4
Sydsport	61	9.0A	33.3	55.0A	66.7A	6.3A	4
MerPP 300	62	3.0	2.3	2.7	5.7	2.0	0
SerPP 43	63	2.3	2.3	4.3	3.7	1.7	0
Mona	64	7.7A	66.7A	66.7A	76.7A	8.0A	5
Lovegreen	65	3.7	12.3	35.3	24.7	3.3	0
Bristol	66	8.0A	26.7	51.7A	65.0A	6.7A	4
Victa	67	6.3A	21.7	43.3A	27.7	2.0	2
Enoble	68	4.0	22.0	48.3A	32.7	3.3	1
SH-2	69	5.7A	11.0	32.3	27.7	5.3A	2
NJ 735	70	5.7A	8.3	33.3	35.0	5.0A	2
SD Common	71	7.3A	5.7	61.7A	48.3A	4.0	3
Merion	72	5.7A	26.7	56.7A	45.0A	4.7A	4
BA-61-91	73	4.3	2.7	30.7	22.7	2.0	0
Bayside	74	8.0A	56.7A	76.7A	80.0A	7.0A	5
225	75	8.3A	50.0	83.3A	85.0A	7.7A	4
Mystic	76	4.0	3.7	18.3	22.7	4.7A	1
Admiral	77	4.3	7.0	24.0	26.7	4.7a	1
Eclipse	78	2.7	3.3	10.3	25.7	2.7	0
Escort	79	4.0	3.7	33.7	40.7	4.0	0
K3-162	80	6.0A	30.0	47.3A	48.3A	6.0A	4
K3-179	81	6.0A	36.7	48.3A	56.7A	5.3A	4
K3-178	82	8.3A	38.3	75.0A	80.0A	7.3A	4
K1-152	83	7.3A	66.7A	70.0A	85.0A	7.0A	5
Barblue	84	5.3A	16.7	36.7	31.7	5.0A	2
# CULTIVARS W/A's		48	60	13	49	45	
# STATIS.GROUPS		11	10	16	16	20	
MEAN		4.9	5.9	24.8	40.3	43.4	
s		1.6	2.2	17.4	22.0	21.6	
C.V.'s		33.5	37.3	69.9	54.6	49.7	

*A's indicate highest statistical group according to Duncan's Multiple range means sepatation test.

[1]All ratings of 1 to 9 scale, 9 = most desirable in month indicated.

[2]Rating based on % of plot.

PR 4155

1982 Zoysiagrass Cultivar Characterizations

W. G. Menn, M. P. Grisham, J. B. Beard, and D. S. Dahms

Zoysiagrass *(Zoysia* sp.) is a warm season perennial grass introduced from China which is characterized by superior wear tolerance plus very good heat and drought hardiness. In addition, it has a reasonably low nitrogen requirement and is adapted to shaded environments. One of the main problems with zoysiagrass is the lack of establishment vigor which may be one of the main reasons it has not been widely used in Texas in the past. The same fundamental growth mechanism also causes a slow recooperative rate. Thus, zoysiagrass is not well adapted for use on sports fields and recreational areas where severe divoting occurs.

Because of the relatively low maintenance requirements in terms of water, energy, and nutrients inputs, zoysiagrass has many favorable attributes that are important for use in minimal maintenance lawn situations. Its desirability would be even further enhanced if selections could be identified that possess superior establishment vigor. Fortunately there are three substantial zoysiagrass breeding programs under way in the United States, including Dr. Engelke's program at the Dallas Center. Because of the great potential for development of improved zoysiagrass cultivars, evaluation studies will continue on near-release selections seeking those that may possess superior adaptation and performance for Texas conditions.

This progress report contains a summary of turfgrass quality evaluations and spring greenup rates, plus the brown patch susceptibilities of four commercially available zoysiagrass cultivars. Twelve experimental selections from the zoysiagrass breeding programs at the USDA in Beltsville and from Kansas State University are also under evaluation, but results will not be reported until next year.

This study is in the third year of a six year evaluation program. A minimum of six continuous years is required to obtain reliable field evaluations of turfgrass cultivars. Thus, final conclusions concerning the adaptation and performance of these zoysiagrasses cannot be made until the termination of this study.

Research Procedure

Four commercially available zoysiagrass cultivars and twelve advanced selections were planted in August of 1979, onto a well drained, modified loamy sand root zone at the TAMU Turfgrass Field Laboratory. All entries were planted vegetatively by sprigging. Plot size for the cultivars assessment study is 5 x 15 ft. (1.5 x 4.5 m) in a randomized complete block design, with three replications. The advanced selection study involves a plot size 4 x 4 ft. (1.2 x 1.2 m) arranged in a randomized block design with two replications.

Starting in 1981, the plots were mowed once a week at a 2 inch (5 cm) cutting height. Prior to that, they had been maintained at a 0.75 inch (1.9 cm) cutting height and mowed twice weekly. Irrigation is applied as needed to prevent visual wilt.

In 1980, the entire study area was fertilized as a rate of 0.5 lb nitrogen/1000 sq. ft.(0.25 kg/are)/growing month. Starting in 1981, three subplot nitrogen fertility differentials were superimposed across the commercially available cultivars at rates of 0.25, 0.5, and 0.75 lb. of nitrogen/1000 sq. ft.(0.12, 0.25, and 0.37 kg/are)/growing month. Phosphorus and potassium are applied as needed based on an annual soil test.

The use of preemergence herbicides or a preventive insecticide/fungicide program is avoided in this cultivar study. A pesticide is applied only as needed to prevent a complete loss of stand. To date, this has not been necessary. Through this approach there is a better opportunity to obtain data concerning the relative susceptibilities of the cultivars to disease causing pathogens and to insects.

Results

Commercially Available Cultivars. After 3 years Meyer, FC-13621, and Emerald zoysiagrass were performing at a comparable level of turfgrass quality. Midwest has been decidely inferior in performance, particularly in terms of a lower shoot density and an unattractive yellowish-green color. To date, the only characteristic where Midwest zoysiagrass has ranked superior to the three is in early spring greenup.

There have been no insect problems that have caused a visual decrease in turfgrass quality. Likewise, there has been no visual problems with rust being evident. However, there has been a sufficiently uniform incidence of brown patch *(Rhizoctonia slolani)* to provide valid comparisons of cultivar susceptibility. Brown patch evaluations were made in the fall of 1981 and in the spring and fall of 1982. All four cultivars of zoysiagrass were susceptible to *R. solani* (Table 1). The highest percentage area diseased was in Emerald and the lowest in Meyer.

Table 1. Response of zoysiagrass cultivars to *Rhizoctonia solani* in 1981-82 at College Station, Texas

Cultivar	Area diseased (%)
Meyer	8 a*
FC 13521	15 ab
Midwest	17 ab
Emerald	29 b

*Means followed by the same letter do not differ significantly (P = .05) by Duncan's multiple range test.

PR 4156

Comparative Evapotranspiration Rates of 13 Turfgrasses

K. S. Kim, J. B. Beard, L. L. Smith, and M. Ganz

Introduction

On the key components in a water conservation strategy is the selection of turfgrass species and cultivars possessing low water use rates. In the past, water was readily available at a low cost. Therefore, little attention is paid to such water conservation strategies. This situation, combined with a need for research in many diverse areas of turfgrass culture, resulted in a very little research information being generated concerning the water use rates of turfgrasses. However, the general public has now become aware of the developing water problem and is beginning to support research into turfgrass water conservation. Thus, the objective of this investigation was to determine quantitatively the water use rate (evapotranspiration) differentials, if any, among the warm season turfgrasses.

Materials and Methods

The evapotranspiration (ET) rates of twelve C-4 warm season turfgrasses and one C-3 cool season turfgrass were evaluated in mini-lysimeters utilizing the water balance method. The experimental design used was a randomized complete block, with three replications of each grass. The turf plots were constructed to insure a natural environment surrounding each mini-lysimeter. The evapotranspiration rates of each species were measured under both non-limiting soil moisture and progressive water stress conditions. During the uniform cultural practices study, all grasses were mowed at a 1.5 inch (3.8 cm) cutting height and fertilized with 0.5 lb nitrogen/1000 sq ft (0.25 kg N/acre)/growing month; while for the optimum cultural practices study the cutting height and nitrogen fertilization rate selected were based on established optimums for each species.

Results

Significant differences in evapotranspiration rates were observed at both the interspecies and intraspecies levels. Emerald zoysiagrass, Common buffalograss, Tifgreen bermudagrass, and Common centipedegrass had low evapotranspiration rates; while Kentucky 31 tall fescue, Texas Common St. Augustinegrass, Argentine bahiagrass, and Adalayd sand knotgrass were characterized as having high evapotranspiration rates. Common bermudagrass, Tifway bermudagrass, Meyer zoysiagrass, and Common blue grama possessed intermediate evapotranspiration rates.

evapotranspiration rates did not show large relative changes between the uniform and the optimum cultural practice regimes and between the two soil moisture conditions. The one exception was bahiagrass which had a low evapotranspiration rate under progressive water stress conditions, in contrast to a high evapotranspiration rate under the non-limiting soil moisture conditions. All grass species exhibited higher evapotranspiration rates when maintained at their optimum nitrogen fertility and cutting height, which was attributed to a more rapid vertical leaf extension rate.

extension rate, high shoot density, low leaf area, and prostrate growing habit tended to have low evapotranspiration rates. These investigations prove that turfgrass species do vary substantially (up to 50%) in water use rates. Thus, this criterion can be used when selecting turfgrasses for use in situations where water conservation is an important consideration.

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PR-4157

Effect of Irrigation Frequency on Turf Water Requirements

M. D. Gerst and C. W. Wendt

Abstract

Studies of the effect of irrigation frequency on the water requirements and quality of an established bermudagrass lawn were continued in 1982. High, medium and low frequencies with application rates of 0.9, 2.5 and 4.7 inches per application, respectively, were compared. The initial irrigation treatments were withheld until most of the available soil water was extracted. Soil water, prior to imposing the irrigation treatments, was extracted 1.5 to 2 feet deeper in the soil profile in the low frequency treatment compared to the high frequency treatment imposed in 1981. Apparently, more precipitation was stored in the wetter soil profile of the infrequent heavy irrigations. In 1982, high frequency (0.9 inch) irrigations were found to wet the soil profile to only 18 inches compared to 42 inches for medium frequency (2.4 inch) and 72 inches for a low frequency 4.7 inch) irrigations. Soil water was extracted 6-24 inches deeper in the medium and low frequency treatments compared to high frequency treatment. Frequent irrigations resulted in steady turf growth, but the poorest turf quality, as indicated by the number of days the turf was green to light green in color (97 days). Turf color was best for the longest period of time (125 days) in the low frequency treatment, but more mowing was required. The medium frequency irrigation resulted in a steady turf growth with good quality turf (110 days).

Introduction

Turfgrass in Texas covers approximatey 3.2 million acres. It is used for recreational, functional, and aesthetic purposes (including lawns for over 2 million homeowners) with an estimated annual maintenance cost of $840 million (2). The major activities in turf maintenance are: irrigating, mowing, fertilizing, cultivating and pest management. As energy costs increase and water supplies decrease, resource efficient cultural practices will be needed for maintenance of turfgrass.

In 1981, a study was initiated at the Lubbock State School, Lubbock, Texas, to determine the influence of irrigation water managment on the water use efficiency of common bermudagrass [Cynodon dactylon (L.) Persoon] in the semi-arid area of West Texas (3). The data obtained suggested that more rainfall would be stored deeper in the soil with infrequent heavy irrigations, rather than frequent light irrigations. This is due to the fact that precipitation moves deeper in a wet than a dry soil profile.

Beard (1) summarized irrigation frequency research and points out that a greater portion of applied water is lost to evaporation from frequent irrigations and the water requirement of turf increases as irrigations become more frequent. He suggests that irrigation should be scheduled when 50 percent or less of the available water is extracted.

In 1982, the turfgrass research study of 1981 was continued and expanded with the following objectives:

1. Determine the influence of irrigation frequency on soil water storage.
2. Determine the effect of irrigation frequency on the water use of common bermudagrass.

Materials and Methods

The twelve plots established in 1981 were the site of the 1982 study (Figures 1 and 2). Although an estimate of available soil water was obtained in 1981, more data were needed to determine the lower limit of available soil water and the maximum depth of soil water extraction by bermudagrass in West Texas. Therefore, in 1982, irrigation was withheld until the bermudagrass had extracted most of the available soil water as indicated by soil water content measurements.

Soil water content was measured (Table 1) with a neutron probe (Troxler Model 3222) at 6 inch increments from 6 inches to 72 inches. The access tubes (2 inch O.D. aluminum) were installed during 1981 in each plot to a depth of 78 inches. The tops of the tubes were even with the soil surface to facilitate mowing and covered between measurements.

Each irrigation in 1982 was applied when the total soil water content or treatment was in the range of 16.2 to 16.5 inches. Irrigations were applied using a traveling sprinkler adjusted to cover an area 20 ft. wide (Figures 3 and 4). The sprinkler moved along a 0.75 inch hose down the center of each plot. Each pass of the sprinkler began 5 feet from the edge of the plot and bisecting the plot, stopping 5 feet beyond the opposite edge. The total path length was 30 feet and the area watered by the sprinkler 914 fs. Water applied was measured with a flowmeter. No runoff was observed for any irrigation. Rainfall recieved at the site was measured with a digital rain gauge to 0.1 inch.

The turf was mowed to a height of 1.75 inches at approximately 2-week intervals beginning on May 4 and continuing until October 8. Both fresh and dry weight of the clippings was determined. Turf quality was determined by color (green to light green, and light green to light brown).

Fertilizer was applied by a hand push spreader at selected intervals Nitrogen was applied at 5 lbs/1000 fs (1 lb N/1000 fs as ammonium sulfate per application). Iron sulfate was applied at 1 lb/1000 fs. On May 5 and June 11, the total study area was fertilized with both nitrogen and iron. Subsequent fertilizations covered only the plot and a three foot border around each plot.

Evapotranspiration was calculated using the model of Jensen (4). Air temperature, relative humidity, and wind speed were obtained from the National Weather Service at the Lubbock airport. Solar radiation was obtained from the TAES weather station at Lubbock, Texas.

Results and Discussion

In the previous year's study (3), 0.8, 2.2 and 3.9 inches of water were applied per application in the high, medium and low frequency treatments during late July, 1981. From July 27, 1981, to May 19, 1982, approximately 19.6 inches of rain were received at the site. Soil water content data on May 19, 1982 are shown in Figure 5. Available water in the top 12 inches of the soil profile was approximately the same for all irrigation treatments. However, between 12 inches to 72 inches, the available water content in the high frequency treatment was 2.72 inches compared to 4.82 and 5.98 for the medium and low frequency treatments of 1981. These data indicate that the medium and low frequency treatments of 1981 stored more precipitation between July 27, 1981 and May 19, 1982, than the high frequency. Since soil water content data obtained on May 19 showed the effect of the previous year's irrigation treatment soil water content, 1982 irrigations were withheld until most of the available water had been extracted.

Soil water content changes between May 19, 1982, and July 29, 1982, (Figure 6) indicate that soil water extraction occurred down to 54, 66 and 72 inches for the high, medium and low frequency treatments of 1981, respectively. The data indicate that the turf in the low frequency treatment extracted soil water 2 feet deeper than the high frequency treatment. By July 29, 1982, most of the available soil water was extracted in the high frequency irrigation treatment of 1981. The high frequency irrigation treatment of 1982 was then initiated. Medium and low frequency treatments were initiated on August 4 and August 17, respectively.

In 1982, soil water content was measured prior to and immediately after each irrigation. The data shown in Figure 7 indicate that frequent irrigation (0.8 to 0.9 inches) increase the water content of the soil to a depth of only 12-18 inches while the medium frequency irrigation of 2.5 inches and the low frequency irrigation of 4.7 inches wet the soil down to depths of 36, 42 and 72 inches, respectively. These data also indicate that 1.0 inch of applied water percolated below 72 inches with the low frequency (4.7 inch) irrigation. Of the treatments used in this study, only the medium frequency treatment wet the soil profile deeply without incurring deep percolation losses.

The accumulative yield on a dry weight basis (Figure 8) indicates similar growth during June and July for all irrigation levels as the avaliable soil water was extracted by the turf. During August, the low frequency irrigation was applied (August 19) which resulted in a substantial increase in growth rate. The high and medium frequency irrigation treatments showed no increase in growth rate after irrigation.

During May and June the turf color of all treatments was green to light green (Table 2) and no differences due to treatment (carryover from the previous year) were observed. During May and June 9.7 inches of precipitation was received (Table 3) and the lack of differences between treatments was probably due to the precipitation. The first differences in turf color were observed in July. During the first 2 weeks of July, 1.1 inches of precipitation were received. Following this period, differences among treatments were noted. The low frequency treatment was the first to show a deterioration in turf quality as evidenced by 17 days with a light green to light brown turf color. The medium frequency irrigation was light green to light brown in color for 3 days while the low frequency irrigation did not indicate a reduction in turf quality during July. In August, the turf quality in all treatments deteriorated. During the study period (May-September) the high frequency treatment had more days (47 of poor quality turf as indicated by a light green to light brown color compared to the medium frequency (34 days) and the low frequency (19 days).

The water use of bermudagrass in this study may be estimated from the total available water including irrigation, precipitation (Table 3) and soil water extraction. Between May 19 and July 29, 1982, prior to the first 1982 irrigation, the total water use of the low, medium and high irrigation treatments of 1981 were 12.36, 12.58 and 12.91 inches, respectively. After the irrigation in 1982, the total water use of the turfgrass were 6.0, 7.9 and 6.7 inches for the high, medium and low frequency irrigation treatments, respectively. The high frequency irrigation treatment received 1.5 inches less irrigation water than either the medium or low frequency treatments which may account for it having the lowest water use. The total water applied in the medium and low frequency irrigation treatments were essentially the same but the low frequency irrigation treatment used one inch less water.

Conclusions

Storage of rainfall in the root zone may be increased by irrigations (2.4 inches or more) which wet the soil profile deeply. This may be due to the prevention of a dry zone in the soil which might otherwise form under frequent light irrigations (0.9 inches).

The data indicated that an infrequent heavy irrigation maintained the best quality turf for the longest period of time (125 days) and had the lowest water use. However, the infrequent heavy irrigation incurred water losses below the root zone and caused an increase in the growth rate of the turf. The frequent light irrigations resulted in steady turf growth with low water use but had the poorest turf quality (light green color for 97 days). The medium irrigation resulted in steady turf growth with good quality (110 days turf color was light green) and the highest water use.

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Table 1. Cultural practices in the irrigation study, Lubbock, Texas, 1982.

Activity	Date
Mowing	6/4, 6/16, 6/30, 7/15* 7/30, 8/16, 9/15, 10/8
Soil water content measurements	5/19, 6/11, 7/5, 7/22, 7/29, 8/2, 8/4, 8/5, 8/10, 8/17, 8/19, 8/23, 9/1, 9/3, 9/10, 9/20
Irrigating	
Low (.9, .8, .8. & .8 inches)	7/29, 8/19, 9/1, 9/23
Medium (2.5, 2.4)	8/4, 9/22
High (4.7 inches)	8/19
Fertilizating	
Iron ($FeSO_4$ ~ 1 lb/1000 fs)	6/11, 7/30, 9/1
Nitrogen (1 lb N/1000 fs)	5/20, 7/30, 9/17

* Mowed but not weighed

Table 2. Turf quality in the irrigation study, Lubbock, Texas, 1982.

	IRRIGATION FREQUENCY					
	HIGH 1/		MEDIUM 2/		LOW 3/	
Months	Green to Light Green	Light Green to Light Brown	Green to Light Green	Light Green to Light Brown	Green to Light Green	Light Green to Light Brown
May	31	0	31	0	31	0
June	31	0	31	0	31	0
July	14	17	28	3	31	0
August	15	16	20	11	12	19
September 1-20	6	14	0	20	20	0
May-September 20	97	47	110	34	125	19

1/ Irrigated on 7/29, 8/19, 9/01, 9/23

2/ Irrigated on 8/04, 9/22

3/ Irrigated on 8/19

Table 3. Precipitation, irrigation, and evapotranspiration measured in the irrigation study, Lubbock, Texas, 1982.

	May 19-May 31	June	July	August	September 1-20	Total May 19-September 20
Precipitation	4.2	5.5	1.1	1.3	0.9	13.0
Irrigation						
Low	0	0	0.9	0.8	1.6	3.3
Medium	0	0	0	2.5	2.4	4.9
High	0	0	0	4.7	0	4.7
Evapotranspiration 1/	3.2	8.2	9.8	9.1	5.3	35.6

1/ Calculated from meterological data.

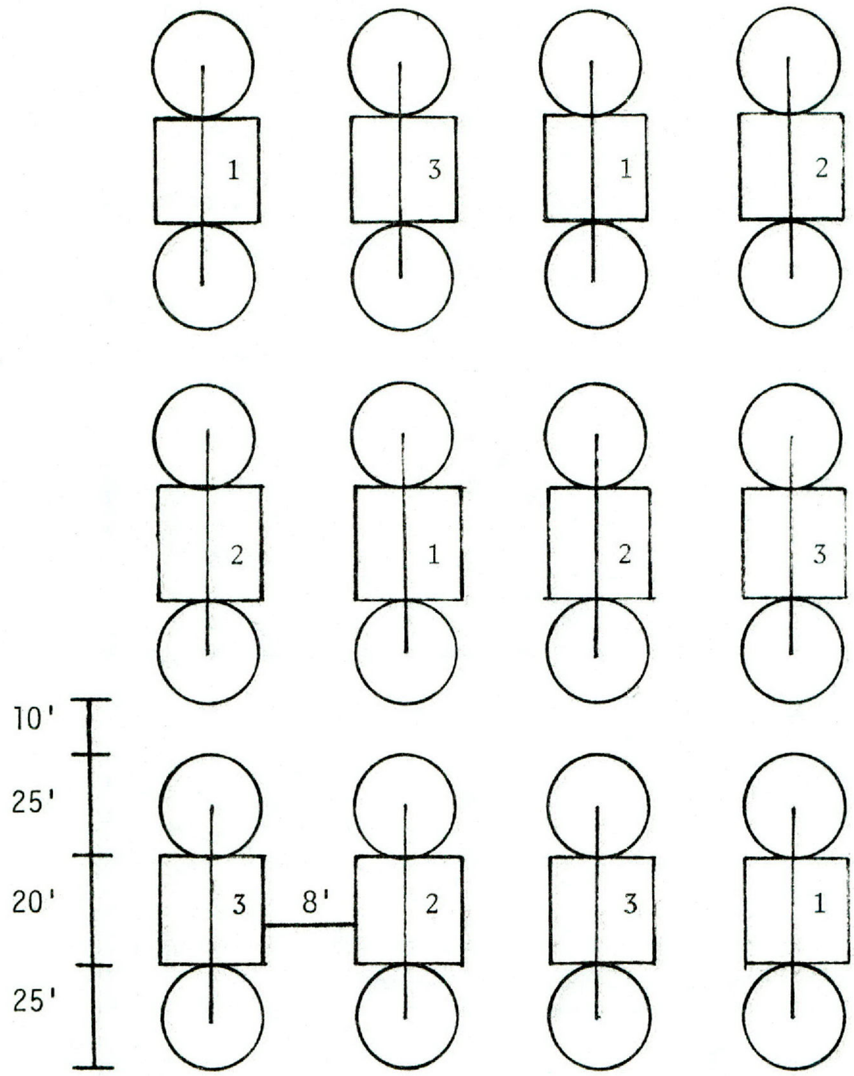

Figure 1. Field plot arrangement in the turf irrigation study, Lubbock, Texas, 1981. Frequencies 1 = low; 2 = medium; 3 = high.

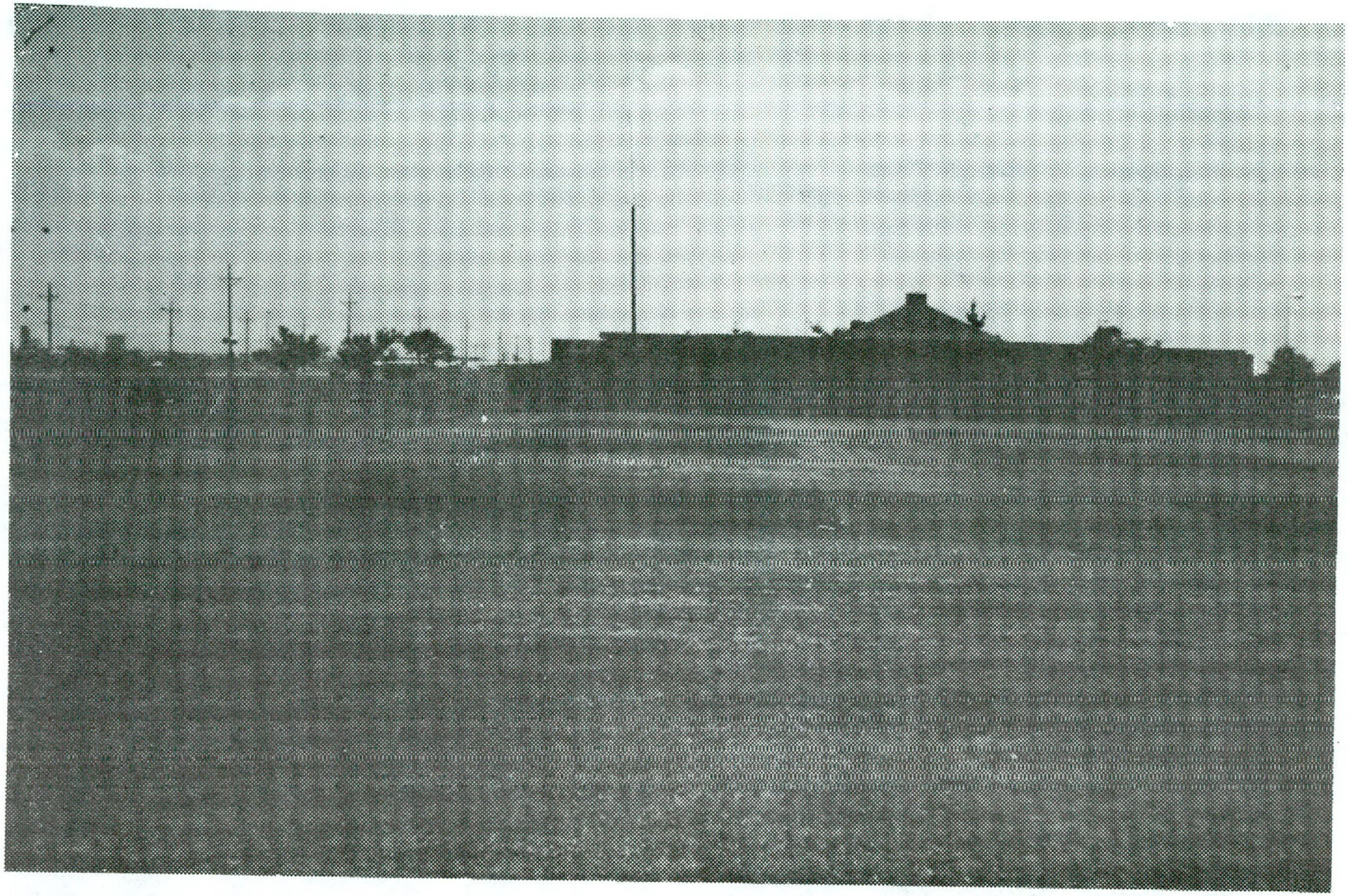

Figure 2. Plots in the turf irrigation study, Lubbock, Texas, 1982.

