Gray Leaf Spot of Ryegrass: A Masterpiece of Orchestrated Cooperation

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Over the past several years, my lab has been conducting research to understand the mechanisms of gray leaf spot resistance in ryegrass using DNA technology as a research tool. This particular project has been funded by the USGA. Recently gray leaf spot (GLS) caused by *Pyricularia grisea* has become one of the most important emerging turf diseases in many states except states in the northern part of the U.S. Due to the sporadic and explosive nature of the disease epidemics, superintendents who manage perennial ryegrass fairways and roughs have extreme trouble battling this disease. Furthermore, fungal isolates are able to fight against fungicides by rapidly becoming insensitive to the fungicides. When you are facing this kind of difficult situation, the only option left is to incorporate plant resistance into the overall disease management. We all remember the disease triangle which consists of three major components; host, pathogen, and environment.

Mr. Joe Curley, a Ph.D. student majoring in the Plant Pathology, has been working hard to unlock a few key genetic questions such as how many genes are involved in ryegrass resistance, where they are located on the chromosomes, and how the defense mechanism(s) in ryegrass are different from ones in rice since the same pathogen can attack both host plants. Through the genetic knowledge accumulated from the well-studied host, rice, and that learned from ryegrass research, we will be able to develop resistant ryegrass cultivars more efficiently. As a result, the disease will be easier to control than before.

So far, we found that there are two or three genes involving in GLS resistance in an interspecific ryegrass population derived from the cross between the perennial ryegrass cultivar 'Manhattan' and the annual ryegrass cultivar 'Floregon'. According to greenhouse inoculation experiments, the resistance appears to originate from the annual ryegrass. At first we thought the results were unexpected, but they make very good sense if you think of how the annual ryegrass was bred.

The Floregon used in our study was bred through a joint breeding program, Dr. Reed Barker at Oregon State University and Dr. Gorden Prine at the University of Florida. In the course of breeding Floregon, unintentional selection for resistance to GLS was successfully made due to natural epidemics in breeding plots. More interestingly, all perennial ryegrass plants tested turned out to be very susceptible to GLS. Resistant plants from our study will surely be incorporated into improving perennial ryegrass via breeding programs. Thanks to DNA technology and genetics tools, we were able to track down the origin of the GLS resistance and the development of improved cultivars is promising.

The next step is to confirm what we discovered from growth chamber experiments under field conditions. In many cases, what was detected in the growth chamber inoculation is not reproduced in a real world situation such as golf courses or athletic fields. Therefore, it is crucial to run the field inoculation experiments to validate what we found in the growth chamber. Thankfully, as you might have already read in some extension articles, no disease incidence has been reported in Wisconsin as of today. Maybe, GLS disease damage has not been high enough to be noticed. Because there is no natural disease occurrence in Wisconsin, we have to set up a research plot where the disease pressure is naturally high. Last fall our first field plot was established at Urbana-Champagne, IL (collaborator: Dr. Andy Hamblin) and was inoculated with an Illinois *P. grisea* isolate. Unfortunately, no disease developed in the plot. That is one difficulty in carrying out the field experiment with this type of disease. That means that we do not fully understand the epidemiology of the pathogen. Very specific conditions (temperature, humidity, moisture, plant condition, and other unknown factors) must be met for the pathogen to cause visible disease symptoms.

Since this project is important for several reasons (the completion of Joe's Ph.D. dissertation, a USGA funded project, and job security), two sites at Carbondale, IL and Lexington, KY where disease incidences were previously reported were selected this year even though they are many miles from us. Dr. Ken Diesburg (Southern Illinois University, Carbondale, IL) and Dr. David Williams (University of Kentucky, Lexington, KY) graciously accepted our request to help prepare a research plot at their turfgrass research facilities.

At first, 4500 plants were split, transferred into plastic pots and filled with soil by Joe Curley, Steve Abler and summer undergraduate students at the O. J. Noer (Brandon Kobilka, Kevin Schneider, Jonathan Rivers, Scott Johnson, and Andy Rubsam). The plants were grown in the greenhouse for three weeks. Then a four-day journey with four people (Joe Curley, Jonathan Rivers, Scott Johnson, and myself) began. The clonally propagated plants and our luggage were packed up into two vans and left Madison at 6:00 am.

As drove down south, the last digit number for air temperature that I remembered was 104°F. It was hot and humid at Carbondale. Despite the weather conditions, the plot looked very good. We transplanted the plants until a bit of light allowed us to see each other. The next morning we finished the rest of transplanting before noon and spent several afternoon hours discussing plot maintenance (irrigation, cutting height, fertility, and inoculation).

We arrived in Lexington late that evening. The next morning we went to a research farm to meet with Dr. David Williams at the University of Kentucky-Lexington. The farm was huge (1500 acres) and well organized under a high security system. Field research projects from many different disciplines including turf were all in one place. It took a full day to finish all transplanting and this included David's field technician and a graduate student. Due to their excellent plot preparation, everything went very smoothly.

I want to thank the collaborators and helpers for their sincere dedication. In spite of their busy time with their own work, they prepared the plots very well and even provided us extra hands so that all of our planned work was successfully completed on time. Our collaborators' genuine participation and patience to carry out our cooperative research projects should be acknowledged. I want to express my special appreciation to two undergraduates for showing their responsibility, endurance, and maturity to help complete the project despite the unpleasant weather and a long day's hard work.

For me, it was a new and joyful experience, meeting and working with people, tasting local foods, and solving biologically complex problems via orchestrated cooperation with diverse expertise. The trip will be vividly remembered. What I am anxiously longing for right now is a phone call from our collaborators informing us that gray leaf spot rampages through our plots.