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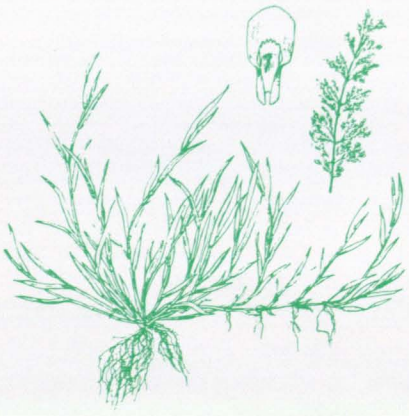
USGA GREEN SECTION

1991 TURFGRASS RESEARCH SUMMARY



CREEPING BENTGRASS

Illustration by Steven M. Batten

1991
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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March 1992

TO: THE READERS OF THE 1991 ANNUAL TURFGRASS RESEARCH REPORT

The USGA Green Section and the Golf Course Superintendents Association of America (GCSAA) teamed up in 1983 to fund a 10-year turfgrass research effort that would reduce water use, pesticide use, and maintenance costs by a significant amount. The major thrust of the effort has involved developing new grasses and improved cultural maintenance practices that meet these objectives. As we enter the 10th year of this program, it is clear that much has been accomplished in addressing these needs.

Important strides have been made in improving major turfgrass species for golf, including bentgrass, bermudagrass, zoysiagrass and even Poa annua. The first commercial introduction from the program was NuMex 'Sahara' bermudagrass, an improved, seeded type that continues to sell very well and bring significant royalty income to the research program.

During 1992, it is expected that two improved, heat tolerant creeping bentgrasses will be released from the breeding program of Dr. Milt Engelke at Texas A&M University. One of these new cultivars will be named 'Cato' bentgrass, in honor of Paul Cato, a long-time supporter of golf and a former president of the Colonial Country Club in Fort Worth, Texas. Paul Cato was also the founding president of Bentgrass Research, Inc., a major contributor to the bentgrass breeding program at Texas A&M.

Major strides also have been made with some of our native grass species, including buffalograss, alkaligrass, blue grama, and curly mesquitegrass. The first improved cultivar among these native species to reach the market was '609' buffalograss, which should be readily available for use on golf courses this year. These native grasses use considerably less water than most other turf species, and will significantly reduce water use on golf courses where they can be used to replace cool season grasses.

USGA

You might call 1991 the "Year of Cooperation" among golf course superintendents, seed companies, and the scientists working on funded projects. Golf course superintendents have enthusiastically embraced the testing of potential new grasses, putting them under a typical golf course maintenance regime and exposing them to high stress conditions. Seed companies have just as enthusiastically cooperated with investigating scientists in testing and screening potential new introductions for seed yield and other desirable characteristics. This spirit of cooperation will ultimately translate into better quality grasses for golf and earlier introductions to the market, and the Turfgrass Research Committee in grateful for this show of support.

It is a pleasure to report that the USGA Executive Committee has agreed to extend the Turfgrass Research Program for five additional years, through 1997. The Research Committee has reviewed more than 80 proposals and has decided to fund 20 projects beginning in 1993. A total of $4.2 million has been committed to this 5-year program, ensuring a steady stream of new grasses and improved maintenance practices to meet the environmental challenges facing the game of golf.

Finally, a sincere thanks to the readers of this report and to those organizations and individuals who, year-in and year-out, offer moral and financial support to carry on this vital work.

With appreciation,

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

United States Golf Association

USGA

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March 25, 1992

To the Readers of the 1991 Annual Turfgrass Research Summary:

Little the USGA does, or it 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 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 seeded bermudagrass and an improved buffalograss. Several heat-tolerant bentgrasses will be released in 1992.

The 1992 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

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.

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1992 Turfgrass Research Budget Summary

Project	Sub-Project	University/Investigator	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Total
Turfgrass	General	Rutgers/Funk	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	50,000
Breeding	Bentgrass	Penn State/Duich	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	40,000
		TX A&M-Dallas/Engelke			47,000	40,000	40,000	40,000	60,000	64,000	64,000	64,000	419,000
		New Zealand/Rumball				10,000	10,000	10,000	13,000	10,000	10,000	5,000	68,000
		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	8,000	59,000
		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	75,000	320,000
	Native Grasses	CO State/Cuany-Koski			10,000	20,000	20,000	25,000	25,000	30,000	30,000	30,000	190,000
		Univ of AZ/Mancino						5,000	12,000	12,800	12,800	12,800	55,400
		Univ of NE/Riordan		4,100	20,000	18,000	19,000	25,000	35,000	35,000	45,000	45,000	246,100
	Poa annua	Univ of MN/White		11,600	15,000	15,000	20,000	30,000	35,000	35,000	35,000	35,000	231,600
	Zoysiagrass	TX A&M-Dallas/Engelke	2,500	42,585	42,000	40,000	40,000	40,000	45,000	45,000	45,000	45,000	387,085
		SUBTOTALS:	20,500	80,785	169,500	198,500	208,000	217,000	279,000	323,800	333,800	328,800	2,159,685
Cultivar	Multiple Sites	University Trials							43,000	43,000	44,200	38,000	168,200
Evaluation		Screening							15,000	15,000	6,200	2,000	38,200
	Bentgrass	Univ of GA/Carrow										6,000	6,000
	Zoysiagrass	Univ of GA/Carrow										20,200	20,200
		SUBTOTALS:	0	0	0	0	0	0	58,000	58,000	50,400	66,200	232,600
Cultural	Management	MI State/Branham			10,000	15,000	15,000						40,000
Practices		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	10,000	60,000
		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	18,000	117,000
	Salt Screening	TX A&M-El Paso/Horst		3,480	15,000	15,000	15,000	15,000	15,000				78,480
	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	40,000	120,000
		SUBTOTALS:	3,000	28,223	69,000	95,000	100,000	65,000	70,500	103,000	108,000	68,000	709,723
Turfgrass		MI State/Cookingham	5,000	96,326	68,000	55,000	65,000	65,000	60,000	70,000	70,000	70,000	624,326
Library		SUBTOTALS:	5,000	96,326	68,000	55,000	65,000	65,000	60,000	70,000	70,000	70,000	624,326
Biotech	Methodology	Univ of IL/Smith						8,400		9,000	9,000	9,000	35,400
	Pathology	OH State/Shane					10,000		10,000	10,500			30,500
		MS State/Krans									21,900	21,900	43,800
	Endophytes	Rutgers/Funk-Day								40,000	40,000	40,000	120,000
		SUBTOTALS:					10,000	8,400	10,000	59,500	70,900	70,900	229,700
Stress	Heat & Drought	TX A&M-Col. Stn./Beard	84,500	87,000	91,000	73,000	70,000	55,000	67,800				528,300
Mechanisms	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	0	0	557,300
Environmental	Lit Review	Spectrum Res./Balogh								25,000	14,000		39,000
		SUBTOTALS:	0	0	0	0	0	0	0	25,000	14,000	0	39,000
Administration	Meetings		13,500	13,766	19,319	11,100	16,500	30,500	35,000	36,422	30,000	42,000	248,107
	Inspections						7,000	20,500	25,000	27,000	43,400	42,000	164,900
	Annual Report						3,500	8,600	10,000	9,140	15,000	23,000	69,240
	Legal Fees								5,000	6,455	5,000	2,000	18,455
		SUBTOTALS:	13,500	13,766	19,319	11,100	27,000	59,600	75,000	79,017	93,400	109,000	500,702
		TOTALS:	126,500	306,100	416,819	432,600	480,000	470,000	620,300	747,317	740,500	712,900	5,053,036