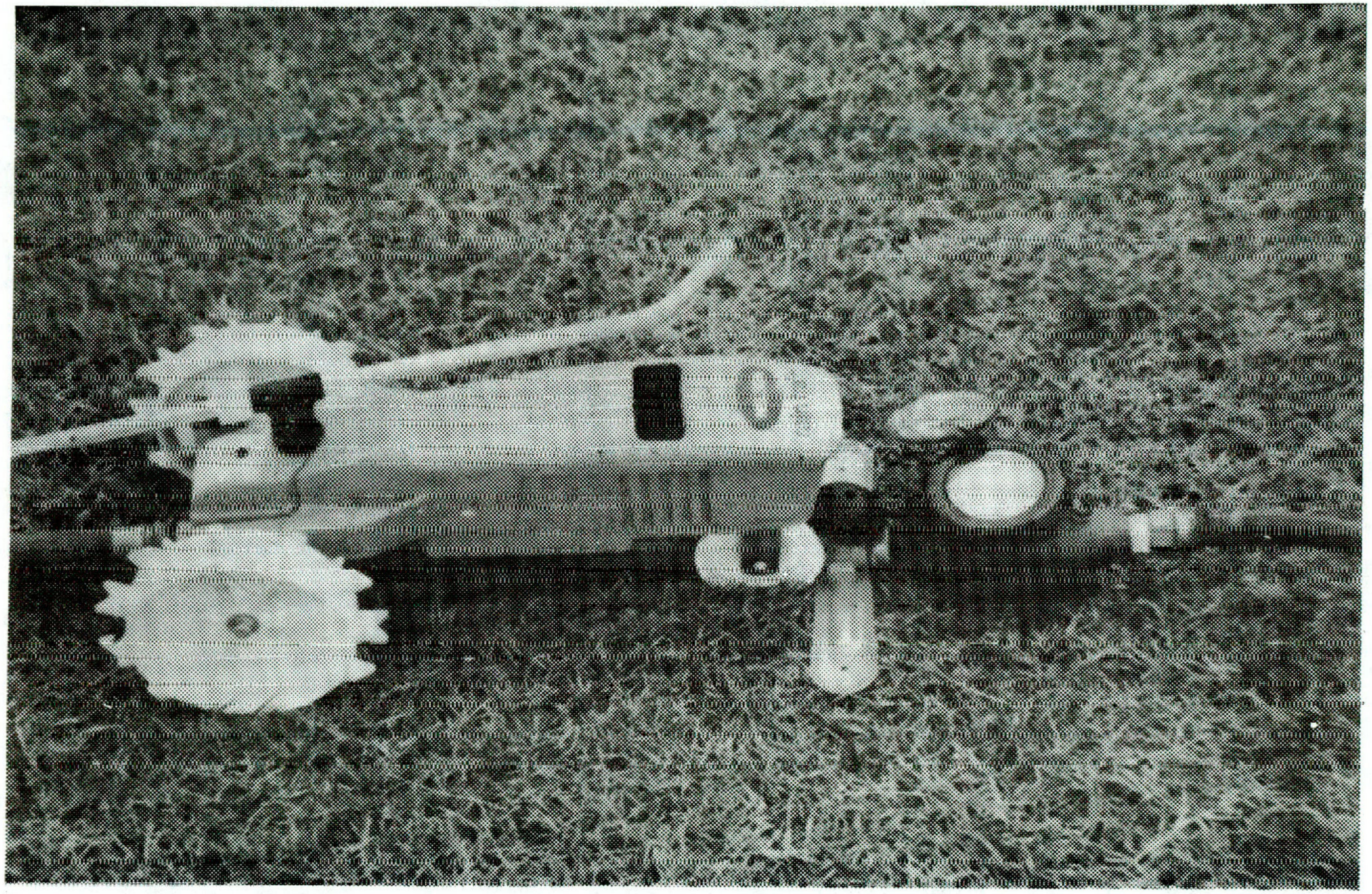

Figure 3. Traveling sprinkler in the turf irrigation study, Lubbock, Texas, 1982.

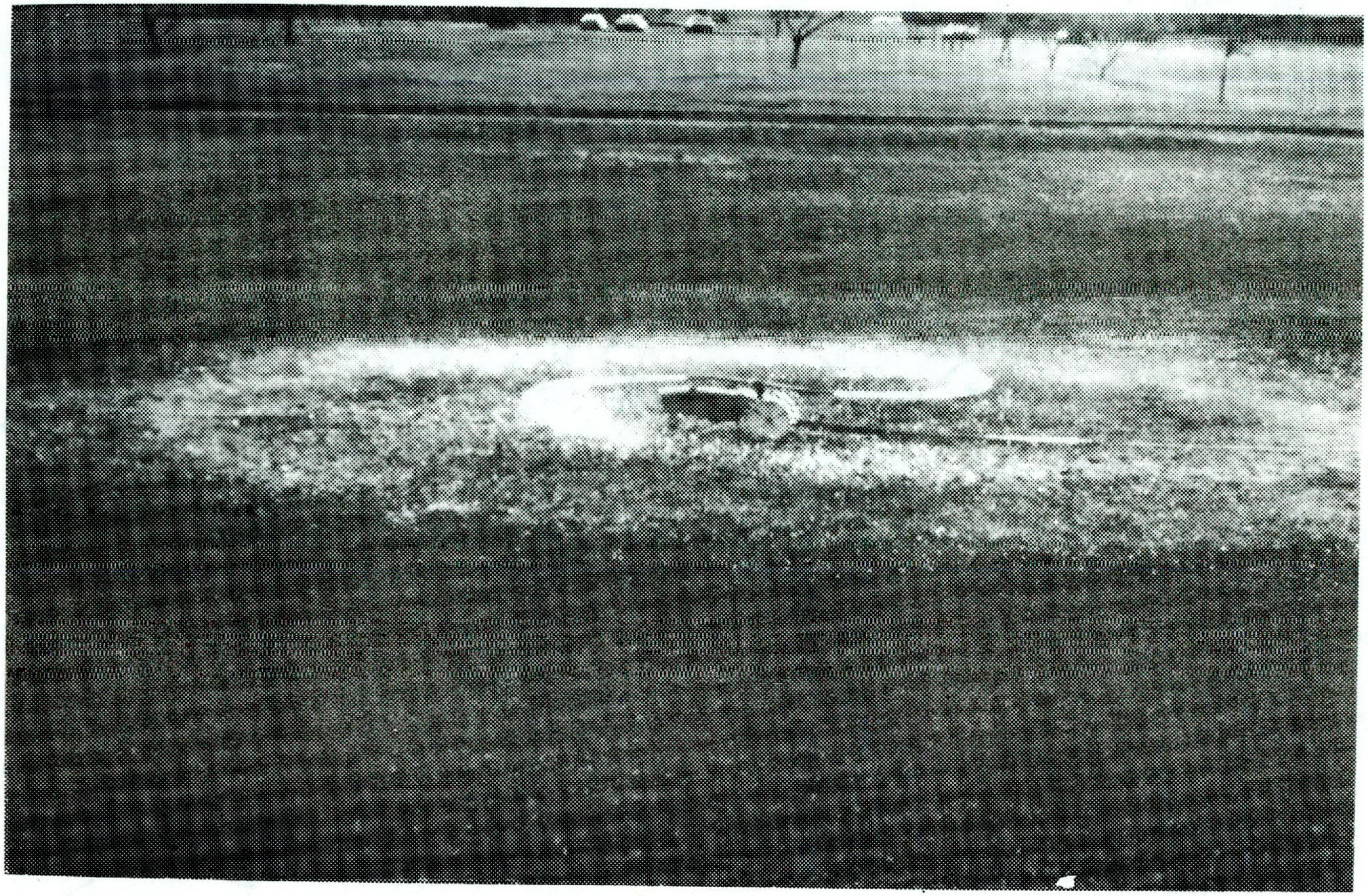

Figure 4. Irrigating with the traveling sprinkler in the turf irrigation study, Lubbock, Texas, 1982.

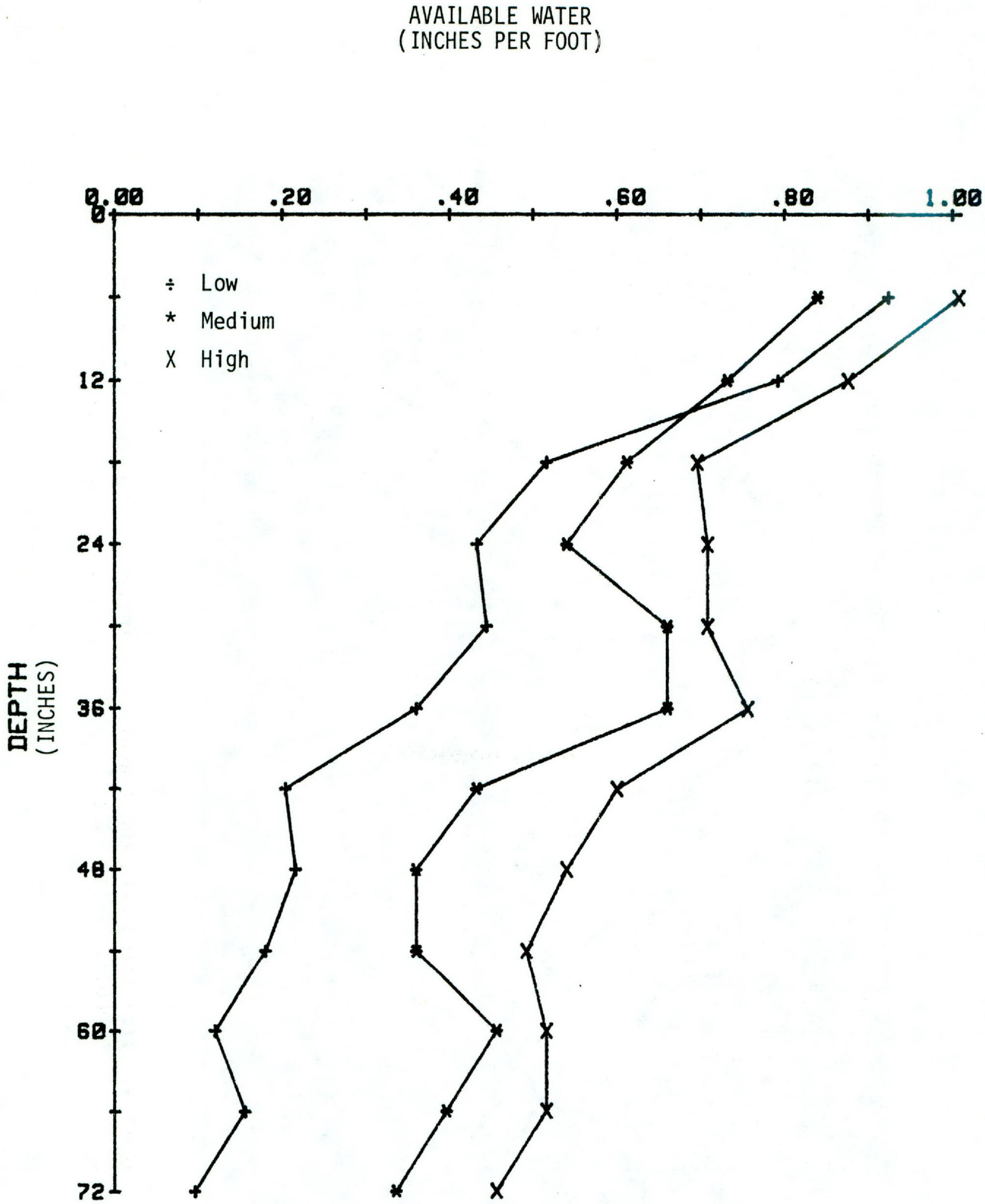

Figure 5. Available soil water (inches/foot) on May 19, 1982 in the 3 irrigation treatments applied in 1981 in the turf irrigation study, Lubbock, Texas, 1982.

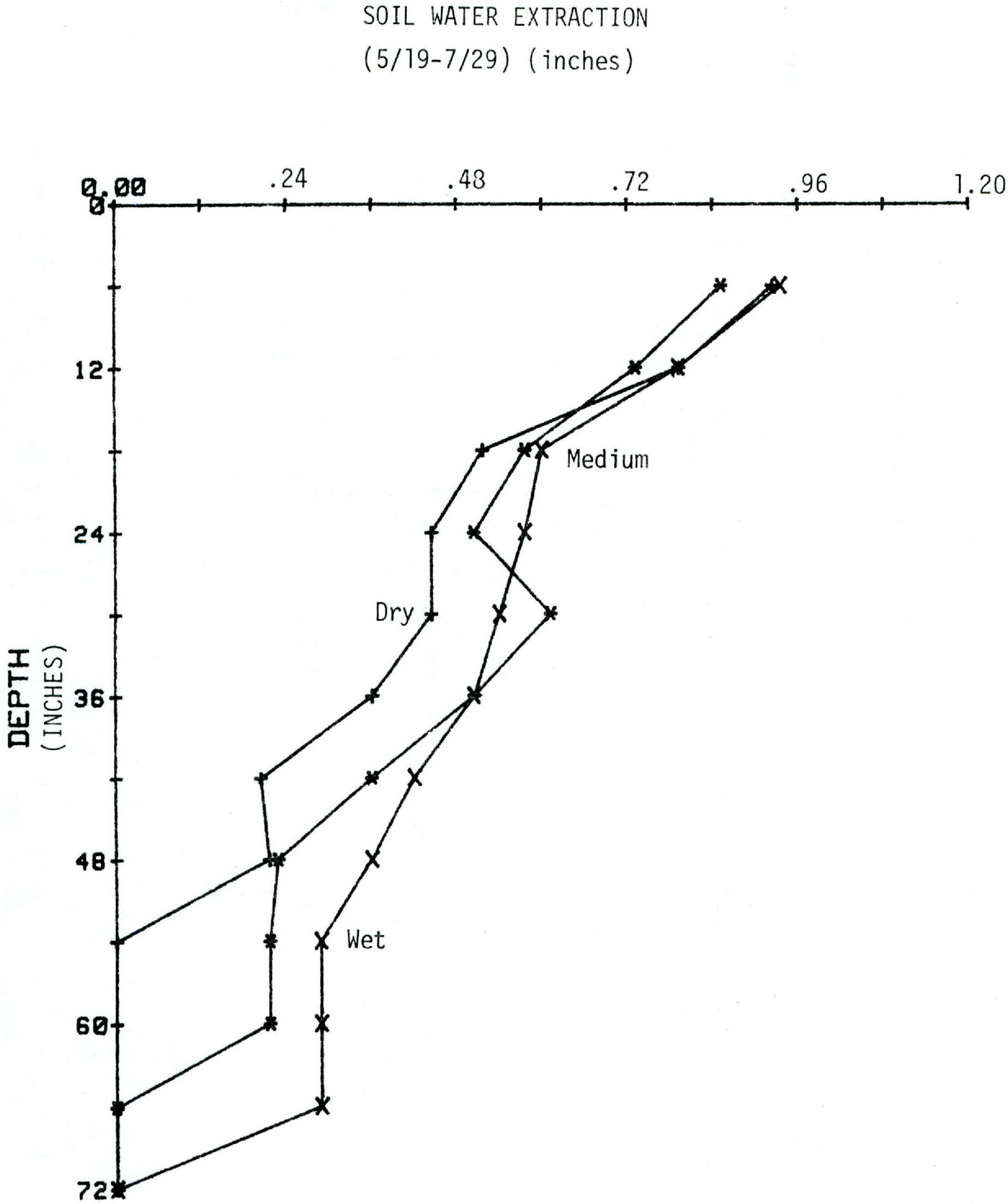

Figure 6. Soil water extraction (inches) by depth between May 19 and July 29, in the turf irrigation study, Lubbock, Texas, 1982.

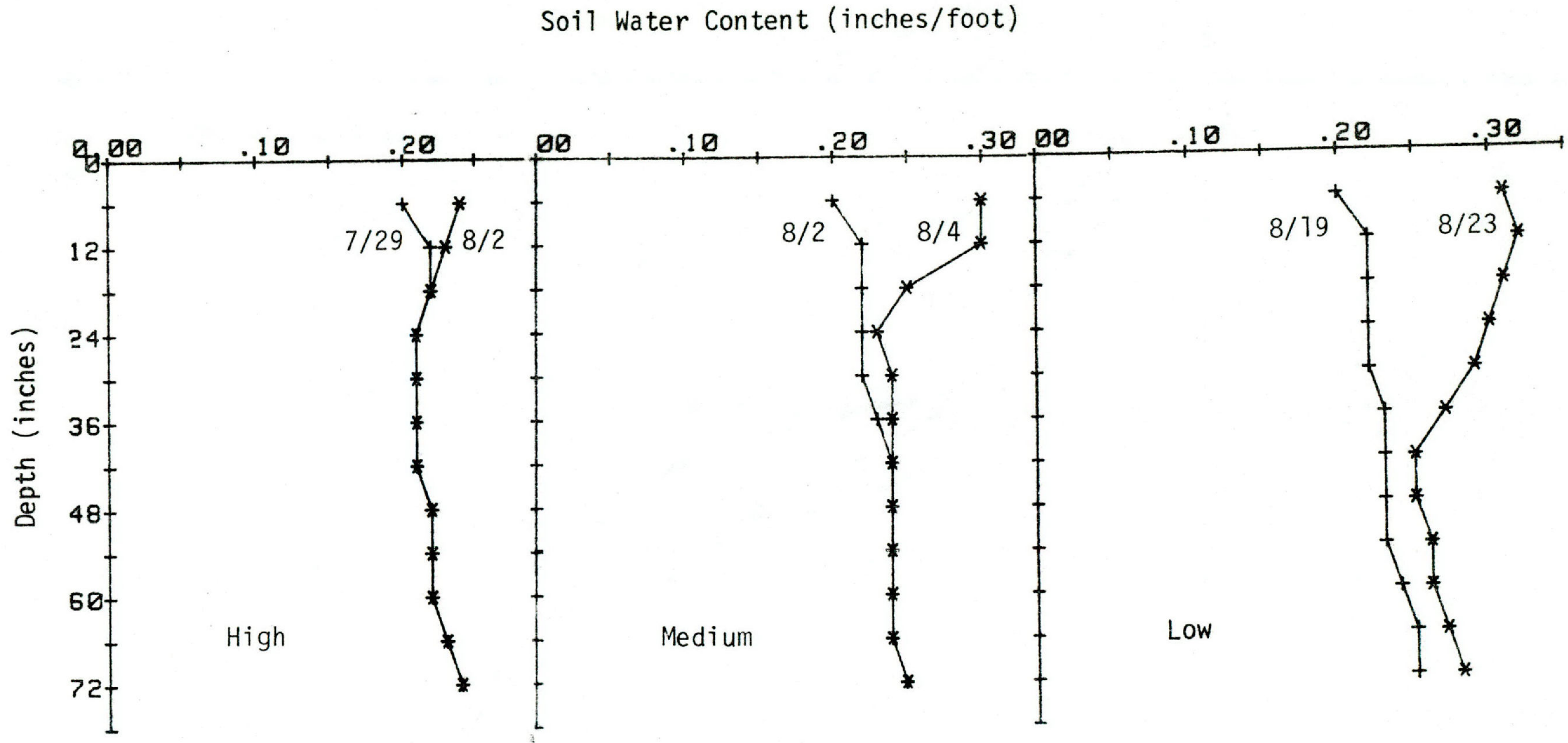

Figure 7. Soil water content before (+) and after (*) irrigation, in the turf irrigation study, Lubbock, Texas, 1982.

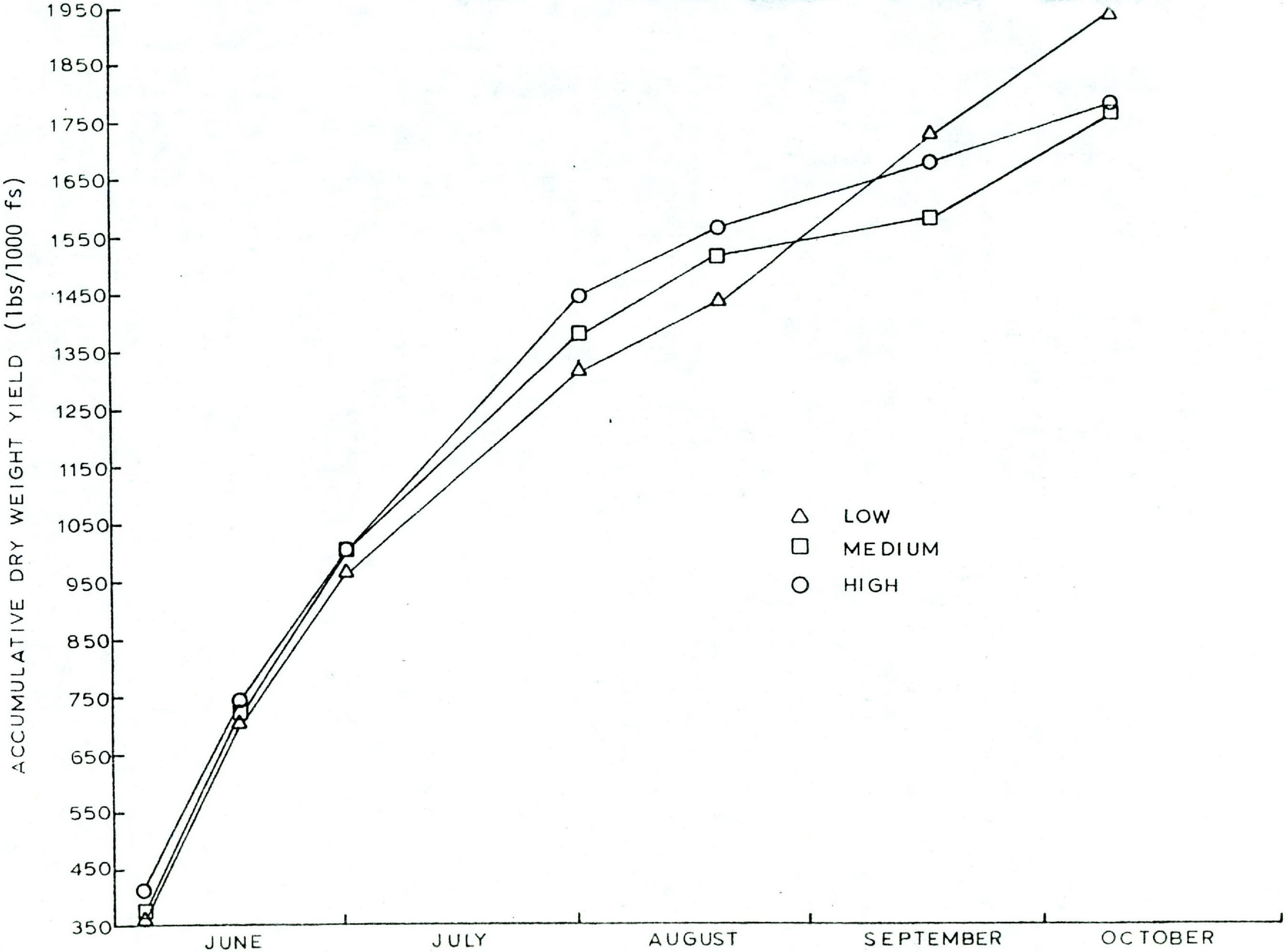

Figure 8. Cumulative yield of dry matter production in the turf irrigation study, Lubbock, Texas, 1982.

PR-4158

Evaluation of Home Lawn Sprinklers

M. D. Gerst and C. W. Wendt

Abstract

A study was conducted in 1982 to determine water losses of home lawn sprinklers during a 24-hour period. Water losses were determined by measuring the inflow and outflow of sprinklers operating on a plastic tarp. Sprinkler types evaluated included rotating, traveling, buried head, impact, ring and oscillating. A commercially available drip irrigation hose was also evaluated for water losses. The sprinklers and drip irrigation hose lost 15 to 60 percent less water at night than during the day. Minimum loss generally occurred from midnight to 8:00 a.m. and maximum loss during midday. Actual water loss was 1.7 to 16 times traditional potential evaporation measurements. The data from the study indicate that water losses from a home lawn sprinkler or a drip line were dependent on several variables including climate, time of day, system characteristics and application period.

Introduction

The most common method of irrigating turfgrasses is by sprinklers (1). In 1942, J. E. Christiansen (2) wrote, "A question frequently asked concerning sprinkling is, 'How much water is lost by evaporation when water is sprayed into the air?'" Today, this question is frequently asked about home lawn sprinklers.

Considerable research has been conducted on agricultural sprinklers. Through the use of catch cans, Christiansen (2), estimated that evaporation losses were as great as 42 percent of the applied water during afternoon tests and as low as 4 percent during early morning tests. Since his work, evaporation losses from sprinklers used to irrigate agricultural crops have been widely investigated. Frost and Schwolen (5) reported evaporation losses as high as 35-45 percent of the applied water on clear, hot, dry days in Arizona. They also showed that evaporation losses from a single sprinkler nozzle greatly exceeded those from two nozzles. Most of their studies were conducted at wind speeds of less than 5 mph with a few at 8-10 mph. They concluded from their sprinkler tests that doubling the wind speed almost doubled the loss to evaporation. Clark and Finley (3) (using a series of nozzles) reported evaporation losses were less than 10 percent of the applied water when wind speeds were less than 5 mph on the Texas High Plains. They found that evaporation losses of 25-30 percent at wind speeds of 15-18 mph.

It is difficult to apply information on agricultural sprinklers to home lawn sprinklers, as the latter are generally of different design and often used as single sprinklers. Kneebone, et al. (10) measured the application rates of six types of home lawn sprinklers (buried head, stationary, impact, rotating, oscillating and traveling). They determined sprinkler application rates through the use of a flowmeter attached to a hose leading to the sprinkler and did not report the application rate to the turf surface or the evaportaion loss of the spray. They reported that application rates of home lawn sprinklers decreased as pattern size and pressure increased. All of their studies were conducted at wind speeds of 5 mph or less.

In the West Texas area, the wind speed averages 10-15 mph (9), maximum temperature often exceeds 100 degrees F, humidities often are less than 10 percent and the light intensity is usually high. Little data are available on the water losses from home lawn sprinklers in such an environment. In 1981, a study (7) was initiated at the Lubbock State School, Lubbock, Texas, to measure the water losses from home lawn sprinklers. Average water losses from home lawn sprinklers for a 24-hour period ranged from 13-47 percent when evapotranspiration calculated from meterologic data ranged from 0.11 to 0.25 inches/day. Although the sprinklers were not evaluated simultaneously, the data indicated that water losses from individual sprinklers varied from 6 to over 70 percent of the applied water depending on the time of day. The data also showed the need for simultaneous measurement of water losses from home lawn sprinklers before recommendations could be made concerning sprinklers. In a separate study in 1981 (6), the Christiansen uniformity coefficient for all the sprinklers tested was less than 70 which is considered to be the lower acceptable limit of uniformity.

Due to limited resources in 1982, it is necessary to choose between obtaining water loss and distribution data. Water loss data was considered more important due to the limited and diminishing water supplies in West Texas. Therefore, a study was conducted to determine the water losses of home lawn sprinklers and drip irrigation hose under climatic conditions prevalent in the West Texas area.

Materials and Methods

The study was established at the Lubbock State School on a pasture with a 2-4 percent slope to facilitate runoff (Figure 1). The ground was smoothed prior to installing the equipment. Five impervious surfaces (two - 10 ft x 80 ft, two - 50 ft x 40 ft, and one - 50 ft x 60 ft) were constructed of a 6 mil black polyethylene sheeting joined with 13 mil black polyethylene tape. Black plastic was used because it was readily available. A schematic of all facilities is shown in Figure 2.

