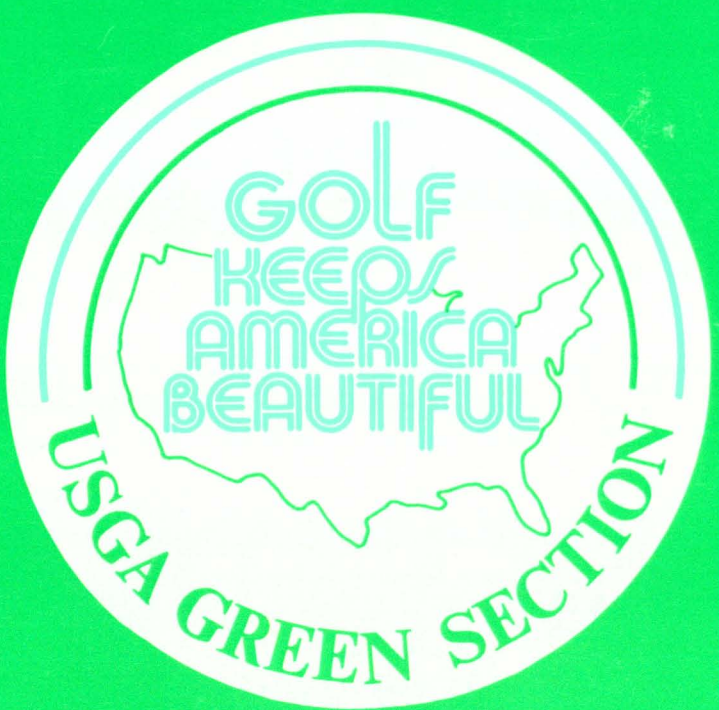
1989 Annual Turfgrass Research Report



1989
TURFGRASS
RESEARCH SUMMARY

SUBMITTED BY:

United States Golf Association
Golf House
Far Hills, New Jersey 07931

IN COOPERATION WITH:

Golf Course Superintendents Association of America
1617 St. Andrews Drive
Lawrence, Kansas 66046

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December 1, 1989

TO: THE READERS OF THE 1989 ANNUAL TURFGRASS RESEARCH SUMMARY

> There is no royal road to anything. One thing at a time, and all things in succession. That which grows slowly, endures.
>
> L. G. Holland

We are entering the eighth year of a decade dedicated to the betterment of golfing turf. Our goal is to reduce, at least by fifty percent, golf course maintenance costs and water requirements based on 1983 figures.

Golf is traditionally played on grass and to ensure this tradition for future generations, new grasses and new management techniques must be found. Economic and environmental requirements demand it. The seventh year of this research effort has just concluded and we are significantly closer to our goals.

If you will read through the Executive Reports of the twenty major research projects listed herein, you will find success stories on new heat and disease tolerant bentgrasses; drought resistant buffalograsses; wear resistant zoysiagrass; salt tolerant native grasses; increased winter hardiness in bermudagrasses; and even improved varieties of annual bluegrasses. Interesting to note, 1989 was the first year of commercial seed production of the new improved Sahara bermudagrass variety. It was a total sellout! We are on our way.

Equal progress was made in the cultural practices studies. It may soon be possible, for example, with the use of newly researched field diagnostic kits, to determine if one of several different disease outbreaks is imminent and thereby enable the superintendent to determine if costly fungicide applications are necessary. The effects of putting green aeration, cutting heights and frequency, fertilization, irrigation and other management practices are also becoming better understood and effectively manipulated by those research studies.

Now a challenge is on the horizon; environmental concerns which could directly affect the future of golf in every community in the United States. Golf courses have always been thought of as "good neighbors," but there are those who would now forcefully end that relationship. The Research Committee, with approval and support of the USGA Executive Committee and the Golf Course Superintendents Association of America, is meeting the challenge. Preliminary studies on the impact of golf course construction and maintenance practices on the environment are already underway. Officials of the Environmental Protection Agency and experienced agricultural scientific consultation agencies are directly involved in guiding and advising the Research Committee regarding needs in this area. By the end of 1990, a clear road map for golf course environmental research will be established and recommendations made to the USGA Executive Committee for specific, essential environmental projects for 1991 funding. Golf courses have long had a positive influence on environmental quality. We will continue to be good neighbors.

As you read this 1989 Turfgrass Research Summary, please recognize yourself as one who has made it possible. Without your interest and financial support, there would be no Summary. Those who serve on the Research Committee have also contributed their time, talent and dedication without compensation. Indeed, everyone in the community of golf has a stake in this historic turfgrass research effort.

Golf Keeps America Beautiful. Turfgrass progress for USGA member clubs forges ahead year after year and the results will endure for future generations of golfers -- and for all of America.

With appreciation,

Bill

William H. Bengeyfield
Chairman, Turfgrass Research Committee
National Director, USGA Green Section

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February 1, 1990

To the Readers of the 1989 Annual Turfgrass Research Summary:

Little the USGA does, or is likely to do, will have more effect on the future of golf than funding and monitoring turfgrass research.

That effort has one aim--to restrain, or perhaps reduce, the amount of money required to maintain golf courses.

We must find a way to control these costs if the game is to continue to thrive. For example, reducing the amount of irrigation water is essential.

The funding process is controlled by the USGA's Executive Committee, and administered by a Turfgrass Research Committee of 13 members with distinguished careers as academics, as agronomists from the USGA Green Section, as golf course superintendents, or as representatives of the turfgrass industry.

The Turfgrass Research Committee not only recommends how the money will be spent, but its members monitor the progress of the work as well.

The first specific results of this effort, which began in 1982, came to the market in the form of an improved bermudagrass that is lower growing, grows a denser turf, and is the first other than common bermudagrass that grows from seed. More developments will be coming.

The 1990 budget calls for 24 grants totaling $745,300, to be distributed to 16 universities or research centers. The USGA has every hope and expectation of not only continuing, but also accelerating future research activity.

Sincerely,

David Fay
Executive Director

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STATEMENT OF INTENT

It is the intent of the United States Golf Association (USGA) and the Golf Course Superintendents Association of America (GCSAA), through the USGA Foundation, to collect and disseminate substantial amounts of money for support of research to improve turfgrasses; specifically, to substantially reduce water use and maintenance costs and, further, to encourage young turf scientists to become leaders in research.

It is anticipated that funds for this purpose will be derived in major part from contributions to the USGA Foundation. Additional funds may be derived in the future from royalties attributed to marketable discoveries. The USGA presently intends to return any income received from royalties to the support of turfgrass research. Institutions which accept the research grants will be asked to engage in a free exchange of information with other investigators.

Historically, the sport of golf has maintained a leadership role in the development of improved turfgrasses through the activities of the USGA Green Section. While those developments have helped to provide better playing areas for golf, they have had a far-reaching impact on turfgrass improvement for other uses. Home lawns, parks, school grounds, highway rights of way and all other turfgrass uses have been improved by developments which were pioneered by the USGA.

The USGA expects to support research at numerous institutions. In some cases, several will be involved with the development of grasses and maintenance practices where the research may interact and overlap.

In view of this Statement of Intent, it is expected that recipients of grants will embrace the spirit of cooperation which the USGA and GCSAA is attempting to promote and that they will engage in a new exchange of information with other investigators.