UNIVERSITY OF ARIZONA

Breeding and Development of Curly Mesquitegrass as a Desert Turf

1991 Research Grant: $12,800
(Fourth year of support)

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

The primary objective of this project is to develop a seed propagated, low-maintenance, low water-requiring turfgrass for the desert southwest. Curly mesquitegrass (*Hilaria belangeri*), a native to parts of Arizona, Texas, New Mexico and southern California, has many desirable turf traits including low stature, density, color, spread and prolific seed production.

Heritability studies, concluded in 1991, have shown that significant genetic variation exists in many of the turfgrass characters mentioned above, such that selection and breeding can produce a population with improved turfgrass traits. In addition, the environment has been shown to have little or no influence on certain physical parameters (total germination, germination rate, seed weight, late season color, overall color, stature, leaf width, leaf length, and density) so that the genetic component for these traits is large and heritable.

More than three years of plant screening has resulted in the selection of over forty plant materials with desirable turf traits. These plants have been incorporated into a plant breeding program. Seed from these crossing blocks will be harvested and planted. These progeny will be evaluated during 1992 and 1993 to further refine the population for turf and reproductive characteristics.

COLORADO STATE UNIVERSITY

Development of Dryland Western Turfgrass Cultivars

1991 Research Grant: $30,000
(Seventh year of support)

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

Work at Colorado State University to evaluate three western turfgrass species alkaligrass (*Puccinellia spp.*), blue gramma (*Bouteloua gracilis*), and fairway crested wheatgrass (*Agropyron cristatum*) for turf-type traits, as well as turf performance, continues.

Alkaligrass, unfortunately, performs poorly in spaced plant nurseries after seed production, but does well in turf evaluation plantings. The seed production capabilities of this species is being evaluated in the Pacific Northwest by Dr. Virginia Lehman (Great Western Seed, Lebanon, OR). Seed from the four best alkaligrass families was sent for testing. Seed production in Fort Collins will be augmented by establishing a large, spaced plant nursery from greenhouse transplants (i.e., from the 10 best families) in early 1992. The turf trials were overseeded with extra seed in 1991 to fill in open areas. This will provide a more uniform surface on which to conduct mowing height evaluations in 1992 (0.75 and 1.5 inches). High and low fertility regimes will also be imposed on the two current alkaligrass turf trials.

Rust incidence was not as severe in 1991 as in 1990, probably due to the higher nitrogen rates applied to stimulate the growth of existing and newly seeded alkaligrass trials. Interestingly, Dr. Lehman noted that accessions resistant to rust in Colorado were infected in Oregon, while those sensitive in Colorado were free of rust in the Oregon trials. This points to the need for more widespread testing of these cultivars. Seed of four experimental materials was sent to University of Illinois and Iowa State University for evaluation.

Blue gamma continues to provide an attractive turf under limited water conditions in our studies. Efforts were made, through the use of isolated recombination blocks of four subgroups (i.e., "elite", "nice", "plus", and "narrow"), to produce more seed of this species. A small amount of seed was produced by the "elite" nursery with full seed production expected to occur in 1992. This is the most promising advanced population and will enter a cycle of vigorous multiplication for foundation seed. Future efforts with this species will be concentrated on the "elite" group because it displays better seed production characteristics than the other groups, as well as desirable turf characteristics. Seed of these experimental cultivars was sent to University of Arizona and University of Nebraska for planting and evaluation.

The fairway crested wheatgrass "cycle 2" evaluation nursery performed well in 1991, with much better seed than in 1990. The seed harvested from individual plants displaying a rhizomatous growth habit will be bulked for spring 1992 turf evaluation plantings. Plants with characteristics of interest were taken from this nursery, cloned, and replanted into four isolated recombination blocks. Two spring-established blocks contain material that

exhibited good disease resistance and narrow leaves in the nursery. The two fall-established blocks contain plants with more rhizomes and broader leaf blade. Full seed production from all four blocks is expected in 1992. This seed will be used for turf evaluation plots, as well as for the possible start of another selection cycle. The most extensive turf trial for this species was planted in September, and will be examined closely for performance under differential mowing and fertility regimes in 1992. A trial was also started at South Dakota State University.

We continue to evaluate experimental and released buffalograsses from Nebraska and Texas A&M, finding them to be greatly improved over 'Texoka' and 'Sharp's Improved' with respect to density, summer color, and dormant color. Those of southern origin green up slowly in the spring and are slow to establish from plugs, but retain color approximately two weeks longer in the fall than those of northern origin. Winterkill is not a problem with any of the new buffalograsses.

The bermudagrasses from Oklahoma State University displayed excellent establishment characteristics, vigorous summer growth, excellent summer color, and surprisingly good low temperature tolerance. Their spring green-up rate is similar to that of buffalograss

UNIVERSITY OF GEORGIA

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

1991 Research Grant: $18,000
(Third year of support)

Dr. Robert N. Carrow
Principal Investigator

Adverse soil physical conditions interfere with turfgrass management by limiting water movement, reducing plant water uptake, reducing soil aeration, and decreasing root/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 adverse soil physical properties. Cultivation is a primary means of alleviating these problems; however, comparative research studies to evaluate different techniques have not been conducted. The objectives of this project were: 1) to evaluate different cultivation techniques for their relative effectiveness in alleviating soil compaction, improving water use efficiency, and improving shoot/root growth; and 2) to develop "cultivation" programs for fairway/tee conditions based on using two or more different cultivation techniques.