Each surface was fitted with a collection pit at the lowest point of drainage. Installed in the pit was a fiberglass or galvanized tub which was equipped with a pump and float control to maintain a constant height of water (Figure 3). Near the collection pit, necessary apparatus [valves, pressure regulator (Clark Reliance 4 RVA-W & Wyatts Model No. VS 5B), pressure indicating gauges and flowsensors (Signet Scientific Model No. MK 515/415)] were installed to monitor the water flow to the sprinkler and from the collection pit (Figure 4). Signals from the flowsensors (Figure 5) were recorded by a datalogger (Doric Digitrend Model 210) located in a shelter (Figure 6).

Data were collected on every 20 minute interval during the day. Each flowsensor was compared periodically to a totalizing flowmeter (Conrad CM2P) to insure accurate measurements. Percent evaporation from the sprinklers was calculated by:

$$E = \frac{I - O}{I} \times 100\ \% \qquad (1)$$

where

E = percent evaporation
I = inflow (gallons)
O = outflow (gallons)

The application rate of a home lawn sprinkler was calculated by

$$P = \frac{F \times 1440}{A \times 0.62} \qquad (2)$$

where

P = application rate (inches/day)
F = flow rate (gallons/min)
A = area covered (fs)
1440 = (minutes/day)
0.62 = gallons/fs-inch

A weather station, equipped with a calibrated 8 day hygrothermograph for measuring temperature and relative humidity, was centrally located on the west side of the study area. Wind speed at a height of 10 feet was continuously recorded.

The sprinklers and drip lines (2-50 foot lines) were all commercially available in the Lubbock area (Table 1 and Figure 7). The sprinklers used during 1982 were the same as those tested in 1981. Although other brands of similar type sprinklers were available, they were not evaluated due to limited resources.

Therefore the information obtained in this study applies only to the sprinklers evaluated and may not apply to similar sprinklers from other manufacturers.

The single sprinklers (oscillating, rotating, traveling, ring and impact) were placed in the center of a surface adequate to receive all of the water applied at wind speeds up to 15 mph. The buried head sprinklers which had a 12 foot radius of spray were installed in a triangular pattern (Figure 8) as recommended by the manufacturer. The system was composed of 10 nozzles: 4-90 degree angle, 4-180 degree angle and 2-270 degree angle. Water pressure of the sprinklers was regulated at 25 psi and the drip line water pressure was regulated at 10 psi using pressure regulators. Flow control valves and pressure regulators are available to the homeowner.

Water losses from sprinklers greatly exceeded evaporative demand in 1982 (7). It is difficult to predict water losses from sprinklers from climatic parameters. Comparisons of water losses between sprinklers (or drip line) not tested at the same time may not be valid due to the variation in climate. Therefore, every effort was made to insure that the different sprinklers were tested simultaneously. The sprinklers and drip line were tested during August and September, 1982. The traveling sprinkler was evaluated as a stationary sprinkler because it was not feasible to evaluate it as it moved.

Results and Discussion

During 1981, the sprinklers were evaluated during a period of low evaporative demand (0.11 to 0.25 inches/day) and were each tested on different dates. In 1982, up to five sprinklers were tested at the same time and all sprinklers were continuously tested for periods of a week or longer. As a result, water losses from the sprinklers may be compared during the periods of higher evaporative demand (0.28 to 0.34 inches) than occurred in 1981. Although, all 7 sprinklers could not be tested at the same time, a comparison of water loss on days of similar evaporative demand is possible due to the range of climate conditions during the testing period. The data presented are representative of those obtained during the testing period.

Comparative water losses during a 24-hour period for the buried head, ring, rotating and oscillating sprinklers and the drip line are shown in Figure 9. The ring sprinkler lost a higher percentage of water than the other sprinklers throughout the test period. Water losses from the drip line increased from 10 percent before dawn to 80 percent at noon before returning to 10 percent after sunset. Possible reasons for these losses include head absorpiton by the black plastic line containing the emitters and the spray rather than droplet application of the emitter.

The buried head, rotating and oscillating sprinklers lost water in ranges of 12 to 20 percent, 10 to 25 percent and 8 to 30 percent, respectively. Of the three, the oscillating sprinkler lost the most water at midday and the least from midnight to 4 a.m. Percent water loss data from the buried head and rotating sprinklers were within 5 to 8 percent of each other throughout the 24-hour period.

In general, water losses from the buried head, ring, rotating and oscillating sprinklers and drip line were lowest from midnight to 8 a.m. and highest from 11 a.m. to 6 p.m.

Water losses from the buried head, impact and traveling sprinklers and the drip line in September are shown in Figure 10. The impact sprinkler which emitted a spray over a large area (Table 2), lost a higher percentage of water at all times than the other sprinklers or drip irrigation hose. Since the buried head is used by some homeowners in Lubbock, as a single sprinkler, it was evaluated as such in 1981. The water loss during 1981 approached 50 percent of the water applied by the single buried head sprinkler. Water losses from the group of buried head sprinklers evaluated in 1982 were less than half this amount which indicates that a system of sprinklers is more water efficient than a single sprinkler. These results are in agreement with those of Frost and Schwolen (5) for water losses from a single agricultural sprinkler and a system of sprinklers. During 1982, the traveling and buried head sprinklers lost less water than the drip irrigation hose or the impact sprinkler. The water loss data from the traveling sprinklers was similar in magnitude to those obtained in 1981 (6).

The daily pattern of water loss from the sprinklers and the drip line generally followed the daily pattern of potential evaporation as calculated from climatological parameters. Water losses were lowest from midnight to 7 a.m. when potential evaporation was lowest and increased from 7 a.m. to 5 p.m. as potential evaporation increased. Water losses from the sprinklers and drip line generally decreased from 5 p.m. to 8 p.m. as potential evaporation decreased.

Potential evaporation calculated from standard climatological parameters or pan evaporation was not related to the amount of water lost from the sprinklers (Table 3). During the 24-hour period, potential evaporation and pan evaporation data predicted a water loss of 0.28 to 0.34 inches. Actual water losses ranged from 0.5 inches for the oscillating sprinkler to 4.6 inches for the ring sprinkler. Pan evaporation and potential evaporation calculated from climatic parameters are both estimates of evaporation from a flat surface. Evaporation during sprinkling (before the droplets impact the surface) occurs from a spherical surface. If unit volumes are compared, a spherical droplet has roughly four times the surface area exposed to evaporation than a flat sheet of water. Therefore, traditional methods of estimating evapotranspiration cannot be used to estimate losses from home lawn sprinklers.

A comparison of the amount and time to apply 2.5 inches of water to the surface by all sprinklers and drip line was made. Six a.m. was selected as the start of irrigation. The percent evaporation losses for each sprinkler were calculated from the data shown in Figures 3 and 4 during the irrigation.

Sprinklers and dripline apply water at different rates. It is difficult to get a measure of water losses from rate data alone. The homeowner is interested in the water lost during the application of a given amount of water to the lawn surface. Time required to apply the 2.5 inch irrigations was calculated by:

$$T = \frac{2.5}{I} \qquad (3)$$

where

T = Time of irrigation (hours)

I = Water reaching tarp surface (inches/hour)

2.5 = Depth of irrigation (inches)

The total irrigation required by each sprinkler was calculated as:

$$I_T = \frac{I_D}{(1-W_L)} \qquad (4)$$

where

I_T = Total irrigation required (inches)

W_L = Water loss (fraction of applied)

I_D = Desired irrigation (2.5 inches)

The additional water needed to take care of water losses to assure that 2.5 inches of water were applied to the surface ranged from 0.27 inches for the oscillating sprinkler to 2.73 inches for the impact sprinkler (Table 4). Time required to apply the irrigation ranged from 3.47 hours (traveling) to 60.0 hours (impact).

Application rates ranged from 0.06 inches/hour (impact) to 0.71 inches/hr (traveling). Ideally, the application rate should be matched to the infiltration rate of the soil. However, no data are available on the infiltration rate of turf in the Lubbock area. Data are available on the agricultural soils. Infiltration rates of sandy soils in the Lubbock area are 7-10 inches/hr during the first 30 minutes and decreased to 1.0 to 1.5 inches/hr thereafter. All of the sprinklers and drip line could be used on sandy soils without water loss due to runoff. However, on clay soil, the infiltration rate is 2-4 inches/hr during the first 30 minutes and decreases to 0.1 – 0.4 inches/hr thereafter. Any of the sprinklers could be used for short periods of time on clay soils without runoff. However, for longer periods of time, runoff may occur when the rotating, ring, and buried head sprinklers are used. Runoff does not normally occur with the traveling sprinkler.

Conclusions

1. Both the 1981 and 1982 sprinkler irrigation data show that the best time to irrigate lawns is between 12 midnight and 8 a.m. Water losses are 50 percent or less of those obtained during midday. This is the period during the day of lower wind speeds and evapotranspiration and decreased temperatures and higher humidity.
2. The data obtained on the impact, traveling, rotary, and oscillating sprinklers were similar to those obtained in 1981. This indicates that the method of evaluation is repeatable.
3. Water losses during 1982 from the group of buried head sprinklers were less than 1/3 of those obtained from a single buried head sprinkler in 1981. Although many homeowners use a single buried head in Lubbock, these should be discouraged because of the high water loss.
4. Losses from the ring sprinkler were higher in 1982 than 1981 when it was operated at higher pressures.
5. The drip irrigation hose lost much more water than expected. The data obtained were inadequate to explain the losses. Possible causes include higher temperatures due to the black tarp and polyethylene line with the emitters and to the emitter design which applied a spray rather than droplets.
6. Since a black plastic tarp is not a home lawn, the data obtained in this study for the sprinklers tested represent qualitative rather than quantitative comparisons relative to performance that might be expected on a home lawn. However, where the sprinklers were operated in the same way both years, the data were comparable. Other brands of similar sprinklers may not perform similarly under the same testing conditions.
7. Many of the sprinklers applied water which exceeded the long term infiltration rate of many agricultural soils except sandy soils. Although little is known of the infiltration rates of soils in urban areas, runoff has been observed from lawns in Lubbock. If the infiltration rates of urban soils are similar to those of agricultural soils, then considerable runoff from lawns may be expected during long periods of irrigation with many of the sprinklers tested in this study.

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Table 1. Description of sprinklers and drip line evaluated at Lubbock, Texas, 1982. 1/

Type	Brand Name	Model No.	Manufacturer
Oscillating	Dial-A-Rain	N-0555A	L. R. Nelson Corp. Peoria, IL 61615
Traveling	Rain Train	187	L. R. Nelson Corp. Peoria, IL 61615
Impact	Impact	1230	L. R. Nelson Corp. Peoria, IL 61615
Rotating	Poppy	N-54	L. R. Nelson Corp. Peoria, IL 61615
Stationary	Ring		Rainbird Glendora, CA 97140
Stationary (Buried Head)		Series 570 2/	Toro Irrigation Div. Riverside, CA 92504
Drip Line		Kit F-50	Submatic, Inc. Lubbock, TX 79404

1/ Sprinklers were operated at 25 psi while the drip line was operated at 10 psi. Pressure was controlled with a pressure regulator.

2/ Irrigation system composed of ten - 12 foot radius of spray sprinkler nozzles.

a. 4-90°
b. 4-180°
c. 2-270°

Table 2. Areas of water application by sprinklers and dripline, Lubbock, Texas, 1982.

Type	Range in Area (fs)[1/]
Buried Head	1225 - 2077
Ring	1550 - 2666
Rotating	868 - 961
Oscillating	915 - 1876
Drip[2/]	200
Impact	2403 - 4635
Traveling	496 - 651

[1/]Values shown are areas covered for a wind speed range of 0 to 15 mph.

[2/]Drip line area was not affected by wind.

Table 3. Water applied and water loss for a 24-hour period from the sprinklers and the drip line on selected dates at Lubbock, exas, 1982.

		Irrigation (inches)		Evaporation		Potential Evaporation (inches/day)	
Date	Type	Applied	Intercepted	(inches)	% of Applied	Calculated	Pan
8/21	Buried Head	11.8	10.2	1.6	13.8	.28	.31
	Ring	14.9	10.3	4.6	30.9		
	Rotating	13.8	11.9	1.9	14.1		
	Oscillating	8.7	8.2	.5	5.9		
	Drip	13.8	9.4	4.4	31.8		
9/17	Impact	2.1	1.0	1.1	51.2	.28	.34
	Traveling	19.7	17.3	2.4	12.2		
	Buried Head	9.5	7.6	1.9	19.9		
	Drip	13.9	10.7	3.2	23.4		

Table 4. Irrigation required to apply 2.5 inches of water with the sprinklers and drip line at Lubbock, Texas, 1982.

Date	Type	Irrigation Applied (inches)	Irrigation Loss (inches)	Irrigation Rate * (inches/hour)	Time to Apply (hours)
8/21	Buried Head	2.89	0.36	0.43	5.8
	Ring	3.29	0.79	0.47	5.3
	Rotating	2.87	0.37	0.50	5.0
	Oscillating	2.67	0.17	0.34	7.4
	Drip	3.67	1.17	0.39	6.4
9/16	Impact	3.80	1.30	0.06	41.4
	Traveling	2.82	0.32	0.71	3.5
	Buried Head	2.99	0.47	0.38	6.8
	Drip	3.23	0.74	0.42	5.9

* - Application rate to tarp surface

Figure 1. Undeveloped site of the sprinkler study, Lubbock, Texas, 1982.

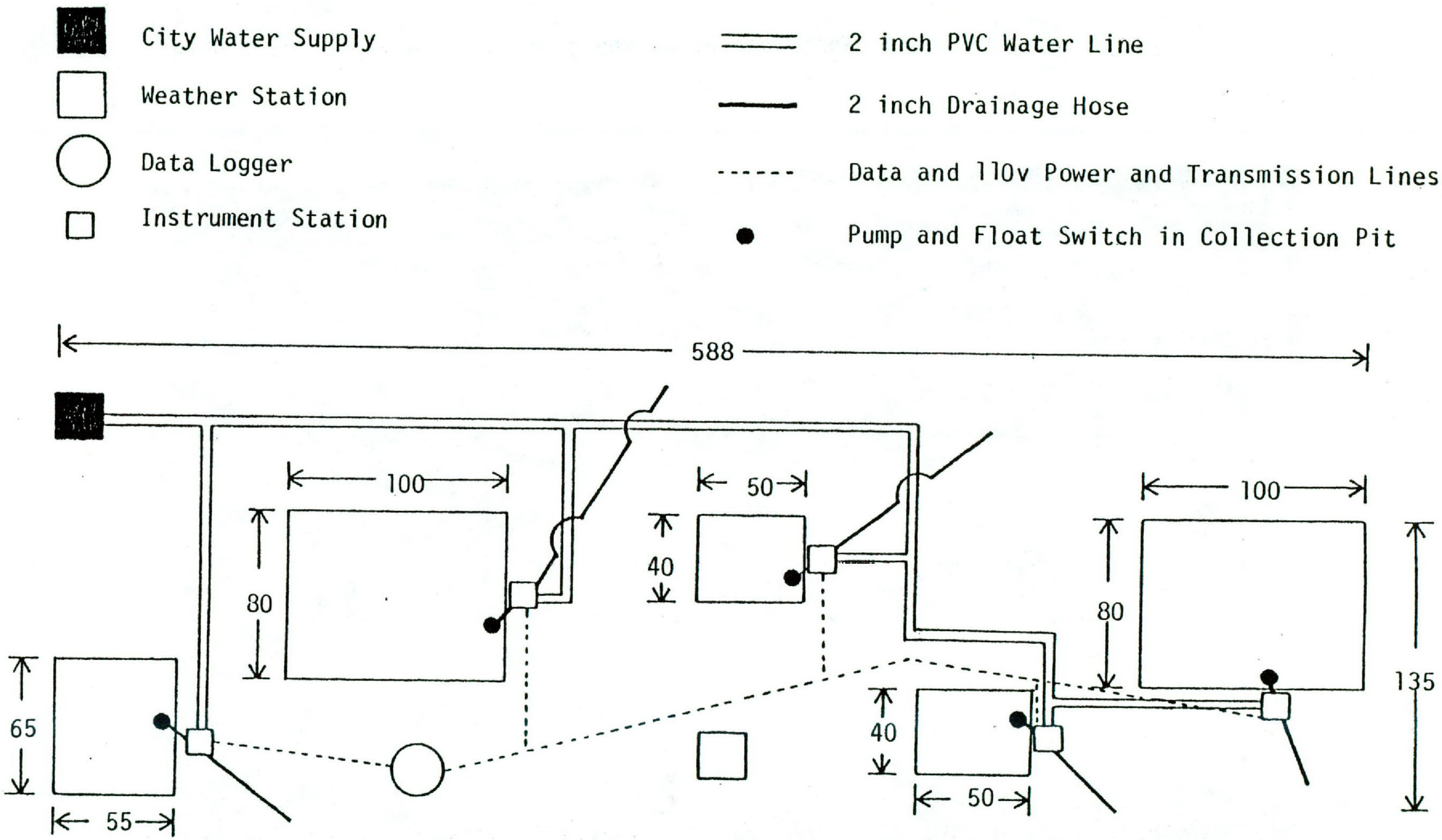


Figure 2. Schematic of field facilities of the sprinkler study, Lubbock, Texas, 1982.

Pump

Float control

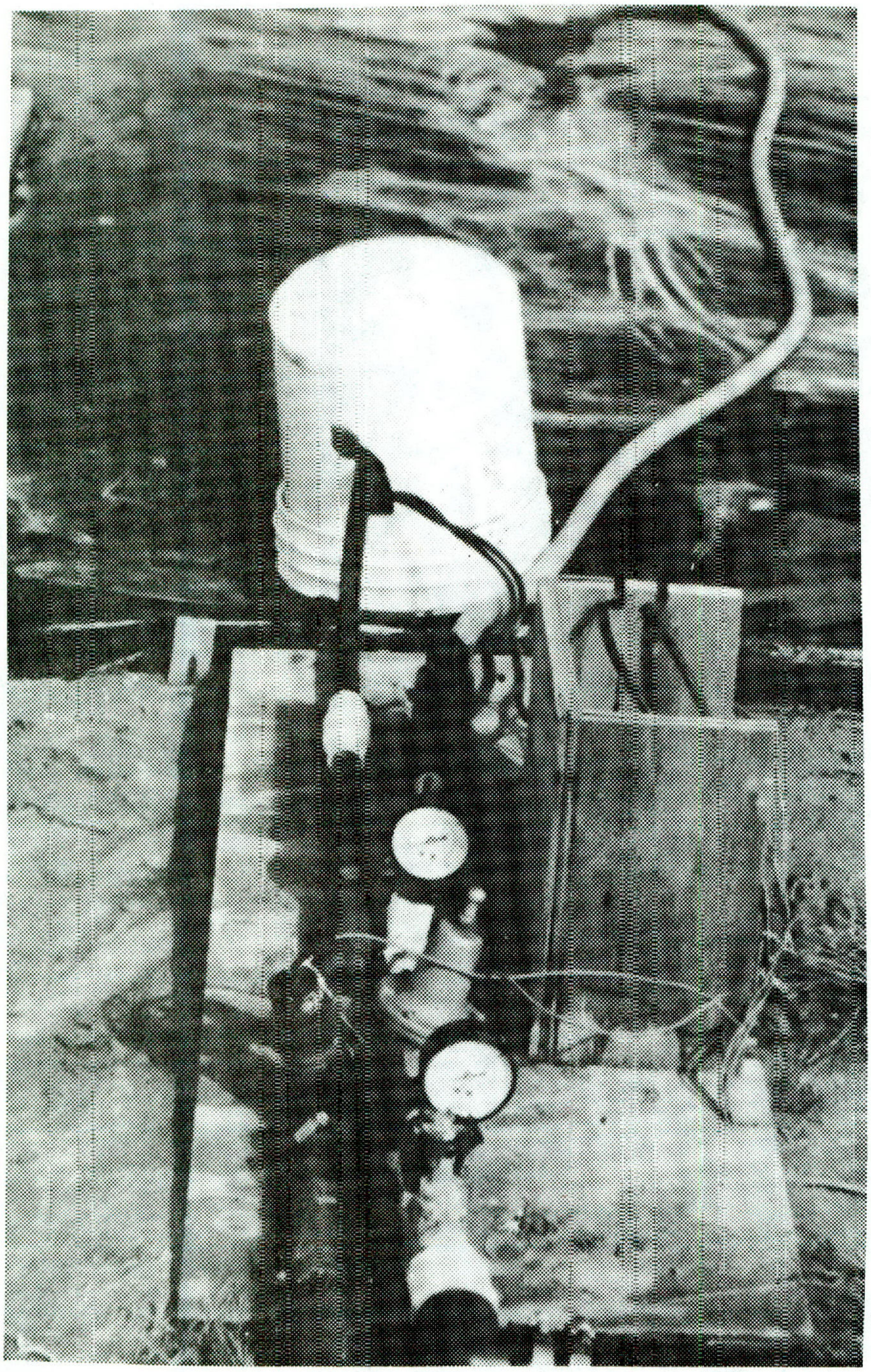
Collection pit

Drainage line

Screen filter

110 VAC line

Figure 3. Runoff water collection pit in the sprinkler study, Lubbock, Texas, 1982.



Pressure regulator

Flowsensors

Pressure gauges

One way valve

Shut off valve

110 VAC line

Sensor signal lines

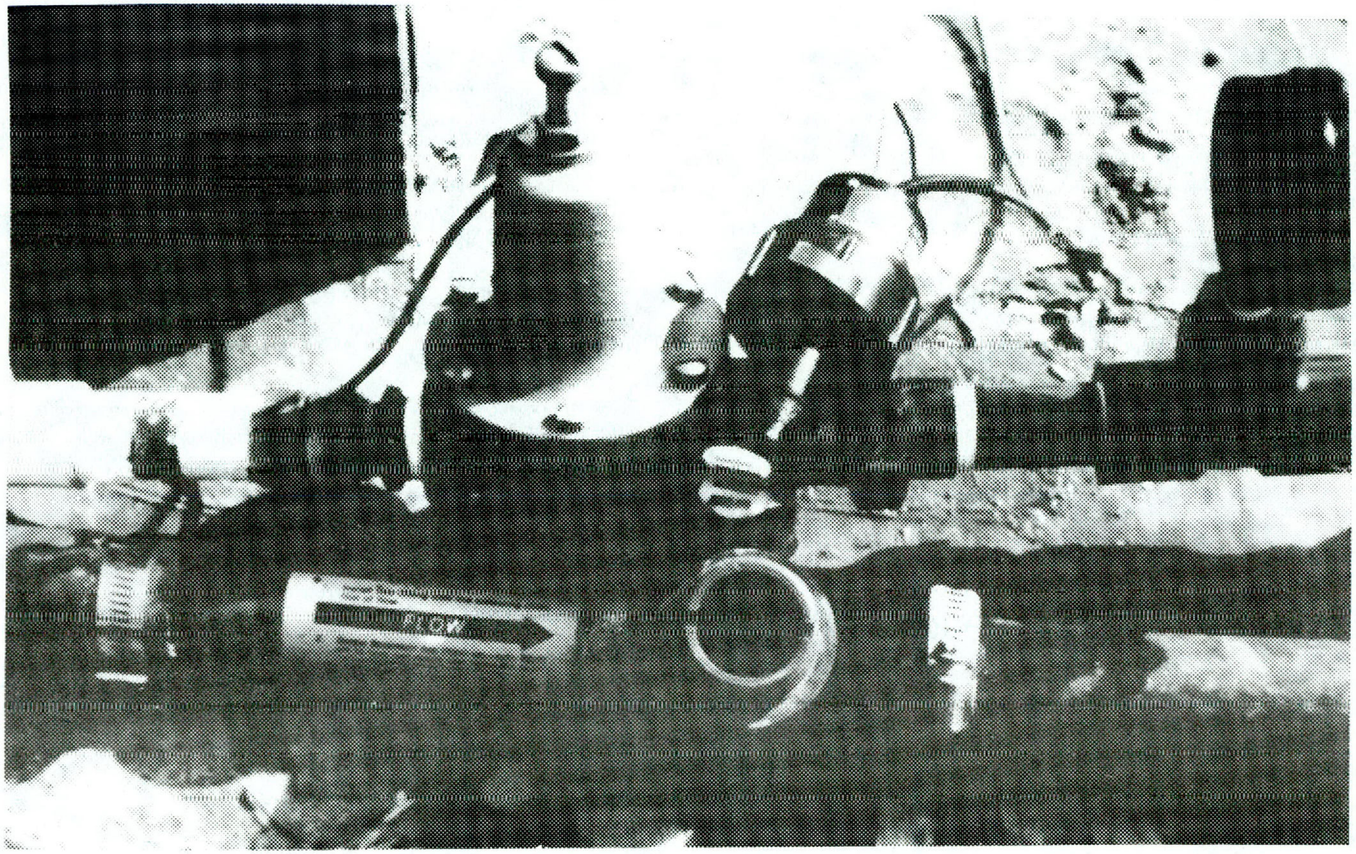
Drainage line

Header line

Hose to sprinkler

Collection pit

Figure 4. Apparatus used in the sprinkler study, Lubbock, Texas, 1982



Flowsensor

Paddle wheel

Regulator

Figure 5. Flowsensor used in the sprinkler study, Lubbock, Texas, 1982.

Figure 6. Datalogger shelter in the sprinkler study, Lubbock, Texas, 1982.

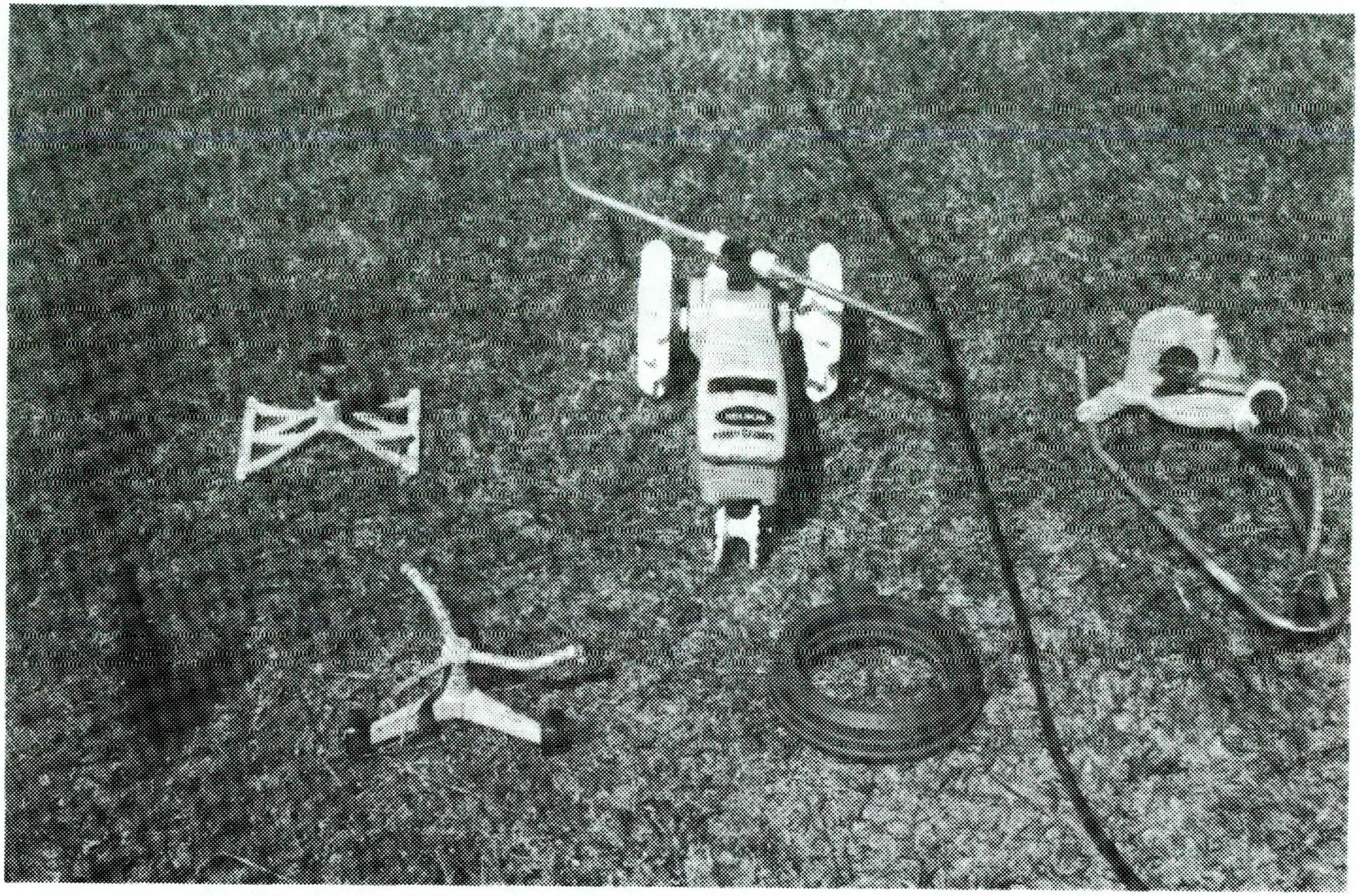


Figure 7. Sprinklers and drip line evaluated in the sprinkler study, Lubbock, Texas, 1982.

