What is Creeping You Out Now?

Ideas In Pest Management

How Do Plants Defend Themselves from Pathogens?

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With the development of fungicides claiming to induce natural plant defenses as a means of disease control, I thought it might be nice to review how a plant defends itself naturally. Yes plants do have a natural defense system, but it is nothing like a mammalian immune system. There are some commonalities, but plants do not have an intricate army of specialized cells to combat microbial invaders. Rather, plants use specific molecules such as proteins, organic molecules such as salicylic acid, or individual elements like calcium to signal an invasion from a pathogen.

What's confusing about plant defense is there are two different pathways plant pathologists believe to be responsible for alerting the plant to pathogen infection (Figures 1 and 2). The two terms commonly used are systemic acquired resistance and induced systemic resistance. These are not the same pathway nor do they affect all pathogens. Systemic acquired resistance refers to the phenomenon that an infected leaf sends a signal to the rest of the plant prior to pathogen infection, which in turn confers resistance to the pathogen. This particular pathway relies on salicylic acid as a key molecule to induce this phenomenon. Specifically researchers have found this pathway to primarily affect biotrophic (pathogens that require a living host) pathogens such as viruses, rust fungi and powdery mildew fungi. However, the dollar spot fungus responds to this pathway as well.

Research from our lab indicates that removing the salicylic acid pathway makes the model plant, an Arabidopsis, more susceptible to the dollar spot fungus. Renee Rioux is currently conducting this work in my program. Our goal is to use this plant (think of it as the white mouse of the plant world) to glean more information about the interaction the dollar spot fungus has with a host and to see if we can apply what we learn from this dicot plant to a turfgrass system. At first we were skeptical of using a dicot to make inferences to a monocot system, but after carefully documenting the infection process in both species an Arabidopsis maybe a good tool. Furthermore, a new product called Daconil Action from Syngenta is hitting the market next year. This fungicide combines chlorothalonil with acibenzolar; the latter induces the salicylic acid pathway in plants. Daconil Action has performed well in our trials at the OJ Noer. We have seen dollar spot control extended from 7 to 10 days with regular Daconil to 14 days and we also observed decent Pythium suppression (Figure 3).

Currently there is a lot talk about this product and some of the talk is incorrect. In particular this product is not going to extend the residual efficacy of chlorothalonil to 21 days. We observed good control on a 14-day interval, which is a longer residual that we typically see with chlorothalonil by itself (Figure 3). Keep in mind that our trials are designed to induce dollar spot and the control windows we observed could be slightly extended or decreased depending on the conditions and management practices at your course. I mentioned that acibenzolar induces the plant innate defense response; well in order to take full advantage of this material the product needs to be applied preventatively! However, applications of this product in any climatic condition did not push turf over the edge. It is possible to see a slight discoloration, but nothing that would be considered injurious to the plant. Finally as mentioned previously, the salicylic acid pathway seems to work only on

pathogens that have a biotrophic habit or phase. Thus dollar spot, anthracnose and Pythium blight are all either controlled or suppressed with this product. The brown patch fungus however, does not appear to be affected by the salicylic acid pathway, leaving just chlorothalonil (not strong on brown patch) to control the fungus.

The other defense pathway plants use for defense is the jasmonic acid pathway. It is a very similar pathway to the salicylic acid pathway, but this pathway seems to be more effective against necrotrophic pathogens like *Rhizoctonia solani* (brown patch). The difference between these two pathways is the molecules used for signaling. The phenomenon triggered by jasmonic acid is induced systemic resistance (ISR). The product Civitas is thought to induce the jasmonic acid pathway in plants. Currently Dr. Tom Hsiang at the University of Guelph is investigating the effects of Civitas on ISR and has shown that when applied early enough ISR is activated. This could be an explanation for the results we observed with tank mixtures of Civitas and lower rates of fungicides for snow mold control (Figure 4).

Plant defense is an extremely complicated process that involves an intricate system of signaling molecules and proteins. It is important for golf course superintendents to start understanding the natural plant defense systems because products are on the market that stimulate these defenses. The more you know about the plant and how it defends itself will help you make an educated decision on the value of some of these products.

