



This is the first fact sheet in a series of nine designed to provide an overview of key concepts in plant pathology. Plant pathology is the study of plant disease including the reasons why plants get sick and how to control or manage healthy plants.

Plants Get Sick Too!

An Introduction to Plant Diseases

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Why Worry About Plant Diseases?

Since the beginning of agriculture, farmers have had to develop means for managing weeds, insect pests, and diseases. Even today, with all the scientific research on crop protection, it is estimated that insects, diseases, weeds, and animal pests eliminate half the food produced in the world during the growing, transporting, and storing of crops. In the tropics, where the environment favors the development of diseases, two-thirds of some crops are lost, thereby adding to the world hunger problem. Although not directly related to the world's supply of safe food, similar losses occur in timber, ornamental, floricultural, and turfgrass production systems. In economic terms, annual losses in food, fiber, and ornamental production systems caused by plant pests and diseases are estimated in the hundreds of billions of dollars. Because of the significant impact plant diseases have on human and animal health, as well as on the economy, it is important for those interested in growing plants to develop a firm understanding of weeds science, entomology (study of insects), and plant pathology (study of plant disease) and how to eradicate, manage, or otherwise minimize losses caused by these important plant pests. The goal of this fact sheet is to provide a general introduction to how plants get sick and some basic principles of plant pathology.

Sick Plants vs. Injured Plants

All plants can get sick and are prone to injury. Disease is defined as “suboptimal plant growth brought about by

a continuous irritant, such as a pathogen (an organism capable of causing disease) or by chronic exposure to less than ideal growing conditions.” In contrast, injury is suboptimal plant growth resulting from an instantaneous event, such as a lightning strike, ice damage, a bad trim job, hail damage, road salt damage, chemical burn, or mechanical damage. For example, someone gets too close to a tree while mowing their grass and ends up cutting the bark. This cut is an injury. Because of the instantaneous and “cause-and-effect” nature of injuries, they are often easy to diagnose. Injured plants are sometimes predisposed to disease.



Figure 1. Injury: Ice damage. The weight of the ice causes the tree branches to break. (Photo by Keith Kresina, Course Superintendent, The Golf Club New Albany)



Figure 2. Injury: Bad trim job. This can be seen in most city parking areas. The branches have been trimmed down so much that it often leads to death of the tree. Bad trimming also opens up the tree to disease by causing wounds that pathogens can enter through. (Photo by Jim Chatfield, Ohio State University Extension)



Figure 3. Injury: Road salt damage. This is frequently seen online roadsides where the salt has caused a toxicity and nothing can grow in that area. (Photo by Joe Rimelspach, The Ohio State University, Turfgrass Pathology)

Two Types of Plant Diseases

In the case of disease, the source of continual irritation may be abiotic (non-living) or biotic (caused by a pathogen). Abiotic diseases are also referred to as non-infectious diseases as they do not spread from plant to plant. In lay terms, they are “not contagious.” Abiotic diseases are very common and should be considered the likely suspect when attempting to diagnose the cause of decreased plant vigor or death. This is very important when working with intensively managed cropping systems in which a high degree of manipulation or handling takes

place. Examples of abiotic plant diseases include damage caused by chronic exposure to air pollutants such as nitrogen dioxide from automobile exhaust, sulfur dioxide from factories, and ground level ozone, a byproduct of photochemical reactions in the atmosphere, nutritional deficiencies and toxicities, and growth under less than ideal light, moisture, or temperature conditions.

Biotic diseases are caused by pathogens and are often referred to as infectious diseases because they can move within and spread between plants. Plant pathogens are very similar to those that cause disease in humans and



Figure 4. Biotic Disease: Corn Smut. The black color seen is the actual teliospores that infect neighboring plants. (Photo by Michael J. Boehm, The Ohio State University, Department of Plant Pathology)



Figure 5. Abiotic Disease. This may look like a pathogen or insect has attacked the plant, but in fact hail caused the damage to the apple tree. (Photo by American Phytopathological Society, 2008)



Figure 6. Disease: Dollar spot. Note the white, mycelia threads and hour-glass lesions that are characteristic of the dollar spot pathogen. (Photo by Michael J. Boehm, The Ohio State University, Department of Plant Pathology)

animals. Pathogens may infect all types of plant tissues to include leaves, shoots, stems, crowns, roots, tubers, fruit, seeds, and vascular tissue and can cause a wide variety of disease types ranging from root rots and rusts to cankers, blights, and wilts. Most plants are immune (resistant) to most pathogens; however, all are susceptible to attack by at least one pathogen—some plants are susceptible to many. Some pathogens like *Rhizoctonia*, *Pythium*, *Fusarium*, and *Sclerotinia* have a broad host range while others only infect a given species.

