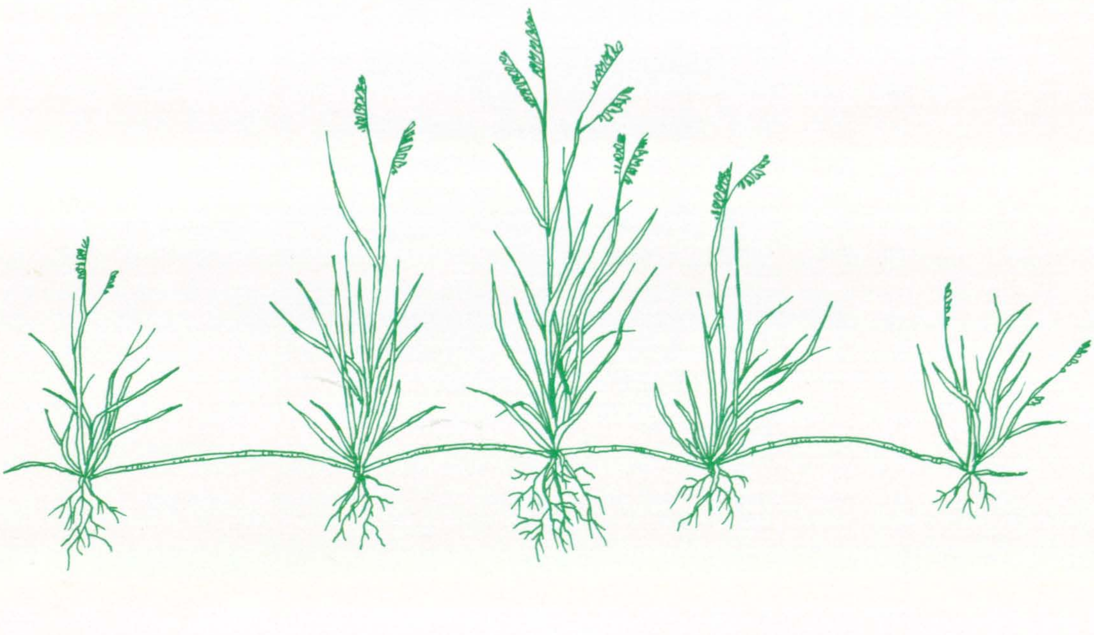
USGA GREEN SECTION

GOLF KEEPS AMERICA BEAUTIFUL

1990

ANNUAL TURFGRASS RESEARCH REPORT



Buffalograss (Buchloe dactyloides)

1990
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
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January, 1990

TO: THE READERS OF THE 1990 ANNUAL TURFGRASS RESEARCH REPORT

As the USGA/GCSAA Turfgrass Research Program enters its ninth year, there are many successes to be counted and future successes to be anticipated with great excitement. The original goal of the Research Committee was to put into motion a long-term program for producing new grasses for golf that would reduce water use and maintenance costs by a significant amount. Based upon the new grasses that have already been developed and from the information contained in this year's report, it seems clear that the committee's long-term goals will be realized.

The first of the new grasses to emanate from the program was 'Sahara' bermudagrass, an improved, seeded bermudagrass that continues to be a sellout in its third season of production. The next new grass to make it to the marketplace will be NE 84-609 buffalograss, from the University of Nebraska. The fine turf characteristics of this new buffalograss, combined with its ability to thrive with much less water than other grasses, will put '609' in great demand in parts of the country where water is scarce and low maintenance characteristics are required.

The most recent milestone for the research program was the submission for release of three creeping bentgrass varieties from the breeding program at Texas A&M. Two of these heat-tolerant, fine-textured grasses should be commercially available by the fall of 1992.

Looking ahead, the next few years will see many new varieties from our sponsored breeding programs coming to market, including improved zoysiagrasses, bermudagrasses, buffalograsses, and bentgrasses. Good progress also continues to be made in the development of *Poa annua* and several native grass species for golf.

The Research Committee feels a special obligation to ensure that the end-users of the newly developed varieties have sound information about the adaptation of these new grasses. The committee, therefore, will be setting aside a substantial amount of money from its budget during the next couple of years to test the grasses before they reach the market, ensuring that users have the facts needed for selecting and maintaining grasses for their courses. There is no point

USGA

introducing new grasses unless they are better than existing varieties and unless enough is known about them to take full advantage of their best characteristics.

On another subject, the USGA Executive Committee took an important step in 1990 with the approval of a 3-year, $2.8 million study to investigate the effects of golf course activities on the environment. Few people involved in golf can be unaware of the impact that environmental concerns are having on the construction and maintenance of golf courses, and it is anticipated that the information gleaned from this study will provide a much clearer picture of the nature of golf's effects on the environment.

The Research Committee initiated this environmental study by commissioning a complete review of the scientific literature pertaining to the interaction of golf courses and the environment. Based upon this report, the committee identified a need to investigate the following topics: 1) The fate of pesticides and nutrients applied to golf courses; 2) The development of alternatives to the use of pesticides for pest control; and 3) The impacts and benefits of golf courses on people and wildlife. From a pool of more than 80 proposals, 17 research projects from land-grant universities have been approved for funding.

The current concern about the environment reflects well on the original members of Research Committee who, in 1982, had the foresight to set goals for the research program that stressed the conservation of our natural resources. What better way of reducing water and pesticide use than to breed grasses for golf that inherently use less water and are resistant to insects and diseases!

A clear course has now been set for determining the impact of golf courses on the environment, and work continues on the genetic improvement of turfgrasses for sports, recreation, and other uses. Golf has made an important moral and financial commitment to protect and enhance the environment, and to conserve our natural resources. Golf courses will continue to be good neighbors in our communities.

Speaking of commitments, I would like to thank you, the readers of this research report, for your continued interest and financial support of the activities of the Research Committee. The USGA also is indebted to the members of the Research Committee, who give so generously of their time and talents on behalf of golf and the environment.

With appreciation,

Jim Snow

James T. Snow
National Director, Green Section
Chairman, Turfgrass Research Committee

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USGA

DAVID B. FAY
Executive Director

March 25, 1991

To the Readers of the 1990 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 16 members with distinguished careers as academics, agronomists from the USGA Green Section, golf course superintendents, and 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 a denser, lower growing turf; and is the first other than common bermudagrass that grows from seed. More developments will be coming.

