FOURTH

ANNUAL PROGRESS REPORT

concerning

BREEDING AND DEVELOPMENT OF BENTGRASS

submitted by

Dr. M. C. Engelke
Turfgrass Breeder and Geneticist

and

Ms. Virginia G. Lehman
Research Associate, Turf Breeding

Texas Agricultural Experiment Station – Dallas
Texas A & M University System

Jointly Sponsored By:
United States Golf Association
Bentgrass Research, Inc.
and
Texas Agricultural Experiment Station

1 November 1988

VOLUME 88-2B

Index

FOURTH ANNUAL REPORT NOVEMBER 1988

BREEDING AND DEVELOPMENT OF BENTGRASS

		Page No.
Executive Summary		
I.	Introduction	i
II.	Personnel and technical support	1
III.	Implementation	1
	A. Germplasm Acquisition	1
	B. Germplasm Assessment	
	1A. Greenhouse - High soil temperature response	2
	1B. - Characterization of roots	3
	2A. Laboratory - Tissue tolerance - temperature	3
	3A. Field - Agronomic Assessment	4
	1. Sand green assessment	5
	2. Native soil assessment	6
	3. Seaside vs Seaside-RHT	6
	4. Comparison of commercial bents	7
	5. Correlation of root performance in the field and greenhouse	8
	6. Germplasm Introduction Nursery (GPIN)	9
	7. Seed production assessment	9
IV.	Tables 1-4	11-14
V.	APPENDIX	

EXECUTIVE SUMMARY
THIRD SEMIANNUAL PROGRESS REPORT
BREEDING AND DEVELOPMENT OF BENTGRASS

Principle Investigator: Dr. M. C. Engelke

Research Associate: Ms. Virginia G. Lehman

Research Perion of This Report: November 1987 to November 1988

The Bentgrass Breeding program is in its fourth year of operation. Excellent progress continues on the selection and evaluation for superior heat tolerance in both root and leaf tissue. A greater emphasis is being directed to field evaluation trials for seed production characteristics, and for root longevity and distribution. New field facilities were constructed in the spring of 1988 at TAES-Dallas to accommodate field testing for root depth and distribution, and longevity. Initial plantings were completed in May with destructive root sampling occurring throughout the summer to monitor root development. Attention is now directed to comparative studies with the greenhouse root tubes to validate the root tube selection procedure, as well as to examine the rate of root density, depth and distribution over time. Gradual dry down and prolonged induced drought stress will be initiated in 1989 and will aid in identifying those individuals with superior stress tolerance.

All hybridization work is completed in Oregon due to problems with floral initiation under Texas conditions. The Oregon field site is donated by Pick Seed West of Tangent, Oregon, along with a considerable degree of the labor, equipment and facilities. The initial plantings were made in 1985. We have continued to expand the total number of plants and the number of synthetics in production each year. Small quantities of seed were harvested from three synthetics, identified as Syn1-88, Syn3-88, and Syn4-88. Seed from each of the synthetics has been germinated and established as individual plants. Approximately 1500 plants of each of the synthetics will be vernalized in special conditioning chambers at TAES-Dallas, and then transferred to isolated field plantings in Oregon in January/February 1989. This will ensure production, and provide sufficient seed of each of the potential new varieties for entry into the 1989 USDA National Bentgrass Trials.

Cooperative research with Dr. Phil Colbaugh is identifying germplasm within the breeding nurseries which have both Brown Patch and Pythium resistance. Some of these parental lines are included in the present synthetics in Oregon, others will be used extensively in future crossing endeavors during 1989 and beyond.

The excellent cooperation between the United States Golf Association, and Bentgrass Research, Inc. has been instrumental in implementing the procedures necessary for timely development of a new bentgrass for the Golf Industry. Finally, appreciation is extended to Pick Seed West for continued contributions and involvement with the seed production and hybridization program in Oregon. As a worthy closing note, Ms. Virginia Lehman passed her written and oral preliminary exams for the Ph. D. degree on 5 October, 1988 and anticipates completing her dissertation by the summer of 1989.

