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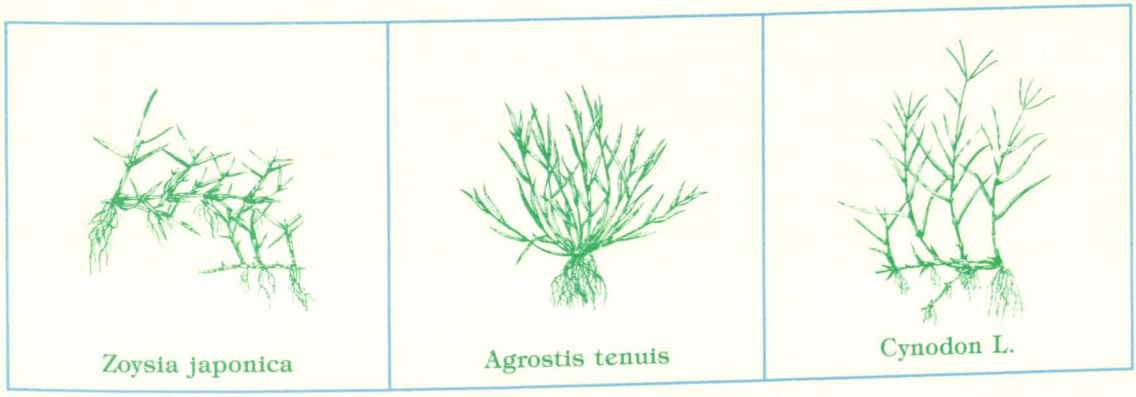
USGA GREEN SECTION®

1988 TURFGRASS RESEARCH SUMMARY



Zoysia japonica | Agrostis tenuis | Cynodon L.

1988 TURFGRASS RESEARCH SUMMARY

SUBMITTED JOINTLY BY:

United States Golf Association
Golf House
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Golf Course Superintendents Association of America
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December 1, 1988

TO: THE READERS OF THE 1988 ANNUAL TURFGRASS RESEARCH SUMMARY

It's easy to feel, when reviewing annual research reports, that too little has been accomplished. This is the sixth year of the joint USGA Green Section - Golf Course Superintendents Association of America's research venture. Our goal remains the same; i.e., to develop new turfgrasses and management techniques that will reduce golf course maintenance costs and water use requirements by 50 percent by 1993.

Where are the new grasses? Why haven't we produced dozens of new varieties by now, capable of growing anywhere and in any manner we wish? What became of the new tools and techniques we were going to create to solve the turfgrass problems of the day? These thoughts are spurred even deeper by the not so old saw, "If we can put a man on the moon, why can't we do thus and so?"

In formulating a reply, it's safe to say that putting a man on the moon is basically (and heroically) an engineering feat. We're dealing with nature. I recall one of Ralph Waldo Emerson's quotations, "Adapt the pace of nature; her secret is patience." I feel better. The progress of turfgrass research IS nature.

And progress there has been! At the moment, the brightest point of light comes from the talents of Dr. Arden Baltensperger, Plant Breeder at New Mexico State University. His newly developed improved variety of seeded common bermudagrass, called SAHARA, is going to be available and on the commercial market in 1989. Dark green in color, exceptional drought resistance, lower growing habit with shorter internodes (tighter turf), SAHARA has also proven to be an excellent seed producer; an important key for the success of any new grass.

Commercial growers are also interested in the new buffalograsses under development by Dr. Terry Riordan at the University of Nebraska. The release of a superior vegetative cultivar in 1989 is planned and improved seeded types are expected within a few years. There are very encouraging signs that the range of adaptability of buffalograss may also be greater than expected and, given the right cultural practices, this low water requirement fairway grass may have far reaching consequences for

golf and potable water conservation in cool season regions of America.

If you are a golfer who prefers bentgrass greens and fairways (but are tired of the problems they usually present each summer), you will want to read the reports from Texas A&M - Dallas, the DSIR in New Zealand, Penn State and Rhode Island. All tell of progress in developing improved types with greater heat tolerance, lower water and fertilizer requirements, and disease resistance; all without loss of superior playing quality. In fact, many of these improved seeded bentgrasses will be entered in the 1989 U.S. Department of Agriculture National Bentgrass Trials. They will receive wide regional testing. The target date of 1991 or 1992 for release of the early, promising, new bentgrass varieties holds firm.

Other breeding projects are progressing equally well. The extremely difficult work at Oklahoma State University in developing a seeded, cold tolerant and fine leaf bermudagrass has been outstanding. Dr. Burton at Tifton, Georgia, released Tifton 10 last year, a vegetative bermudagrass selection he found in China in 1974. Breeding research continues with Poa annua in Minnesota, Curley Mesquitegrass in Arizona, Zoysiagrass (Texas), Native Grasses (Colorado), and the excellent work of Dr. Reed Funk at Rutgers.

A major advance in the USGA Turfgrass Research Committee's work in 1988 occurred at Michigan State University. The computerized Turfgrass Information File (TGIF) went 'online.' The bibliographic research database of over 14,000 entries may now be accessed by telephone from anywhere in the world. Be sure to read this exciting research report telling of an unbelievable advancement in the dissemination of turfgrass information.

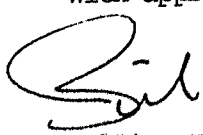
The Research Committee also conducted a three day joint meeting involving all USGA funded plant breeders with plant physiologist James Beard in Portland, Oregon in July, 1988. Dr. Beard updated the breeders on his plant stress mechanism studies and how that information may be successfully used in their breeding programs. The group visited the extraordinary turfgrass farms of Turf-Seed, Inc. It was an international meeting of sorts. Dr. Peter Hayes, Director of the Sports Turf Research Institute, Bingley, England was the invited guest of the Research Committee. Some of The Institute's work has recently been supported by the R&A.

Monitoring visits to all experiment stations receiving major funding from the USGA were continued in 1988. One and often two or more committee members travel to the research sites and review progress with each project leader. It is one sure way of keeping in touch and on top of the funded research programs.

You will find additional reports in the pages that follow; vital work carried out by dedicated scientists. In all, $470,000 was invested in these undertakings in 1988. As you read through the reports, I'm confident you will feel the same enthusiasm, the same excitement as do members of the Research Committee. The names of the committee members appear on one of the following pages and we are most grateful to them for contributing their time and great talents to this venture, for they serve without compensation.

Like crocus in the snows of spring, our achievements of the last six years are just beginning to show. The program will succeed, we are confident of that. We are grateful to all the golfers and organizations who have and continue to support turfgrass research of this magnitude. By itself, this is unique in all of Sportsdom. No other group of players or athletes, amateur or professional, have ever done anything like it before. Golfers have not only contributed to the advancement of their own game, but have also contributed to an improved environment and a higher standard of living for everyone in America. Golf Keeps America Beautiful! "The Pace of Nature" assures it.

With appreciation,



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

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February 1, 1989

To the Readers of the 1988 Annual Turfgrass Research Summary:

Nothing the USGA does, or is likely to do, will have more of an effect on the future of golf than funding and monitoring turfgrass research.

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

If the game is to continue to thrive there has to be a way of getting hold of these costs. For example, reducing the amount of water used for golf is essential.

The funding process is controlled by a Turfgrass Research Committee--a group of eleven who have distinguished careers as academics, as agronomists from the USGA Green Section, as golf course superintendents, or as leaders of the turfgrass industry.

The Turfgrass Research Committee not only determines how the money will be spent but, just as important, its members go out and personally track the progress of the work.