Organisms That Make Plants Sick Are Called Pathogens

Plant pathogens are very similar to those that cause disease in humans and animals. The pathogens responsible for causing most biotic plant diseases include viruses, bacteria and phytoplasmas, fungi and fungal-like organisms, nematodes, and parasitic higher plants. A description of each of these groups is listed below.

- **Viruses:** Viruses are intracellular (inside the cells) pathogenic particles that infect other living organisms. They live off the host's nutrients.
- **Bacteria:** Bacteria are microscopic, single-celled prokaryotic organisms that reproduce asexually by binary fission (one cell

splitting into two). Phytoplasmas are a certain type of bacteria that lack a cell wall.

- **Fungi and Fungal-Like Organisms:** Collectively, fungi and fungal-like organisms (FLOs) cause more plant diseases than any other group of plant pathogens. Fungi and FLOs are heterotrophic (cannot make their own food), eukaryotic organisms that have a filamentous growth habit and which may or may not produce spores.
- **Nematodes:** Nematodes are simple, microscopic, multi-cellular animals—typically containing 1,000 cells or less. They are worm-like in appearance but are taxonomically distinct from earthworms, wireworms, or flatworms.
- **Parasitic Higher Plants:** Some plants cannot make their own food and parasitize other plants to obtain nutrients and water. Examples include mistletoe, dwarf mistletoe, and dodder.

Three Factors Influencing the Development of Disease: The Disease Triangle

For an infectious disease to develop there must be a susceptible *host*, a *pathogen* capable of causing disease, and a favorable *environment* for pathogen development. Collectively, these three aspects are known as the “Disease Triangle.” If any one of these factors is not present, disease will not develop. In the case of infectious plant diseases, any practice that favors plant growth and reduces either the amount of pathogen present or its development or activity will result in significantly less disease. Visit this

