1988 ANNUAL RESEARCH REPORT

DEVELOPMENT OF DRYLAND WESTERN TURFGRASS CULTIVARS

Submitted by

Colorado State University
Departments of Agronomy and Horticulture
Ft. Collins, CO 80523

Principal Investigators:

Dr. Robin L. Cuany
Mr. Gary L. Thor

Consulting Investigator:

Dr. Anthony Koski

Submitted to

The United States Golf Association - Green Section
and Golf Course Superintendents Association of America

October 31, 1988

EXECUTIVE SUMMARY

Breeding research and selection at Colorado State University has continued on four western grasses that could produce new turf cultivars for minimum maintenance plantings and for areas with special soil or moisture problems. The species under study are alkaligrass (Puccinellia spp.), blue grama (Bouteloua gracilis), fairway wheatgrass (Agropyron cristatum) and inland saltgrass (Distichlis spicata). Improved cultivars would give golf course superintendents more choices for their problem areas and for lower maintenance roughs, and would also be useful in minimum maintenance areas such as roadsides, airports and industrial sites.

Alkaligrass is useful in low areas where it tolerates saline, sodic and waterlogged conditions and yet appears very similar to Kentucky bluegrass. Turf testing with 1 and 2 inch mowing has identified some outstanding accessions among the materials assembled from 6 western states and 5 foreign countries. Spaced plant nurseries established in 1988 will yield seed for testing and plants for recombination and production of an advanced generation. Materials are being cooperatively tested by other researchers in three diverse environments, Nebraska, Oklahoma, and Michigan.

Blue grama is useful in dry, alkaline soils since it dominates many western grasslands. Advanced generation polycross progenies were screened for deep emergence and seedling vigor in greenhouse tests and established in a field evaluation plot. In 1989 elite parents can be chosen from them in the second cycle of selection. Two turf seedings of the species were established, look good, and will receive cultural maintenance tests in 1989, including mowing at two heights.

Fairway wheatgrass has an extreme ability to survive drought and recover greenness quickly when water is available. Cycle one selected parents produced advanced generation seed which was planted in a turf test of the various accessions in September 1988. Their turf performance should give data in 1989 which may be used to choose elite lines to be carried into the second selection cycle, for a synthetic variety to be widely tested.

Inland saltgrass has been reduced to a minimum level of emphasis in the program because its lack of density and high seed dormancy reduce its usefulness as a traditional seeded turfgrass. We are maintaining the accession evaluation nurseries so parents will be available should further work be indicated for this species that tolerates salty waterlogged soils with an extensive rhizome system.

We are testing cooperative materials from Nebraska and Texas of buffalograss, in a dryland plot area at Fort Collins, and we are also cooperating with winterhardiness tests here of promising bermudagrass strains from Oklahoma.

INTRODUCTION

The Colorado State University turfgrass breeding program progressed significantly toward the goal of development of several new turfgrass cultivars of several nontraditional species. Work is continuing on alkaligrass (Puccinellia spp.), blue grama (Bouteloua gracilis) and fairway wheatgrass (Agropyron cristatum). The fourth species, inland saltgrass (Distichlis spicata), was significantly deemphasized in 1988 after discussion and a site visit with William Bengeyfield and James Watson. These native species have shown an ability to survive with minimum care on poor soil and could serve to fulfill the need for specialty turfgrasses for various problem soils and special conditions.

We were kept busy with maintenance, testing, evaluation, and seed harvests on 10 separate spaced plant nurseries and 11 seeded or sprigged turf evaluation plots in 1988. Materials have been exchanged for cooperative testing in various environments with three other turf research groups. Detailed progress reports for each of the four species follow, as well as a note on cooperation.

A. Alkaligrass

1) Breeding nurseries

The original 1985 nursery was discarded after the only surviving plants were transplanted in 1988 to a new plot for reproduction of mite and drought-resistant survivors in the elite sources. We are learning how to manage post-reproductive alkaligrass plants but can hardly hope for 100% survival. We may have to treat the species as a biennial in seed production, though

it seems perennial in turf stands. Material from Western U.S. sources (1986 nursery seed) was re-established in multiplication plots, and its disposition will depend on the 10-variety test results (see A.3).