During 1989, the first specific results of this effort, which began in 1982, will come to the market in the form of an improved bermudagrass. There will be more to come.

The 1989 budget calls for 21 grants, totaling $620,300, at 14 universities. The USGA has every hope and expectation of not only continuing, but accelerating the research activity in the future.

Sincerely,

Frank Hannigan
Senior 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 free exchange of information with other investigators.

USGA Turfgrass Research Committee

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January 6, 1989

TURFGRASS RESEARCH GRANTS

PROJECT	SUBPROJECT	UNIVERSITY/INVESTIGATOR	ACTUAL GRANTS 1983	1984	1985	1986	1987	1988	TOTAL ACTUAL 1983-1988	1989 GRANTS	TOTAL GRANTS 1983-1989	AVERAGE GRANT PER YR
STRESS MECHANISMS		Texas A&M-Coll.Sta/Beard	84,500	87,000	91,000	73,000	70,000	55,000	460,500	67,800	528,300	75,471
		SUBTOTALS:	84,500	87,000	91,000	73,000	70,000	55,000	460,500	67,800	528,300	
TURFGRASS BREEDING	Breeding General	Rutgers/Funk	5,000	5,000	5,000	5,000	5,000	5,000	30,000	5,000	35,000	5,000
	Bentgrass	Penn State/Duich	4,000	4,000	4,000	4,000	4,000	4,000	24,000	4,000	28,000	4,000
*	Bentgrass	Texas A&M-Dallas/Engelke			47,000	40,000	40,000	40,000	167,000	60,000	227,000	45,400
	Bentgrass	New Zealand DSIR/Rumball				10,000	10,000	10,000	30,000	10,000	40,000	10,000
	Bentgrass	Univ of RI/Skogley	1,500	1,500	1,500	1,500	5,000	5,000	16,000	5,000	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	30,000	5,000	35,000	5,000
	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	60,000	35,000	95,000	23,750
	Native Grass	CO State/Cuany			10,000	20,000	20,000	25,000	75,000	25,000	100,000	20,000
	Native Grass	Univ of AZ/Mancino						5,000	5,000	12,000	17,000	8,500
	Native Grass	Univ of ME/Riordan		4,100	20,000	18,000	19,000	25,000	86,100	35,000	121,100	20,183
	Poa Annua	Univ of MN/White		11,600	15,000	15,000	20,000	30,000	91,600	35,000	126,600	21,100
	Zoysiagrass	Texas A&M-Dallas/Engelke	2,500	42,585	42,000	40,000	40,000	40,000	207,085	45,000	252,085	36,012
**	Cultivar Eval.	Multiple Sites								43,000	43,000	43,000
	Screening Eval.	Multiple Sites								15,000	15,000	15,000
	Dryland Bentgrass	New Zealand DSIR/Rumball								3,000	3,000	3,000
		SUBTOTALS:	20,500	80,785	169,500	198,500	208,000	217,000	894,285	337,000	1,231,285	
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	45,000	18,000	63,000	15,750
	Pathology	Texas A&M-Dallas/Colbaugh					10,000	10,000	20,000	10,000	30,000	10,000
	Pathology	OH State/Shane & Hameth					10,000		10,000		10,000	10,000
	Pathology	MI State/Vargas		1,500					1,500		1,500	1,500
	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	Texas A&M-El Paso/Horst		3,480	15,000	15,000	15,000	15,000	63,480	5,000	68,480	11,413
	Interactions	Univ of NE/Shearman		4,000	23,000	20,000	20,000	25,000	92,000	25,000	117,000	19,500
***	Kikuyugrass	Univ of CA-Riverside/Shaw								45,000	45,000	45,000
	Morphology	MS State/Krans								2,500	2,500	2,500
		SUBTOTALS:	3,000	14,723	69,000	95,000	110,000	65,000	356,723	105,500	462,223	
BIOTECH	Methodology	Univ of IL/Smith						8,400	8,400		8,400	8,400
		SUBTOTALS:						8,400	8,400		8,400	
TURFGRASS RESEARCH LIBRARY		MI State/Chapin	5,000	96,326	68,000	55,000	65,000	65,000	354,326	60,000	414,326	59,189
		SUBTOTALS:	5,000	96,326	68,000	55,000	65,000	65,000	354,326	60,000	414,326	
ADMINISTRATION	Research Cte Meetings		13,500	13,766	19,319	11,100	16,500	30,500	104,685	33,000	137,685	19,669
	Project Insp.						7,000	20,500	27,500	22,000	49,500	16,500
	Printing						3,500	8,600	12,100	10,000	22,100	7,366
	Legal Fees									5,000	5,000	5,000
		SUBTOTALS:	13,500	13,766	19,319	11,100	27,000	59,600	144,285	70,000	214,285	
CONTINGENCY ****										20,000	20,000	20,000
		SUBTOTALS:								20,000	20,000	
		TOTALS:	126,500	292,600	416,819	432,600	480,000	470,000	2,218,519	660,300	2,878,819	411,259

(RSCHGRNT)

* Includes matching grant by Bentgrass Research, Inc. of Fort Worth, TX: 1985 - $27,000; 1986-1989 - $20,000/year.

** Cultivar Evaluations for new grasses - budget formulas: Bentgrass - $300/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 MN); Native Grass (4-CO State).

*** Kikuyugrass improvement and control: $20,000 each provided by NCGA & SCGA; total annual grant - $45,000.

**** Contingency. These funds pending confirmation of two research proposals by the USGA Turfgrass Research Committee.

TURFGRASS RESEARCH GRANTS

SUMMARY: 1983-1989 ACTUALS

JANUARY 6, 1989 (B:RSCHSUM)

PROJECT CATEGORIES	ACTUAL GRANTS 1983	1984	1985	1986	1987	1988	1989	TOTAL ACTUAL 1983-1989	AVERAGE ACTUAL PER YEAR
STRESS MECHANISMS									
TOTALS:	84,500	87,000	91,000	73,000	70,000	55,000	67,800	528,300	75,471
PCT OF ANNUAL TOTAL:	66.8	29.7	21.8	16.9	14.6	11.7	10.3	18.4	
TURFGRASS RESEARCH LIBRARY									
TOTALS:	5,000	96,326	68,000	55,000	65,000	65,000	60,000	414,326	59,189
PCT OF ANNUAL TOTAL:	4.0	32.9	16.3	12.7	13.5	13.8	9.1	14.4	
BIOTECH									
TOTALS:						8,400		8,400	1,200
PCT OF ANNUAL TOTAL:						1.8		.3	
TURFGRASS BREEDING									
TOTALS:	20,500	80,785	169,500	198,500	208,000	217,000	337,000	1,231,285	175,897
PCT OF ANNUAL TOTAL:	16.2	27.6	40.7	45.9	43.3	46.2	51.0	42.8	
CULTURAL PRACTICES									
TOTALS:	3,000	14,723	69,000	95,000	110,000	65,000	105,500	462,223	66,031
PCT OF ANNUAL TOTAL:	2.4	5.0	16.6	22.0	22.9	13.8	16.0	16.1	
ADMINISTRATION									
TOTALS:	13,500	13,766	19,319	11,100	27,000	59,600	70,000	214,285	30,612
PCT OF ANNUAL TOTAL:	10.7	4.7	4.6	2.6	5.6	12.7	10.6	7.4	
CONTINGENCY *									
TOTALS:							20,000	20,000	2,857
PCT OF ANNUAL TOTAL:							3.0	.7	
ALL CATEGORIES ANNUAL TOTALS:	126,500	292,600	416,819	432,600	480,000	470,000	660,300	2,878,819	411,259
TOTAL PERCENT:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Contingency. These funds pending confirmation of two research proposals by the USGA Turfgrass Research Committee.