The 1991 budget calls for 22 grants totaling $750,000 to be distributed to 16 universities and research centers. The USGA has every hope and expectation of continuing and 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 a substantial amount 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 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/GCSAA Turfgrass Research Committee

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1991 Turfgrass Research Budget Summary

Project	Sub-Project	University/Investigator	1983	1984	1985	1986	1987	1988	1989	1990	1991	Total
Turfgrass Breeding	General	Rutgers/Funk	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	45,000
	Bentgrass	Penn State/Duich	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	36,000
		TX A&M-Dallas/Engelke			47,000	40,000	40,000	40,000	60,000	64,000	64,000	355,000
		New Zealand/Rumball				10,000	10,000	10,000	13,000	10,000	10,000	63,000
		Univ of RI/Skogley	1,500	1,500	1,500	1,500	5,000	5,000	5,000			21,000
		MS State/Krans	2,500	2,500								5,000
	Bermudagrass	Univ of GA/Burton	5,000	5,000	5,000	5,000	5,000	5,000	5,000	8,000	8,000	51,000
		NM State/Baltensperger		4,500	20,000	20,000	20,000	3,000				67,500
		OK ST/Taliaferro-Barber				20,000	20,000	20,000	35,000	75,000	75,000	245,000
	Native Grasses	CO State/Cuany-Koski			10,000	20,000	20,000	25,000	25,000	30,000	30,000	160,000
		Univ of AZ/Mancino						5,000	12,000	12,800	12,800	42,600
		Univ of NE/Riordan		4,100	20,000	18,000	19,000	25,000	35,000	35,000	45,000	201,100
	Poa annua	Univ of MN/White		11,600	15,000	15,000	20,000	30,000	35,000	35,000	35,000	196,600
	Zoysiagrass	TX A&M-Dallas/Engelke	2,500	42,585	42,000	40,000	40,000	40,000	45,000	45,000	45,000	342,085
	Evaluation	Multiple Sites							43,000	43,000	44,200	130,200
	Screening	Multiple Sites							15,000	15,000	6,200	36,200
		SUBTOTALS:	20,500	80,785	169,500	198,500	208,000	217,000	337,000	381,800	384,200	1,997,285
Cultural Practices	Management	MI State/Branham			10,000	15,000	15,000					40,000
		OH State/Danneberger				15,000	15,000					30,000
		WA State/Brauen		1,243	1,000							2,243
	Pathology	TX A&M-Dallas/Colbaugh					10,000	10,000	10,000	10,000	10,000	50,000
		MI State/Vargas		15,000								15,000
		Cornell/Petrovic		1,500								1,500
		Cornell-OR ST/Smiley			7,000						1,000	8,000
		NC State/Lucas			10,000	10,000	10,000					30,000
	Soil Compaction	MI State/Rieke	3,000	3,000	3,000	5,000						14,000
		Univ of GA/Carrow				15,000	15,000	15,000	18,000	18,000	18,000	99,000
	Salt Screening	TX A&M-El Paso/Horst		3,480	15,000	15,000	15,000	15,000	15,000			
	Interactions	Univ of NE/Horst		4,000	23,000	20,000	20,000	25,000	25,000	25,000	29,000	171,000
	Morphology	MS State/Krans							2,500			2,500
	Entomology	Independent/Stacy								10,000	10,000	20,000
	Mycorrhizae	Univ of RI/Jackson								40,000	40,000	80,000
		SUBTOTALS:	3,000	28,223	69,000	95,000	100,000	65,000	70,500	103,000	108,000	641,723
Turfgrass Library		MI State/Cookingham	5,000	96,326	68,000	55,000	65,000	65,000	60,000	70,000	70,000	554,326
		SUBTOTALS:	5,000	96,326	68,000	55,000	65,000	65,000	60,000	70,000	70,000	554,326
Biotech	Methodology	Univ of IL/Smith						8,400		9,000	9,000	26,400
	Pathology	OH State/Shane					10,000		10,000	10,500	18,800	49,300
		MS State/Krans									21,900	21,900
	Endophytes	Rutgers/Funk-Day								40,000	40,000	80,000
		SUBTOTALS:					10,000	8,400	10,000	59,500	89,700	177,600
Stress Mechanisms	Heat & Drought	TX A&M-Col. Stn./Beard	84,500	87,000	91,000	73,000	70,000	55,000	67,800			528,300
	Salt Tolerance	TX A&M-El Paso/Horst								29,000		29,000
		SUBTOTALS:	84,500	87,000	91,000	73,000	70,000	55,000	67,800	29,000		557,300
Environmental	Lit Review	Spectrum Res./Balogh								25,000		25,000
		SUBTOTALS:								25,000		25,000
Administration	Meetings		13,500	13,766	19,319	11,100	16,500	30,500	35,000	36,422	30,000	206,107
	Inspections						7,000	20,500	25,000	27,000	43,400	122,900
	Annual Report						3,500	8,600	10,000	9,140	15,000	46,240
	Legal Fees								5,000	6,455	5,000	16,455
		SUBTOTALS:	13,500	13,766	19,319	11,100	27,000	59,600	75,000	79,017	93,400	391,702
		TOTALS:	126,500	306,100	416,819	432,600	480,000	470,000	620,300	747,317	745,300	4,344,936

UNIVERSITY OF ARIZONA

Breeding and Development of Curly Mesquitegrass as a Desert Turf

1990 Research Grant: $12,800
(Third year of support)

Dr. Charles F. Mancino
Andrew E. Ralowicz
Principal Investigators

Curly mesquitegrass (*Hilaria belangeri*), similar in appearance to buffalograss, is being evaluated as a minimum input, low water requiring desert turfgrass. Thus far, the use of curly mesquitegrass as a seed established desert turfgrass appears promising. Research during 1990 identified substantial genetic variation in turf quality and reproductive traits, and continued to assess field performance of selected plant material to cultural practices. Other efforts concentrated on identifying additional superior turf type plants, establishing crossing blocks of these plants, and harvesting this seed to begin developing an improved 'turf-type' synthetic population.

The genetic components of turfgrass characters and seed production traits were determined in 1990. Most of the traits investigated can be considered as moderately to highly heritable. This indicates that rapid progress through recurrent selection can be made in improving turfgrass quality and seed production in this species.

The ongoing Cultural Practices Experiment reconfirmed the cutting requirement to maintain this species as a healthy turf. Poor color and overall quality of the uncut plots was evident throughout 1990. Mowing heights of 2 and 4 inches produced very dense turfs with complete ground cover.

In addition to the eight superior 'turf-type' selections made in 1989, 12 more selections were made in 1990. Selected plants from both years were increased and planted into eight crossing blocks for seed production. Eight harvests of seed occurred this season from August to October, and one more final harvest is anticipated. Multiple harvests of seed is a key feature in maximizing seed production of this species.

COLORADO STATE UNIVERSITY

Development of Dryland Western Turfgrass Cultivars

1990 Research Grant: $30,000
(Sixth year of support)

Dr. Robin L. Cuany
Dr. Anthony Koski
Principal Investigator

The Colorado State University project went a stage further in developing turfgrass varietal material of three western adapted species: alkaligrass, blue grama, and fairway (crested) wheatgrass. These three grass species would be extremely useful in minimum maintenance turfgrass plantings and for areas with special soil or moisture problems. In all these grasses we have been evaluating nurseries for plant type, seed productivity and other seed traits, and exercising our best efforts to produce enough seed for the multiplication stage and the early verification of turf behavior and quality.

Since all these grasses are (purposely) different from Kentucky bluegrass and bermudagrass, they have a different appearance and different cultural needs, in addition to being adapted to specialized uses such as saline soils, low water inputs, or reduced grooming. These grasses are not highly domesticated and they are not suitable for use on greens, but two of them are suitable for fairways and low-maintenance roughs, while the fairway crested wheatgrass is probably better suited for roughs than for modern close-cut fairways on golf courses.

Alkaligrass (*Puccinellia* spp.) is salt-tolerant, not very drought resistant, and exhibits summer dormancy during hot weather regardless of water status. As a cool-season grass it greens up very early (late March, before bluegrass) and retains color well into winter. We have identified lines which are much more resistant to rust than the cultivar Fults. Alkaligrass nurseries produced less seed in their second full-season year than their first, with some of the loss due to a decreased number of plants (i.e. not true perennial plants). This could be solved by more frequent establishment of seed fields as is done for annual crops. Our selections have been from the best surviving plants of Eurasian and Western U.S. sources, and several promising lines are in production and in turf tests.