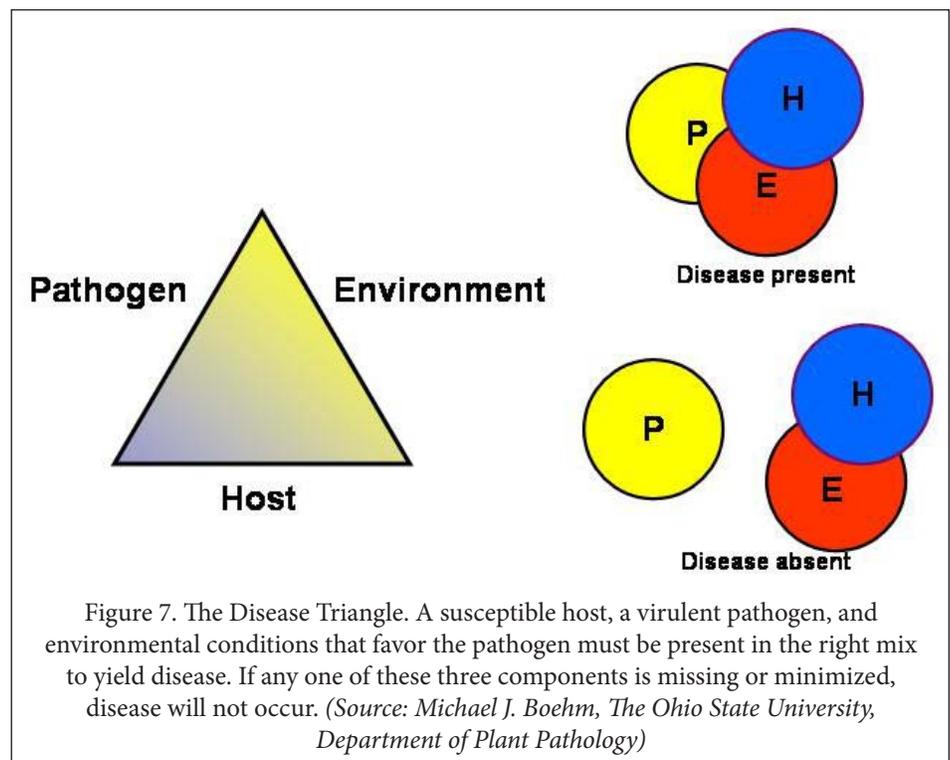


Figure 7. The Disease Triangle. A susceptible host, a virulent pathogen, and environmental conditions that favor the pathogen must be present in the right mix to yield disease. If any one of these three components is missing or minimized, disease will not occur. (Source: Michael J. Boehm, The Ohio State University, Department of Plant Pathology)

module on the Disease Triangle for a detailed explanation: <http://www.ag.ohio-state.edu/%7Etriangle>.

How a Pathogen Infects a Plant: The Disease Cycle

The development of visual disease symptoms on a plant requires that the pathogen must (a) come into contact with a susceptible host (referred to as inoculation); (b) gain entrance or penetrate the host through either a wound, a natural opening (stomates, lenticels, hydathodes) or via direct penetration of the host; (c) establish itself within the host; (d) grow and reproduce within or on the host; and ultimately, (e) be able to spread to other susceptible plants (referred to as dissemination). Successful pathogens must also be able to survive prolonged periods of unfavorable environmental conditions in the absence of a susceptible plant host. Collectively, these steps are referred to as the disease cycle (see figure 7). If this cycle is disrupted, either naturally or via the concerted efforts of a grower, the disease will be less intense or fail to develop. In general, there are five methods used to manage plant diseases. These include use of genetically resistant plants, cultural practices, chemical application, beneficial microorganisms to suppress or counter the activity of the pathogen (known as biological control), and the use of quarantines and other regulatory practices. The collective use of all of these strategies is referred to as Integrated Pest Management. For additional information, refer to the third fact sheet in this series, “Keeping Plants Healthy: An Overview of Integrated Plant Health Management” (PP401.03).

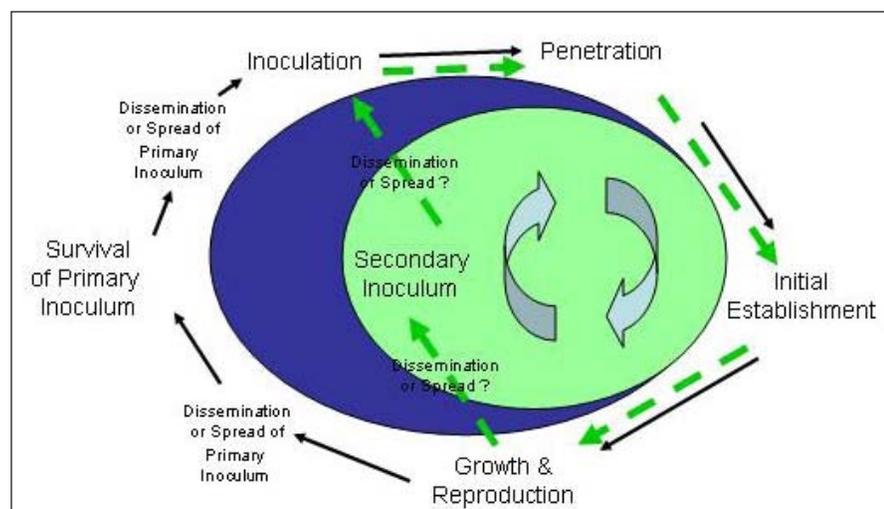


Figure 8. The Disease Cycle: A disease with only one cycle (outbreak) per season is called a **monocyclic** or “one-cycled” disease. A disease with multiple cycles (outbreaks) per season is called a **polycyclic** or “many-cycled” disease. (Source: Michael J. Boehm, The Ohio State University, Department of Plant Pathology)

What Do Sick Plants Look Like?