EVALUATION OF CURLY MESQUITEGRASS

AS A DESERT TURFGRASS

THE UNIVERSITY OF ARIZONA
Tucson, Arizona

Dr. Charles F. Mancino
Principal Investigator

1988 Research Grant: $5,000
(first year of support)

Mancino and Ralowicz at Arizona have made considerable progress on the Curly Mesquitegrass Project with USGA funding for the last eight months. Curly Mesquitegrass (Hilaria belangeri), similar in appearance to buffalograss, is being evaluated as a minimum input, low water requiring desert turfgrass. Plant materials (100 selections) collected in Arizona from approximately 25 specific sites have proven to be diverse, and are maintained in a germ plasm nursery at the Campus Agricultural Center. Plant collections are being planned for higher elevation areas in Arizona. At present, accessions possessing turfgrass qualities for minimum to medium maintenance situations have been identified. This plant material is being vegetatively increased for an experiment investigating responses to cutting and fertilizing. Additionally, other accessions appear to be promising soil stabilizing plants.

Early research focused on flowering biology. Female flowers finish emerging one week before male flowers shed pollen on the same spike. Research then progressed to seed related investigations. Two experiments were performed to evaluate germination responses of (a) range, and (b) nursery produced seed. Seed gathered on the range had an average germination of 31.2 percent while germination of nursery produced seed averaged 41.9 percent. Nursery produced seed had a greater average seed index (wt/100 seed); however, range produced seed germinated faster. In both germination experiments, seed treated with a growth hormone, gibberellic acid, germinated better than seed treated with distilled water or potassium nitrate. Accessions displaying high germination rates and percentages in both range and nursery produced seed are being vegetatively increased as seed production is essential for commercial acceptability of this grass.

Polyacrylamide gel electrophoresis is a method of identifying or fingerprinting plants with respect to specific plant enzymes. The end result of electrophoretic analysis is either an identical pattern of bands between plants having the same genes for the enzyme (the same fingerprint), or different banding patterns between plants with different genes for that enzyme (different fingerprints). A common misconception has been that curly mesquitegrass does not reproduce by seed on the range, but rather that it spreads vegetatively by stolons. Stolon plants are clones which manifest the same electrophoretic fingerprints. Plants that looked identical and were collected within inches of each on the range have shown different enzyme banding patterns. This indicated that these plants were not clones, but more likely produced from seed. In view of the powers of electrophoretic

analysis, individual plants are being isolated and clonally increased in the greenhouse. These plants will be fingerprinted for the peroxidase enzyme and then used in an experiment to determine if plants can pollinate themselves and produce viable seed. The seed will be grown out and fingerprinted to confirm the parents used for pollination.

DEVELOPMENT OF DRYLAND WESTERN TURFGRASS CULTIVARS

COLORADO STATE UNIVERSITY
Fort Collins, Colorado

Dr. Robin Cuany
Principal Investigator

1988 Research Grant: $25,000
(fourth year of support)

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. Advance 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 advance 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 winter hardiness tests here of promising bermudagrass strains from Oklahoma.

COLONIAL BENTGRASS BREEDING

DEPARTMENT OF SCIENTIFIC & INDUSTRIAL RESEARCH - NEW ZEALAND

Dr. William Rumball
Principal Investigator

1988 Research Grant: $10,000
(third year of support)

This New Zealand-based project sets out to breed a cultivar of Colonial bentgrass (Agrostis tenuis) that is attractive and stable under low-input conditions. The material used so far in the project has been collected from over 70 golf courses in the drier regions of New Zealand, and largely from those parts of the courses that have no upkeep except mowing.

The project is proceeding to schedule, though several strategy changes have been made during the year. On the one hand, there is now evidence that "dryland bent" (Argostis castellana) is more immediately useful than A. tenuis for dry soils. It has some natural disadvantages as well, such as relative paucity of seed production and an undistinguished color. However, there is scope within the existing Grasslands material to reduce these weaknesses.

On the other hand, we continue to suspect that A. tenius has less genetic ability to adapt to severely dry sites than might have been assumed. There has been no difficulty locating plants of A. tenuis in non-irrigated golf courses, but we suspect they are usually confined to microsites that are damper or of heavier soil texture than average. Where the greens or other parts of a course are irrigated, it is noticeable that the A. tenuis is much more frequent. However, we are continuing to gather data on all 1,400 plants collected in 1987 and 1988, both for seed-producing potential and for agronomic desirability in close-mown swards. The question to be next considered is whether it is wise to complete a refined selection program entirely within New Zealand, i.e. totally unexposed to the unique American stresses of high temperature, disease races etc., that a selection must eventually meet. It may be more sensible to make an early selection of the most promising New Zealand collection, and then to evaluate this in the USA for guidance on further improvements.

A further option as a breeding strategy is to apply an artificial low-maintenance screen across large numbers of seedlings, either of our two successful cultivars Egmont and Sefton, or of the large and varied unselected gene pool of A. tenuis naturalized throughout New Zealand. We have preferred to take the ecotypic approach of collecting material from existing low-maintenance sites because it is simpler and quicker. There is little question now that if such naturally selected material exits in New Zealand, it is probably contained within our two collections. Our immediate task is to locate the most adapted plants, and to assemble them into a selection for evaluation and further screening.

BERMUDAGRASS BREEDING -- VEGETATIVE

UNIVERSITY OF GEORGIA
Tifton, Georgia

Dr. Glenn W. Burton
Principal Investigator

1988 Research Grant: $5,000
(ongoing since 1956)

The most significant accomplishment of our turf research program at Tifton, Georgia in 1988 was the official release of Tifton 10 turf bermudagrass. This is an increase of vegetative material that I collected from a lawn in Shanghai, China in 1974. It sheds pollen but sets few seeds and must, therefore, be propagated vegetatively. It is a hexaploid with 2n = 54 chromosomes. Common bermudagrass has 36 chromosomes and the Tif turf bermudas have 27. Tifton 10 has a unique bluish-green color that sets it aside from other turf bermudagrasses. It has been evaluated at nine locations in Georgia, Florida, Texas, and New Jersey.

Tifton 10 rapidly establishes from stolons and above ground stems. Under low-cost management (2.5 lbs. N/1,000 sq. ft./yr., irrigated only in dry periods and mowed at 1 1/2 inch once a week), it has maintained turf quality similar (but coarser textured) to Tifway and Tifway 2 at all locations except Ft. Lauderdale, Florida where severe mole cricket damage destroyed stands during establishment. Tifton 10 was not seriously affected by mole cricket infestations at Gainesville, Florida and showed the least damage of 26 bermudagrass entries at Savannah, Georgia. Tifton 10 has received higher turf quality ratings than Midiron at locations where the two cultivars were compared. Tifton 10 received top winter survival ratings in New Brunswick, New Jersey and has survived at the Mountain Station at Blairsville, Georgia when the winter temperature in 1983-84 dropped to -20°F.

Tifton 10 should be suited for roughs, roadsides, low traffic athletic fields, commercial landscaping areas, and lawns. Its unusual dark bluish-green color will be useful for contrast plantings in various recreational areas. Because of its stonloniferous habit, care will need to be taken to keep it out of flower beds and other non-grassed areas. Traffic tolerance tests have not been conducted on Tifton 10 but its rapid recovery indicates it may have a use in low traffic athletic areas.

