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Disease Diagnosis Guidelines for Master Gardeners[1]

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The word "pathology" comes from two Greek words, “pathos” (suffering), and “logos” (study). Therefore, plant pathology is the study of the suffering or diseases of plants. Normally, non-parasitic disorders of plants are not included in the study of diseases, but it is still important to recognize them. These disorders include nutrient imbalances, temperature extremes, toxic chemicals, mechanical injury, water imbalances, air pollution, and genetic problems. Most environmentally induced problems tend to be uniform, whereas disease may show up in spots throughout a field. Our concentration here will be on parasitic diseases; those caused by microorganisms which can be seen only with a microscope. These microorganisms include fungi, bacteria, and viruses.

Descriptions of Pathogens - - Fungi, Bacteria, and Viruses

About 85% of plant diseases are caused by fungi. Fungi are not plants. Fungi are multicelled and during certain stages of their life cycles, may be seen without a microscope. They have no chlorophyll and though they do have cell walls, the walls of many species are not made of cellulose as in true plants. Many species of fungi produce spores, which are reproductive structures which aid in dispersal and survival. Most fungi can be identified by the structure of these microscopic spores. Some fungi have no spores (e.g., *Rhizoctonia*). *Rhizoctonia* can be identified by the very characteristic right angle branches of its fungal threads. Some fungi can survive on their own without a host for long periods of time (e.g., *Rhizoctonia*).

Wind is important in the dispersal of most fungal pathogens. Spores can be carried for miles in the wind. Fungi can penetrate directly through the cuticle of plants; therefore they do not need natural openings in the plant or wounds for access.

Though fungi cause more diseases than bacteria, bacterial diseases can be some of the most difficult to control and can be devastating to plants. Bacteria are not plants; they are one-celled organisms which are so small, they can be seen only with a microscope. Though some bacteria do produce spores, there are **no** plant pathogenic bacteria that produce spores. Some bacteria can survive in the soil in decaying plant material for a time. Unlike fungi, they usually need the host to survive.

Bacteria are dependent on outside agents for dispersal. Splashing water is the chief means by which bacteria are disseminated. Another important means of dispersal is through human contact. Many bacterial diseases can be spread simply by touching an infected plant and then touching a healthy plant. Bacteria

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cannot penetrate the cuticle of plants, but must enter the plant through a wound or natural opening.

Viruses are the smallest of the three pathogens mentioned here. They can only be seen with an electron microscope. They are not plants or animals; in fact, they may not be alive at all. Viruses are genetic material (RNA or DNA) wrapped in a protein coat. They must have a living host in order to reproduce. Viruses are usually vectored from diseased to healthy plants by insects. In Florida, most viruses are vectored by aphids.

Symptoms and Signs

Symptoms are abnormal states that indicate something is wrong. It is important to be able to use the proper name for a symptom. Many are self-explanatory. A spot is just that, a spot. It is necessary to also mention the part of the plant which is infected. If there are spots on the leaves, it will be called a leaf spot; on the fruit, a fruit spot. As spots grow and coalesce, the symptom may be termed a blight. This differs from a spot because larger amounts of tissue are affected. Galls or tumors may be found on stems or sometimes on leaves. These are masses of undifferentiated tissue growth (similar to cancerous tumors in people). Cankers, found most often on stems, are sunken lesions. Wilts and rots are just what the names imply. It is important to note that a rot does not have to be wet and “yucky,” there are dry rots. "Damping off" is another term that is often used to describe the rotting of seedlings as they emerge from the soil. This is sometimes also called wire stem. Most of these symptoms can be caused by any of the pathogen groups at one time or another.

It is important to remember that a positive diagnosis of a plant disease is often difficult or nearly impossible on the basis of symptoms alone. To properly identify a disease, one must look for the **signs** of the pathogen. A sign of the pathogen is the presence of the pathogen, itself.

In fungi, one can often see the actual fungal growth. Examples of these signs are mycelium, molds, rusts, sclerotia, conks and mushrooms. A mycelium is a mass of fungal “threads” that can often be seen on or around a lesion. Sclerotia are small, hard bodies which are the resting state of the fungus. Fungi can survive for years in this state. If a fungus is suspected as the cause of a disease, but there is no sign of the fungus, a moisture chamber can be made. This is a container (e.g., coffee can) in which moist paper towel is put along with a piece of the diseased tissue. After a day or two in the closed can, mycelium will often be evident if the disease is indeed caused by a fungus.

Along with the above related fungal sumptoms, bacterial infections often produce watersoaking around the area where the pathogen entered. Later the lower surface of the leaf will take on a dark, greasy appearance. This greasy appearance is most evident in foliar infections, but can sometimes be seen on other plant organs. Though, these are good indications of a bacterial disease, one must again look for signs of the pathogen. Often, bacterial ooze can be seen coming from a lesion, especially in the morning hours. Some bacterial diseases have distinctive odors. An easy test to determine if wilt symptoms are caused by bacteria is called a bacterial streaming test. This may be done by cutting the stem horizontally and inserting it into a jar of water. If bacteria are present, they will produce a cloudy stream within a few minutes. This stream is composed of millions of bacteria.