Blue grama (*Bouteloua gracilis*) is a warm-season grass, green from late April until frost, and shows an attractive apple-green color under mowing heights at 1 to 2 inches and very limited water. In order to show sufficiently dense turf it needs to be seeded at 2 to 3 lb. per 1000 sq. ft. The chief breeding objective is to increase the seed harvestable from a plant or a field. Blue grama has low seed fertility (viable seeds per spikelet are often less than 10%) so we have selected the best parents for seed traits and are preparing a large recombination block for 1991 seed production. Other blocks have been planted to explore the narrow-leaf trait shown by a few plants, and a June 1990 turf test shows Western material of the "Elite" type to have a darker green than the cultivar Hachita.

Fairway crested wheatgrass (*Agropyron cristatum*) has been surveyed in several nurseries totalling more than 1,000 plants, which show considerable variation in leaf width, tendency to put out one or two rhizomatous shoots, and incidence of a summer clump-disease causing lodging of seed-stalks. Selections were made for narrower leaves and/or more rhizomes within the healthy group, and recombinations will set seed in 1991. Previous turf trials have shown this grass to be poorly adapted to a regime of three mowings per week at 3/4 inches when not irrigated, but it is not bad when provided with some supplemental water. The best performance occurs at mowing heights of 1 1/2 to 2 inches and indicates the species will be best suited for use in golf course roughs.

DEPARTMENT OF SCIENTIFIC & INDUSTRIAL RESEARCH (DSIR) - NEW ZEALAND

Colonial Bentgrass Breeding

1990 Research Grant: $10,000
(Fifth year of support)

Dr. William Rumball
Principal Investigator

The original objective of this project was to breed a Colonial bentgrass cultivar for U.S. golf courses using New Zealand breeding materials, and doing the breeding work in New Zealand. 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 breeding material fulfilling the objectives would probably be found on sites such as non-irrigated, low-input fairways of golf courses in hot, dry regions of New Zealand.

During August 1990, the project was visited by Dr. Peter Hayes. (Sports Turf Research Institute, Bingley). Dr. Hayes was able to examine and discuss the selections, meet other staff in the project, and share his perspective of the overall program. I discussed with him my concerns that the evaluations (and therefore the rankings and subsequent publicity) our selections are receiving in the USA are not related to low maintenance conditions. This could be a real problem in the National Turfgrass Evaluation Program, where irrigation, frequent mowing, etc. will probably be applied if stress appears in the trials.

In a trip through the USA in 1990, I learned that bentgrass color other than the color of "Providence" creeping bentgrass is bad. I saw the scores on several trials, and all entries of *A. castellana* and *A. tenuis* were marked down because they did not have the dull blue color of creeping bentgrass. In other turf respects they (currently) equalled or surpassed the creeping bentgrasses. This fixation with color had special mortification for me, as it downgraded our NZ-bred 'Egmont' colonial bent. At the Sports Turf Research Institute in England, where comparative color is not so important, Egmont is the best bentgrass. However, we will try to make adjustments in our project to account for these American concerns. Standards of surface excellence will not be allowed to drop just for the sake of low maintenance, and we will try to make the colors darker. This should not delay or require an expansion of the project.

The project remains for me a most exciting and enjoyable part of my work. The targets are environmentally very worthwhile, and the plant material is interesting. Most of all, the feeling of being able to collaborate in a bi-national project, and one at the forefront of customer use and funding is unique. It is a great change from the highly competitive aspects of many other breeding projects.

UNIVERSITY OF GEORGIA

Bermudagrass Breeding - Vegetative

1990 Research Grant: $8,000
(Ongoing support since 1946)

Dr. Glenn W. Burton
Principal Investigator

In recent years, our main objective under this cooperative USDA-ARS project has been to develop new hybrids with greater cold tolerance and quality similar to the Tif-bermudas. These hybrids have involved the winter hardy Berlin bermudagrass and our best *Cynodon transvaalensis* bermudagrass from South Africa.

We learned during the development of the Tif-bermudas that it required at least three years of turf management for lawns, fairways or golf greens in replicated small plots to separate the best one or two from a group of many hybrids. We have just completed a "three-year test" of 64 of the Berlin x *C. transvaalensis* hybrids with the six Tif-bermudas, Midiron and Vamont as checks. The parents used were a Berlin bermuda selection that survived a winter in Pine Valley, New Jersey when others were killed. This test of 72 bermudagrasses planted in replicated 6 x 7 foot plots has received low cost fairway maintenance for three years. Tifway (Tifton 419) and Tifway II topped the entries in this test. None of the 64 new hybrids equalled the Tif-bermudas in overall performance. One, perhaps several more, were good enough to warrant evaluation for cold tolerance. We understand that Dr. Jeffrey Anderson, Horticulture Department, Oklahoma State University, has developed a laboratory test that may be used to determine the cold tolerance of bermudagrasses. We hope to have him rate our best selections for cold tolerance. Plantings of earlier hybrids on golf courses in the North Georgia and North Carolina mountains are waiting for a suitable winter to eliminate all but the best ones.

In my 1989 report, I described our good fortune in getting the very winter hardy bermudagrass clone from the Soil Conservation Service Plant Materials Center, Quicksand, Kentucky. The rhizomes we received were labeled 9034348 and called Quicksand Common. We have found it to be fine-stemmed, highly disease resistant and a rapid spreader. It has the 36 chromosome characteristic of common bermudagrass but failed to shed pollen for us in 1990. If it has equal or better winter hardiness than our Berlin bermudagrass, it could give better hybrids when crossed with our best *Cynodon transvaalensis* clones. We have made the creation and evaluation of these hybrids one of our main activities under this project.

Tifton 10 bermudagrass, officially released in 1988, was registered as a crop cultivar by the Crop Science Society of America in 1990. Tifton 10 has performed well at many locations, receiving higher quality ratings than Midiron wherever compared. Its dark bluish green color sets it apart from other turf bermudagrasses. It establishes rapidly from stolons or rhizomes.

(Please Note: The Turfgrass Research Committee is proud to continue its support of Dr. Burton's prolific breeding program. The Committee's small grant covers but a small fraction of the cost of the program.)

UNIVERSITY OF GEORGIA

Development of Cultivation Programs on Turfgrass to Reduce Water Use and Improve Turf Quality

1990 Research Grant: $18,000 (Second year of support)

Dr. Robert N. Carrow
Principal Investigator

Poor soil physical conditions interfere with turfgrass management by limiting water movement, reducing soil aeration, and decreasing root and shoot growth. Compaction of the soil surface and excessively fine-textured (i.e., high in clay and silt content) soil profiles are two of the most common soil problems found on golf courses. Cultivation is an important method of alleviating these problems; however, comparative research studies to evaluate different techniques have not been conducted.

Five cultivation techniques were compared for their effectiveness in improving soil physical properties and growth of common bermudagrass (*Cynodon dactylon*). The site was a Cecil clay loam, typical of the Piedmont region of the southeast. A non-compacted control and compacted control were included and all cultivation techniques were evaluated under compacted conditions. Severe compaction was applied with a smooth power roller in April, May and July, 1989, and in March and July, 1990. The cultivation treatments were hollow tine core aeration (3 inches depth of penetration), Verti-drain (12 inches), Verti-slicer (4.5 inches), Aera-vator (3 inches), and Hydro-Jet (6 to 8 inches). Cultivation treatments were applied during May and July in 1989 and during April and August in 1990.

