

The disease triangle and the disease cycle

by Dr. Eric B. Nelson

For those of you who have had an introductory course in plant pathology, you might remember learning at least two important concepts: the concept of the disease triangle and the concept of a disease cycle. I would like to refresh your memories about these two important concepts and their applicability to managing turfgrass diseases. In fact, they are perhaps the two most important concepts to know in turfgrass disease management.



The disease triangle

First, let us define plant disease. A plant disease is any disturbance to the normal physiology of the plant brought about by an agent so that the affected plant changes in appearance and/or is less productive than a normal healthy plant of the same variety.

In nearly all turfgrass diseases, the primary disease-causing agent is a fungus. In fact, with the exception of nematode-incited diseases, all of the economically-important turfgrass diseases are caused by fungi.

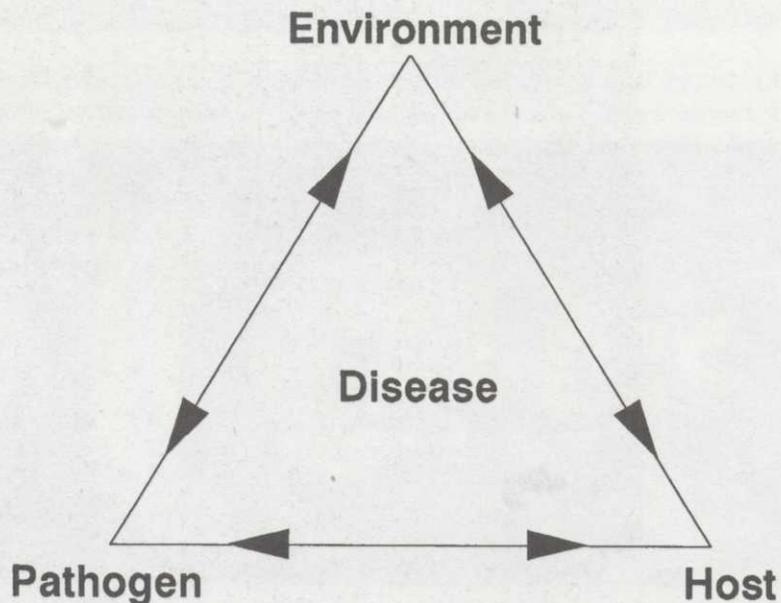
Over the years, pathologists have come to learn that disease development in a plant population is determined primarily by the interactions among three major factors. These are: the presence of a susceptible host plant, the presence of a virulent pathogen, and a favorable physical, chemical, and biological environment.

The interactions among these factors have been traditionally conceptualized in the form of a disease triangle (See figure right).

Conceptually, these interactions dictate that if either the host is less susceptible, the pathogen is less virulent, or the environment is less favorable, diseases will either occur at a reduced level, or they will not occur at all.

Now, how can this concept be applied to turfgrass diseases? There are a few facts about turfgrass diseases to consider. First, for the vast majority of turfgrass germ plasm, there is little or no resistance to turfgrass diseases (obviously there are plenty of specific examples contrary to this statement). Second, since both the turfgrass plants and the pathogens are perennial in nature, infections in turfgrass plants are also perennial. In other words, turfgrass plants are continuously infected with virulent fungal pathogens.

Therefore, the environmental conditions are the overriding factors in determining whether or not a turfgrass disease develops at all. As a result, many control strategies are aimed primarily at alleviating the more favorable environmental conditions favoring disease epidemics. For example, cultural management practices such as fertilization can be manipulated so that the increased or decreased fertility not only creates an environment less favorable for the pathogen, but it helps increase the plants natural abilities to withstand pathogen attack, thus reducing disease development. It should be understood, however, that if environmental conditions favoring disease development are not minimized, other control strategies will not be as effective.



The disease triangle

Figure provided by Dr. Eric B. Nelson, Cornell University

The disease cycle

Another important concept relative to turfgrass disease management is the concept of the disease cycle. A disease cycle is the chain of events involved in the development of a disease, including the stages of development of the pathogen and the effects of the disease on the host plants.

All infectious disease-causing agents go through a disease cycle. A generalized disease cycle is illustrated in the figure below.

