PROGRESS REPORT

concerning

PHYSIOLOGICAL INVESTIGATIONS

in

DEVELOPING WATER CONSERVING, MINIMAL MAINTENANCE TURFGRASSES AND CULTURAL SYSTEMS

Submitted By:

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Jointly Sponsored By:

United States Golf Association

and

Texas Agricultural Experiment Station

September 30, 1983

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I. INTRODUCTION

This first six-month Progress Report, as established in the original contract, is for the period from March 31, 1983 to September 30, 1983. Dr. Robert G. Merrifield, Associate Director of the Texas Agricultural Experiment Station, signed the contract agreement on March 28, 1983 with Mr. Chuck W. Smith of the United States Golf Association signing on March 30, 1983.

A check for the first quarter funding of this research project arrived in late April and the appropriate work was initiated through the Texas A&M Research Foundation. The formal arrangements were completed within a two week period and we were authorized to spend money under an assigned research account on May 9, 1983. Thus, a five week period or 20% of the initial six month reporting period were devoted to activities not related to the actual conduct of experiments per se. Fortunately, there were several areas of investigation already underway that could be accelerated rapidly once funds were available. Thus, the lag time for start-up of the research program was minimal.

This report will consist of the following: A description of the implementation phase including organization, personnel procurement, and research facilities development. This will be followed by a summary of research progress based on the Annual Plan of Work submitted approximately one year ago. Finally, there are sections on the budget status and on publicity related to the research project. Although not required, a preliminary report on the project was submitted by J. B. Beard on June 6, 1983. Selected portions of the preliminary report will be included in this report as appropriate.