Figures:

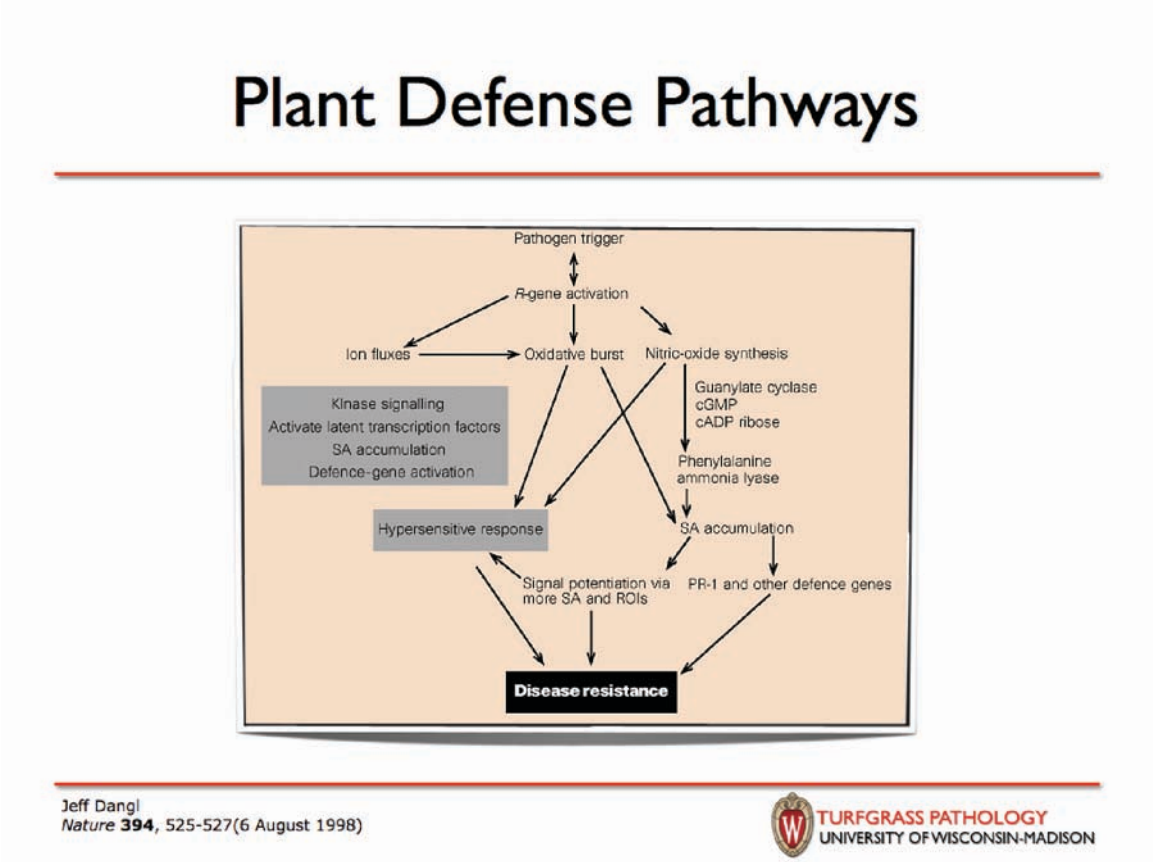


Figure 1. Flow chart of how a plant defends itself. Notice the importance of salicylic acid (SA) in the flow chart.

