BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS FOR GOLF COURSE TURF

RESEARCH SUMMARY - FALL 1994

Executive Summary

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS FOR GOLF COURSE TURF

STATUS OF VEGETATIVE RELEASES

Sales of '609' are expected to meet Crenshaw & Doguet projections of $1.5 million for 1994. Sales are still predominately from their original farm at Bastrop, Texas. Three new farms in Bay City, Poteet, and outside of Dallas, will bring total production in Texas to over 400 acres. A royalty check of over $40,000 was received from sales of '609', for the first half of 1994. Performance of '609' has been excellent. The '609' planted in the rough at the Boulders Golf Course in Lake Acworth, GA seems to be doing well. This course was rated the top new golf course in Georgia in 1994.

Approximately $60,000 of '378' plugs were sold by Todd Valley Farms Inc., Mead, NE and $10,000 of '315' plugs were sold by Oak Point Sod, Nickerson, NE during 1994.

STATUS OF SEEDED VARIETIES

Native Turf Group will have seed available from two new varieties in 1995. Poor weather and adjustments in planting procedures have resulted in delays in obtaining their first commercial harvest. Sharps Bros. provided seed from six experimentals for our 1994 Evaluation Trial, each a potential new variety.

BREEDING WORK

During 1994, the project focused on improving tolerance to wear and low mowing, insect resistance, and seedling vigor. To evaluate low mowing tolerance, the mowing height of the 1990 evaluation trial was lowered to 5/8 inch in 1993. Significant differences in turf quality were found among entries, indicating that some genotypes were able to better tolerate low mowing. The top ten entries, four male and six female, were selected from this trial and established in a polycross in May 1994 to allow for recombination and the development of a buffalograss variety for fairway use.

In order to develop a seeded cultivar with improved seedling vigor, divergent phenotypic recurrent selection for caryopsis size is being performed with two synthetic populations. Larger caryopsis size has been shown to increase seedling vigor in buffalograss. For each population, three isolated crossing blocks were established with plants derived from either large, small, or unselected caryopses. Burs were harvested from individual maternal plants in each block in early October 1994. For each maternal parent, weight per 100 caryopses will be recorded. Realized heritability estimates will be calculated for selection for large and small caryopsis size.

Traffic treatments were applied to two evaluation trials with a traffic simulator. Treatments were applied to half of each plot from June-August 1993. Significant differences were found among selections in their traffic tolerance; '315' and a number of experimentals were among the top performers. For some cultivars, the difference between trafficked and untrafficked halves was minimal. In a trial containing 2000 plants, severe traffic pressure was applied May-July 1994. At the end of treatments, the 81 most traffic-tolerant plants were selected for further evaluation.

Results from the 1993 trial indicate that two of the synthetic populations developed by J. Klingenberg, 90-503 and 90-504, are performing well. It is hoped that one of these will soon be released as a seeded cultivar. Nine vegetative selections were increased in 1994 for possible commercialization. The three with the most potential appear to be 86-61, 91-118, and 86-120.

A new replicated evaluation trial, consisting of 48 entries, was also planted in 1994 and a total of 132 new selections were made from our nurseries, native stands or old turfs.

BUFFALOGRASS MANAGEMENT STUDIES

Weed pressure continues to be a major problem during buffalograss establishment. Research was initiated in 1994 to investigate registered and unregistered herbicides for use during seeded buffalograss establishment at two locations in Nebraska and one in Kansas. Plots treated with herbicides of the imidazolinone family (Pursuit, Cadre) showed significantly higher establishment rates than plots treated with other tested herbicides. Additionally, herbicides currently registered for use on established buffalograss (i.e. Dimension, Ronstar G, Surflan and Dacthal) severely retarded seeded establishment. Pursuit and Image are also being evaluated in a replicated trial on a Crenshaw & Doguet sod farm.

Sod strength of 22 entries in the National Buffalograss Trial were evaluated at two locations using an S-beam load cell connected to a digital read-out. Prairie and '609' exhibited superior sod strength, while seeded and diploid entries exhibited unacceptable sod strengths. Root regrowth was also measured on National Trial entries and '609' had superior root regrowth. Transplant shock was evaluated for '315' and '378'. '378' exhibited superior recovery characteristics over '315', and sod replanted immediately recovered quicker than sod replanted at 48 hours after harvest. Three antitranspirants tested had no effect on sod recovery.

BUFFALOGRASS INSECT AND DISEASE RESEARCH

When a highly significant positive correlation was found between amount of pubescence and susceptibility to mealybugs ($r=0.78$), scanning electron microscopy was used to investigate this possible mechanism of resistance. Results suggest that pubescence may provide a framework for the waxy ovisac and a foothold for the mobile first instar. Work is also being done on inheritance of mealybug resistance and developing a seeded, resistant cultivar. Seed has been harvested from a crossing block containing mealybug resistant plants, and seedlings from this crossing block are currently being evaluated for resistance.

A study was conducted to develop an effective, non-destructive way to monitor mealybug populations on buffalograss plants. Adhesive-covered "sticky stakes" were placed in pots of mealybug-infested buffalograss to determine if the stakes would trap mealybugs. Large numbers of mealybugs were captured on the sticky stakes indicating that they can be used to detect mealybugs. Work is underway on the biology and life cycle of these mealybug pests and to determine the role several parasitic wasp species play in reducing mealybug population levels.