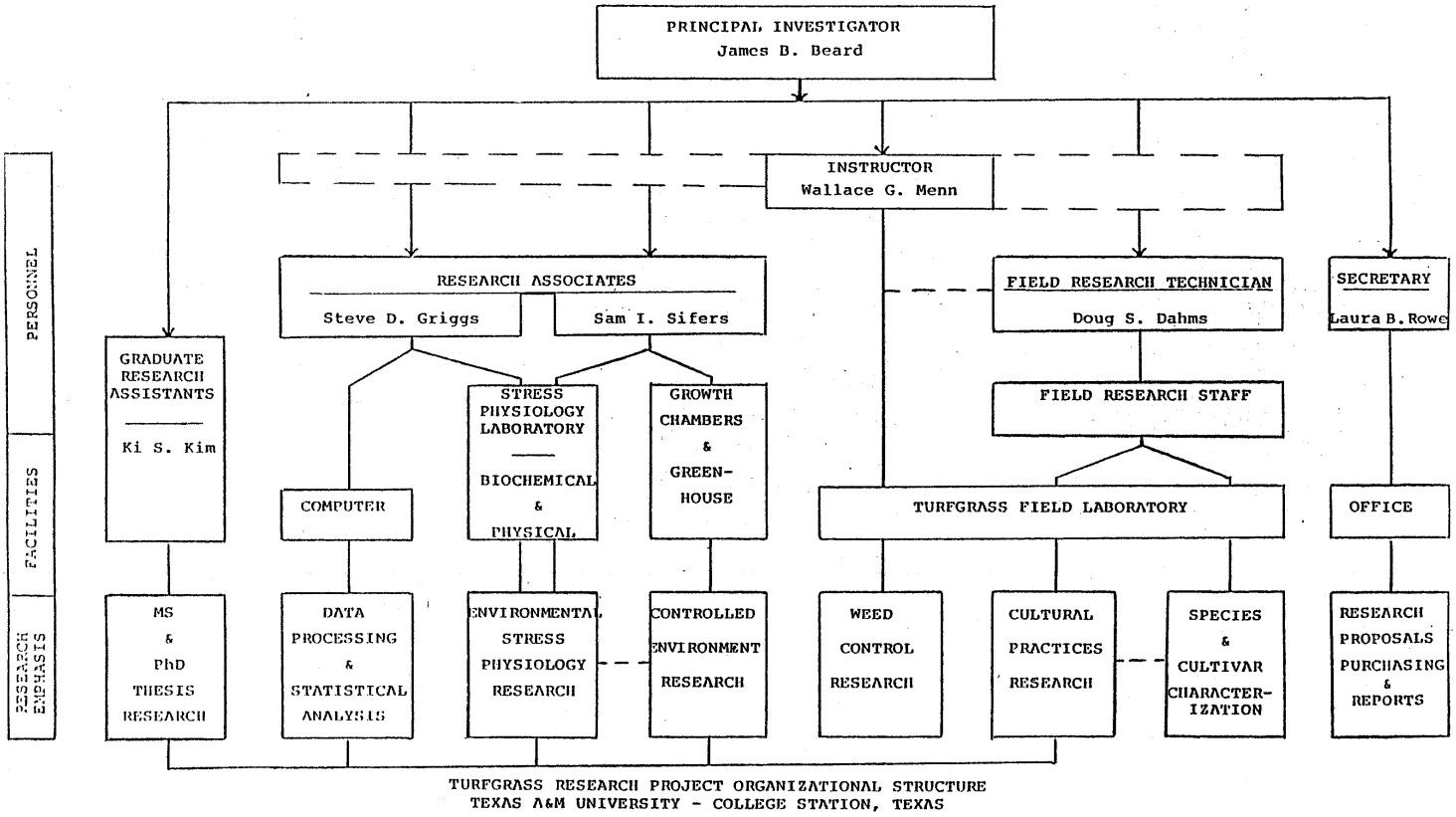
II. IMPLEMENTATION

The initial few weeks were devoted to (a) reorganization of the project, (b) interviewing and employment of project personnel, and (c) the design and construction of facilities needed to activate the proposed experiments. These initial activities are summarized in the following three sub-sections.

A. Organization.

The increased research emphasis in the area of water conservation and minimal maintenance turfgrasses required a reorganization of both the project personnel, including the new positions added, and the associated project research emphasis. A flow plan illustrating the new organizational structure being utilized on this project is shown in Figure 1. All areas of research emphasis, except for the weed research conducted by Wallace Menn, will involve this research project to varying degrees. Mr. Steven D. Griggs has been designated the overall project coordinator under Dr. Beard. He is responsible for maintaining and checking purchase orders, monthly expenditures, and monthly budget summaries in relation to projected expenditures. He is working in close contact with Mrs. Jayne Thetford, who has been assigned as the Texas A&M Research Foundation Representative for this project.

Figure 1.



TURFGRASS RESEARCH PROJECT ORGANIZATIONAL STRUCTURE
TEXAS A&M UNIVERSITY - COLLEGE STATION, TEXAS

B. Personnel

The first phase in implementation of the research project involved the interview and selection of project personnel. The existing TAES positions which had already been filled included Wallace G. Menn, Instructor; Doug S. Dahms, Agricultural Technician; and Laura B. Rowe, Secretary. Resumes of these individuals plus that of Dr. James B. Beard were included in the original research proposal.

In anticipation that the project would be funded by the USGA, Mr. Steven D. Griggs was employed in August of 1982 as a Research Associate using alternate grant funds in the interim period. The second Research Associate position funded totally from USGA funds was filled by Mr. Sam I. Sifers on June 1, 1983. A resume of Mr. Sifers is attached.

To sustain the high level of research activity planned at the Turfgrass Field Laboratory, a group of hourly student workers was employed for the summer growing season. These workers averaged 120 hours per week. This level of employment will be phased down to aproximately 60 hours per week for the winter period.

The only position that remained unfilled was that identified as the Graduate Student position. Unfortunately, all quality graduate students had accepted assistantship offers at other institutions before the funds became available to activate the position. An alternative, short term Post-Doctoral positon has been established and was filled by Dr. David Casnoff on Sept. 14, 1983. Dr. Casnoff's resume is attached. He will be providing leadership in the studies of rooting potential and root morphological characterization at both the interspecies and intraspecies levels.

This group of researchers is very well qualified in terms of both formal training and past experience to accomplish the goals of this research project. Their strong personal dedication and interest in their research motivates them to make the extra effort and dedication of time well above a 40 hour week in order to achieve our goals.

Resumes

Sam I. Sifers, Jr. graduated from Ohio University in 1951 with a B.A. degree in Government and History. He immediately entered the United States Air Force. He held many high level staff and command positions and attained the rank of colonel prior to completing his Air Force career in 1979. Senior level career assignments included duty as: Inspector General, Defense Mapping Agency; Vice Commander, 322nd Tactical Airlift Wing; Base Commander, Lackland Air Force Base; Deputy Director for Inspection, Headquarters, United States Air Force. He completed resident schooling at the Armed Forces Staff College, and also completed the Air War College and the Industrial College of the National Defense College.

Pursuing a life long interest in turfgrasses he entered Texas A&M. In 1981, he completed the requirements for a B.S. degree in Agronomy, with a major in Turf Management. He will complete the course and thesis requirements for a Master of Science in Agronomy in 1984, and has been a Teaching Assistant in Soil and Crop Sciences Turfgrass Science).