USGA Turfgrass Research Committee

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1990 BUDGET

TURFGRASS RESEARCH GRANTS

December 18, 1989

PROJECT	SUBPROJECT	UNIVERSITY/INVESTIGATOR	ACTUAL GRANTS 1983	1984	1985	1986	1987	1988	1989	TOTAL ACTUALS 1983-1989	1990 BUDGET	TOTAL GRANTS 1983-1990	AVERAGE GRANT PER YR
TURFGRASS BREEDING	Breeding General	Rutgers/Funk	5,000	5,000	5,000	5,000	5,000	5,000	5,000	35,000	5,000	40,000	5,000
	Bentgrass	Penn State/Duich	4,000	4,000	4,000	4,000	4,000	4,000	4,000	28,000	4,000	32,000	4,000
*	Bentgrass	Texas A&M-Dallas/Engelke			47,000	40,000	40,000	40,000	60,000	227,000	64,000	291,000	48,500
	Bentgrass	New Zealand DSIR/Rumball				10,000	10,000	10,000	10,000	40,000	10,000	50,000	10,000
	Bentgrass	Univ of RI/Skogley	1,500	1,500	1,500	1,500	5,000	5,000	5,000	21,000		21,000	3,000
	Bentgrass	MS State/Krans	2,500	2,500						5,000		5,000	2,500
	Bermudagrass	Univ of GA/Burton	5,000	5,000	5,000	5,000	5,000	5,000	5,000	35,000	8,000	43,000	5,375
	Bermudagrass	NM State/Baltensperger		4,500	20,000	20,000	20,000	3,000		67,500		67,500	13,500
	Bermudagrass	OK State/Taliaferro				20,000	20,000	20,000	35,000	95,000	75,000	170,000	34,000
	Native Grass	CO State/Cuany/Koski			10,000	20,000	20,000	25,000	25,000	100,000	30,000	130,000	21,666
	Native Grass	Univ of AZ/Mancino						5,000	12,000	17,000	12,800	29,800	9,933
	Native Grass	Univ of NE/Riordan		4,100	20,000	18,000	19,000	25,000	35,000	121,100	35,000	156,100	22,300
	Poa Annua	Univ of NH/White		11,600	15,000	15,000	20,000	30,000	35,000	126,600	35,000	161,600	23,085
	Zoysiagrass	Texas A&M-Dallas/Engelke	2,500	42,585	42,000	40,000	40,000	40,000	45,000	252,085	45,000	297,085	37,135
**	Cultivar Eval.	Multiple Sites							43,000	43,000	43,000	86,000	43,000
	Screening Eval.	Multiple Sites							15,000	15,000	15,000	30,000	15,000
	Dryland Bentgrass	New Zealand DSIR/Rumball							3,000	3,000		3,000	3,000
		SUBTOTALS:	20,500	80,785	169,500	198,500	208,000	217,000	337,000	1,231,285	381,800	1,613,085	
CULTURAL PRACTICES	Management	MI State/Branham			10,000	15,000	15,000			40,000		40,000	13,333
	Management	OH State/Dannenberger				15,000	15,000			30,000		30,000	15,000
	Management	WA State/Brauen		1,243	1,000					2,243		2,243	1,121
	Management	Univ of GA/Carrow				15,000	15,000	15,000	18,000	63,000	18,000	81,000	16,200
	Pathology	Texas A&M-Dallas/Colbaugh					10,000	10,000	10,000	30,000	10,000	40,000	10,000
	Pathology	MI State/Vargas		15,000						15,000		15,000	15,000
	Pathology	Cornell/Petrovic		1,500						1,500		1,500	1,500
	Pathology	Cornell/Smiley			7,000					7,000		7,000	7,000
	Pathology	NC State/Lucas			10,000	10,000	10,000			30,000		30,000	10,000
	Soil Compaction	MI State/Rieke	3,000	3,000	3,000	5,000				14,000		14,000	3,500
	Salt Mechanisms	Texas A&M-El Paso/Horst		3,480	15,000	15,000	15,000	15,000	15,000	78,480	29,000	107,480	15,354
	Interactions	Univ of NE/Shearman		4,000	23,000	20,000	20,000	25,000	25,000	117,000	25,000	142,000	20,285
	Morphology	MS State/Krans							2,500	2,500		2,500	2,500
	Entomology	Independent/Stacey									10,000	10,000	10,000
	Mycorrhizae	Univ of RI/Jackson									40,000	40,000	40,000
		SUBTOTALS:	3,000	28,223	69,000	95,000	100,000	65,000	70,500	430,723	132,000	562,723	

PROJECT	SUBPROJECT	UNIVERSITY/INVESTIGATOR	ACTUAL GRANTS 1983	1984	1985	1986	1987	1988	1989	TOTAL ACTUALS 1983-1989	1990 BUDGET	TOTAL GRANTS 1983-1990	AVERAGE GRANT PER YR
TURFGRASS RESEARCH LIBRARY		MI State/Chapin	5,000	96,326	68,000	55,000	65,000	65,000	60,000	414,326	70,000	484,326	60,540
		SUBTOTALS:	5,000	96,326	68,000	55,000	65,000	65,000	60,000	414,326	70,000	484,326	
BIOTECH	Methodology	Univ of IL/Smith						8,400		8,400	9,000	17,400	8,700
	Pathology	OH State/Shane & Hameth					10,000		10,000	20,000	10,500	30,500	10,166
	Endophytes	Rutgers/Day									40,000	40,000	40,000
		SUBTOTALS:					10,000	8,400	10,000	28,400	59,500	87,900	
STRESS MECHANISMS		Texas A&M-Coll.Sta/Beard	84,500	87,000	91,000	73,000	70,000	55,000	67,800	528,300		528,300	75,471
		SUBTOTALS:	84,500	87,000	91,000	73,000	70,000	55,000	67,800	528,300		528,300	
ENVIRONMENTAL STUDY	Literature Search	Spectrum Research/Balogh									25,000	25,000	25,000
		SUBTOTALS:									25,000	25,000	
ADMINISTRATION	Research Cte Meetings		13,500	13,766	19,319	11,100	16,500	30,500	35,000	139,685	38,000	177,685	22,210
	Project Inspections						7,000	20,500	25,000	52,500	27,000	79,500	19,875
	Printing						3,500	8,600	10,000	22,100	12,000	34,100	8,525
	Legal Fees								5,000	5,000		5,000	5,000
		SUBTOTALS:	13,500	13,766	19,319	11,100	27,000	59,600	75,000	219,285	77,000	296,285	
		TOTALS:	126,500	306,100	416,819	432,600	480,900	470,000	620,300	2,852,319	745,300	3,597,619	447,202

(RSCH-BUD)

* Includes donation by Bentgrass Research, Inc. of Fort Worth, TX: 1985 - $27,000; 1986-1989 - $20,000 per year; 1990 - $24,000.

** Cultivar Evaluations for new grasses - budget formulas: Bentgrass - $200/selection x 5 sites x 6 selections = $ 9,000 x 3 years = $ 27,000.
Others - $200/selection x 5 sites x 34 selections = $34,000 x 3 years = $102,000.

40 $43,000 $129,000

No. of selections: Bermudagrass (6-OK State; 4-NM State); Zoysiagrass (8-Texas A&M-Dallas); Buffalo Grass (8-Univ of NE); Bentgrass (6-Texas A&M-Dallas); Poa Annua (4-Univ of NH); Native Grass (4-CO State).

TURFGRASS RESEARCH GRANTS

SUMMARY: 1983-1990 ACTUALS

December 18, 1989 (RSCHSUM)

PROJECT CATEGORIES	ACTUAL GRANTS 1983	1984	1985	1986	1987	1988	1989	1990 BUDGET	TOTAL 1983-1990	AVERAGE PER YEAR
STRESS MECHANISMS										
TOTALS:	84,500	87,000	91,000	73,000	70,000	55,000	67,800		528,300	66,037
PCT OF ANNUAL TOTAL:	66.8	29.7	21.8	16.9	14.6	11.7	10.9	.0	14.7	
TURFGRASS RESEARCH LIBRARY										
TOTALS:	5,000	96,326	68,000	55,000	65,000	65,000	60,000	70,000	484,326	60,540
PCT OF ANNUAL TOTAL:	4.0	32.9	16.3	12.7	13.5	13.8	9.7	9.4	13.5	
BIOTECH										
TOTALS:						8,400	10,000	59,500	87,900	10,987
PCT OF ANNUAL TOTAL:						1.8	1.6	8.0	2.4	
TURFGRASS BREEDING										
TOTALS:	20,500	80,785	169,500	198,500	208,000	217,000	337,000	381,800	1,613,085	201,635
PCT OF ANNUAL TOTAL:	16.2	27.6	40.7	45.9	43.3	46.2	54.3	51.2	44.8	
CULTURAL PRACTICES										
TOTALS:	3,000	14,723	69,000	95,000	110,000	65,000	70,500	132,000	562,723	70,340
PCT OF ANNUAL TOTAL:	2.4	5.0	16.6	22.0	22.9	13.8	11.4	17.7	15.6	
ENVIRONMENT										
TOTALS:								25,000	25,000	3,125
PCT OF ANNUAL TOTAL:								3.4	.7	
ADMINISTRATION										
TOTALS:	13,500	13,766	19,319	11,100	27,000	59,600	75,000	77,000	296,285	37,035
PCT OF ANNUAL TOTAL:	10.7	4.7	4.6	2.6	5.6	12.7	12.1	10.3	8.2	
ALL CATEGORIES ANNUAL TOTALS:	126,500	292,600	416,819	432,600	480,000	470,000	620,300	745,300	3,597,619	449,702
TOTAL PERCENT:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NOTE: Average Actual per Year computes over entire eight year project total.