Phase I (1989 to 1990) of this project focused on objective (1) and was summarized in the 1990 annual report; but new cultivation techniques will still be evaluated over the last two years (1991 to 1992). The primary focus in 1991 through 1992, however, will be to evaluate cultivation programs (i.e., objective 2). The soil is a Cecil sandy clay loam with 55.1% sand, 17.6% silt, 27.3% clay and 2.14% organic matter content. A common bermudagrass mowed at 0.75 to 1.0 inch was used.

Seven cultivation treatments plus two control treatments are under investigation in the 1991-1992 study. From the previous study in Phase I, the most effective cultivation technique was the Verti-Drain for deep soil improvement (see *Green Section Record* Vol. 30, No.1, pp. 5-9), while hollow tine coring improved surface conditions. Thus, intensity of Verti-Drain treatment (1x, 2x times over the plot area), as well as Verti-Drain plus hollow-tine coring combinations are being explored. The Yeager-Twose Turf Conditioner (a subaerification unit) has not been evaluated in research studies for comparative effectiveness as a turfgrass cultivation unit. The vibrating shank of this device goes to a depth of 7 inches and, with proper attachments, can inject granular components to this depth.

Considerable data has been collected and is under preparation and analysis related to soil physical and chemical properties by depth; water use and extraction patterns by depth; and root growth by soil depth. Shoot responses in 1991 revealed improved turf quality and shoot density from the Turf Conditioner + gypsum and Verti-Drain + core aeration treatments. Late summer shoot growth rate was enhanced by Turf Conditioner + gypsum and Verti-Drain cultivation. The fact that improvements in visual quality, shoot density, color and shoot growth rate occurred for the Turf Conditioner + gypsum treatment, but not Turf Conditioner alone, implies a significant response to gypsum. Gypsum has the potential to reduce aluminum root phytotoxicity on these low pH soils.

UNIVERSITY OF GEORGIA

Fertility Effects on Creeping Bentgrass Pest, Water and Root Relationships

1991 Research Grant: $5,679
(Second year of support)

Dr. Robert N. Carrow
Principal Investigator

Creeping bentgrass (*Agrostis palustris* Huds.) is the preferred species for golf greens in the upper South. The hot, humid environment of the Southeast, however, results in substantial high temperature and disease stress on this cool-season species. Dr. Milt Engelke, Texas A&M University, has an extensive bentgrass breeding program to develop bentgrass cultivars that will exhibit improved adaptation to summer stresses. The objectives of this project were to compare three of Dr. Engelke's experimentals with two industry standards for 1) root growth and water extraction patterns in the summer months, 2) shoot growth, and 3) disease and insect tolerances. The five bentgrasses included Penncross, Pennlinks, SYN-1-88, SYN-3-88, and SYN-4-88.

To define appropriate cultural regimes, two nitrogen fertility programs and two fungicide programs were included for each species. The annual fertility programs were 3.5 lb nitrogen and 7.0 lb nitrogen per 1000 ft^2, while the two fungicide programs were preventative and curative. The preventative program was based on the use of a number of fungicides applied on a preventative (to prevent disease appearance) schedule. For the curative program, substantial disease development was allowed before curative rates of a fungicide were applied. This allowed disease infection and recovery from disease to be monitored. The mowing height was 5/32 inch with clippings removed. The site was a 5-year old USGA specification golf green at Griffin, GA. Establishment of the bentgrass was in September 1990.

During the August-September period when continuous summer stresses often cause bentgrass to deteriorate, SYN-4-88 demonstrated the highest visual quality, color, and shoot density of all cultivars under the high nitrogen preventative fungicide regime. SYN-3-88 also preformed very well under these conditions. At the low nitrogen preventative fungicide treatments, best visual quality was noted for SYN-3-88 followed by SYN-4-88.

Very severe brown patch and dollar spot disease pressures were apparent in 1991. Under a preventative fungicide program, the lowest brown patch infection occurred on SYN-4-88 and Penncross, while SYN-1-88 was most susceptible. With the curative program, SYN-3-88 and Penncross demonstrated the least infection. For dollar spot, SYN-3-88 was most susceptible.

Root samples by depth and water extraction by depth data were obtained in early July and late August. Samples and data are under preparation.

UNIVERSITY OF GEORGIA

Zoysiagrass Performance, Water Use, and Rooting as Affected by Traffic and Nitrogen

1991 Research Grant: $10,296
(First year of support)

Dr. Robert N. Carrow
Principal Investigator

Zoysiagrass (*Zoysia japonica*) is a deep rooted, drought resistant species in many areas of the United States, especially the transition zone. Due to considerable genetic diversity among ecotypes, zoysiagrass has been targeted by the USGA as a species that could be developed through breeding/genetics to exhibit low water use, high drought avoidance and high drought tolerance.

Areas requiring special attention for developing a water conserving zoysiagrass are: 1) have moderate to low ET rates under both non-limited and limited soil moisture, 2) develop and maintain a deep, viable root system under the major soil stresses of high soil strength and high acidity, and 3) have good to excellent drought tolerance when tissues are subjected to drying. Objectives of the current study were to evaluate nine zoysiagrass experimentals from the Texas A&M University (Dr. Milt Engelke) zoysiagrass breeding program versus three commercial cultivars for:

a) ET, spatial rooting/water extraction patterns, and drought avoidance/tolerance responses
b) basic cultural requirements (fertility, disease, insect, traffic tolerance)
c) determination the stability of these grasses to environment, disease, and insect pressures.

Grasses were plugged at 12 inch centers on 8 through 12 July 1991 from plugs provided by Dr. Milt Engelke. Fertilization was monthly with 10-10-10 analysis at 1.0 lb nitrogen per 1000 square feet from July through September. Mowing was at 1.0 inch with clippings returned. Ronstar® 2G was applied after plugging at a rate of 1.75 lbs ai/acre for preemergence annual grass control.

