USGA PROGRESS REPORT - FALL 1990

Breeding, Evaluation and Culture of Buffalograss for Golf Course Turf

Terrance P. Riordan
Associate Professor of Turfgrass Breeding

Leonard A. Wit
Supervisor, JSA Turfgrass Faciltiy

Support Staff:

Susan A. de Shazer
Research Assistant

Kyoung Nam Kin
Graduate Student

Ronald W. Moore
Graduate Student

Jeffery P. Klingenberg
Graduate Student

Samuel D. Royes
Graduate Student

Katherine A. Kerner
Graduate Student

Cooperators:

F. P. Baxendale
Assistant Professor of Entomology

R.N. Stougaard
Assistant Professor of Agronomy

C. C. Hawley
Nuckolls County Extension Agent

J.E. Watkins
Professor of Plant Pathology

EXECUTIVE SUMMARY

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS FOR GOLF COURSE TURF

PLANT PATENT UPDATE: Plant Patents and crop registrations are still being prepared for NE 84-609, NE 84-315 and NE 85-378. These three selections will be included n the National Buffalograss Evaluation Trial next year. It is possible that two other selections will also be included.

NE 84-609 COMMERCIALIZATION: The NE 84-609 planting made May 14, 1990, established successfully with no problems. David Doguet hopes to have 100+ acres of 609 by next summer; however, this will not be enough sod to meet the present demand. An additional one acre foundation planting was made in Florida in September. A small amount of 609 will be planted on the new Barton Creek Golf Course.

COMMERCIALIZATION - SEEDED BUFFALOGRASS: Native Turf Development Group harvested seed from plantings made this summer. Three to five of the synthetics will be included in the National Buffalograss Evaluation Trial.

BUFFALOGRASS SEEDED SELECTION: The 1991 Nursery will have approximately 3,000 individual seedlings originating from Dr. Garald Horst's salt selection research. The seed will be established in the greenhouse and planted to the field in 1991. The seed was collected from buffalograss genotypes shown to withstand severe drought conditions. This nursery will serve as a population from which improved selections will be made for advanced testing.

BUFFALOGRASS TISSUE CULTURE: Utilizing buffalograss var. NE 84-609, research has been completed on the callus initiation phase. The most important conclusions that have been found from this research include:

1) An extremely low concentration level (2.5 μm) of the auxin Dicamba can be used to initiate and maintain callus.
2) Differences in callus morphologies are seen when a minimum of 150 milligrams of callus is induced from the nodal segment.

BUFFALOGRASS HYBRIDIZATION METHODS: The hand pollination method was superior to the field and shaker methods in making buffalograss crosses. The temperature priming treatment is better than scarification for enhancing germination. Matching flowering dates for crossing was found possible by staggering the dates when male and female clones were brought into the greenhouse.

EXECUTIVE SUMMARY

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS FOR GOLF COURSE TURF

DEVELOPMENT OF TURF-TYPE SEEDED BUFFALOGRASS WITH IMPROVED DROUGHT RESISTANCE: The goal of this project is to evaluate a buffalograss breeding system using selection techniques based on parental performance, and realized heritability estimates. The components being studied are drought resistance and improved turf quality. The aim of the breeding program is to develop a dioecious synthetic mating system. The project includes three areas of extensive evaluation. They include: components of root performance, water use efficiency, and components of parental turf quality and seed production. Performance of parent and progeny material in each area will determine final selection criteria for the initial synthetic generation of an advanced population of buffalograss.

VEGETATIVE ESTABLISHMENT - FERTILIZER EVALUATION: Treatments of the inorganic nitrogen carrier gave significantly higher mean values for stolon number per plug and stolon length per plug compared to the organic carrier in the greenhouse study. Results from the same study duplicated in the field indicated no significant differences between the organic and inorganic treatments. A possible reason for the field results could be the previous cropping systems used in the area prior to this study. Soils in the area were analyzed and were shown to have a high soil fertility level.

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS FOR GOLF COURSE TURF

I. BUFFALOGRASS PROPAGATION

A. BUFFALOGRASS VEGETATIVE CULTIVAR SELECTION

1. **1990 Evaluation Nursery** - Selections collected in Texas were vegetatively planted in this nursery to provide a new population for continued buffalograss breeding. These genotypes are segregates of 'Texoka' and were selected for their ability to withstand severe drought conditions yet maintain acceptable turfgrass quality.

2. **1990 Male Nursery** - Outstanding male buffalograss genotypes were selected and vegetatively increased. The male selections exhibited outstanding turfgrass characteristics and variation.