FOURTH ANNUAL BENTGRASS REPORT 1988

M. C. Engelke and V. G. Lehman

I. INTRODUCTION

The bentgrass breeding program is a research project funded cooperatively by the Texas Agricultural Experiment Station, the United States Golf Association, and Bentgrass Research, Inc. This project was initiated in April 1985. Semiannual reports are submitted 1 May, and annual reports are submitted 1 November each year. This is the fourth annual bentgrass report and summarizes activities for the period of 1 November 1987 to 1 November 1988. This report, in conjunction with the semiannual report of 1 May 1988, constitutes the Fourth Annual Bentgrass Report. The primary objective of the project is to develop heat resistant bentgrasses with improved adaptation to natural environmental extremes.

II. PROFESSIONAL AND TECHNICAL SUPPORT

The bentgrass breeding project has maintained the same personnel, including Virginia Lehman, Research Associate, and Mark McCormack, halftime technician. Additional technical support was provided by Ms. Jeanie Cernosek in funds received through contracts for varietal and chemical evaluation studies. Ms. Cernosek is a 1988 Texas Tech graduate in Horticulture.

III. IMPLEMENTATION

A. GERMPLASM ACQUISITION

INTRODUCTION: Genetic variability is essential for cultivar improvement. Genetic recombination of individual plants with variation in specific characters will result in the accumulation of several characters in one improved variety.

OBJECTIVE: Assemble and characterize bentgrass germplasm.

PROGRESS: The current collection contains 375 unique vegetative accessions, 270 advanced generation selections, and 70 seeded accessions. During 1988, polycross seed lots were developed in Oregon in each of the synthetic blocks. These seed lots have been thrashed, and have been planted in the greenhouse for progeny assessment. Seed of the varieties 'SR1020', 'National', 'Putter', and 'Southshore' have been obtained to include in further testing. Nine additional vegetative clones were collected from golf courses in Florida during October 1988.

FUTURE WORK: The accumulation of germplasm is a continuing process, with the evaluation phase serving to eliminate many of the genotypes, while simultaneously concentrating genes of desirable constitution. It will be necessary in the near future to collect additional plant types from the Southern United States. The need for an extensive collection trip throughout the Southern United States is increasing. Numerous bermudagrass courses which previously overseeded with bentgrass are being renovated. These old greens are a prime source of "adapted" bentgrasses which should be obtained prior to reconstruction, otherwise the advantages of natural selection are lost.

B. GERMPLASM ASSESSMENT

INTRODUCTION: Evaluation of plants is necessary to determine which traits are to be included in selection indices. This characterization, both morphological and physiological is conducted in three arenas: greenhouse, laboratory, and field.

1A. GREENHOUSE - RESPONSE TO HIGH SOIL TEMPERATURES

1. Response of commercial bentgrass cultivars to high soil temperatures.

JUSTIFICATION: Evaluation of the relative heat resistance of the commercially available bentgrass cultivars should provide much needed information regarding cultivar performance in high temperature stress areas, and aid in identification of which cultivars may be suited to such environments.

PROGRESS: This study is being conducted in the circulated hot water greenhouse bench. The first phase was completed and reported in the 1987 semiannual report. A second seeding was completed in December 1987, with projected date of heat treatment of 15 May 1988. Equipment failure resulted in excessive heat accumulation and plant loss. The bench was reseeded, the temperature was elevated to 32.2 C on 3 October, and elevated to 40 C on 10 October. As of this report, all facilities are functioning, and the material is just beginning to show stress (Figure 1).

FUTURE WORK: The heat bench is a practical tool for identification of relative heat tolerance among germplasm lines, and for selection of individual plants with superior root zone heat tolerance. The bench will be used routinely for evaluating advanced generations of our newly developed synthetics, and in heritability studies concerning root heat tolerance in the bentgrasses and other species.

1B. GREENHOUSE - CHARACTERIZATION OF ROOTS

OBJECTIVE: Comparison of root characters of Seaside and Seaside-RHT (Root Heat Tolerant) bentgrass populations.

JUSTIFICATION: A deeper, more extensive root system will allow the bentgrass plant to more efficiently utilize soil moisture lower in the soil profile, allowing the plant to avoid, secondary, heat-induced moisture stress.