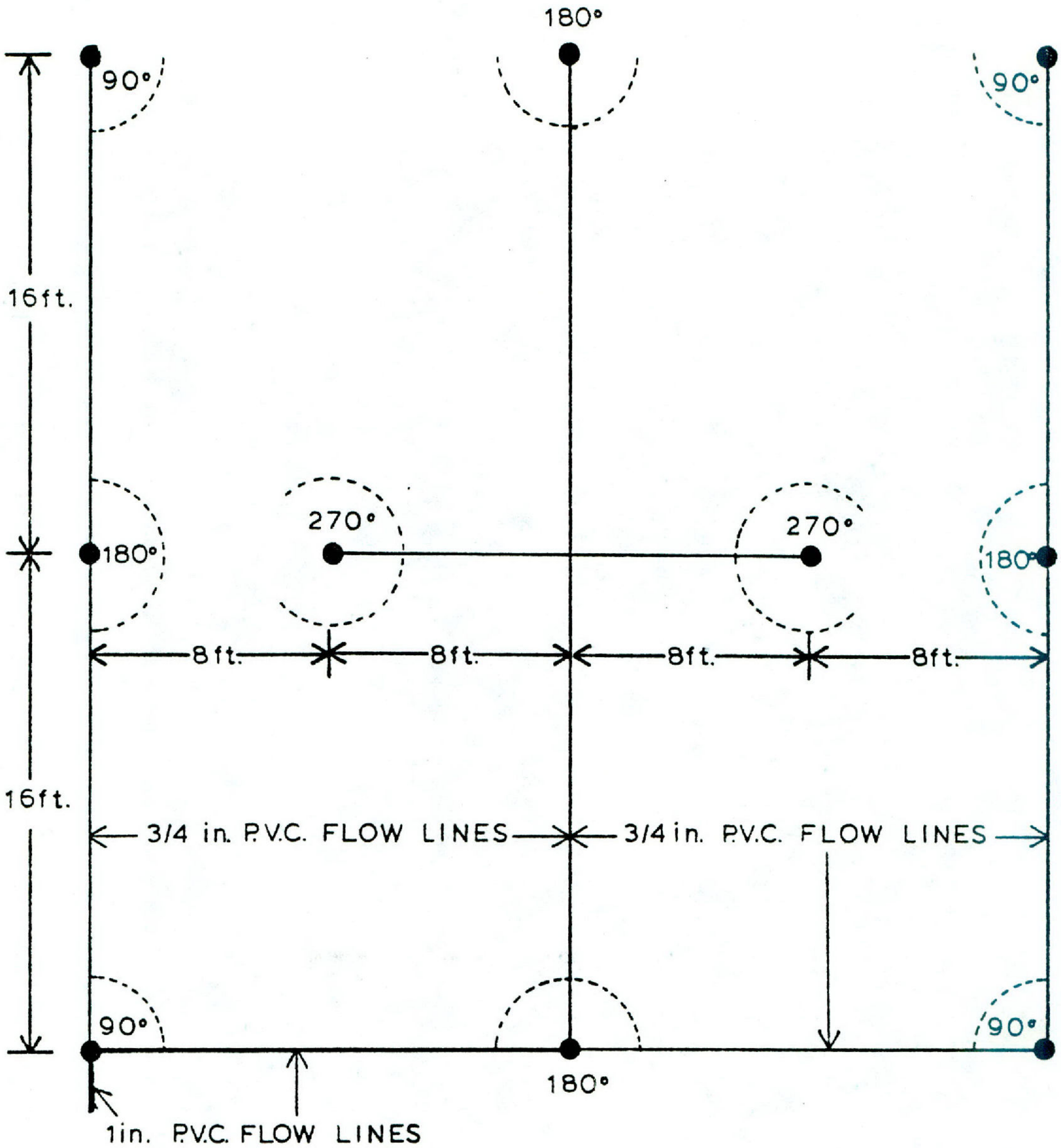


Figure 8. Schematic of fixed buried head sprinkler system with 12 foot nozzles evaluated in the sprinkler study, Lubbock, Texas, 1982.

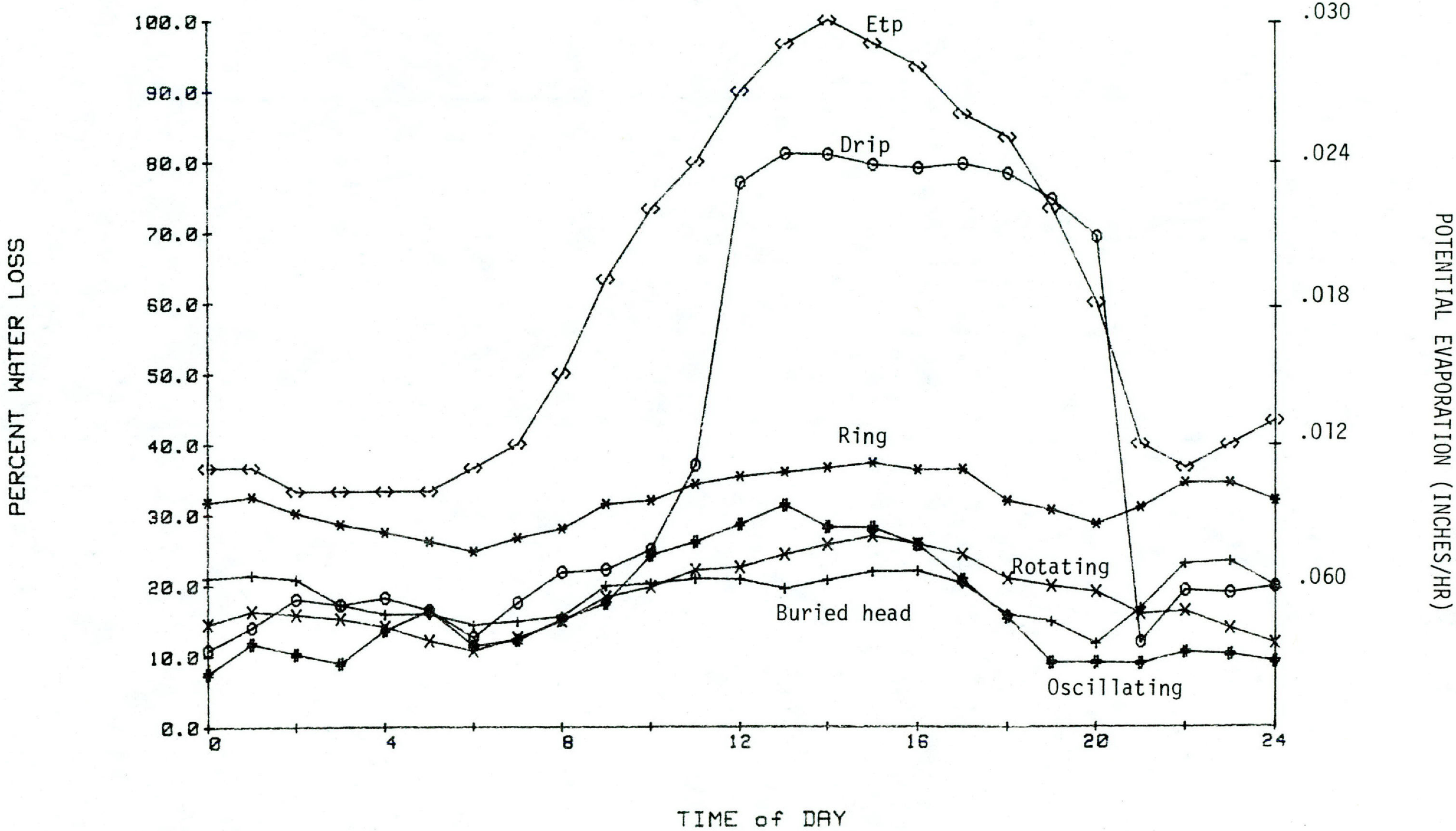


Figure 9. Percent evaporation loss for the buried head, ring, rotating and oscillating sprinklers, and the drip line on August 15, Lubbock, Texas, 1982.

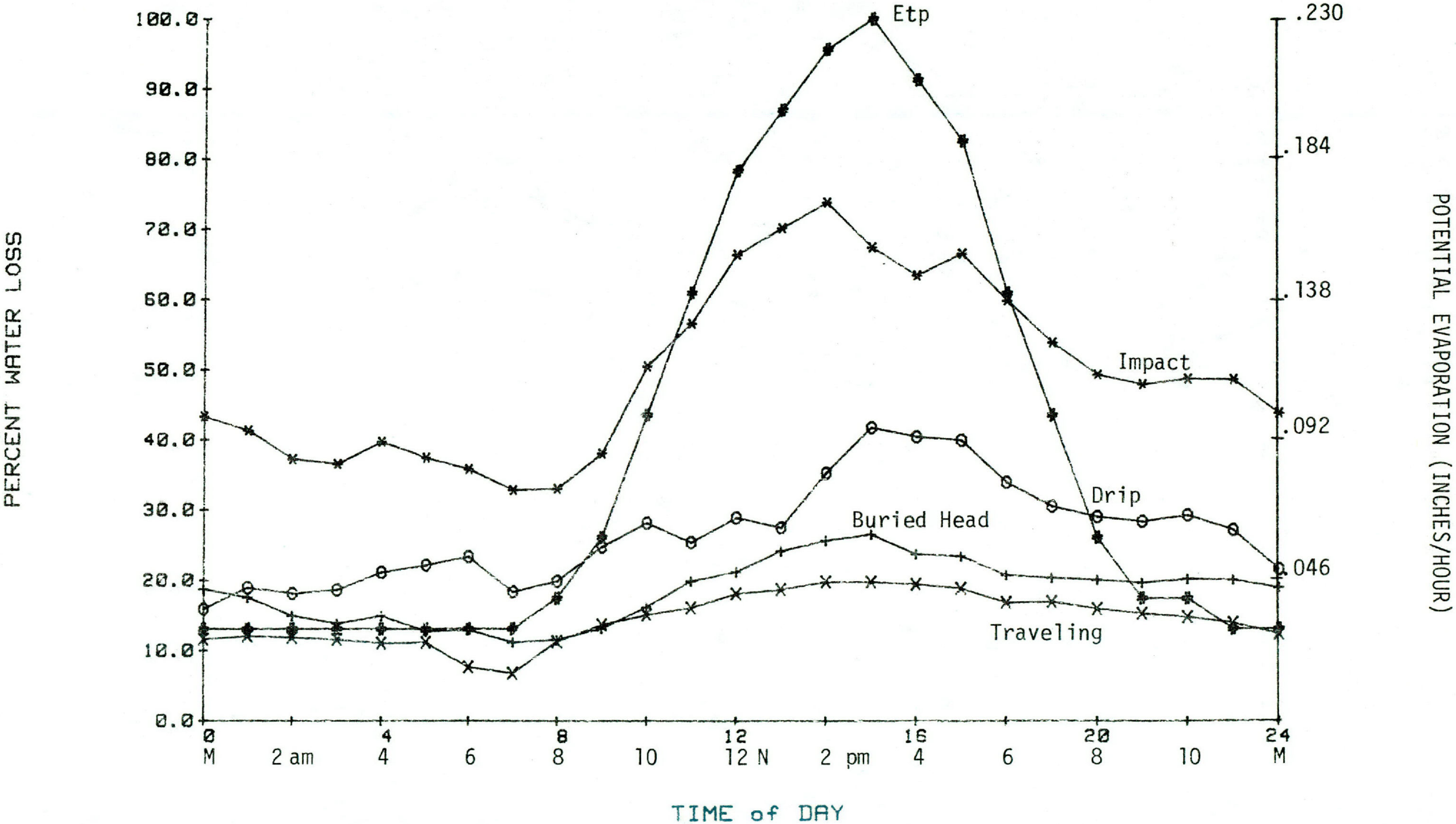


Figure 10. Percent evaporation of loss for the buried head, drip line, impact, and traveling sprinklers on September 17, Lubbock, Texas, 1982.

Appendix A. Electronic Flow Monitoring System

1. System Overview

The output from the paddlewheel flowsensors was conditioned and recorded on a datalogger. Data were obtained at specific intervals from the datalogger.

1.1 Description

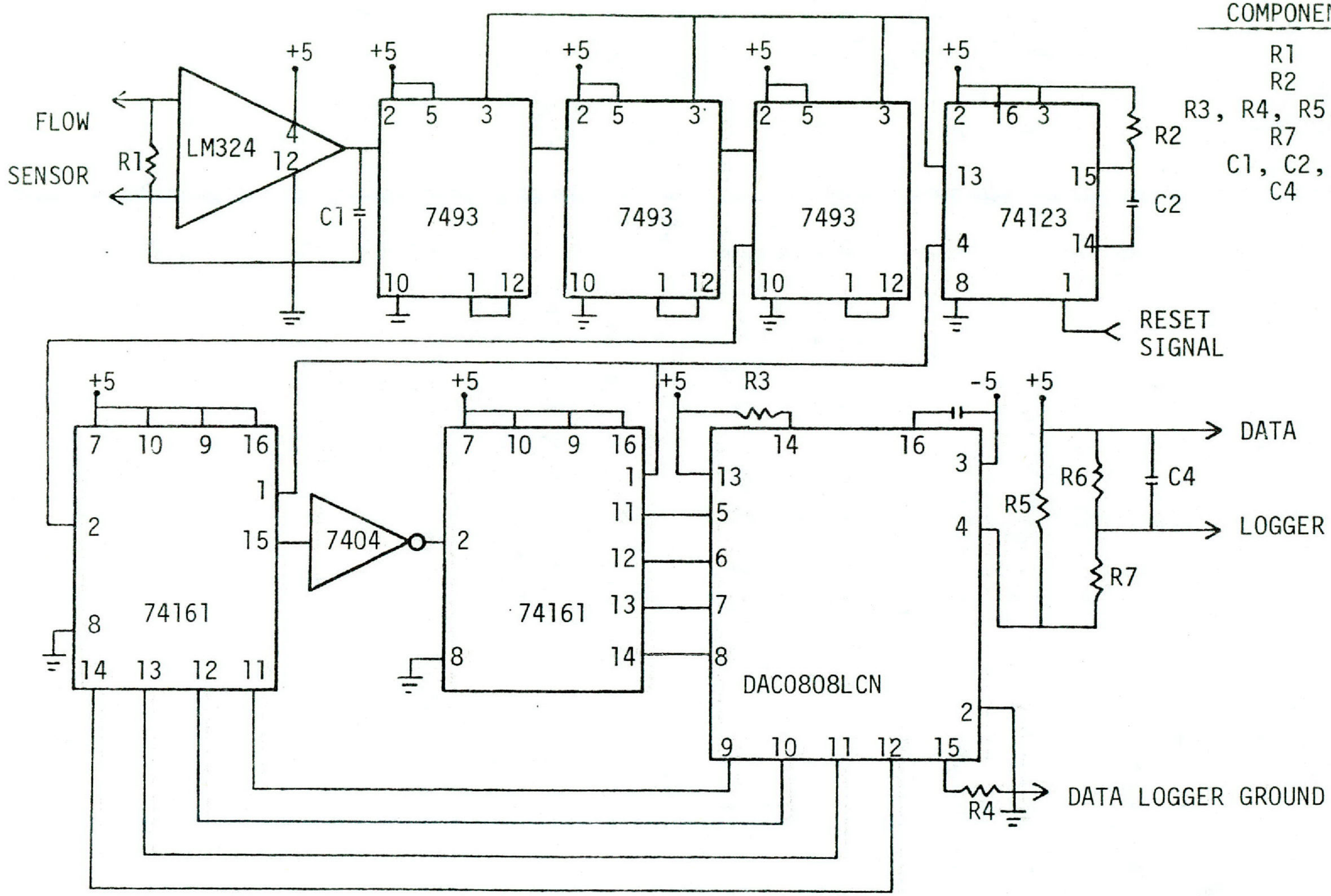
1.1.1 Paddlewheel Flowsensor

Refer to the instruction manual by Signet Scientific for the MK 515/415 paddlewheel flowsensors.

1.1.2 Counter and D/A converter

A. Signal Conditioning

Since the voltage from the flowsensors varies in magnitude as well as frequency, the signal must be conditioned to make it transistor to transistor logic (TTL) compatible. This was accomplished with operational amplifiers (OP AMPS) (LM 324) (Appendix Figure A). The signal lines were tied directly to the inverting and non-inverting inputs across which contained a 300 OHM resistor. This resistor protected the OP AMPS and filtered noise. The output frequencies of the OP AMPS were square waves identical to the flowsensor signals.



COMPONENT	VALUE
R1	300 Ohm
R2	36k Ohm
R3, R4, R5, R6	2.4k Ohm
R7	1M Ohm
C1, C2, C3	0.1 mF
C4	1.0 mF

Appendix Figure 1. Schematic of signal conditioner designed to convert digital output of flow-sensors to analog signal for recording on datalogger, Lubbock, Texas, 1982.

B. Division

Three four-bit binary counters (SN 7493A) were used to divide the original count frequency by 512. This is done to keep the number of counts at a reasonable level. Division by 512 was accomplished by cascading the three counters. Each counter was wired for division by 8 (8 x 8 x 8 = 512). These counters were reset after each period of operation (see "reset").

C. Binary Count

The pulses from the dividing network were counted by an 8-bit binary counter. This 8-bit counter was constructed from two synchronous 4-bit counters (SN74161) cascaded together with an inverter. These binary counters were reset after each period of operation (see "reset").

D. Digital-To-Analog Conversion

The eight outputs of each binary counter were used as inputs to a D/A converter integrated circuit (DAC0808LCN). With a resistor network, the output current was converted into a small direct current voltage signal which was compatible with our millivolt datalogger.

E. Reset

With a "finish" signal from the datalogger, it was possible to reset the binary count to zero with a retriggerable monostable multivibrator (SN74123) operating as a one-shot signal generator. The time constant was set with a 0.1μf capacitor and a 36K OHM resistor.

1.1.3 Data Logging

A Doric 210 datalogger was used to record millivolt output signals and to provide a finish signal at the end of each period to reset counters. The logger was set for a 20 minute scan interval. The logger printed the instantaneous voltage present at the end of each period. At the end of print cycle the datalogger reset the counters. The analog signal accumulated throughout the 20 minute period, but only the voltage at the end of the period was recorded. The total flow of water was porportional to the voltage recorded.

Appendix B. Calibration of the Electronic Flow Monitoring System

Initial calibration tests were conducted on the flow monitoring system in the laboratory at TAES-Lubbock. The purposes of these tests were to (1) determine the influence of temperature on system and (2) determine the accuracy of the calculated water flow.

The influence of temperature on the data recorder was obtained by heating the system and recording data at 1° C intervals from 24 to 35° C. No water flow occurred during these tests. The zero offset between channels ranged from -3.5 to 4.0. However, it was not influenced by temperature.

The relationship between counts and water flow was determined in both the laboratory and field by installing all 10 flowsensors in series. A calibrated Corad CM2P flowmeter was attached upstream from the first flowsensor and pipe fitting and a valve was connected downstream from the last flowsensor. Count data were obtained for 50, 100, 150, 200 and 250 gallons of flow. The recorded count data were corrected for the zero offset. The corrected count data were compared to the total gallons of water flow and regression equations were calculated for count data vs. gallons of water. These data are presented in Appendix Tables 1 and 2. Water flow was accurately calculated from the count data as indicated by r^2 values > 0.99. Regression equations calculated from laboratory and field data differed. However, these differences were probably due to field modification of the system to reject spurious signals.

Appendix Table 1. Regressions between counts and gallons of water in the laboratory tests, Lubbock, Texas, 1982.

	Flowsensor Numbers									
	1	2	3	4	5	6	7	8	9	10
Slope (gallons / count)	1.11	1.36	1.25	1.47	1.41	1.30	1.49	1.34	1.18	1.14
Intercept (gallons)	-10.90	-9.44	-12.57	-17.39	-13.05	-13.54	-11.24	-8.91	-13.95	-6.06
r^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

Appendix Table 2 Regressions between counts and gallons of water in the field tests, Lubbock, Texas.

	Flowsensor Numbers									
	1	2	3	4	5	6	7	8	9	10
Slope (Gallons / Count)	1.35	1.42	1.24	1.32	1.27	1.29	1.05	1.37	1.32	1.24
Intercept (gallons)	-10.58	-13.39	-10.80	-8.36	-6.59	-8.16	-4.72	-8.66	-9.46	-10.18
r^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

PR-4159

Evaluation of Water Requirements of Four Turfgrass Varieties

C. A. Kelly, J. L. Mabry, M. C. Engelke, and C. W. Wendt

Abstract

A study was initiated at Lubbock, Texas, during 1982 to compare the water requirements of four different turfgrass varieties in the West Texas environment. Plots were located under a portable rainout shelter so that the water applied could be controlled. To determine the amount of water required to maintain an aesthetically pleasing visual appearance, the irrigation water applied and soil water extracted were measured. The data indicated that during establishment zoysiagrass and tall fescue required the more frequent irrigation and more water than bermudagrass and buffalograss. It should be emphasized that 1982 was a year of establishment and the data obtained may not be related to what might be expected after the grasses are established.

Introduction

The importance of turfgrass in everyday life ranges from functional to recreational to aesthetic. It is estimated that turf covers approximatey 3.2 million acres in Texas alone. Therefore, with increasing energy costs and limited non-renewable resources, water conservation has become paramount.

To date, bermudagrass has been the common turf species grown in the Lubbock area. However, several other species may have potential for this environment. Therefore, this study was designed to compare the water requirements of 'Texoka Buffalograss' [Buchloe dactyloides (Nutt.) Engelm.], 'Kentucky 31 Tall Fescue' [Festuca arundinacea (schreb.)], 'Meyer Zoysiagrass' (Zoysia japonica Steud.) and 'Midiron Bermudagrass' [Cynodon dactylon (L.) Pers.].

Materials and Methods

The study was conducted under a rainout shelter so that water applications could be controlled. The 20 ft. x 40 ft. shelter area (Figure 1) was divided into 8 - 10 ft. x 10 ft. plots (Figure 2). Tall fescue and buffalograss plots were hand seeded on April 27, and zoysiagrass and bermudagrass plots were sodded on April 30 (Table 1). The plots were initially irrigated with a hand sprinkler until they had a complete cover. A drip system (Figure 3) was then used to apply water to field capacity. The remaining irrigations were applied with a mini-drip irrigation system (Figure 4). As a particular variety began to show visual signs of being dry (wilting, decreased wear tolerance), approximately 1.0 inch of water was applied with the drip system. A neutron probe access tube located in each plot to a depth of 8 ft. permitted periodic soil water measurements.

Results

Cultural practices performed under the shelter are presented in Table 1. Soil water content measurements were begun on August 18 after the soil profile was watered to field capacity. Table 2 shows dates of irrigation and amount of water applied. Zoysiagrass and tall fescue required the most water (4.8 in.) to maintain a healthy appearance, followed by bermudagrass (2.7 in.) and buffalograss (1.2 in.).

Table 3 gives the water requirement from August 18 to October 7 at 3 ft. and 8 ft. Since the turf was just being established, the primary water extraction occurred within the top 3 feet. However, zoysiagrass, the high water user, actually extracted the least amount of water from the surface 3 feet. This is probably due to the fact that the roots never became fully established and therefore, were not able to extract water from the soil. Tall fescue extracted the most water from the top 3 ft., followed by buffalograss, and bermudagrass, respectively. Changes in soil water content in the total soil profile showed a different trend. Bermudagrass and zoysiagrass showed the least change. Both these varieties were sodded and the root systems may have been shallower than those of the varieties that were seeded. Tall fescue and buffalograss showed a change of 2.4 in. or a difference of almost 1.0 in. when compared to the other two varieties. However, comparison of total water requirement reveal the same trend observed in the amount of water applied.

This study will be continued beyond the establishment year to determine water use rates and will include agronomic parameters of biomass production, density of stand, color, general turf quality and persistance.

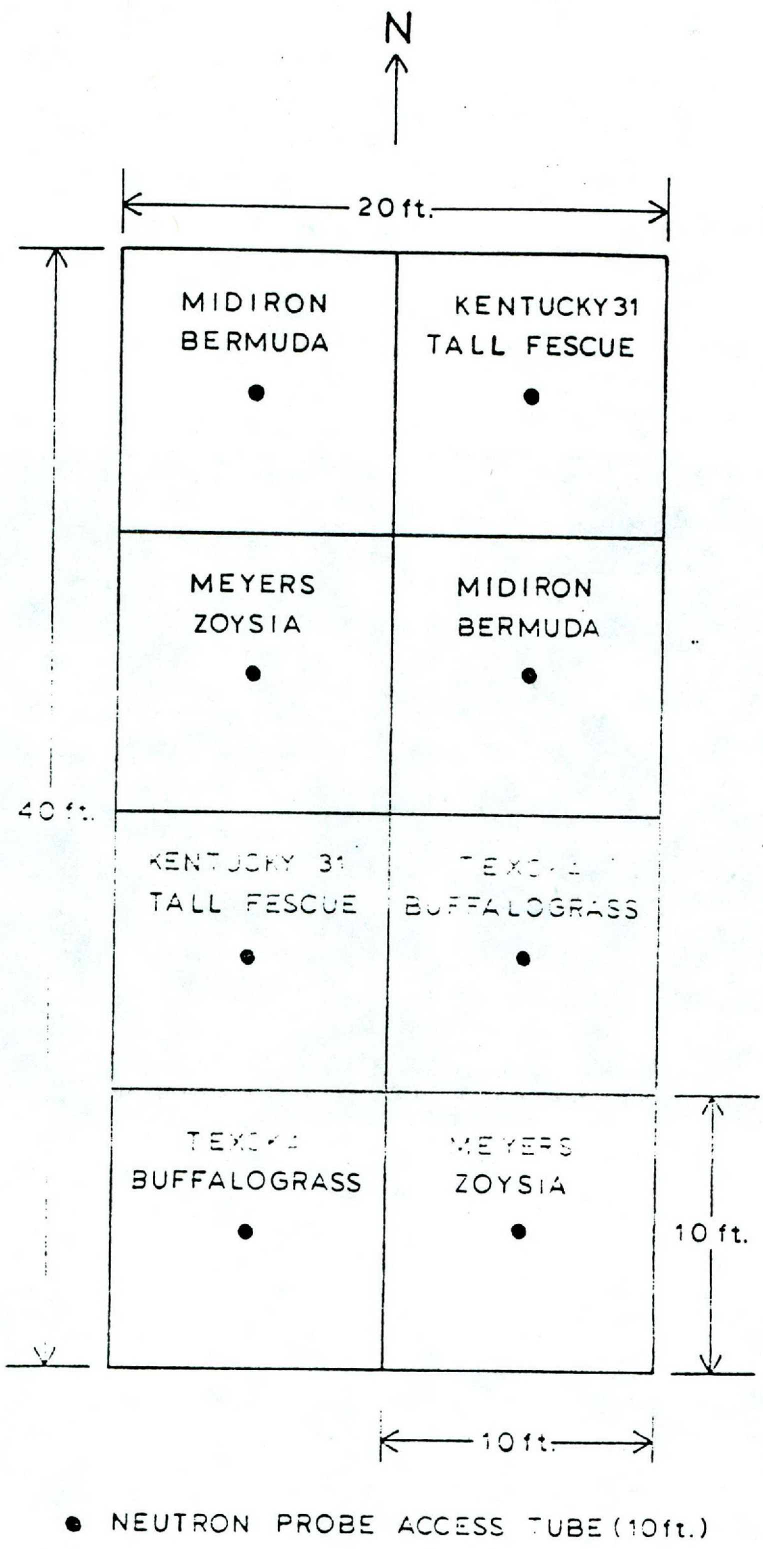


Figure 1. Plot design for the turf variety study under a rainout shelter, Lubbock, Texas, 1982.