Soil Physical Properties. Within the surface 3 inches, only hollow tine core aeration significantly reduced soil bulk density and increased total porosity relative to the compacted control. Soil strength, a measure of soil hardness, was determined in March, May and August, 1990. The Verti-drain reduced soil strength by 23% to a depth of 8 inches in March and May, and 27% in August at the 4 inches depth. The Aera-vator treatment resulted in a 27% decline in soil strength in the May period to a depth of 2 inches. Hydraulic conductivity, a measure of water infiltration, increased 7.5 fold in May 1990 after Verti-drain treatment and 4.5 fold in August 1990 after Aera-vator application. Oxygen diffusion measurements were made at four periods in 1989 and 1990. No cultivation treatment improved oxygen diffusion compared to the compacted control.

Root and Water Relations. Root weights and root length density data were obtained during June and September in 1989, and July and September in 1990. Only the 1989 data are available. No root responses to treatments were observed in June 1989. On the September 1989 sample date, root weights in the 12 to 24 inches zone were decreased by Aera-vator and Verti-slice procedures, while root length densities increased 79% by Verti-drain treatment in the 12 to 24 inches zone relative to the compacted control. Water extraction data obtained during eight periods throughout

1989 and 1990 revealed higher water extraction than the compacted control on two dates for the Verti-slicer and one date for all other cultivation methods.

Shoot Growth. Turfgrass quality declined for one to two weeks after cultivation for all procedures except the Hydro-Jet in 1989. Some loss of shoot density occurred in August 1989 after Verti-slicer and hollow tine core aeration. In May, 1990 improved visual quality and shoot density were apparent for Verti-drain and hollow tine core aeration plots. Also, Aera-vator application increased visual quality. Higher visual quality versus the compacted control was observed in June and October for the Verti-drain and Hydro-Jet treatments, respectively. At one week after cultivation in early August, some decline in shoot density occurred in the Aera-vator, Verti-slicer, and hollow tine coring plots.

Summary.

(a) Verti-drain reduced soil strength to a depth of 8 inches and improved infiltration. These effects on soil physical properties enhanced deep rooting in late summer.

(b) Aera-vator reduced soil strength in the 2 to 4 inches soil zone on one date and enhanced infiltration. These improvements in the physical properties of the surface few inches did not result in better rooting since deep root growth in late summer was less than the control.

(c) Hollow tine core aeration improved soil surface conditions as shown by low bulk density and higher aeration porosity; however, rooting was not affected.

(d) Verti-slicer and Hydro-Jet treatments did not influence measured soil physical properties or rooting.

(e) Improved soil water extraction during dry-down periods was observed one out of eight times for all procedures (2 out of 8 for the Verti-slicer).

(f) All methods except the Hydro-Jet caused some decline in visual quality and/or shoot density within a week of treatment on at least one occasion. The Verti-slicer and hollow tine core aeration exhibited this trend most often (i.e., 4 out of 5 treatments).

(g) All cultivation procedures resulted in some improvement in visual quality and/or shoot density during some period of the study, except the Verti-slicer treatment.

Future Direction. The results from this study and a previous one (funded by the USGA to evaluate 5 other procedures) will be used to formulate several cultivation programs. Cultivation programs will include two to three different procedures applied at appropriate times of the year. New procedures may also be included. This phase will be conducted in 1991 and 1992.

UNIVERSITY OF ILLINOIS

A Realistic Whole Plant Microculture Selection System For Turfgrasses

1990 Research Grant: $ 9,000
(Second year of support)

Dr. M.A.L. Smith
Principal Investigator

Superior salt and drought-tolerant turfgrass lines are needed for marginal planting sites, or irrigated sites where salt build-up is likely to occur. Effective selection of stress tolerant genotypes is extremely complicated in the field due to environmental interactions that sometimes mask stress tolerance traits. Controlled environments can provide a more uniform test environment to permit efficient germplasm pre-screening and selection prior to scale-up for field evaluations.

As part of this turfgrass program, comparative, parallel studies to elucidate the symptoms of salt tolerance in warm and cool season turfgrasses have been completed in both solution culture (plant cells grown in solution) and whole plant microculture. Plants are monitored from the small plug or seedling stage through an extended test period to define adaptations in both the root and shoot zone to increasing salt levels over time. Video image analysis uses a video camera and microcomputer to capture quantitative (plant height, shoot area, root length and area) and spectral (visual density, color index) data on grass performance. Since the technique is completely non-destructive, plants can be effectively monitored as they adapt over time.

The turfgrass responses to salt stress in both the solution culture and microculture systems have shown excellent correlation, and have identified key growth responses to stress, levels of salt that induce growth reductions, and the amount of time required before stress symptoms are evident. The visual data collected rapidly through image analysis agrees with conventional growth analysis of the treatments (the latter requires destructive sampling and dry weight measurement of plants). The experiments initiated in 1988 and 1989 were repeated in late 1989 and 1990 to provide additional replication of the experimental system data.

In whole plant microculture, additional tests have separated the response characteristics of grasses similar to the "shock" they experience when transplanted into saline soils or when allowed to gradually adapt to those same salt concentrations. The recovery from salt stress is evaluated after grass samples are transplanted back to non-saline control media. The microculture salt stress screens, however, can be conducted on a smaller scale than field or greenhouse tests, do not require the high maintenance of growth chambers, and can be rapidly accomplished on a year-round basis. The tests will be extended to novel selections which have been first screened for salt tolerance at the cell level (solution culture), then regenerated into whole plants. This intermediate whole plant microculture step is an effective laboratory pre-screen to determine whether cell-level traits are actually expressed in whole turfgrass plants before the time and expense of field trials are conducted.

MICHIGAN STATE UNIVERSITY

USGA Turfgrass Information File Project

1990 Research Grant: $70,000
(Eighth year of support)

Peter O. Cookingham
Project Manager

The purpose of the USGA Turfgrass Information File (**USGA TGIF**) 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 is being provided for the research community, for practitioners (such as golf course superintendents), for extension-type services, and for commercial concerns.

We have accomplished the four goals originally established for the project which include: 1) acquire, maintain, and preserve all appropriate printed and processed materials reporting on research related to turfgrass growth, development, and maintenance; 2) construct an on-line index to the turf science literature (**USGA TGIF**), including both currently published literature and gradual retrospective processing back to 1972 to compliment the Beard *Bibliography*; 3) make the on-line index **USGA TGIF** available to support research, education, and management needs; and 4) provide library loans and/or appropriate photocopies to all users who have reason to need access to this collection.

USGA TGIF continues to evolve as the number of records grows and as we experiment with new ways of packaging and delivering bibliographic information. During February 1991, the 20,000th record was entered into **USGA TGIF.** A new menu structure, screen revisions, and features were developed which we hope will make **USGA-TGIF** easier to use. A growing list of "pre-searched" topics on turfgrass benefits, environmental issues, disease and insect problems, and other relevant topics was added to make the data base more user friendly. In response to requests by many users, the "log on" procedure was streamlined to make computer access to the **USGA TGIF** faster and easier.'