Symptoms in viral diseases include mottling in the color of leaves and fruit, yellowing and/or crinkling of leaves, misshapened leaves, and shortened internodes, which make the plants very squat. In order to get a definitive diagnosis of a virus, samples must be sent to a clinic which has the special equipment necessary to do the proper tests.

It is handy to have a hand lens and knife available. A hand lens is often necessary to see the fungal growth on a lesion. It is simple to tell if a pathogen is responsible for a wilt by making a vertical cut near the base of the plant. If a pathogen is present, the vascular tissue will appear dark. A plant wilting from simple water stress will have normal white or light-green vascular tissue.

Control

In order for a disease to develop in a plant, there must be three things present: the pathogen; the host; and an environment favorable for disease development. This is called the disease triangle. All three parts of the triangle must be present for the disease to occur. In order to control a disease, it is necessary to remove one of these three parts. Plant disease controls include crop resistance, cultural and physical methods, pesticides, and regulation.

Immunity is the rule in the plant kingdom; most plants are immune to most pathogens. Therefore, one does not have to worry that the black spot on roses will next appear on the garden tomatoes. Plant breeders strive to select varieties of host plants that have resistance to plant diseases. Many hybrids of vegetable crops, ornamentals, etc. have been developed that have some level of crop resistance. Merely choosing and planting these hybrids will cut down disease problems. This is your first line of defense! There are also varieties that show more tolerance for a disease. The plant may seem to have as many symptoms as the plant that is not tolerant, but somehow will still thrive and produce.

There are cultural methods that can be used to help control disease. These include sanitation, crop rotation, host eradication and improvement of crop environment. Sanitation involves removal of diseased plants and plant parts from the area to prevent spread of the pathogen. As stated above, most pathogens are fairly host specific. By rotating crops from season to season, populations of the pathogen will decrease because one aspect of the disease triangle - the host - has been removed. Sometimes, the weeds surrounding a field also act as hosts for a particular pathogen. By eradicating these weeds, a possible host has been removed.

Watering only the soil around the roots of plants is preferable to wetting the foliage. It is not necessary to wet the leaves. It is also important to water after the dew has dried, but early enough to allow for fairly rapid drying of the irrigation water. The late morning hours are a good choice for watering.

As was mentioned earlier, some pathogens can be carried from plant to plant on hands and tools, especially pruning tools. It is important to disinfect hands and tools that are used with the plants. A 10-20% solution of household bleach in water makes a good disinfectant. Rubbing alcohol from the drug store will also work.

There are many ways to improve the crop environment, making it more difficult for a disease to take hold. Producing seed in low rainfall areas improves the chances that the seed is not infected. Most bacteria love warm, humid environments, so seed produced in dry environments has a better chance of being disease free. Knowing the proper time to plant and the proper depth to place the seeds or seedlings is also important. Poorly drained soil should be avoided; if possible, even in home gardens one should plant on raised beds to ensure good drainage. Fertilizer should only be applied after soil has been tested to find out what its deficiencies are. Knowing the history of the field and what disease problems have been present can lead to better decisions about how plants will fare. Spacing of plants is important. Wider spacing promotes more rapid drying after rains and provides for good air movement. Injuries provide access for pathogens, so one should avoid injuries to plants and plant parts during production, harvesting, storage, and distribution. Finally, plants will do better in soil that is not compacted, but has been well-tilled. Mulching can also be helpful in keeping weeds down and keeping foliage and fruit from touching infested ground.

When buying plants for home use it is very important to make sure the plants are disease free. This is especially important for bacterial diseases. It is not uncommon to find infected seedlings in many of the department-store retail nurseries.

In the end, one may still consider judicious applications of chemicals. Chemicals should only be used as part of an Integrated Pest Management program, and should not be the first or exclusive choice for plant disease management. Chemical methods include seed treatment, and foliar sprays or dusts. It is important to always use only the amounts specified on the labels and to use the proper fungicide for the plant and the particular problem. It is necessary to make sure the chemical is labeled for that particular

plant. Correct timing is also important; one should follow extension guidelines in planning an IPM program.

Disease Diagnostic Information and Submission of Samples

There are several steps the master gardener should follow when attempting to diagnose disease problems in the plants brought into the Extension office. It is very helpful to get as much information as possible. It is important to find out from the person bringing in the plant how many plants are affected, when symptoms appeared, the pattern of development in the field or garden, the severity of the disease, any recent cultural practices (e.g., use of pesticides or fertilizers), and any weather conditions that might have affected the plants. Handouts and other reference materials are available in the Extension office.

There will be cases where it will be necessary to send a sample to one of the disease clinics. The samples should be properly packaged for shipment. Preferably the whole plant should be sent. The root ball should be wrapped in wet paper towels and put in a plastic bag to keep it moist. Then the entire plant can be placed in a paper bag. If mailing, the plant can be carefully placed in a box and mailed to the proper clinic. Whenever possible, single leaf samples should not be sent. These samples often will not arrive in proper condition to be tested. Fruit can be wrapped carefully in paper, not in plastic, and mailed in a box. The samples should be submitted with the appropriate paperwork, through a county agent, to one of the regional plant disease clinics. Your county agent can help determine where the samples are to be sent.