2) Turf tests of accessions from Eurasia

The 1986 and 1987 test plots (both September seedings) in 4' x 4' plots were managed in 1988 with timely irrigation aiming at 1/4" per day but sometimes less than this due to wind and system problems. Cutting heights from late April to late October were 1" on the western half of each plot and 2" on the eastern half, obtained with Jacobsen reel and rotary mowers, respectively. Based on site-visit discussions we will try 3/4" on the low side and 1 1/2" for the high side in 1989, both with reel mowers. Results in 1988 (Table 1) indicated that 2" height gave a more satisfactory quality than 1" although this is a subjective judgement.

The cultivar 'Fults' (entry 4 in Table 1) was more resistant to summer dormancy, being less brown in July, but it did not recover as well from 1987's intentional dry spell, and even in 1988 when water was not withheld, it ended the season with poorer color (a large part of the September quality score) than the promising new materials. These (2, 14, 15, 17, 18, 20) showed poorer July color, but better September color than Fults, and have kept a better June quality in two years. They were more resistant to mites in spring 1987 and to drought in summer 1987, through their heat-dormancy response, than was Fults. Accession 21 from Germany may be as good as Fults and perhaps worth another look, although

Table 1. Mean 1988 turf performance of Eurasian accessions, seeded Sept. 1986 from 1986 nursery seed.

Accession No.	Origin	Quality 1" June	Quality 2" June	Density 1" July 8	Density 2" July 8	Color July 20	Color 1" Sept 20	Color 2" Sept 20	Sum of ratings
1	USA	5.0	5.0	4.7	3.7	2.7	6.7	5.3	33.0
3	FRAN	5.0	5.3	5.3	4.0	3.7	6.0	6.0	35.3
4	'Fults'(check)	5.7	6.0	6.7	5.7	3.7	6.3	6.0	40.0
21	GER	5.7	6.3	6.7	5.7	3.7	7.0	6.7	41.7
19	IRAN	5.7	6.7	5.3	5.3	1.0	6.0	6.0	36.0
16	IRAN	5.7	7.7	4.7	5.3	2.0	6.3	6.7	38.3
13	IRAN	5.7	6.3	2.3	3.3	1.0	4.3	5.7	28.7
2	USSR	7.0	7.3	6.3	5.7	1.7	7.0	7.0	42.0
14	IRAN	6.7	8.3	5.3	5.3	1.3	6.0	6.0	39.0
15	AFGH	7.0	8.0	6.7	6.0	1.7	7.0	7.0	43.3
17	IRAN	7.0	8.0	5.3	4.3	2.0	7.7	7.3	41.7
18	IRAN	6.7	8.0	4.3	5.0	2.0	7.0	7.0	40.0
20	USSR	6.7	8.3	5.7	6.0	2.0	6.7	6.0	41.3
	mean	6.1	7.0	5.3	5.0	2.2	6.5	6.4	38.5
	SE ±	0.5	0.5	0.7	0.6	0.4	0.4	0.3	2.4
	P	*	***	**	*	***	***	**	**

Quality, density and Sept. Color ratings on 0-9 scale, July color on 1-4 scale (1 brown to 4 green)

Sum of ratings could reach 58 maximum.

it was just as drought and mite susceptible. Accessions 1, 3, 19, 16, 13 have been poor on most counts.

In the 1987 test (Table 2) accessions show distinct differences, 13 and 19 being poor in color and density, while 2, 14, 15, 17, 18, and 20 were better than Fults in overall score. Five of these are being tested in 3 other locations (see E.1) and are suggested for further evaluation for commercialization. We had enough seed of some individual plants in the 1987 harvest of mite-attack survivors to plant a progeny test in September 1987 alongside the test (just described) of the bulks of each accession's survivors. This test (Table 3) included several individual progenies from the elite accessions 2, 14, and 18, as well as several from the poor 13 and 19. For the most part, they behaved as their family bulks in Table 2 did, though the mediocrity of (2) 5-3-3 suggests that original acc. 2 contained a mixture of plant types. In general appearance the 2" mowing height was more pleasing than the 1" height, though this may have been influenced by blade sharpness. The taller height can conceal small irregularities in stand density, as well as the decumbent stems typical of alkaligrass in late spring. On the other hand, needs of golf course fairways are not the same as those of home lawns and we will continue to rate at two heights, 3/4" and 1 1/2".