Anyone can take advantage of **USGA TGIF** by calling **(517) 353-7209.** If you do not have access to a computer, then the search can be completed for you and mailed to your address within a few days. The staff of **USGA TGIF** are extremely cooperative and want to make this valuable information source available to you.

Each citation in **USGA TGIF** represents an article or report in turf culture or golf course management. The data base can disseminate published research findings, help avoid redundancy in research efforts, span geography and time in linking an identified need and a potentially relevant finding, and cumulate the published research and management experience of the discipline. Students, practitioners, and researchers, can all utilize this unique tool to bring this wealth into their learning and decision-making. Tap into this reservoir of knowledge.

UNIVERSITY OF MINNESOTA

Improvement of Poa Annua for Golf Turf

1990 Research Grant: $35,000
(Seventh year of support)

Dr. Donald B. White
Principal Investigator

Poa annua is one of the most widely adapted cultivated grass species in North America, and throughout the world, makes up a major component of golf course turf. It is much maligned, however, because of susceptibility to damage by summer heat and water stress, and an inability to overwinter or tolerate crown dehydration and freezing. Despite vigorous control programs, *Poa annua* has the ability to quickly invade when ever the preferred perennial turfgrass is damaged.

Problems with *Poa annua* are accentuated by the absence of improved types and its habit of seeding continuously in the spring and fall. *Poa annua* is reported to be the evolutionary offspring of *Poa supina* and *Poa infirma*. There are two types of *Poa annua*: 1) *Poa annua* 'annua' which has an upright growth habit and produces a limited number of shoots and roots, and normally survives from one to two years; and 2) *Poa annua* 'reptans' which exhibits a perennial, stoloniferous habit of growth, and has more prolific stem and root production. The objective of this project is to stabilize and consolidate desirable perennial characteristics into improved cultivars for golf course use.

Approximately 1500 individual accessions or selections continue to be maintained and propagated for field evaluation. The eight 'prime' selections under evaluation and consideration for introduction all performed well over the difficult winter of 1990. *Poa annua* selections #117 (10-C) and #184 (16-B) received the highest ratings over winter. *Poa annua* #117 (10-C), #493 (NY-12), #42 (3-A) and *Poa supina* #391 (29-F) exhibited excellent flowering habits this spring. A total of 101 new accessions from 25 locations were integrated into the germplasm pool of the project.

Several new selections have been identified for the next cycle of evaluation for introduction. New evaluation plots, under close mowing, were established at the University of Minnesota, nine golf courses around the country, and at three universities. Work was completed on improving and adapting a mist technique to regulate pollen release and assist in emasculation to facilitate our ability to accomplish specific crosses. Work on improving an excised stem technique was completed and applied to practice. The sugar, fructose, improved seed production and uniformity compared to sucrose. Contrary to other work, no biocide was required and seed matured 15 days after pollination with the stems maintained in the fructose solution.

Approximately 75 crosses were completed with the eight 'prime' selections; and forty additional crosses were made to incorporate and combine desirable characteristics. Fifty self pollinations were completed in a continuing effort to ascertain heritability of specific characteristics. Several successful interspecific crosses between *Poa annua* and *Poa supina* were accomplished using mist and excised stem techniques. Plants resulting from seed of these crosses are currently under evaluation. These are the first interspecific crosses we have been able to accomplish.

In the spring, a field seed production trial was established at the University of Minnesota to evaluate seed production potential of the eight advanced selections. A seed production trial of 4,000 plants, 500 each of the eight advanced selections, was space planted in November on Pickseed West land in Tangent Oregon. The primary objectives of this planting are: 1) to assess the seed production capabilities of each selection under supervision of a commercial seed grower; 2) to compare differences in seed production between materials; and 3) to produce a supply of breeder's seed that can be used for increase. It is planned that all current studies will continue. Collection of new materials and selective crossing will continue. Strong emphasis will focus on the seed production aspects with the eight advanced materials.

UNIVERSITY OF NEBRASKA

Breeding, Evaluation and Culture of Buffalograss for Golf Course Turf

1990 Research Grant: $35,000
(Seventh year of support)

Dr. Terrance P. Riordan
Dr. Garald L. Horst
Principal Investigators

Buffalograss (*Buchloe dactyloides*) is considered to be a low water user, have low maintenance requirements, and able to survive the heat, drought, and cold extremes of the great plains region of the USA. This project is the first concerted effort to enhance the turfgrass characteristics of buffalograss. The following items update the status on cultivar releases and research progress.

Plant Patent Update. Plant Patents and crop registrations are still being prepared for NE 84-609, NE 84-315 and NE 85-378. These three selections will be included in the National Buffalograss Evaluation Trial scheduled for 1991. It is possible that two other selections from this project will be included.

NE 84-609 Commercialization. The NE 86-609 planting made May 14, 1990, established successfully with no problems. David Doguet, Crenshaw and Doguet Turfgrass, hopes to have 100 acres of 609 by next summer; however, this will not be enough sod to meet the present demand. An additional one acre foundation planting was made in Florida during September, 1990. A small amount of 609 will be planted on the new Barton Creek Golf Course in Austin, Texas.

Commercialization - Seeded Buffalograss. Native Turf Development Group (a consortium of Farmers Marketing Corporation, Yuma, Arizona; Arrow Seed, Broken Bow, Nebraska; and Johnston Seed, Enid, Oklahoma) harvested seed from a seed yield trial established during summer, 1989. Three to five of the synthetics will be included in the National Buffalograss Evaluation Trial.

Seeded Buffalograss Selection. The 1991 nursery will have approximately 3,000 individual seedlings originating from Dr. Garald Horst's salt screening research. The seed will be established in the greenhouse and planted to the field in 1991. The seed was collected from buffalograss genotypes able to withstand severe drought and saline conditions. This nursery will serve as a population from which improved selections will be made for advanced testing.

Buffalograss Tissue Culture. Utilizing buffalograss variety NE 84-609, research was completed on the callus initiation phase. The most important conclusions that have been found from this research include:

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

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

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

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

UNIVERSITY OF NEBRASKA

Cultural Practice Interactions of Golf Course Turf

1990 Research Grant: $25,000
(Seventh year of support)

Dr. Terrance P. Riordan
Dr. Garald L. Horst
Principal Investigators

Vertical Mowing Frequency and Mowing Height Effects on Putting Green Quality and Plant Stress. This project continues to study the effects of vertical mowing frequency and mowing height on putting speed, rooting, and stress resistance. Grooming by vertical mowing at 28 and 14 day intervals did not influence putting speed under the conditions of this study. As expected, mowing height influenced putting speed. Mean ball roll for 1990 was 7% greater for mowing heights at 1/8 inches than at 5/32 inches, and 15% greater at 1/8 inches than at 3/16 inches. Vertical mowing intervals did not influence average monthly visual color and quality ratings. Mowing height did influence visual color and quality with 5/32 inches having up to 49% greater quality than mowing heights at 1/8 inches in July 1990. Color and quality ratings for mowing heights at 3/16 inches were up to 40% greater than at 1/8 inches in July 1990. Vertical mowing frequency did not influence the vegetation index (amount or density of turf) as measured by light reflectance.