Two studies were conducted to evaluate control of buffalograss chinch bugs using *Beauvaria bassiana* and entomopathogenic nematodes, and combinations of insecticidal soap and reduced rates of conventional insecticides.

Severe dollar spot disease occurred on several of our trials and fertility level is being investigated for its effect on disease incidence.

STUDENT PROGRESS

Three new students have been recruited to work on graduate programs. Kevin Frank will work on buffalograss management starting in January; Tiffany Heng will work on buffalograss insects starting in June; and Fei Shui Zhang initiated a Ph.D. project on tissue culture of buffalograss in September. Charles Rodgers is making good progress on his Ph.D. project studying buffalograss seed vigor and establishment. Jennifer Johnson-Cicalese will return to graduate student status on January 1, and complete her Ph.D. on resistance to mealybugs in May 1995. Matt Giese will complete his M.S. on sod characteristics in May 1995.

USGA PROGRESS REPORT - FALL 1994

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A USGA/GCSAA/University of Nebraska Research Project Initiated February, 1993

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS FOR GOLF COURSE TURF

STATUS OF VEGETATIVE RELEASES

'609' Sales are expected to meet Crenshaw & Doguet projections of $1.5 million for 1994. Sales are still predominately from their original farm at Bastrop, Texas. However, production is also on line in Bay City and Poteet, TX. They are also planting a new farm outside of Dallas, TX. These new farms will bring total production in Texas to over 400 acres. Efforts continue to be made in increasing production and sales in California, Missouri, Oklahoma, Arizona and Colorado. A royalty check of over $40,000 was received from national sales of '609', for the first half of 1994.

Performance of '609' has been excellent, but not perfect. The dry summer of 1993 and a tough winter in Texas damaged other species more than the stress tolerant buffalograss. The wet spring and summer in 1994 and lack of herbicide knowledge resulted in a heavy weed population in some buffalograss lawns. Management education with this new species is still an important priority. The Boulders Golf Course in Lake Acworth, Georgia was visited twice. '609' buffalograss seems to be doing well in the rough. Some areas are weak, but this is probably due to poor soil conditions or overseeding competition. This course was rated the top new golf course in Georgia in 1994.

'378' Approximately $60,000 of '378' plugs were sold by Todd Valley Farms Inc., Mead, NE during 1994. This northern-adapted buffalograss has performed well in most sites. In 1995, sod will be available in addition to plugs. This sod farm will be the host for the 1995 Turfgrass Producers International (previously known as ASPA) Summer Field Day.

'315' Approximately $10,000 of '315' plugs were sold by Oak Point Sod, Nickerson, NE during 1994. This northern-adapted buffalograss is performing well.

STATUS OF SEEDED VARIETIES

Native Turf Group (NTG) will have seed available from two new varieties in 1995. Poor weather and adjustments in planting procedures have resulted in delays in obtaining their first commercial harvest. To date, varieties have not been named.

Sharps Bros. provided seed from six experimentals for our 1994 Evaluation Trial. These experimentals are each a potential new variety. It is assumed that sufficient seed will not be available until 1996.

LICENSING AGREEMENTS

The following licenses are currently in effect:

1.	'609'	Proprietary license to grow, market, and sublicense '609' - Crenshaw & Doguet
2.	Vegetative Buffalograss	Proprietary license to grow and market all vegetatively-propagated buffalograsses from our program - Crenshaw & Doguet
3.	Seeded Buffalograss	Proprietary license to produce seed from a select group of experimentals - NTG
4.	Seeded Buffalograss	Proprietary license to produce seed from a select group of experimentals - Sharps Brothers
5.	'315'	Proprietary license to grow and market '315' in Nebraska - Oak Point Sod
6.	'378'	Proprietary license to grow and market '378' in Nebraska - Todd Valley Farms
7.	'315'	Proprietary license to grow, market, and sublicense '315' - Crenshaw & Doguet

NTG would like to have an agreement to produce and market all seeded buffalograsses developed in the future. It is very unlikely that this will be granted.

NATIONAL BUFFALOGRASS TRIAL

The first National Buffalograss Trial was planted in June 1991 at 39 locations throughout the United States. The trial included eleven vegetative and eleven seeded experimentals and/or standards. The seeded plots were planted using plugs of seedlings started in the greenhouse. A randomized complete block design was used, with three replications. This data provides useful information on adaptation and performance of buffalograss throughout the United States.

In Nebraska, the trial was maintained at a moderate level for buffalograss. It received two applications of .5 lbs N/1000 sq.ft. and a preemergent herbicide application, was mowed biweekly at two inches, and received no supplemental irrigation. During 1993, the trial was affected by a wet summer and some water damage. Several buffalograss genotypes, especially those with southern origin, had some winter damage. The data demonstrate that northern-selected genotypes had better winter survival, spring greenup, and percent cover than southern material (Table 1.) This can be seen in genotypes such as '378' (northern) and '609' (southern).

Quality was rated throughout the 1993 growing season. The effect of winter damage also shows up in this data, especially in the early part of the year. The yearly average shows that '378', AZ 143, '315', NE 84-436, and NTDG 2 performed well. These cultivars did well throughout the growing season, while '609' performed well only in the fall.

The color averages show that several experimental buffalograsses have color superior to standards, such as Texoka and Sharp's Improved buffalograsses. '609', Bam 202 (Topgun), '378', AZ 143 and NTDG 2 had an excellent dark green color for the entire growing season.