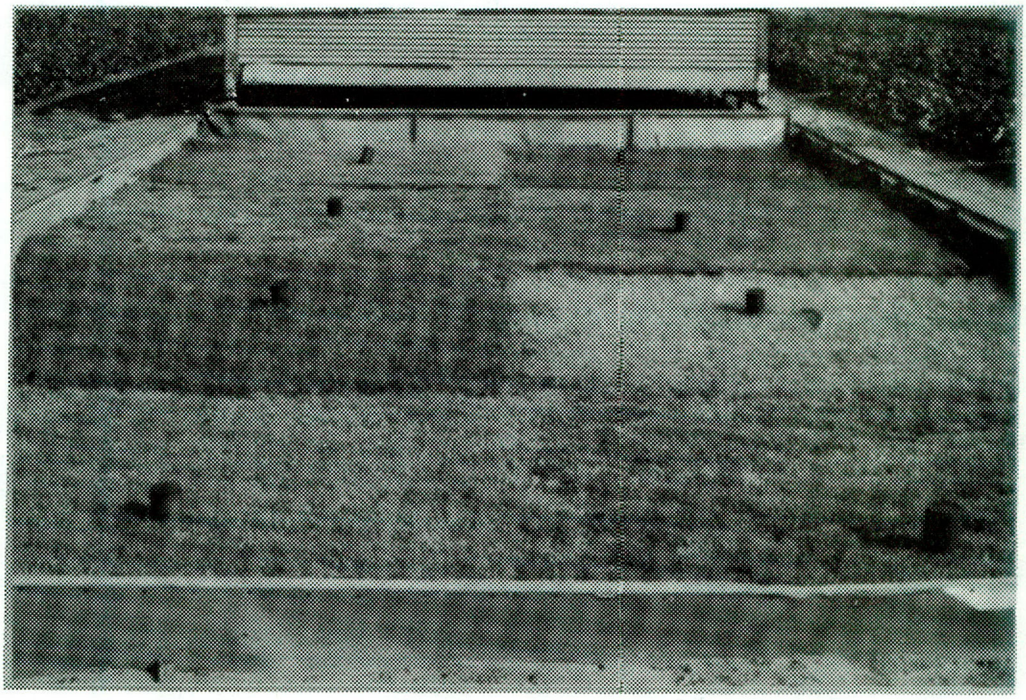


Figure 2. Turf variety study under a rainout shelter, Lubbock, Texas, 1982.

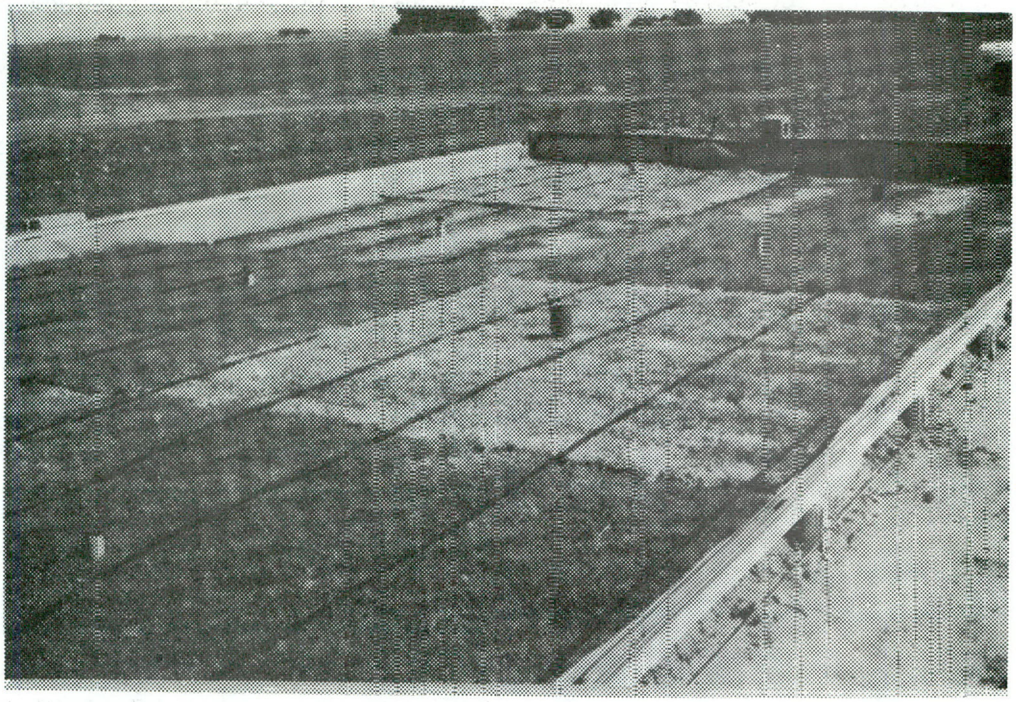


Figure 3. Drip irrigation system used to irrigate rainout shelter area, Lubbock, Texas, 1982.

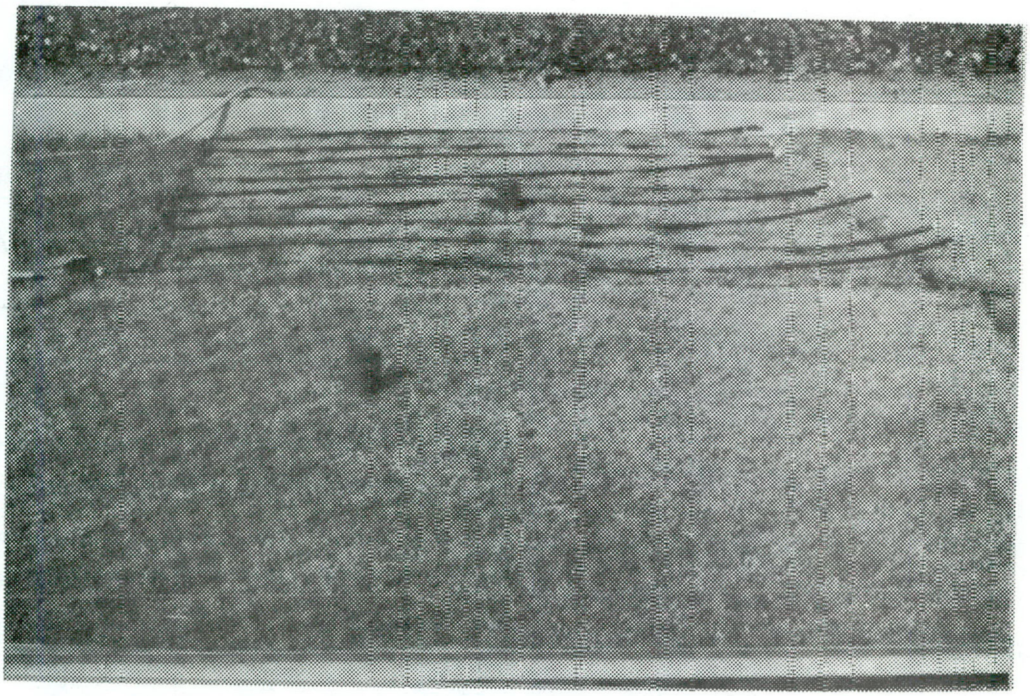


Figure 4. Mini-drip irrigation system used to irrigate one plot under the rainout shelter, Lubbock, Texas, 1982.

Table 1. Cultural practices in the variety study, Lubbock, Texas, 1982.

Activity	Dates
Planting	
(a) Seed - Tall fescue and buffalograss	4/27
(b) Sodded - Zoysiagrass and bermudagrass	4/30
Irrigating	6/2 - 6/4] Establishment period
	6/21[1/]]
	8/18, 8/27, 9/8, 9/9
	9/17, 9/24, 9/28
Fertilizing	
Ammonium nitrate (1 #N/1000 fs)	5/24[2/]
" " " (and Fe)	7/29
Mowing	7/6[3/], 8/5, 8/11, 8/20

[1/]Zoysia (plot #3) only

[2/]Except buffalograss

[3/]Tall Fescue only

Table 2. Date and amount of water applied (in.) to turf in the variety study, Lubbock, Texas, 1982.

Date	Variety							
	Buffalo		Fescue		Zoysia		Bermuda	
	(rep 1)	(rep 2)	(rep 1)	(rep 2)	(rep 1)	(rep 2)	(rep 1)	(rep 2)
8/27			2.2	2.1	1.0	1.0		
9/08			1.4	1.5	1.9	1.3		
9/09							1.5	1.5
9/17			1.2	1.2	1.2	1.2		
9/24					1.0	1.0		
9/28	1.0	1.4					1.3	1.0
Total	1.0	1.4	4.8	4.8	5.1	4.5	2.8	2.5
$\overline{x}$	1.2		4.8		4.8		2.7	

Table 3. Changes in soil water content in turf plots, August 18 to October 7 in the variety study, Lubbock, Texas, 1982.

Variety	Water Changes (8/18-10/7)			
	Water Applied (in.)	Soil Water Content Change (in.) (0-3 ft.)	Soil Water Content Change (in.) (0-8 ft.)	Total Water Requirement (in.)
Zoysiagrass	4.8	0.8	1.9	6.7
Fescue	4.8	2.0	2.4	7.2
Bermudagrass	2.7	1.4	1.8	4.5
Buffalograss	1.2	1.5	2.4	3.6

PR 4160

Relationship of Winter Environments to Stolon Dieback on Tifgreen Bermudagrass Putting Greens

P. F. Colbaugh and G. N. Taplin

Introduction

The yearly transition of warm season turfgrasses from winter dormancy to active growth in the spring is frequently complicated by the appearance of variable sized areas of dead grass following spring green-up. Circular or irregular shaped areas of dead grass have been observed in the spring on most cultivars of bermudagrass and St. Augustinegrass grown in Texas. Dieback symptoms are commonly observed on residential lawns, industrial landscapes, municipal parks, and golf course facilities. The winter dieback problem is most common in the northern regions of the state, however, similar symptoms have been noted on turfed areas as far south as San Antonio.

Survival of perennial warm season turf during the winter relies on the ability of dormant stolons to withstand a variety of environmental, biological, and man-made factors capable of causing their destruction. The inability of dormant plant parts to recover from injuries by recuperative growth activity makes them particularly susceptible to destruction during the winter. Stolon dieback and reduced recovery of dormant turf in the spring have been attributed to a number of causal factors including, freezing winter temperatures, harmful effects of mechanical injuries related to dethatching and aerifying operations in the fall and spring season, and the occurrence of disease activity during the dormant season.

Stolon dieback on overseeded bermudagrass golf greens is a recurring problem which appears to be greater than dieback observed with the same hybrid bermudagrass cultivar used for other purposes. While the occurrence of stolon dieback on golf greens is frequent, the severity of the dieback condition typically varies from year to year. Investigations were initiated at the TAMU-Dallas Center to determine the nature of winter dieback on overseeded bermudagrass golf greens. This is a report on the current status of the investigation.

Research Procedure

a) Climatological Data

Comparisons of climatological data were used to determine the relationship of temperature and moisture patterns with the occurrence of stolon dieback during successive years. Weather records were collected at the TAMU-Dallas Center as follows: Temperature measurements were assessed using a recording thermometer. Daily minimum temperatures were averaged to determine mean minimum temperatures for each month from September to May during 1981 to 1983. This period coincided with the dormancy of warm season turfgrasses in the Dallas area. Rainfall data were recorded and tabulated for total rainfall during each month of the period.

b) Pathogen Isolation

Attempts were made to determine potential pathogens associated with dead and dying plant parts from overseeded golf greens in the spring. Samples of dead stolons were collected from dead areas of golf greens overseeded with perennial ryegrass or bentgrass during the 1982 winter season. Bermudagrass stolons were collected during May. Plant tissue was sectioned with a razor blade and surface sterilized 2 minutes with sodium hypochlorite solutions, placed on agar in petri plates, and incubated 5 days on a laboratory bench to determine the identity of fungal colonies associated with the tissue.

c) Foliar Fungicide Influence

Overseeded Tifgreen bermudagrass was used to determine the influence of repeated applications of foliar fungicides on survival of stolons during the dormant season. Bermudagrass plots were overseeded with annual ryegrass on 10 November at a rate of 9 kg/93 square ft. The test plot was maintained at a cutting height of 2.5 cm during the winter and received no fertilizer. The plots were irrigated as needed to maintain the turf through the winter. During April, the turfgrass fungicides Daconil 2787 (8 oz) and Subdue 2E (2 oz) were applied to the plots. Each fungicide was applied to four replicated subplots, each 23 square meters, using a pressurized sprayer set at a delivery pressure of 2.8 kg/sq cm. Application dates for the fungicide treatments were 18 April, and 11 and 28 May. On 1 June samples of dormant bermudagrass stolons were collected from each plot area and washed in running water to remove soil. Stolon samples were collected from plots overseeded or not overseeded, and that did or did not receive applications of Daconil 2787 or Subdue 2E fungicide.

Results and Conclusions

The severity of bermudagrass stolon dieback on overseeded golf greens in north central Texas was greater during the winter of 1981 than during that of 1982. Contrasting environments during the two successive winters could explain differences in the extent of stolon dieback observed on golf greens. Summaries of moisture and temperature data during the two winters are given in Figures 1 & 2. High levels of rainfall occurred in the late fall and early spring of 1981. Rainfall during October and May in 1981 was much higher than during the same period in 1982 (Figure 1). Similar rainfall was recorded for both years during November to April. Data of minimum temperature also indicate contrasting environmental conditions occurred during the two winter periods (Figure 2). Monthly mean minimum temperatures for December-February were much lower than the 7-year average minimum temperatures or temperatures recorded during the winter months of 1982. The presence of greater transitional season rainfall and lower winter temperatures during 1981 are two environmental factors that could contribute to a greater severity of stolon dieback during the year.

Attempts to isolate pathogenic organisms from bermudagrass stolons recovered from dead areas of golf greens in May were not conclusive. *Pythium* spp. and *Fusarium* spp. were recovered in a number of the isolation attempts suggesting the fungi could be important pathogens in the decaying process. The diversity of fungi represented in recovery isolation plates on agar, however, suggested the tissue was in an advanced stage of decomposition with a large number of secondary fungi in the tissue sampled.

Use of two foliar applied fungicides during the 1982 winter months to enhance the survival of dormant bermudagrass stolons did not appear to be effective. No differences were noted for survival of stolons recovered from either treated or untreated field plots (Table 1). The failure to detect differences with fungicide treatments could be attributed to a low incidence of stolon dieback that occurred during the winter.

Environmental factors appear to play an important role in determining the incidence and severity of winter stolon dieback on bermudagrass golf greens. The presence of excessive moisture or prolonged periods of low temperature during the winter dormant period could contribute to increased rotting activity by soil-borne pathogens. These same environmental factors can also directly reduce the survival of dormant stolons during the winter months. Further studies are in progress to determine the interrelationship of winter environments and disease activity on dormant bermudagrass stolons.

Table 1. Healthy stolon count from overseeded Tifgreen bermudagrass maintained with and without applications of foliar-applied fungicides at TAMU-Dallas Center.

Treatment	Number of 2.5 cm Stolon Segments Observed	% of Total	
		Diseased	Healthy
1) Not overseeded, not treated	336	3.8	96.3a*
2) Overseeded, not treated	592	4.4	95.6a
3) Overseeded, treated (3 applications) Daconil 2787	483	6.1	93.9a
4) Overseeded, treated (3 applications) Subdue 2E	460	8.0	92.0a

*Means in columns followed by the same letter are not statistically different (5% level, Duncan's Multiple Range Test).

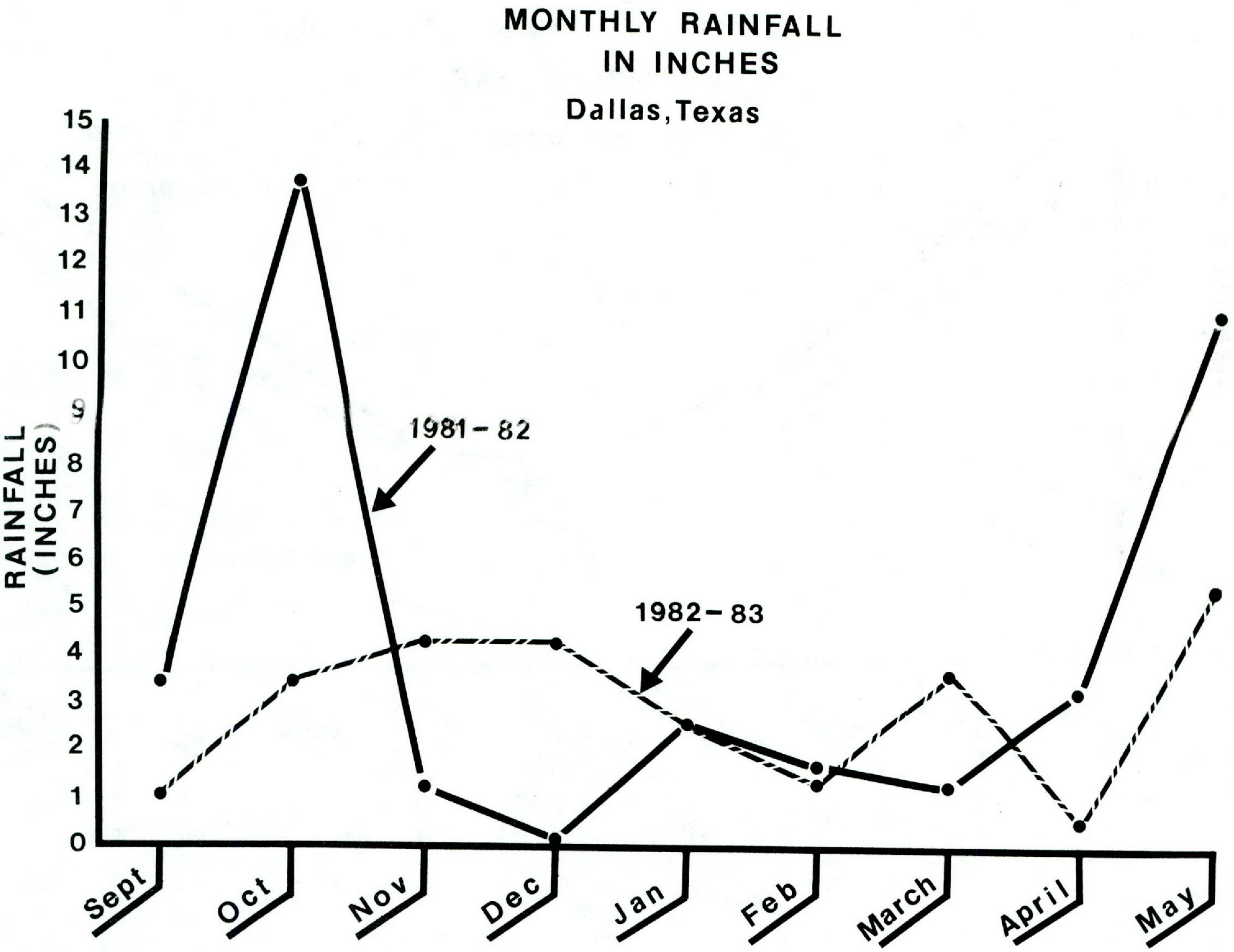


Figure 1. Monthly rainfall data for months September - May, collected at the TAMU-Dallas Center, 1981-83.

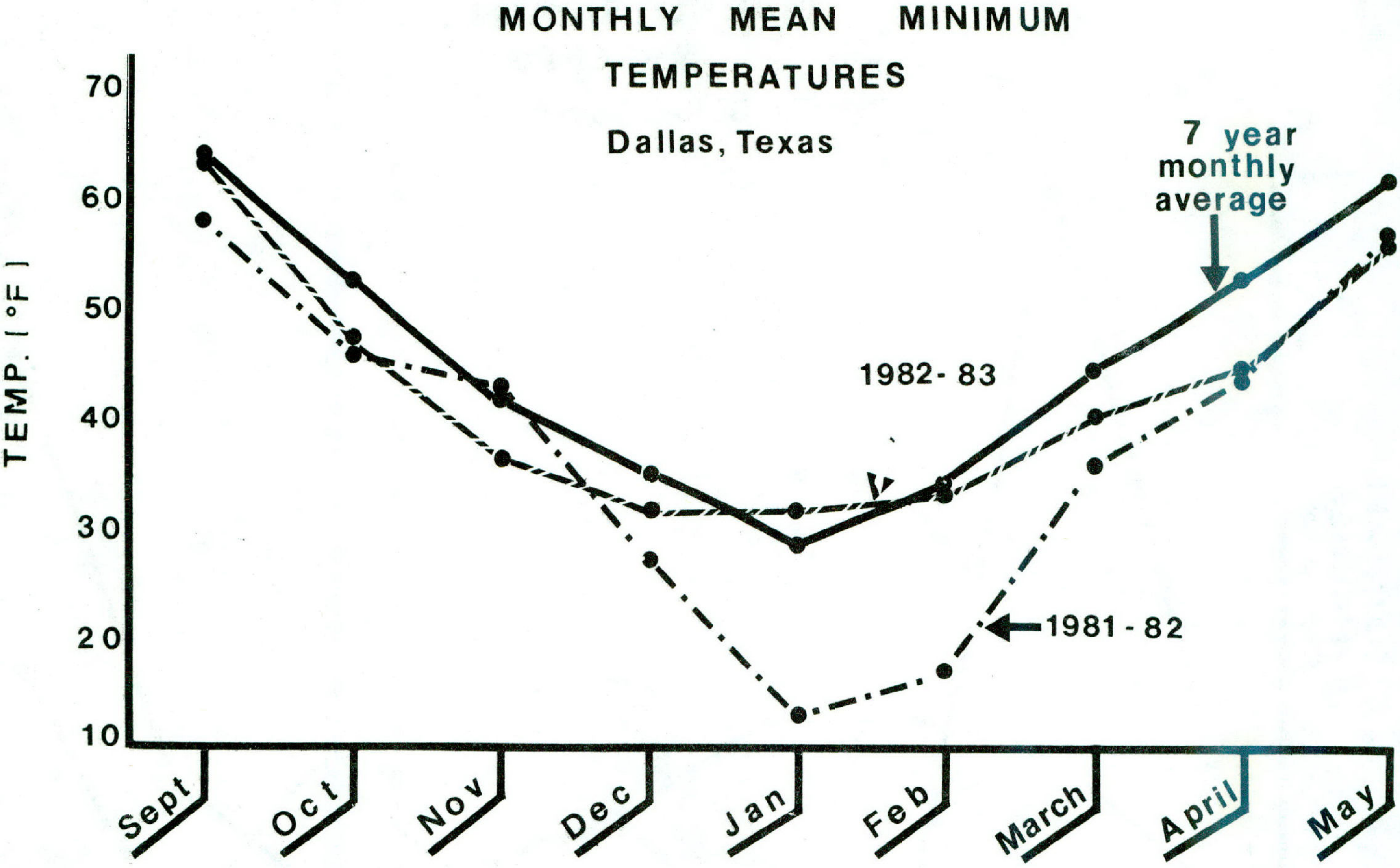


Figure 2. Monthly mean minimum temperatures September - May, collected at the TAMU-Dallas Center, 1981-83.

PR 4161

St. Augustinegrass Winter Survival in North Texas

M.C. Engelke

Introduction

St. Augustinegrass *(Stenotaphrum secundatum* (Walt.) Kuntze) spreads by stolons and forms a dense coarse textured turf. With an extensive, fibrous root system and stoloniferous growth, St. Augustinegrass is well adapted to sod production. Possessing more shade tolerance than most other warm season grasses, St. Augustinegrass' area of utilization in Texas is limited by its lack of cold and drought tolerance. A space plant evaluation was established to monitor general turf performance, winter survival and spring recovery of St. Augustinegrass at the Texas A & M Agricultural Research and Extension Center at Dallas. Numerous notes concerning agronomic characteristics and performance were recorded throughout 1981 and 1982.

Materials and Methods

Eighteen plots of 'Raleigh' and 19 plots of 'Texas Common' were established in field plots 5 May 1981, from 2 inch greenhouse pots into 2.3 sq m (25 sq ft) plot areas. The plots were mowed weekly at 1.5 inches (3.8 cm), fertilized with 4 lbs actual N/1000 sq ft (1.86 kg N/93 sq m) per year, and irrigated to prevent wilt. Winter survival denotes the percent of plots with at least 1% green living tissue on 15 June 1982. Spring greenup notes were recorded and defined as emergence of new leaf tissue, and recorded as the first date observed. Average coverage defines the amount of plot area covered by growing turf. The winter of 1981-82 was especially beneficial for the assessment of cold tolerance . A low temperature reading of -13.3 C (8 F) was incurred for two nights on 10 and 11 Feb. 1982, with the last frost of the year occurring on 6 Mar. 1982.

Results

'Raleigh' and 'Texas Common' differed in their response to the 1981-82 winter (Table 1). Greenup of 'Raleigh' was 10 days earlier than the earliest 'Texas Common', averaging 8 days earlier across all plots. A higher percentage of the individual plots of 'Raleigh' survived than 'Texas Common'. The early greenup of 'Raleigh' and rapid growth was also reflected in area of plot covered compared to 'Texas Common'.

Of concern in the state testing program, and in comparison with data from different studies, is the continuity in using identical germ plasm sources. Since 'Texas Common' per se. is so highly variable from source to source, it is imperative the different research projects utilize the same uniform germplasm sources to make valid comparisons. The source of "Texas Common" utilized in this study was a commercial sod field, however, its performance in comparison to other 'Texas Common' is unknown. The Texas Turf Researchers have since standardized our germplasm sources. Further years of testing and evaluation are needed to fully assess St. Augustinegrass cultivars under the northernmost regions of its adaptability.

Table 1. 1981-82 winter survival, date of greenup and average coverage of 'Raleigh' and 'Texas Common' St. Augustinegrass at Dallas, TX.