3) Turf tests (1986 and 1988) of native collections

The first alkaligrass turf test was planted in September 1986 and included 32 sources whose parent plants were collected in 6 western states in 1985 and transplanted to the nursery for 1986 seed production. None of these plants survived the 1987 mite

Table 2. Mean 1988 turf performance of Eurasian alkaligrass accessions (1987 seed of surviving nursery plants). Seeded Sept. 1987.

Accession		Late Winter 1-3 March 9	Color 1-4 July 20	Quality 1" June	Quality 1" July 4	Quality 2" July 4	Quality 1" Sept 20	Quality 2" Sept 20	Sum of ratings
2	USSR	2.2	3.5	7.8	7.8	8.5	7.5	8.0	45.2
13	IRAN	2.0	1.5	5.8	5.2	6.2	5.8	5.2	31.8
14	IRAN	2.0	3.0	8.0	7.5	8.2	7.8	8.0	44.5
15	AFGH	2.3	3.7	7.7	7.7	8.7	7.7	7.7	45.3
17	IRAN	2.2	3.2	7.8	7.5	8.0	7.8	8.0	44.5
18	IRAN	2.2	3.2	7.5	8.0	8.2	7.5	7.0	43.8
19	IRAN	1.5	1.5	5.8	5.0	5.8	5.0	5.0	29.5
20	USSR	2.0	2.8	7.5	7.2	8.0	7.5	7.5	42.5
Fults (cultivar)		2.0	4.0	6.3	7.4	7.4	6.0	5.9	39.1
	SE (±)	0.2	0.3	0.4	0.4	0.4	0.3	0.4	1.2
	P	n.s.	**	**	***	***	***	***	***

Quality ratings on 0-9 scale (9 best)

Color is 1 brown to 4 green (desirable)

Sum of ratings could reach 52 maximum

Table 3. Mean 1988 performance of 18 progenies from individual-plant 1987 harvests of alkaligrass, with Fults as check. Seeded Sept. 1987 and cut in 1988 at two cutting heights.

Accession	progeny	Late winter 1-3 March 9	Color 1-4 July 2	Quality 1" June	Quality 1" July 4	Quality 2" July 4	Quality 1" Sept 20	Quality 2" Sept 20	Sum of ratings
2	2-3-3	2.0	4.0	8.0	7.5	8.5	7.0	7.5	44.5
	4-3-3	2.0	3.5	8.0	7.5	9.0	6.5	7.0	43.5
	5-3-1	2.5	3.0	8.0	7.5	7.5	7.5	7.0	43.0
	5-3-3	2.0	2.0	8.0	5.5	6.0	4.5	5.5	33.5
	6-9-3	2.5	3.5	8.5	7.5	8.5	7.5	8.0	46.0
14	1-4-2	3.0	3.0	8.0	7.5	8.5	7.0	6.5	43.5
	2-7-2	2.0	2.0	7.5	7.5	8.0	7.0	6.5	40.5
	5-11-1	2.5	3.0	8.0	7.5	8.5	7.0	7.5	44.0
	7-5-3	2.5	3.0	6.5	7.0	7.5	7.0	7.5	41.0
	8-8-3	2.0	2.5	8.0	7.5	7.5	7.5	7.5	42.5
	9-11-3	2.0	3.0	8.0	8.0	8.5	7.0	8.0	44.5
18	4-5-5	2.5	3.5	7.0	6.5	7.5	7.0	7.0	41.0
	6-2-2	3.0	3.5	7.5	8.5	8.5	7.0	7.5	45.5
19	2-8-3	2.0	1.0	6.0	5.0	6.0	5.5	5.5	31.0
	4-12-1	2.0	1.0	6.0	5.0	5.5	4.0	5.0	28.5
	4-12-2	2.0	1.0	7.0	5.0	6.0	5.0	5.5	31.5
	4-12-3	2.0	1.0	6.0	4.5	6.0	4.5	5.0	29.0
13	7-9-4	2.0	1.0	6.0	5.0	6.5	4.0	5.5	30.0
Fults (cultivar)		2.5	3.8	7.8	8.2	8.2	6.0	6.2	42.8
	SE (±)	n.s.	0.4	0.5	0.4	0.5	0.5	0.6	1.3
	p	-	**	**	**	**	**	*	**