Fall dormancy ratings suggest that the more northern-adapted buffalograsses go dormant earlier than the southern-adapted types. This is demonstrated by the new cultivars, 'Prairie' and '609', which are still actively growing in October. However, cold hardiness is sacrificed by this late season growth in a warm season turfgrass. Present data suggest that these cultivars do not have sufficient cold hardiness to be used in Nebraska.

In 1994, this test was used for Matt Giese's sod harvest study. This study was evaluated for the entire 1994 growing season and will be terminated during 1995.

Table 1. Performance of buffalograss cultivars and selections during 1993 in the National Buffalograss Trial established May 29, 1991 at Mead, NE.

Cultivar	Spring greenup[1]	Quality[2]					%Cover	Color[3]			Dormancy[4]
	5/14	6/25	7/28	9/2	9/29	Ave.	7/15	7/28	9/29	Ave.	10/14
378	6.7	7.7	6.7	7.3	7.0	7.2	93.3	6.3	5.3	5.8	3.3
AZ143	6.0	6.0	7.0	6.7	7.0	6.7	100.0	5.7	6.0	5.8	5.0
315	6.7	8.3	6.0	5.7	6.7	6.7	93.3	6.0	4.7	5.3	2.7
NE84-436	6.0	6.7	7.0	6.3	6.3	6.6	100.0	5.3	4.7	5.0	3.7
NTDG2	6.0	6.3	5.7	6.0	6.0	6.0	100.0	6.0	5.7	5.8	4.3
NE84-45-3	7.0	6.0	5.7	5.7	6.0	5.8	90.0	6.0	5.0	5.5	2.3
609	2.3	3.3	6.3	7.0	6.3	5.8	43.3	7.3	6.3	6.8	6.7
NTDG3	5.3	6.0	5.3	5.7	6.0	5.8	96.7	5.0	5.7	5.3	4.0
NTDG5	6.0	6.3	5.0	5.7	6.0	5.8	93.3	5.3	5.3	5.3	4.0
NTDG1	5.3	6.0	5.7	5.3	5.7	5.7	96.7	5.7	5.7	5.7	4.0
NTDG4	5.0	5.7	5.3	5.3	5.7	5.5	86.7	5.3	5.7	5.5	4.0
BAM101	5.7	6.0	5.0	5.3	5.3	5.4	100.0	5.0	5.7	5.3	4.3
Texoka	5.3	5.3	5.0	5.0	6.0	5.3	90.0	5.0	5.3	5.2	4.0
BAM202	4.7	5.3	5.0	5.0	5.3	5.2	90.0	5.7	6.3	6.0	4.0
Sharps Imp.	5.3	5.7	5.0	5.0	5.0	5.2	96.7	5.3	5.0	5.2	4.0
Prairie	2.7	5.0	4.7	5.7	5.0	5.1	86.7	5.0	5.3	5.2	6.3
Bison	5.0	5.0	4.3	5.0	5.7	5.0	93.3	5.7	6.7	6.2	4.3
Bufflawn	1.0	3.7	3.3	4.0	5.3	4.1	60.0	4.3	6.7	5.5	5.7
Highlight4	1.7	2.7	2.3	3.7	5.0	3.4	30.0	4.7	7.0	5.8	6.0
Highlight25	2.0	2.3	2.0	3.3	4.3	3.0	23.3	4.7	7.0	5.8	6.0
Highlight15	2.3	2.7	2.3	3.0	3.7	2.9	21.7	5.0	6.3	5.7	6.0
Rutgers	3.0	2.0	2.0	3.0	4.0	2.8	25.0	4.5	6.5	5.5	6.0
LSD at 5%	1.2	1.1	1.0	1.0	1.2	0.6	10.1	1.1	1.1	0.8	0.7

1 Spring greenup 1 to 9 scale, 9=completely green
2 Quality 1 to 9 scale, 9=best
3 Color 1 to 9 scale, 9=darkest green
4 Fall dormancy 1 to 9 scale, 9=no dormancy

BREEDING WORK

This breeding project is now ten years old, and significant progress has been made in improving characteristics of buffalograss. The project has focused on selecting plants that have improved density, color, rate of spread and overall quality, but more recently plants have been selected for tolerance to wear and low mowing, early spring greenup, late fall dormancy, and insect and disease resistance. Efforts are also being made to select plants that have improved seed yields, germination rates, seedling vigor and improved sod characteristics. In 1994, a total of 132 selections were made from our nurseries, native stands, and old turfs. The best of these selections will be planted in a replicated evaluation study in 1995.

Performance of Buffalograss Selections Established in 1990 and 1991 - This section summarizes the third year of testing for two buffalograss trials established in 1990 and 1991. The August 1990 trial consists of 92 vegetative selections from 28 maternal lines. These progeny were selected in late fall of 1989, based on turf quality characteristics and late fall dormancy. The April 1991 trial contains 99 vegetative selections from many of the same maternal lines. In this study, selections were made based on early spring greenup in addition to turf quality. Commercially available turf-type buffalograsses ('609', '315', '378', or Prairie) and a forage-type, Texoka, were included in the trials as standards.

Experimental design was a randomized complete block design with three replications. Plots were vegetatively established with four 4-inch plugs per plot, spaced equally within a 5 ft. x 5 ft. area. Maintenance of the studies included biweekly mowing at 2.5 inches, fertilizer at 1-1.5 lbs. N/M/season, and pre- and postemergent herbicides were applied as needed.