Cultivar	Winter Survival[1]	Greenup[2]		Coverage[3]	
		Average	First	11 June	14 June
	--% Plots--	-----Date--------		--Average Plot--	
Raleigh	94.4	21 Mar	5 Mar	38.2	55.6
Texas Common	63.2	29 Mar	15 Mar	31.1	45.4

1 Defined as number of plots with living tissue on 15 June 1982.
2 Defined as emergence of first green tissue.
3 Defined as amount of plot area covered with growing turf.

PR 4162

Active Ingredient and Application Date Influence on Efficacy of Treatments for Control of White Grubs in Texas Turfgrass

Robert L. Crocker

Abstract

The efficacy of insecticides applied for the control of white grubs (*Cyclocephala immaculata* Oliver and *Phyllophaga crinita* (Burmeister)) in turfgrass differed according to the active ingredient and the date of treatment application in a 1981 test in Dallas, Texas. For most of the tested insecticides, optimal treatment time in this test was 7–9 weeks following the termination of detectable levels of flight activity by adult beetles of the parental generation. Further testing will be necessary to determine whether such postponement of treatment application is generally desirable.

Introduction

White grubs (including *Phyllophaga crinta* (Burmeister), *Phyllophaga* spp. and *Cyclocephala immaculata* Oliver) constitute the most important group of turf pests in the Southwest. Feeding by these larval scarab beetles on turfgrass roots frequently causes such severe damage that the turf can be lifted like a rug. Large areas of turf can be destroyed in a single season where heavy populations of the insects are present.

Control of white grubs in turfgrass is difficult to achieve. Improper timing of treatments frequently is a factor in treatment failures. It is thought that the optimal time to control white grubs is soon after they hatch. At that time they have done little turf damage and usually are near the soil surface (where they can be more easily reached by pesticides). Treatments applied too early frequently lose their effectiveness before the pest appears. Late treatments allow the insects to become larger (and probably harder to kill) and result in needless turf damage.

Southwestern white grubs found in lawns primarily have a 1-year life cycle. Other regional species (with a 2-year life cycle) appear on the basis of present data not to be significant turf pests. The adults of species with a 1-year life cycle have a fairly synchronized reproductive period that occurs in mid-to-late summer. The timing of flights is affected by the geographic latitude of the site and by rainfall patterns.

The present experiment had two parts. The main part of the experiment consisted of the application of liquid and granular formulations of three soil insecticides to different plots at 2-week intervals from 17 July to 23 October, 1981. The purpose of that portion of the test was to measure the effects of active ingredient, formulation, and time of application on treatment efficacy. The second part of the test involved the application of various other pesticides to separate plots on what was estimated to be an optimal test date. The purpose of that part of the test was to permit a one time comparison of several additional formulations and one other active ingredient with those materials in the main body of the test.

Materials and Methods

Treatment materials were applied on the dates indicated (Table 1) to successive sets of plots arranged according to a randomized complete block design (6 replications per date) in a continuous irrigated turf of common bermudagrass, *Cynodon dactylon* (L.)

Persoon. The soil was Houston Black, one of the dominant montmorillonite clays of the Texas Blackland Prairies. Plots (1.5 x 2.0 m) were separated from each other on all sides by 0.5 m of turfgrass. Spray treatments were applied with a hose-end sprayer. Granular treatments were applied using a hand-held shaker. All treatment materials were thoroughly irrigated into the turf immediately following application.

Data were collected a minimum of 45 days posttreatment. Extremely heavy, protracted rains necessitated delays in collecting data from some blocks. A flexible sampling system was utilized to compensate for natural variability in white grub density over space and to compensate for secondary flood-related declines in the white grub populations in some blocks. The procedure required that all untreated control plots for a given treatment date be sampled first. The counts for those plots formed the basis for determining the number of subsamples to be taken per plot from each block. If <3 larvae were taken, the block was dropped from the experiment. If >2 and <5 larvae were taken, 5 or 10 more subsamples were taken from the plot. If >4 larvae were recovered, no further samples were taken. The same number of subsamples was taken from each plot in the block as was taken from its control plot. The purposes of the proceeding procedure were 1) to ensure adequate total numbers of larvae in the controls to allow gradations of estimation between the control, other treatments, and zero, and 2) to avoid biasing the analysis. Subsamples (0.09 m2 = 0.1 ft2 ea) were extracted from plots with a golf cup cutter.

Data were transformed according to $X_{t1}=(X + 0.375)^{1/2}$ where X_{t1} is the transformed value and X is the mean number of larvae per subsample in a plot. These transformed data were analyzed according to Duncan's multiple range test.

In a second analysis, the data were transformed according to $X_{t2} = (X_p)/(X_c)$; where Xp is the number of larvae recovered from the control plot of the same block. The ratios were then transformed according to $X_{t3} = (X_{t2} + 0.375)^{1/2}$. The resulting transformed values were analyzed using Duncan's multiple range test. Values reported for treatment means (Tables 1,2) were computed from totals and ratios, respectively, not subjected to square root transformation.

Reproductive/dispersal flights of adult scarab beetles were monitored daily throughout the spring and summer flight seasons by means of a standard black light insect trap fitted with a 15 watt fluorescent black light. The species and sex of each scarab beetle taken in the trap were determined microscopically.

A final ninth treatment date had originally been planned for spring 1982, after the grass broke dormancy. That treatment date was dropped when subsampling in February and March of overwintering populations of larvae indicated that population densities in untreated turfs had dropped to only about two per square foot in all turfs that could have been utilized. That density of larvae was judged to be too low to permit meaningful evaluation of the treatments.

Results and Discussions

Comparison of Treatments

Statistically detectable ($p=0.05$) levels of larval mortality compared to the untreated control were produced on at least one treatment date by all the tested materials with the exception of dioxathion applied at 3.9 lbs. ai/A-1 (Table 1). However, of the treatments tested on multiple dates, only the isofenphos EC spray produced statistically detectable levels of larval mortality on all test dates. Lower numbers of white grubs were recovered from the XRM-4608 and the Knox-Out treated plots than from plots treated with other formulations of the same active ingredients. This suggests that further research on formulations which may enhance the availibility of diazinon and chlorpyrifos to white grubs in soil overlaid with thatch and turf should be worthwhile. Such formulations might be expected to improve penetration to target and residual activity by these pesticides. Thus, they might increase the dependability of these materials. Use of such formulations also might make it possible to obtain acceptable levels of control with reduced rates of active ingredient.

Comparison of Treatment Dates

Flight activity for *P. crinita* and *C. immaculata* ran from late May to late July in Dallas, Texas, in 1981. Although this is within the period in which flights usually take place in the Dallas area, 1981 was distinctive in comparison to previous years. In all previous years since 1975, one of the surges of flight activity has been much greater than all of the others. During such "major" flight periods, 1-2 thousand beetles characteristically have been trapped per night for one to a few nights. In 1981, there was no such "major" flight period.

August 28 - September 25 treatment dates yielded the best results overall in terms of reducing white grub populations (Table 2). Different treatments however, varied considerably from the average. The granular formulation and to a lesser extent the EC formulation of diazinon produced somewhat erratic results from date-to-date. On several dates, however, both of those materials were highly effective.

Chlorpyrifos also evidenced some unevenness of performance from date-to-date. Both in the case of chlorpyrifos and diazinon, however, the best treatment times occurred in the August 28-September 25 period in this 1981 test. Isofenphos treatments displayed the greatest latitude for tolerance of treatment timing. The granular formulation was less effective on the earliest and latest treatment dates than on intermediate treatment dates; the best application date for the granular formulation of isofenphos was 25 September in this 1981 test. Within the range of test dates included in this experiment, the spray formulation of isofenphos performed so evenly from date-to-date that no statistical separation ($p=0.05$) of the data could be achieved. It should be noted that all data for the reseach reported here were gathered after all reproductive activity had ended. That is, all treatments for all dates were tested with respect to their efficacy against subsequently hatching larvae as well as against larvae present when the materials were applied.

Further research into the optimization of application timing clearly is called for in view of the promising nature of the present results. Such research is needed to provide an adequate basis for predicting the optimal treatment period in future years.

Table 1. Comparisons (by date and overall) of mean numbers of white grubs (*Cyclocephala immaculata* and *Phyllophaga crinita*) recovered/ft^2 from common bermudagrass post-treatment with various materials on 8 dates, Three-six replications/date; Dallas, TX, 1981.

Treatment Material		Application Rate		Mean # of White Grubs/Ft^2*								
				Application Date								
Brand Name	Common Name	Lbs. a.i. Per acre	Amt. Actual Formulation 1000 ft^2	17-JUL	31-JUL	14-AUG	28-AUG	11-SEP	25-SEP	9-OCT	23-OCT	All Dates
Control	-	-	-	7.2 a	9.7 a	4.8 abc	8.7 a	6.8 a	7.2 a	5.0 a	4.1 a	6.5 a
Deltic™ 2E	dioxathion	3.9	4.80 fl.oz.	-	-	-	4.3 ab	-	-	-	-	-
Dursban™ 1/2 G	chlorpyrifos	4.0	18.75 lbs.	5.8 a	8.0 a	8.6 a	1.7 bc	3.3 b	1.5 b	2.6 bc	2.2 b	3.9 b
Deltic 2E	dioxathion	7.8	9.60 fl.oz.	-	-	-	3.3 bc	-	-	-	-	-
Dursban 4E	chlorpyrifos	4.0	3.00 fl.oz.	4.3 ab	5.3 ab	6.3 ab	3.7 abc	2.0 bc	0.0 b	3.4 ab	0.6 ab	3.0 bc
Spectracide™ 6000	diazinon	6.8	3.12 lbs.	2.5 ab	1.3 bc	6.7 ab	0.7 bc	0.5 cd	5.5 a	1.4 bc	0.9 bc	2.3 cd
D-Z-N Diazinon™	diazinon	6.8	10.00 fl.oz.	1.3 ab	8.3 a	2.7 bc	1.0 bc	1.2 cd	0.2 b	1.4 bc	0.8 bc	1.9 cde
XRM-4608	chlorpyrifos	4.0	11.80 fl.oz.	-	-	-	1.3 bc	-	-	-	-	-
Oftanol™ 5%G	isofenphos	1.0	7.35 oz	-	-	-	1.3 bc	-	-	-	-	-
Oftanol 5%G	isofenphos	2.0	14.70 oz.	2.8 ab	0.7 c	1.6 bc	1.7 bc	1.5 cd	0.0 b	0.6 bc	1.0 bc	1.1 de
Oftanol 6E	isofenphos	2.0	0.98 fl.oz.	0.0 b	2.0 bc	0.7 c	0.3 c	0.2 d	1.5 b	0.8 c	0.2 c	0.7 e
Knox-Out™	diaxinon	6.8	10.00 fl.oz.	-	-	-	0.7 bc	-	-	-	-	-

*Values within column followed by the same letter are not significantly different @ P= 0.05 according to Duncan's multiple range test.

Table 2. Comparisons (by treatment and overall) of treatment efficacy according to the date the treatment was applied. Data are ratios of larvae taken from treatment and control plots for given treatment dates. Separate statistical comparisons were made for each treatment material.

Treatment Date	diazinon (6.8 lb. a.i./A)		chlorpyrifos (4.0 lbs. a.i./A)		isofenphos (2 lbs. a.i./A)		Mean of All Treatments
	Spectracide 6000	D-Z-N Diazinon	Dursban 4E	Dursban 1/2G	Oftanol 5%G	Oftanol 6 lb.gal.	
17JUL	.50 ab*	.17 b	.75 abc	1.0 ab	.42 a	0.0 a	.55 b
31JUL	.12 b	.76 a	.48 abcd	.7 ab	.06 ab	.18 a	.48 b
14AUG	1.2 a	.43 ab	1.2 a	1.6 a	.28 a	.10 a	.84 a
28AUG	.10 b	.14 b	.52 abcd	.24 b	.24 ab	.05 a	.33 bc
11SEP	.03 b	.07 b	.11 cd	.18 b	.08 ab	.01 a	.21 c
25SEP	.55 ab	.03 b	0.0 d	.15 b	0.0 b	.15 a	.27 c
09OCT	.35 b	.35 ab	.85 ab	.65 ab	.15 ab	.20 a	.51 b
23OCT	.25 b	.31 ab	.25 bcd	1.0 ab	.38 a	.06 a	.46 b

*Values within column followed by the same letter are not significantly different @ P= 0.05 according to Duncan's multiple range test.

PR 4163

Crown Rust Resistance Among Tall Fescue Cultivars

M.P. Grisham, J.B. Beard, and D.S. Dahms

Introduction

Turfgrass breeders have achieved a major breakthrough in the development of turf-type tall fescue cultivars. Historically the tall fescues utilized in turf areas were developed for forage purposes. Included are Alta and Kentucky 31 tall fescues. As a result of breeding efforts, a number of new turf-type tall fescues have been released during the 1980's. Earlier investigations by Beard, et al, at College Station, Texas, showed that turf-type tall fescues to have promise for use under warm, humid environments typical of College Station Texas, if irrigated. This investigation has been initiated to assess the potential for turf-type tall fescues when grown in full sun under warm, humid conditions.

Research Procedure

Twelve tall fescue cultivars were seeded on November 16, 1981, onto a well drained, modified loamy sand root zone, at the TAMU Turfgrass Field Laboratory. The plot size was 5 x 8 feet (1.5 x 2.4 m) in a randomized complete block design of three replications. The experimental area is mowed twice weekly at a 2 inch (5 cm) cutting height with clippings returned. The nitrogen fertilization program consists of 0.5 lb N/1,000 sq. ft. (0.25 kg/are)/growing month from October 15 through April 15. Phosphorus and potassium applications are made based on an annual soil test. Irrigation is applied as needed to prevent wilt. No pesticides have been applied to the area to date.

Results

The overall turfgrass quality of these tall fescue cultivars was comparable during the first full growing season. However, significant differentials in susceptibility to *Puccinia coronata,* causal agent of crown rust, were observed as shown in Table 1. Ratings were made on October 26, 1982. Crown rust was observed in the experimental area during May 1983, however, the incidence of the disease was too low to differentiate cultivar response.

All cultivars tested were susceptible to *P. coronata,* with the lowest incident of disease in Brookston, Rebel, and Mustang. The results represent evaluations made during the first growing season. Evaluations will continue to be made in subsequent years.

Table 1. Susceptibility to tall fescue cultivars to *Puccinia coronata*, causal agent of crown rust, at College Station, Texas - Fall 1982

Cultivar	Leaves infected (%)*
Brookston	9 a
Rebel	10 a
Mustang	11 a
Houndog	14 ab
Falcon	14 ab
Olympic	17 abc
Fawn	18 abc
Kentucky 31	22 abc
Galway	30 bc
Alta	31 bc
Kenmont	31 bc
Clemfine	33 c

*Percentage of infected leaves in a 100-cm^2 area of each plot, mean of three replications. Values followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

PR 4164

FIELD EVALUATIONS OF ST. AUGUSTINEGRASS CULTIVARS AND ACCESSIONS FOR RESISTANCE TO SCLEROPHTHORA MACROSPORA

M.P. Grisham, R.W. Toler, and J.B. Beard

Downy mildew, caused by *Sclerophthora macrospora,* is a major fungal disease of St. Augustinegrass in Texas. Symptoms appear as white, raised, linear streaks that develop parallel to the leaf midvein. Severe symptoms include leaf yellowing and premature necrosis of leaves and reduction of internode length. Infected plants may be stunted as much as 54 percent.

Control of turf diseases using host resistance contributes to maintaining a high quality turf at minimum cost. Available cultivars and accessions of St. Augustinegrass have been evaluated for resistance to downy mildew at College Station, Texas.

Research Procedure

Sixty-four St. Augustinegrass cultivars and accessions were established in 1978 at the Texas A&M Turfgrass Field Laboratory at College Station on a modified loamy sand root zone. The plots were 1.2 x 1.2 m, randomized, with two replications. In 1982, 38 cultivars and assessions were selected for continued evaluation. Plots were evaluated for downy mildew on 19 June 1981, 31 May 1982, and 27 May 1983. Disease evaluations consisted of determining the percentage of infected leaves in a 100-cm^2 area of each plot.

Results

During the three years of evaluation, infection levels ranged from 0 to 95 percent. One cultivar and three accessions had zero percent disease for 3 years, and six others had zero percent disease for the 2 years they were evaluated (Table 1). Thirteen cultivars and accessions had mean ratings of over 25 percent disease.

Table 1. Field reactions of St. Augustinegrass cultivars and accessions to Sclerophthora macrospora-1981-83.

Cultivar or accession	Leaves infected (%) Mean of 3 years
Scott 1081	63
PI 410357	60
TX 104	58*
Floratam Mut 12	51
FA 243	51
TX 33	50*
TX 103	46
PI 410360	45
Scott 516	40
TX 111	34*
PI 410355	32*
Bitterblue	32
TX 108	27
New Zealand Red Leaf	22*
FA 87	20*
TX 112	20*
FA 118	18
Floratam	18
FA 46	15*
Texas Common	14
Floratam Mut 13	14
Floratam Mut 7	13
FA 108	12
GA 141	12*
Floratine	11
TX 107	11
FA 231	10*
Florida Common	10
PI 410356	9
FA 217	8

FA 82	8
FA 64	8
Floratam Mut 5	8
FA 131	8*
PI 410364	7
TX 102	7
Floratam Mut 8	7
NCSA - 21	6
TX 106	5
TX 101	5*
New Zealand	5
FA 69	4*
FA 121	4*
FA 26	4*
FA 38	3*
FA 201	2*
FA 83	2*
TX 109	2
FA 145	1
FA 107	Trace*
FA 121	Trace
FA 80	Trace*
TX 105	Trace
FA 223	0*
FA 34	0*
FA 7	0*
GA 72-101	0*
FA 73	0*
FA 48	0*
FA 159	0
Roselawn	0
Floratam Mut 6	0
Floratam Mut 10	0

*Mean of 1981 and 1982 evaluations.

PR 4165

Emerald Zoysiagrass Encroachment into Bentgrass Greens

G. Stahnke, W.G. Menn, and J.B. Beard

Introduction

When maintaining bentgrass *(Agrostis palustris* Huds.) greens in the transition zone where warm season grasses persist, encroachment of the warm season species has always been a problem. Several techniques and chemicals have been employed in an attempt to suppress the bermudagrass *(Cynodon* sp.) invasion onto the bentgrass greens. One method that has been suggested is bordering the bentgrass putting surface with one of the slower growing zoysiagrass species. It was felt that the zoysiagrass would not encroach onto the bentgrass green as quickly as the faster growing bermudagrasses. This zoysiagrass bordering technique was installed at the Texas A&M Turfgrass Field Laboratory in 1979 and assessment for the last 3.5 years.

Research Procedure

A Penncross bentgrass green was planted on March 28, 1979, on a well drained, modified sand root zone. The size of this green was approximately 2500 sq. ft. (225 m^2) in a square configuration.

On August 16 and 17, 1979, an 18 inch (45 cm) wide strip of sod was removed from around the perimeter of the green in the vicinity of the bentgrass - bermudagrass interface. This area was excavated to a depth of 4 inches (10 cm) to eliminate bermudagrass rhizome out crop. The 18 inch strip was then solid sodded to Emerald zoysiagrass *(zoysia japonica x z. tenuifolia)* on August 18, 1979. This green was maintained at a cutting height of 0.25 inch (6 mm) and watered as required to prevent visual wilt. The green was also treated with several fungicides and insecticides but on a curative basis only.

Measurements of lateral encroachment of the zoysiagrass into the bentgrass were made on October 14, 1982.

Results

Measurements of solid encroachment after a 3-year period showed that the Emearald zoysiagrass had invaded the bentgrass en masse an average of 4 feet (1.2 m) around the entire perimeter of the green. Some stolons had spread as far as 10 feet (3 m) onto the green surface with numerous stolons being in the range 5 to 6 foot (1.5 to 1.8 m) in length. These results would indicate a 1 to 2 foot (30 to 60 cm) encroachment rate per year. This is a fairly rapid rate. The long growing season for zoysiagrass under College Station conditions plus the severe heat stress that impaired competition from the bentgrass shoots probably enhanced the rate of Emerald zoysiagrass encroachment.

PR 4166

Fenarimol as a Preemergance Herbicide for Controlling Annual Bluegrass in Overseeded Bermudagrass Turfs

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

Introduction

Nearly all bermudagrass *(Cynodon spp.)* greens in Texas are winter overseeded on an annual basis with some species or combination of species of cool season grasses. One of the major problems on overseeded greens, especially in late winter-early spring, is the occurrence of annual bluegrass *(Poa annua L.)*. This weedy cool season grass not only disrupts the aesthetics of the turf, but it also affects the smoothness and playability of the green as it matures.

Some practioners have tried to use conventional preemergence herbicides in either late summer or very early fall before winter overseeding to control the initial germination of annual bluegrass. When doing this, one is faced with the risk that the residual persistance of the herbicide might adversely affect the stand of overseeded cool season grass.

This study was conducted to determine the preemergent herbicidal activity of fenarimol on annual bluegrass in an overseeded bermudagrass green. Note: fenarimol or EL 222 is currently registered and marketed as a fungicide, Rubigan. It is not labeled for use as a herbicide.

Research Procedure

This study was conducted simultaneously on both Tifgreen and Tifdwarf bermudagrass *(Cynodon* spp.) greens which in previous years had shown moderate to heavy infestations of annual bluegrass. Fenarimol was applied at a rate of 0.5 oz. active ingredient per 1000 sq. ft. (14.2 gms a.i./are).

Beginning on August 6, 1982, a total of six applications were made at two week intervals. The treatment was replicated three times on plots measuring 4 x 6 feet (1.2 x 1.8 meters). The last application was made on October 10, 1982, approximately two weeks before overseeding. Both greens were overseeded with Derby perennial ryegrass *(Lolium perenne* L.) at a rate of 35 pounds per 1000 sq. ft. (16 kg/are).

Visual estimates were made of percent annual bluegrass present on February 23, and on April 13, 1983. Ratings of phytotoxicity to both the overseeded perennial ryegrass and to the bermudagrass (pre-dormancy) also were made.

Results

Applications of fenarimol to both Tifgreen and Tifdwarf bermudagresses showed approximately 90 percent preemergence control of annual bluegrass at the February 23, 1983 rating date. This was just prior to the prolific seeding period of annual bluegrass which began in March. At the later rating date, April 13, 1983, more annual bluegrass was apparent with the fenarimol treated plots exhibiting at least 75 percent control of the annual bluegrass with no visual damage to the overseeded perennial ryegrass (Figure 1). Fenarimol did not affect the emergence, establishment, or shoot growth of the perennial ryegrass when applied at the cumulative rate of 3.0 oz a.i. per 1000 sq. ft. (85 grams a.i./are).

When applied at the recommended rate, fenarimol produced no phytotoxic effects on either Tifgreen or Tifdwarf bermudagrasses. It should be noted that, as with most herbicides, excessively high rates could cause thinning of the bermudagrasses, especially in intense traffic areas.

Summary

In addition to fungicidal properties, fenarimol exhibited substantial preemergent herbicidal control of annual bluegrass in a perennial ryegrass winter overseeding situation. When applied at the proper time using the recommended cumulative rate, fenarimol was not phytotoxic to the perennial ryegrass or to the permenant bermudagrass. Based on the promising results just described, this approach to annual bluegrass control in conjunction with winter overseeding will be investigated in great detail during the 1983-84 winter.

This investigation was partially supported by a grant from the Lilly Research Laboratories, Elanco Products Company.

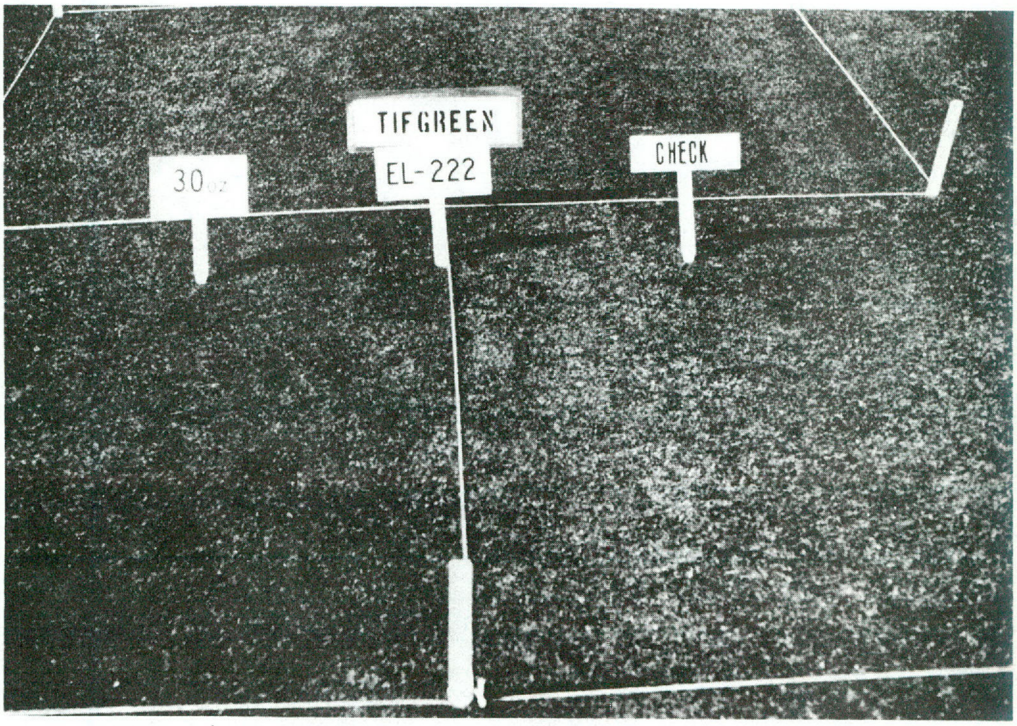


Figure 1. A comparison of a fenarimol treated plot on the left versus an untreated plot on right that is extensively infested with annual bluegrass.

PR 4167

Slow Release Nitrogen Carrier Evaluations On a Tifgreen Bermudagrass Turf

W.G. Menn, J.B. Beard, D.S. Dahms, and M. Ganz

Introduction

There are numeroud nitrogen fertilizers on the market today and most are utilized in some aspect of turfgrass maintenance. New forms of nitrogen fertilizer are being developed each year for possible use in the turf industry. This study was designed to assess and compare the performance of nine nitrogen carriers on a Tifgreen bermudagrass *(Cynodon dactylon X C. tranvaalensis)* green. Several of the carriers are included as standards and some are newly developed slow release nitrogen carriers that are not commercially available.

The objective of this study was to determine the most effective slow release nitrogen carriers in terms of maintaining the highest turfgrass quality with the least amount of vertical shoot growth during mid-summer high temperature conditions.

Research Procedure

The study was conducted on a relatively flat, rectangular, 15-year-old stand of Tifgreen bermudagrass. The growing medium was a partially sand modified root zone having a pH of 8.5. All nitrogen carriers, with exception of oxamide sprayable powder, were applied using a two foot (0.6 m) wide drop-type spreader. A list of the nitrogen carriers included in this study is shown in Table 1. The sprayable powder was applied using a perforated nozzle on a conventional sprinkler can. Plot size was 6 x 8 foot (1.8 x 2.4 m) in a randomized complete block design of three replications. The area was mowed at a 0.25 inch (6 mm) height six times per week and maintained under typical putting green conditions throughout the study, including irrigation as needed to prevent visual wilt.

All nitrogen materials were applied on July 21, 1982, at a single application rate of 2 lbs. of actual N/1,000 sq. ft. (1 kg N/are). The test area was irrigated immediately following material application. Potassium and phosphorus were applied previously at a rate based on soil test recommendations.