B. BUFFALOGRASS SEEDED SELECTION

1. **1991 Nursery** - Approximately 3,000 individual seedlings evaluated in Garald Horst's salt selection research will be established in the greenhouse and planted to the field in 1991. The seed was collected from buffalograss genotypes shown to withstand severe drought conditions. This nursery will serve as a population from which improved selections will be made for advanced testing.

C. BUFFALOGRASS TISSUE CULTURE

In the Spring 1990 progress summary on buffalograss tissue culture, it was reported that work was being carried out in the first of three interdependent phases. These are: 1) callus initiation; 2) callus maintenance and proliferation; and 3) regeneration from callus. Utilizing buffalograss var. NE 84-609, research has been completed on the callus initiation phase. The most important conclusions that have been found from this research include:

1) An extremely low concentration level (2.5 μm) of the auxin Dicamba can be used to initiate and maintain callus.

2) Differences in callus morphologies are seen when a minimum of 150 milligrams of callus is induced from the nodal segment.

The one type of calli that has been identified has a white, compact structure which when induced at a low concentration could be highly amenable to embryogenesis. Future research will include: identification of other genotypes that can induce white, compact calli, and the finding of a suitable regeneration media. Long-term plans will be to obtain high frequency regeneration of quality, somatic embryos (artificial seeds) via a cell suspension culture system. The cell suspension culture technique has the capability of producing millions of active cells that can be induced to form somatic embryos. This method will be necessary to meet the demands of producing an all female seeded buffalograss.

II. BUFFALOGRASS PLANT BREEDING

A. BUFFALOGRASS BREEDING TECHNIQUES

1. Hybridization Methods

A plant breeding program must identify superior parents through evaluation of their progeny, and then allow these parents to cross so their desirable traits may combine. Obtaining progeny from a single female clone can be done by simply harvesting burs from this clone. Evaluating a male parent however, requires that burs be harvested from plants which are known to be pollinated by that particular male clone. This study evaluates three methods of producing progeny where both the male and female parents are known. Progeny produced in such a way could then be evaluated to determine the breeding value or general combining ability of both the male and female parents, as well as the specific combining abilities of each pair.

Research Objective: Evaluate three hybridization methods for their ability to produce progeny of a specific cross between a single male clone and a single female clone.

The three hybridization methods being evaluated are:

1. Field Method
2. Shaker Method
3. Hand Pollination Method

Field Method

1989 Field - The field crosses were established at the John Seaton Anderson research facility near Mead, Nebraska in late May of 1989. Six male and ten female clones were used in field crosses. Six crossing blocks were located in an area which contained no buffalograss prior to the crossing block establishment. Each of the six blocks contained one male clone, unique to that block, and all ten of the female clones, common to all blocks. The blocks were isolated from each other by a minimum distance of 50 meters. The male clone was established in the middle of the block and the ten female plots were positioned in a circular pattern around the male. In July of 1989, small plugs of the male clone were planted around the outside of the blocks. Plants were irrigated during the establishment period.

The first harvest was in October of 1989. The plots were mowed with a rotary mower with the clippings collected. Each plot was vacuumed using a 10 gallon vacuum. The vacuum contents and clippings were then cleaned using screens and a small blower.

To reduce the dormancy of the buffalograss burs they were stored for 2 months at 4° C. The burs were then scarified by grinding between two bricks. Following scarification the burs were placed on moist blotter paper in a germination chamber for germination. The temperature was a constant 28° C. Seedlings that emerged were transferred to potting flats in the greenhouse in February of 1990 and then planted to field evaluation plots.

1990 Field - The plots established in 1989 were also harvested in 1990. Winter damage was severe on several plots, particularly 84-502 , 84-512, and 84-609. No attempt was made to replant these because winter kill is one of the hazards of the field crossing method and should be reflected in the data. No irrigation was provided except natural precipitation to the plots in 1990. Harvesting was done using the same procedure, but in July instead of October.

A new cold temperature procedure for breaking dormancy was used for 1990. The cold storage treatment procedure allowed moisture to be taken up by the bur which removes the germination inhibiting factors. This method has shown great success in previous trials and should provide optimum germination conditions without the labor intensive hand scarification process.

Field Results - Bur production for both years and germination percentages for 1989 were recorded for the field plots. The experimental design for bur production was a randomized complete block design, using the males as blocks. Analysis was done using MSTAT statistical package. The F value for significance of the females was 4.93 (PR < .0001). Germination data is only observational because females were not replicated within males (Table 1, page 3).