Quality ratings on 0-9 scale (9 best)

Color is 1 brown to 4 green (desirable)

Sum of all ratings could reach 52 maximum

attack, but remnant seed was used in 1988 both to plant a new turf test of the best 10 entries and to be multiplied.

The 1986 test continued to show rather imperfect stands as a result of the 1987 intentional dry summer, though some have recovered from gappy stands better than others (Table 4). In general we could say that the truly native species Puccinellia airoides and other non-distans types (shown by a +) come out worse, none having an overall score over 27. We have not identified other sources as being better than the check Fults in the same plot, though some approach it. On the basis of 1987 results we chose 10 to be studied further.

The 1988 test got off to a slow start from April 29 seeding, due perhaps to cooler soils than in September, and certainly suffering more from annual weeds before herbicide was applied. Nevertheless we see (Table 5) that at least three or four accessions were not significantly worse than Fults. This test will also be managed under two mowing heights in 1989.

4) Mode of reproduction in alkaligrass

In order to detect progeny segregation (a sign of sexual behavior from a heterozygous parent) versus uniformity from apomixis as found in Kentucky bluegrass, we put out 1270 O.P. progenies from 44 single parent plants yielding a 1987 seed crop. Seedlings were raised in the greenhouse and transplanted to the field June 1988 in a randomized block design with rows of 10 seedlings from a parent as individual plots, and 3 replications to give a possible total of 30 per parent (a few were short). Growth during the summer was hampered by hot weather but they have grown

Table 4. Mean 1988 turf performance of western U.S. collected materials, seeded Sept. 1986 from 1986 nursery seed.

	Accession	Quality		Density		Color			
		1"	2"	1"	2"	1"	2"	Sum of	
No.	Place	June	June	July 8	July 8	Sept 20	Sept 20	ratings	New test
6	Sterling CO	5.5	6.0	5.0	6.0	6.0	5.5	34.0	#
22	Alamosa CO	5.0	5.0	5.0	5.0	5.5	6.0	31.5	#
23	Alamosa CO	5.5	6.0	5.0	4.5	5.5	6.0	32.5	
24	Alamosa CO	5.0	5.5	4.5	5.0	6.5	6.0	32.5	#
25	Monte Vista CO	4.5	5.0	5.0	4.5	6.5	6.5	32.0	
26	Arriola CO	5.5	5.0	5.0	5.0	5.5	5.5	31.5	#
27	Cortez CO	3.0	4.0	4.0	4.0	6.0	5.0	26.0	
28	Mancos CO	5.5	6.0	4.5	5.0	6.0	6.0	33.0	
50	Rock Spgs WY	5.0	5.0	5.0	4.5	5.0	5.0	29.5	
52	Bear River UT	4.0	5.0	4.0	4.5	5.5	5.0	28.0	
57	Aberdeen ID	4.5	6.5	4.5	5.5	6.5	5.0	32.5	#
+ 69	Humboldt Sk NV	3.5	4.5	2.5	3.5	6.0	5.0	25.0	
+ 70	Carson Sk NV	3.0	4.5	2.5	3.5	4.5	5.5	23.5	
71	Sparks NV	5.5	6.0	4.5	5.0	6.0	6.0	33.0	#
74	Bridgeport CA	5.5	5.5	4.5	4.5	6.0	6.0	32.0	
+ 77	Mono Lake CA	3.0	3.5	3.0	3.5	5.0	5.0	23.0	
79	Warm Spgs NV	5.0	4.5	4.0	4.0	7.5	6.5	31.5	
81	Cedar City UT	5.5	5.5	5.5	4.5	7.5	5.5	34.0	#
82	Henrieville UT	4.5	4.5	3.5	4.0	5.5	5.5	27.5	
+ 83	Henrieville UT	3.0	4.5	2.5	3.0	4.5	5.5	23.0	
85	Mack CO	2.5	4.0	3.0	4.0	5.5	6.0	25.0	
+ 86	Mack CO	4.5	6.0	3.0	4.0	5.0	4.5	27.0	
87	Grand Jcn. CO	5.0	5.5	3.5	4.0	6.5	6.0	30.5	#
89	Mesa CO	5.0	5.0	5.0	4.5	6.0	6.0	31.5	
93	DeBeque CO	5.0	6.0	4.5	4.5	6.5	5.5	32.0	#
96	Walden CO	4.5	5.5	4.5	5.0	6.5	6.0	32.0	
97	Walden CO	4.5	6.0	4.5	6.0	6.5	6.5	34.0	#
+ 101	Laramie WY	3.0	4.0	3.0	3.5	5.0	5.0	23.5	
+ 107	Frannie WY	3.0	4.0	3.0	3.0	5.0	4.0	22.0	
+ 111	Goldeneye WY	4.0	5.0	3.0	4.0	5.0	5.5	26.5	
+ 112	Medicine Bow WY	3.0	4.5	2.0	3.0	5.0	5.0	22.5	
+ 114	Rock River WY	4.0	4.0	3.0	3.0	6.0	5.5	25.5	
4	Fults (check)	5.7	6.0	6.7	5.7	6.3	6.0	36.4	
mean (excl. Fults)		4.4	5.1	4.0	4.4	5.8	5.6	29.3	
SE	±	0.6	0.6	0.4	0.5	0.4	0.6	1.7	
P		**	ns	***	**	***	ns	***	

