Kentucky bluegrass, then biotechnology techniques were to be employed to help produce new endophytes that would work in these important turfgrass species.

The research project acquired a large turfgrass germplasm and endophyte culture collection from throughout the United States and other parts of the world. After extensive screening of more than 700 collections, some 14 fungal endophyte-infected species of *Poa* and *Agrostis* were obtained. A collection of 30 fungal endophyte cultures was established on agar medium and contains representative isolates from a variety of turfgrass genera.

Fungal endophyte-specific DNA probes were produced by the polymerase chain reaction (PCR). Ribosomal RNA internally transcribed spacer sequences (ITS-A) were isolated from *A. typhinum, A. starrii,* and *A. coenophiallum* using PCR primers. These are of similar size and their DNA sequences are being compared. The RAPD (randomly assigned primer DNA) method of using PCR with single ten-base DNA primers was tested with DNA extracts of eleven endophytes using different primers with varying guanine/cytosine contents. The technique is excepted to be useful for developing probes for detecting the presence of endophytes in grasses.

Callus cultures were obtained from six cultivars of Kentucky bluegrass (*Poa pratensis*) and four of creeping bentgrasses (*Agrostis palustris*) tested in tissue culture using mature seeds germinated on a callus induction medium. Several embryogenic callus lines were selected from 'Emerald' and 'Putter' bentgrass and 'Baron' Kentucky bluegrass. The usefulness of embryogenic callus as a target to create new endophyte-turfgrass combinations is under evaluation. The possibility of introducing foreign genes into turfgrass cells by DNA particle bombardment techniques also was investigated.

Sea Island, Georgia - Dr. A. Leon Stacy

Mole Cricket Pheromones and IPM

This project evaluated scouting methods to monitor population dynamics and the potential use of pheromones to reduce pesticide applications for the control of mole crickets on golf courses. Biologically active materials were discovered and, with further refinements, could be produced for commercial marketing. No previous research had been done with mole cricket pheromones when this study was initiated.

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 still needed to improve on the pheromone dispensing system and to further refine optimum rates of activity.

Results from the study were extremely encouraging. The attractants and the alarm substance could 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. This use possibly could reduce the turf area requiring treatments.

Although no previous work had been done with mole cricket pheromones, the concept was used successfully in eradication programs for several insect pests of agronomic importance and millions of dollars were saved. This project successfully identified biologically active materials; however, cooperation with a qualified pheromone chemist will be needed before efficient testing of the effects of these compounds on the population dynamics can proceed.

Mycorrhizae

University of Rhode Island - Dr. Noel Jackson

Use of Mycorrhizae in the Establishment and Maintenance of Greens Turf

This research project took yet another approach to improve turfgrass water use in sandy soils. Mycorrhizal fungi grow in close association with plant roots and increase the surface area for nutrient and water uptake. Dominant species of mycorrhizal fungi associated with creeping bentgrass and *Poa annua* were isolated from old putting greens receiving routine fungicide applications. The dominant species of mycorrhizal fungi occurring in sand dune soils in New England also were collected. In fact, mycorrhizal fungi isolated from sand dunes were superior to non-dune fungi in stimulating growth of turfgrasses grown in the sand putting green medium.

Responses of creeping bentgrass to mycorrhizal fungi and growth mixes continue to be evaluated. Two methods for producing inoculum were developed for greenhouse conditions. A method to inoculate bentgrass plants with mycorrhizal fungi

under sterile laboratory conditions was developed to conduct basic research studies and provide an additional screening technique to identify promising strains of mycorrhizae.

Turfgrass Breeding

The quality and stress tolerance of a turf is the product of environment, management practices and genetic potential of the grass plant. In many cases, the major limitations to quality turf is its inability to limit various stress effects, many of which can be modified or controlled through plant breeding.

Turfgrass breeding projects were directed toward reducing water use and maintenance costs, and developing resistance to several stresses. The intent was that scientists responsible for the breeding projects incorporate and utilize results of the stress mechanism and cultural practices studies.

The characteristics most desirable in potential new turfgrasses include:

- drought tolerance
- high and low temperature tolerance
- tolerance of non-potable water
- tolerance to acid, alkaline or saline soils
- reduced mowing and fertilization requirements
- traffic tolerance
- genetic stability of characters
- disease, insect and nematode resistance
- weed competition to reduce herbicide use
- tolerance to smog and other pollutants
- shade tolerance

The primary attention in turfgrass breeding focused on the improvement of zoysiagrass, native grasses, *Poa annua*, bermudagrass and bentgrass. Other turfgrass species and ground covers of potential merit also were considered. The quality of turfgrasses or other ground covers resulting from the proposed research were required to meet the needs of golf courses. In Table 15, the breeding projects, species, and status of varieties were summarized.

General - Cool Season Species

Rutgers University - Dr. C. Reed Funk

Kentucky Bluegrass, Tall Fescue, and Perennial Ryegrass

The USGA, golf and the entire turfgrass industry will be forever indebted to Dr. Funk for the turfgrass varieties his breeding program has developed. His experience, methodology, keen eye and spirit of cooperation with industry has produced landmark varieties in our major cool-season turfgrass species. The USGA is very proud of the long and productive relationship with Dr. Funk, his research staff, graduate students, and colleagues at Rutgers University.

Dr. Funk, through the years, has had many significant accomplishments. He developed the first successful method of producing Kentucky bluegrass cultivars by intra-specific hybridization of apomictic parents. He revolutionized the use of perennial ryegrasses through the development of 'Manhattan' which is considered a landmark cultivar that significantly enhanced the usefulness of this species for golf and sports turf. Subsequent to the development of Manhattan, Dr. Funk has participated in the development of many widely used turf-type perennial ryegrasses.

In addition to breeding work with Kentucky bluegrass and perennial ryegrass, Dr. Funk developed the first and most widely used turf-type roughstalk bluegrass (*Poa trivialis*) in North America and ushered in a new generation of turf-type tall fescues. He has participated in the development of several strong creeping red fescues and hard fescues. During his travels and career, he has accumulated one of the most valuable collections of *Poa* and *Festuca* germplasm available in the world.

Dr. Funk participated in the discovery that endophytic fungi are associated with enhanced performance of perennial ryegrass, tall fescue, hard fescue, creeping red fescue, and Chewings fescue. This research demonstrated an association between the presence of endophytic fungi and resistance to chinch bugs, sod webworms and bill bugs. Within the fine and tall fescues, endophytic fungi produce resistance to chinch bugs, and also improve performance during summer stress. The breeding program has developed methods and procedures for creating turfgrass cultivars possessing endophyte enhanced performance.

Bentgrass

Creeping bentgrass (*Agrostis palustris*) and colonial bentgrass (*A. castellana*) are the two major types utilized in the United States. The major use of creeping bent is on golf greens and fairways. Colonial bent is used for golf course fairways, lawns and wherever there is a need for low growing, closely mowed turf. Greater activity in breeding colonial bentgrass was promoted by the Research Committee.