Table 1: 1989-1990 Field Bur Production and Germination Percentages

Female	1989 Bur Production	1990 Bur Production	1989 Germ Percent[1]
NE 84-63	394.5 a[2]	519.2 a	2.8
NE 84-502	392.2 a	33.0 cd	0.3
NE 84-104	318.3 ab	91.3 bcd	0.1
NE 84-409	226.0 b	112.2 bcd	0.1
NE 84-512	207.8 bc	44.2 cd	0.1
NE 84-609	204.2 bc	10.7 d	0.1
NE 84-315	202.7 bc	245.7 b	0.1
NE 84-904	75.7 cd	195.8 bc	0.1
NE 84-903	62.3 d	168.2 bcd	0.9
NE 84-25-2	31.8 d	51.3 cd	0.0

[1] Germination of the 1990 burs has not been completed at this time.
[2] Duncan's Multiple Range Testing ranking. Values with the same letter are not significantly different from each other at the 5% probability level.

Shaker Method

The shaker apparatus is a machine which mechanically shakes the male plants promoting pollen to drop onto the female plants. Four male and four female clones were crossed in 1989. In 1990 only three males and three females were used on the shaker. The male and female plants were brought into the greenhouse on April 20 in 1989 and on March 15 in 1990. Plant material is taken from the field as a 10 cm plug. These plugs were potted in 1 liter pots. The females were placed into cells on the shaker apparatus. The male plants were then placed above the females on the moving portion of the machine. Muslin cloth surrounded each cell to prevent pollen movement between cells. The shaker was connected to a series of clocks set on a 30 minute cycle. The cycle ran from 9:00 AM to 1:00 PM. The machine vibrated for 5 minutes, causing the pollen to drop from the males onto the females, and then a 25 minute rest cycle allows pollen to build up.

Burs were harvested by hand on July 11 1989 and June 20 1990. Caryopsis were excised from the burs by hand for the 1989 burs. In 1990 the cold treatment procedure was used. Germination data for 1990 is not available at this time.

Shaker Results - The one liter pots did not produce a sufficient number of male flowers for effective pollination. Production of female flowers was not consistent between pots. Average bur production over all pots was not consistent over years. A method of maintaining the buffalograss plugs in a better physiological state is needed to use the shaker apparatus effectively.

Hand Pollination Method

On March 30 1989 four male and four female clones were brought into the greenhouse. On April 20, and May 4 more plugs from the same female were also brought in. Plant material was collected as 20 cm plugs and potted into 8 liter pots. The plants were placed into four separate greenhouses. Each greenhouse contained one male and all four females. A 17.5 cm electric fan was used to promote pollen movement. Burs were harvested by hand and the caryopsis were excised from the burs by hand.

In 1990 the procedure for the greenhouse crosses was modified. The plants were collected on March 15 and April 1. Plants were placed into separate greenhouses again, but instead of using a fan for pollen movement, the pollen was collected from the males each day and hand applied to the females using a paintbrush. All pollinated flowers were tagged with the date on which the cross was made. Burs were then harvested according to the week in which the cross had been made. Burs which had not been hand pollinated were also harvested as a check. Burs are being cold treated at this time.

Hand Pollination Results - Germination percentage for 1989 crosses was less than two percent for all combinations of males and females. The results from pollination done by hand in 1990 to improve the germination percentages is not available at this time.

2. Buffalograss Time of Flowering Evaluation

Observations of buffalograss in the field have shown that as a species buffalograss flowers continuously from May to October. Individual plants flower at different times during this period. In order to cross two plants the plant breeder must be able to manipulate them into flowering at the same time.

Research Objective - Observe the flowering of male and female buffalograss plants over time.

Five plants of four male clones and eight plants of four female clones were brought into the greenhouse on March 15, 1990. Eight plants of the same four female clones were also brought in on April 1. The male plants were observed daily for pollen production. The male inflorescence were tapped lightly, the number which visibly shed pollen were recorded for each plant. The female flowering was recorded on a weekly basis. A female inflorescence was considered receptive to pollen if the stigmas were purple in color.

Results - Two of the males produced very few inflorescence. Flowering of the other two males and all four females is shown on Table 1, page 6. The male inflorescence normally shed pollen on one or two days, the female stigmas remain purple for three weeks when they remain unpollinated. The female plants which were brought in on April 1 exhibited a trend of flowering two weeks later than the same clone brought in on March 15. This would indicate that a plant breeder could match male and female flowering dates by varying the date plants are brought into the greenhouse. More research could be done varying male plants, and varying both male and female plants over longer time periods.