David M. Casnoff graduated from the Pennsylvania State University in 1975 with a B.S. degree in Agronomy (Turfgrass Management). He immediately entered Graduate School at the Pennsylvania State University and graduated with a M.S. degree in Agronomy (Soil Physics). The thesis project was "Soil Strength and Soil Temperature: Their Effects on the Root Growth of Tall Fescue." In May of 1978, he began his Ph.D. program in quantitative genetics at the University of Nebraska - Lincoln. The Ph.D. degree was conferred as of August 12, 1983. The thesis project was: "Nitrogen: Its Effects on the Expression of Prolificacy and its Utilization by Prolific and Non-prolific Genotypes of Maize."

Dr. Casnoff is currently a Post-Doctorate at Texas A&M University working with Dr. James B. Beard. He has gained insight into root studies and root evaluation techniques due to his 8 years of work with both tall fescue and maize root systems. This experience will be of great value in his rooting investigations planned for the next 6 months.

C. Facilities Development

In addition to good personnel, the proper physical facilities are required in order to solve each problem. By July 1 of 1983 both the Turfgrass Field Laboratory building and plots, as well as the Stress Physiology Lab, had been refurbished and reorganized to meet the requirements of the planned research. While most of the required physical facilities were already in place, there were three priority items as follows:

Water-Heat Stress Simulator - The electronic control system and associated dewpoint and temperature sensors were inoperative. After considerable testing, it was concluded that the costs for repair of the existing units would be so high that the best alternative would be the installation of an entirely new unit. This involved a switch from the electronic control unit built by Scientific Systems of Louisiana to a lower cost, but an equally effective, system available from Rheem Manufacturing of North Carolina. Installation of the new system was completed in early August of 1983. With the above modifications the Texas A&M Physical Plant personnel can now repair the unit as needed at a considerably lower cost, whereas the other unit had to be shipped back to the manufacturer. Environmental test simulation runs involving monitoring of temperature, dewpoint, and wind velocity in the chamber have been underway since then (Figure 2). Minor modifications in the dewpoint sensing element are now being made. It is anticipated that the system will be operational by October 10. Steve Griggs and Sam Sifers have been involved in these activities.

Rainout Shelter - A rainout shelter is essential for drought studies that will be conducted during the upcoming years. The first attempt at construction of a low cost rainout shelter proved unsuccessful during 1982. This unit was destroyed during a strong wind storm. The rainout shelter was redesigned during June of 1983; construction was completed over the next 6-week period; and the unit is now in the process of being tested (Figure 3). Some minor modifications are being made. On August 25, 1983, the eye of the tropical hurricane Alicia passed right over College Station, Texas. We were most pleased that the rainout shelter weathered this heavy wind storm without problems. Now the main problem is to strenghten the construction materials and some of the supporting joints. It is anticipated that the rainout shelter will be fully operational for the 1984 growing season. Design and construction of the rainout shelter was accomplished under the leadership of Sam Sifers.

Cultural Systems Field Study Area - Well drained field plot areas are essential for studies involving the assessment of cultural practices as they affect water use rates. In preparation for the initiation of these studies in 1985 a set of field plots were established during the 1983 growing season. This involved installation of a 25 cm deep (minimum) sand root zone over a subsurface drain line system consisting of 10 cm laterals on a 4 meter spacing, plus installation of two underground irrigation lines and associated rotary, popup sprinkler heads (Figure 4). Subsequently the 5,230 square foot area was vegetatively planted to Tifway bermudagrass. Complete establishment of the plot area will be achieved during the 1983 growing season. This project has been under the direction of Doug Dahms, Sam Sifers, and Wallace Menn.

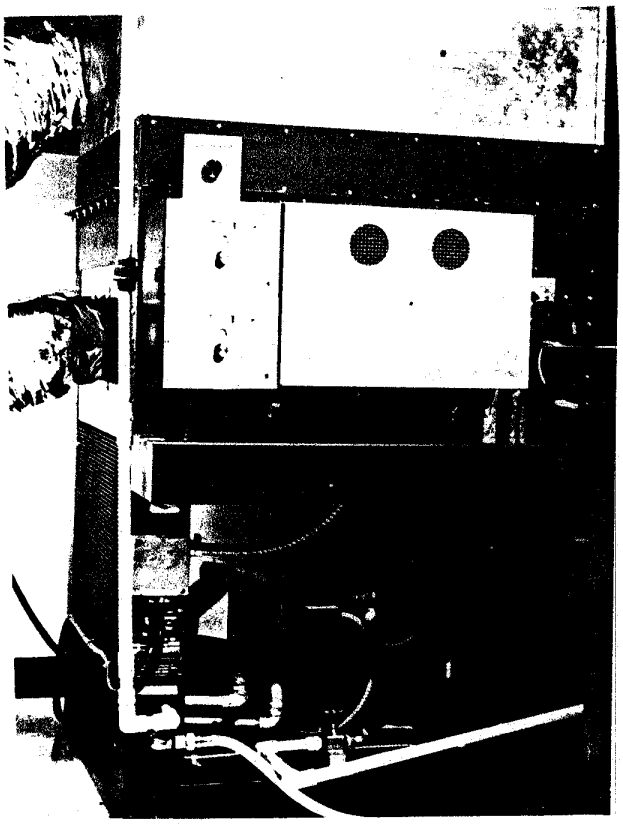


Figure 2. View of the water-heat stress simulator.