PROGRESS: On 25 June, six clones each of Seaside and Seaside RHT, and one standard, were planted in root tubes in the greenhouse. The plantings consisted of cores cut to a 5 cm depth, 3.2 cm in diameter, and placed inside a clear polyethylene sleeve on top of a sand base, with six replications of each accession. This plant material was chosen because a field study was planted simultaneously (see section 3A.5). Depth of longest root was marked every 7 days, with number of roots counted per 10 cm depth, and number of rooted tillers counted. As was determined in previous studies, there were no differences between the populations, however, significant differences did exist between clones (Table 1).

FUTURE WORK: Syn 6-86 is a 10 clone synthetic from which seed was harvested in 1988 by maternal parent. These maternal populations will be used in progeny test to identify heritabilities of rooting characteristics. Seed from each parent will be planted in November 1988 with subsequent evaluations following.

2A. LABORATORY - TISSUE TOLERANCE TO HIGH TEMPERATURES - THERMOSTABILITY

INTRODUCTION: The ability of a plant to survive high temperature stress consists of resistance to either direct or indirect stresses. Cell membranes are the sites of much of the important chemical reactions in plants. Other researchers have been successful in determining the heat tolerance of grasses by subjecting the plant material to high temperature stress and then measuring the electrolyte conductivity (EC) (Wallner, et al., 1982). This procedure is used to determine the severity of membrane destruction as it relates to the release of cell contents. The greater the release of cytoplasm, the higher the EC, and the lower the heat tolerance. Obviously then we are looking for those plants which are able to maintain their structural integrity at higher temperatures.

OBJECTIVE: Determine if selection for root heat tolerance has associated heat tolerance in leaf tissue.

JUSTIFICATION: Selection of plant materials for increased heat tolerance in root systems may contribute genes for heat resistance in an additive fashion to new cultivars.

PROGRESS: This study is in progress. Currently, 13 clones, replicated four times are being subjected to high soil temperatures in a cable heated bench. This planting was subjected to 32.2 C soil temperatures on 3 October, with elevation to approximately 37 C minimum 10 October. Temperatures will be kept elevated for 4 weeks, after which EC will be measured beginning 7 November on both shoot and root tissue.

FUTURE WORK: Evaluating thermal stability through the procedures defined will become tools to aid the breeding program in identifying individual genotypes with superior tissue tolerance to high ambient temperatures, and to further verify the presence of these biological characteristics in newly developed hybrids and synthetics. An additional 30 clones of bentgrass have been planted for further thermostability observations beginning in December, 1988.

3A. FIELD - AGRONOMIC ASSESSMENT

INTRODUCTION: The phenotypic expression (P) of observed plant performance is the product of a plants genetic constitution (G), as it grows in a specific environment (E). Simplified, the mathematical expression is **P = G + E**. As the environment changes, the expression of the plant may also change. Occasionally, however, the performance may not be as predicted based on this simple formula. If deviations occur they may be a result of an interaction between the G and the E, in which case the formula becomes **P = G + E + GxE**. In order to determine if this **GxE** interaction is significant or of value requires extensive testing in many different environments. The purpose of the breeding program is to strengthen the genetic component of the interaction, and to reduce the impact of adverse environment upon expression. This increases the stability of the variety and predictability of performance.

1. **OBJECTIVE:** Identify genotypes with superior agronomic traits on a sand green with management similar to a putting green.

JUSTIFICATION: Evaluation of plant materials on a sand green identifies superior genotypes under a given environment.

PROGRESS: Ninety-six elite clones of bentgrass were established in two replications on a sand green on 24 September 1985, additional clones were added in 1986, for a total of 103 genotypes. During 1987, these clones were subjected to severe stress by verticutting in June (see page 4, semiannual 1988). As reported in the 1987 annual report, mortality of some clones resulted, with noticeably large areas of damage in the green.