Table 1. Number of female and male flowers per pot[1].

Plant	4-18	4-25	5-2	5-9	5-16	5-23	5-30	6-6	6-13
104A[2a]									
25A	1.4	9.0	17.8	18.8	15.4	8.4	2.3	2.1	1.1
409A		4.2	13.8	18.3	13.3	5.3	4.7	8.2	10.6
609A			1.0	4.9	5.4	6.4	5.4	3.8	1.8
Male1[3]	2.0	7.4	3.8	7.2	7.0	5.8	6.0	4.0	3.8
Male2[4]	15.8	48	15.6	3.6	2.6	1.8	2.2	1.2	
104B[2b]					5.4	13.4	24.4	25.5	26.4
25B			.4	5.0	9.9	11.3	5.8	4.8	1.5
409B			.1	4.0	8.5	12.9	15.9	17.8	13.1
609B						.1	1.4	4.4	6.9

[1] Female flowers were recorded weekly. Male flowers were recorded daily.
[2a] Female plants brought into the greenhouse on March 15.
[2b] Female plants brought into the greenhouse on April 1.
[3] Male 1 is a progeny of female 84-104.
[4] Male 2 is a progeny of female 84-25-2.

3. Development of Turf-Type Seeded Buffalograss with Improved Drought Resistance

The goal of this project is to evaluate a buffalograss breeding system using selection techniques based on parental performance, and realized heritability estimates. The components being studied are drought resistance and improved turf quality. The aim of the breeding program is to develop a dioecious synthetic mating system. The project includes three areas of extensive evaluation. They include: components of root performance, water use efficiency, and components of parental turf quality and seed production. Performance of parent and progeny material in each area will determine final selection criteria for the initial synthetic generation of an advanced population of buffalograss.

The following information summarizes work completed or is in progress for the year 1990. All experiments will be repeated during 1991 to accumulate at least two years' data, and the addition of progeny testing which will allow for maternal half-sib analysis procedures.

a. Greenhouse Slant-Tube Root Observation Study Among 119 Buffalograss Genotypes
b. 1990 Buffalograss Crossing Block of Genotypes Selected for Root Performance
c. Buffalograss Water Use Efficiency Field Study
d. Advanced Turfgrass Evaluation Among 100 Buffalograss Genotypes
e. Field Spike Density Production Among Five Selected Buffalograss Males

a. Greenhouse Slant-Tube Root Observation Study Among 119 Buffalograss Genotypes

One hundred nineteen buffalograss genotypes were evaluated for root initiation, penetration, growth consistency, and weight performance using a slant-tube root observation system. This initial test was used to screen the population to a manageable size for field study and future testing of progeny performance. Preliminary conclusions from the initial test completed during the first week of February 1990 were as follows:

1. The slant-tube root observation system provided an efficient means of quantifying rooting performance under optimal conditions.

2. Significant differences were found among genotypes for all characters measured.

3. Although a significant linear trend ($P < 0.01$) was found for root penetration over time for the population, there were nonsignificant correlations in intermittent (seven day) root penetrations within genotypes (Table 1, page 8). Results of intermittent root fluctuations within genotypes indicated undetected random effects and/or significant genotypic response in seven-day root performance under these conditions. Therefore, additional testing of this material is necessary to assess the usefulness of the technique.

Table 1. Simple correlation coefficients among characters measured in the January 1990 greenhouse slant-tube root observation study.

Character	TRL	TRN	SC	FW	DW	L1	L2	L3	L4
Total Rt. Length (TRL)	-	-	-	-	-	-	-	-	-
Total Rt. Number (TRN)	*	-	-	-	-	-	-	-	-
Shoot Count (SC)	*	**	-	-	-	-	-	-	-
Fresh Weight (FW)	**	**	**	-	-	-	-	-	-
Dry Weight (DW)	**	**	**	**	-	-	-	-	-
Rt. Length Week 1 (L1)	**	NS	NS	*	*	-	-	-	-
Rt. Length Week 2 (L2)	**	*	*	**	**	**	-	-	-
Rt. Length Week 3 (L3)	**	NS	NS	*	**	**	NS	-	-
Rt. Length Week 4 (L4)	*	NS	NS	*	NS	NS	NS	NS	-

*, ** = significant correlations at ($P < 0.05$) and ($P < 0.01$), respectively
NS = nonsignificant correlation