The mild winters that we experienced in 1987-88 kept us from getting differential ratings on the winter hardiness tests that we have planted on the golf courses in Blairsville, Georgia and Highland, North Carolina.

INFLUENCE OF SOIL MOISTURE LEVEL ON TURFGRASS WATER USE AND GROWTH

UNIVERSITY OF GEORGIA
Griffin, Georgia

Dr. Robert N. Carrow
Principal Investigator

1988 Research Grant: $10,000
(third and last year of support)

In this study, we subjected three warm-season grasses (Tifway bermudagrass, Meyer zoysiagrass, and common centipedegrass) to three irrigation regimes: well irrigated (WI), moderate stress (MS), and severe stress (SS). Significant accomplishments to date are:

A. Water use.

1. Evapotranspiration (ET) ranges for the three grasses under MS irrigation were: 2.5-3.1 (Tifway bermuda), 3.1-5.2 (Meyer zoysia), and 3.3-3.5 mm day^{-1} (common centipedegrass). Evapotranspiration rates for all grasses were 50-65% less than for the same cultivars reported from semi-arid or arid regions which reflects the influence of climate. Highest ET rates occurred in late summer, while late spring to mid-summer ET rates were 20% (bermuda), 40% (zoysia), and 6% (centipede) lower.

2. When comparing the WI versus MS irrigation programs (reflecting irrigation at 33% and 56% available soil water depletion), ET declined 13% to 18% for bermudagrass, while zoysiagrass had from +11% to -9% and centipedegrass +14% to -24% changes in ET. The positive increases in ET under the MS irrigation program occurred at times when increased deep rooting or root water extraction efficiency increased relative to the WI program. Thus, the higher ET under MS irrigation reflected better utilization of soil water and not an increase in applied irrigation.

B. Root Responses and Shoot Growth.

1. Tifway bermudagrass and common centipedegrass maintained good root length densities (RLD) at 0-10, 11-20, and 21-60 cm soil depths regardless of irrigation regime.

2. Meyer zoysiagrass rooting was most sensitive to increasing drought stress with RLD's declining 55% and 43% in the 0-10 and 11-20 cm zones, respectively, as stress increased from WI to SS. RLD's in the 21-60 cm zone increased slightly from WI to SS but root water extraction efficiency declined 56% indicating low viability of roots.

3. Total root length (in terms of cm/cm^2) in the 0-60 cm

zone for the WI, MS, and SS irrigation regimes, respectively, were 115, 109, 127 (bermuda), 55, 38, 36 (Meyer zoysia), and 213, 119, 139 (common centipede).

4. Soil water extraction by depth was closely related to RLD's at the same depths and these data can be used to explain the ET responses of each grass as it was subjected to drought stress.

5. Drought resistance rankings were:; Tifway bermudagrass (highest) >> common centipedegrass > Meyer zoysiagrass (least).

6. Meyer zoysiagrass exhibited initial wilt at -0.30 to -0.40 MPa soil water potential (at 15 cm), centipedegrass at -0.50 to -0.60 MPa, and bermudagrass did not exhibit wilt even at -0.70 MPa.

7. Within 1-3 days of reaching -0.40 MPa soil water potential, Meyer zoysiagrass started to show leaf firing (to dry by heat) from the leaf tip and margins down the whole leaf. Severe leaf firing and color loss occurred within 2-3 days of initial symptoms. The plant became semi-dormant and ET declined by 45-55%. Longer term shoot responses included decreased verdure and turf cover. Centipedegrass showed wilt at -0.50 MPa but leaf firing was not evident even at -0.70 MPa. Some loss of color would occur several days after wilting and verdure declined over time. Tifway bermudagrass exhibited only a slight decrease in visual quality even at -0.70 MPa soil water potential and no leaf firing, wilting or loss of verdure.

C. Irrigation Scheduling.

Based on water use savings and maintenance of adequate shoot quality/growth, the following irrigation regimes are suggested for growers using soil moisture sensors:

* Tifway bermudagrass at -0.40 MPa to -0.70 MPa at 15 cm depth or 56 - 76% soil water depletion (SWD) of the root zone.

* Meyer zoysiagrass at -0.30 MPa to -0.40 MPa at 15 cm depth or 42 - 56% SWD.

* Common centipedegrass at -0.50 to -0.60 MPa at 15 cm depth or 58 - 65% SWD.

The more frequent irrigation regime should be used in high use situations.

D. Implications to the USGA.

1. Unless zoysiagrasses other than Meyer exhibit substantial improvement in water use (at all irrigation regimes) and much better rooting when subjected to drought stress, this species may not prove to exhibit: (a) sufficiently low ET (water use), (b) drought tolerance, or (c) drought avoidance to achieve USGA water conservation goals.

2. Potential turfgrass releases from the USGA program should be evaluated in terms of ET, drought tolerance, and drought avoidance in field situations under expected drought stress conditions. The results of this project illustrate that: (a) estimation of ET from well irrigated conditions differs significantly from more stressed situations; (b) root systems may change dramatically and thus alter drought avoidance. These changes will not be evident in shallow lysemeters; and (c) some grasses may exhibit insufficient drought tolerance to use in drought stress conditions.

3. Potential releases that do seem to have deep root systems in near ideal conditions (such as zoysia does) must be evaluated not only under soil water stress but also under several soil conditions that are major causes for restricting potential rooting. Minimum conditions would be acid pH (surface or subsurface) and high bulk density (natural or from compaction). These two situations are the most prevalent soil conditions that limit maximum rooting. Unless a grass can maintain an adequate root system under soil moisture stress, acid pH, and/or high bulk densities for fine texture soils, the grass will either not exhibit necessary drought resistance and low ET or it will be limited in adaptation.

CULTIVATION METHODS ON TURFGRASS WATER RELATIONSHIPS AND GROWTH UNDER SOIL COMPACTION

UNIVERSITY OF GEORGIA
Griffin, Georgia

Dr. Robert N. Carrow
Principal Investigator

1988 Research Grant: $5,000
(third and last year of support)

Soil compaction is a major problem on recreational turfgrass sites because it adversely effects rooting and water relationships. A principal means of alleviating soil compaction is by cultivation. Limited data exists on the relative effectiveness of different cultivation techniques. In this project, five cultivation methods were compared under compacted soil conditions using Tifway bermudagrass: deep drill aerifier, hollow-tine coring, solid-tine (shattercore) coring, Aerway slicer and Ryan slicer.

On the Cecil sandy loam used in this study, soil oxygen diffusion was not strongly influenced by compaction and cultivation treatment. However, penetrometer resistance, a measure of soil hardness that restricts root growth, increased by 28% with compaction. Except for the deep drill aerifier, all cultivation methods substantially reduced penetrometer resistance and hollow-tine coring was most effective. Root growth in the 8-24 inch soil zone was enhanced by Aerway slicer (53-120%), deep drill aerifier (31-55%), and hollow-tine coring (20-35%) relative to the compacted control. Soil water extraction from difference depths was determined. On a compacted soil, a cultivation method that results in better uptake of soil moisture would be viewed as beneficial. Treatments exhibiting the best water use were hollow-tine coring, deep drill aerification and Aerway slicer. Improved water extraction came from the 4-8 and 8-24 inch zones. Most cultivation methods improved shoot growth (clipping yields) in 1987 but not significantly in 1988. These results reveal that, even on a very tolerant grass to compaction stress, differences in effectiveness of various cultivation methods occur. Cultivation procedures that removed a surface core (hollow-tine) or penetrated 6-10 inches deep (deep drill, Aerway slicer) on this compacted Piedmont soil were most effective in promoting root growth and best soil water use.