Visual estimates of turfgrass quality were initiated one week after application and continued on a weekly basis throughout the study (see Table 2). Quality ratings were based upon shoot density, uniformity, and overall appearance of the grass.

Vertical shoot growth measurements consisted of collecting clipping samples on 2 week intervals using a 22 inch (56 cm), walking greensmower equipped with a catcher. Clipping samples were bagged, dried in a forced draft oven at 50 degrees C, weighed, and then recorded as grams of dry weight per square meter (see Table 3).

Results

The standard quick release, water soluble nitrogen carriers, ammonium sulfate, ammonium nitrate, and urea were included. They produced an early response in shoot growth and enhanced turf quality. After 6 to 7 weeks, this response had diminished to the point of unacceptability.

SCU. The sulfur-coated urea yielded much the same response as did the quick release carriers. This was a very fine granule material which probably accounts for the quick response.

Natural Organic. The natural organic source of nitrogen, Milorganite®, produced somewhat erratic results on both shoot growth and turfgrass quality. Under optimum moisture conditions and high temperature, Milorganite®

exhibited a very quick response similar to the rapid release nitrogen materials.

Oxamide-Granular. The oxamide granular formulation did not affect shoot growth or visual quality until the third week following application. However, once a response was noted, it continued throughout the thirteenth week of the study. The most noticeable and desirable effect produced by the granular form of oxamide was its enhancement of visual turfgrass quality without the excess growth response promoted by many other nitrogen carriers. Finally, oxamide-granular produced a distinct dark green coloration.

Oxamide-Sprayable. In comparing the responses obtained from the two forms of oxamide, granular and sprayable, it was found that the sprayable formulation produced responses in both visual quality and in shoot growth that were very similar to the effects observed from ammonium sulfate. Considerable difficulty was encountered in applying the sprayable formulation. Several Tee Jet nozzle sizes were used up to 8008 and all were clogged almost immediately when using the sprayable oxamide material. The material was eventually applied using a one-gallon sprinkling can equipped with extra large perforations (approximately 2.0 mm in diameter). It is assumed that the rate was too high to accommodate a sprayable solution.

IBDU. Isobulylidene diurea produced a visual turfgrass quality response closely resembling that of the oxamide granular material with about the same residual. The big difference between responses of these two materials was found in the vertical shoot growth rate. IBDU produced a much higher growth rate between the second and eighth week following application. Even though causing rather high shoot growth rates between the fifth and seventh weeks after application, the ureaformaldehyde nitrogen source never exhibited very high turf quality ratings.

Summary

For the most part, visual turfgrass quality is closely associated with shoot growth. Most of the materials examined in this study showed this expected association. The granular form of oxamide was the exception. This material produced very favorable visual turfgrass quality without promoting excessive vertical shoot growth. Furthermore, oxamide granular sustained this response for 13 weeks.

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Table 1. Summary of Nine Nitrogen Carriers on Tifgreen Bermudagrass in 1982. College Station, Texas

Name of Nitrogen Carrier	Nitrogen Content Percent	Type of Carrier
Ammonium Sulfate	21	Synthetic Inorganic
Ammonium Nitrate	34	Synthetic Inorganic
Urea	45	Synthetic Organic
Milorganite	6	Natural Organic
IBDU	31	Synthetic Organic
Ureaformaldehyde (UF)	38	Synthetic Organic
Oxamide, Granular	32	Synthetic Organic
Oxamide, Spray	32	Synthetic Organic
Sulfur-Coated Urea (SCU)	32	Coated Carrier

Table 2. The Visual Turfgrass Quality [1] of Tifgreen Bermudagrass From Nine Nitrogen Carriers When Applied in Midsummer. College Station, Texas

Nitrogen Carrier	WEEKS FOLLOWING APPLICATION								
	1	2	3	6	7	10	12	13	Avg.[2]
Ammonium Nitrate	7.0	8.2	8.0	6.7	6.3	4.7	3.2	2.3	5.8 a
IBDU	3.8	4.7	7.5	8.0	7.5	5.3	4.0	3.3	5.5 a
Sulfur-Coated Urea	6.5	8.1	7.7	6.3	5.8	4.3	2.3	2.3	5.4 a
Ammonium Sulfate	7.0	7.7	7.7	6.2	5.7	3.8	2.3	2.5	5.4 a
Oxamide (Granular)	3.8	3.8	4.7	6.8	7.4	5.7	5.5	4.2	5.2 a
Oxamide (Sprayable)	6.3	7.2	7.0	6.3	5.2	3.8	2.8	2.8	5.2 a
Urea	6.5	6.5	7.3	6.5	5.3	3.8	2.7	2.3	5.1 a
Milorganite	4.7	5.3	5.0	6.7	5.5	4.0	2.8	2.5	4.6 ab
Ureaformaldehyde	4.8	4.2	4.5	4.7	4.2	3.5	2.5	2.7	3.9 ab
Untreated	3.2	3.0	3.3	3.5	3.5	3.0	1.8	2.0	2.9 b

[1]Visual Turfgrass Quality Ratings based on 9 = Best; 1 = Poorest.

[2]All values followed by the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 3. The Shoot Growth Response[1] of Tifgreen Bermudagrass From Nine Nitrogen Carriers When Applied in Midsummer. College Station, Texas

Nitrogen Carrier	WEEKS FOLLOWING APPLICATION					
	2	4	6	8	13	Avg.[2]
Ammonium Nitrate	13.7	19.1	16.2	7.0	2.5	11.7 a
Sulfur-Coated Urea	16.2	15.0	14.8	7.1	2.4	11.1 ab
Oxamide (Sprayable)	11.5	14.1	14.7	6.4	1.5	9.6 abc
IBDU	7.9	12.4	14.7	8.0	2.8	9.1 abc
Ammonium Sulfate	10.2	11.9	12.8	5.3	1.0	8.3 abc
Milorganite	10.5	7.9	12.8	5.0	2.4	7.7 bc
Urea	10.4	9.4	10.2	5.0	0.9	7.2 cd
Oxamide (Granular)	7.1	7.3	10.0	6.8	2.1	6.7 cd
Ureaformaldehyde	8.3	6.2	12.8	4.3	1.6	6.6 cd
Untreated	4.5	3.6	7.5	3.1	0.9	3.9 d

[1]Growth response measured in grams of dry weight per meter^2.

[2]All values followed by the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

PR-4168

The Influence of Growth Regulators on Common Bermudagrass

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Abstract

A study was initiated at the Lubbock State School, Lubbock, Texas, during 1981 to determine the influence of various growth regulators on the growth, aesthetic appearance and water use of common bermudagrass. A subsequent study in 1982 included both a residual analysis of chemicals sprayed in 1981, and further evaluation of the more promising chemicals at a different location. Parameters measured included soil water estraction, color, injury, height, number of seed heads and percent moisture. The measurements showed that none of the growth regulators sprayed in 1981 had any residual effect on common bermudagrass in 1982.

Of the chemicals applied in 1982, Embark treatments were shorter and produced significantly less wet and dry weight than the controls, but the trend did not continue. It appears that future studies of growth regulators should include multiple applications.

Introduction

Irrigation of a well-landscaped home lawn can require more than one-third of the household water and cause monthly water bills to be more than $100.00. As a result of increasing costs and, in some cases, declining water supplies, water conservation is paramount. One possible approach to conserve water is to apply chemicals which retard growth and decrease water use. In 1981, a study was initiated to determine the potential of using growth regulators to increase the water use efficiency of common bermudagrass [Cynodon dactylon (L.) Pers.] at the Lubbock State School in which 16 growth regulators were evaluated. Five of the most effective chemicals were selected for a subsequent study in 1982. The objectives of the 1982 study were to: (1) determine the residual effects of growth regulators sprayed in 1981 on growth and water use efficency of turfgrass and (2) evaluate the effects of different rates of the more promising growth regulators on growth and water use efficiency of turf.

Materials and Methods

Objective 1 -- The initial study was begun on August 3, 1981, and evaluted at regular intervals through October. The plots were not retreated in 1982, but were mowed as needed. Due to the frequency of rainfall, supplemental irrigation was not required. Plots were evaluated for visual differences (1 = totally brown to 10 = 100 percent lush green growth). Color, injury, stand, height and seed head measurements were made on August 6, 1982. A scale of 1-10 was used to rate color (1 = totally brown; 10 = 100 percent lush green growth) injury (0 = dead; 10 = 100 percent lush green growth-no injury) and stand (0 = no grass; 10 = 100 percent stand). Clippings were collected from each plot for dry weight comparisons.

Objective 2 -- A second study was initiated on May 14, 1982 at the Devro industrial site which had a uniform stand of common bermudagrass (Figure 1). The plot design, chemicals and rates of application on May 14 are shown in Figure 2. Cultural practices are listed in Table 1. The evaluation parameters were the same as those in Objective 1, plus soil water content and height. Plots were rated on June 12, 30, July 19 and August 6. Data were analyzed statistically and treatment means were compared using Duncan's multiple range test.

Results and Discussion

Objective 1 -- There were some visual differences on May 6 between the treated and the control plots (Table 2). Some treatments had injury and poor stands [Dowco 453 (0.1 lb/A), Fusilade (0.5 lb/A), Poast (0.5 lb/A) and MN 4621 (3.0 lb/A)]. Other treatments [Dual (2 lb/A), EL 500 (0.75 and 1.5 lb/A), Embark (2 lb/A) and Surflan (4 lb/A)] rated higher visually than the control treatment. However, only the Dowco 453 (0.1 lb/A) was significantly different from the control. No differences were observed in color, injury or height between the treatments and the untreated plots on August 6 (Table 3). Plots treated with Dowco 453 (0.2 lb/A) and Fusilade (0.5 lb/A) were less dense than the other treatments but the differences were not significant. Poast (0.5 lb/A) and CGA 82725 (1.0 lb/Z) treatments were significantly taller than MN 4621 (3.0 lb/A) and S-734 (1 lb/A) treatments, but not different from the untreated plots.

There were differences in fresh weight, dry weight and percent moisture (Table 4). Differences in fresh weight and percent moisture were not significant. Most of the dry weights of the treatments were higher than the untreated plots. However only MBR 18337 (1.0 lb/A) was significantly higher. It can be concluded that no definite delterious residual effects were obtained from any of the chemicals sprayed in 1981.

Objective 2 -- In the growth regulator study at the Devro industrial site, treatments included both untreated controls mowed weekly and mowed following evaluation of the growth regulator treatments. In this discussion the growth regulator treatments will be compared with the untreated "unmowed" plots which were mowed at the same time as the plots treated with growth regulators.

Color and Injury

Turf color is an indication of health which can be used to measure the effectiveness of growth regulators. A scale of 1 to 10 was used to rate color (1 = totally brown; 10 = 100 percent lush green growth). Color data are presented in Table 5. There were no significant differences in color between the "unmowed" controls and the growth regulator treatments. This indicates that there were no adverse effects of growth regulators on color.

Ratings of 0 (dead) to 10 (no injury) were used to rate the treatments for injury. There were significant differences (Table 6) in injury due to treatment on June 6 (Dual and Maleic hydrazide - 2 lb/A) and August 6 (Maleic hydrazide - 2 lb/A). A slight degree of injury was observed in all plots on August 6. However, this was due to moisture stress rather than growth regulators.

Height

Growth regulators that would decrease height and mowing would be desirable. There were no significant differences in height between the "unmowed" controls and the plots treated with growth regulators (Table 7). However the height in some growth regulator treated plots was 0.4 inch less than the controls on same dates [S-734 on June 6, June 30 and July 19; Embark (1 lb/A) on June 6 and July 19; Surflan and Embark (2 lb/A) on June 6 and EL 500 on June 30]. It is possible that height could have possibly been reduced more by further applications of growth regulators.

Seed Heads

Seed heads per unit area were variable between replications as well as treatments as indicated by the lack of significant differences even though differences between treatments were large (Table 8). The Maleic hydrazide (2 lb/A) treatment had significantly less seed heads than the "unmowed" control. Plots treated with Dual had less seed heads on June 30, July 19, and August 6; Embark (2 lb/A) June 30 and August 6; EL 500 (0.75 lb/A) June 30 and July 19; and maleic hudrazide (1.0 and 2.0 lb/A) on August 6. Plots treated with Maleic Hydrazide (2 lb/A) had essentially ceased seed production, but they also included the most injury. However, these latter differences were not significant. The data do suggest that growth regulators show the possibility of reducing seed head number. The variability between replications would probably need to be overcome by increaseing the number of replications.

Weight, Percent Moisture and Soil Water Content

Growth regulators which would decrease the amount of grass produced while maintaining turf quality would be desirable. On June 6, the wet weight (Table 9) and dry weight (Table 10) of the grass of the Embark treatments were significantly less than unmowed controls. The fact that no other decreases were obtained suggests that grass may need to be treated more than one time during the growing season. The wet and dry weights of Dual and maleic hydrazide (2 lb/A) treatments was significantly higher on June 12 and July 19. There were no significant differences between the "unmowed" controls and the treatments on any date in percent moisture (Table 11) and soil water content (Table 12).

Summary and Conclusions

1. There were no residual effects from growth regulators applied in 1981 on bermudagrass appearance and growth in 1982.
2. Growth regulators applied in 1982 did not affect color and were not injurious.
3. Embark, Surflan and S-734 treatments were shorter than the controls early in the season, but the differences were not significant.
4. Seed head production between treatments was erratic and there was no trend due to treatment.
5. The Embark treatments were shorter, produced significantly less wet and dry weight than the controls early in season, but the trend did not continue. It appears that future studies of growth regulators should include multiple applications.
6. There was no significant differences in percent moisture of grass clippings or soil water content change.

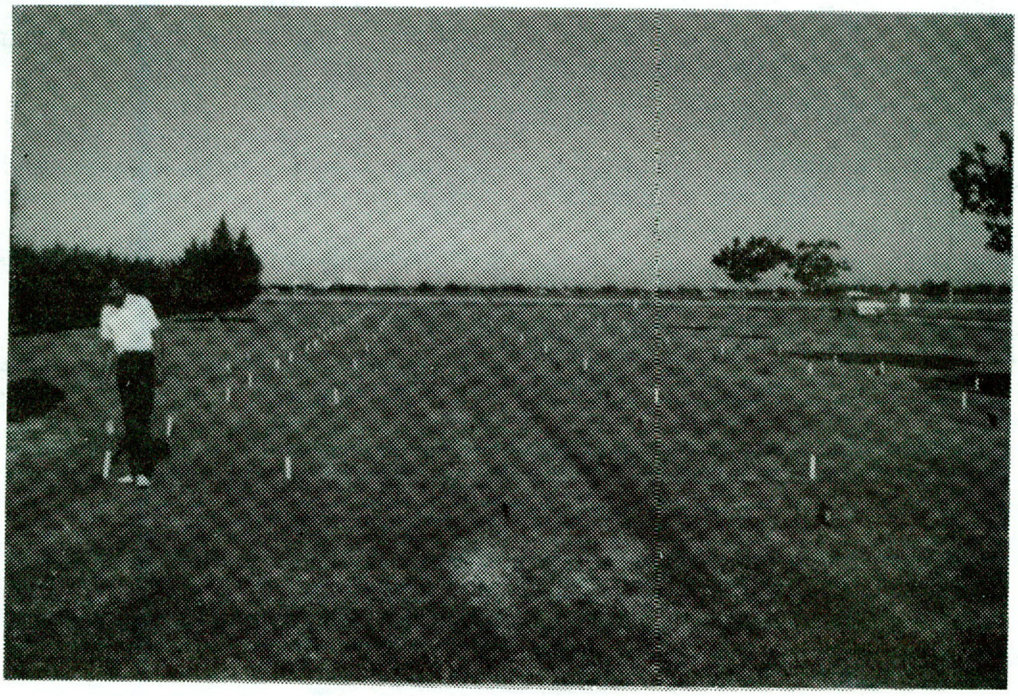
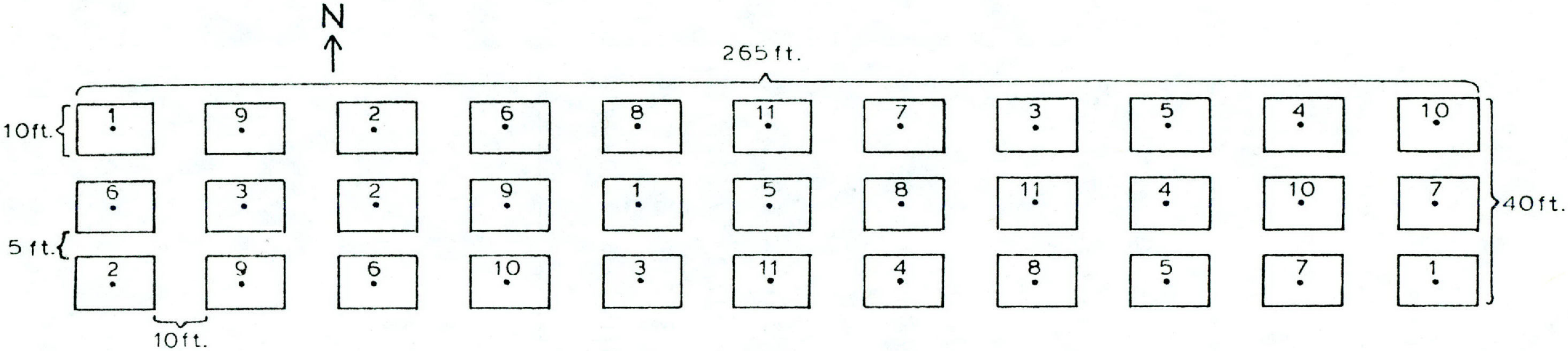


Figure 1. Growth regulator plots at the Devro industrial site, Lubbock, Texas, 1982.



LEGEND

SYMBOL	TREATMENT (RATE)
1	SURFLAN (4 lbs./acre)
2	DUAL (4 lbs./acre)
3	S-734 (2 lbs./acre)
4	EMBARK (1 lb./acre)
5	EMBARK (2 lbs./acre)
6	EL 500 (.75 lbs./acre)
7	EL 500 (1.5 lbs./acre)
8	MALIC HYDRAZIDE (2 lbs./acre)
9	MALIC HYDRAZIDE (4 lbs./acre)
10	MOWED
11	UNMOWED
•	NEUTRON PROBE TUBE

Figure 2. Plot design in the turf growth regulator study at Devro industrial site, Lubbock, Texas, 1982.

Table 1. Cultural practices in the growth regulator study, Devro, Inc., Lubbock, Texas, 1982.

Activity	Dates
Irrigating	7/12, 7/26, 8/6, 8/20
Fertilizing	
Iron (chelate) 0.23 lbs/1000 fs	7/9
Nitrogen (Ammonium Nitrate) 2.23 lbs/1000 fs	8/25
Mowing (to height of 1 1/2 in.)	
Mowed untreated plots	6/8, 6/15, 6/22, 6/29
	7/6, 7/13, 7/20, 7/27,
	8/3, 8/10, 8/17, 8/24
Other treatments	6/15, 7/6, 7/20, 8/10

Table 2. Visual appearance of residual growth regulator plots at Lubbock, Texas, on May 5, 1982. (1 = totally brown, 10 = 100 percent lush green growth).

Treatment	Rate lb/A	Visual Appearance
DOWCO 453	0.2	2.3* a
Fusilade	0.5	3.0 ab
Poast	0.5	3.3 abc
MN4621	3.0	3.5 abc
Dual	4.0	3.7 abcd
MBR 22359	2.0	3.7 abcd
MBR 22359	1.0	4.0 abcde
CGA 82725	1.0	4.0 abcde
DOWCO 453	0.1	4.0 abcde
Fusilade	0.25	4.0 abcde
MN 4621	0.8	4.3 abcdef
S-734	1.0	4.3 abcdef
NCI 96683	0.5	4.3 abcdef
Embark	1.0	4.7 abcdef
CGA 82725	0.5	4.7 abcdef
Surflan	2.0	5.0 bcdef
Poast	0.25	5.0 bcdef
RO 138895	0.1	5.0 bcdef
MBR 18337	2.0	5.0 bcdef
MBR 23709	1.0	5.0 bcdef
MBR 23709	2.0	5.0 bcdef
NCI 96683	0.2	5.0 bcdef
Poast	0.1	5.3 bcdef
RO 138895	0.2	5.3 bcdef
S-734	2.0	5.3 bcdef
MBR 18337	1.0	5.3 bcdef
Untreated		5.3 bcdef
Dual	2.0	5.7 cdef
EL 500	0.75	6.0 def
Polada	0.5	6.3 ef
Embark	2.0	6.3 ef
EL 500	1.5	6.3 ef
Surflan	4.0	6.7 f

*Numbers with a common letter in the visual appearance column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 3. Average quality ratings for residual effects of growth regulators at Lubbock, Texas, 1981.

		8/6/82			
Treatment	Rate lb/A	Color	Injury	Stand	Height (in)
Polada	0.5	7.7 a*	0.0 a	9.7 c	1.93 abcde
Surflan	2.0	8.0 a	0.0 a	10.0 c	1.77 abcd
Surflan	4.0	8.0 a	0.0 a	10.0 c	1.89 abcde
Dual	2.0	8.0 a	0.0 a	10.0 c	1.97 abcde
Dual	4.0	8.0 a	0.0 a	9.7 c	1.93 abcde
Poast	0.1	7.7 a	0.0 a	10.0 c	1.93 abcde
Poast	0.25	8.0 a	0.0 a	10.0 c	1.81 abcd
Poast	0.5	8.0 a	0.0 a	9.7 c	2.24 de
RO 133395	0.1	7.5 a	0.0 a	9.7 c	2.17 bcde
RO 133895	0.2	8.0 a	0.0 a	10.0 c	2.09 abcde
MN 4621	3.0	7.7 a	0.0 a	10.0 c	2.13 abcde
MN 4621	5.0	7.7 a	0.0 a	9.7 c	1.65 a
S-734	1.0	7.7 a	0.0 a	10.0 c	1.73 abc
S-734	2.0	7.7 a	0.0 a	9.7 c	1.93 abcde
MBR 18337	1.0	7.3 a	0.3 a	9.7 c	2.13 abcde
MBR 18337	2.0	7.7 a	0.3 a	9.7 c	1.81 abcd
MBR 22359	1.0	8.0 a	0.0 a	10.0 c	1.69 ab
MBR 22359	2.0	7.3 a	0.0 a	10.0 c	1.89 abcde
MBR 23709	1.0	7.7 a	0.0 a	10.0 c	1.97 abcde
MBR 23709	2.0	7.3 a	0.0 a	10.0 c	1.89 abcde
Embark	1.0	8.0 a	0.0 a	9.7 c	1.85 abcd
Embark	2.0	8.0 a	0.0 a	10.0 c	2.05 abcde
CGA 82725	0.5	8.0 a	0.0 a	10.0 c	1.85 abcd
CGA 82725	1.0	7.3 a	0.3 a	10.0 c	2.36 e
DOWCO 453	0.1	8.0 a	0.0 a	9.1 bc	2.13 abcde
DOWCO 453	0.2	7.3 a	0.3 a	7.7 a	1.93 abcde
NCI 96683	0.2	8.0 a	0.0 a	10.0 c	1.73 abc
NCI 96683	0.5	7.7 a	0.0 a	9.7 c	2.05 abcde
EL 500	0.75	7.7 a	0.0 a	9.7 c	2.09 abcde
EL 500	1.5	7.7 a	0.0 a	10.0 c	2.20 cde
Fusilade	0.25	8.0 a	0.0 a	10.0 c	2.20 bcde
Fusilade	0.5	7.3 a	0.3 a	8.3 ab	2.05 abcde
Untreated	-	8.0 a	0.0 a	9.7 c	1.93 abcde

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 4. Wet weight, dry weight and percent moisture of grass samples from the residual growth regulator plots, Lubbock, Texas, 1982.

