evaluated in the laboratory for their ability to inhibit the growth of the fungi and to inhibit disease expression. The results indicate that the melanin in *G. graminis* var. *graminis, G. incrustans* and *Magnaporthe poae* is DHN melanin. However, inhibition of melanin production does not appear to inhibit their ability to cause disease.

Seventy-five mutant strains of *G. graminis* var. *graminis* have been obtained. Twenty-nine have been evaluated for their ability to cause disease. All strains were still pathogenic; however, their ability to produce the sexual spores of this fungus and a structure called a hyphopodia were severely impaired. The remaining strains must be evaluated before we will know if this will be a viable method for obtaining biological control of patch diseases.

Dr. Monica Elliott

Cornell University

Microbial Basis of Disease Suppression in Composts Applied to Golf Course Turf

The goal of this project is to develop more effective biological control strategies with compost-based organic fertilizers by understanding the microbial ecology of disease-suppressive composts. The specific objectives of this study are to: 1) determine the spectrum of turfgrass pathogens suppressed by compost applications, 2) establish relationships between overall microbial activity, microbial biomass, and disease suppression in composts, 3) identify microorganisms from suppressive composts that are capable of imparting disease-suppressive properties to conducive composts or those rendered conducive by heat treatment, and 4) determine the fate of compost-derived antagonists in golf course putting greens following application of individual antagonists or composts fortified with these antagonists.

The suppressiveness of various composts to turfgrass disease caused by two different *Pythium* species and *Typhula incarnata* has been established. This extends the range of turfgrass pathogens already known to be suppressed by compost applications. In field studies, some composts are as effective as standard fungicides in suppressing *Pythium* root rot and *Typhula* blight on creeping bentgrass putting greens.

Laboratory studies have focussed on *Pythium* incited disease of creeping bentgrass. We have shown that disease suppression in some composts is a result of microbial activity, whereas suppression in other composts is due to non-microbiological factors. In general, immature composts (less than 1 yr old) are less suppressive to *Pythium* than mature composts (greater than 1.5 yr old). Sterilization of some composts eliminates disease-suppressive properties. These results further indicate a microbiological nature to disease suppression in these composts. In examining a number of suppressive and conducive composts, we have shown direct relationships between microbial activity and disease suppression.

In preliminary experiments with a poultry manure compost, populations of fungi and actinomycetes were quite low, whereas populations of bacteria ranged from 4.4 to 7.5 million cells per gram of compost. Current studies are focussing on the qualitative microbiological differences between suppressive and conducive composts, and the interactions of specific microorganisms with turfgrass pathogens. Our goal is to determine the key microorganisms inhabiting composts so that their physiology and ecology might be better understood. This information will be important in predicting whether composts, at particular stages of maturity, will be suppressive under a set of environmental conditions.

Dr. Eric Nelson

Iowa State University

Potential for Physiological Management of Symptom Expression by Turfgrass Infected by Bipolaris sorokiniana

Ethylene has been found to contribute substantially to the loss of chlorophyll in leaves of *Poa pratensis* infected by *Bipolaris sorokiniana* (leaf spot). The physiological basis of the elevated endogenous ethylene levels is unknown, however. This research project was initiated to determine if the endogenous ethylene, or its mode action, could be manipulated to prevent the loss of chlorophyll in infected leaves and thereby prevent yellowing. The ultimate objective is to develop a means of controlling disease symptom expression. Infection would not be prevented, but yellowing would not occur and normal mowing procedures would remove infected leaves. The use of fungicides for diseases of this type could be substantially reduced or eliminated.

Initial studies with aminooxyacetic acid (AOA) have provided some positive results. AOA blocks the enzymatic conversion of S-adenosyl-L-methionine (SAM) to 1-aminocyclopropane-1-carboxylic acid (ACC) in the biosynthetic pathway of ethylene in higher plants. This action ultimately reduces the total ethylene produced. Leaves of inoculated plants showed elevated levels of endogenous ethylene at 24, 48, 72, and 96 hr after inoculation; peak endogenous ethylene production occurred at 48 hr (1000 ul 1^{-1}). Plants inoculated and treated with AOA (10^{-3}M) produced less endogenous ethylene at all sampling times than untreated inoculated plants. At 48 hr, the leaves of inoculated plants treated with AOA produced 642 $\mu l \, l^{-1}$ of endogenous ethylene compared to 1000 $\mu l \, l^{-1}$ produced by untreated inoculated plants.

Chlorophyll loss was initiated after peak endogenous ethylene production (48 hr) and became progressively more severe with time. Chlorophyll content of leaves of untreated inoculated plants was 57 percent of that in healthy control leaves at 96 hr after inoculation; chlorophyll content of leaves of AOA treated and inoculated plants was 81 percent. The decrease in endogenous ethylene in infected leaves of AOA treated plants clearly decreased the chlorophyll loss associated with the disease. No phytotoxic effects were observed to be associated with AOA.

These initial observations are encouraging and suggest that manipulation of symptom expression (yellowing) by leaves infected with *B. sorokiniana* may be feasible. Several additional substances that interfere with ethylene biosynthesis, or with the mode of action of ethylene, will be examined during the next year.

Dr. Clinton Hodges

USDA, Rutgers University, University of California

Biological Control of Turf Pests: Isolation and Evaluation of Nematode and Bacterial Pathogens

White grubs are chronic and often serious problems for golf course and other turfgrass managers throughout the United States. In the Eastern States, the Japanese beetle alone is responsible for over $230 million in control and turf replacement costs. Turf managers are seeking alternatives to the conventional chemical insecticides now available for grub control due to concerns about effectiveness, groundwater contamination, chemical trespass, and adverse effects on non-target organisms. The development of effective and reliable biological control agents will provide options for use in managing turf pests. Two groups of organisms, insect parasitic nematodes (microscopic worms) and bacteria, have shown promise in controlling a variety of insects. A team of federal and university researchers in Ohio, New Jersey, and California are searching for new isolates of nematodes and bacteria with increased effectiveness against white grubs in turf.

Initial efforts have been placed on the isolation of new strains of insect parasitic nematodes from golf courses and other turf areas. In New Jersey, nearly 300 sites across the state have been examined and more than 50 new isolates have been collected. Representatives from the two major genera of insect parasitic nematodes have been recovered. New strains of a nematode originally isolated from Japanese beetle larvae in the 1930's were found. Field tests demonstrated that new strains of two different species of nematodes were more effective than strains now used in commercial production, and were as effective in controlling Japanese beetle larvae as a chemical insecticide standard. Efforts in Ohio and California have resulted in the isolation of new strains of both genera of insect pathogenic nematodes from soil, as well as from natural field infections of white grubs. Strains from grubs may be adapted to these hosts and offer promise for controlling these pests.

Efforts to identify bacterial pathogens of white grubs have located the organism responsible for causing "amber disease" in New Zealand. These bacteria are commercially available there, but their strains have no effect on white grubs in the USA. We have isolated several bacteria from the Japanese beetle in Ohio and New Jersey, and from masked chafer larvae in California on media that is selective for the amber disease organisms. One isolate from California has been identified as similar to the New Zealand bacteria, thus indicating real promise for finding effective bacterial pathogens in the United States. Additional iso-