In both trials, significant differences among selections were found in turf quality, spring greenup, and fall dormancy ratings during 1993. Many of the experimental selections have better quality than the standard Texoka, and several seem to be performing better than the newly released turf-type cultivars, indicating potential for improvement.

In the 1990 trial, '609' remained green late into the fall in both 1992 and 1993, but performed poorly early in the season because of its lack of winter hardiness in Nebraska. Cultivars '315' and '378' had high quality ratings and went dormant earlier in the fall. They are considered northern types and will be useful new cultivars in Nebraska and other northern locations.

In making the selections in these trials, we had hoped to identify buffalograsses with an extended growing season, a serious constraint to the use of this warm-season species. However, it appears that many of the selections that remain greener longer in the fall lack winter hardiness. There are a few exceptions, such as selections 90-86 or 90-12.

Evaluation of these selections will continue for several more years under varied environmental and cultural conditions. The extremely wet weather in 1993 made it impossible to evaluate the trials for drought tolerance. Although buffalograss is generally drought tolerant, it will be important to continue to screen selections for this characteristic.

Evaluation of Low Mowing Tolerance in Buffalograss - Buffalograss is currently being utilized in low maintenance turf situations. A goal of this project is to develop buffalograss varieties that can be used on golf course fairways. The current mowing recommendation for buffalograss is 2 inches every two weeks. Golf course fairways are generally mowed two to three times a week at 5/8 to 3/4 inches. This is required so that the turf has a high density resulting in a good lie. Buffalograsses developed for use on fairways must be able to perform well under intensive management. A buffalograss cultivar suited to fairway use would reduce the negative environmental impact golf courses may have, because of reduced water, fertilizer, and pesticide requirements.

A buffalograss evaluation test was established on July 13, 1990 at Mead, NE and mowed at 2 inches until the beginning of the 1993 growing season. At this time the mowing height was gradually lowered to 5/8 inch and mowed twice per week. Clippings were not collected. The trial received two 0.5 lb/N/M applications of nitrogen during the growing season (June 9 and August 4), and preemergent and postemergent herbicides as needed for the control of weeds. Plots were not irrigated during the 1993 growing season. The experimental design is a randomized complete block design with 3 replications and 98 entries. Analysis of variance was performed using SAS (Cary, NC). Means were separated using the least significant difference test, controlling the experimentwise error rate. The plots were evaluated for spring greenup, turf quality, and fall dormancy (Table 2).

Variability was found for turf quality among the entries indicating that some genotypes were able to better tolerate low mowing. Turf quality was generally lower at 5/8 inch mowing, compared to the 2 inch mowing height in 1992, indicating that the lower mowing resulted in stress on the turf.

Most of the selections that performed well in 1993 had performed well in 1992. 86-120, '315', and 86-61 were the top three performers under both mowing heights, all of these are female plants. 87-76 and 85-443 (a male and female plant respectively) also performed well both years. It is interesting to note that in 1992 at the 2 inch mowing height (performed every two weeks) the male selections 87-93, 84-45-3, and 87-80 did not have superior turf quality when compared to either Texoka or Prairie. However, with more frequent mowing at a lower height in 1993, these selections had significantly higher turf quality when compared to both Texoka and Prairie. This illustrates the presumption that the male flower detracts from turf quality by giving the turf a less uniform appearance. In 1993, with the lower mowing height and more frequent mowing male flower development was suppressed, therefore not detracting from turf quality.

Four male entries and six female entries were selected from this trial for superior turf quality, and were established in a polycross in May 1994 to allow for recombination and the development of a buffalograss variety that performs well under the low mowing environment (Table 2). Seed was harvested from this crossing block in October, and the progeny will be evaluated in 1995.

Table 2. **Quality, Spring Greenup, and Fall Dormancy Ratings for Low Mowing Trial at Mead, NE.**

		1993						
	1992	Quality[1]					Spring Greenup[2]	Fall Dormancy[3]
Selection	Avg.	Avg.	5/27	7/12	9/2	9/29	5/14	10/14
315*	7.3	6.6	7.0	7.0	6.3	6.0	6.0	4.3
86-61*	7.2	6.4	5.7	6.7	7.0	6.3	5.7	3.3
87-76**	6.9	5.9	5.3	6.0	6.3	6.0	6.0	2.3
86-120*	7.4	5.9	7.0	5.7	5.7	5.3	6.3	3.7
87-80**	5.8	5.8	5.0	5.3	6.3	6.7	4.3	4.0
87-93**	6.0	5.8	5.3	5.3	6.0	6.7	5.0	3.7
84-45-3**	5.9	5.5	5.0	5.7	5.3	6.0	6.0	1.7
85-648*	6.4	5.5	4.3	5.7	6.3	5.7	4.7	1.3
85-443*	6.6	5.5	6.0	5.3	5.7	5.0	6.0	1.3
86-23*	7.0	5.4	5.7	5.0	5.0	6.0	5.7	3.7
378	6.9	5.3	5.0	5.3	5.7	5.0	5.0	1.7
609	6.4	5.0	3.3	4.3	6.3	6.0	3.0	5.3
Texoka	5.4	4.5	5.7	3.7	4.0	4.7	5.0	4.3
Prairie	5.9	4.3	3.7	3.0	5.0	5.3	3.0	6.3
LSD at 5%	0.6	0.7	1.1	1.1	1.0	1.0	1.0	1.1