Proper diagnosis is a critical step in the management of plant diseases. Before you can establish what control strategies should be taken, you must first determine the exact culprit and rule out all other possibilities. Two terms often used when discussing plant disease are sign and symptom. Knowing how to properly diagnose and distinguish a sign versus a symptom is the first step in determining why your plant is sick. The term sign is used when the pathogen or part of the pathogen is observed. Examples include hyphae, mycelium, spores, fruiting bodies, bacterial ooze, and nematodes. Although many plant diseases can be diagnosed in the field based on the observation of diagnostic signs, many require observation by trained specialists in the laboratory or clinic. In contrast to signs, symptoms are visual or otherwise detectable alterations in a plant that result from disease or injury. Symptoms of disease often change over time as the disease progresses. Initial symptoms are often invisible or very small and nondescript. Symptoms can generally be placed in the following categories:

1. Abnormal tissue coloration—Leaf appearance commonly changes. Leaves may become chlorotic (yellowish) or necrotic (brown) or exhibit purpling, bronzing, reddening; mosaic or mottling patterns may appear.
2. Wilting—Drought stress causes wilt. If a pathogen interferes with the uptake of water by the host plant, a part of the plant or the whole plant may die. Fungi belonging to the genera *Verticillium* and *Fusarium* and bacteria in the genus *Xanthomonas* are often associated with wilt diseases as they colonize the xylem of plants leading to a lack of water transport.
3. Tissue death—Necrotic (dead) tissue can appear in leaves, stems, or root, either as spots or as entire organs. Decay of soft succulent tissue, as in damping off in young seedlings, is common.
4. Defoliation—As the infectious disease progresses, the plant may lose all its leaves and sometimes drop its fruit.
5. Abnormal increase in tissue size—Some diseases increase cell numbers or cell size in the plant tissues, twisting and curling the leaves or forming galls on stems or roots.
6. Dwarfing—In some cases the pathogenic organism will reduce cell

number or size, stunting parts of the host plant or the whole host plant.

7. Replacement of host plant tissue by tissue of the infectious organism—This occurs commonly where floral parts or fruits are involved. Examples include ergot on rye and other cereal crops caused by the fungus *Claviceps purpurea* and corn smut caused by the fungus *Ustilago maydis*.

Glossary of Important Plant Pathology Terms

Injury—damage caused by transitory interaction with an agent such as an insect, chemical, or unfavorable environmental condition.

Disease—abnormal functioning of an organism.

Biotic—relating to life, as disease caused by living organisms.

Abiotic—pertaining to the absence of life, as diseases not caused by living organisms.

Pathogen—a disease-producing organism or agent, such as bacteria, viruses, or fungi.

Sign—indication of disease from direct observation of a pathogen or its parts.

Symptom—indication of disease by reaction of the host, e.g. canker, leaf spot, wilt.

Susceptible host—prone to develop disease when infected by a pathogen.

Resistant host—possessing properties that prevent or impede disease development.

Toxicity—capacity of a substance to interfere with the vital processes of an organism.

Parasite—organism that lives in intimate association with another organism on which it depends for its nutrition; not necessarily a pathogen.

Inoculum—pathogen or its parts, capable of causing infection when transferred to a favorable location.

For a complete list of definitions look on *APSnet* Illustrated Glossary of Plant Pathology:

<http://www.apsnet.org/education/IllustratedGlossary/default.htm>

Links

1. Intro to Plant Pathology narrated PowerPoint: <http://www.ag.ohio-state.edu/~boehm/Intro%20to%20Plant%20Pathology/Intro%20to%20Plant%20Pathology.html>
2. What is Plant Pathology? narrated PowerPoint: <http://www.ag.ohio-state.edu/~boehm/EllisFeb2008/EllisFeb2008.html>

For detailed information on each of the IPM strategies, see the fourth fact sheet in this series, “Keeping Plants Healthy: An Overview of Integrated Plant Health Management” (PP401.04).

Introduction to Plant Disease Series

PP401.01: Plants Get Sick Too! An Introduction to Plant Diseases

PP401.02: Diagnosing Sick Plants

PP401.03: 20 Questions on Plant Diagnosis

PP401.04: Keeping Plants Healthy: An Overview of Integrated Plant Health Management

PP401.05: Viral Diseases of Plants

PP401.06: Bacterial Diseases of Plants

PP401.07: Fungal and Fungal-like Diseases of Plants

PP401.08: Nematode Diseases of Plants

PP401.09: Parasitic Higher Plants

These fact sheets can be found at OSU Extension’s “Ohioline” web site: <http://ohioline.osu.edu>. Search for “Plant Disease Series” to find these and other plant pathology fact sheets.

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