TURFGRASS EVALUATIONS OF CURLY MESQUITEGRASS

THE UNIVERSITY OF ARIZONA
Tucson, Arizona

Dr. Charles F. Mancino
Principal Investigator

1989 Research Grant: $12,000
[second year of support]

Curly mesquitegrass, Hilaria belangeri, is being evaluated for utilization as a desert turf. Research efforts during 1989 focussed on quantifying the natural variation in turfgrass qualities in this species, assessing the effects of planting date and seeding rate on seedling establishment, and evaluating the field performance of selected plant material to fertilizing and mowing practices.

Nursery swards were rated in July 1989 for growing height, leaf length, leaf width, and color. Without exception, the medium class of the first three characteristics contained the majority of individuals. In addition, only 35% of the accessions were rated as having acceptable or better than acceptable color for home lawns. This illustrates the natural variation within the population with respect to these traits, and moreover, indicates that through selection and breeding of the minority a new population can be constructed manifesting low height, short leaves, fine leaf width, and acceptable color. Six accessions had low growing height, short leaves, and fine leaf width, and are being vegetatively increased.

Curly mesquitegrass has been observed flowering on the range in early March. Early flowering may result in an extended period of seed production for breeding purposes and ultimately for commercial seed production.

A seeding rate study was established to determine the optimum seeding rate and planting date for curly mesquitegrass in Southern Arizona. Seedlings of curly mesquitegrass were recognizable 11 days after planting for each planting time and seeding rate. Seeds did not display staggered or delayed germination into the following months. After six weeks it was difficult to recognize original individual seedlings because of prolific stolon production. Although the June planting date produced a lower average number of seedlings, plots seeded in June had the highest percent ground cover by October, 1989 due to a longer growing season which allowed for more vegetative spread.

Current controlled environment germination experiments have lead to the conclusion that Gibberellic Acid at a concentration of 250 ppm significantly promotes germination. Furthermore, the average germination of curly mesquite seeds in the control treatments of these

experiments was 80%, a sharp increase from the 34% average germination of the control treatments of previous experiments. This may indicate an after-ripening requirement for curly mesquitegrass seeds.

A Cultural Practices Study was established in March 1989 to evaluate responses of five sources of selected plant material to combinations of cutting heights [5 cm, 10 cm, and no cut] and nitrogen applications [0, 1, and 2 lb/N 1,000 sq. ft.]. This experiment was vegetatively established.

Plots were rated in July and August for color and percent ground cover. No differences existed among accessions for the color ratings. Nitrogen had no influence on color for the July or the August rating. Increasing nitrogen increased percent ground cover for both rating dates. Significant differences were observed among accessions in percent ground cover for both ratings. The average ground cover for five accessions ranged from 33 to 13 percent in July, and from 72 to 49 percent in August. Increasing cutting height also increased the percent ground cover. Fewer stolons were removed from the 10 cm height of cut than from the 5 cm cutting height. The no cut treatment had the highest average percent ground cover [70.5%] for the August rating.

Within the cultural practices study, stolon counts were performed on 100 individual propagules. The number of stolons per plant ranged from 10 to 94 and averaged 35 + 16. No correlation existed between high nitrogen rate and high stolon number, indicating that stolon production has a significant genetic component. Selection for high stolon number is important in developing a dense, uniform turfgrass. Thirty-five individuals were identified as having 40 or more stolons. Stolons were harvested from these 35 plants and were propagated in the greenhouse. Currently, stolons from 14 of the 35 plants have survived, and eight have been planted into the field.

Eight selections from the cultural practices study, along with six selections based on nursery ratings, possess excellent plant color, and short leaf length. These selections demonstrate that curly mesquitegrass has the potential to become an arid region turf. Breeding and selection efforts have already identified plant material with improved germination and turfgrass characteristics. These ratings and experiments must be performed for a number of years to properly evaluate and confirm the performance of this species as a turfgrass.

DEVELOPMENT OF DRYLAND WESTERN TURFGRASS CULTIVARS

COLORADO STATE UNIVERSITY
Ft. Collins, Colorado

Dr. Robin Cuany
Principal Investigator

1989 Research Grant: $25,000
[fifth year of support]

Our work at Fort Collins, CO, on western-adapted grasses continues in the breeding and turf adaptation phases. The three grasses alkaligrass, blue grama and fairway wheatgrass are all in the middle of the second cycle of selection for numerous traits. Seed production, plant type, and small plot evaluation for turf appearance and tolerance to weather, disease, and two mowing heights [3/4" and 1-1/2" by reel mowers, three times a week] are the most important. Seed production of elite types for regional testing is a vital step which is being pursued more vigorously as we get nearer to knowing the identify of the desired parents. For each of the three grasses we have reported progress in the breeding nurseries and in turf evaluation plots and in some cases we can predict their role in fairway and rough plantings and other turf uses; none of these grasses is suitable for use on greens.

Alkaligrass proved to be a cross-pollinated grass with segregation possibilities to select new genotypes. Plants with a bluish-green [glaucous] leaf color may have more upright stems but they make poor turf. Many plants are semi-prostrate but have good green color and produce attractive turf in spring and fall, better than the cultivar Fults, which was attacked by a brown patch disease in midsummer and by rust in fall. All alkaligrass looks worse in summer due to heat stress, even when given 1" - 1.5" irrigation per week, but we have selected materials which are least affected. This species is salt tolerant and survives where bluegrass dies. It tolerates 3/4" mowing well, but is not fertilizer responsive. The better sources are under test in larger plots in Michigan, Nebraska, and Oklahoma as well as here.

Blue grama tolerates the drought of the Great Plains and has produced an attractive turf under both mowing heights, with only 1/2" supplemental moisture in a dry summer. It greens up in late April and stays green until October frost, with no noticeable response to nitrogen. Since the chief constraint to its wider use as dryland turf is seed supply and cost, we have selected families and plants in the second cycle with more seed-bearing capacity, and some with more or finer leaves. Seed of these will need testing to ensure favorable effects on turf quality as we put together the parents for a synthetic cultivar.

Fairway wheatgrass [FWG] was tested severely by the 1989 summer where we had two four-week periods without rain, and a week with daily temperatures above 95° [Denver had 5 consecutive days above 100°, a

record]. As a cool-season grass, FWG went brown and dormant, but watering 1/2" - 1" every two weeks from mid-July brought greening and partial recovery, some of the stand density being lost. It tolerated mowing at 1-1/2" better than 3/4" so FWG's role may be in roughs rather than modern fairways. However, we are selecting for variation in amount of rhizomes or buried shoots which could cause stand repair and thickening, and also for finer leaves, so the results of the second breeding cycle may show increased versatility.

Cooperative testing here included buffalograss from Nebraska's program, which did only moderately well, probably because of soil salinity up to 8 mmhos/cm. Bermudagrass from Oklahoma, planted in late August, failed to survive a -28°F February cold snap.

COLONIAL BENTGRASS BREEDING

DEPARTMENT OF SCIENTIFIC & INDUSTRIAL RESEARCH - NEW ZEALAND

Dr. William Rumball
Principal Investigator

1989 Research Grant: $13,000
[fourth year of support]

The original aim of this project was to breed a cultivar of Colonial bentgrass [Agrostis capillaris] entirely within New Zealand, but suitable for use in the USGA. The resulting cultivar would hopefully require much less water and maintenance than those currently available in the USA, but still be attractive and persistent.

The project took the pragmatic approach that if such breeding material was to be found in New Zealand, it would probably be on sites such as unirrigated, low-input fairways of golf courses in hot, dry regions. Accordingly, a large collection of plants was made from such sites in 1987, and a smaller, but more selective one in 1988. These materials are now being evaluated at Palmerston North under both sward and flowering conditions. Data are being collected which we hope will lead to a selection, progeny-testing and seed increase to provide a candidate line for the next National Evaluation Series for Bentgrass in the USA.