To date, zoysiagrasses demonstrating the most rapid establishment are El Toro, DALZ 8514 and DALZ 8512, while those slowest to cover were DALZ 8502 and DALZ 8516. All grasses had good genetic color, but the darkest green were DALZ 8516, 8508, 9006 and 8502. Narrowest leaf texture (about 2.0 mm) was exhibited by DALZ 8502, 9006, 8507 and 8508, while widest (5.0 mm) were DALZ 8512, 8514, and El Toro. While not a part of the original project, Dr. Kris Braman is determining the resistance of these cultivars to mole cricket and white grub injury.

UNIVERSITY OF ILLINOIS

A Realistic Whole Plant Microculture Selection System For Turfgrasses

1991 Research Grant: $ 9,000
(Third year of support)

Dr. M.A.L. Smith
Principal Investigator

New methods for assessing the responses of turfgrass to salinity in the root zone are required to help identify selections with potential for use on marginal sites. The response of a turfgrass cultivar to salt stress is an important evaluation criterion, because the demand for new selections that will tolerate saline conditions is escalating. Due to the experimental complexity involved, few screens have attempted to gauge comprehensive salt stress reactions of entire grass plants over time. Some plant adaptations, notably those in the root zone, are particularly difficult to observe or quantify.

Solution culture and whole plant microculture techniques were compared for paired cultivars from three turfgrass species (bermudagrass, creeping bentgrass and St. Augustinegrass). Shoot and root growth (using machine vision), and osmotic adjustment responses within the test environments were evaluated. While all of the turfgrass cultivars exhibited growth reductions under conditions of elevated salinity stress, the degree of response was more dramatic for cultivars of bermudagrass and St. Augustinegrass which had previously been rated as salt-sensitive in field evaluations. Morphological shoot growth evaluations between solution culture and whole plant microculture tests exhibited similar trends, while root responses were more variable in microculture. Osmotic adaptation responses were highly correlated between solution culture and whole plant microculture. In general, the whole plant microculture system provided a simpler, smaller scale test environment which allowed non-intrusive evaluation of salt stress adaptation over the course of the screening test.

Now that we have validated the system using turfgrass lines with established salt tolerance [ST] or salt susceptible characteristics (as identified by breeders in extensive field tests), we see the project extending in two important ways. First, the whole plant microculture (WPMC) system can be used to test the ST of unique germplasm developed using the tools of biotechnology. *In vitro* methods for manipulating turfgrass lines have very recently been worked out for many important species. Cell level screening for ST (with callus cells growing on high salt media) can be an effective way to rapidly isolate unique lines with cell level tolerance to salt. The WPMC system can provide an excellent vehicle to facilitate a intermediate testing stage; to quickly and efficiently identify and isolate cell lines selected through biotechnology. Towards this objective, I currently have a student working with callus generation/regeneration of turfgrass callus on high salt media, and testing these new regenerated lines using the WPMC system.

Second, the WPMC system we have developed can be an effective tool to test turfgrasses for other stresses (heat, drought tolerance, etc.). We can establish an effective link with traditional turfgrass breeders at this point for pretesting new lines they have developed, prior to scaling up for full field testing of the turf.

MICHIGAN STATE UNIVERSITY

USGA Turfgrass Information File Project

1991 Research Grant: $70,000
(Ninth year of support)

Peter Cookingham
Project Manager

The Michigan State University (MSU) Libraries are pleased to report steady progress on three important fronts during the 1990/1991 USGA Turfgrass Information File (USGA TGIF) project year. The issues include ease-of-use, levels of use, and the size of the database itself.

Ease-of-use

Based on Research Committee and subscriber feedback, 1990/1991 project efforts focused on making the software "front-end" to USGA TGIF more streamlined and "user-friendly". A revised menu system, redesigned search screens, and quicker entry and exit procedures highlighted these improvements. Changes will continue to be made to the system based on user feedback, database evolution, and software improvements. The August release of the *USGA TGIF Simulator Series* as an orientation, training, and promotional tool has provided new and potential users of the database with a low-key and realistic taste of the system without the pressure of "live" online telecommunications.

Levels of use

During the year, search and service requests from 42 states and five countries were processed at the Turfgrass Information Center (TIC). The new availability of the continuously expanding TOPICS bibliography series, with 40 now "in print", has provided an additional format for users of the literature. These will continue to expand in number based on expressed topical interest, with updated revisions on a regular basis.

USGA TGIF DATABASE

USGA TGIF passed a milestone in February 1991, when the 20,000th record was entered into the database. Continuous growth of the file reflects both the current growth of the literature and the processing of materials published since 1972. By the end of September 1991, over 21,300 records had been entered.

Conclusion

Continued software and database evolution, enhanced services and data availability, and an aggressive outreach and marketing program will characterize the upcoming project period. Thank you for your continued support of our efforts to provide universal, convenient, comprehensive, rapid, and affordable access to the turf science literature.

Please give us a call!
(517)-353-7209

UNIVERSITY OF MINNESOTA

Improvement of *Poa Annua* var *reptans* for Golf Turf

1991 Research Grant: $35,000
(Eighth year of support)

Dr. Donald B. White
Principal Investigator

The project is on schedule for evaluation, seed production and introduction of five of the original eight superior lines of *Poa annua* var. *reptans* and *P. supina*. The seed production field established in 1990 at Pickseed West in Tangent, Oregon was harvested in July of 1991. Seed from these lines was allocated for a breeder's seed planting in Oregon and seeded golf course management plantings were established in Minnesota. The breeder's seed planting was seeded on October 12 and seed from this planting will be harvested and used in 1992 to increase the breeder's seed supply and allow for more widespread evaluation of the selections.

One hundred fifty selections were collected from 23 locations were added to the program in 1991; however, emphasis is being placed on *Poa annua* var *reptans* #42, #117, #184, #208, and #234 for further evaluation, naming and introduction. Selections #117 and #208 received the highest laboratory cold tolerance ratings while all five performed well over the winter in the field trials. Several new selections and F1 hybrids continue to exhibit characteristics that would qualify them for the next breeding cycle. Two selections exhibit truly exceptional color, density, and persistance.