A REALISTIC WHOLE PLANT

MICROCULTURE SELECTION SYSTEM FOR TURFGRASSES

THE UNIVERSITY OF ILLINOIS
Urbana, Illinois

Dr. M. A. L. Smith
Principal Investigator

1988 Research Grant: $8,400
(one year project)

A broad range of warm and cool season turfgrass lines with definitive variations in salt and drought stress resistance (based on field tests) have been adapted into a comprehensive, uniform, continuous whole plant microculture system. The microenvironmental conditions have been optimized to provide a realistic analog to natural conditions and enhance visualization of the cultures during time course evaluation. The specific adaptations provide excellent root systems area and adequate aerial atmosphere so that each of the plant organs can respond to imposed stress with natural mechanisms of defense. Novel (microcomputerized video image analysis) methods for whole plant microculture screening analysis, and non-destructive quantification have been developed to amplify and strenghen the analytical approach.

The whole plant microculture system is directly compared in simultaneous tests with a solution batch culture system for evaluation of turfgrass salt tolerance characteristics. Paired sets of resistant and susceptible lines from each species are concurrently screened in solutions and whole plant microculture by gradually increasing salt concentrations to mimic field stress conditions. Both the solution culture and microculture systems have been designed to yield critical information that has previously been unavailable to turfgrass researchers in the stress tolerance arena of investigations/ information on turfgrass relative growth rate, osmotic adjustment, and quantitative color and morphometric response to imposed salt stress regimes. Both systems also allow unobstructed visualization and measurement of root system response to increasing salt stress information that is inherently unavailable in conventional field or greenhouse research.

Information gleaned from these completed studies will augment previous field results testing relative to salt tolerance responses of grasses. In addition, the microculture screen provides a rapid method for presecreening germ plasm that has not been feild evaluated, aids in elucidation of stress tolerance mechanisms, and can be readily adpated to screeing of somaclonal variants from callus-phase and biotechnological turfgass research efforts.

TURFGRASS RESEARCH LIBRARY

MICHIGAN STATE UNIVERSITY
East Lansing, Michigan

Dr. Richard C. Chapin
Principal Investigator

1988 Research Grant: $65,000
(sixth year of support)

In the spring of 1984, after an initial earlier grant, the USGA and Michigan State University signed an agreement whereby the MSU Library would design and develop a computer-based bibliographic database to provide access to published materials reporting the results of research that affects turfgrass and its maintenance. As of October, 1988, 13,000 records were entered in the bibliographic database. The USGA's Turfgrass Information File (TGIF) is housed in an Alpha Micro multi-user microcomputer, using the STAR database management software. It continues to work well with regular and continuing enhancements to record structure and searching capabilities.

Access and information services from TGIF were offered without charge until August, 1988. Following that date, searches became a billable activity with significant discounts (bordering on subsidy) for subscribers, and an outright subsidy (with a token $2.00 charge) for students. Making the database available for students in any location, under such an arrangement is, perhaps, a national precedent in bibliographic practice. Search requests from 31 states during the past year indicate the increasing level of recognition the file is receiving.

A full color brochure was published in August, 1988 describing TGIF, its charges, and how to access the index on-line, via telephone, or via mail. The brochure is available from USGA Green Section offices, or by contacting Peter O. Cookingham, Project Manager, Michigan State University Libraries, East Lansing, MI 48824 (517-353-7209).

To further promote TGIF, an insert post card was included in the July, 1988 Green Section Record magazine. Some 273 cards were returned, including responses from Australia, Brazil, Canada, Japan, Malaysia, The Netherlands and Thailand. Cards continue to arrive. Articles in The Record, the GCSAA Golf Course Management magazine and Grounds Maintenance, as well as numerous superintendent newsletters, assisted awareness activities.

The Turfgrass Information Center (TIC) at Michigan State also distributes the TGIF brochure as a part of it's Subscriber Application Package, which includes the details and forms necessary to subscribe to USGA TGIF and open an account with TIC. About 650 packets have been distributed since July, 1988.

VuePort, the PC software needed to dial into the Alpha Micro and STAR, is distributed to subscribers. The USGA Turfgrass Information

File Dial-Up User's Manual became available for subscriber use in October, 1988. The Manual provides an introduction to searching, USGA TGIF, TIC services, and guidance in using USGA TGIF as a tool in research and management. Revision and enhancement of the Manual will be a continuing activity of TIC, as we respond to user needs, inquiries, and system/service enhancements.

The initial subscribers to on-line access number 40 thus far, from 23 states and provinces. This group of pioneers roughly breaks out as 51% clubs/courses; 28% research/academic; 12% not-for-profit agencies; and 9% private sector. We are quite pleased with this initial distribution, which we feel gives us a good feel for expectations from several perspectives.

The first public edition of a Turfgrass Thesaurus, to aid in search strategy construction, awaits completion of developmental efforts to strengthen its usefulness and comprehensiveness. This is a primary activity of the Graduate Assistant working on the project, Douglas Lee. We hope that a first public print edition of the Thesaurus will be available in early or mid-1989. The Thesaurus, a necessary element to provide long-term stability to file structure, details inter-relationships between some 12,500 keywords related to turf culture. In time, it may become a standard turf reference work in and of itself, available both on-line alongside USGA TGIF and in print form.

In July, a survey was distributed to all turfgrass affiliated members of the American Society of Agronomy. It included information regarding USGA TGIF and resulted in a significant response, in terms of awareness, interest, and donation of materials. Summary results will be reported during this coming year.

In the meantime, data acquisition and entries continue to be made to the TGIF file. All pertinent information on turfgrass research, theses, dissertations, unpublished manuscripts, monographs, technical and popular journal articles, maintenance literature; any material deemed valuable is added to the file on a systematic basis. Emphasis continues on the completion of the 1980 - 1988 conference proceedings. In addition, citation tracing of currently published refereed turfgrass material adds to the comprehensiveness of the file. These file building techniques have resulted in TGIF citations originating from more than 1,270 different serial sources.

As file users have become acquainted with database objectives and usefulness, many materials have been contributed for processing and addition. Such contributions are particularly important for annual progress reports, theses and dissertations, and unpublished manuscripts. A systematic effort to encourage even more extensive collection donations will begin in the coming year.

IMPROVEMENT OF POA ANNUA AND POA SUPINA FOR GOLF TURF

UNIVERSITY OF MINNESOTA
St. Paul, Minnesota

Dr. Donald B. White
Principal Investigator

1988 Research Grant: $30,000
(fifth year of support)

New materials were added to the program from Alabama, California, Texas, Rhode Island, and Minnesota. Several tall seeded accessions were collected in Northern Minnesota.

Severe drought and heat conditions resulted in identification of stress tolerant strains of Poa annua and Poa supina. Summer dormancy mechanisms were observed in several materials in the field. All these materials were collected, increased and established in a new field space planting.

Replicated plantings of 8 selections were established at 18 golf courses located in 16 different states for evaluation. Progeny testing is being conducted for heritability for materials up to the 7th generation from when received. Seed dormancy of up to 3 months was found in some biotypes. Stolons of Poa annua and Poa supina maintained viability throughout 24 weeks of cold storage. Chlorophyll (green color) was maintained in the dark cold storage in Poa annua for 12 weeks.