This original program is up to schedule. However, we have now made two modifications which should improve the end result, expand it and hasten it: 1] an interim selection has already been made, and the separate 107 progenies were sent to a collaborator in the USA in 1989. It will allow screening for tolerance to USA diseases and climate stresses. It will not delay the timing of final selections, but should allow extra [and very important] data to be taken into account as well, and 2] about two years ago, we suggested that Dryland bentgrass [A. castellana] be added to the project, since it has some natural advantages over Colonial bentgrass in dry situations [and some disadvantages too]. After viewing the collected material, however, it was felt that an existing DSIR selection of Dryland bentgrass was already superior. With some slight breeding modification, it has been seed-increased and inserted into the 1989 National Evaluation Series as a DSIR-USGA candidate.

Final Note: The evidence collected during my 1986 period in California, and from the subsequent golf course collections through New Zealand, suggests we should not expect any Colonial bent selection to be as tolerant of heat, or drought, as might be desired. It seems that in consistently dry conditions, Colonial bent tends to be replaced by Dryland bent.

This justifies our approach of breeding projects in both species. It would be easy to envisage that both cultivars are marketed,

preferably in blends for marginal sites. The proportion of either species in the blend would relate to the site characteristics. Quite apart from the extra drought-resistance Dryland bent would give to the blend, the two selections should compliment each other in seasonal color. Dryland bent is always most attractive in winter; Colonial bent in the warmer season.

BERMUDAGRASS BREEDING - VEGETATIVE

UNIVERSITY OF GEORGIA
Tifton, Georgia

Dr. Glenn W. Burton
Principal Investigator

1989 Research Grant: $5000

The most significant accomplishment of our turf research program in 1989 was the discovery of a unique bermudagrass at the SCS Plant Materials Center, Quicksand, Kentucky when I spoke there at a Warm-Season Grass Symposium in the Kentucky mountains, March 7, 1989. The grass was dormant at that time but the enthusiasm of the people over its performance for them caused me to obtain sprigs and establish test plots this summer. They reported that it was very winter hardy, had been around for many years and had been referred to as Quicksand common. Its origin was not known. The rhizomes they sent me were labeled 9034348 bermudagrass. They told me they were planning to release it as a lawn grass.

We found this bermuda that I will call "Quicksand" [they will probably give it another name] to be very fine-stemmed, highly disease resistant, very vigorous and a rapid spreader. It is fertile and could be a better parent for making winter hardy triploid hybrids than the Berlin bermuda that we have used thus far.

Our Cynodon transvaalensis introductions were through heading before our "Quicksand" bermuda produced heads so no crosses could be made this year. I expect to make a lot of Quicksand x transvaalensis hybrids in 1990.

Increasing the winterhardiness of the Tifton turf bermudagrasses continues to be our major objective. Toward that end, we have a number of mutants and hybrids established on golf courses in the mountains in Blairsville, GA and Highlands, NC. We hope that the 1989-90 winter will be cold enough to kill most of them. I hope the plant physiologists working with turf will be able to develop an effective screen for winter survival that can be used to get this important information. It takes too long to wait for the right kind of winter in the South.

In my last report, I expressed the hope that the trend to cut golf greens at 1/8" could be reversed. We have some good looking mutants from Midiron and Tifton 419 that could make very satisfactory greens if they could be mowed at 3/16" to 1/4". Only true dwarfs like Tifdwarf can take the very close mowing the pros are demanding and they would look a lot better and satisfy most golfers if the cutting height could be raised.

DEVELOPMENT OF CULTIVATION PROGRAMS ON TURFGRASS TO REDUCE WATER USE AND IMPROVE TURF QUALITY

UNIVERSITY OF GEORGIA
Griffin, GA

Dr. Robert N. Carrow
Principal Investigator

1989 Research Grant: $18,000
[first year of support]

A major cause of deterioration and increased water use on golf course turfgrasses is soil compaction, which limits rooting and reduces water infiltration. Cultivation is the primary means to alleviate soil compaction. Five cultivation techniques were compared for their relative effectiveness under compacted soil conditions to improve soil physical properties and shoot/root growth of common bermudagrass. The techniques were: core aeration, Verti-drain with solid tines to 10", Verti-slicer, solid tine Agri-vator, and a new experimental approach by Toro. Compacted and non-compacted treatments were included. The site is a Cecil clay loam, typical of the Piedmont region of the South-east.

Severe compaction was applied with a smooth power roller in early May and early July with a maintenance level at other times. Cultivation by the various methods was applied the week after the two severe compaction periods.

Plant measurements included: root sampling on 30 June and 12 September at 0-8 and 8-24 inch depths; clipping yield; verdure, visual quality; color, and shoot density. Water extraction from the soil by depth [0-8 inch, 8-24 inch] and evapotranspiration were obtained periodically throughout the season. Oxygen diffusion, bulk density and water infiltration determinations were also obtained.

Data under preparation and computer analysis include rooting, water extraction, and soil physical properties. Preliminary results on shoot responses indicated that a short term [1-2 weeks] decline in shoot density and quality was apparent from the Verti-slice, Agri-vator, and hollow-tine coring treatments. However, after two weeks, shoot density and quality were similar to the compacted control.

A REALISTIC WHOLE PLANT MICROCULTURE SELECTION SYSTEM FOR TURFGRASSES

THE UNIVERSITY OF ILLINOIS
Urbana, Illinois

Dr. M. A. L. Smith
Principal Investigator

1989 Research Grant:
[Not funded in 1989]

Although the program was partially crippled by the lack of USGA funding support for 1989, our research later in 1988 and in 1989 adapted parallel salt-tolerant and salt-susceptible lines of bermudagrass, creeping bentgrass, and St. Augustinegrass to both solution batch culture and microculture test systems, in order to thoroughly evaluate the symptoms and responses that characterize reaction to saline environments in the root zone.

The solution batch culture system [similar to systems now used in testing for tolerance by the NASA 'Plants in Space' program] was specifically developed to accommodate the grasses from small plug stage [start of experiment] to 8-week old plant [termination]. The batch culture system allowed multiple replicates to be grown in control [2.2 dSm] nutrient solution, or, for the appropriate treatments, very gradually brought up to encounter high-salinity levels similar to what might be found in saline soils. The systems approach allowed the whole plant to be continuously monitored for response to saline conditions - not just a single feature like clippings growth or size as in previous research.

Microcomputerized video image analysis was adapted to analyze parameters of shoot growth and density, blade color, root length, and root system area over time. The technique yielded highly quantitative data on overall growth response. In addition, measurements of dry weight facilitated RGR analysis and osmotic adjustment response was quantified using a vapor pressure osmometer. The unique attributes of this batch system approach have been recently reported [Meyer et al., 1989, J. Plant Nutrition 12:893-908]. The microculture system parallel was designed to make some of the same analyses on tolerant and susceptible grass responses in a compact, efficient screening test. While dry weight [RGR] analysis was not feasible in microculture, additional advantages of the microculture system include smaller scale, and very clear presentation and observation of root system responses in the gellan-gum tissue culture matrix.

Both systems have been quite effective at separating traits of grasses in terms of their relative tolerance to saline environments; most notable the overall growth response [stunting], ability of tolerant plant root systems to increase in length proportionate to level of

stress, and osmotic adjustment. Given the high degree of correlation between solution culture and microculture screening tests, the more efficient and scaled-down microculture screen is envisioned as a practical tool for screening untested germplasm for use in roadside erosion control, or for turfgrasses to be irrigated with saline water.

TURFGRASS RESEARCH LIBRARY

MICHIGAN STATE UNIVERSITY
East Lansing, Michigan

Dr. Richard C. Chapin
Principal Investigator

The purpose of the USGA Turfgrass Information File is to provide efficient and effective access to all published and processed materials reporting the results of research affecting turfgrass and its maintenance. The access will be provided for the research community, for practitioners [such as golf course superintendents], for extension-type services, and for commercial concerns.

The USGA Turfgrass Information File [USGA TGIF] continues to be housed in an Alpha Micro multi-user microcomputer, using the STAR database management software. Both the hardware and software continue to work well with regular and continuing enhancements to record structure and searching capabilities. Addendum I, "Production Statistics", details records added to the file between May 1, 1988 and April 30, 1989. The total of 2,484, above the intended project annual target and consistent with recent production, is particularly noteworthy in light of the sizable [and increasing] unit time commitment to the searching, technical support, and service roles of the Turfgrass Information Center [TIC]. By October 1989, 16,000 records were in the bibliographic database. Current published literature is added to the file after processing by TIC staff; older materials are being added to the files on a systematic basis. Emphasis continues on the completion of the 1972-1989 conference proceedings and annual research reports.