Due to low or non-correlations among some of the characters, values were assigned to each character in an attempt to apply phenotypic rooting performance to genotypic worth. Selection indices were established among genotypes for the following characters: total root length, shoot counts, dry weight, and the four intermittent root lengths. The process provided a single value for a genotype which represented its overall performance in the rooting test. Truncated selection was then made by selecting the top 30% of the population for continuance of the program. Further selection in this advanced group will be based on individual and progeny performance from additional experiments. Repeated measures using the slant-tube rooting technique on the selected genotypes will begin November 15, 1990.

b. 1990 Buffalograss Crossing Block of Genotypes Selected for Root Performance

In June of 1990, 41 buffalograss genotypes were established in isolation plots at Mead, Nebraska using pre-rooted plugs. Thirty-five of the clones were selections from the slant-tube root experiment and the added six clones represent the full range of performance from that test.

The experimental design was a randomized block with four replications of each female clone. The block consisted of 36 females and five males. The five male clones were composited in equal amounts for each male plot to ensure equal and random pollination at all points of the crossing block. Future work includes testing of female genotypes for highest seed yield and performance. The best female clones will be test crossed to the separated male genotypes in isolation.

The block was set up in an 8:2 female to male ratio with all plots managed as separate units. Plot size was approximately 1.5 m^2. Male plots were arranged down the middle of each replication bordered by three females on each side. Plot areas had complete coverage by the end of August 1990. In addition, there was enough significant, observable male flower and mature female burr production to warrant harvest procedures four months after planting.

Harvest of buffalograss burrs was accomplished by first mowing at 1.3 cm and then using an industrial shop vacuum to harvest remaining burrs on the soil surface and burrs lodged in the turf verdure. Both mowed and vacuumed material was sifted before bagging and storing. Harvest yield estimates will be made on a total plot basis and all seed obtained will be kept separate for future testing. Currently, all plots have been harvested and material awaits final cleaning procedures before being placed into cold storage. Progeny testing will begin around March, 1991.

c. Buffalograss Water Use Efficiency Field Study

Forty-one genotypes selected from the slant-tube rooting experiment were evaluated for water use (evapotranspiration [ET]) efficiency in 8-liter mini-lysimeter pots with fritted clay medium during the summer of 1990. Thirty-five of the genotypes were the top root performers from the initial slant-tube experiment with the additional six genotypes representing the full range of performance from the experiment. A randomized block design of three replications totaling 123 lysimeter observations was installed in an established area of Texoka buffalograss. The proposed number of lysimeter runs during the summer was two per month, for a total of eight runs. However, due to 1990 summer weather conditions, only four lysimeter runs were completed. Each run consisted of 25, 48 and 72 hour weighings after saturation. Estimated actual ET in grams water loss is reported in mm of water loss per lysimeter. Significant differences ($P<0.01$) in water loss were found among genotypes for three of the four lysimeter runs (Table 1, page 9).

Table 1. Mean totals, ranges, mean separations, expected mean squares, and coefficients of variations for the four buffalograss lysimeter runs during the summer of 1990 at Mead, NE.

	H_2O Loss/Lysimeter (mm)				
Date	$\bar{x}$ Total	Range	LSD⁺	EMS	CV
7/3 - 7/5	13.23	9.51 - 15.70	1.73	.035**	8.05
7/16 - 7/18	11.41	7.31 - 17.10	1.33	.024**	7.17
8/7 - 8/9	8.37	7.20 - 10.00	0.54	.008**	3.94
8/28 - 8/30	9.98	7.35 - 11.52	2.86	.045 NS	17.67

$^{+}$ LSD (0.05)
** Genotypic variance is highly significant at 0.01 level of probability

Water use rates among clones varied from 13.0% to 68.6% for the four runs indicating genotype by environment interaction. However, 20 genotypes with lower water use rates remained consistent for all four runs. Therefore, the varied degrees of water use may be attributed to the populations reaction to external weather conditions justifying the need for additional measurements per season.

Although no correlations of this test and the slant-tube rooting experiment have been made the results of this summer's buffalograss ET data indicate potential to select for lower water-using accessions of buffalograss.

d. Advanced Turfgrass Evaluation Among 100 Buffalograss Genotypes

Components of turfgrass quality have been measured in a continuing program among 100 buffalograss genotypes located at Mead, Nebraska. The advanced evaluation site was established with 50 clones in 1986 and another 50 clones in 1987. The experimental design was a randomized complete block with four replications, and genotypes were analyzed as categorical independent variables. Numerous data have been recorded and analyzed for the past three years. This information will be used to characterize the population on a clone by clone comparison for turf performance and to assist in selection procedures within the population.

