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What's your problem? Diagnosing plant disease for nursery growers

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Production of healthy plants is the goal of any plant propagator. When it comes to producing healthy plants, all activities and practices at the nursery are connected and must be considered in order to prevent plant diseases. There are occasions when plant pathogens find a way to infect plants even when we apply good practices at each stage of plant production.

WHAT IS A PLANT DISEASE AND WHAT ARE THE POSSIBLE CAUSES?

Plant disease may be generally described as any change or alteration in the normal development of a plant. The causes of plant diseases can be either living or non-living factors. Non-living factors are also referred to as 'abiotic factors'. Abiotic factors that can cause plant injury include: low or high temperatures, changes in pH, nutrient deficiencies, air pollution, water stress, excess water, and various chemicals. There is no organism to reproduce or spread from plant to plant. Symptoms may appear suddenly (i.e., following cold temperatures), but usually show up over time. Herbaceous plants can show damage immediately, whereas some woody plants may display damage weeks later. Usually, the problem does not get worse over time.

Living causes of plant disease, referred to as 'biotic factors', are any living organisms that cause damage to a plant. In this category, we can include insects, nematodes, weeds, and microorganisms. Plant-disease-causing microorganisms are called 'pathogens' and are the main cause of plant diseases. Pathogens can spread from a diseased plant to a healthy plant, causing disease on susceptible hosts. The problem generally gets worse over time under the same environmental conditions if we do not employ control measures. Some diseases can even spread over a wide area if we have not initiated a disease management plan.

Plant pathogens (disease-causing organisms) are microscopic and not visible to the naked eye, and include bacteria, fungi, and viruses. All these microorganisms have characteristics that allow them to infect a plant and reproduce on or inside a plant. Bacteria can colonize plants by growing between the cells and absorbing plant nutrients. Bacteria may build up to such high numbers that they plug the vascular system, and are sometimes visible when they ooze out of the plant tissue. Fungi are the largest group of plant pathogens and produce fruiting bodies with thousands of spores that help them to spread. Viruses are extremely small and can only be observed under an electron microscope. Viruses can be transmitted by insects and nematodes, are easily carried on dirty tools, and may be transmitted by workers' hands from one plant to another.

THE DISEASE TRIANGLE

There are three elements that must be present at the same time for a plant disease to occur, and we refer to this as the "disease triangle". These elements are: 1) the pathogen, 2) a conducive environment for the pathogen, and 3) a susceptible host (a plant that allows penetration and establishment of the pathogen). Different pathogens find different environments most suitable. Wet weather is favorable for downy mildew, leaf spots, rusts, and root rot diseases. Cool, humid weather is favorable for gray mold (*Botrytis*). Hot, humid weather is conducive for *Rhizoctonia* diseases.

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DIAGNOSING PLANT DISEASES

When it comes to identifying a plant disease, early detection and correct diagnosis are important. A correct diagnosis is useful information for a nursery manager, helping to reduce losses and prevent the spread of a problem. This information will also help in development of management strategies and better production decisions. The first step in diagnosing plant problems is to examine all plant parts for signs and symptoms of disease. Look at the plant closely for clues and consider the possible causes or agents of the problem. Observations are key.

SYMPTOMS OF DISEASE

A symptom of disease is a visible change in the normal appearance of a plant. Carefully observe the affected plants and the general environment. Symptoms of disease can include: leaf spots and leaf blight, wilt, galls, cankers, rots, necrosis, chlorosis, and general decline. Some symptoms caused by bacteria, fungus, virus, or even abiotic causes can look similar. Do not jump to conclusions when a plant problem is first noticed, as disease may not be the cause. Sometimes we can use information to determine the type of pathogen based on specific characteristics. For example, leaf spots caused by bacterial pathogens may have an angular shape, may have a chlorotic halo, or may appear as streaks on monocotyledonous plants. Leaf spots caused by fungi may appear as necrotic or chlorotic spots, whereas viruses often produce a mosaic pattern, showing chlorotic areas that alternate with green areas of leaf tissue. Plant stems may show external symptoms, such as stem cankers, or internal symptoms, such as dark rings in the wood caused by the presence of fungal fruiting bodies seen when you cut a stem and observe the cross section. Symptoms of disease on plant roots may appear as root rot, caused mainly by fungal pathogens, or abnormal tissue growth (e.g., knots), caused by nematodes.