The excised stem-mist emasculation (ES-ME) technique has been fully employed in the crossing program and has enabled completion of many difficult crosses this year. Seedling plants show more spreading vigor than vegetatively established plants. When progeny from the same parents were evaluated, stolons spread, on average, one third more on first-year plants compared to those on vegetatively re-established second-year plants. Fifty different crosses were performed to develop F_1 hybrids and over 2,000 offspring were evaluated. Several of these hybrids have superior characteristics and are uniform among plants. Several F_2 hybrids also show promise with improved vigor, density, color, texture, and uniformity. Selections #184 and #117 are superior parents for use in the production of desirable F1 hybrids. Surprisingly, interspecific crosses between *P. annua* (2n=28) and *P. supina* (2n=14) resulted in fertile and promising progeny. However, four of our plants, all of which are dense, dwarf, dark green, desirable plant types have only 14 chromosomes (1/2 the expected number). This could open the door to much easier inheritance research with *P.* annua and *P. supina*.

Three distinct flowering types, day neutral, cold + short day (spring), and short day were identified. Some crosses segregated to a 3:1 ratio of seasonal to day neutral habit which may indicate a simple single gene, two allele system of inheritance for spring flowering types. This information will be extremely valuable for future breeding efforts. Other research indicates that fourteen-year-old *P. annua* seed had 50% germination, demonstrating the potential value (or problems) of the current *Poa* seed bank in the soil.

MISSISSIPPI STATE UNIVERSITY

Refinement of the Host-Pathogen Interaction System

1991 Research Grant: $21,000
(Second year of support)

Dr. Jeffrey Krans
Maria Tomaso-Peterson
Principal Investigators

The Host-Pathogen Interaction System (HPIS) is an *in vitro* cell selection system developed in conjuction with efforts to obtain creeping bentgrass with resistance to *Rhizoctonia solani.* The HPIS is a unique cell selection technique which permits the simultaneous transfer of various substances from a disease organism to a callus culture during concurrent growth, yet which avoids direct physical contact between the organisms. The assembly and application of the HPIS evolved through a series of experiments dating back to 1988. With an understanding of its application for *in vitro* cell selection, we have focused our efforts in 1991 on refining HPIS protocol.

Isolates from the USGA culture collection of *Rhizoctonia* spp., (courtesy of Dr. Phil Colbaugh, Texas A&M University), were co-cultured (concurrently grown) with creeping bentgrass callus in the HPIS. The pathogenic isolates inhibited callus growth and development, whereas the non-pathogenic isolates had no effect on callus viability. Studies were conducted, to determine effects of various tissue culture media on vigor and pathogenicity of *R. solani*, primarily hormones and energy source concentrations. Various HPIS cultural studies were conducted, focusing on the length of incubation, duration of concurrent growth-interactions, establishing cultural practices for calli following co-culturing in the HPIS, and examining the persistance of toxicity within the HPIS plates.

Some important questions pertaining to HPIS protocol have been answered by these refinement studies. We know that: 1) pathogenicity at the whole plant level is similar to pathogenicity at the cellular level; 2) media components, especially growth hormones and energy sources, play an important role in the pathogenic expression of *R. solani* in the HPIS; 3) we can maximize the use of HPIS plates with successive co-cultures; and 4) *R. solani* must incubate at least seven days in the HPIS and there must be a 24-hour duration of concurrent growth-interactions between *R. solani* and creeping bentgrass callus before resistant callus can be recovered.

We are rapidly achieving an understanding of how to optimize the HPIS toward our overall and final goal of developing disease resistant variants. Remaining questions will be addressed in current and future HPIS studies.

UNIVERSITY OF NEBRASKA

Breeding, Evaluation and Culture of Buffalograss for Golf Course Turf

1991 Research Grant: $45,000
(Eighth year of support)

Dr. Terrance P. Riordan
Principal Investigator

Patent rights and sod certification have been obtained for the cultivar NE 84-609 ('609'). First official sales of '609' were made September 9, 1991 by the Crenshaw & Doguet Turfgrass Corporation. Production, marketing, sublicensing and research are continuing on this cultivar. Aggressive production of '609' has increased the acreage from 1.5 acres in May 1990, to 90 acres as of September 1991. Currently, California, Arizona and Oklahoma have been granted '609' sublicenses by Crenshaw & Doguet with the stipulation that they meet the certification standards developed in Texas. Royalties for '609' from the 1991 season will not be significant; however, projections for 1992 indicate a substantial increase.

Two Nebraska experimentals (NE 84-315 and NE 85-378) are advanced enough in the program that patent documentation information is currently being assembled for submission this winter. Additional experimentals are concurrently being advanced for release in 1992. The Native Turf Development Group (NTDG) has made significant progress in the development of seeded buffalograss. Four test sites were established with 2,000 nursery plants to assess sex ratios and performance of the five potential cultivars developed by the group. The five cultivars have been entered into the "National Buffalograss Evaluation Trial" conducted by the National Turfgrass Evaluation Trial Program. The release of the best entry among these five seeded buffalograsses is projected for 1993.

Research on insect pests of buffalograss continues with emphasis on the "buffalograss mealybug" and chinch bug. This research is important for a complete understanding of buffalograss management. Emphasis on buffalograss establishment and cultural practices continues in order to aid the turfgrass industry in their utilization of this relatively new turfgrass species.

UNIVERSITY OF NEBRASKA

Cultural Practice Interactions of Golf Course Turf

1991 Research Grant: $29,000
(Seventh year of support completed)

Dr. Garald L. Horst
Principal Investigator

Annual bluegrass is recognized as a serious weed problem in highly maintained turf. The invasion of annual bluegrass has negatively influenced turf quality and playability on golf courses. This study was initiated to determine the effects of irrigation frequency, clipping removal, nitrogen nutrition and traffic on creeping bentgrass fairway turf quality, playing conditions and annual bluegrass encroachment.

Attempts at controlling annual bluegrass with herbicides date back to the 1930's. Even if the existing *Poa annua* can be eliminated, it will doubtlessly return unless a good cultural program is established. A basic principle of turfgrass science states that each grass species will thrive best under a specific environmental and cultural regime, and that the regime for each species will be different. Thus by structuring a cultural maintenance program to fit a desirable species as much as possible, it would be possible to reduce the population of *Poa annua* in a turfgrass stand.

The typical conditions found on golf course greens, tees, and fairways are high fertility, close mowing, and frequent watering. These areas generally have compacted soils caused by traffic of vehicles, equipment, and golfers. Under these conditions, annual bluegrass (*Poa annua* L.) invades, persists and becomes a major component of the trufgrass stand. In other words, the cultural practices and soil conditions on current golf courses are ideal for the invasion of annual bluegrass.