[1]Quality: 1-9 scale, 9=best

[2]Spring Greenup: 1-9 scale, 9=100% greenup

[3]Fall Dormancy: 1-9 scale, 9=no dormancy

*Selected for use as female parents in Low Mowing Tolerant Crossing Block

**Selected for use as male parents in Low Mowing Tolerant Crossing Block

Performance of Seeded and Vegetative Selections Established in 1992 and 1993 - Collection and evaluation of new buffalograss genotypes is key to the success of the breeding program. Clones collected from the wild or new genotypes resulting from a cross-pollination can be clonally propagated and evaluated as a vegetatively propagated cultivar. For the development of a seed propagated buffalograss cultivar, parents must be identified that combine well and produce progeny with desirable turf characteristics.

In 1992, an advanced seeded progeny evaluation test was established to evaluate the genetic worth of female parents. This information will be used in the selection of parents or half-sib families for the development of seeded buffalograss cultivars. The test consisted of 21 half-sib families, 4 composites, and Texoka as a standard cultivar. In 1993, an evaluation test was established with the objective of evaluating vegetative and seeded material developed in the breeding program for the identification of superior individuals or populations for potential release as a cultivar. This trial consisted of 25 seeded, and 59 vegetative entries.

In both trials, seeded material was treated using a priming treatment developed by Kamterter; burs were treated for a total of 6 weeks. Plots were seeded at a rate of 2 lbs/M. Vegetative plots were established with 16 plugs on one foot spacings. Plot size was 25 ft^2 (5 ft by 5 ft). The experimental areas were irrigated during establishment only. Plots received 1 lb/N/M per growing season and were mowed every two weeks at a 2 inch height. Pre- and post emergent herbicides were applied as needed. Percent cover ratings were made during establishment to assess the aggressiveness or vigor of selections. Plots are evaluated for spring greenup and fall dormancy to indicate the length of growing season, and rated for quality throughout the growing season.

In the 1992 Advanced Seeded Progeny Evaluation, seven of the half-sib families had a higher cover rating than Texoka. All entries had similar turf quality when compared to Texoka during the seedling year, except for 92-528-11, which was significantly lower. During the 1993 growing season, seventeen of twenty-one half-sib families had superior turf quality when compared to Texoka. The maternal parents of these half-sib families were selected for turf quality, bur yield, rooting depth, lower evapotranspiration rates, false smut resistance, and higher 3- and 15- day seedling emergence rates of progeny. The half-sib families therefore possess desirable turfgrass characteristics, and would have greater uniformity than the cultivar Texoka. The composite 92-2 had superior turf quality when compared to Texoka.

Sixteen of the half-sib families were selected for the development of four synthetic cultivars. Four half-sib families were combined for each synthetic cultivar. These synthetics were planted in isolated crossing blocks in 1992, harvested in 1993, and are being tested in the 1994 buffalograss evaluation trial. By utilizing family structure it is hoped that stability and uniformity can be achieved, and by combining several families inbreeding depression and loss of vigor can be avoided. In order to obtain preliminary information on the performance of these synthetics, seed from the four appropriate maternal parents were combined and planted in the 1993 trial and designated as 90-501, 90-502, 90-503, and 90-504.

In preliminary results from the 1993 trial, only three entries had superior turf quality when compared to Texoka; 92-122, 90-503, and 90-504. Seeded plots had greater uniformity when compared to vegetative plots because the seed was broadcast uniformly over the plots.

The vegetative entries were planted on one foot centers resulting in clumps with bare ground between plants, therefore it is believed that planting method biased the turf quality ratings. By the end of September, almost all of the plots had filled in. During the 1994 growing season a better estimate of turf quality of a mature grass sward can be obtained. This is of greater importance since buffalograss is a perennial.

'315' appears to be more aggressive than '378', with 90% and 72% coverage on the September 29 rating, respectively. This was also observed in the National Buffalograss Trial at Mead, NE.

Two seeded entries had superior turf quality when compared to Texoka, 90-503 and 90-504. These experimentals each had average quality ratings of 6.7 compared to 5.5 for Texoka. After further testing it is hoped that one of these populations will be released from the University of Nebraska Breeding program.

Enhancing Establishment Characteristics for Seeded Turf-type Buffalograss Populations - Divergent phenotypic recurrent selection for caryopsis size is being performed with two synthetic populations developed within the program. Larger caryopsis size has shown to result in increased seedling vigor in buffalograss. The goal of this research is to develop a seeded cultivar with improved seedling vigor.

Within each synthetic a population derived from large caryopsis, small caryopsis, and unselected for caryopsis size were established in isolated crossing blocks in the field on May 15, 1994. Each crossing block consisted of 144 individual genotypes. Burs were harvested from individual maternal plants from September 27 - October 10, 1994. For each maternal parent weight per 100 caryopses will be recorded. Realized heritability estimates will be calculated for selection for large and small caryopsis size.

A second cycle of divergent phenotypic selection will be performed in 1995. Thirty half-sib families will be selected from each synthetic. Replicated half-sib families will be planted in the field and heritability estimates will be made for selection for large and small caryopsis size utilizing half-sib family analysis.