Poa annua was separable from Poa supina and pedigree relationships were distinguishable in some crosses and selfs. Papers on stolon storage, electrophoresis, reproductive biology in poas, and chemical suppression of flowering to maintain pure stands were or will be presented at Society meetings. Experiments demonstrated that Poa annua and Poa supina are resistant to the grass herbicide Sethoxydin.

The "floral pic" technique for isolation and control of crossing performed equally well whether the carbon sources were sucrose or fructose sugar. Approximately 1,000 matings and seed collections were accomplished with the floral pic technique and analysis of resulting data is underway. Analysis of data indicates that, with some biotype, more than twice as much seed is produced from sib crossing as with selfs or crosses. This information is extremely important to developing a seed production system.

Divergence - Incongruity (Barriers to crossing and hybridization) were found. The phenomena were found in materials that were collected from wide geographic areas. For instance, materials from Arizona will not cross with materials from western Canada and materials from New York did not cross as well as local materials with Canadian materials.

Twenty-seven different esterases* were found in 54 Poa annua biotypes while 23 were displayed by 10 Poa supina biotypes. the electrophoretic gels of the 64 biotypes displayed 46 different esterase patterns.

In addition to maintaining the vitality of the project, the work for 1989 will focus on seed production evaluations and problems and field evaluation of selected materials.

*Esterase -- any of a group of enzymes by whose action the hydrolysis of esters is accelerated.
Ester -- an organic compound, comparable to an inorganic salt, formed by the reaction of an acid and an alcohol.

BREEDING, EVALUATION AND CULTURE OF BUFFALOGRASS

UNIVERSITY OF NEBRASKA
Lincoln, Nebraska

Dr. Terrance P. Riordan
Principal Investigator

1988 Research Grant: $25,000
(fifth year of support)

1. Commercialization of New Turf Type Buffalograsses

At the present time, there is interest in a vegetative release of buffalograss by 5 companies and interest from 7 companies for a release of a seeded variety. Our group feels it is important to make our initial release of a vegetative cultivar during 1989.

2. Buffalograss Evaluations

Oklahoma State University, Stillwater, OK: Dr. Joel Barber established improved buffalograss cultivars in 1987. The buffalograss did not exhibit any insect infestation or disease; however, competition with bermudagrass was a problem. Cultivars which rated high for color, quality and percent cover were: 84-409, 84-415, 85-364, 85-129, 84-5-2, 85-152-1 and 85-478-2.

Nuckolls County Extension Service, Nelson, NE: Mr. Chet Hawley established several improved buffalograss cultivars in 1987. Cultural practices were kept to a minimum with infrequent mowing and little or no irrigation or fertilizer. Cultivars which produced favorable turf-type qualities were 84-609, 84-104 and 84-514. The Ne 84-315 selection exhibited symptoms similar to those found at the Mead facility.

Texas A&M University, Dallas, TX: Dr. M. Engelke has evaluated several improved buffalograss selections and initially found several to have good performance.

3. Cultivar Development - Seed

Farmers Marketing Corporation: Is interested in continuing their efforts with buffalograss. They have had discussions with Arrow Seed (Nebraska) and Johnson Seed (Oklahoma) about the possibility of cooperatively producing seed of a proprietary cultivar at several locations.

Lofts Pedigreed Seed - Madris, Oregon: A small planting of experimental clones and Texoka were made in Madris during 1987. Observations this year suggest that buffalograss can grow and possibly produce very good seed (burrs) in these dry land production areas.

4. Synthetic Planting/Harvest plans for 1989

Female plants in this synthetic study were harvested during late September and early October. This seed will be processed over the winter for 1989 research and used for further seed development projects.

5. Plants for F1 Seeded Variety

Following discussions with Dr. Robert Ahring, retired Oklahoma State University professor in buffalograss seed production, the following plan for development of a seeded variety was made: Select several combinations of both male and female materials to produce either an F1 or a synthetic variety.

6. Evaluation of Time and Storage on Buffalograss

High germination of the caryopses stored at room temperature will encourage further study into removal of the caryopses from the burr.

7. Image Analysis

The method of image analysis reduces the time spent on collecting and analyzing rooting data and increases the accuracy of root information obtained. This method will be useful to researchers when studying rooting characteristics of cultural and breeding practices.

8. Problems/NE 84-315

During the summer of 1988, the buffalograsses performed quite well through the middle of July, even though we were under a severe drought and no irrigation had been applied to any of the advanced buffalograss plots. However, in the middle of July several of the clones of buffalograss including NE 84-315 had a severe drop-off in turf quality. After extensive work by Dr. Baxendale, it was concluded that the mealybug was causing the damage in the turf. The mealybug is a microscopic insect that seems to live in the sheath of the plant and suck juices from the individual stems. Hopefully, this was a one-year problem that may not occur again, but it is helpful to have this knowledge as we go forward on this project.

TURFGRASS CULTURAL PRACTICES AND THEIR INTERACTIVE EFFECTS ON ROOTING

UNIVERSITY OF NEBRASKA
Lincoln Nebraska

Dr. Robert Shearman
Principal Investigator

1988 Research Grant: $25,000
(fifth year of support)

This research project has taken a significant change in direction in the past year. It is now more in line with the Research Committee's original goals for cultural practices studies. The University of Nebraska's Mead Experiment Station, about 50 miles north of Lincoln, has 30 acres now in turfgrass research plots and an additional 11 acres have recently been acquired. It is obviously a growing research center. There is a good spirit of teamwork between university staff members and an excellent turfgrass graduate student program has been developed.

The specific new research projects funded by the USGA include:

1. Creeping Bentgrass/Poa annua Fairway Management (nitrogen, clipping removal, irrigation, traffic)

2. Seeded Creeping Bentgrass/Nitrogen Nutrition (six different popular bentgrasses are being evaluated for playability, wear, traffic tolerance, nitrogen rates, vertical mowing and topdressing effects)

3. Seeded Creeping Bentgrass Cultivars and Potassium Interaction Studies
(three different levels of potassium and two different nitrogen levels are being investigated)

4. Bentgrass Syringing x Nitrogen x Potassium Study (verticutting and topdressing practices are also included)

5. Creeping Bentgrass Mowing Height and Vertical Mowing Frequency Studies
(three different mowing heights and three different frequencies of vertical mowing are being investigated)

The plots are well organized and established on quality turf. Dr. Sherman will determine bentgrass root system distribution and bentgrass water use rates on the plots under study.

BREEDING IMPROVED SEEDED BERMUDAGRASS FOR TURF

NEW MEXICO STATE UNIVERSITY
Las Cruces, New Mexico

Dr. Arden Baltensperger
Principal Investigator

1988 Research Grant: $3,000
(fifth year of support)

The Research Committee is indebted to Dr. Arden Baltensperger, Plant Breeder at New Mexico State University for the development and release of SAHARA bermudagrass, the first such improved bermudagrass and the first improved grass variety to come from the USGA-GCSAA joint research effort. SAHARA exhibits a dark green color, has a lower natural height of growth and shorter internodes; all desirable characteristics in producing a superior playing turf. SAHARA has shown an exceptional drought resistance and has proved to be an excellent seed producer. The latter trait is particularly essential to successful marketing and making available any improved variety of grass.

Dr. Baltensperger announced his retirement from the University in early 1988. The research grant of $3,000 was placed with the University to help support maintenance of their turfgrass nursery and preservation of the bermudagrass germ plasm Dr. Baltensperger carefully developed over the years.