Interactive effects of irrigation frequency, clipping removal or return, nitrogen rate and traffic on 'Penncross' creeping bentgrass competition with annual bluegrass (*Poa annual L.*) were evaluated under fairway management conditions. Differences were observed for turfgrass color and quality, playing conditions and annual bluegrass encroachment when traffic and nontraffic conditions were compared. Turfgrass color and quality rating values increased with irrigation frequency, nitrogen rate and lack of traffic. Fairway playing conditions improved with reduced irrigation frequency, clipping removal, reduced nitrogen nutrition and traffic. Annual bluegrass encroachment (*Poa annua* var *reptans*) increased with nitrogen rate. These preliminary results support the premise that cultural practices play an important role in enhancing or deterring annual bluegrass and creeping bentgrass interactions. The various interactions demonstrate the need for a combination of management practices to maintain quality creeping bentgrass fairways.

Trying to contain the *Poa* population on a golf course to a reasonable level is a difficult and somewhat frustrating problem even under the best of circumstances. By knowing which cultural practices will optimize fairway turf quality and playability, yet limit *Poa annua* to a relatively small populations, the golf course superintendent can then choose a proper fairway maintenance program.

OKLAHOMA STATE UNIVERSITY

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

1991 Research Grant: $75,000
(Sixth year of support)

Dr. Charles M. Taliaferro
Principal Investigator

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

Beginning in the mid-1980's, cold tolerant bermudagrass germplasm populations with moderate seed production potential were subjected to recurrent selection for increased basic fertility (seed set). Three selection cycles resulted in a threefold increase in fertility. Four seeded experimental varieties synthesized from these populations in 1989 and planted in field tests in 1990 survived the 1990-91 winter without significant injury at Ft. Collins, CO; Columbia, MO; and Stillwater, OK. All of the varieties suffered severe injury at Ames, IA where cold injury to all plants was above average. These varieties appear to have good cold tolerance, but are coarser in texture than desired. In the past two years, the breeding populations from which these varieties were synthesized have undergone intense selection for characters affecting turf quality and seed production. New experimental varieties were synthesized in 1991 from these populations for comprehensive and intensive evaluation as potential new varieties. One or more experimental seeded varieties will be entered in the National Turfgrass Evaluation Program bermudagrass test scheduled for 1992.

A laboratory procedure for mass-screening bermudagrass plants for cold-tolerance has been developed. The procedure has been used during the past two years to screen plant populations (totalling over 3,000 plants) with excellent seed production capability and good turf quality, but poor cold-tolerance. Selected plants have been polycrossed for progeny testing and renewed selection. A summer 1991 experiment, in which previously selected plants were cloned and retested along with unselected progeny plants from the same source population, provided evidence that the mass screening procedure effectively selects for greater cold-tolerance.

Thirty-three hundred *C. transvaalensis* progeny plants are being evaluated in nurseries at Stillwater, OK. Five hundred eighty-nine of the 3,300 plants were established in nurseries on golf courses in Georgia and Florida under putting green management. Superior plants from these nurseries will be selected over the next few months as they begin to "sort out". Wide variation among the *C. transvaalensis* progenies for important turf performance traits exists and indicates significant potential for improved cultivar development within the species.

Several vegetatively-propagated *C. transvaalensis* intraspecific, and *C. transvaalensis x C. dactylon* interspecific, hybrids were tested during 1991 and performed well in comparison to check varieties. Additional intra- and inter-specific crosses were made among selected parental plants in 1991. Resulting hybrid progenies will be field-planted in spring 1992.

Evaluation of 11 seeded and 16 vegetatively-propagated experimental bermudagrasses by Dr. Ronnie Duncan, Georgia Experiment Station, Griffin, GA, indicated that several have excellent tolerance to low soil pH.

UNIVERSITY OF RHODE ISLAND

Use of Mycorrhizae in the Establishment and Maintenance of Greens Turf

1991 Research Grant: $ 40,000
(Second year of support)

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

The project consists of several interdependent studies which include: 1) identifying the species of mycorrhizal fungi that are associated with velvet and creeping bentgrass and *Poa annua* in New England, 2) culturing the dominant or most promising species of fungi, and 3) testing the ability of the fungi to promote establishment of putting green turf in a sand medium, minimize application of phosphorous fertilizers and water, and offer protection against root pathogens.

Twenty-eight species of mycorrhizal fungi were isolated from bentgrass and *P. annua* turfgrasses. Two species were never isolated from root zones of *Poa annua*, but were commonly recovered from beneath both bentgrass species. This information may be useful in reducing the competitive abilities of *Poa* in greens. Nine species of mycorrhizal fungi have been established in pot culture. Some of the isolates are from sand dune soils (associated with beachgrass) and offer promise for use in sand greens (see below).

Numerous screening experiments have been conducted to identify the most effective fungi for sand green culture. We have tested 7 isolates/species of mycorrhizal fungi, three different levels of phosphorous fertilization, two kinds of peat (sphagnum and sedge), and three grass species. The most effective fungi were those isolated from sand dunes. Fungi isolated from turf soils often were ineffective in the USGA sand green medium (sand and peat). Preliminary observations also suggested that the dune fungi conferred tolerance to drought.

A field trial involving two kinds of peat, four levels of phosphorus fertilization, and two turfgrasses and mycorrhizal fungi is in progress.

An inexpensive method for producing highly infective inoculum of mycorrhizal fungi has been developed.

A method has been developed to grow bentgrass plants with mycorrhizal fungi under sterile laboratory conditions.

This technique will facilitate study of the interaction between mycorrhizal roots and pathogenic fungi.

RUTGERS UNIVERSITY

Endophytes of Turfgrasses: New Tools and Approaches

1991 Research Grant: $40,000
(Second year of support)

Dr. Peter Day
Dr. Reed Funk
Principal Investigators

This project was proposed and initiated by Dr. Peter Day, AgBIOTECH Center and Dr. Reed Funk, Department of Crop Science, Rutgers. Dr. T.M.A. Wilson, AgBIOTECH Center, is responsible for supervision of the laboratory work of the project. Program goals are to: 1) produce a germplasm collection of fungal endophyte-infected grasses concentrating on *Poa* and *Agrostis* species; 2) produce a collection of endophyte cultures for classical and molecular analysis; 3) produce endophyte-specific DNA probes; 4) use the probes to characterize endophyte variability and produce RFLP maps for taxonomy; 5) develop gene transfer methods for fungal endophytes; and 6) identify the genes responsible for insect repellent alkaloid biosynthesis and metabolism.