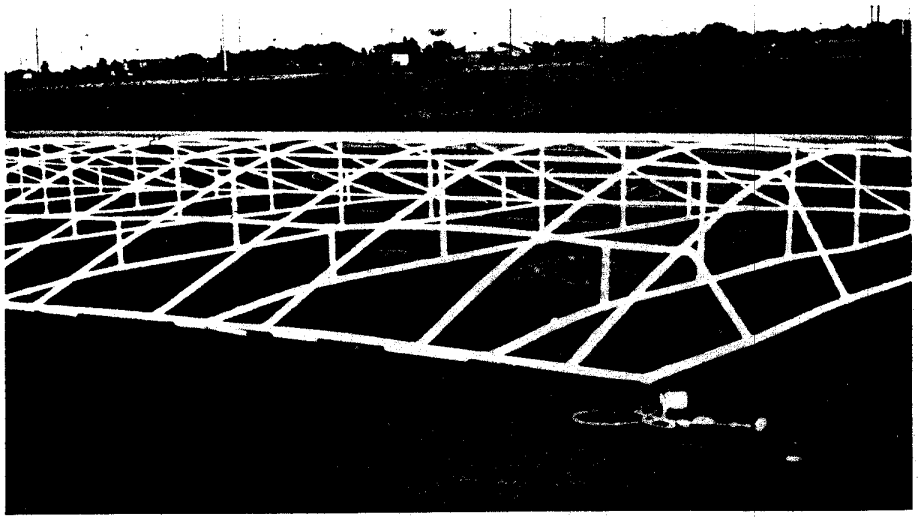


Figure 3. View of the rainout shelter structure just prior to covering with an opaque polyethylene sheeting with a saran - shade cloth placed on top.

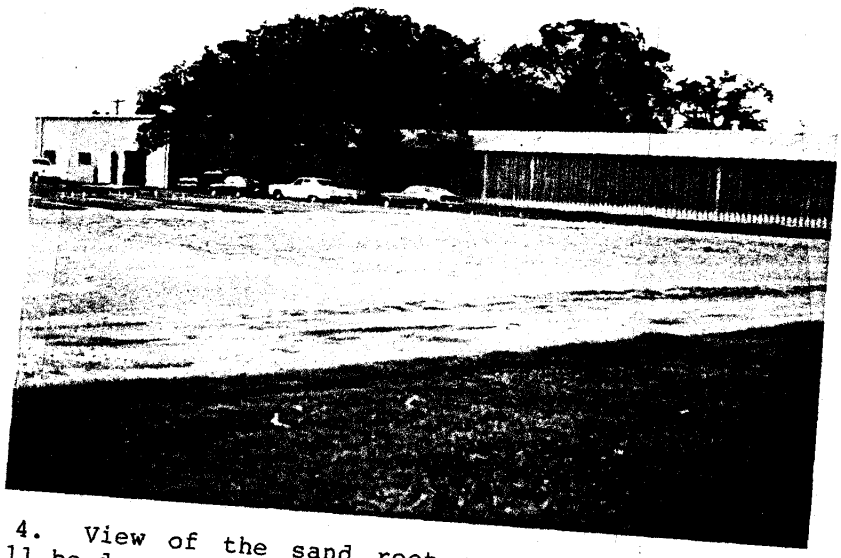


Figure 4. View of the sand root zone just before planting. This area will be devoted to studies concerning the effects of various cultural practices on water use rates.

III. SIX MONTHS STATUS - ANNUAL PLAN OF WORK

A long range plan of work was developed as part of the original project proposal (Figure 5). Subsequently, a flow plan for the first year's research was developed as shown in Figure 6. The flow plan represents an optimum that assumed no breakdowns in equipment; unanticipated loss of turfs due to diseases or insect problems; and a full complement of personnel. Our original goal was to complete a minimum of 70% of the annual plan of work. How much more can be completed is dictated by whether there are any serious difficulties encountered that delay progress of earlier scheduled research.

In summary, the first year's field lab and growth chamber studies are ahead of schedule, whereas the ET rate studies in the simulation chamber of the stress lab are running behind schedule. The delay in the simulation chamber work is due to a longer time than originally projected to repair the electronic control system.