Subscriber packets and brochures are distributed to callers, visitors, and at conferences by TIC, in addition to USGA Green Section distribution. For subscribers, software will be made available to enable the IBM PC or compatible microcomputer with modem to directly access the file, along with documentation to guide remote searching.

Vueport, the PC software necessary to dial into the Alpha Micro and STAR, is distributed to subscribers, along with the Dial-Up User's Manual. Edition 1.2 of the Manual was issued beginning in April. It includes some revisions, expanded explanations, the use of color coded pages, etc. As of November 1, 1989, subscribers [excluding complimentary users] to online access number 96, from 34 states and provinces. This group of pioneers breaks roughly out as 53% clubs/courses; 29% research/academic; 8% not-for-profit agencies; and 9% private sector [other than clubs/courses]. We are quite pleased with this distribution, which we feel will give us a good feel for expectations from several perspectives.

A total of 390 mediated searches were conducted May 1, 1988 to April 30, 1989. When combined with "information only" queries, a total

of 48 states and 5 countries are represented. Addendum II, "Search Statistics", details the distribution of these queries by user type and method of contact.

Monographic requests have been handled per normal Interlibrary loan arrangements. Photocopy requests are a service offered as a part of the supplementary services fee schedule, with discounted rates for subscribers. Photocopy requests totaled 228 items, with 183 supplied.

Continuing promotional efforts involved presentations, mailings, and published articles. A blanket mailing to all known institutions offering certificate or degree programs in turf culture [not already subscribers] was made in late summer. The booth space provided by GCSAA at the International Golf Course Conference and Show [2/89, Anaheim], resulted in hundreds of inquiries, discussions and training opportunities in concert with the Green Section Agronomists immediately next door. We were also represented at the New Jersey Turf Expo [12/88], sponsored by the New Jersey Superintendent's Association, the Michigan Turfgrass Conference, and at a USGA Regional Seminar [5/89, Dayton]. During the year, regular production of The Sward, TIC's newsletter, began in August. It is intended that issues will be produced at least quarterly, providing a regular communication channel to subscribers and other users.

During the year, additional space was allocated by the MSU Libraries to TIC, increasing our physical size by about 25%. This is a prerequisite for future efforts in data preparation, entry, and processing. The acquisition and installation of additional disk storage on the Alpha Micro has provided the ability to:

a] enhance retrieval sophistication even further this coming year [highlighting of search terms, proximity operators available, etc], and

b] enable the continued growth of USGA TGIF for several years into the ease of use.

There is no question "ease of use" issues will continue to dominate discussion of USGA TGIF use now and continuously into the future. We are, in part, attempting to do something that has little historical precedent in bibliographic practice until recently; that is, to provide practitioners in a discipline with article-level electronic indexing, including direct document delivery linkages.

Historically, when such access has been provided, whether in print or electronically, it has been fundamentally designed to serve research and academic purposes. This is its basic role; to serve the literature review process. That it can serve many other purposes, also, is a function of the power of on-line, interactive information retrieval.

As in most software, this retrieval is inevitably a continuous trade-off between convenience on one hand and power on the other. In

general, these attributes are inversely proportional. This does not mean, however, that we cannot continue to evolve to serve varying populations; on the contrary, we can continue to modify, permute, and supplement the current "core" [the bibliographic database] with variant and complimentary data structures if desirable, feasible, and practical.

A case in point is our intention to make available pre-searched, pre-sorted "bibliographies" online which need only be selected from a list to be downloaded without ever entering STAR [as long as we can identify the "topic" ahead of time]. The bottom line here is an "easier" alterna-tive for some users under certain circumstances. It does, however, mean more "options" on the system. Is this "simplification" or "complication"? It depends on your definition.

We are, of course, continually attempting to make changes to software, displays, etc., to improve ease-of-use. The forthcoming version of STAR [3.0] gives use control over the content of the online help system for the first time. We are currently preparing an interactive, off-line tutorial to literally walk a new user through a simulated online session before they ever use the modem. We'd like to hear more ideas, from users, from the Committee, or from non-users. This feedback is crucial as we continue to evolve.

On July 1, Dr. Richard E. Chapin retired as Director of Libraries, and, as well, as Project Director of the Turfgrass Information File effort. Without his involvement in the turfgrass literature, beginning many years ago, it is unlikely the Noer Collection, Turfgrass Information Center, or USGA TGIF would exist at MSU as we know them today. His leadership, inspiration, and, not infrequently, his sense of good humor and perspective will be sorely missed. We wish him well in future endeavors and "retirement".

IMPROVEMENT OF POA ANNUA & POA SUPINA FOR GOLF TURF

UNIVERSITY OF MINNESOTA
St. Paul, Minnesota

Dr. Donald B. White
Principal Investigator

1989 Research Grant: $35,000
[sixth year of support]

Replicated plantings of 8 advanced selections were established as sods and sent for evaluation by cooperators at the Universities of Massachusetts, Ohio State, Nebraska-Lincoln, Texas A&M - Dallas Station, and Washington State - Puyallup Station. In addition, the University of Nebraska was furnished enough material of selection #117 for 576 3-inch plugs for a long term golf course experiment.

Reports of evaluation of the 8 selections from the golf course planting across the country indicate that most of the 8 selections are performing well across all environments. Most reports indicated some outstanding performers.

Progeny testing continued for heritability of desirable characteristics. Several of the 8 selections exhibit excellent heritability and uniformity of progeny from seed. Initial seed production plantings were harvested and indicated that most of the 8 advanced selections produced seed heads between 8 and 12 inches tall. This is considered within the range for mechanical harvest.

Seventy-five new materials were added to the program from Georgia, Wisconsin, North Carolina, Minnesota, Montana, Washington, Virginia, Ohio, Kentucky, Florida, South Carolina, New York, Tennessee, New Jersey, California and Indiana. Research continues on developing improved breeding techniques and in executing crosses to combine desirable characteristics within Poa annua and Poa supina. For the first time, six interspecific crosses between the two species have been accomplished. Seeds are currently being germinated and will be closely observed for heritability of desirable characteristics. Cytological studies will also be conducted on the seedlings.

Fifty additional crosses were accomplished between Poa annua selections that exhibit superior traits. Research indicates that sucrose and water alone offer the best media for floral pic culture of excised flowers for crossing. Preliminary investigation reveals that flogging maturing flowers may offer an easy aid to techniques for emasculation of flowers. If this is successful, it could dramatically reduce that work involved in accomplishing controlled crosses.

A computerized record system was developed and installed to document pedigrees and keep track of all breeding data. The record system currently accommodates over 1300 individual accessions under field and greenhouse evaluation and 8500 seed accessions as well as on-going breeding efforts.

Research indicated that Poa annua seed can absorb moisture, start to germinate, and be dried without killing the seed. In addition, several cycles of wetting and drying results in synchronized germination of virtually all of the viable seed within a 24 hour period.

Work for 1989-90 will continue to focus on vegetative evaluations and seed production of the 8 advanced selections as well as breeding and collection efforts.

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS

UNIVERSITY OF NEBRASKA
Lincoln, Nebraska

Dr. Terrance P. Riordan
Principal Investigator

1989 Research Grant: $35,000
[sixth year of support]

GRASSES DUE TO BE COMMERCIALIZED - The number 1 genotype throughout the country and in our research plots at the University of Nebraska was NE 84-609. This buffalograss is a southern type with good adaptation in the south and potential adaptation in the north. We are proceeding with developing a crop registration, a plant patent, and release of NE 84-609 for use in the southern United States.

COMMERCIALIZATION--SEEDED BUFFALOGRASS - An agreement has been received from a consortium of companies which includes Farmers Marketing Corporation, Yuma, Arizona; Arrow Seed, Broken Bow, Nebraska; and Johnston Seed, Enid, Oklahoma. This agreement calls for the development of a new seeded turf-type buffalograss using plant material from the University of Nebraska.

COMMERCIALIZATION -- VEGETATIVE BUFFALOGRASS - We have been contacted by Crenshaw/Douget, Inc., that has an interest in NE 84-609 for use in the Texas market. It is believed that an agreement will be received shortly from this company that may be worthy of consideration.