All ratings on 0-9 scale. Sum could reach 54 maximum

\+ These are not *P. distans*. May be *P. airoides* or other native species

\# See text and Table 5.

Table 5. Mean 1988 turf performance of western states accessions, seeded April 29, 1988 from 1986 seed.

Accession No.	Origin	Density July 4	Quality Sept. 20
6	Sterling CO	6.0	6.3
22	Alamosa CO	7.3	7.3
24	Alamosa CO	6.7	7.0
26	Arriola CO	5.3	5.7
57	Aberdeen ID	6.0	6.3
71	Sparks NV	6.7	6.7
81	Cedar City UT	4.5	6.0
87	Grand Junction CO	7.7	7.0
93	DeBeque CO	6.7	6.3
97	Walden CO	5.0	4.0
Fults	(cultivar)	9.0	7.5
	S.E. ±	0.6	0.6
	P	*	n.s.

This test shows at least 3 or 4 of the accessions to be not significantly poorer than Fults at 2" cutting height in the seedling year. Data on two cutting heights to be gathered in 1989, under improved fertility.

better in September-October. The overall impression is that most rows are showing segregation for plant size, leaf angle, and color. Although there are a few late season inflorescences, the main rating for segregation in type of panicle branches and other flowering traits such as flowering dates will come in spring of 1989. Meanwhile it would be prudent to regard alkaligrass as probably cross pollinated, to use isolation in multiplication plots, and to base cultivars on several parent plants of similar growth habit and desired traits. Attention will also be paid to disease resistance and single-plant seed productivity. It is important to make the right compromise between seed production and turf quality, which can only be tested with an adequate amount of sowing seed for each of several replications (in the initial screening tests). Plots of 3' x 3' or less do not offer a chance for testing different cultural practices on the turf.

B. Blue grama

1) Breeding nurseries

We have four breeding nurseries from which we can harvest seed; one of them is the 1982 forage breeding nursery and another the Cycle-2 recombination of heavy-seeded plants from it, which has given rise to Exper. Cultivar 9055923 in a Foundation Seed field east of Fort Collins. The other two are the Generation-0 turf source nursery and the 27 Cycle-1 selections in 3 vegetative pieces making up the recombination block. Because the latter yielded only small quantities of seed in 1987, we decided to use that seed to make a Generation-1 nursery for further single-plant

selection on growth type, seed yield, and turf potential. The seed was planted in the greenhouse in pots, covered with 2 cm of dry soil, sub-irrigated for 4 weeks, and only the biggest emerged seedlings were used for the new 1988 (Gen-1) nursery. This technique has proved valuable in previous work to concentrate the genes for seed size (caryopsis weight) and seedling vigor, including the ability of seedlings to tolerate dry spells while becoming well established [it is expected that many turf sites would use supplemental sprinkler irrigation for establishment, but not all will have that potential].