Detailed research objectives for the year were presented in the Annual Plan of Work submitted prior to initiation of the research. The current status of the Annual Plan of Work will constitute the remainder of the presentation in this section.

Figure 5. SCHEDULE OF RESEARCH ACTIVITIES BASED ON THE PROJECTED BUDGET LEVEL

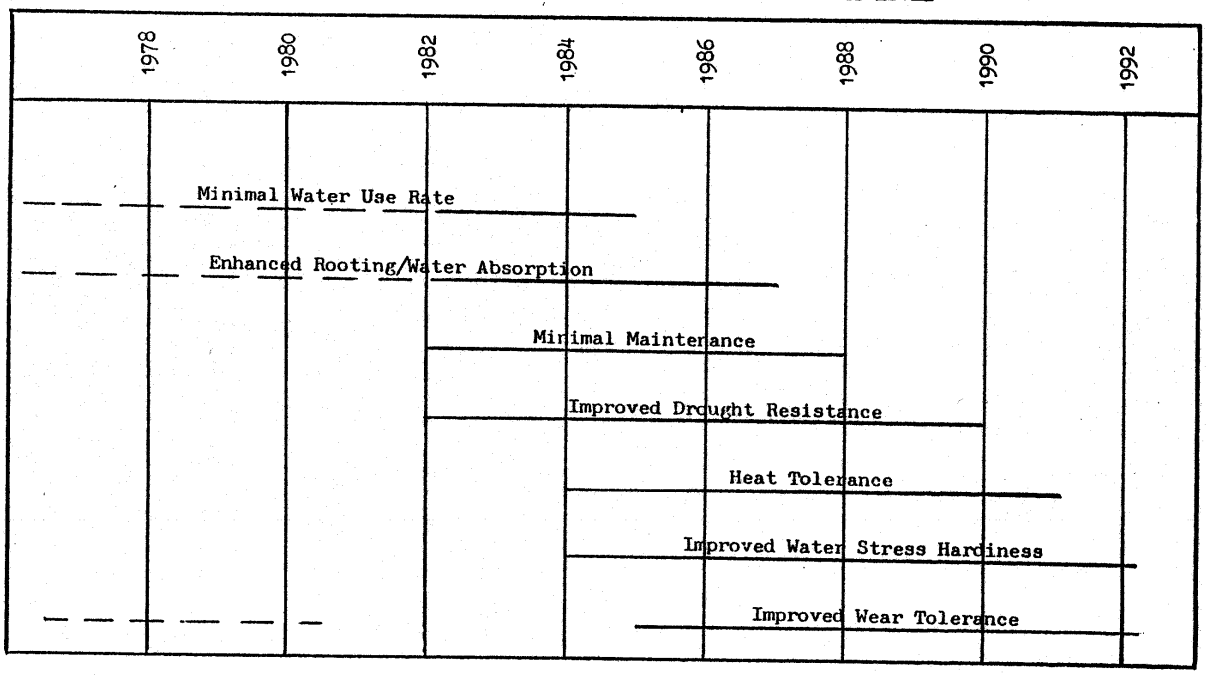
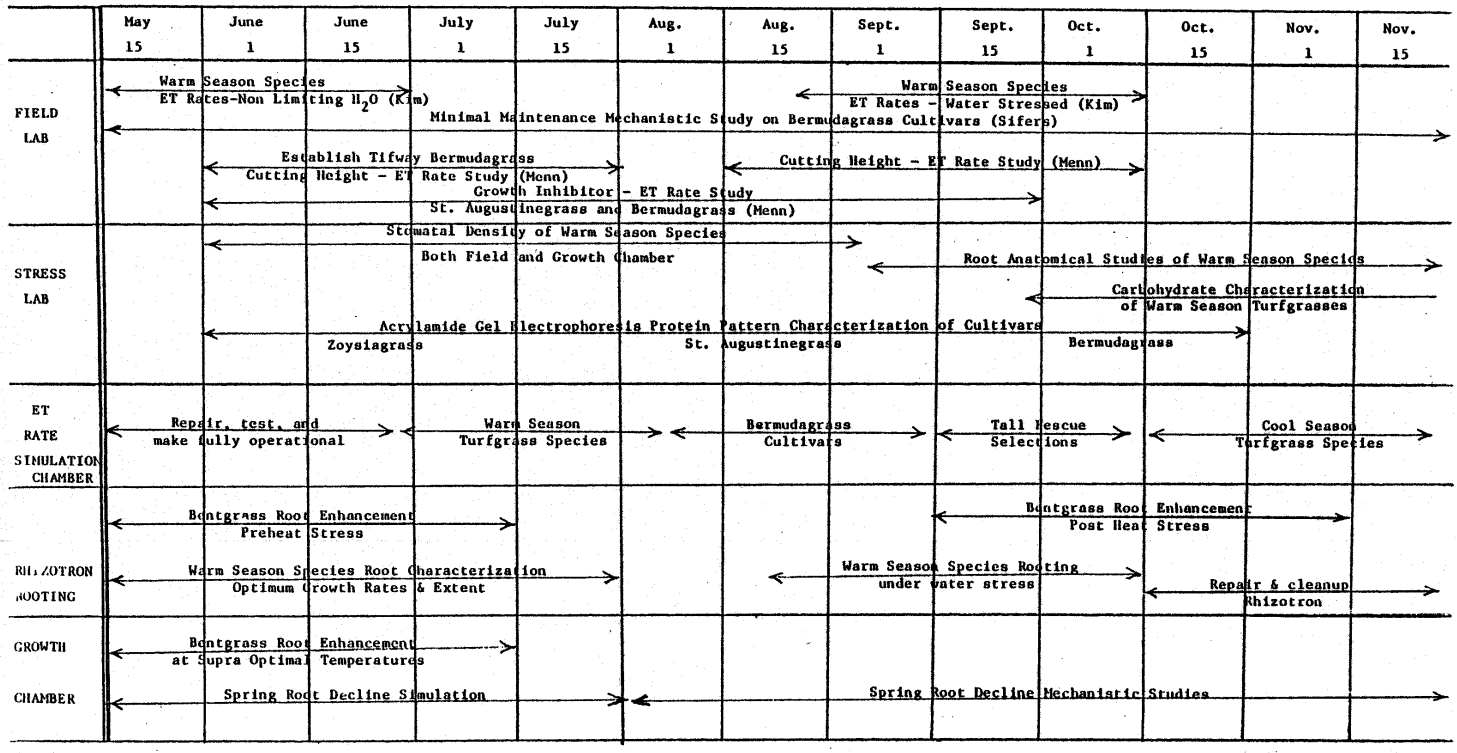