Another breeding project is involved in developing a seeded variety with improved seed vigor. This will be performed by selecting maternal plants that produce caryopses and burs with higher germination rates. Seed vigor is defined as the percentage and rate of seed germination. A pilot study was performed in 1993 on identifying variability of seed vigor from plants of diverse origin. Open pollinated seed was harvested from 22 plants with superior turf quality from a nursery area. Germination tests were performed on burs and caryopses of these plants in a growth chamber. Germination counts were performed every 72 hours, and a seed vigor value, which was weighted for germination over time, was calculated. No significant differences were found for vigor values of caryopses from different maternal plants, however significant differences existed for vigor values of burs. The mean vigor value for burs and caryopses was 24 and 65, respectively. The range in vigor values for burs was 53. Burs from experimental 22-324 had a vigor value of 62, and burs from cultivar '315' had a value of 9.

In 1994 these 22 genotypes along with 8 others were established in a replicated top cross. The male plant used was 84-45-3, an experimental with high turf quality. Germination tests will be performed on burs and caryopses harvested in 1994. Differences in seed vigor scores

will be due to maternal effects only. Other data taken will be bur yield, vigor, and turf quality. Full-sib families with high vigor values could be combined for the development of a synthetic cultivar, or a maternal plant could be vegetatively established with 84-45-3 in isolation for the development of an F_1 hybrid.

Traffic Tolerance Screening - Traffic treatments were applied to two evaluation trials, each containing 50 cultivars and experimental selections, with a modified Brinkman Traffic Simulator. Treatments were applied from June-August 1993 and only half of each plot received the traffic treatment. As expected, the untrafficked halves had better quality throughout the season. There were a few exceptions however, after treatments stopped some trafficked plots rated higher than their untrafficked halves, indicating exceptional recovery. For some cultivars, the difference between trafficked and untrafficked halves was minimal. Significant differences were found among cultivars and selections in their traffic tolerance, '315' and a number of experimentals were among the top performers.

In a progeny evaluation trial containing 2000 plants, severe traffic pressure was applied May-July 1994. Many plants were killed off by the end of treatments. The best 81 plants were selected and will be either planted in a replicated trial or placed in an isolated crossing block in 1995.

Possible New Vegetative Varieties - The following experimental selections were increased in May 1994 for potential commercialization:

Experimental Selection	Available Square Feet	Commercialization Date	Use
86-61	2400	1996	Home Lawn, Fairways - Northern U.S.
91-118	3350	1996	General- Northern U.S.
86-120	3500	1996	Home Lawn, Fairways- Northern U.S.
85-158-2	900	?	General
84-436	2200	?	General
84-113	1500	?	General
91-116	3500	?	Fairways
91-94	1500	?	General
90-72	2250	?	General

Tests established in 1994 - A replicated buffalograss evaluation trial, consisting of 48 entries, was planted June 17, 1994. Sixteen entries were seeded at 2 lb/1000 sq.ft., including five experimentals from our breeding project, two from NTG, and six from Sharps, and three commercial varieties. Thirty-two entries were vegetatively established using 16 plugs per 5'x5' plot, including 16 advanced progeny selections, 5 collections from old turf stands, 9 potential releases, and 2 standards. This trial is well established and will allow ongoing evaluation and comparisons between currently available cultivars and new experimental selections.

The 1993 Shade Trial was replanted this summer due to flood damage so we were unable to start collecting shade tolerance data.

A small trial of 13 entries was also established at Pure Seed Testing, Rolesville, NC. The 7 vegetative and 6 seeded entries included standards and potential releases, allowing for evaluation of this material in the southeast United States.

BUFFALOGRASS MANAGEMENT STUDIES

Weed Control - Weed pressure continues to surface as a major problem during buffalograss establishment. Research was initiated in 1994 to investigate registered and unregistered herbicides for use during buffalograss establishment. Seeded buffalograss establishment was evaluated at two locations in Nebraska and one in Kansas. Dr. Jack Fry at Kansas State University and Dr. Robert Masters, a USDA weed scientist, are co-investigators on this study. Herbicide treatments were applied at time of seeding. Data were collected on several establishment criteria. Plots treated with herbicides of the imadazolinone family (Pursuit, Cadre) showed significantly higher establishment rates than plots treated with other tested herbicides. Additionally, herbicides currently registered for use on established buffalograss (i.e. Dimension, Ronstar G, Surflan and Dacthal) severely retarded seed establishment. This project will be submitted for publication in Weed Technology in early 1995.

Two imidazolinone herbicides (Pursuit and Image) are also being evaluated in a replicated trial on a Crenshaw & Doguet sod farm located near Poteet, TX. Treatments were fall applied, before or after plugging or sodding, at 3 rates. Data will be collected in the spring on establishment and weed control criteria. Both the seeded and vegetative establishment study data will be used to facilitate EPA registration of promising herbicides.

Sod Characteristics of Improved Turf-type Buffalograss - Research was conducted to evaluate sod strength, transplant shock, and root regrowth of improved turf-type buffalograss. Sod strength was measured using a S-beam load cell connected to a digital read-out. Sod strength of 22 entries in the National Buffalograss Evaluation trial were evaluated at two locations. Preliminary results indicated that the vegetatively propagated selections, Prairie and '609', exhibited superior sod strength. Seeded and diploid entries, in general, exhibited sod strengths that would be considered unacceptable for commercial sod production.