The nursery was established by transplanting 15 seedlings from each of the 20 best polycross parents in 3 replications of 5 plants each, and will yield definitive quantities of seed in 1989. The seed produced is to be bulked according to plant type, for turf plot tests in May or June 1990.

2) Turf tests

Two tests of available material including check (forage/range) cultivars have been seeded at the Horticulture Farm. The first planted 14 August 1987, was present as a fairly dense stand of very small 3 or 4 leaf seedlings through the winter and we were relieved this spring to find the stands had survived; they continued to look good all through summer with very limited irrigation, and 2" cutting height. Local materials rated 7.7 quality. For reasons of seed supply only 3' x 3' plots were used, and with the increased emphasis desired on cultural practices we decided to plant a second test on 1 August 1988 in 4' x 4' plots so they could be split at

least for cutting height in 1989, and possibly also for N fertilizer amount. This second plot could not yet incorporate new breeding material for reasons stated above in B.1, but we had four entries in three replications:

Lovington Hachita	} checks (NM materials)	score 1.7 score 3.0
Tall bulk from Forage nursery ('85 seed)		score 4.7
Bulk harvest of Forage (2000 pl., '87 seed)		score 4.7

These 1988 seedlings are establishing well (as shown by scores on 1-5 scale) and much taller in fall than the 1987 turf plot. They have experienced much warmer conditions, without heavy frost to October 22.

A turf test of the plant progenies from the turf Cycle-1 recombination block will not be possible in May 1989 because of hail damage to the 1988 seed harvest. An alternative test might include a bulk from that nursery and also check cultivars and "forage" experimental cultivars 9044169 and 9055923, for partial irrigation rather than the dryland management planned for the 1988 turf test.

C. Fairway wheatgrass

1) Breeding nursery

The problem with the herbicide effect of 2,4-D and dicamba was finally avoided with extra precaution against accidental spray and we were able to harvest 60 of the 78 plants before the Aug. 4 hailstorm, leaving only 18 plants whose yield was considerably less (Table 6). The harvest weights varied a lot from plant to plant nevertheless, single plants yielding from 0 to 107 g, and source means varied from 6 to 46 g/plant. Seed production is important

Table 6. Weights of harvested seed from selected plants of different sources in fairway wheatgrass recombination block (Cycle-1) 1988.

	Source		Unhailed (g) mean	Unhailed (g) range	Unhailed (g) no. pl.	Hailed (g) mean	Hailed (g) range	Hailed (g) no. pl
1	'Ephraim'		32.5	10-56	5	4.4	-	1
2	Turkey		19.5	2-40	6	-	-	-
3	"		16.4	2-55	4	7.1	1-13	2
4	"		30.9	18-47	3	4.2	0-7	3
5	"		39.8	14-94	5	26.0	-	1
6	"		25.6	12-38	3	6.7	1-19	3
7	"		40.5	1-77	4	8.7	4-13	2
8	"	*	13.4	3-27	4	6.6	0-13	2
9	Iran		28.2	2-107	5	0.2	-	1
10	"	*	19.1	15-21	3	-	-	-
11	"	*	5.6	3-8	2	0.0	-	1
12	"	*	19.7	12-32	3	-	-	-
13	"	*	9.9	4-16	2	5.7	-	1
14	"		26.8	21-31	3	-	-	-
15	"		46.3	20-72	2	3.2	-	1
16	"		36.6	20-54	3	-	-	-
17	'Ruff'	*	9.8	0-18	3	-	-	-
	Mean		25.5	-	60	6.5	-	18

* Wt. of seed required to plant 3 reps of 4' x 4' plots was 24.2 g. Source 11 had insufficient, and 8, 10, 12, 13, 17 not in all reps. of the Sept. 1988 turf performance test.

but may turn out to be negatively correlated with turf quality. Yet it is necessary to have certain seed quantities for the turf performance tests, and some sources did not have enough seed (24.2 g per plot) to supply 3 replications. It would be prudent to have at least 4 or 5 replicated pieces of any genotype to be used as a parent in a polycross recombination, so that one could count on 100 g of seed to be tested as a single-plant progeny. As it is, we had to bulk parents within each source to come up with the comparative performance test of the sources.