Figure 6.

1983 FLOW PLAN OF USGA GRANT RESEARCH PROJECT
TURFGRASS PROJECT, TAMU, COLLEGE STATION



ANNUAL PLAN OF WORK

A. Objective - Minimal Water Use Rates

1. Determine the comparative water use rates (potential evapotranspiration) of 11 warm season turfgrass species under non-limiting moisture water conditions. First of a two year study. (Species Comparison)

Status - Two full experiments have been completed as part of the first year of this two year study under non-limiting water conditions.

Results - The potential evapotranspiration rates of eleven C-4 warm season turfgrasses and one C-3 cool season turfgrass were evaluated in mini-lysimeters utilizing the water balance method. The turf plots were constructed to insure a natural environment surrounding each mini-lysimeter. Potential evapotranspiration rates of each species were measured under non-limiting soil moisture conditions. The grasses were mowed at a 3.8 cm cutting height and fertilized with 0.25 kg N are^{-1} growing $month^{-1}$.

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

2. Assess the relationships of leaf width, leaf area index, and leaf extension rate to the water use rates of the 11 major warm season turfgrass species. First of a two year study. (Mechanistic and Development of Screening Technique).

Status - The first year encompassing two experiments has been completed.

Results - In conjunction with the study discussed above, the same plant materials were assessed in terms of growth and morphological characteristics that could reduce the water use rate. Good correlations were found between a low water use rate and a (1) slow vertical leaf extension rate, (2) high shoot density, (3) narrow leaf width, and (4) prostrate growth

habit. In contrast, leaf water potental measurements did not correlate with water use rate.

3. Compare the stomatal characteristics and densities among 11 major warm season and 12 major cool season turfgrasses under uniform growth chamber conditions. (Mechanistic Study)

   Status - A preliminary study has been completed on the 11 major warm season turfgrasses. It is planned that a majority of this research objective will be completed during the winter of 1983-84.

   Results - Preliminary results suggest that significant differentials do exist among the warm season turfgrass species at both the interspecies and intraspecies levels, with the latter involving a comparison within the bermudagrasses only.

4. Establish the accuracy with which the water use rate/stress simulation module reproduces representative water use rates observed in the field. (Techniques study)

   Status - Study to be initiated in October, 1983.

5. Assuming the simulation module proves representative, determine the comparative water use rates of 12 cool season turfgrass species. First of a two year study. (Species comparison)

   Status - Scheduled to be conducted during the winter of 1983-84.

6. Determine the potential of leaf growth inhibitors in water conservation. Two year study. (Mechanistic and Cultural Studies)

   Status - A greenhouse study with St. Augustinegrass has been completed and two field studies with Texas Common St. Augustinegrass and Tifway bermudagrass are just now in the process of being completed. The two growth inhibitors being assessed are flurprimidol and mefluidide.