Small replicated plot areas were seeded to the commercially available cultivars in the 1982 green in January 1986. During May 1988, 8 cores per plot, 1.7 cm diameter, were removed and used to evaluate agronomic and morphological characters of the commercial varieties. Significant differences existed between cultivars in number of rooted tillers per core, internode length, and leaf blade width (Table 2). Spearman's Rank Correlation indicated that the ranking of tiller number was significantly different from the ranking investigated on survivors from the same varieties planted on the 1987 green (see Semiannual report, 1988, Table 3). This may indicate that exposure to heat treatment eliminates certain morphological types.

On 31 May 1988, the clones were inoculated with Pythium cultures (see Colbaugh, USGA report, annual 1988), with essentially no field disease noted. However, the bentgrass plots were removed from a close-clipping regime to allow more tissue for disease testing. As a result, significant differences were noted in overall plant height and a quality note was taken on 8 July which reflects these differences. Some clones expressed vertical leaf extensions of almost 3.8 cm, while others remained at no greater than 1.3 cm in expression. Quality ratings ranged from a mean high of 8.5 to 1.5, with a negative weighting for leaf extension. The 10 clones previously selected for inclusion into expanded crossing blocks in Oregon were all in the top rating for this date.

FUTURE WORK: This nursery, established in 1985, presently serves as an observation block for gross morphological differences between genotypes, and most importantly as a source of germplasm for cooperative research efforts with Dr. Phil Colbaugh. This field site will be removed for planting of the 1989 National Bentgrass Evaluation Test.

2. **OBJECTIVE:** Identify creeping bent genotypes adapted to native Texas soils and fairway conditions.

JUSTIFICATION: Creeping bentgrass provides a high quality, fine textured turf with the potential for 12 month active growth, since it does not undergo winter dormancy or discoloration in much of the Southern United States.

PROGRESS: Trials were established on native soil (Houston clay series) in May 1986. Considerable data has been accumulated on this planting (see previous reports).

FUTURE WORK: As mentioned in the 1988 semiannual report, this planting must have additional selection pressure applied to distinguish potential types for fairway uses. The tremendous variability in morphological characters such as density, leaf extension, thatch, color, and texture suggest that progress may be made. With present limitations on equipment, labor, and facilities, we have been unable to evaluate genotypic response to traffic conditions. Avenues are presently under investigation to 'excuse the expression': beg, borrow, steal, purchase, or construct a simulation device to aid us in assessing wear and compaction tolerance of bentgrass and zoysiagrass germplasm.

3. **OBJECTIVES:** Determine differences in agronomic performance between Seaside and Seaside RHT under greens conditions.

JUSTIFICATION: Populations A and B of Seaside RHT were selected for heat tolerance with the heat bench in the greenhouse. Turf quality must also be determined on these selections to ensure that we retain high quality as we improve heat tolerance.

PROGRESS: Vegetative propagules of approximately stressed (heat tolerant) and non-stressed selections will aid in identification of agronomic, morphological and biological characteristics associated with heat tolerance. Preliminary comparisons between sets (see section 3A.1.) suggests that the differences do in fact exist. Further observations are necessary prior to drawing any distinctive conclusions.

Dr. Colbaugh has sampled these plots for use in disease screening and assessment and will report those results. An interesting comparison between the plants selected for heat tolerance, and those randomly representing each of the cultivars will reveal the possibility of associated characters. If the heat selected clones prove to be more disease resistant, then heat resistance may also include tolerance to secondary heat induced disease susceptibility.

5. **OBJECTIVES:** Determine the correlation in performance of root growth of bentgrasses in the field (TRIF) and in root tubes.

JUSTIFICATION: The root tube procedure has the capability of screening large numbers of plant materials in rapid fashion, whereas similar field studies are laborious, time consuming and considerably more expensive. By simultaneously examining identical clones growing in both the field and in root tubes, greater assurance may be credited to the root tube procedure.

PROGRESS: Construction of the turfgrass root investigation facility (TRIF) was completed in May 1988 (see Bentgrass Semiannual Report 1988). Three separate plantings of bentgrasses were made on TRIF (Figure 3). The first planting consisted of sod strips of 13 clones of bentgrass, including six Seaside, six Seaside-RHT,and one standard, TAES 2735, placed on 21 May 1988, with a 9" surrounding border. A duplicate set of germplasm, consisting of cup cuts was placed in an adjacent area on 22 May. In addition, 14 clones of the elite bentgrasses (Section 3A.1) were planted, with four replications.