Characters measured during the 1990 growing season are listed below:

Color	Internode Length
Quality	Visible Stolons Above Turf
Density	Burr Height
Plant Height	Stress (Leaf Firing) Rating
Shoot Density	Dormancy Rating
Clipping Weight	Spectroradiometry

Principal component analysis procedures were applied to all variables measured in an attempt to partition those traits which best contribute to variance of the population with regard to overall turf performance (Table 1, page 11). Principal component one (PrC1) which comprises 43.46% of the variation in turf quality is significantly affected by five of the six variables. PrC2, which accounts for 25.97% of the variation in turf quality, indicates that visible stolons above the turf surface have a significant negative correlation to turf quality.

Table 1. Results of principal components (PrCn) analysis for six characters on turf quality measured among 100 genotypes, May through August 1990. Data were analyzed from a correlation matrix.

Character	PrC1	PrC2	PrC3
Color	-.46*	.62**	-.01 ns
Density	-.77**	.32*	.02 ns
Internode length	.74**	.07 ns	-.09 ns
Floating stolon	-.14 ns	-.82**	.62**
Plant ht.	.80**	.29 ns	.43**
Clipping wt.	.75**	.55**	.44**
Percent variance	43.46	25.97	12.13
Cumulative	43.46	69.43	81.56

* ,** Correlations significant and highly significant at ($P<0.05$) and ($P<0.01$), respectively.
ns = Non-significant correlations.

Comparing turf quality data with the first three of the six possible principal components indicates that PrC1 and PrC2 have significance (Table 2, page 11). Therefore, since PrC1 was significantly affected by five of the six variables and the sixth (floating stolon) explains another 25.97% of the variation, it was concluded that measurements on all these variables were necessary in estimating differences in turf quality among these genotypes. This information is essential in a selection program because it reveals those characters of greatest importance to turf performance. In turn, a breeder can save valuable time by not measuring characters which have minimal effect on improvement of turfgrass aesthetics and growth parameters.

Table 2. Correlation of principal components and turfgrass quality.

Components	Correlation	Probability
PrC1	-.707	.001
PrC2	.322	.020
PrC3	.038	.795

e. Field Spike Density Production Among Five Selected Buffalograss Males

Five males from a selected group of 35 buffalograss genotypes were evaluated for spike density production during the summer of 1990 at Mead, Nebraska. The purpose was to test the uniformity of flower production for "nick" purposes in field crossing blocks. The five genotypes were the best male performers in the slant-tube rooting experiment, and are to be tested for combining ability with all females under top cross conditions. The clones were replicated three times in a male nursery and analyzed as a completely randomized design. Five spike counts were taken throughout the growing season. Criteria for counting at each date included flowers that were emerging from the leaf sheath, pre-anthesis and /or post-anthesis. Post- anthesis flowers were not counted if glumes were completely desiccated. Floral production after the month of August dropped significantly for all genotypes with no significant differences among genotypes (Table 1, page 12).

Table 1. Mean separations by Duncan's multiple range test for spike production among five selected male genotypes for the summer of 1990 at Mead, NE.

	Date				
Genotype	7/11	7/23	7/30	8/10	8/28
3-9-73	23.0 BC	34.0 B	64.3 C	128.0 C	225.0 C
3-8-82	21.3 AB	60.0 A	96.0 A	180.3 AB	350.3 A
1-8-33	17.7 C	25.7 B	42.0 D	100.7 C	274.0 B
3-10-59	34.7 A	84.3 A	114.7 A	191.3 A	365.3 A
2-7-78	30.7 AB	81.3 A	116.3 B	188.0 B	305.3 B
LSD (0.05)	7.38	13.40	15.69	35.69	31.64

Although significant differences among clones were found for flower production over five dates, all clones increased steadily over time in live floral production (Table 1, page 12). Information from this test indicated that one clone will not have a significant competitive edge under open pollinated conditions and that the competitive edge lies in the male randomization process, pollen viability, compatibility and field management.

III. VEGETATIVE ESTABLISHMENT

A. FERTILIZER EVALUATION

1. Fertilizer Source on the Establishment of Buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.)

Increasing demands for more environmentally compatible turf care products have lead to investigations of their effectiveness. Scott's Starter Fertilizer (17-26-3) is an inorganic nitrogen carrier and Ringer Re-Start (5-10-3) is an organic nitrogen carrier. The fertilizers were compared in greenhouse and field studies to determine which performed more effectively in establishing buffalograss. The objectives of these studies were:

1) Determine the treatment effect on the establishment of buffalograss.
2) Evaluate the effect of the application rate.
3) Evaluate the effect of the nitrogen carrier type.