Creeping Bentgrass Fairway Management. The fairway management study is being conducted to determine effects of irrigation frequency, clipping removal or return, nitrogen nutrition, and traffic on Penncross creeping bentgrass competition with annual bluegrass. Turfgrass quality and color ratings increased with high nitrogen application in both traffic conditions. Responses to fairway playing conditions for load bearing capacity, divot tolerance recovery, and ball speed in 1990 were similar to those reported in 1989. Leaf nitrogen content increased with frequent irrigation, clipping return, and high nitrogen treatment. A general trend was that soil nitrogen content decreased with frequent irrigation, clipping return, and high nitrogen rate under both traffic conditions. Low nitrogen application produced less thatch than high nitrogen application. Perennial-biotype spread of annual bluegrass decreased with low nitrogen application in traffic and non-traffic conditions. Attempts to infest this research area with annual-biotype annual bluegrass have failed, perhaps indicating a strong competitive advantage toward the bentgrass fairway culture under the management and traffic regimes of this study.

Syringing on a Creeping Bentgrass Green. A syringing study has been initiated to study interactive effects of nitrogen and potassium nutrition. The study was designed so treatment modifications over time would allow investigation of the amount of water applied during syringing, and of application timing effects on syringing treatments. The data collected, thus far, indicates a significant canopy turfgrass cooling influence from mid-day syringing and indicates the value of this technique to reduce heat stress on putting surfaces. Currently, design and implementation aspects of this research project are under evaluation to improve the timing and frequency of syringing applications during summer stress.

OHIO STATE UNIVERSITY

Monoclonal Antibodies for Rapid Diagnosis of Summer Patch and Necrotic Ring Spot Diseases of Turfgrasses

1990 Research Grant: $10,500
(Third year of support)

Dr. William W. Shane
Dr. Stephen T. Nameth
Principal Investigators

Slow-growing patch diseases are among the most difficult problems to diagnose on turfgrasses. Research at the Ohio State University, Department of Plant Pathology has focused on the development and use of immunological techniques for rapid diagnosis. We previously reported our success in developing a monoclonal antibody-producing clone that was selective for *Leptosphaeria korrae*, the causal agent of necrotic ring spot. The antibody, a small protein that can bind to the fungus, can now be grown in great quantity in a laboratory flask. The antibody allows us to test for the presence of the pathogen in a plant sample. Our antibody was highly reactive against all fungal strains of *Leptosphaeria korrae* tested.

The usefulness of the antibody for *L. korrae* has been tested thoroughly against diseased turfgrass samples submitted to the Ohio State University Plant and Pest Diagnostic Clinic and additional Kentucky bluegrass samples collected by our laboratory. The *L. korrae* pathogen was successfully isolated from all Kentucky bluegrass samples exhibiting a significant reaction with the LK antibody. In addition, the LK antibody was successfully used to study the distribution of *L. korrae* in the various regions of "frog eye" patches and on turfgrass plant parts to gain a better understanding of the life cycle of this disease. Through this research effort, sampling techniques for detection of *L. korrae* with the LK antibody were optimized.

The LK antibody successfully detected *Leptosphaeria korrae* in certain bermudagrass sites with spring dead spot symptoms. The antibody will be useful in determining the causal agent of spring dead spot. Currently, at least three fungi (*L. korrae, Ophiosphaerella herpotricha*, and *Gaeumannomyces graminis*) have been shown to be causes of this disease.

Development of monoclonal antibody against the causal fungus of summer patch (*Magnaporthe poae*) is in progress. A third set of mice have been immunized using an improved protocol. Reactivity of mouse serum will be tested in November 1990, followed by production of monoclonal antibody clones. Screening of clones will begin in mid-December, followed by field testing in the summer of 1991. The result will be a fast, reliable method to diagnose and monitor this disease.

OKLAHOMA STATE UNIVERSITY

Breeding and Evaluation of Cold-tolerant Bermudagrass Varieties and Bermudagrass Varieties for Golf Course Putting Greens

1990 Research Grant: $75,000
(Fifth year of support)

Dr. Charles M. Taliaferro
Dr. Joel F. Barber
Principal Investigator

Present objectives of the bermudagrass breeding program are to: 1) develop seed-propagated, cold-tolerant, finer-textured varieties for the transition zone; and 2) develop improved varieties for golf course putting greens, with emphasis on adaptation to southern coastal states.

Significant progress was made last year in development of cold-tolerant, seed-propagated bermudagrass varieties for the U.S. transition zone. Four experimental synthetic varieties were produced in 1989 and established in turf evaluation trials in Colorado, Iowa, Missouri, and Oklahoma this spring (1990). These experimental varieties will be tested for cold tolerance and suitability for use in fairways and roughs.

To further improve turf quality, bermudagrass populations bred for increased basic fertility (seed-set) were subjected to intense greenhouse screening for finer texture and increased density. In 1989, 162 of 10,000 plants were selected (1.6%) and established in spring 1990 in Oklahoma and Arizona nurseries. Inter-crossed seed from these plants were used to establish an additional 10,000 greenhouse plants for selection in late summer, 1990. From this population, 328 selections were established in field polycross nurseries in September 1990. Continued selection in these breeding populations for turf quality, cold-tolerance, and seed yield should refine them to a level permitting development of high-quality, seed-propagated, cold-tolerant varieties.

Development of new bermudagrass varieties for putting greens is proceeding on schedule. Thirty-three hundred *C. transvaalensis* progeny plant selections were established at Stillwater, Oklahoma, in early June for evaluation under putting green maintenance. In late October 1990, the 500 best appearing plants from this nursery were planted in groups of 100 on five Florida golf courses. Evaluations over the next year at Stillwater and the five Florida locations will be used to select 25 to 30 plants which will be subjected to more intensive evaluation.

An experiment was completed to assess the effects of temperature and duration of exposure on cold acclimation of bermudagrass plants in the growth chamber. The information allows refinement of a mass screening procedure for cold hardiness whereby we grow plants in cone-tainers in the greenhouse, acclimate them in a growth chamber, and then subject them to freezing temperatures as a screen for cold tolerance. Results to date suggest the procedure to be a feasible means of mass screening bermudagrass plants for cold tolerance.

UNIVERSITY OF RHODE ISLAND

Use of Mycorrhizae in the Establishment and Maintenance of Greens Turf

1990 Research Grant: $ 40,000
(First year of support)

Dr. Noel Jackson
Dr. R.E. Koske
Dr. J.N. Genna
Principal Investigators

Most of the research on mycorrhizae, fungi which have a beneficial association with plant roots, has focused on crop plants. Lack of research on turfgrasses may be due to an unsubstantiated theory that plants with fine roots and abundant root hairs do not benefit from mycorrhizae, especially if soil phosphorus is adequate. In fact preliminary investigations in this lab indicate that turfgrasses have up to 80% of their root systems colonized by mycorrhizal fungi.

SURVEY OF TURFGRASS SOILS FOR MYCORRHIZAL FUNGI.

Two different methods have been employed to determine what species of mycorrhizal fungi are present in soils from established plots of *Agrostis palustris* cv. Penncross, *A. canina* cv. Kingstown, and *Poa annua*.

Direct Soil Isolation. Turf soils are examined each month for spores of mycorrhizal fungi. This method indicates what species are present and their relative abundance in the soil at the time of collection.