On 13 and 21 September 1988, the Seaside selections were sampled for maximum root extension, root number per 10 cm depth, and tiller number per core (Figure 4). Significant differences existed in all characters (Table 3) between clones, but no differences were present between the populations. Spearman's rank correlation was made between mean root extension from greenhouse root examinations and those obtained on TRIF. With 11 degrees of freedom, the r value was 0.5097, and significance at the 10 % level (p=0.10), indicating the root tubes adequately predicted field performance in 12 of the 13 clones tested.

FUTURE WORK: Additional sampling of TRIF is planned to reduce sampling error in root extension. Correlations need to be made between root and tiller number in the greenhouse and the field. Additional samplings will be made at future dates. In addition, covariate analysis will be performed with other agronomic characters assessed on both root tube and field grown samples.

6. **OBJECTIVE:** Characterize new bentgrass accessions in the Germplasm Introduction Nursery (GPIN).

JUSTIFICATION: The GPIN serves to screen and eliminate the less desirable bentgrass accessions from further, expensive testing.

PROGRESS: Evaluation of this nursery is an ongoing process. The mowing height on this material was lowered to .63 cm during the summer of 1988, with associated topdressing to produce conditions more closely approximating that of a green. Notes have been recorded on quality and will be reported at the conclusion of the study.

FUTURE WORK: Germplasm assessment is a continuing requirement. As plant materials come into the program, they will be added to the GPIN for assessment.

7. **OBJECTIVE:** Determine the floral production characteristics and associated seed production of the elite clones of bentgrass in a commercial seed production area.

JUSTIFICATION: The floral response of bentgrass is photo-thermoperiodically determined. Early screening for floral and seed production will eliminate sterile and nonproductive clones from the breeding program.

PROGRESS: One additional synthetic was added in Oregon in 1987, instead of the two reported in the semiannual report. Syn 1-88 is composed of 9 clones, with various morphological criteria as listed in the semiannual report. Syn 1-88 produced adequate quantities of seed for testing (Table 4), from which progeny tests were initiated in the greenhouse 10

October 1988. Clone 604B produced much less seed than the other eight clones, and may be eliminated from the final synthetic unless seed yield improves in 1989.

Synthetic 4-88, designated orange flag, consisting of 6 elite clones with medium floral maturity, produced 216 grams seed in 1988, from which seeds were planted for progeny tests in the greenhouse on 4 October 1988. Syn. 4-88 consists of the following clones: 1198, 1247, 1252, 2758, 2761, and 2897.

Synthetic 3-88, green flag, which has 6 elite clones with mid-early floral maturity, produced 124 grams seed. Plants were also started from Syn 3-88 for progeny tests on 4 October 1988. Synthetic 3-88 consists of the following clones: 2737, 2739, 2740, 2741, 2743, and 2895.

FUTURE WORK: Approximately 1500 progeny from Syn2-88 and Syn3-88 were established as individual plants on 10 October 1988 in the greenhouse. These seedlings will be transplanted to individual pots and will be vernalized in special chilling chambers at TAES-Dallas until January/February 1989, when they will be moved to Oregon. Pre-vernalization should enable us to obtain an improved seed crop in the year of establishment. Approximately 10-20 pounds of seed will be required for the National Bentgrass Evaluation trials scheduled for the fall of 1989.

LITERATURE CITED

Wallner, S. J., M. R. Becwar, and J. D. Butler. 1982. Measurement of turfgrass heat tolerance in vitro. J. Amer. Soc. Hort. Sci. 107:608-613.

Table 1. Root morphology characters of 13 bentgrass genotypes in greenhouse investigations, summer 1988, Dallas, Tx. Date planted, 25 June 1988.