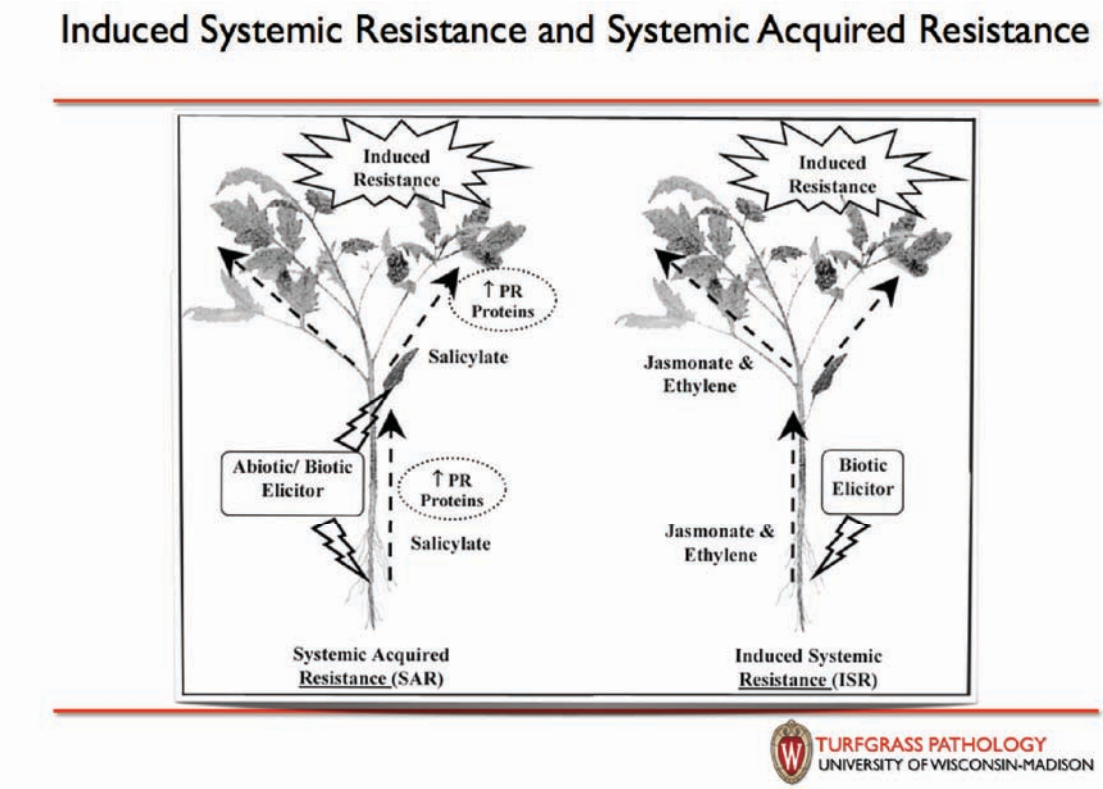
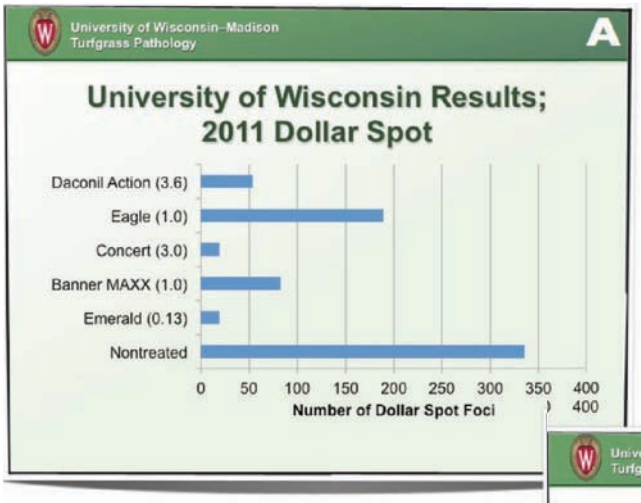


Figure 2. Comparison of systemic acquired resistance to induced systemic resistance in plants. Both are considered key defense pathways for plants and currently the thought is they are almost interchangeable. Yet there still is a difference in the types of pathogens these pathways are effective against.



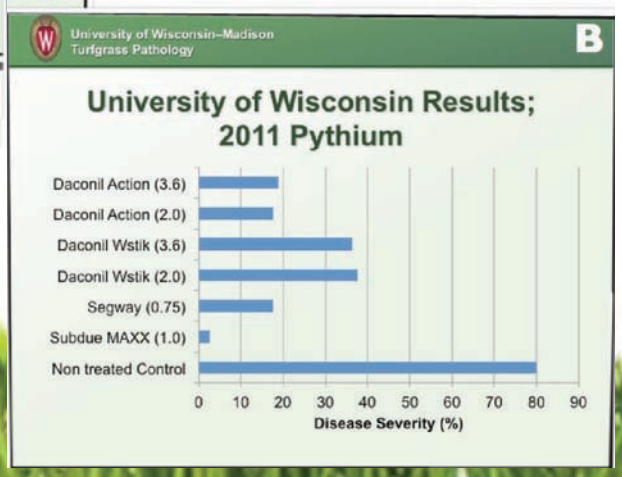


Figure 3. A) Dollar spot control with Daconil Action and other fungicides. Daconil Action was applied on a 14 day interval as were the other fungicides (except for Concert which was applied on a 7 day interval) and this rating was conducted on September 20th, 2011. **B)** Pythium control with various fungicides. All products were applied only once on July 14th, 2011 and each plot was inoculated one day later.