If we use fungal pathogens as an example, the over-seasoning stage of most fungal turfgrass pathogens occurs in the winter months when the pathogen persists either in soil, thatch, or in root and crown tissues as a quiescent spore. Snow mold pathogens are the exception to this rule. They over-season during the summer months. When temperature and moisture conditions become favorable, these spores can be transported to adjacent healthy turfgrass plants either by wind, rain, irrigation water, equipment or other means.

Once at the surface of the healthy plant, the spore can then germinate and penetrate the plant tissues. In penetrating tissues, a nutritional relationship is eventually established between the pathogen and the plant. It is at this stage that the plant is considered to be infected. As the pathogen continues to grow between and within cells of the host plant, it can rapidly invade adjacent tissues and organs. It is during this invasive stage that plant symptoms become

apparent. Eventually a new batch of spores are produced on and within infected plant tissues. These spores can be again transported to adjacent healthy plants where they initiate secondary disease cycles, or they can over-season in a quiescent state once again.

The importance of knowing the disease cycle of various turfgrass diseases is apparent when one considers that each stage in this cycle is required for the next stage. Therefore, if any part of the cycle is interrupted, the disease will not develop.

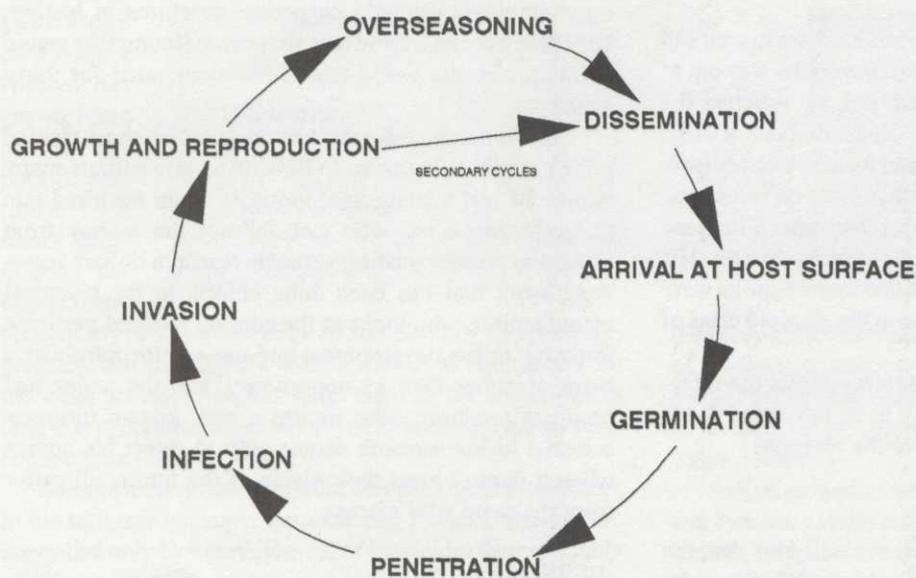
Turfgrass managers can use this knowledge to develop control strategies. For example, since most fungal pathogens are disseminated by water, simple management of water movement on turfgrass surfaces can minimize losses from certain diseases. Furthermore, water management may reduce the amount of spore germination. Since fungal spores generally require water films in which to germinate, practices that minimize leaf wetness periods will greatly reduce or prevent spores from germinating, thus interrupting the disease cycle. Similarly, most fungicide applications are aimed at preventing spore germination, penetration, and invasion of the fungal pathogen on and in turfgrass plants.

It is clear that, due to the nature of turfgrass ecosystems, environmental conditions are the principal factors driving disease development. Certainly the most effective long-term disease control strategies will be those aimed at minimizing environmental conditions favorable for patho-

gen germination, spread, penetration, and sporulation. Similarly, environmental conditions that enhance plants' natural abilities to tolerate chronic infections will ultimately be the best approach to disease control.

The concept of the disease triangle and disease cycles are important in understanding what makes diseases develop and how to tackle disease control.

Turfgrass managers will continually be faced with unique and difficult disease control situations. Applying the knowledge of the disease triangle and the disease cycle will enable managers like you to develop logical strategies for minimizing turf losses. ■



The disease cycle

Figure provided by Dr. Eric B. Nelson, Cornell University