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

OHIO STATE UNIVERSITY
Columbus, Ohio

Drs. William W. Shane &
Stephen T. Nameth,
Principal Investigators

1987 Research Grant: $10,000

THIS REPORT REPRESENTS ONGOING WORK WITH 1987 FUNDS

Summer patch and necrotic ring spot diseases of Kentucky bluegrass annual bluegrass, and other turf grasses are extremely difficult to diagnose with traditional techniques. Research at Ohio State University is focused on the use of immunological techniques for rapid diagnosis of these two diseases.

Antibody-producing clones were developed for the causal agent of necrotic ring spot (Leptosphaeria korrae [LK]). Sixteen original clones were subcloned, purified, and screened against LK and non-LK fungi, soil, plant tissue. A single clone with the desired selectivity was increased for bulk antibody production. The final antibody reacted strongly against all verified strains of LK tested (including three from bermudagrass) and did not react significantly with 42 non-LK antigens (including (Magnaporthe, Gaummanomyces, plant tissue, soil and common plant-inhabiting fungi). Final refinements underway are: testing of LK antibodies using field-infected plant material and optimizing assay procedures for routine clinic use.

Similarly, monoclonal antibodies for summer patch (Magnaporthe poae) are under development. The first screen has been completed and indicated that the mouse antibodies react well with the original M. poae strain used for immunization. Subcloning, purification, and extensive screening are underway to acquire antibodies of the desired selectivity.

BREEDING AND EVALUATION OF SEEDED COLD TOLERANT BERMUDAGRASS

OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma

Drs. Charles Taliaferro,
J.A. Anderson, M.P. Kenna
Principal Investigators

1988 Research Grant: $20,000
(third year of support)

Mean fertility (seed set) has been tripled in a cold-tolerant broad gene-base bermudagrass population using phenotypic recurrent selection. Progress has also been made in selecting for finer texture within this population. The premise of the recurrent selection breeding procedure is ongoing population improvement via increase in the frequency of favorable quantitative genes controlling the characters under selection. Experimental strains derived from this population are now being tested for turf performance, and new strains will be available on a regular basis for evaluation.

Plants of the very fine textured C. transvaalensis having excellent seed head production and seed set were found in our germ plasm nurseries. The four best of these plants had seed set percentages of 83, 77, 73, and 72. These plants will be further assessed for seed yield and genetic improvement potential. Because this material already possesses extremely fine texture, sod density, and cold tolerance, the development of strains with economic seed yield potential would be of major importance.

Research to date has demonstrated the reliability and feasibility of two laboratory techniques for measuring cold tolerance of bermudagrass plants. Further assessment of the electrolyte leakage and freeze/regrowth techniques during the winter of 1987-88 confirmed earlier results indicating good agreement between the techniques, with both accurately ranking varieties of known relative cold tolerance.

Tissue culture techniques have been developed permitting regeneration of large numbers of bermudagrass plants from embryogenic callus derived from somatic (diploid meristematic) tissue explants. Although regeneration of plants from cultured bermudagrass anthers has not been achieved to date, some anther callus from some bermudagrass plants has been produced. This and the fact that haploid plants have been regenerated in several grass species via anther culture gives hope that continued refinement in several grass species via anther culture gives hope that continued refinement of technique will result in eventual success with bermudagrass.

BENTGRASS BREEDING

PENNSYLVANIA STATE UNIVERSITY
University Park, Pennsylvania

Dr. Joseph M. Duich
Principal Investigator

1988 Research Grant: $4,000
(ongoing support since 1958)

Creeping Bentgrass

Second cycle reselections were made on 24 Penncross lines (northern selections), 24 Penncross (southern selections), 22 very close cut putting green selections, and 22 fairway bents. Seed increase and yield trials were Oregon established for 25 experimental lines.

Two seasons of triplex mowing at 3/8 inch with and without baskets were completed on Penncross, Penneagle, Pennlinks, and Seaside originally seeded into Poa annua infested area. First year treatments with growth regulator treatments applied fall, spring, or combination completed. Fairway turf quality and Poa annua competition in descending order of Penneagle, Pennlinks, Penncross, and Seaside. Paclobutrazol Poa inhibition excellent in combination with management treatments.

Modification of 17,000 sq. ft. area in progress as both soil-less and high sand media for creeping bent varietal and management studies.

Electrophoresis varietal identification utilizing both standard gel and phast systems in progress on 55 Agrostis cultivars, commercial and experimental.

Colonial Bentgrass

Rhizome screening program continued on progeny of over 1,000 advanced generation selfed and open pollinated lines and sibs, and new selections.

Complete somatic tissue culture system from seed explants of A. tenuis and A. castellana was developed. Previous attempts with A. tunuis by other researchers were reported failures. There were no previous reports with A. castellana. Attempts to produce haploid plants of A. castellana through anther culture resulted in no callus growth.

Studies to enhance earliest possible floral induction and initiation of A. tenuis and A. castellana well under way. A threshold temperature of below 24 degrees centigrade in combination with short day treatment necessary. Acceptable flowering possible in 11 weeks from germination of seed.

SELECTION AND BREEDING OF SUPERIOR BENTGRASSES

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island

Dr. Richard Skogley
Principal Investigator

1988 Research Grant: $5,000
(ongoing support since 1960)

The USGA research support continues to be utilized primarily for assistance in our grass improvement (breeding) program. About 300 recently collected bentgrasses and 250 fine fescues were vegetatively increased during 1988 for 1989 seed production. Over 100 of our developmental bentgrasses are under evaluation for putting green or fairway useage. One superior creeping bentgrass, developed through polycrossing, has been selected for commercial release during 1988. Several experimental colonial and velvet bentgrasses appear to be superior to available varieties. A major study involves water use or moisture stress tolerance of our collection.

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

1988 Research Grant: $5,000
(ongoing support since 1961)

The New Jersey Agricultural Experiment Station of Rutgers University continues to devote considerable resources to the turfgrass breeding program. We are directing much of our work on the major turfgrass species including the perennial ryegrasses, tall fescues and Kentucky bluegrass to more basic studies. Most of our cultivar development work involves cooperative efforts with breeders in major seed producing regions. We are also directing increased effort to germ plasm enhancement of turfgrass species that have been neglected by other breeders. We see great opportunities for the continued genetic improvement of turfgrasses using innovative conventional breeding techniques while keeping abreast of new technologies that will result from advances in turfgrass science, stress physiology, plant pathology, entomology, soil science, and molecular genetics.

PLANT STRESS MECHANISMS

TEXAS A&M UNIVERSITY
College Station, Texas

Dr. James B. Beard
Principal Investigator

1988 Research Grant: $55,000
(sixth year of support)

Climatic conditions in College Station, Texas during 1988 were exceptional for an intense assessment of drought resistance and its components avoidance and tolerance among 65 commercially available turfgrass species and varieties including 55 warm-season turfgrasses. Four replications of each individual turfgrass were allowed to grow in a deep sand root zone for 158 days without significant rainfall or supplemental irrigation. Included in the assessments were 26 bermudagrasses, 9 zoysiagrasses, 8 St. Augustinegrasses, 6 centipedegrasses, 2 seashore paspalums and 2 buffalograsses; also, two heat tolerant varieties each of creeping bentgrass, Kentucky bluegrass, tall fescue, perennial ryegrass and fine fescue.

In terms of the greatest ability to retain green color throughout the 158 days of drought, there were 5 bermudagrasses that retained 83 - 88% green leaves. These varieties included Ormond, Midiron, and FB 119 and two Mexico State University selections developed via the USGA grant program, including the recently released Nu Mex Sahara.