COMMERCIAL TESTING/EVALUATION - During 1990, the University of Nebraska will work with golf courses and sod producers in evaluating the performance and potential of vegetative buffalograsses in various locations. It will be our effort to make these planned releases available under agreement to individuals who would have the most positive effect on our project. We will be working with the United States Golf Association and the Golf Course Superintendents Association of America on this portion of the project.

BUFFALOGRASS VEGETATIVE INCREASE - Establishment of vegetative increase areas started in 1987 and has continued with additional material added each year. To-date, seventeen cultivars have been increased for a total of 83,000 ft^2. This area is used to provide plant material for advanced testing studies.

DEMONSTRATION & STUDY TOURS - Texas A&M Univ.; Milt Engelke - Dallas, TX: Plugs of several buffalograss selections [Prairie, Texoka, NE 84-409, NE 84-609, NE 84-315, NE 84-304 and NE 85-378] planted May 18, 1988 were observed at the Texas Agricultural Experimental Station in Dallas. Turf quality data values showed NE 84-609, NE 84-304 and Prairie as exhibiting good turf-type qualities. Prairie and NE 84-609 exhibited the best turf color throughout the season.

BUFFALOGRASS BIOTECHNOLOGY - After a great deal of preliminary experimentation, a breakthrough has been made on the buffalograss biotechnology project. Callus has been initiated from stolon tips of the female cultivars NE 84-609, NE 85-378 and NE 84-315. This is an important discovery for four reasons: [1] these three cultivars are projected as being patented in the early 1990's; [2] the explant utilized is clonal material; [3] stolon tips are easily handled and can be grown in an unlimited supply in the greenhouse; and [4] callus is being induced from the aesthetically pleasing female plant.

BUFFALOGRASS WATER USE RATES - Preliminary results show experimental varieties NE 84-315 and NE 8a4-409 along with the common variety Homes exhibited the lowest 48-hour water use rates at 10.33, 11.37 and 11.76 mm, respectively. Varieties NE 84-304, NE 84-609 and Texoka showed relatively higher 48-hour rates at 11.89, 12.61, 12.62 mm, respectively. All the varieties tested show a substantial water savings compared to the most commonly used turfgrasses which have water use rates ranging from 12 to over 20 mm per 48-hour cycle.

IMAGE ANALYSIS - The application of remote sensing and digital analysis, thereby decreasing processing time and increasing accuracy. Time and manual input by operator was reduced by 50% with the computer method. Processing of digital images by different operators was possible without loss of accuracy.

FAIRWAY MANAGEMENT STUDY - Observations of research plots since 1985 suggests that buffalograss could be used on golf course fairways with significant savings of water, fertilizer, pesticides and mowing. Results from studies indicate a savings of greater than 50% for water and fertilizer use. A study was initiated to evaluate buffalograss turfgrass quality and performance under modified fairway maintenance schedules and playing conditions.

MECHANICAL TURF PLUGGER FOR BUFFALOGRASS - A mechanical turf plugger was developed by retrofitting a Ryan GA 30 aerator plugging tines. The mechanical turf plugger was evaluated under field conditions to determine the adaptation of this method of plugging for extracting buffalograss [Buchloe dactyloides (Nutt.) Engelm.] plugs.

BUFFALOGRASS INSECT STUDIES - At the present time, studies are underway at the John Seaton Anderson Turfgrass Facility located at Mead, Nebraska, to secure a better understanding of mealybug biology, ecology, geographic distribution, seasonal abundance and injury potential in buffalograss.

CULTURAL PRACTICE INTERACTIONS ON GOLF COURSE TURF

UNIVERSITY OF NEBRASKA
Lincoln, Nebraska

Dr. Robert Shearman
Principal Investigator

1989 Research Grant: $25,000
[sixth year of support]

Irrigation and Potassium Effects on Fairway Kentucky Bluegrass Turf - Irrigation based on 100%, 80% and 60% potential ET [ETp] and potassium at 0, 20, 40, and 60 g K m per season were applied to field-grown Kentucky bluegrass turf. The turf was mowed four times weekly at 22 mm and clippings were removed. Potassium soil tests ranged from 310 to 821 mg. kg . Leaf potassium varied from 1.9 to 2.5%. Turf was visually evaluated monthly for color and quality. Turfs maintained acceptable color and quality ratings at all ET levels. Irrigation meters monitored weekly water use. In the summer of 1988 plots maintained at 60% ETp had acceptable color and quality ratings. Water savings of 52% [392,000 liters/hectare] and 27% [186,667 liters/hectare] were recorded for the 60% ETp during September when compared to the 100% and 80% ETp treatments. In the spring of 1989 the 60% ETp had 38% [930,119 1/ha] 21% [430,957 1/ha] water savings when compared to the 100% and 80% treatments. Additional data were taken on load bearing capacity, penetrometer readings, thatch, shoot density and verdure.

Vertical Mowing Frequency and Mowing Height Effects on Putting Green Quality and Plant Stress - This project was initiated to study the effects of vertical mowing frequency and mowing height on putting speed, rooting and stress resistance. Turfgrass root production and distribution increased as mowing height treatment increased from the 1/8 [3.2 mm] inch height of cut to either 5/32 [4.0 mm] or 3/16 [4.8 mm] inch. Rooting increased with vertical mowing frequencies of 14 to 28 days, when compared to turfs not receiving vertical mowing. The maximum soil temperature observed at the 1.0 inch [2.5 cm] soil depth was greatest for the 1/8 inch height of cut treatment. The two higher heights of cut had a wider range in diurnal temperatures than the 1/8 inch treatment. Vertical mowing treatments had no significant effect on soil temperatures. Putting speed, measured as ball roll, was highest at 1/8 and 5/32 inch mowing height treatments. Vertical mowing frequencies had no effect on ball roll during the 1989 study.

Syringing on A Creeping Bentgrass Green - A syringing study was initiated to study interactive effects with nitrogen and potassium nutrition. The study was designed so that treatment modifications over time would allow investigation of amount of water applied during syringing, application timing effects, and type of nozzle used to apply

syringing treatments. Only limited data were collected, during 1989. A comparison of syringed versus not syringed treatments indicated lower canopy and higher soil temperatures for the syringed treatment. More data will be collected from this study during 1990.

Creeping Bentgrass Fairway Management - The fairway management study was conducted to determine effects of irrigation frequency, clipping removal or return, nitrogen nutrition, and traffic on Penncross creeping bentgrass competition with annual bluegrass and maintenance of fairway quality. No data were presented on annual bluegrass competition due to this year being only the first of a three year study. Preliminary trends may be misleading. Turfgrass color and visual quality ratings increased with irrigation frequency and nitrogen nutrition under trafficked conditions. Ball roll increased with decreased irrigation frequency, clipping removal and decreased nitrogen nutrition. Load bearing capacity or ball holding characteristics of the turf was better for infrequent irrigation, clippings removed, and low nitrogen treatments when compared to their counterpart treatments. Divot tolerance was negatively correlated to soil moisture content. Divot injury was reduced under infrequent irrigation, clippings removed, and low nitrogen levels, but recovery was more rapid for counterpart treatments. Thatch accumulation trends were variable and were not summarized, since these trends need to be assessed over the three year study. Nutrient analysis data were not included because they were not summarized at this time.

MONOCLONAL ANTIBODIES FOR RAPID DIAGNOSIS OF SUMMER PATCH AND NECROTIC RING SPOT DISEASES OF TURFGRASSES

OHIO STATE UNIVERSITY
Columbus, Ohio

Drs. William M. Shane &
Stephen T. Nameth
Principal Investigators

1989 Research Grant: $10,000
[second year of support]

Necrotic ring spot and summer patch diseases of Kentucky bluegrass annual bluegrass, and other turfgrasses are extremely difficult to diagnose with traditional techniques. Research at Ohio State University is focussed on the use of immunological techniques for rapid diagnosis of these two diseases.

A monoclonal antibody-producing clone, LKc50 was developed that was selective for the causal agent of necrotic ring spot [Leptosphaeria korrae {LK}]. The antibody, used in an indirect ELISA test, reacted strongly against all verified strains of LK [>40] tested in laboratory studies, including strains from bermudagrass displaying symptoms of spring deadspot. The antibody did not react significantly with 42 non-LK antigens including Magnaporthe poae [summer patch pathogen], Gaeummanomyces [take-all], plant tissue, and common plant-inhabiting fungi.