After extensive screening of turfgrass germplasm collections, particularly *Poa* and *Agrostis* species throughout the U.S.A. and Europe (in collaboration with Dr. Jim White, Auburn University, Alabama), we have obtained a limited number of fungal endophyte-infected grasses in these two genera. To date, however, the presence of fungal endophytes in Kentucky bluegrass and creeping bentgrass continues to elude us. Recently acquired endophytes in other *Poa* and *Agrostis* species are being cultured with a view to introducing them into germinating seedlings of Kentucky bluegrass and creeping bentgrass.

A collection of fungal endophyte cultures has been established on agar plates and contains representative isolates from a wide variety of turfgrass genera. Selected examples are being used for DNA cloning and genetic fingerprint analysis. Fungal endophyte-specific DNA probes have been produced by the polymerase chain reaction (PCR) and diagnostic fingerprints of DNA sequences generated by randomly amplified polymorphic DNA (RAPD)-PCR methods.

The RAPD-PCR technique has demonstrated an exquisite sensitivity for variation in total genomic DNA sequences, and in many cases, has shown as much inter-isolate variation as inter-specific and inter-generic variation at the DNA level. This result highlights the primitive nature of fungal endophyte taxonomy, as well as providing diagnostic banding patterns for a particular endophyte "species". We have therefore elected to provide more precise DNA sequence information to aid fungal endophyte taxonomy.

This work is in collaboration with Dr. Christopher Schardl (University of Kentucky, Plant Pathology Dept.) and requires that we obtain the DNA sequences of the poorly conserved spacer regions between the more highly conserved ribosomal RNA genes. Schardl has already developed an evolutionary tree of turfgrass fungal endophytes of the *Acremonium* genus (anamorph *Epichloe*) from a limited number of grasses and our data will provide additional resolution to this taxonomic device. Work on the development of

gene transfer methods for fungal endophytes has progressed in a parallel project through production of fungal protoplasts and attempts to introduce recombinant DNA plasmids containing convenient antibiotic resistance genes. In principle, the technique looks feasible; however, some additional selectable marker genes must be sought as *Acremonium* spp. have a high endogenous resistance to hygromycin.

Because of the absence of widely available, natural endophytes in *Poa* and *Agrostis* species of interest to the USGA, we have elected to take a different route toward production of insect-resistant or otherwise modified turfgrasses for golf courses. Since March 1991, the project has therefore focused on the development of techniques for *Poa* and *Agrostis* tissue culture and regeneration of mature culms from single cells or disorganized calli (grass tumors). This work has been extremely successful and highly regenerable embryogenic turfgrass tissue cultures have been developed.

We have also investigated the possibility of introducing foreign genes into turfgrass cells by DNA particle bombardment techniques. To date, the level of transient reporter gene expression has been encouraging and we are currently selecting for stable transformed turfgrass cell lines which express a gene conferring resistance to the herbicide bialaphos (Basta™). In parallel with bialaphos resistance, we are negotiating with several commercial organizations for genes which might confer insect resistance, virus resistance, growth retardation, resistance to fungal and bacterial pathogens and a variety of other single-gene traits. We consider this to be a major technological breakthrough for the production of transgenic turfgrass with improved agronomic performance through insertion of one, or a few desirable genes.

TEXAS A&M UNIVERSITY

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

1991 Research Grant: $10,000
(Fifth year of support)

Dr. Phillip F. Colbaugh
Principal Investigator

USGA research on resistance of bentgrasses and zoysiagrasses to *Pythium* and *Rhizoctonia* blight diseases is completing the fifth year of study. Progress during the last year has centered on assessments of germplasm material from the heat tolerant germplasm and new progeny from crossing blocks that include parental bentgrass lines which are resistant to one or both of the diseases. Virulent isolates of USGA culture collections for both pathogens are being used for the disease resistance screening program.

Plant samples obtained from heat tolerant bentgrass field plots were inoculated in the walk-in growth chamber which simultaneously evaluated 720 test cells for resistance to root rot disease caused by *Pythium* spp. The plant samples represented genotypic segregates of seven varieties in each of the field nurseries. Soil cores containing the plants were placed in growing trays which were partially submerged in sterile water and inoculated with *Pythium aphanidermatum*. Observations on the death of the field plugs were recorded over a four week period under high humidity in the laboratory. Root rot resistance among 720 genotypes was greater in the non-heat tolerant bentgrass nursery than in the heat tolerant nursery. These observations are consistent with previous observations on *Pythium* blight visual ratings on the field plots during 1990.

Pythium inoculations of established germplasm lines from a genetic crossing block were made in the greenhouse on a sand heat bench used for identifying heat stress tolerant bentgrass genotypes. The limited disease ratings obtained with plants inoculated on the greenhouse bench required further testing of the genotypes in the walk-in growth chamber. Inoculations in the walk-in chamber using previously established methods with cups gave significantly higher disease ratings on the same genetic material. In contrast to greenhouse studies which allowed only low disease pressure, 38% of the population was susceptible to *Pythium* foliar blighting four days after inoculation.

TEXAS A&M UNIVERSITY

Breeding and Development of Zoysiagrass

1991 Research Grant: $45,000
(Eighth year of support)

Dr. M.C. Engelke
Principal Investigator

The purpose of this project is to develop zoysiagrasses which are better adapted to natural environmental conditions. This year, 1991, marks the initiation of an extensive national testing program for zoysiagrasses through the National Turfgrass Evaluation Program (NTEP). Material of 24 unique experimental and commercial cultivars were vegetatively increased and distributed to 39 locations throughout the United States, extending from Tangent, OR to Kingston, RI to Riverside, CA and West Palm Beach, FL. The USGA/TAES zoysiagrass breeding program has nine elite entries in this trial. These entries range in texture from rather broad leaved aggressive *Zoysia japonica* types to fine texture, highly rhizomatous *Z. matrella* types. These elite lines were selected for a combination of characters related to survival and turf quality under natural environmental conditions. Specific emphasis was placed on low water-use, competitive ability against weed invasion, recovery from injury, low fertility, and production characters. The nine entries are all vegetative. Numerous hybrids have been produced which show seed production potential and will be included in the next cycle of NTEP evaluations.