Clone	Root Extension^	Soil Depth 10cm	20cm	30cm	Tiller
	-cm-	-num-	-num-	-num-	-num-
307A	41.0a*	21.5bcd	11.5 b	7.2bcd	30.8bcd
404A	40.9a	27.5ab	18.0ab	10.3abc	23.3 d
502A	38.0ab	27.0ab	16.0ab	7.8bcd	23.5 d
503A	35.4ab	31.3a	17.2ab	8.7abc	48.5a
505A	35.1ab	21.3bcd	10.8bc	7.2bcd	25.0 cd
703A	42.7a	30.5a	20.8a	13.5a	24.5 cd
107R	36.9ab	28.0ab	15.0ab	6.7b-e	42.5ab
204R	17.0 cd	31.0a	10.7 bc	0.5 f	25.5 cd
2735	19.6 cd	14.5 d	4.2 c	1.5 ef	32.5bcd
304R	23.7 cd	20.7bcd	8.5 bc	2.7def	30.3bcd
401R	15.1 d	18.2 cd	4.1 c	0.1 f	30.2bcd
604R	28.4 bc	30.0a	16.3ab	6.3cde	37.7abc
701R	43.5a	26.0abc	16.3ab	12.2ab	31.8bcd

^Date=18 August 1988, 54 days post transplant.
*Means followed by the same letter are not significantly different using least squares means (p=0.05).

Table 2. Morphological characters of seven commercially available bentgrass varieties maintained under greens mowing height at TAES, Dallas, TX, in May 1988.

Cultivar	Tiller	Leaf blade Width	Internode Length
	-num-	-mm-	-mm
Cobra	17.2abc*	1.1ab	1.16ab
Emerald	19.4ab	1.2a	1.23a
PSU126	18.4abc	1.2a	1.07ab
Penncross	16.8 bc	1.1ab	0.80 c
Penneagle	20.4a	1.0 b	0.99 bc
Prominent	15.0 c	1.1ab	1.12ab
Seaside	15.1 c	1.2a	1.23a

*Means followed by the same letter are not significantly different using least squares means (p=0.05).

Table 3. Tiller number, maximum root extension, and root number per 10 cm depth of 13 bentgrass clones from 2 populations from sod pads, on the sampling date of 21 September 1988.

Clone	Tiller	Root Extension	Soil Depth 10cm	20cm	30cm
	-num-	-mm-	-num-	-num-	-num-
307A	19.0 bc	28.3a*	14.3 de	11.6ab	9.5a
404A	12.9 e	23.9 b	17.6abc	12.4ab	5.8bcd
502A	12.6 e	17.5 ef	14.3 de	8.4cd	0.4ef
503A	16.4c-e	18.0 de	20.6a	13.3a	0.9ef
505A	18.0 bc	20.3b-e	16.4cde	11.9ab	2.1def
703A	14.1 de	23.0 bc	17.1bcd	12.6ab	5.6 cd
107R	19.8 b	20.4b-e	17.3a-d	12.1ab	3.8 de
204R	13.6 e	22.8bcd	18.6abc	12.5ab	8.6abc
2735	26.8a	19.4cde	13.1 e	10.0bcd	1.1 ef
304R	15.5cde	17.8 e	16.1cde	9.9bcd	0.6 ef
401R	19.4 b	13.8 f	13.6 e	6.9 d	0.0 f
604R	17.8bcd	21.1b-e	19.8ab	13.3a	3.1def
701R	19.9 b	20.8b-e	15.3cde	11.0abc	2.3def

*Means followed by the same letter are not significantly different using least square means (p=0.05).

Table 4. Seed yield weights of Syn 1-88, maternal harvest, Tangent, OR, 1988.

Clone	Seed yield
	-g-
1004A	15
1007A	14
604A	37
203A	26
902A	41
706A	28
605B	25
604B	4
606B	55

V. APPENDIX

1. Figure 1. Commercial varieties of bentgrass expressing differential response to heat stress imposed under controlled conditions in a greenhouse.

2. Figure 2a. Differential stress response of Penncross (center) and clones of Seaside and Seaside-RHT selected for heat tolerance (top and bottom).

3. Figure 2b. Graphic map of stress areas identified in Figure 2a above.

4. Figure 3. The turfgrass root investigation facility (TRIF) was planted to three separate bentgrass studies in summer, 1988.

