Molecular Approach to Solve Rust Disease on Turfgrass

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When I began to work with Dr. Jung, I knew a little about turfgrass as I had worked in fungal molecular genetics for my Masters degree. Over the past year of working with turfgrass, I have come to realize that turfgrasses are playing important role in our lives, even if they are not edible crops.

Can you imagine our life without turfgrass? How could you design beautiful outdoor architecture without it? Since I want to apply my knowledge and experience of molecular biology techniques to the study of turfgrass, my work in Dr. Jung's lab has started with genetic research of perennial ryegrass (Lolium perenne), which is one of the most widely grown cool-season turfgrasses and foliage crops in the world.

The DNA marker-based chromosome map is a useful tool for genetic analysis of important traits such as disease resistance. With the construction of a DNA marker-based chromosome map of perennial ryegrass, I can study the genetic mechanisms of disease resistance for my PhD research. Rust is one of the most important diseases on turfgrass, and the genetic study of its disease resistance in perennial ryegrass has been insufficiently explored.

In this article, I would like to tell you about the general knowledge of rust diseases on turfgrass and then discuss my research project.

Rusts occur on all commonly grown turfgrass species. Although many rusts have been documented over the years, they have generally been considered as a minor problem on turfgrass. However, rusts have recently become a major disease problem of both warm and cool season turfgrasses due to the more widespread use of susceptible species and cultivars.

The occurrence of rust diseases is favored by warm humid conditions. The optimal temperature range for the diseases is between 65 and 86°F, depending on the rust species. The diseases develop most frequently on plants stressed by drought conditions, low nitrogen fertility, and shade. Turfgrass with reduced growth rate due to a lack of nitrogen, insufficient watering, or other growth-limiting factor is susceptible to a more severe infection of rusts.

Causal agents of rust diseases include a variety of *Puccinia* and *Uromyces* species. The rust fungi are initially grouped according to uredinial characteristics: 1) presence or absence of paraphyses, which are sterile, hairlike appendages occurring within or at the periphery of the uredinia; 2) the ornamentation of the urediniospore wall, either echinulate or verrucose with flat or rounded warts; 3) the arrangement of germ pores in the urediniospore wall, either equatorial (aligned around the spore's equatorial) or scattered (not in a single line at the equator).

The rust fungi are specific to species within the grass subfamilies used as turfgrasses, chloridoid, panicoid, and pooid. On perennial ryegrass, which is one of the most susceptible cool-season turfgrasses, the common rusts can be readily separated into stem (*Puccinia graminis*) and crown (*P. coronata*) rusts. They both have rounded to oblong uredinia. On zoysiagrass (*Zoysia japonica*), which is often a target of severe rust damage among warm season turfgrasses, rust is caused by *Puccinia zoysiae*. Many rust fungi have complicated life cycles with multiple spore stages.

The appearance of light yellow flecks on leaves or stems is the initial sign of rust infection. The yellowish spots of the infected area enlarge and elongate parallel to the leaf or stem axis as the infection develops. Within sev-

eral days, orange to reddish-brown pustules, which are known as uredinia, appear in the area of the yellow flecks, breaking through host epidermis. Uredinispores are exposed from uredinia. Uredinispores may be yellow, orange, brownish yellow, chestnut brown, or brick red and they appear as a powdery mass.

Although most rust fungi can also produce another spore type, called the teliospore, this spore is primarily produced on unmowed grasses. Therefore teliospores are rarely important for the occurrence of rusts on turfgrasses. As rust disease develops, infected plants become thin and weak and then die as excessive moisture from infected leaves is lost.

Rust diseases, like many other diseases of turfgrasses, are managed mostly by cultural practices, such as use of resistant cultivars and use of fungicides. The damage of rusts can be greatly reduced by maintaining recommended fertility, avoiding moisture stress or overwatering, and adjusting mowing heights according to turfgrass requirements. Adequate nitrogen levels that sustain a moderate growth rate are a critical factor in rust control on turfgrasses. Another effective control strategy is frequently mowing turfgrasses at recommended heights until symptoms disappear. However, low mowing heights must be avoided because they will stress the plants.

The use of a rust-resistant cultivar can be an effective control strategy. On perennial ryegrass, several cultivars such as Elka, Tara, Gator, Ovation, and Ranger have good rust resistance. However, Regal, Manhattan, Citation, Linn, and Dergy perennial ryegrass cultivars are highly susceptible to rust. The use of fungicides is recommended for rust control on golf courses and athletic fields but not home lawns.

Genetic analysis of rust resistance using DNA marker technology on perennial ryegrass allows us to understand host resistance and possibly develop a rust resistant cultivar more effectively than conventional methods. This is the ultimate goal of my research. My first effort will be to construct a DNA marker-based chromosome map of perennial ryegrass. I am using a mapping population derived from the crosses of annual and perennial ryegrass clones made at Oregon State University. The DNA marker-based chromosome map is being constructed with various DNA marker types. This map can be a useful tool with several applications for improving turfgrass: genetic analysis of important turf disease resistance, DNA-marker assisted transfer of agriculturally important genes, and molecular cloning of high-value genes.

In closing, I am very glad to be working on genetic analysis of disease resistance on perennial ryegrass for my PhD. Understanding how many genes control disease resistance and how they interact promises many interesting results, both for scientists and end-users of turfgrass.