Approximately 50% of cultures displaying LK characteristics received or isolated at Ohio State University have not produced the sexual stage [ascospores]. The ELISA test for LK has allowed us to identify these non-sporulating cultures as LK with relatively high certainty.

The ELISA test for LK also allows us to detect the pathogen direct ly on infected plant tissue. Samples of Kentucky bluegrass naturally-infected with LK were collected from Ohio, Washington, and Colorado during the summer and fall of 1989. Antibody of LKc50 reacted significantly with all plant samples from LK-infected turf but not with healthy turfgrass.

The ELISA test for LK in conjunction with standard culturing procedures can verify the presence of this pathogen in turfgrass with low infestations within 9 days. Infected plant tissue is plated on standard isolation media. Next, the ELISA test for LK is done when the fungus has grown out sufficiently to allow sampling with a 7 mm diameter cork borer [approximately 7 days]. This technique is appropriate when amounts of the pathogen on the turf sample are too low to detect directly with the ELISA test.

Monoclonal antibodies for the fungus causing summer patch, Magnaporthe poae [MP], are still under development. The first set of monoclonal antibodies for MP proved to be unsatisfactory. A second set of immunizations has been done with a new set of mice to obtain a set of clones with better selectivity. We expect to have clones with the desired selectivity by summer of 1990.

BREEDING AND EVALUATION OF FINE-TEXTURED, COLD-TOLERANT, SEED-PROPAGATED BERMUDAGRASS CULTIVARS

OKLAHOMA STATE UNIVERSITY
Stillwater, OK

Dr. C. M. Taliaferro
Principal Investigator

1989 Research Grant: $35,000
[fourth year of support]

RESEARCH PROGRESS

Basic fertility, as indicated by percent of florets setting seed, has been tripled in a cold-tolerant bermudagrass population via phenotypic recurrent selection. Intensive greenhouse selection for fine texture [small leaves and stems] was initiated in summer 1989. Several experimental synthetic varieties from this population will be placed in field evaluation trials in transition zone states in spring 1990. The ongoing population improvement breeding effort should result in successive improvement in turf quality and seed production potential.

Four very fine-textured, dense, cold-tolerant Cynodon transvaalensis accessions with good seed set were discovered in our germplasm nurseries in 1988. Six hundred and eighty-eight progeny from these plants were field planted August 1, 1988, and demonstrated significant variation for morphological features and winterhardiness. Almost 4000 progeny from the four C. transvaalensis accessions were space planted in field nurseries in 1989. Three thousand of these will be entered in a putting green evaluation test in spring 1990.

Two methods ["Freeze-Regrowth" and "Electrolyte Leakage"] for accurately measuring relative and absolute cold tolerance of bermudagrass plants have been perfected. The two methods are accurate, but time and labor intensive. Good progress was made in 1989 in developing a third method for rapid screening of large numbers of greenhouse grown bermudagrass plants.

Efforts during the past two years to regenerate bermudagrass plants from anther culture have not been successful; but effective, efficient procedures for regenerating plants from meristematic tissues have been developed. These procedures are currently being used to effect screening procedures for traits such as herbicide and salt tolerance, and to obtain genetic variants of potential value.

Four turfgrass evaluation trials are underway at a high maintenance level [fairway conditions]. The national bermudagrass trial, parental line evaluation, and a seeded bermudagrass trial are generating needed adaptation data. A holding nursery of 90 potential parents demonstrates the wide range of morphological features expressed when close mowing [3/4 inch].

BENTGRASS BREEDING

PENNSYLVANIA STATE UNIVERSITY
University Park, Pennsylvania

Dr. Joseph M. Duich
Principal Investigator

1989 Research Grant: $4,000
(ongoing support since 1958)

Utilizing starch gel electrophoresis, all but two of 26 varieties from four bentgrass species were distinctly identified by four enzyme banding patterns. PGI and TPI enzymes separated varieties into groups, and GOT and PRX into six groups. Seven of nine uncertified seedlots of Penncross were revealed not to be Penncross using PGI and TPI. Three of them even showed colonial bent patterns, which was also confirmed by results of GOT and PRX. A number of golf clubs have encountered serious putting green problems due to the sale of "bogus" Penncross seed.

A series of studies were completed involving work to enhance colonial bentgrass breeding. Early flowering response beginning with seed germination showed that a 17 week combination of controlled induction and initiation could result in a satisfactory number of seed heads. This was the shortest period in time efficiency. Haploid plant production from anther tissue culture was not successful for several varieties of colonial bentgrass. Levels of 2,4-D were evaluated to determine the feasibility of a somatic tissue culture system. Genotype variation for percentage of callusing seedlings and callus size was observed after culture. Astoria was ranked as the best variety with 59% callusing and a mean size of 4.3 mm. Microspore maturity and callose deposition relative to panicle development in Agrostis castellana, Highland bent, were investigated in four stages of panicle development. Evidence suggests that callose could limit response of young microspores to tissue culture.

A putting green evaluation test with 38 varieties, including 28 PSU experimentals, was established. Six experimentals were very promising after the first year in three international trials. Over 200 progeny lines were established in a nursery to develop close-cut tolerant creeping bentgrasses.

Second year fairway management results show;

1) near elimination of Poa annua with two paclobutrazol applications, especially with clipping removal,

2) less leafspot, dollarspot, and brownpatch with clipping removal,

3) best turf quality and Poa annua competition in descending order with Penneagle, Pennlinks, Penncross and Seaside varieties, respectively.

SELECTION AND BREEDING OF SUPERIOR BENTGRASSES

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island

Dr. Richard Skogley
Principal Investigator

1989 Research Grant: $5000
[ongoing support since 1960]

The USGA research grant has been utilized to support our extensive effort in plant improvement. First year seed production was achieved on about 300 collected bentgrasses and 300 fine fescues. Turf performance of about 120 experimental bentgrasses was monitored. First year commercial release of "Providence" creeping bentgrass occurred and seed was sold to 40-50 New England golf courses and many others nationally. An improved, endophyte-containing, variety of Chewings fescue was released during 1989. Several improved creeping, colonial and velvet bents have been sent to seed companies for possible release.

BREEDING AND EVALUATION OF KENTUCKY BLUEGRASS, TALL FESCUE, AND PERENNIAL RYEGRASS FOR GOLF

RUTGERS UNIVERSITY
New Brunswick, New Jersey

Dr. C. Reed Funk
Principal Investigator

1989 Research Grant: $5000
[ongoing support since 1961]

We are continuing an extensive program to collect, evaluate, enhance, and preserve turfgrass germplasm and to develop turfgrass cultivars with improved stress tolerance, greater pest resistance, increased persistence, better turf-forming properties, and reduced maintenance requirements. Much of this work involves cooperation with scientists in other disciplines, continued contact with people throughout the turfgrass industry, and increasing cooperation with breeders and management specialists in the major seed producing regions. It includes numerous contributions by students and technicians. Training of students is an important part of our program.

Nearly 200 entries of colonial bentgrass from New Zealand were established in turf tests at North Brunswick in addition to the "fairway" and "greens" tests received from the National Turfgrass Evaluation Program. The colonial bentgrasses came from Dr. William Rumball and are the result of the USGA turfgrass improvement program.

Buffalograss received from the USGA program at the University of Nebraska were established in turf trials adjacent to collections made from old turfs in New Jersey.

PLANT STRESS MECHANISMS

TEXAS A&M UNIVERSITY
College Station, Texas

Dr. James B. Beard
Principal Investigator

1989 Research Grant: $67,800
[seventh and last year of support]

Support of Dr. Beard's work on Plant Stress Mechanisms was concluded in 1989. At the time of preparing this document, Dr. Beard's final summary report was in the preparation stage and could not be included in time for this printing. His final report will appear in the 1990 Turfgrass Research Summary.

DEVELOPING BROWN PATCH AND PYTHIUM DISEASE RESISTANCE IN BENTGRASS AND ZOYSIAGRASS

TEXAS A&M UNIVERSITY
Dallas, Texas

Dr. Phillip F. Colbaugh
Principal Investigator

1989 Research Grant: $10,000
[third year of support]

New techniques developed for volume handling and inoculating of turfgrass field samples were successfully used for mass screening of bentgrass germplasm lines for Pythium spp. resistance. Core samples from the field or greenhouse were placed in plastic McDonald's sundae cups and were covered with plastic lids containing aeration holes. The sundae cups were placed in covered clear plastic boxes after grass samples were inoculated with pathogenic fungi and maintained in a moisture saturated environment for a 7-day period.

