

# The Principles of Plant Pathology: The Disease Triangle and Influence of the Environment

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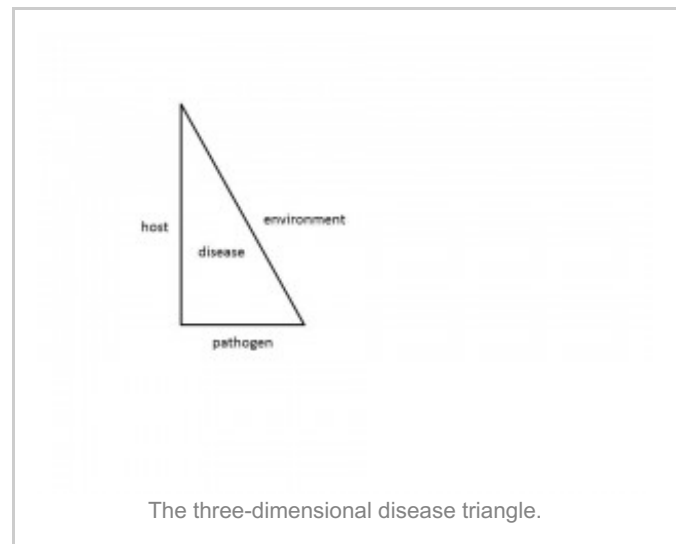
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September 1, 2012

For the purposes of this particular update I will focus exclusively on foliar fungal diseases.

One of the hardest things regarding plant pathology has to do with the timing of disease incidence and when the disease symptoms become observable in the field. More often than not, disease is present in most fields, regardless of specific crop, by the end of the season. However, more specifically, a disease may not threaten yield if it is detected at advanced growth stages (e.g., dent in corn, R6 in soybean). For example, in specific corn settings, such as a continuous corn field, a susceptible plant is more than likely present with enough pathogenic inoculum for disease to occur. However, additional elements in the form of environmental conditions as well as time can play an important role in whether or not disease will result.

As a plant pathologist one of the things that I likely neglect to spend a lot of time discussing are the specific factors that contribute to plant diseases occurring. Unfortunately, I realize this is typically considered a boring topic that is usually saved for the classroom. But, the information that is more generally contained in the disease triangle is important in determining why a disease either has or has not occurred in a specific setting and in some cases can help make a management decision. Traditionally speaking the disease triangle is most often comprised of three factors: host, organism, environment. However, in some less traditional settings a fourth factor (time) is included in a four-dimensional figure to show the impact of time in addition to the host, organism, and environment. A period of time is normally required between when a host comes in contact with a pathogen and a favorable environment for disease to develop occurs (see: <http://www.mississippi-crops.com/2012/08/31/impact-of-hurricane-isaac-on-soybean-rust-and-potential-management-decisions/> regarding the time necessary for infection to occur once a soybean rust spore lands on a leaf).



More specifically, each of the factors are outlined below:

## 1. The host:

In our production system, regardless of planted crop (whether corn, cotton, grain sorghum, rice, soybean, wheat) more often than not, but not in every field situation, a susceptible cultivar is planted that does not contain resistance genes for a particular disease. Excluding rusts (common rust of corn, southern rust of corn, soybean rust of soybean, peanut rust) in this particular section since they have to blow into the MS production system from somewhere to our south and ALL corn and soybean varieties are susceptible to rusts. Wheat rusts are similar in that they have to blow into MS; however, tolerant varieties exist. However, for some foliar diseases, specifically in corn and soybean, there are plenty of varieties available with some level of tolerance to a particular pathogen/disease (e.g., frogeye leaf spot).

## **2. The pathogen:**

The pathogen is simply any particular organism (bacterial, fungal, or viral), but in this particular situation I will continue to refer to the fungal organisms, that can cause a disease in a particular crop plant. In some cases the pathogen is present at a particular location especially if a continuous crop has been grown. Most fungal organisms can overwinter in a field between seasons on senesced plant material or even in the soil profile. The fact that fungi can overwinter within a particular field is one major reason that rotation as well as planting a resistant variety is such an important consideration. Again, in this particular situation, rusts are the exception to this particular rule.

## **3. The environment:**

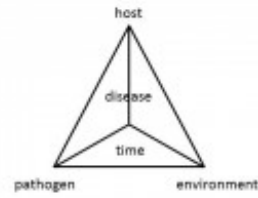
The environment is probably the single most delimiting factor for the development of a plant disease situation. Hence the side of the disease triangle for the environmental factor being skewed. Without a conducive environment, a plant disease will not occur. In most cases, a conducive environment involves high humidity, or free moisture on the leaf surface in the form of dew as well as moderate temperatures. Most fungi do not like the temperature extremes. However, the environment must remain conducive for a specific amount of time for disease to occur. Time is the key component lacking in the three-dimensional disease triangle and the reason for the additional fourth component since a prolonged period of exposure between the host and the pathogen in a conducive environment will be required prior to disease incidence and symptom expression.

## **4. Time**

Disease does not occur instantaneously, even in situations where a conducive environment remains present for an extended period of time. Time is required for the pathogen to infect the plant and produce characteristic lesions as well as produce sporulation (the asexual phase of reproduction). A prolonged period of time can also elapse between infection of the plant and symptom expression. Specific diseases where this likely tends to occur include *Cercospora* leaf blight and soybean rust.

In addition, in certain disease situations an extended period of time may be required for infection, disease development, and continued sporulation to occur. As I said above, disease incidence is not instantaneous. Several days may be required to go through several stages of

reproduction.



The four-dimensional disease pyramid with “time” added.