Study 1A and Study 1B were performed in the greenhouse. Each study used 132 cm^3 plugs of buffalograss variety NE 84-609. These prerooted plugs were planted in 3.78 L. pots containing a mixture of 85% sand and 15% Sharpsburg silty clay loam. There were 56 pots for each study. The treatments were Ringer Re-Start or Scott's Starter Fertilizer applied at the rate of 0. 2.4, 4.9 and 9.8 g N m^{-2}. The treatments were topdressed and there was one treatment per pot. Study 1B had a second treatment was applied at 6 weeks after the start of the study. Study 2 was similar to Study 1A except it was performed in the field. Studies 1A and 1B used CRD and there were 8 reps. Study 2 also had 8 reps and was RCBD.

Study 1A and 1B measurements included stolon number per plug, stolon length per plug and tiller number per plug. Color, percent cover and quality were measured using a visual scale of 1 - 9, 9 being the best. Study 2 measurements included stolon number per plug. The same visual characteristics as those in Studies 1A and 1B were measured.

Implication that a second application of fertilizer increases stolon number and stolon length on a rate by rate basis was noted (Table 1, page 14). Treatments of the inorganic nitrogen carrier gave significantly higher mean values for stolon number per plug and stolon length per plug (Table 1, page 14). There were no significant differences among treatments in Study 2 (Table 2, page 14). The field area where the study was performed had been cropped for several previous seasons before planting of this study. Soils in this area have been analyzed and are shown to have a high soil fertility level. These two factors perhaps account for the lack of treatment effect. In a situation were the soil fertility was low and/or the soil had a high sand content different results may be obtained.

Table 1. A comparison of Study 1A and 1B treatment means for stolon number and average stolon length.

FERTILIZER TREATMENT	STUDY 1A STOLON #	STUDY 1B STOLON #	STUDY 1A AVERAGE LENGTH	STUDY 1B AVERAGE LENGTH
SCOTT'S 9.8 g N m^{-2}	6.8a	10.5 a	39.7 a	45.2 a
SCOTT'S 4.9 g N m^{-2}	4.0 c	6.9 b	33.6 b	36.9 c
SCOTT'S 2.4 g N m^{-2}	1.6 d	3.1 d	24.3 c	32.1 d
RINGER 9.8 g N/m^{-2}	5.2 b	7.0 b	35.7 b	41.5 b
RINGER 4.9 g N m^{-2}	1.3 de	4.7 c	26.9 c	33.4 d
RINGER 2.4 g N/m^{-2}	0.7 e	3.1 d	11.1 d	27.1 e
CONTROL	0.2 f	0.8 e	7.3 e	16.3 f

Means with the same letter are not significantly different from each other. Means within columns are separated by Duncan's multiple range test, 5% probability.

Table 2. A comparison of average stolon number per plug in Study 2.

FERTILIZER TREATMENT	STOLO N #/PLUG
SCOTT'S STARTER 9.8 g N m^{-2}	9.5 a
SCOTT'S STARTER 4.9 g N m^{-2}	9.6 a
SCOTT'S STARTER 2.4 g N/m^{-2}	9.4 a
RINGER RE-START 9.8 g N/m^{-2}	9.3 a
RINGER RE-START 4.9 g N/m^{-2}	9.6 a
RINGER RE-START 2.4 g N/m^{-2}	9.0 a
CONTROL	9.0 a

Means separated by Duncan's multiple range test, 5% probability.
Means with the same letter are not significantly different.

IV. CULTURAL PRACTICES

A. ADVANCED TURFGRASS EVALUATION

1. **1990 Advanced Progeny Evaluation** - Ninety-eight offspring turf-type genotypes were selected from two existing progeny nurseries used in previous studies (Buffalograss Female/Male Sex Ratio study and Synthetic progeny nursery) and vegetatively propagated to a randomized complete block study with three replications. This study will be maintained under varying mowing heights and frequencies and fertilizer treatments. Evaluation of the genotypes for turf characteristics will be monitored and compared to female parent performance.

2. **1990 Advanced Parent Evaluation** - Ninety-eight turf-type genotypes were selected from collection nurseries. This material was vegetatively propagated from parent material to a randomized complete block study with three replications. Study will be evaluated under varying mowing heights and frequencies and fertilizer treatments. Turf characteristics will be evaluated throughout the study.