Perhaps most surprising were 4 St. Agustinegrass varieties that ranked with the bermudagrasses in ability to retain green color throughout the 158 days of drought stress. All four varieties exhibited more than 90% green leaf color retention. Top ranked were Floratam and Floralawn and two selections from the turfgrass breeding program of Texas A&M University at Dallas.

Ranking next in drought avoidance was one variety of seashore paspalum, specifically Adalayd, with 82% green color retention after 158 days of drought.

Among the buffalograss and centipedegrass varieties, none retained any significant level of color retention during the 158 days of drought stress. Buffalograss discolored and entered dormancy the earliest of all the species. In the case of centipedegrass, leaf color was retained somewhat longer but recovered from the extended period of water stress with great difficulty. All the cool-season turfgrasses were dead within the first month of drought stress--May.

The most striking finding from these data is that a number of varieties exist among the warm-season turfgrasses that possess a superior ability to maintain green color over a period of five months under severe drought stress. These varieties, representing 4 different species, offer superior germ plasm resources to be used in breeding programs to select for improved water conserving turfgrasses.

BROWN PATCH AND PYTHIUM DISEASE RESISTANCE IN BENTGRASS AND ZOYSIAGRASS

TEXAS A&M UNIVERSITY
Dallas, Texas

Dr. Philip F. Colbaugh
Principal Investigator

1988 Research Grant: $10,000
(second year of support)

Progress during the period from May to November 1988 has followed several lines of investigation. The fungal culture collections for Rhizoctonia spp. and Pythium spp. attacking turfgrasses now number 70 and 41 isolates, respectively. The most virulent strains of these fungi are currently being used for disease resistance screening studies with experimental lines of bentgrass and zoysiagrass. Cultures for both of the fungal collections were placed in long-term storage vials which are being maintained at temperatures favoring their extended survival.

The past six months of pathology investigations have focused on inoculation studies with members of the elite collection of bentgrass germ plasm lines located at Dallas. Results of these investigations have been very worthwhile. Inoculations with Pythium spp. were conducted in the field, greenhouse and laboratory utilizing four of the most virulent isolates from the USGA culture collection. Weather conditions were not favorable for successful field inoculations; however, both laboratory and greenhouse trials with these pathogens demonstrated experimental germ plasm lines with high degrees of tolerance to foliar blighting, when compared to the commercial variety "Penncross" which was easily killed.

Results of inoculation trials with four virulent isolates of Rhizoctonia spp. on a similar collection of bentgrass experimental lines also demonstrated resistance to foliar blighting compared to the variety "Pencross." Rhizoctonia isolates used in the test were very aggressive foliar blighting pathogens. Less than 5% of the experimental germ plasm lines tested demonstrated resistance to all four pathogen isolates.

Field observations of diseases on zoysiagrass during the past summer and fall included the dollar spot and Rhizoctonia brown patch diseases. The reaction of varieties in field plantings to the dollar spot disease were generally the same as those noted during 1987. The fine-leaved zoysiagrass varieties were more susceptible to dollar spot. Observations of Rhizoctonia brown patch on replicated nursery plantings of ten zoysiagrass selections also indicated that one experimental line, and the commercial variety "Meyer," were more susceptible to the disease than the other experimental lines under evaluation.

BREEDING AND DEVELOPMENT OF ZOYSIAGRASS

TEXAS A&M UNIVERSITY
Dallas, Texas

Dr. M. C. Engelke
Principal Investigator

1988 Reserach Grant: $40,000
(sixth year of support)

The zoysiagrass breeding program is in its sixth year with the financial support of the United States Golf Association. Major Regional Field Trials were initiated as early as 1986, with cooperators from several states providing comparative evaluation of four experimental DALZ zoysia varieties with four commercially available zoysiagrass cultivars, including "Meyer," "Emerald," "Belair," and "El Toro." Additional trials have been established to evaluate sod production potential (Ferris, Texas), and under the Linear Gradient Irrigation System (LGIS) at Texas Agricultural Experiment Station (TAES) -Dallas. The first full moisture gradient will be applied to the experimental zoysiagrasses during 1989.

DALZ8501 and DALZ8502 have been identified for their superior regrowth and recovery ability due to highly rhizomatous growth characters. Neither of these clones have sufficient winterhardiness to fit the mid-continent states, based on regional trials conducted the past two years in that area. However, as they are grown further south, along the Golf Coast States and in California, they demonstrate superior performance in winter color, density of stand, and quality of turf. Recognizing their primary area of adaptation is a crucial element in the development of all turfgrass varieties, trials will be established in Florida and Georgia in 1988/89. Both DALZ8501 and DALZ8502 are fine textured and highly rhizomatous selections. 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 as a putting surface. Breeder/Foundation production fields (0.5 acres) of both DALZ8501 and DALZ8502 were planted on fumigated ground in June, 1988 with the assistance of the Texas Sod Producers Association. Both fields are in excellent condition going into the winter and should reach nearly full coverage by midsummer 1989. DALZ8501 will be further expanded to cover a full 20,000 square feet in early spring 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. Dr. Lin Wu, University of California - Davis, has completed the electrophoresis studies on the initial group of DALZ lines which

included DALZ8501 and DALZ8502. This information was presented in the spring report (Semiannual 1988) and will be used in conjunction with field performance data as documentation of plant variety release and plant patenting.

BREEDING AND DEVELOPMENT OF BENTGRASS

TEXAS A&M UNIVERSITY
Dallas, Texas

Dr. M. C. Engelke
Principal Investigator

1988 Research Grant: $40,000
(fourth year of support; $20,000 of the 1988 total was contributed by Bentgrass Research, Inc. of Fort Worth, Texas)

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

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

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

The excellent cooperation between the United States Golf Association and Bentgrass Research, Inc. has been instrumental in implementing the procedures necessary for timely development of a new bentgrass for the Golf Industry. Finally, appreciation is

extended to Pick Seed West for continued contributions and involvement with the seed production and hybridization program in Oregon. As a worthy closing note, Ms. Virginia Lehman passed her written and oral preliminary exams for a Ph.D. degree on 5 October, 1988 and anticipates completing her dissertation by the summer of 1989.

DEVELOPING SALT, DROUGHT AND HEAT RESISTANT TURFGRASSES FOR MINIMAL MAINTENANCE

TEXAS A&M UNIVERSITY
El Paso, Texas

Dr. Garald L. Horst
Principal Investigator

1988 Research Grant: $15,000
(fifth year of support)

Research Accomplished:

1. This year the initial set of 27 buffalograss selections was evaluated in the last of 4 experiments that make up the salt resistance stress evaluation series.

2. Buffalograss appears to have a rather low potential for salt resistance, at least in the limited germ plasm base that was tested. This plant material base was from Texas collections.

3. Buffalograss plant material from the Nebraska program under the direction of Dr. Terrance P. Riordan is currently being increased for salt resistance evaluation. Perhaps this plant material has a broader genetic base and will have greater salt resistance potential.

4. The past year has also allowed the completion of evaluation on the initial set of 29 zoysiagrass selections. There were 4 experiments with 4 replications of each selection in each experiment.

5. There are selections in the initial zoysiagrass set which appear to have good salt resistance. The selections could be useful in both cultivar improvement and perhaps used in saline environments without additional selection pressure.

6. Bentgrass plant material (45 entries) from the improvement program under the direction of Dr. M. C. Engelke has been received. The material is currently being increased for salt resistance evaluation.