5. Figure 4a. Sampling selections of bentgrass from TRIF for determination of rooting characteristics.

6. Figure 4b. Gentle mist washing of TRIF cores removes sand to enable distinction of root characters.

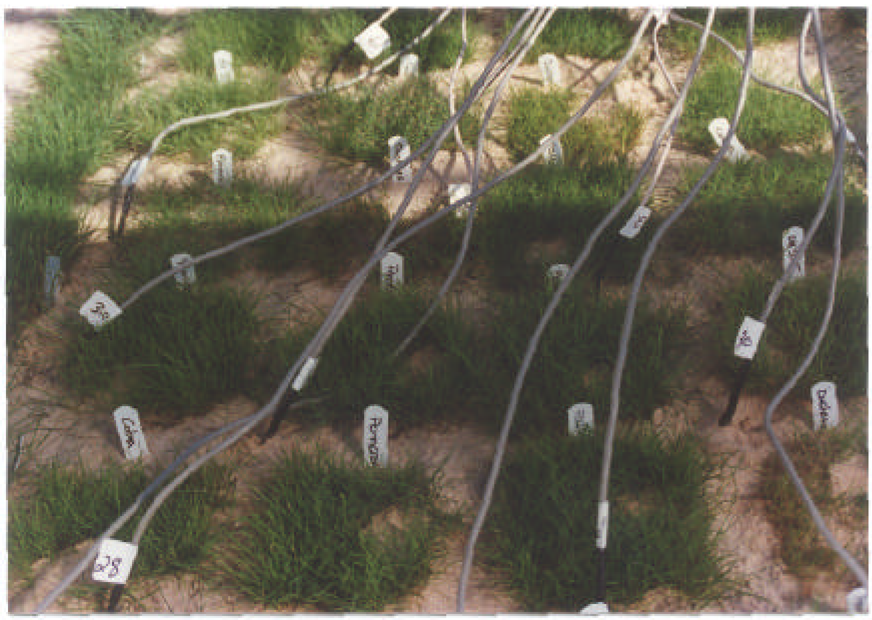

Figure 1. Commercial varieties of bentgrass expressing differential response to heat stress imposed under controlled conditions in a greenhouse.

Figure 2a. Differential stress response of Penncross (center) and clones of Seaside and Seaside-RHT selected for heat tolerance (top and bottom).

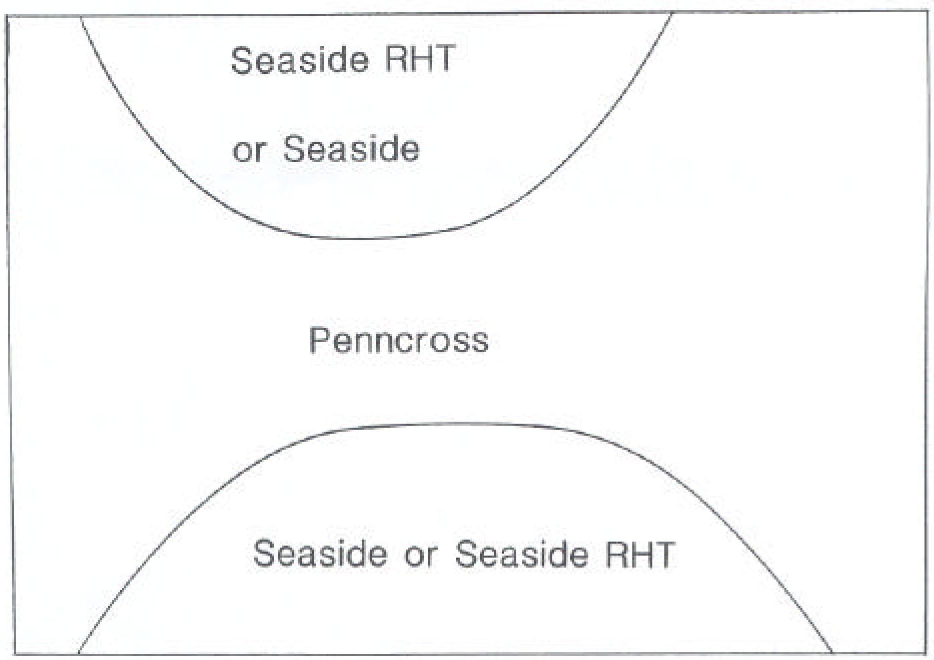

Figure 2b. Graphic map of stress areas identified in Figure 2a above.