		8/6/82		
Treatment	Rate lb/A	Fresh lb/1000 fs	Dry lb/1000 fs	Moisture (%)
Polada	0.5	5.3 a*	2.7 abcd	47.5 a
Surflan	2.0	5.4 a	3.0 abcd	44.7 a
Surflan	4.0	4.6 a	2.5 abcd	45.2 a
Dual	2.0	5.5 a	2.8 abcd	48.7 a
Dual	4.0	4.6 a	2.6 abcd	43.9 a
Poast	0.1	3.9 a	2.2 abcd	43.0 a
Poast	0.25	4.3 a	2.3 abcd	45.7 a
Poast	0.5	5.5 a	3.1 abcd	42.8 a
RO 138895	0.1	6.5 a	3.0 abcd	53.4 a
RO 138895	0.2	6.0 a	3.2 cd	46.2 a
MN 4621	3.0	5.6 a	3.2 cd	43.3 a
MN 4621	5.0	4.4 a	2.5 abcd	43.6 a
S-734	1.0	4.6 a	2.7 abcd	42.7 a
S-734	2.0	3.9 a	2.2 abc	43.8 a
MBR 18337	1.0	5.9 a	3.4 d	41.6 a
MBR 18337	2.0	5.8 a	3.2 bcd	45.1 a
MBR 22359	1.0	4.2 a	2.5 abcd	40.5 a
MBR 22359	2.0	4.3 a	2.4 abcd	43.2 a
MBR 23709	1.0	5.0 a	2.6 abcd	48.1 a
MBR 23709	2.0	4.7 a	2.6 abcd	44.3 a
Embark	1.0	5.0 a	2.6 abcd	46.8 a
Embark	2.0	4.7 a	2.3 abcd	50.4 a
CGA 82725	0.5	5.7 a	3.0 abcd	46.2 a
CGA 82725	1.0	5.0 a	2.7 abcd	45.9 a
DOWCO 453	0.1	5.5 a	2.6 abcd	51.1 a
DOWCO 453	0.2	5.9 a	2.9 abcd	50.5 a
NCI 96683	0.2	3.8 a	2.0 a	45.6 a
NCI 96683	0.5	5.5 a	2.6 abcd	50.0 a
EL 500	0.75	4.3 a	2.5 abcd	43.0 a
EL 500	1.5	5.0 a	2.4 abcd	50.2 a
Fusilade	0.25	5.5 a	3.1 abcd	41.7 a
Fusilade	0.5	4.4 a	2.1 ab	47.3 a
Untreated	-	5.2 a	2.2 abc	54.3 a

* Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 5. Average color ratings of growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate (lb/A)	6/12	6/30	7/19	8/06
Surflan	4.0	9.3 abc*	9.7 b	9.0 abc	8.7 ab
Dual	4.0	9.3 abc	9.7 b	9.5 abc	9.0 ab
S-734	2.0	9.7 bc	9.3 ab	9.0 abc	8.3 ab
Embark	1.0	8.7 ab	9.7 b	9.7 bc	8.0 ab
Embark	2.0	8.7 ab	9.7 b	10.0 c	9.0 ab
EL 500	0.75	10.0 c	9.0 ab	8.3 a	9.0 ab
EL 500	1.5	9.0 abc	8.3 a	8.7 ab	9.3 b
Maleic hydrazide	1.0	9.0 abc	9.3 ab	9.3 abc	8.0 ab
Maleic hydrazide	2.0	9.0 abc	9.7 b	9.0 abc	7.7 a
Mowed	-	8.3 a	8.3 a	8.3 a	8.3 ab
Unmowed	-	9.3 abc	9.3 ab	9.3 abc	8.3 ab

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 6. Average injury ratings of growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate lb/A	6/12	6/30	7/19	8/06
Surflan	4.0	10 c*	10 a	10 a	9 b
Dual	4.0	9 c	10 a	7 a	8 b
S-734	2.0	10 c	10 a	10 a	8 b
Embark	1.0	10 c	10 a	7 a	8 b
Embark	2.0	10 c	10 a	10 a	8 b
EL 500	0.75	10 c	10 a	9 a	8 b
EL 500	1.5	10 c	10 a	9 a	9 b
Maleic hydrazide	1.0	10 c	10 a	10 a	8 b
Maleic hydrazide	2.0	8 a	10 a	10 a	6 a
Mowed	-	10 c	10 a	10 a	9 b
Unmowed	-	10 c	10 a	10 a	3 b

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 7. Average height (in.) of growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate lb/A	6/12	6/30	7/19	8/06
Surflan	4.0	3.0 ab*	2.6 bcd	3.1 ab	2.6 ab
Dual	4.0	4.3 c	3.1 d	3.6 b	2.7 bc
S-734	2.0	3.1 ab	2.3 bc	3.0 ab	2.8 bc
Embark	1.0	3.1 ab	2.9 bcd	2.4 ab	3.0 bc
Embark	2.0	3.0 ab	2.6 bcd	3.4 ab	3.2 c
EL 500	0.75	3.6 bc	2.7 bcd	3.1 ab	2.9 bc
EL 500	1.5	3.4 ab	2.3 bc	3.1 ab	2.8 bc
Maleic hydrazide	1.0	3.3 ab	3.1 d	3.4 ab	2.7 bc
Maleic hydrazide	2.0	3.3 ab	2.7 bcd	3.5 b	2.8 bc
Mowed	-	2.3 a	1.1 a	2.1 a	2.2 a
Unmowed	-	3.5 bc	2.7 bcd	3.4 ab	2.7 bc

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 8. Seed heads per 5.4 fs in growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate lb/A	6/12	6/30	7/19	8/06
Surflan	4.0	449 bcd*	250 d	157 abc	49 ab
Dual	4.0	498 d	74 ab	92 ab	12 ab
S-734	2.0	451 bcd	179 cd	187 abc	44 ab
Embark	1.0	372 bcd	206 d	314 c	87 b
Embark	2.0	244 abc	101 bc	202 abc	18 ab
EL 500	0.75	505 d	96 bc	115 abc	47 ab
EL 500	1.5	470 bcd	243 d	233 bc	65 ab
Maleic hydrazide	1.0	317 bcd	181 cd	279 bc	18 ab
Maleic hydrazide	2.0	220 ab	174 cd	234 bc	1 a
Mowed	-	5 a	0 a	29 a	71 ab
Unmowed	-	485 cd	166 cd	213 abc	44 ab

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 9. Wet weight (lbs/1000 fs) on selected dates of growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate lb/A	6/12	6/30	7/19	8/06
Surflan	4.0	60.4 c*	44.4 bcd	42.0 bc	17.3 b
Dual	4.0	99.0 e	49.1 bcd	54.7 c	16.5 ab
S-734	2.0	55.7 bc	33.5 b	34.6 b	15.6 ab
Embark	1.0	30.9 ab	55.4 cd	36.9 b	15.7 ab
Embark	2.0	26.4 ab	43.2 bcd	43.4 bc	14.3 ab
EL 500	0.75	88.9 de	40.7 bcd	29.2 b	18.1 b
EL 500	1.5	53.8 bc	32.5 b	27.4 b	15.0 ab
Maleic hydrazide	1.0	45.4 bc	46.6 bcd	33.4 b	10.1 ab
Maleic hydrazide	2.0	60.6 c	59.2 d	54.4 c	12.8 ab
Mowed	-	4.8 a	3.4 a	7.9 a	6.8 a
Unmowed	-	63.2 cd	37.5 bc	28.9 b	11.9 ab

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 10. Dry weight (lbs/1000 fs) on selected dates of growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate lb/A	6/12	6/30	7/19	8/06
Surflan	4.0	17.8 de*	11.9 bc	15.3 bc	6.8 b
Dual	4.0	27.2 f	13.0 bc	21.6 d	6.6 b
S-734	2.0	16.8 cde	8.9 b	13.1 bc	6.2 b
Embark	1.0	9.8 bc	14.9 bc	14.4 bc	6.0 b
Embark	2.0	8.7 ab	11.9 bc	16.7 cd	5.7 ab
EL 500	0.75	23.0 ef	11.2 bc	13.4 bc	6.9 b
EL 500	1.5	17.7 de	8.9 b	10.5 b	5.8 b
Maleic hydrazide	1.0	14.3 bcd	13.0 bc	13.2 bc	4.3 ab
Maleic hydrazide	2.0	17.7 de	16.3 c	21.0 d	5.6 ab
Mowed	-	1.4 a	0.7 a	3.2 a	3.0 a
Unmowed	-	18.9 de	10.3 bc	12.1 bc	5.1 ab

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 11. Percent moisture of growth regulator treatments at Lubbock, Texas, 1982.

Treatment	Rate (lb/A)	6/12	6/30	7/19	8/06
Surflan	4.0	70.5 ab*	73.4 a	63.0 b	59.7 a
Dual	4 0	72.5 ab	73.5 a	60.3 ab	59.4 a
S-734	2.0	69.8 ab	73.6 a	62.3 ab	59.8 a
Embark	1.0	68.3 ab	73.0 a	60.3 ab	60.0 a
Embark	2.0	67.0 a	72.2 a	61.0 ab	57.7 a
EL 500	0.75	74.1 b	73.0 a	52.0 a	60.1 a
EL 500	1.5	67.1 a	72.3 a	61.6 ab	60.6 a
Maleic hydrazide	1.0	68.5 ab	72.3 a	60.7 ab	56.7 a
Maleic hydrazide	2.0	70.7 ab	72.6 a	61.3 ab	56.3 a
Mowed	-	70.8 ab	80.6 a	59.7 ab	55.4 a
Unmowed	-	70.0 ab	72.2 a	58.7 ab	56.8 a

*Numbers with a common letter within each column are not significantly different at the 5 percent level of probability according to Duncan's multiple range test.

Table 12. Soil water content of the surface 96 inches of growth regulator treatments at Lubbock, Texas, 1982.

		Total Water (inches)									Change (Δ)
Treatment	Rate (lb/A)	6/09	6/22	6/29	7/06	7/29	8/04	8/10	8/17	8/24	6/09-8/24
Surflan	4.0	22.0	21.6	22.3	22.2	20.2	20.1	19.6	18.9	18.8	-3.2
Dual	4.0	21.3	21.4	21.9	21.8	19.7	19.4	19.0	18.6	18.3	-3.0
S-734	2.0	22.4	21.9	22.6	22.6	20.6	20.5	20.1	19.6	19.4	-3.0
Embark	1.0	22.2	21.7	22.6	22.5	20.2	20.0	19.7	19.0	18.9	-3.3
Embark	2.00	21.8	21.7	22.2	22.0	20.0	19.7	19.5	18.9	18.6	-3.2
EL 500	0.75	21.9	21.9	22.4	22.2	20.2	19.9	19.6	18.9	18.7	-3.2
EL 500	1.5	22.4	22.0	23.1	22.8	20.5	20.3	20.0	19.3	19.2	-3.1
Maleic hydrazide	1.0	22.1	21.9	22.4	22.3	19.9	20.0	19.7	19.0	18.8	-3.3
Maleic hydrazide	2.0	22.8	22.9	23.3	23.2	21.1	20.8	20.5	19.9	19.7	-3.1
Mowed	-	22.3	22.1	22.7	22.6	20.4	20.0	19.8	19.1	19.0	-3.4
Unmowed	-	22.4	22.3	22.8	22.7	20.5	20.5	19.9	19.4	19.2	-3.3

Recommendations

1. A better site is needed for future evaluations of sprinklers. The site should have as many characteristics of the turf as possible. It should be equipped so that water losses and distribution can be obtained simultaneously from a number of sprinklers operating at the same time.
2. Water loses from sprinklers exceeded the traditional measurements of evaporative demand in both 1981 and 1982. It appears that the evaporative demand in the area of the sprinklers differs from the traditional evaporative demand measurements. It would be helpful if water losses from sprinklers were modeled and the models evaluated with sprinklers operating in the open environment. In addition to the knowledge concerning evaporative demand that would be obtained from such a study, information would be provided that might aid in better design and operation of sprinklers.
3. Information on the infiltration rate of home lawns is needed so that the proper irrigation system can be recommended. Such information is currently limited. It is recommended that a rainfall simulator be designed to determine the steady state infiltration rates of home lawns.
4. After the infiltration rates are studied and the irrigation application systems are evaluated, it is recommended that a study be conducted on home lawns to determine if the information obtained is adequae for making recommendations concerning the sprinkler design and operation of lawn irrigation systems. In all cases, adequate climatic parameters need to be measured.
5. Criteria need to be developed for the initiaion irrigation of turf. The data obtained in both 1981 and 1982 indicated that heavy infrequent irrigations have some merit. However, not enough information is available to recommend when these irrigations should be initiated, especially in relation to natural precipitation.
6. Differences were obtained in amount of water required to establish and maintain quality of zoysiagrass, fescue, bermudagrass and buffalograss under a rainout shelter. These studies should be continued to determine if differences in water requirement exist following establishment.
7. Results from growth regulators applied in 1982 were not as definitive as they were in 1981. Other researchers have had similar results. Since growth regulators have a great potential to decrease mowing and water use, it is recommended their research be continued and more parameters measured to determine the conditions, under which they are effective.

PR 4169

Buffalograss Seed Pretreatment Germination

V. G. Hickey, F. A. Miller, and M. C. Engelke

Introduction

Buffalograss (Buchloe dactyloides (Nutt.) Engelm. possesses some characteristics which make it highly desirable for use as a turf-grass species in Texas. A perennial native of the shortgrass prairie regions of the Central United States, it has heat and drought tolerance, persists on heavy soils and tolerates traffic. However, establishment of buffalograss is often difficult due to limited quantities of available seed, and dormancy caused by a factor associated with the burs. Lengthly pretreatment of the burs adds to the expense and difficulty of establishing buffalograss turf areas. Knoop (1982) reported that soaking buffalograss burs in a 0.5% solution of KNO3 for 24 hours followed by chilling at 40 degrees F for 4 weeks improved germination. Ahring and Todd (1977) found that an oil-like material present in the burs inhibited germination. When caryopses were extracted by hand, pre-chilled at 5 degrees C for 6-8 weeks, or treated in a 5.25% sodium hypochlorite solution, germination improved significantly. In attempting to germinate buffalograss seeds using the 5.25% sodium hypochlorite solution recommended by Ahring and Todd, difficulties encountered stimulated interest in other seed treatments to improve the germination of buffalograss.

Materials and Methods

Four accessions of buffalograss were selected at random from a collection of grasses by the Soil Conservation Service:

01277 from Pawnee County, Kansas;
01281 from Ohawa County, Kansas;
01359 from Webster County, Nebraska;
01370 from Farmer County, Texas.

Thirty burs from each of the four accessions were subjected to the following pretreatments.

1. No pretreatment (Control).
2. Soak burs in 10 ml 68 C(180 F) tap water for five minutes.
3. Soak burs in 10 ml 68 C(180F) tap water for five minutes, followed by a five minute post wash in running cool tap water.
4. Soak burs in 10 ml tap water for 12 hours.
5. Soak burs in 10 ml tap water for 12 hours, followed by a five minute post wash in cool running tap water.
6. Soak burs in 2% tap water-Aquagrow solution for 12 hours.
7. Soak burs in 2% tap water-Aquagrow solution for 12 hours followed by a five minute wash in cool running tap water.
8. Soak burs in 5.25% sodium hypochlorite solution (commercial bleach, full strength) for 12 hours.
9. Soak burs in 5.25% sodium hypochlorite solution for 12 hours followed by a 5 minute wash in cool running tap water.
10. Soak burs in equal parts of 2% Aquagrow and 5.25% sodium hypochlorite solution for 12 hours.
11. Soak burs in equal pats of 2% Aquagrow and 5.25% sodium hypochlorite solution for 12 hours followed by a 5 minute rinse in cool running tap water.
12. Soak burs in 5% KNO3 solution for 12 hours.
13. Soak burs in 5% KNO3 solution for 12 hours followed by a 5 minute rinse in cool running tap water.
14. Soak burs in equal parts 5% KNO3 solution and 2% Aquagrow solution for 12 hours.
15. Soak burs in equal parts 5% KNO3 solution and 2% Aquagrow solution for 12 hours followed by a five minute rinse in cool running tap water for five

minutes.

16. Hand scarify by extracting caryopsis with tweezers .
17. Hand scarify by extracting caryopsis with tweezers and removing all bur material.
18. Scarify with small blender and remove all bur material.

After pretreatment, the 30 burs were divided into three replications of 10 burs each, which were placed in sterile plastic petri dishes on moistened paper toweling. For the duration of the study, they were placed in a controlled environment chamber, held at 26 degrees C with 24 hour illumination under cool white florescent lamps. Additional moisture was added to the dishes to prevent drying as needed.

Results and Discussion

Germination varied among cultivars (Table 1). Differences in age of seed and other factors not controlled during collection may account for differences in germination of seeds. Removal of the caryopsis from the bur appears to stimulate germination (Table 2). However, germination following this pretreatment did not differ significantly from that of seed treated in bleach. These results concur with those reported by Ahring and Todd. However, it was believed that use of the blender to pretreat the seeds would provide an acceptable method if the length of time which the burs were ground was more carefully monitored. Where KNO3 and Aquagrow were combined (Treatments 14 and 15), germination was poorer than with either alone as a pretreatment, possibly indicating a toxic reaction. Use of the commercial bleach solution or aquagrow and bleach combined to soak the burs provided the simplist method of treating the burs since it obviates the chilling step and KNO3 can be difficult to obtain. Based on the results of this study and information reported by Hartman and Kester (1975), further studies concerning the use of growth regulators relating to seed dormancy in buffalograss germination might be beneficial.

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3. Hartman, H. T. and D. E. Kester. 1975. Plant propagation. Principles and Practices. Prentice–Hall, Englewoods Cliffs, New Jersey. pp. 160–161.
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Table 1. Mean germination of buffalograss accessions averaged across 18 pretreatments.

Accession #	Number germinated
01370	2.8a*
01359	2.3a
01281	2.4a
01277	1.6b

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

Table 2. Mean number of seeds which germinated following various seed pretreatments of buffalograss.

Treatment	Germination mean/10 burs
16. Hand scarify	6.8a*
11. Bleach+2%Aquagrow+Rinse	6.3ab
9. Bleach, 12 hours +Rinse	5.5b
17. Hand scarify, remove bur material	5.4b
12. KNO_3, 12 hour soaK	3.7c
10. Bleach+2%AquagroW	3.4c
8. Bleach	2.7c
13. KNO_3, 12 hour soak+Rinse	1.5d
18. BlendeR	1.3ed
4. Water soak, 12 hours	0.9ed
7. Water+2%Aquagrow soak, 12 hours	0.9ed
5. Water soak, 12 hours + Rinse	0.8ed
3. Hot water soak, 5 minutes,+ Rinse	0.7ed
2. Hot water soak, 5 minutes	0.5ed
6. Water+2%Aquagrow soak, 12 hours	0.5ed
1. No pretreatment, control	0.3ed
15. KNO_3+2%Aquagrow+Rinse	0.3ed
14. KNO_3+2%Aquagrow	0.0e

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

PR 4170

Effect of Experimental Seed Coating on Bermudagrass Seed Germination

V. G. Hickey and M. C. Engelke

Introduction

Establishment of bermudagrass *(Cynodon dactylon* L. Pers.) turf areas from seed is less expensive than with sod or sprigs. Germination and establishment is dependent upon ideal moisture and nutrient levels. Use of a carrier with the seed, which would aid in maintaining moisture and provide nutrients and which could be rapidly metabolized by the emerging plant, should aid in turf establishment. Screening of seed to insure uniform seed size and to eliminate incompletely filled or broken seed should result in a more uniform seed distribution. A study was designed to compare the germination of sized and unsized bermudagrass seed with and without an experimental seed coating containing a starter fertilizer. The experimental seed coating was formulated by K-F Seeds. Information concerning nutrient content and manufacturing process was not made available.

Materials and Methods

Laboratory germination counts were made by placing 100 seeds each of hulled-uncoated, sized-coated, and unsized-coated seeds on moist blotter paper in sterile plastic petri dishes. The greenhouse study included hulled bermudagrass seed planted in flats of Austin silty clay soil (fine-silty, carbonetic, thermic, Entic Haplustolls). Uncoated hulled unsized (control), sized coated, and unsized coated bermudagrass seed was planted at a rate of 48.8 kg/ha(1#/1000 sq ft). In addition, the coated seed was planted at a rate of 97.6 kg/ha(2#/1000 sq ft). The effective seeding rate of 1# coated material per unit area is 1/2# seed per unit area. Therefore 2 planting rates of coated seed were evaluated to approximate 1# of seed plus material. Seed was hand sown on the soil surface, lightly covered with soil, and irrigated to keep moist. Clear polyethylene sheeting was used to cover the flats to maintain humidity. Germination counts were made with a 6.5 sq in. (42 cm2) ring, placed at random within the flats for six successive days after initial germination was noted. The field studies were conducted on an Austin silty clay soil using a randomized complete block design with three replications. Seeds were sown in 49 sq ft (4.5 m2) plots, lightly raked and irrigated daily. Germination counts were made over a 9 day period following initial germination. Analysis of variance and Duncan's Multiple Range mean separation tests were performed on the data.

Results and Discussion

Petri plate germination indicated seed viability was not affected by seed coating (Table 1). Differences in fungal growth appeared to exist between the coated and uncoated seed. The uncoated seed plates had few fungal colonies but Penicillium sp., Alternaria sp., and Botrytis sp. thrived in the plates with coated seed;

Differences in seedling number under greenhouse conditions were a function of seeding rate and not of seed coating (Table 1). Date x seed treatment interaction was non-significant in the greenhouse, indicating that the seed coating did not influence the rate of germination under controlled germination conditions.

A slight suppression of seedling emergence was noted under field conditions for coated versus uncoated seed at the same effective seeding rate (Table 1). As the coated seeding rate was increased to approximate the normal 1x seeding rate, number of seedlings increased, indicating compensation for seed coating weights must be made in seeding rates. The wetting-drying cycles experienced in the field suppressed seed germination for the coated seed as compared to the hulled uncoated seed. Increased moisture levels may be needed to dissolve the carrier which may divert moisture from the seed itself. Date x seed treatment interaction was not significant under field conditions, indicating that the seed coating did not influence the rate of germination. Number of seedlings in the field was dependent on date of evaluation (Table 2), which indicates that the greenhouse environment was more uniform for germination.

Acknowledgments

This investigation is partially supported by grants from K-F Seeds.

Table 1. Effect of sizing and experimental seed coating on seedling number of bermudagrass.

Seed Treatment	Planting Rate	Seeding rate	Greenhouse Seedlings[1]	Field Seedlings[2]	Petri plate Germination[3]
	kg/ha (lb/1000 ft^2)		#/42 cm^2 (6.5 in^2)	#/760 cm^2 (118 in^2)	%
Hulled uncoated	48.8(1 lb)	1x	37a*	52a	81
Sized Coated	48.8(1 lb)	1x	23b	15c	88
Unsized Coated	48.8(1 lb)	1x	21b	17c	83
Sized Coated	97.6(2 lb)	2x	33a	34b	
Unsized Coated	97.6(2 lb)	2x	32a	27bc	

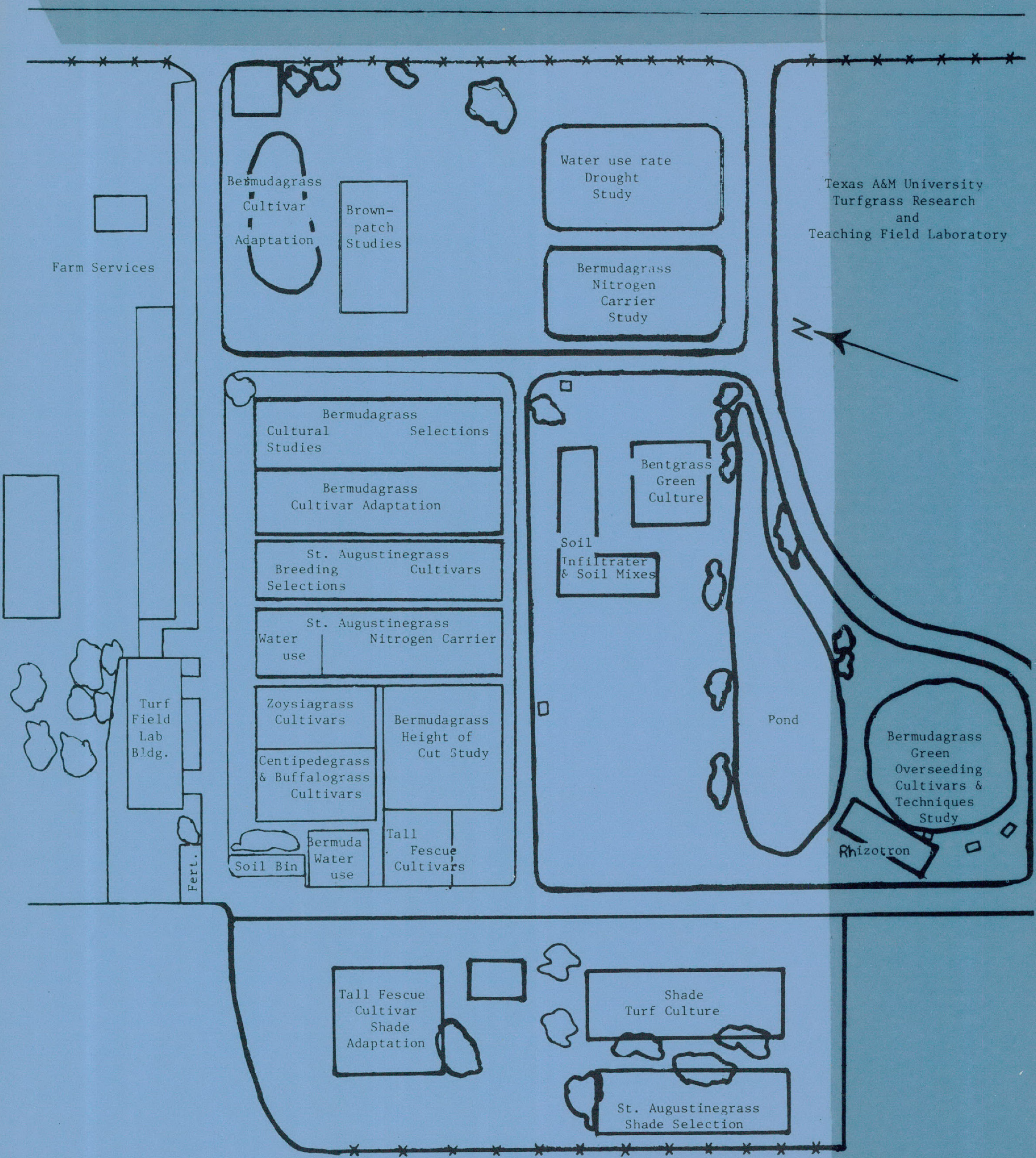
1 Average for six dates.
2 Average for nine dates.
3 Average of two plates seven days after planting.
* Means followed by the same letter are not significantly different at the .05 level of probability by Duncan's Multiple Range Test.

Table 2. Average germination of five bermudagrass seed treatments by day from date of first germination under greenhouse and field conditions.

Day	Greenhouse Seedlings	Field Seedlings
	#/7.3cm^2 ring (6.5in^2)	#/760 cm^2 (118in^2)
1	30a*	0.3b*
2	26a	0.5b
3	32a	3.0b
4	31a	10.9b
5	29a	42.0a
6	26a	53.7a

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

Acknowledgements: This investigation is partially supported by grants from K-F Seeds.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St. Augustinegrass Water use Nitrogen Carrier
Zoysiagrass Cultivars
Centipedegrass & Buffalograss Cultivars
Bermudagrass Height of Cut Study
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Shade Turf Culture
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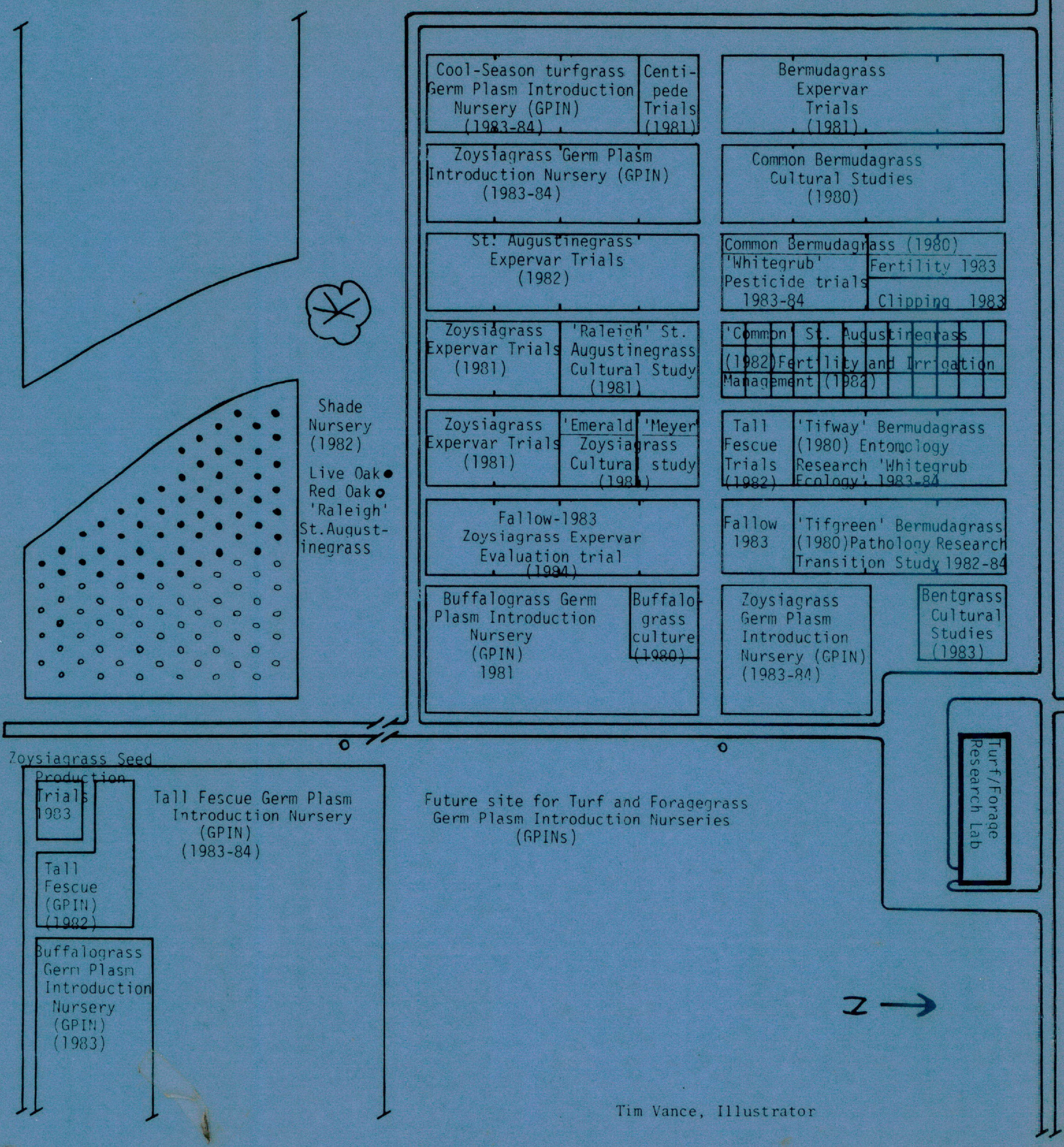

Tim Vance, Illustrator