3. **National Buffalograss Study** - The National Turfgrass Evaluation Program (NTEP) has established a national study designed to evaluate advanced buffalograss selections throughout the United States. The University of Nebraska will serve as the coordinating center. Plant material will be received by the university, vegetatively increased if necessary then distributed to the individual testing sites. To date approximately 20 selections have been submitted to the study. Total number of test sites is not known as of yet, however, many institutions have shown interest in participation.

V. COMMERCIALIZATION OF IMPROVED BUFFALOGRASS

A. PLANT PATENT UPDATE

Plant Patents and crop registrations are still being prepared for NE 84-609, NE 84-315 and NE 85-378. It is critical that the patent of 609 be finished soon and the others shortly thereafter. It is planned that the final write-ups will be completed by the end of the year. These three selections will be included in the National Buffalograss Evaluation Trial next year. It is possible that two other selections will be included also.

B. NE 84-609 COMMERCIALIZATION

The NE 84-609 planting made May 14, 1990, established successfully with no problems. The planting, made with pre-rooted plugs set on three foot centers, covered by September 1. This planting was harvested by a conventional sod harvester and the sod was used to plant an additional twenty-two acres. This later planting is doing well, and the original planting will be able to be re-harvested early next year. David Doguet hopes to have 100+ acres of 609 by next summer; however, this will not be enough sod to meet the present demand. An additional one acre foundation planting was made in Florida in September. This planting, using plugs harvested with the Cushman GA 30, will provide material for evaluating buffalograss plug production. A small amount of 609 will be planted on the new Barton Creek Golf Course. This will be the first commercial use of 609.

C. OTHER VEGETATIVE CULTIVAR COMMERCIALIZATION

As soon as plant patents are filed and cultivars are released by the University of Nebraska, there will be an announcement of availability and a request for marketing proposals. There is significant interest in these other cultivars both in the North and the South.

D. COMMERCIALIZATION - SEEDED BUFFALOGRASS

1. Native Turf Development Group (NTDG) - The first harvest of their plantings was made this summer. This seed will be used for the next generation of synthetic seed production and for testing. Three to five of the synthetics will be included in the National Test. Bob Ahring, their consultant, is modifying the male plants in their synthetics, but he is very encouraged by the seed production yields (up to 1300 lbs/acre).

2. Sharps Bros - The initial plantings were made in August and the first harvest will be made next year.

3. Other Cooperators - The University has placed a hold on other ventures at this time. This is a political decision, but they would like to see the initial producers be successful. One possible exception to the hold is a Nebraska producer who the University would like to see involved either with NTDG, Sharps or by themselves. However, other than some questionable advertisements, the University believes they have excellent cooperators.

VI. PRESENTATIONS

A. POSTERS

Kerner, K.A., T.P. Riordan and G. Horst. Evaluation of Fertilizer Source on Rate of Buffalograss Establishment. American Society of Agronomy. October 1990.

Moore, R.W., P.E. Read and T.P. Riordan. Effect of Plant Growth Regulators on the Callus Initiation of the Youngest Stolon Segment of Buchloe dactyloides, (Nutt.) Engelm. Var. NE 84-609. American Society of Agronomy. October 1990.

Riordan, T.P., J.P. Klingenberg and B.E. Johnson. Heritability of Drought Avoidance Mechanisms in Turf-Type Seeded Buffalograss. American Society of Agronomy. October 1990.

Moore, R.W., P.E. Read and T.P. Riordan. Effect of 2,4-D Level and Nodal Position on the Callus Initiation of Nodal Segments of Buchloe dactyloides, Engelm. (Nutt.) Var. NE 84-609. American Society of Horticulture Science. November 1990.

B. PAPERS

Klingenberg, J.P., T.P. Riordan and B.E. Johnson. Slant-Tube Root Screening Technique for Selection Among 119 Buffalograss Genotypes. American Society of Agronomy. October 1990.

Royes, S.D., T.P. Riordan. Buffalograss Hybridization Techniques. American Society of Agronomy. October 1990.

C. PRESENTATIONS

Riordan, T.P., North California Golf Association/U.S. Golf Association Conference, "New Grasses for the Year 2000".

Riordan, T.P., Horticulture Expo Trade Show Seminars, Sioux Falls, SD., "Drought Lawn Care".

Riordan, T.P., NCGA/USGA Green Section Regional Conference, "New Grasses for the Year 2000".

Riordan, T.P., Seed Research of Oregon Annual Meeting, "Buffalograss".

Riordan, T.P., Crenshaw-Doguet Turfgrass Field Day, "Development of New USGA Turf-Type Buffalograss".

Riordan, T.P., Channel 6, "Buffalograss" - April 1990.