Figure 3. The turfgrass root investigation facility (TRIF) was planted to three separate bentgrass studies in summer, 1988.

Figure 4a. Sampling selections of bentgrass from TRIF for determination of rooting characteristics.

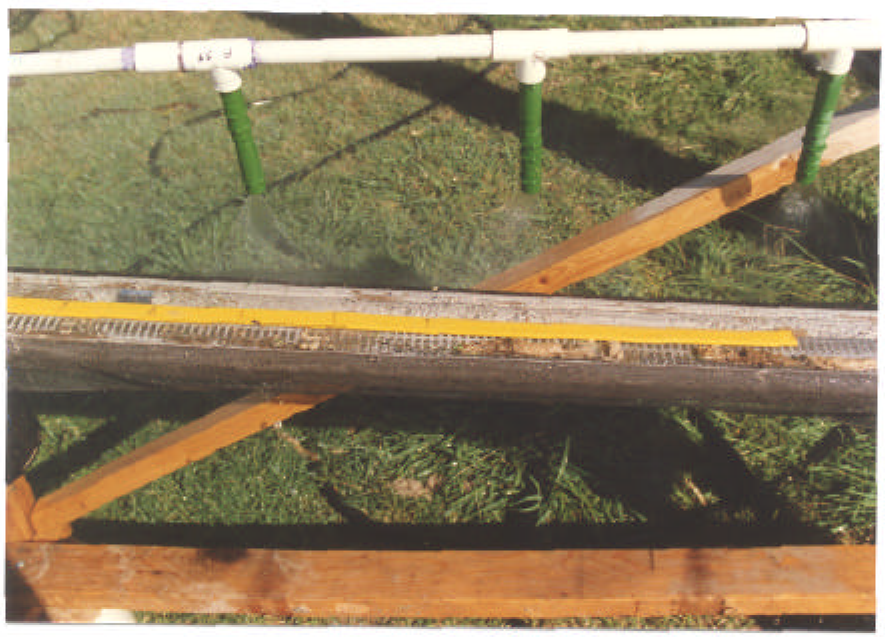

Figure 4b. Gentle mist washing of TRIF cores removes sand to enable distinction of root characters.

TAES

TEXAS A&M UNIVERSITY
RESEARCH AND EXTENSION CENTER AT DALLAS
The Texas Agricultural Experiment Station

17360 Coit Road Dallas, Texas 75252-6599 PHONE (214) 231-5362

October 28, 1988

Mr. Bill Bengeyfield
National Director
USGA Green Section Chairman,
Box 3375
Tustin, CA 92681

Dear Bill:

The 1988 Annual reports for both the Bentgrass and the Zoysiagrass Breeding programs are being transmitted to you with this letter. We have had a good year all things considered and look forward to making even greater progress to our primary goal of developing and releasing new turfgrass varieties. I am quite appreciative of the decision made by your committee concerning support for regional testing of these new varieties.

As always, we are appreciative of the support from the United States Golf Association, Golf Course Superintendents Association of America, and Bentgrass Grass Research Inc. for your continued support.

Sincerely,

M. C. Engelke
Associate Professor
Turfgrass Breeding and Genetics

enc.
cc:
Dr. Neville P. Clarke, Director
Texas Agricultural Experiment Station
Dr. James A. Reinert, Resident Director, TAES-Dallas
Ms. Joanne Treat, President, Texas A&M Research Foundation
USGA/GCSAA Research Committee
Bentgrass Research, Inc. Executive Committee (Bent)
Ms. Virginia Lehman, Research Associate (Bent)
Ms. Melinda R. Quick, Research Assistant (Zoysia)
Dr. Phil Colbaugh, Turf Pathologist
Dr. James B. Beard, Turf Physiologist
Dr. Garald L. Horst, Turf Physiologist