   Results - Experiments under both greenhouse and field conditions confirmed the hypothesis that growth inhibitors have potential as a cultural technique to achieve water conservation. The reduction in water use rates has been in the order of 15 to 35%, depending on the specific environmental conditions and the inherent shoot

growth rate of the turfgrass species involved. This is based on the assumption that the growth regulator being used is effective without phytotoxicity or adverse morphological effects on leaf and stem development. It should be emphasized that the use of growth inhibitors in water conservation is a strategy that has potential for use under irrigated conditions. This does not imply that it is equally of value under periodic water stress or severe drought conditions.

7. Compare the influence of cutting height and nitrogen rate on the water use rates of 11 major warm season turfgrasses. First of a three year study. (Improved cultural systems)

   Status - First year of a three year study completed. The initial phase involved field assessments using mini-lysimeters.

   Results - Preliminary results reveal that the water use rate increases as the mowing height and/or nitrogen level are raised. The combined cutting height - nitrogen level regime that produced the most rapid leaf growth rate, also was associated with the highest water use rates, regardless of the species involved.

B. OBJECTIVE-ENHANCED ROOTING/WATER ABSORPTION

1. Characterize the root systems of 11 warm season turfgrass species under non-limiting and water stressed conditions. First of a two year study. (Species comparisons)

   Status - The initial characterization of the root systems of 11 warm season turfgrass species which have been growing in the rhizotron for two years is approximately 50% completed. It is anticipated that this first phase of investigations should be finished sometime in October.

   Results - Preliminary results reveal substantial differences among warm season species at the interspecies level under non-limiting moisture conditions. There is variability in depth, diameter, branching, and rate of root extension. Details of potential variability of root hair (including length, density, and longevity of life span) are yet to be determined.

2. Assess the maximum genetic potentials in root growth rate of 11 major warm season turfgrass species. (Mechanistic study)

   Status - This investigation is scheduled to be initiated in early October. Dr. Dave Casnoff is now in the process of a literature survey concerning appropriate techniques to use in assessing the genetic potential of these grasses from the rooting standpoint.

3. Investigate the relationship of rooting to water use rate under water stress conditions. Preliminary. (Mechanistic study)

   Status - This investigation is scheduled to be initiated in the Spring of 1984 under field conditions.

4. Conduct exploratory studies of root enhancing agents. (Mechanistic and Cultural studies)

   Status - Investigations were conducted in both the field and rhizotron, as well as in a controlled environment growth chamber under heat stress conditions. The Penncross creeping bentgrass was maintained at a 1.8 cm cutting height. Preliminary results indicated a positive potential for several organic materials. There have been difficulties in establishing the proper heat stress levels in the growth chamber. This experiment is

scheduled to be repeated starting in October of 1983.

C. Objective - Improved Drought Resistance

1. Characterize the morphological, anatomical and physiological responses of 11 major warm season turfgrass species that develope during onset and progression of water stress. First of three year study. (Mechanistic study).

Status - An initial study has been completed on 11 major warm season turfgrass species. More detailed investigations are scheduled for the 1984 growing season utilizing the recently completed rainout shelter.

Results - The water use rates of the 11 major warm season turfgrass species decreased in direct proportion to the degree of soil water stress. The relative rankings among the 11 species in terms of their evaportranspiration rates did not show large relative changes between the optimum moisture versus water stress regimes, with one exception. In the case of bahiagrass, it had a very high evapotranspiration rate under nonlimiting moisture conditions, but exhibited a very low evapotranspiration rate under progressive water stress. This suggests that adaptive mechanisms exist in bahiagrass that may be of great significance in the study of water conservation and drought resistance. It is hoped that this avenue of inquiry can be pursued in the near future.

SUMMARY OF THE C-4 WARM TURFGRASS UTILIZED IN STUDIES A - 1, 2, 3, and 7; B-1, 2, and 3; and C-1

Turfgrass Species		
Common Name	Scientific Name	Cultivar
Bahiagrass	Paspalum notatum	Argentene*
Bermudagrass	Cynodon dactylon	Arizona Common*
Bermudagrass	Cynodon dactylon x C. transvaalensis	Tifgreen
Bermudagrass	Cynodon dactylon x C. transvaalensis	Tifway
Blue Grama	Bouteloua gracilis	Common*
Buffalograss	Buchloe dactyloides	Common*
Centipedegrass	Eremochloa ophiuroides	Common*
Sand Knotgrass	Paspalum vaginatum	Adalayd
St. Augustinegrass	Stenotaphrum secundatum	Texas Common
Zoysiagrass	Z. japonica x Z. tenuifolia	Emerald
Zoysiagrass	Zoysia japonica	Meyer