Transplant shock was evaluated for the vegetative entries, '315' and '378'. Each entry was treated with 3 antitranspirants prior to sod harvest. After harvest, sod was replanted immediately or 48 hours after harvest. '378' exhibited superior recovery characteristics over

'315', and sod replanted immediately recovered quicker than sod replanted at 48 hours after harvest. The antitranspirants exhibited no effect on sod recovery.

Root regrowth was measured using a load cell on the 22 entries of the National Buffalograss Evaluation trial. Results indicate '609' as the superior buffalograss in root regrowth.

BUFFALOGRASS INSECT AND DISEASE RESEARCH

Mealybug Resistance Work - Two potential insect pests of buffalograss are the mealybugs *Tridiscus sporoboli* and *Trionymus* sp. Field and greenhouse screening trials have demonstrated dramatic differences among buffalograss selections in resistance to mealybugs. Initial observations of two highly resistant selections, Prairie and '609', showed very little leaf pubescence. Therefore, 25 selections exhibiting a range of resistance levels were evaluated and a highly significant positive correlation was found between amount of pubescence and susceptibility ($r=0.78$). Scanning electron microscopy studies evaluated leaf pubescence and mealybug interaction with the leaf surface. Observations suggest that pubescence may provide a framework for the waxy ovisac and a foothold for the mobile first instar.

Studies are also being conducted to learn about inheritance of mealybug resistance and eventually develop a seeded, resistant cultivar. Progeny of susceptible and resistant plants were screened for resistance in 1992. Resistant seedlings were placed in an isolated crossing block, seed was harvested in 1993, and seedlings from this crossing block are currently being evaluated for resistance.

Additional field data were obtained late this summer when a mealybug infestation occurred on a replicated evaluation trial. Mealybug counts and ratings indicate differences in resistance among buffalograss selections.

Mealybug Monitoring Method, Biology, and Parasites - Current sampling methods for buffalograss mealybugs result in destruction of the plant and are therefore unacceptable for many research purposes. A study was conducted to develop an effective, non-destructive way to monitor mealybug populations on buffalograss plants. Adhesive-covered "sticky stakes" were placed in pots of mealybug-infested buffalograss to determine if the stakes would trap mealybugs. A 3.8cm piece of clear, double coated adhesive tape (Scotch C-40 Brand) was placed on each side of a 12.5cm long plastic pot label. To determine if mealybugs were attracted to one color stake over another, five colors (blue, green, red, yellow, and white) were evaluated. Thirty pots were arranged on a greenhouse bench in a RCBD, with 6 replications, and 5 color treatments. Mealybug and turf quality ratings were made on a weekly basis, and stakes were changed and counted twice a week, for a total of 8 weeks.

Large numbers of mealybugs (4324) were captured on the sticky stakes (Table 3) indicating that they can effectively be used to detect mealybugs on buffalograss. There was a significant positive correlation between mealybug ratings and counts for each week except week 5 (Table 4). During week 5 very few mealybugs were captured. In addition, as the mealybug counts increased the quality ratings declined, indicating that the mealybugs were

adversely affecting the plant. Even though there were large numerical differences, analysis of variance failed to detect statistically significant differences in mealybug numbers among the five stake colors (Table 3). Blue stakes captured the fewest mealybugs, while white and yellow sticky stakes captured the greatest number. Thus, we have decided to use white and yellow stakes for future monitoring studies.

Although large numbers of immatures were captured on the stakes, very few adult males and females were observed. Immature populations steadily increased until the fifth week of the study, then dramatically decreased (Table 4). For the last three weeks of the study, mealybugs captured again rapidly increased. Although little information is available on the life cycle of these two mealybugs, the observed fluctuations in the population levels in the pots likely reflect natural peaks and declines of immatures between generations. Another possible reason for the decrease of immatures during week 5 could have been an increase in mealybug parasites in the greenhouse. Large numbers of parasitic wasps were captured on the sticky stakes. These wasps have also been dissected from female mealybugs.

A laboratory rearing technique for mealybugs is being developed which will enable us to determine egg production, number of instars, and duration of nymphal stadia. To better understand the role parasitic wasps play in reducing mealybug population levels, a study has been conducted on mealybug-infested field plots. Half of the cages were treated with a selective insecticide to kill the wasps, but not the mealybugs. The grass within these cages has been harvested. When the mealybugs are counted, a difference in mealybug numbers between treated (hopefully wasp-free) and untreated (wasp-infested) cages will indicate the wasps' impact. Parasites are being reared from the mealybugs so that species can be identified and rate of parasitism determined. Control methods using insecticides are also being investigated.

Table 3. Number of mealybugs captured, indicating effectiveness of sticky stakes.

	Total mealybug counts per pot*							
Color	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Total counts	Mean counts**
Red	1	18	17	126	111	181	454	9.5
Blue	4	17	22	116	200	50	409	8.5
Green	13	28	11	245	266	236	799	16.7
Yellow	3	14	20	429	126	255	847	19.4
White	1	4	4	103	656	1047	1815	37.8
Total	22	81	74	1019	1359	1769	4324	

*Total counts are the totals for the 8-week testing period.
**Mean counts are the mean per week for each color.

Table 4. Correlation of mealybug infestation ratings and mean counts.

Week	Infestation Rating[1]	Mean Counts	Corr.	P>
1	1.8	1.1	.41	.025
2	1.8	11.3	.53	.003
3	2.0	12.3	.41	.024
4	1.8	14.4	.55	.001
5	2.2	1.6	.29	.120
6	3.3	10.3	.56	.001
7	3.5	50.6	.51	.004
8	3.4	45.1	.68	.000

[1] Mealybug infestation rating using a 0-5 scale, 0=no mealybugs or cottony mass and 5=nearly every tiller infested and plant close to death.