Pot Culture Technique. Because mycorrhizal fungi are obligate symbionts, they can only be cultured when grown with a host plant ("pot culture"). Pot cultures of turf soils are established each month. These cultures are harvested after four to six months to check for spore production. Species of fungi vary in their ability to sporulate, and some species sporulate more readily in pot culture than in the field. Thus by combining data from pot culturing and direct soil isolation, we will obtain a more complete survey of the fungal community in turf soils.

MYCORRHIZAL INOCULATION EXPERIMENTS

Greenhouse: The mycorrhizal fungus *Glomus intraradix* produced a significant increase in shoot dry weight in both species of bentgrass (*A. palustris* and *A. canina*) as compared to non-inoculated plants. A mixed culture of mycorrhizal fungi isolated from turf soils did not increase shoot dry weight. Techniques to generate inoculum on a large sale are being investigated.

Field: A small sand green (USGA specifications) was installed in the field in September 1990. The effect of mycorrhizal inoculation with *Glomus intraradix* and different levels of phosphorus on *A. palustris* and *A. canina* will be evaluated. The green was divided into 288 square-foot plots using a plywood grid. Some plots are being used to examine the interaction of two different peat sources, sedge and sphagnum, on bentgrass growth and mycorrhizal inoculation. A parallel study will be established in the greenhouse by December 1990.

Laboratory: A new method of inoculating bentgrass plants with mycorrhizal fungi under monoxenic conditions in liquid culture has been developed. Attempts to establish root organ cultures of bentgrass have not been successful to date.

RUTGERS UNIVERSITY

Endophytes of Turfgrasses: New Tools and Approaches

1990 Research Grant: $40,000
(First year of support)

Dr. Peter Day
Dr. Reed Funk
Principal Investigators

Endophytes are fungi which live within several turfgrass species without causing damage to the host plant. In turn, endophytes have demonstrated an ability to impart increased resistance to insect pests through the production of alkaloid compounds. This project was proposed and initiated by Dr. Peter Day, Center for Agricultural Molecular Biology (AgBIOTECH) and Dr. Reed Funk, Department of Crop Science, Rutgers University. Dr. Jane Breen, a post-doctoral researcher began work on the project in April 1990, in the laboratory of Dr. Michael Wilson (Professor, AgBIOTECH).

The objectives of this project are to: (a) produce a germplasm collection of fungal endophyte-infected grasses concentrating on *Poa* (bluegrass) and *Agrostis* (bentgrass) species; (b) produce a collection of unifungal endophyte cultures for both classical and molecular analysis; (c) produce endophyte-specific DNA probes for sensitive detection of particular species and/or isolates of endophyte by nucleic acid hybridization techniques and by recently developed polymerase chain reaction (PCR) amplification methods; (d) use these and other molecular probes to characterize endophyte variability and produce RFLP maps as taxonomic aids in this field; (e) develop gene transfer methods for fungal endophytes, as well as fungal transfer methods between different turfgrasses, to test for compatibility or incompatibility; and (f) identify those genes responsible for insect repellant alkaloid biosynthesis and metabolism, particularly in beneficial endophyte-grass combinations.

Including material collected recently using USGA-funds and acquisitions from Dr. Funk's turf breeding program, we now have a germplasm collection of multiple selections of fourteen species of endophyte-infected turfgrasses, including some bentgrasses and bluegrasses (*Agrostis hiemalis, A. scabra, A. alba* and *Poa palustris, P. autumnalis, P. ampla*), in addition to a number of tall fescues, perennial ryegrasses and fine fescues. Our endophyte collection includes multiple isolates of eight species of *Acremonium* fungal endophytes which infect a broad range of grasses. A DNA library has been developed from *Acremonium starrii*, which will be used to provide probes for DNA 'fingerprinting'. These probes will be used to evaluate and quantify genetic differences among endophytes, particularly in terms of those which confer insect resistance or have the ability to produce choke disease in livestock.

RUTGERS UNIVERSITY

Breeding and Evaluation of Kentucky Bluegrass, Tall Fescue, Perennial Ryegrass, and Bentgrass for Golf Turf

1990 Research Grant: $ 5,000 — Dr. C. Reed Funk
(Eighth year of support) — Principal Investigator

We are continuing an extensive program to collect, evaluate, enhance, and preserve turfgrass germplasm and to participate in the development of turfgrass cultivars with improved stress tolerance, increased persistence, greater pest resistance, and reduced maintenance requirements.

1. Additional turfgrass germplasm collections were made in Delaware, Louisiana, Maryland, New Jersey, and Texas.

2. Over 1,000 newly collected plants were screened for useful *Acremonium* endophytes. New sources of endophyte were found in blue fescues, strong creeping red fescues, slender creeping red fescues, and Chewings fescues. However, we have been unsuccessful, to date, in finding a useful *Acremonium* endophyte in Kentucky bluegrass, creeping bentgrass, or Colonial bentgrass.

3. The first certified seed crops were harvested from Advent, Envy, Legacy, and SR-4000 perennial ryegrass; Austin, Hubbard 87, and Shenandoah tall fescues; SR-5000 Chewings fescue; and Suffolk Kentucky bluegrass.

4. Over 9,000 turf plots were seeded in 1990 along with over seven additional acres of space-plant nurseries.

5. Striking resistance to chinch bugs was observed in strong creeping red fescues containing some, but not all, biotypes of *Acremonium typhinum*. Various strains of endophytes are showing significant differences in their ability to enhance host plant performance.

6. Progeny of an *Acremonium* endophyte infected strong creeping red fescue collected from the Rose City Cemetery in Portland, Oregon showed excellent resistance to dollar spot in turf trials in New Jersey. Studies have been initiated to determine if this resistance is genetic or associated with this particular strain of endophyte.

7. Considerable genetic variability in resistance to summer patch has been observed both within and between species and subspecies of fine fescue in field and growth chamber tests. Opportunity exists to develop more resistance cultivars.

(Please Note: The Turfgrass Research Committee is proud to continue its support of Dr. Funk's prolific breeding program. The Committee's small grant covers but a small fraction of the costs of the program.)

ST. SIMONS ISLAND, GEORGIA

Mole Cricket Pheromones

1990 Research Grant: $10,000
(First year of support)

Dr. A. Leon Stacey
Principal Investigator

This report summarizes the first year of intense research activity devoted to isolating and utilizing pheromones to affect mole cricket population dynamics on golf courses. Biologically active materials were found and, with further refinements, may be produced for commercial marketing. No previous research has been done with mole cricket pheromones. The current research could potentially develop into a new and environmentally sound approach to managing turf insect pests.

Various glands and body parts were dissected from both male and female crickets. During the cricket flight season, acetone homogenate of the spermatheca (♀ crickets) and an unknown gland (♂ crickets) were biologically active and appeared to act as attractants (sex or aggregating pheromones). An alarm substance from the rectum (♀ and ♂) significantly reduced "fly-in" crickets. Additional tests are needed to improve on the pheromone dispensing system and to further refine optimum rates needed for activity.

Late season tests with the alarm substance formulated in spray mixes and applied to turf had no apparent influence on crickets.

Results of the first year's study are extremely encouraging. The attractants and the alarm substance may eventually fit well into a pest management system by influencing the population dynamics of crickets, i.e. concentrating crickets into one area while repelling them from others. Such uses could reduce our total dependence on insecticides by reducing the turf area requiring treatments.

Although no previous work has been done with mole cricket pheromones, the concept has been used successfully in eradication programs for several insect pests of agronomic importance and millions of dollars have been saved.