*Seeded

IV. BUDGET STATUS

The Texas A&M Research Foundation has set up a group of sub-classifications of expenditures which allows us to keep a more detailed record of cost centers. The classifications are summarized as follows:

Stress Lab 4893 - 1
On Campus Payroll
Maint./Repair - Res. Equipment
Supplies - Research
Equipment - Purchase
Other Expenses
Domestic Travel

Turfgrass Plots 4893 - 2
On Campus Payroll
Maint/Repair - Res. Equipment
Supplies - Research
Equipment Rental

The receipt of invoices and final billings of a number of items can be delayed by as much as thirty days. Thus, we cannot give a firm figure as to the current level of expenditures. However, based on our available records, it appears that 55% of the annual grant of $72,800 has been expended. Concerning a comparison of the actual expenditures in the budgeted categories relative to the original projected amounts, it is too early to assess the accuracy of the original budget. The first year's report, the 12-month interval, should allow us to make a reliable assessment of expenditures by category in relation to the original budget. Adjustments can then be made in the second year's budget at that time.

V. PUBLICITY

During the last year considerable effort has been devoted to speaking at Turfgrass Conferences and to writing technical and popular articles concerning the TAES water conservation research sponsored by the USGA. Hopefully these efforts will assist in the fund raising activities of Mr. Don Spencer. It also should give national recognition to the USGA and to the Texas Agricultural Experiment Station for their efforts in solving the water shortage problems facing the turfgrass industry in the upcoming decades.

A. Talks Presented

Dr. J. B. Beard had the opportunity to present talks on the subject of water conservation and the research being conducted at Texas A&M University under sponsorship of the USGA at two national turfgrass conferences and four regional/state turfgrass conferences during the past year.

National Conferences

Breeding for Water Conservation and Low Maintenance Cultivars - International Turfgrass Conference of GCSAA, Atlanta, Georgia, February, 1983.

Identifying Future Turf Needs As Related to Water - Annual Mid-Winter Conference, The American Sod Producers Association, San Antonio, Texas, February, 1983.

Regional and State Conferences

Maximizing Rooting of Grasses, Florida Turfgrass Conference, Tampa, Florida, October, 1982.

Managing Environmental Stresses on the Golf Course, North Central Turfgrass Exposition, Arlington Heights, Illinois, November, 1982.

Watering Effects on Turfgrasses, New Jersey Turfgrass Expo, Atlantic City, New Jersey, November, 1982.

Water and Rooting of Turfgrasses, New Jersey Turfgrass Expo, Atlantic City, New Jersey, December, 1982.

New Horizons in Turfgrass Managment, North Carolina Turfgrass Conference, Pinehurst, North Carolina, January, 1982.

American Society of Agronomy

Comparative ET Rates of Eleven Major Warm Season Turfgrasses Grown Under Uniform and Optimum Cultural Regimes. K.S. Kim and J.B. Beard. ASA Annual Meeting, Washington, D.C., August, 1983.

B. Papers Published

Water Use by Turfgrass. 1983. Proceedings of the 54th International Turfgrass Conference. pp. 161-168.

Identifying Future Turf Needs as Related to Water. 1983. Proceedings of the Annual Mid-Winter Conference, The American Sod Producers Association. pp. 3-4.

Comparative ET Rates of Eleven Major Warm Season Turfgrasses Grown Under Uniform and Optimum Cultural Regimes. 1983. Agronomy Abstracts. p. 127.

C. Symposium

J. B. Beard participated in a two day Water Symposium sponsored by the American Sod Producers Association. Twelve turfgrass researchers assembled from around the USA were invited to present papers and participate in the discussions. J. B. Beard presented a review paper on turfgrass water use rates. Included were an assessment of research techniques, a critique of past research, and a report on current water use rate research being conducted at Texas A&M University.

A 66 page manuscript has been written and will be included as one chapter in a book to be published by the University of California Press.

D. Television

During the first week in June of 1983, an ABC Sports television crew spent a full day at Texas A&M University. They took approximately 54 minutes covering the Turfgrass Stress Lab, Greenhouse, and Field Laboratory facilities. Emphasis was placed on the water-heat stress simulator, rhizotron, and mini-lysimeters with rainout shelter. This material was used for short segments presented on TV during the 1983 US Open.

E. USGA - Don Spencer

Considerable printed and verbal information has been provided to Mr. Don Spencer to assist in his fund raising efforts. He visited the research facilities at Texas A&M University in February of 1983. At that time he was given a fairly detailed overview of the types of the problems and the research facilities and activities that are required to solve these problems. There was a very good interchange and subsequent periodic contacts and inputs were given as requested by Mr. Spencer throughout 1983.