This technique allows the fungi to grow in water saturated air and provides conditions under which predictable results can be expected with regard to the pathogenic development of the fungi. Large scale disease screening efforts with the cups was accomplished with two walk-in environmental chambers maintained with continuous incandescent lighting and temperatures of 26 C. The technique is now being used routinely to screen as many as 530 turfgrass genotypes with reliable Pythium blight results in five to seven days.

Considerable progress has been made in the identification of bentgrass genotypic lines with resistance to Pythium foliar blighting. Large numbers of bentgrass genotypes have been challenged with highly virulent Pythium spp. strains, and some of the genotypes which withstood the initial inoculations were re-challenged with Pythium spp. to reinforce their resistance status. Of 1203 field collected bentgrass lines inoculated during the reporting period, 5.9% expressed Pythium blight resistance, while 11% showed disease tolerance and 83% were moderately or highly susceptible to the disease. The commercial bentgrass variety, Penncross, was consistently highly susceptible with an overall mean disease severity rating of 96.3%. Previous studies have shown that bentgrass germplasm lines obtained from the field were more resistant to Pythium blight than the same plants grown on a greenhouse bench for extended periods prior to inoculation. At this time, all inoculations are carried out on field-grown turfgrass samples in order to maximize the identification of disease resistance.

BREEDING AND DEVELOPMENT OF ZOYSIAGRASS

TEXAS A&M UNIVERSITY
Dallas, Texas

Dr. M. C. Engelke
Principal Investigator

1989 Research Grant: $45,000
[seventh year of support]

A major redirection within the zoysiagrass program occurred in 1989 with the addition of Dr. Richard H. White, as Assistant Research Scientist specializing in turfgrass physiology, and Dr. Bridget Ruemmele in turfgrass breeding. The combined efforts of the group have been directed specifically to the assessment of germplasm relative to stress tolerance mechanisms and the specific hybridization of selected accessions in order to study the relative heritabilities of such traits and to combine multiple desirable traits into new varieties.

Maintenance of the zoysiagrass germplasm nurseries will receive considerable attention these next few years due to the reduction in turfgrass research efforts on the part of the United States Department of Agriculture. The Oriental zoysiagrass collection will be consolidated and eventually entered into the Plant Introduction System. Vegetative maintenance and production of these accessions, as well as newly developed cultivars, has become streamlined and more expedient with the use of thin-layer sod production techniques developed here.

Numerous elite accessions of zoysiagrasses have been evaluated for water-use requirements under field conditions using the Linear Gradient Irrigation System [LGIS]. A parallel set of accessions are also being evaluated for growth response under the Turfgrass Root Investigation Facility [TRIF] as well as under heavy natural shade. The combined testing facilities suggest considerable genetic variability exist within the elite accessions [DALZ lines] as well as the Oriental collection. Of greatest promise is the variation noted for water-use, canopy temperature, growth response, growth habit, texture and turf quality. Regional trials suggest good variability exist among the lines under evaluation for cold hardiness, rate of spread, texture and turf quality.

Regional field trials have been established in several locations including Missouri, Illinois, Arizona, California, Oklahoma and Florida as well as several locations in Texas. Electrophoresis has been completed on 23 DALZ lines by Dr. Lin Wu, University of California, Davis.

DALZ8501 and DALZ8502 have been identified for their superior regrowth and recovery ability due to highly rhizomatous growth characters. DALZ8502 has potential for use in the deep south for putting greens. It retains an excellent winter growth characteristic, has been identified as a low water-user, and has a relatively low

nutritional requirement. Additional testing will be initiated for its potential use on the putting surface. Foundation production fields of both DALZ8501 [1.0 acres at TAES-Dallas] and DALZ8502 [1.7 acres in Bay City, Texas] were planted in the spring of 1989.

Numerous selections have been identified in the Oriental collection for turf quality, color retention, greenup, drought hardiness, seed production potential, and numerous desirable agronomic traits. Considering the cold susceptibility of DALZ8501, and DALZ8502, it will be necessary to concentrate on identifying and developing accessions with considerably more winter hardiness.

BREEDING AND DEVELOPMENT OF BENTGRASSES

TEXAS A&M UNIVERSITY
Dallas, Texas

Dr. M. C. Engelke
Principal Investigator

1989 Research Grant: $60,000
[fifth year of support; $20,000 of the 1989 total was contributed by Bentgrass Research, Inc. of Ft. Worth, TX]

The bentgrass breeding program is entering its sixth year of funding by the USGA/GCSAA - Bentgrass Research, Inc. Considerable progress has been made these past four-plus years with three synthetic populations being advanced to breeder/foundation fields in Oregon in January, 1989. New crossing blocks and hybridization nurseries were established in Oregon in 1988-89 and will be used for extensive single and polycross matings beginning in 1990.

Foundation fields of the three synthetics suffered severe winter damage in February 1989 resulting in poor seed production this year. Regardless, sufficient seed of Syn1-88 was produced on an older planting and was entered in the NTEP Bentgrass Test for Modified Soils and has been planted at 16 locations in the United States. The NTEP Bentgrass Trial with a total of 20 entries was planted on 10 October at TAES-Dallas on a modified green.

Syn3-88 and Syn4-88 failed to produce sufficient seed to enter at all the NTEP trial sites. However, we have contracted with five key locations across the United States to include both of these in the NTEP trials for comparative evaluation. Additional transplants of all three synthetics were replanted into the foundation fields in Oregon in October, 1989.

Quality evaluations of Syn1-88, Syn3-88, and Syn4-88, tested at Augusta, GA and Dallas, Texas indicate significant differences in performance of the first products of the program. The synthetics are distinct from each other and from the commercially available varieties. Quality ratings by the USGA research group evaluations on 18 July indicate that the three varieties from the program were in the top performance grouping for that date. Phenotypic stability ranking of quality ratings by TAES researchers also indicates progress in the breeding of bentgrasses from this program for use in the Southern United States.

The flexible tube procedure for screening root characters of bentgrass germplasm was completed during 1989. Based on parent-progeny regression analysis, heritability of root extension is 0.76, with significant correlations between root extension and root number, and root number and root area. Heritability estimates for tiller number and tiller dry weights was estimated at 0.31 and 0.32 respectively.

Field observations completed in August 1989, of bentgrass genotypes indicated a significant correlation between root extension and drought resistance.

Assessment of genotype performance continues in the greenhouse, field, and laboratory, with continued screening of germplasm. Superior plants are continually being identified and recycled in the breeding program. Invaluable cooperation continues from Pickseed West, with Mr. Kent Wiley and Dr. Jerry Pepin.

DEVELOPING SALT, DROUGHT AND HEAT RESISTANT TURFGRASSES FOR MINIMAL MAINTENANCE

TEXAS A&M UNIVERSITY
El Paso, Texas

Dr. Garald L. Horst
Principal Investigator

1989 Research Grant: $15,000
[sixth year of support]

RESEARCH ACCOMPLISHED

Initial zoysiagrass evaluation was completed as of fall, 1988, where [29] entries were evaluated in four tests.

Zoysiagrass appears to have medium potential for salt resistance in the limited germplasm base that was tested. This plant material base was from the Texas collection.

Some zoysiagrass selections appear to have good salt resistance. The selections could be useful in cultivar improvement work and in saline environments without additional selection pressure.

Bentgrass germplasm [25 entries] from the improvement program under the direction of Dr. M. C. Engelke was received at the end of 1988. The material is currently being evaluated for salt resistance.

The advanced long term study is underway, and the first trial of bentgrass is going to take place in the course of this year.

CURRENT RESEARCH

The initial bentgrass germplasm base is being evaluated for salt resistance.

Promising bentgrasses will be evaluated in our new advanced salt resistance study set up.

RESEARCH PLANNED 1989/90

Continue bentgrass evaluation tests.

Begin to proto-type advance salt resistance studies as an option, or support of our current aeroponic tank system.

Begin evaluation of the Nebraska buffalograss germplasm base for salt resistance.