SIGNS OF DISEASE

A sign is the physical evidence of the pathogen, and includes fungal fruiting bodies (such as mushrooms or pycnidia), mycelia, bacterial slime, or presence of nematodes. Mycelium (plural: mycelia) is the vegetative part of a fungus, consisting of a mass of branching, thread-like hyphae. Signs of rust disease are rusty-red spots on the underside of the leaf. Keep in mind that plants kept in the greenhouse or field throughout the year may act as reservoirs of pathogens and insects, and should be scouted regularly and kept under strict disease control.

OTHER DIAGNOSTIC TOOLS

Signs and symptoms are not the only way to diagnose a plant disease. Other tools include molecular techniques, such as PCR (polymerase chain reaction) and immunological tests (such as immune-strips and agglutination tests). Pocket diagnostic test kits are available and useful in a nursery setting for detecting of several plant pathogens, such as *Phytophthora* species.

SOME EXAMPLES OF CHALLENGING DISEASES IN NURSERIES AND LANDSCAPES

Boxwood is susceptible to several diseases. Currently, boxwood blight (caused by *Cylindrocladium pseudonaviculatum*) is of major concern. This disease is characterized by stem lesions and leaf spots, with defoliation occurring soon after the leaf spots are first observed. Infected plants may lose most of their foliage. Some plants may recover, but become infected again and finally die. The pathogen only infects the aerial parts of the plant, not the roots. The pathogen may also infect species of *Pachysandra* and *Sarcococca*. Boxwood blight is sometimes confused with *Volutella* blight (caused by *Volutella buxi*), with the latter characterized by salmon-pink-colored fruiting bodies on the leaves. Boxwood is also susceptible to root rot caused by *Phytophthora citrophthora* and *P. cinnamomi*.

Symptoms of downy mildew on garden impatiens are blossom drop and lack of flowers. A sign of downy mildew is the white mycelium, which may be observed on the undersides of the leaves. Sporangia, which are sac-like structures with motile spores (called zoospores), may also be seen. Oospores are the survival/overwintering structures of the fungus. Oospores are formed in the stems and leaves of infected plants and can survive for several years in the soil.

A SUMMARY OF PLANT PROBLEM DIAGNOSIS STEPS

1. Consider the possible causal agents:
 - Biotic disease – symptoms progress and nearby plants become infected.
 - Abiotic problem – generally a lack of symptom progression; does not spread.
2. Ask questions such as:
 - When was the problem noticed?
 - Was the damage sudden or gradual?
 - How old are the affected plants?
 - What percentage of plants are affected?
3. Observe patterns:
 - Large area/all plants – generally abiotic.
 - Scattered, localized – generally biotic
4. Check for distribution of symptoms:
 - Uniform – generally abiotic.
 - Random – generally biotic.
5. Review cultural practices:
 - Is proper planting technique being used?
 - Is there an overapplication of fertilizers and/or pesticides?
 - Is there an irrigation problem?
6. Review environmental conditions:
 - Recent extreme temperatures?
 - Drought or excess rain?
 - Soil type and conditions?
7. Check for signs and symptoms.
8. Consult literature resources for possible diseases and disorders:
 - Indices listing hosts and their pathogens.
 - Websites providing information.
 - Books with background info and host/pathogen lists.
9. If you do not find an answer and the problem continues to grow, send a sample to a plant diagnostic laboratory, or consult with an Extension specialist.

ADDITIONAL RESOURCES

Diagnosing plant diseases

<https://ohioline.osu.edu/factsheet/plpath-gen-2>

<https://www.apsnet.org/edcenter/intropp/topics/Pages/PlantDiseaseDiagnosis.aspx>

<http://edis.ifas.ufl.edu/mg441>

Bacterial pathogens

<https://www.apsnet.org/edcenter/intropp/PathogenGroups/Pages/Bacteria.aspx>

Nematodes

<http://edis.ifas.ufl.edu/in138>