Buffalograss Chinch Bug Control - Two studies were conducted on a buffalograss lawn in Lincoln, NE to evaluate control of chinch bugs using *Beauvaria bassiana* and entomopathogenic nematodes, and combinations of insecticidal soap and reduced rates of conventional insecticides. Plots were 4 x 4 ft with 3 replications in a RCBD. Treatments were applied early September with a CO_2 sprayer calibrated to deliver 5 gal/1000 ft² at 24 psi. Immediately following application, plots were syringed with 0.25 inches water. Product efficacy was evaluated by removing from each plot three turf-soil cores to a depth of 1 inch with a 4.25-inch diam cup cutter (0.3 ft² total area per plot). Cores were returned to the laboratory and placed in Berlese funnels. Extracted chinch bugs were counted after 48 hr.

Pretreatment counts indicated 10-15 chinch bugs (nymphs and adults) per square foot. In the first study (Table 5), only the Sevin 80WSP treatment provided statistically significant reductions in chinch bug numbers. This occurred in part, because of a high degree of variability among plots which resulted in poor separation of the means. Numerically, however, both the Biosys nematode # 25 and *Beauvaria bassiana* (AF4) treatments seemed to provide some measure of chinch bug reduction.

In the second study (Table 6), all rates of diazinon and the 6.0 lb rate of Sevimol 4 when combined with Safer Insecticidal Concentrate resulted in 100% chinch bug control. The insecticidal soap alone provided only 33% chinch bug reduction. No phytotoxicity was observed.

Table 5. Evaluation of chinch bug control using *Beauvaria bassiana* (AF4) and nematodes.

Treatment	Rate lb AI/acre	Avg. no. chinch bugs/0.3 ft² (% Control) 7 DAT			14 DAT		
Sevin 80WSP	6.0	0.0	a	(100.0)	0.0	a	(100.0)
Biosys Nem #25	1 bil	4.3	b	(42.9)	5.0	ab	(58.3)
AF4	10^{12}conidia/1000 ft²	5.0	b	(42.9)	7.3	ab	(38.9)
AF4	10^{11}conidia/1000 ft²	5.0	b	(39.3)	7.7	ab	(36.1)
Biosys Nem #355	1 bil	5.5	b	(32.1)	10.3	ab	(13.9)
AF4	10^{13}conidia/1000 ft²	6.0	b	(14.3)	5.3	ab	(55.6)
UTC	—	7.0	b	—	12.0	b	—

Means in a column followed by the same letter are not significantly different (P = 0.05; LSD)

Table 6. Evaluation of chinch bug control using insecticidal soap and reduced rates of conventional insecticides.

Treatment	Rate lb AI/acre	Avg. no. chinch bugs/0.3 ft²	% Control
Diazinon 25EC +IC[1]	4.5 + 2.5 oz/gal	0.0 a	100.0
Diazinon 25EC +IC	3.0 + 2.5 oz/gal	0.0 a	100.0
Diazinon 25EC +IC	1.5 + 2.5 oz/gal	0.0 a	100.0
Sevimol 4 +IC	6.0 + 2.5 oz/gal	0.0 a	100.0
Sevimol 4 +IC	4.0 + 2.5 oz/gal	1.3 ab	66.7
Safer Insecticidal Soap Conc.	2.5 oz/gal	2.5 ab	33.3
Sevimol 4 +IC	2.0 + 2.5 oz/gal	2.5 ab	33.3
Malathion 50EC +IC	1.13 + 2.5 oz/gal	3.3 b	13.3
Malathion 50EC +IC	0.75 + 2.5 oz/gal	3.5 b	6.7
Malathion 50EC +IC	0.38 + 2.5 oz/gal	3.8 b	0.0
UTC	---	3.8 b	---

Means in a column followed by the same letter are not significantly different (P = 0.05; LSD).
[1]IC = Safer Insecticidal Soap Concentrate.

Buffalograss Disease Work - Severe dollar spot disease was noted on two of our older cultivar evaluation trials in late August and disease ratings were made. To determine if fertility influences incidence of this disease on buffalograss, split plot fertility treatments were applied in September and will be continued in 1995. Percent dollar spot ratings will be made on both halves of each plot.

Another disease which may be a problem in seed production is a rust (species not yet identified). This rust has been observed in our crossing blocks in 1993 and 1994. Severely diseased plants were rogued from the blocks.

STUDENT PROGRESS

Three new students have been recruited to work on graduate programs at Nebraska. Kevin Frank will work on buffalograss management starting in January, following his graduation from Wyoming; Tiffany Heng, a student at Nebraska, will work on insects of buffalograss starting in June; and Fei Shui Zhang initiated a Ph.D. project on tissue culture of buffalograss in September. Jennifer Johnson-Cicalese will finish her work at Nebraska in June 1995. On January 1, she will return to graduate student status until she completes her degree. Matt Giese will complete his M.S. in May 1995, and Charles Rodgers is making good progress on his Ph.D. program. Matt is studying characteristics of buffalograss sod and transplant shock, while Charles is studying buffalograss seed germination and seed vigor in order to enhance establishment.

RELATED PUBLICATIONS AND PRESENTATIONS

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