Further work with this nursery will depend on the turf test results. We may be able to rule out certain sources on the basis of performance by June 1989, and make seed only on the better sources to carry the program forward another generation.

2) Turf tests

The old 1985 test has been cut at 1" and 2" with a June rating showing quality of 6.0 and 7.0 respectively, a highly significant difference. The cultivars Ruff and Ephraim did not differ significantly but there was a color difference between green and grayish-green in this unirrigated test. There remained a slight difference between the seeding rates of 1.1 lb/M (2 per sq. in.) and 2.2 lb/M (4 per sq. in.), which gave quality ratings of 6.2 and 6.8.

The new 1988 test planted on Sept. 22 used seed from the bulked selected plants of 16 sources (excluding source 11) and 5 check cultivars in 4' x 4' plots and 3 replications. The test has established well under sprinkler irrigation and some seedlings were

3" tall by mid-October. The only noticeable difference was the grayer color of the check Ephraim. Other checks were Ruff, Hycrest, Fairway, and Asay's I-28 experimental. Next season this plot will be cut at two heights but not irrigated. An additional test will be planted with some or all of the same entries, to be irrigated at some fraction of the water used by bluegrass or alkaligrass. This test is targeted for seeding in September 1989, at the same seeding rate of 20 g PLS per 16 sq. ft., which is 5 seed/sq. in.

D. Inland Saltgrass

Field work on inland saltgrass was reduced to a minimum level sufficient to maintain the three cycle 1 accession evaluation nurseries since the species has been considerably deemphasized in the breeding program. The high dormancy of seed has caused the reduced expectation of the usefulness of the species as a low maintenance turfgrass. Seed harvests of 1986 and 87 will serve for any future seed work with germination enhancement or turf field tests.

Several experiments ancillary to the breeding work were completed this year. In one, we concluded that for practical purposes, seed harvests could be maximized by cutting plants to the ground level (as with a combine) with no detrimental effects on the next year's growth or seed production. Another test, started in August 1987, sought to establish turf plots from seed, but had shown no germination in 1987. By the fall of 1988 we had obtained the very low germination rate of about 0.5% on one of the

two seed sources tested, reinforcing the conclusion that inland saltgrass would be an extremely difficult species (without some dormancy-lowering treatment) to establish from seed for turf applications. A further test looked for vegetative growth differences after a fertilization with 1 pound of nitrogen per 1000 square feet. The visual quality and characters of the vegetative growth were not affected in the first or second year.

The test of cold stratification in water or 0.5% KNO_3 solution started in 1986 was concluded in October 1988 by testing the treated inland saltgrass seeds 20 months after completion of the stratification. Table 7 shows that even after 20 months, germination was elevated by the cold moist treatments and that KNO_3 solution was a better medium than water. There was however, a significant decrease in the levels of germination enhancement after 20 months of storage of the seeds at 32^0 F in a dry condition, compared to the germination levels achieved last year immediately after completion of the stratification.

E. Cooperative plantings of promising cultivars

1) Colorado materials sent out

We sent enough material for 3 plots of 5' x 5' of five promising alkaligrasses and a Fults check to three sites for adaptation testing. They went to Riordan in Lincoln, NE; Kenna in Stillwater, OK; and Branham in E. Lansing, MI. Because of delays in making the arrangements, and our finding that fall seeding does much better in Colorado than spring seeding, we sent them about 1

Table 7. Germination of inland saltgrass seed stratified at 32 or 42°F for 31 or 61 days in water or 0.5% KNO_3 solution.