TEXAS A&M UNIVERSITY

Developing Rhizoctonia Brown Patch and Pythium Disease Resistance in Bentgrass and Zoysiagrass

1990 Research Grant: $10,000
(Fourth year of support)

Dr. Phillip F. Colbaugh
Principal Investigator

Techniques for handling and inoculating large numbers of bentgrass field samples are being used to identify resistance to *Pythium* and *Rhizoctonia* blight diseases. Large culture collections of both pathogens have assisted in the use of highly virulent strains of the fungi for disease screening. Previous inoculation studies with bentgrass genotypes obtained from the germplasm introduction nursery, HTS (heat treatment selection nursery), NHTS (not heat treated selection nursery) and the elite bentgrass nursery have been examined for *Pythium* foliar blight resistance. Repeated inoculation studies compared with the standard variety Penncross demonstrated improved *Pythium* resistance among several members of the experimental bentgrass germplasm collections. Of the 1,203 germplasm lines screened during 1989, 6% demonstrated resistance to *Pythium* foliar blight.

Wet weather during the spring allowed research investigations to focus on field evaluations of *Pythium* blight symptoms in field nurseries. Disease symptoms were observed in June on two field nurseries following lengthy environmental periods favoring disease pressure. Typical visual symptoms of foliar thinning and decline were observed on 15.4% and 29.4% of the NHTS and HTS plots, respectively. Disease symptoms appeared to be greater on germplasm from the variety Prominent than on other parental lines observed in both nurseries. Greenhouse studies were used to correlate disease symptoms from the HTS nursery field plots with a seedling bioassay for *Pythium* blight in small plastic cups. Blighting of seedling stands in cups produced by sampling soil cores from field plots was greater in cups than on the field plots. Among the tested experimental cultivars showing field resistance (less than 25% disease), 41% were substantiated by seedling blight data. These results indicate the importance of obtaining field plot visual data to identify sources of resistance to *Pythium* blight. *Rhizoctonia* spp. inoculation studies on germplasm from HTS and NHTS field nursery plots showing field resistance to *Pythium* blight did not show a high level of resistance to both diseases. Of 105 *Pythium* resistant genotypes examined, 11 demonstrated potential resistance to both *Pythium* and *Rhizoctonia* blight diseases.

The USGA *Rhizoctonia* culture collection has also made valuable contributions in the area of developing refined techniques for tissue culture selection of resistant genotypes. Cooperative research with Dr. Jeff Krans, Mississippi State University, screens bentgrasses originating from tissue culture lines against *Rhizoctonia* blight. Isolates of fungi causing *Helminthosporium* diseases and *Sclerotinia* dollar spot are being collected and samples will be greatfully received from any available sources. The isolates will be maintained in long-term storage with other USGA isolates.

TEXAS A&M UNIVERSITY

Breeding and Development of Zoysiagrass

1990 Research Grant: $45,000 — Dr. M.C. Engelke
(Eighth year of support) — Principal Investigator

A major redirection within the zoysiagrass program occurred in 1989 and 1990 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 desirable traits into new varieties. Considerable progress has been made in the area of developing seeded zoysiagrasses.

Maintenance of the zoysiagrass germplasm nurseries will receive considerable attention during the next few years due to the reduction in turfgrass research efforts on the part of the United States Department of Agriculture. Due to Federal budget problems, the Oriental zoysiagrass collection will be preserved vegetatively at TAES-Dallas. However, no funds are available to complete the documentation or to develop the CORE collection for entry into the Plant Introduction (PI) System, or for increase and distribution. Regardless, vegetative maintenance and production of these accessions has become streamlined and more expedient with the use of thin-layer sod production techniques developed at TAES-Dallas. Once entered into the PI system, the CORE collection will be available to requesting agencies as prescribed by the rules and regulations of the USDA Plant Introduction system.

Numerous elite accessions of zoysiagrasses have been evaluated for water-use requirements under field conditions using the Linear Gradient Irrigation System (LGIS). Major separations occurred for plant growth response and survival among zoysiagrass cultivars and accessions. Of the commercial cultivars, El Toro and Belair required less water than Meyer or FC13521. A number of the DALZ lines have remarkable potential to recover from drought stress. The Turfgrass Root Investigation Facility (TRIF) has provided considerable information on the rooting characters of many of the elite lines. The shade trials continue with marked separation of plant materials in their ability to persist and grow under limited light. The combined testing facilities suggest considerable genetic variability exists 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 exists among the lines under evaluation for cold hardiness, rate of spread, texture and turf quality.

Results from 11 regional field trials continue to provide excellent information on area of adaptation and potential utility of the elite accessions under development. Regional field trials are located in 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. DNA finger printing of five elite lines in comparison to Meyer zoysiagrass has been completed by Dr. Lloyd Callahan and Dr. Peter Gresshoff of the University of Tennessee.

The National Turf Evaluation Program will sponsor a zoysiagrass trial to be planted in the spring of 1991. A total of 23 entries, including four commercial varieties, will be established at approximately 30 locations across the United States. The TAES-Dallas project will enter approximately ten elite accessions. Data from these national tests are invaluable in defining adaptive characters as well as potential uses of newly developed varieties. TAES-Dallas will assume the responsibility for increasing all of the entries for these trials, with distribution anticipated in mid-May 1991.

Numerous selections have been identified in the Oriental collection for turf quality, color retention, green up, drought hardiness, seed production potential, and several desirable agronomic traits. Approximately 1,500 progeny are under field evaluation for turf performance and seed production potential. Heritability studies and parent-progeny populations are included for seed production, drought resistance, root characteristics and general turf performance.

TEXAS A&M UNIVERSITY

Breeding and Development of Bentgrass

1990 Research Grant: $64,000
(Sixth year of support)

Dr. Milt C. Engelke
Principal Investigator

As a major milestone, three creeping bentgrass varieties developed by Texas A&M were submitted for release in 1990. The initial petition for release of Syn3-88 was filed in September, and Syn4-88 and Syn1-88 were filed in October, 1990. Foundation seed production fields were established for Syn3-88 (10 acres) and Syn4-88 (12 acres) in September of 1990. Foundation production of Syn1-88 will be planted in the spring of 1991 (~10 acres). The anticipated production cycle will permit certified production fields of Syn3-88 and Syn4-88 to be established in 1991, with the first commercial production to be harvested and available to the industry by the fall of 1992. Syn1-88 production cycle will lag behind by one year with first commercial production available in 1993.

Selection, hybridization, and advanced screening programs rapidly advance with the production of 14 new polycross populations and 24 single cross populations being produced in 1990. We presently have over 9000 individual plants established in the greenhouse for additional screening and evaluation. Emphasis over the next few years will be on the continued development of improved turfgrass characteristics into new varieties. While effective screening procedures are being developed, heritability work is being conducted for disease resistance mechanisms, drought and heat tolerance characters, and perennial root growth characters.

The leaf-stem hydration work completed by Dr. Virginia Lehman suggests that a very strong relationship exists between leaf water content and heat tolerance. This procedure will be used extensively, along with the flexible tube procedure which measures rooting depth, to screen root characters of bentgrass in the development of the next generation of superior heat tolerant varieties.

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

(Please Note: This project is jointly funded through a grant from the USGA and Bentgrass Research, Inc. located in Dallas, Texas.)