Extensive field plantings have been made in Georgia, Florida and Texas using a 'near-release' elite variety to evaluate its performance in these environments, as well as to assess performance under shaded tees and putting green conditions. All areas were solid sodded in July-August 1991.

A cooperative project was initiated with Dr. Bob Carrow to examine water use and fertility requirements of selected zoysiagrasses under Georgia conditions. This study, in combination with performance data from the NTEP, will add substantially to the understanding of varietal adaptation in other regions of the country.

The Linear Gradient Irrigation System study with 26 zoysiagrasses was terminated after 5 years of testing. The area will be excavated, fumigated and reestablished to larger plot areas of the most promising lines from the project. Future studies will enable us to evaluate the nutritional and mowing response of the new varieties under a water-gradient. To date, this information is lacking. In order to lower the water required by zoysiagrass, it is imperative to understand how the associated cultural practices must be altered, i.e. fertility, mowing, aerification, etc., to maximize turf performance.

TEXAS A&M UNIVERSITY

Breeding and Development of Bentgrass

1991 Research Grant: $64,000
(Seventh year of support)

Dr. Milt C. Engelke
Principal Investigator

In 1990, three bentgrasses identified as Syn1-88, Syn3-88 and Syn4-88 were submitted to the Texas A&M Plant Improvement Review Committee for release. Through due course of review, it was decided additional information was necessary to warrant release, and it was suggested additional locations be included in the evaluation and performance. Sufficient seed of Syn3-88 (approximately 4,000 pounds), and of Syn4-88 (approximately 2,000 pounds) was produced in 1991. Limited quantities of seed were made available for demonstration plantings, additional replicated trials and for nursery plantings on approximately 35 golf courses throughout the central and southern United States. In addition, two new golf courses have selected Syn4-88 (CATO) for use on all new greens. One course is located in Montgomery, Texas just north of Houston, and the second is just south of Dallas. A third course in Jonesboro, GA has selected Syn3-88 for use on nine newly constructed greens.

Syn4-88, once released, will be named "Cato" creeping bentgrass in honor of the late Paul Cato, Colonial Country Club, Fort Worth and founding president of Bentgrass Research, Inc. Both Syn3-88 and Syn4-88 have performed well in trials conducted at several locations throughout the southern United States. Each will be resubmitted for release this fall. Syn1-88 continues to demonstrate considerable strength in root persistence and performance under adverse conditions. If released this fall, seed increase will be initiated in the Spring of 1992. Ample seed stocks exist of all three varieties to support additional field plantings.

Reselection, hybridization, and advanced screening programs resulted in the development of seven new polycross populations in 1991. These, in addition to the 14 populations generated during 1990, are being extensively evaluated for heat resistance, root growth characters, disease resistance and leaf hydration response. The disease resistance studies are continuing in cooperation with Dr. Phil Colbaugh with intentions of examining the heritability mechanisms of disease resistance, as well as intensely reselecting for improved disease resistance. Two additional manuscripts have been prepared for publication. The first is an article on selection techniques concerning leaf water hydration and its relationship to heat tolerance in creeping bentgrass, and the second concerns results from a gross heat tolerance screening of the commercially available creeping bentgrass cultivars. Assessment of germplasm and genotype performance continues in the greenhouse, field and laboratory. Superior plants are being identified and recycled in the breeding program. Invaluable cooperation continues with Dr. Jerry Pepin and Mr. Doug King, of Pickseed West in Tangent, OR, and with Dr. Virginia Lehman of Loft's Great Western in Lebanon, OR.

(Please Note: As mentioned, this research project is funded in cooperation with Bentgrass Research, Inc., Dallas, TX. Bentgrass Research, Inc. has contributed at or over $20,000 per year for the last seven years!)

USDA/UNIVERSITY OF GEORGIA

Bermudagrass Breeding - Vegetative

1991 Research Grant: $8,000
(Ongoing support since 1946)

Dr. Glenn W. Burton
Principal Investigator

The main objective under this cooperative USDA-ARS project has been to develop new bermudagrass hybrids with greater cold tolerance and quality similar to the Tif-bermudas (i.e., Tifdwarf, Tifgreen, and Tifway). These hybrids have involved the winter-hardy Berlin bermudagrass and our best *Cynodon transvaalensis* bermudagrass from South Africa.

None of the new hybrids equalled the Tif-bermuda in overall performance. One, perhaps several more, were good enough to warrant evaluation for cold tolerance. These materials were sent to Oklahoma State University to determine their cold tolerance.

Tifton 10 bermudagrass, officially released in 1988, was registered as a crop cultivar by the Crop Science Society of America in 1990. Tifton 10 continues to perform 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.)

OHIO STATE UNIVERSITY

Monoclonal Antibodies for Rapid Diagnosis Necrotic Ring Spot Turfgrasses

1991 Completed

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

This project focused on the development and use of immunological techniques for rapid diagnosis of slow growing patch diseases. The project was successful 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 can test for the presence of the pathogen in a plant sample. The antibody was highly reactive against all fungal strains of *Leptosphaeria korrae* isolated from both Kentucky bluegrass (Necrotic Ring Spot) and bermudagrass (Spring Dead Spot). Currently, a company (or university) is being sought to continue with the commercailization and maintenance of the LK_{50} clone.

RUTGERS UNIVERSITY

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

1991 Research Grant: $ 5,000
(Ongoing support)

Dr. C. Reed Funk
Principal Investigator

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

Dr. Funk has also cooperated in the evaluation of colonial bentgrass breeding materials from DSIR-New Zealand. He has agreed to maintain these materials until a breeding program in the USA can be identified.

(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

1991 Research Grant: $10,000
(Completed)

Dr. A. Leon Stacey
Principal Investigator

The objective of this project was to isolate and utilize 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. Currently, cooperation from the USDA-ARS research center in Peoria, Illinois is under consideration to determine the chemistry of these phermones.

DEPARTMENT OF SCIENTIFIC & INDUSTRIAL RESEARCH (DSIR)
NEW ZEALAND

Colonial Bentgrass Breeding

1991 Research Grant: $10,000
(Completed)

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.

Breeding materials from this project have been under evaluation at Rutgers University by Dr. Reed Funk. Results from the performance of colonial bentgrass in the National Turfrass Evaluation Program Trials indicate that the species may be useful in maritime climates in the USA. The continuation of the breeding program by a U.S. university is currently being considered.