Seed Source[1]	Temp (°F)	Days	Treatment	% Germination: Immediately after stratification	% Germination: 20 months after stratification
E	32	31	Water	77.5	40.7
E	32	31	KNO_3 solution	90.0	63.8
E	32	61	Water	72.5	42.0
E	32	61	KNO_3 solution	86.2	64.8
E	42	31	Water	71.2	50.0
E	42	31	KNO_3 solution	86.2	63.8
E	42	61	Water	60.0	54.8
E	42	61	KNO_3 solution	83.8	81.2
E	Control with no stratification			23.8	22.5
W	32	31	Water	25.9	5.7
W	32	31	KNO_3 solution	47.5	16.8
W	32	61	Water	26.2	7.8
W	32	61	KNO_3 solution	72.5	10.0
W	42	31	Water	12.5	1.4
W	42	31	KNO_3 solution	75.0	5.4
W	42	61	Water	10.0	2.6
W	42	61	KNO_3 solution	62.5	20.4
W	Control with no stratification			0.0	0

1/ Seed source was E = Eastern Colorado accessions or W = Western Colorado collection near Delta by Jess Fults.

Sept. 1988. Based on reports in 1989 from these cooperators, and other information about salinity tolerance to be sought from Cooperator Gerald Horst, El Paso TX, we expect to send another batch of candidate strains to E. and/or W. Coast sites. Due to summer heat dormancy behavior, it does not seem that the SE or desert SW would be a likely environment for this species. As we get more seed from the best native collections of 1985, we may change our strategy.

Blue grama and Fairway wheatgrass are not quite at the stage for cooperative testing but we hope to have some first candidates for consideration in 1989 seed harvest (BG for the late spring '90, FWG for fall '89 seeding).

2) Other states' material sent to Colorado

We have planted two 3-replication tests in August 1988, one with six buffalograsses from Riordan (NE), a Dallas selection from Engelke, and a local lawn type. The other contains four bermudagrasses from the program of Kenna and Taliaferro in OK, to which we will add Midiron (KS) and a locally adapted bermudagrass that Jack Butler had in his lawn. While bermudagrass is not a principal turfgrass in the northern half of CO or above 4,000', it is important to find out which strains have the most winterhardiness, and what their greening and browning dates are in our marginal site. On the other hand, buffalograss is native to our area and our cooperators are interested in relative turf performance of their potential cultivars, in our part of the

climatic range. We expect to cut both these grasses at 1 1/2" and 3/4" in split plots.

F. Other collaborative research proposed

1) Salinity

Materials will be sent to Gerald Horst at El Paso TX for evaluation of salinity tolerance.

2) Water use efficiency

Dr. Dan Smith of this Dept. of Agronomy is currently at Jim Beard's laboratory in College Station TX and working on criteria for measuring water use and avoidance of drought stress. When he returns in January 1989 we will discuss details of experiments with the western grasses to establish their water use and whether there is variation among different sources. We expect that Dr. Tony Koski will be involved in the planning and possibly also in the research.

3) Nitrogen and other fertilizer response.

Dr. Koski assisted us by putting a uniform fall application of 1 lb N/1000 on all our turf plots, as well as some P and K on the plot area for the bermudagrass. This winter we will coordinate on a schedule for additional 2 lb N/1000 on parts of the plots, with the split right angles to the cutting height strips. Dr. Koski has started fertilizer experiments on some of the other turfgrass areas (bentgrass, perennial ryegrass, bluegrass, etc.) this fall, and he participated in our site visit.

STATEMENT OF EXPENDITURES
U.S. Golf Association
Funding of 2/25/88 - 2/24/89

	Expenses 9/30/88	Encumbered	TOTAL
PERSONNEL			
G. Thor - Salary	$ 8,740	$ 6,596	$15,336
G. Thor - PERA	1,567	1,207	2,774
Student Hourly	3,172		3,172
MATERIALS AND SUPPLIES	195	3	198
OTHER DIRECT COSTS	72		72
TOTAL DIRECT COSTS	13,746	7,806	21,552
INDIRECT COST, 16%	2,200	1,248	3,448
TOTAL EXPENDITURES	$15,946	$ 9,054	$25,000