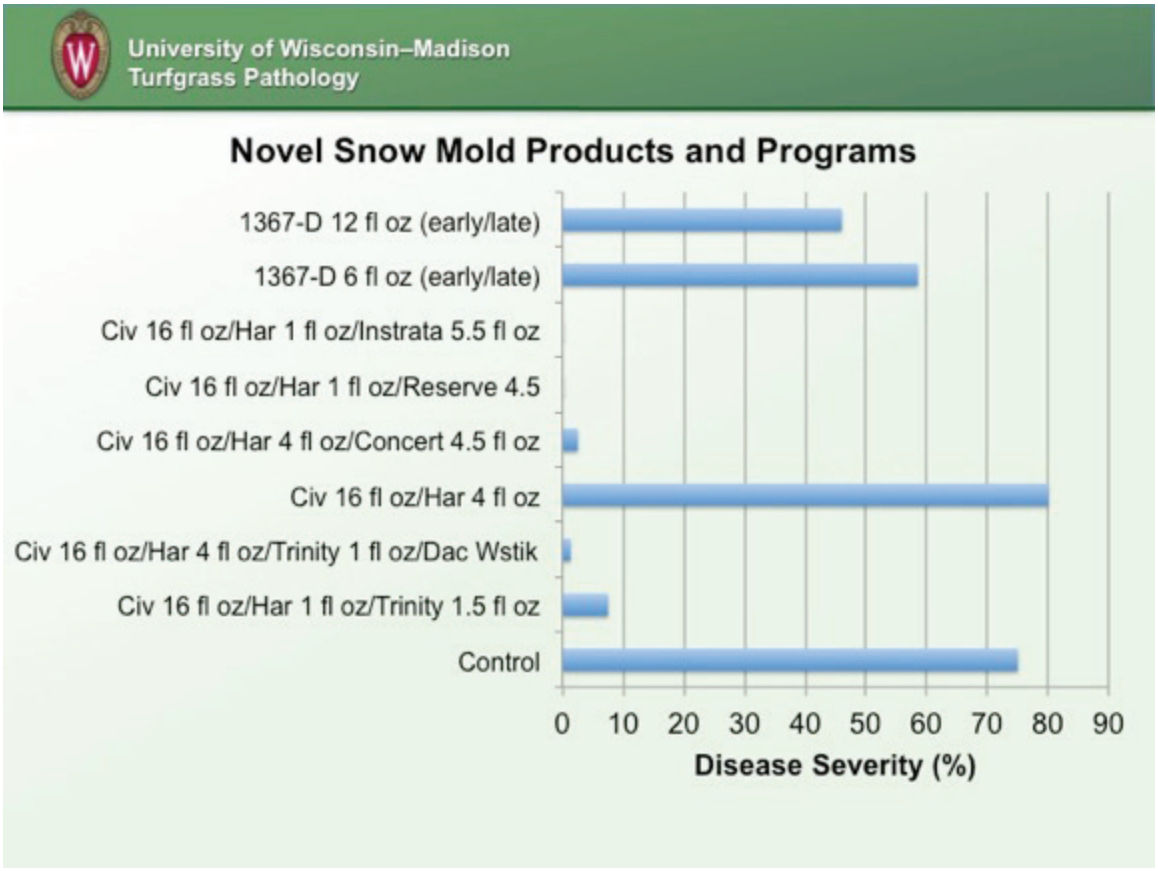


Figure 4. Control of snow mold with novel fungicide products, which included mixtures of Civitas and various other chemistries. Alone Civitas did not suppress snow mold development, but when mixed with standard fungicides, some at fairly low rates, excellent control was achieved.

About Our Guest Writer

Jim Kerns is an Assistant Professor and Extension Specialist in the Department of Plant Pathology at UW-Madison. Jim's program focuses on the biology, epidemiology and management of turfgrass diseases prevalent in the Midwest.