the callus to various concentrations of the toxic substances for only 24 hours.

The results from both procedures indicate *R. solani* must be actively growing in the HPIS for at least 7 days before the level of toxic substances is such that only 25 percent of the viable callus population can be recovered. From that 25 percent viable callus population, an average of two plantlets are regenerated. Some of these plantlets display enhanced resistance to *R. solani*.

A special HPIS chamber was developed for screening the germplasm obtained from the HPIS refinement experiments. This system is similar to the HPIS in principle, but is adapted to allow unrestricted growth of the plantlets. The bottom compartment of the chamber consists of the actively growing *R. solani*. The top compartment has been modified by the addition of a 9.5 cm (high) by 9.0 cm (diameter) glass cylinder. This expended space in the upper compartment permits the use of additional growth medium required by larger plantlets, and provides adequate 'head space' which plantlets require for optimum development.

The plantlets were screened in the HPIS chamber for two weeks. Thirty-three percent of the plantlets exposed to *R. solani* died. The surviving plantlets were extremely stressed, displaying purple leaves and stunted growth. They were then transferred to tissue culture boxes where vigorous shoot and root development occurred. The plantlets subsequently have been transferred to soil and will be screened for resistance to *R. solani* at the whole plant level. This will provide critical and much needed evidence on the efficacy of the HPIS approach, as well as providing plants with enhanced resistance to *R. solani*.

***Ohio State University - Dr. William W. Shane and Dr. Stephen T. Nameth***

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

Slow-growing patch diseases are among the most difficult problems to diagnose on turfgrasses. This project focused on the development and use of immunological techniques for rapid diagnosis. A monoclonal antibody-producing clone, selective for necrotic ring spot (*Leptosphaeria korrae*), was produced. The antibody, a small protein that can bind to the fungus, can be grown in great quantity within a laboratory flask. The antibody was highly reactive against all fungal strains of *Leptosphaeria korrae* tested.

The usefulness of the antibody for *L. korrae* was tested thoroughly against diseased turfgrass samples collected thoughout the United States or submitted to the Ohio State University Plant and Pest Diagnostic Clinic. 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 individual turfgrass plant parts to gain a better understanding of the life cycle of this disease. Through this research effort, sampling techniques for the detection of *L. korrae* with the LK antibody were optimized.

In addition, the LK antibody successfully detected *Leptosphaeria korrae* from certain bermudagrass sites with spring dead spot symptoms. Therefore, the antibody could 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 cause this disease. Despite the successes associated with the LK clone, no commercial company followed through with formal licensing of the technology.

Development of a monoclonal antibody for summer patch (*Magnaporthe poae*) was not completed. Difficulties occurred with the toxicity of the pathogen to immunized mice and rabbits. Reactivity of the mouse serum which was produced did not adequately select *M. poae* from diseased turfgrasses. Unfortunately, the project was terminated early when the principal investigator left Ohio State University for another position in industry.

**Soil Compaction**

***Michigan State University - Dr. Paul E. Rieke***

*Hollow and Solid Tine Cultivation Effects on Soil Structure and Turfgrass Root Growth*

Hollow and solid tine cultivation effects, as influenced by soil compaction and moisture content during cultivation, were evaluated on the basis of soil structural properties and root growth.

As expected, compaction resulted in pronounced detrimental effects on soil structure and root growth. Both cultivation methods resulted in positive and negative effects on soil structure. Cultivation increased the amount of large soil pores, with hollow tine coring being the most effective in producing this response. Regardless of compaction level, solid tine cultivation increased the amount of intermediate sized pores when compared to hollow tine cultivation. Therefore, due to the increased amount of total soil pore space produced, hollow tine cultivation provided the most beneficial changes in soil porosity.

Soil strength within the zone of cultivation (surface 2 to 3 inches) was reduced after cultivation. Initially, solid tine cultivation was more effective in loosening the surface soil than hollow tine cultivation; however, this effect was reversed by the end of this study. Water conductivity rate dropped dramatically after cultivation, indicating that compaction at the bottom of the cultivation zone restricted water flow.

Compaction stress decreased root growth, while cultivation had a limited effect on root growth. Cultivation decreased surface rooting in non-compacted soil, but had no influence on rooting in compacted soil. Cultivation in non-compacted soil tended to increase rooting in June, but again, had no effect on rooting in compacted soil. Throughout the study, hollow tine cultivation ranked equal to or higher than solid tine cultivation in visual quality.

***University of Georgia - Dr. Robert N. Carrow***

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

The objective of this research project was to compare the relative effectiveness of different turf cultivation procedures to alleviate soil compaction, improve root and shoot growth, and increase soil water use. The most effective cultivation techniques were then incorporated into cultivation "programs." Each program was evaluated for its effectiveness in improving water use efficiency.

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 soil profiles (i.e., high in clay and silt content) 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 had not been conducted.

Five cultivation techniques were compared for their effectiveness in improving soil physical properties and growth of common bermudagrass (*Cynodon dactylon*). The soil was a Cecil clay loam, typical of the Piedmont region of the southeast. A non-compacted 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-Ject (6 to 8 inches). Cultivation treatments were applied during May and July in 1989 and during April and August in 1990.

The first study indicated that the Verti-Drain reduced soil strength to a depth of 8 inches and improved infiltration. These effects on soil physical properties enhanced deep rooting in the late summer. The 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 first few surface inches did not result in better rooting since deep root growth in late summer was less than the control.

Hollow tine core aeration improved soil surface conditions, as shown by low bulk density and higher aeration porosity; however, rooting was not affected. The Verti-Slicer and Hydro-Ject treatments did not influence the measured soil physical properties or rooting. Improved soil water extraction during dry-down periods was observed, at least one out of eight times measured, for all procedures. All methods, except the Hydro-Ject, caused some decline in visual quality and/or shoot density within a week after treatment on at least one occasion. The Verti-Slicer and hollow tine core aeration exhibited this trend most often (4 out of 5 treatments). Last, all cultivation procedures, except the Verti-Slicer treatment, resulted in some improvement in visual quality and/or shoot density during some period of the study.

From the previous study, the most effective cultivation technique for making improvements deeper in the soil profile was the Verti-Drain, while hollow tine coring improved soil surface conditions. Thus, the intensity of Verti-Drain treatment (i.e., 1X, 2X times over the plot area), as well as Verti-Drain plus hollow-tine coring combinations, were explored.

The Yeager-Twose Turf Conditioner (a subsurface aerification unit) was not evaluated in previous 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 materials to this depth. Since high aluminum (Al) saturation of the cation exchange complex of Piedmont soils is a major cause of