Basic Plant Pathology

THE WORD PATHOLOGY comes from two Greek words, Apathos@ (suffering), and Alogos@ (study). Therefore, plant pathology is the study of the suffering or diseases of plants. Normally, nonparasitic 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 nursery. Our concentration here will be on parasitic diseases **C** those caused by microorganisms that can be seen only with a microscope. These microorganisms include fungi, bacteria, and viruses.

Descriptions of Pathogens

About 85 percent 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 that 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 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.

There are several groups of fungi that are important in causing plant diseases in the nursery. One group is now classified as the Afungal-like@ chromistans. The most significant subgroup are the Oomycetes, which contain the serious pathogens *Pythium* and *Phytophthora*. These fungi are sometimes referred to by the common name of Awater molds.@ As the name implies, they are most aggressive under highmoisture regimes. They are primarily soilborne and cause damping-off, root rots, and crown rots. Stem canker symptoms are associated with a number of *Phytophthora* species. If observed under the microscope, the hyphae (fungal threads) do not have cross-walls.

Management of *Pythium* and *Phytophthora* center on the soil or soil mix that may harbor propagules of the fungi. Options include fungicide drenching, plant stock treatment, soil pasteurization or sterilization, and use of composted bark media.

Another important group of fungi are the Ascomycetes. These true fungi produce specialized spores, called ascospores, which are often borne on the wind to susceptible host plants. Ascospores are always produced as a result of sexual reproduction.

Closely related fungi called imperfect fungi (*Fungi imperfecti*) also very often produce airborne spores. However, these spores, named conidia, result from asexual reproduction. A particular fungus may produce ascospores in the sexually reproductive stage of its life cycle and many generations of conidia during its asexual stage. It is even possible that two different names will be used for the same fungus, depending on whether the sexual or asexual stage is observed. Several imperfect fungi important in the nursery industry include *Botrytis*, *Cercospora*,

Alternaria, Phomopsis, Septoria, and *Colletotrichum*.

Since so many Ascomycetes and imperfect fungal pathogens are airborne and attack plant shoots, fungicide sprays are important in their management. Sanitation, resistant cultivars, and crop rotation also figure heavily in an integrated program for disease management.

The Basidiomycetes are the other major group of fungal pathogens. These are advanced fungi with complex life cycles. Often, different life stages occur on different hosts, leading to an Aalternation of generations.@ These fungi often are obligate parasites (i.e., they can=t be cultured on artificial media).

The Basidiomycetes include the familiar Arusts@ and Asmuts.@ Rusts are characterized by more-or-less rust-colored pustules or shoot tissue. These pustules are usually eruptions through the epidermis of masses of rust spores (often urediospores) that give the pustule its characteristic color. Sometimes sexual spores initiate epidemics of rust in the beginning of a season, but repeated asexual spore production (urediospores) usually account for most of the epidemic.

Smut fungi produce many fine, black masses of spores, hence the name Asmut.@ These also are obligate parasites. Both the rusts and the smuts tend to have very narrow host ranges. Cultivar resistance is important in control when available. As with the Ascomycetes and imperfect fungi, routine fungicide sprays are often indicated to maintain acceptable levels of control in commercial nurseries.

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 that 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 depend 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 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 be seen only with an electron microscope. They are not plants or animals; as conventionally defined, 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 that 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 Ayucky@; 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 Athreads@ that can often be seen on or around a lesion. Sclerotia are small, hard bodies that 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 symptoms related above for fungi, bacterial infections often produce water-soaking 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.

A streaming test can also be used on leaf samples. The suspected lesion must be cut through several times with a razor blade and then observed under the microscope for a milky ooze issuing from the cut surface.

Symptoms in viral diseases include mottling in the color of leaves and fruit, yellowing and/or crinkling of leaves, misshapen leaves, and shortened internodes, which make the plants very squat. To get a definitive diagnosis of a virus, samples must be sent to a clinic that 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.

General Control Measures

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 crossandra. Plant breeders strive to select varieties of host plants that have resistance to plant diseases. Many hybrids of ornamentals have been developed that have some level of host 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 be as heavily infected 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 **C** the host **C** has been removed. Sometimes the weeds surrounding a greenhouse or shade house 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- to 20-percent 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 planting stock from meristem tip culture eliminates some important pathogens, particularly viruses and some bacteria. Knowing the proper time to plant and the proper depth to place the seeds or seedlings is also important. Poorly drained soil or potting mix should be avoided. Use only recommended blends and rates of fertilizer. Knowing the history of the nursery 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 irrigation and provides for good air movement. Injuries provide access for pathogens, so one should avoid injuries to plants and plant parts during production and distribution. Mulching around nurseries can also be helpful in keeping weeds down. It is, of course, important to start with clean, healthy, pathogen-free stock when beginning any new nursery crop.

In the end, one may still consider judicious applications of chemicals. Chemicals should be used only as part of an Integrated Pest Management program, and should not be the first or exclusive choice for plant disease management. Chemical methods include planting stock treatment, drenches, 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 nursery manager and IPM scout should follow when attempting to diagnose disease problems. Keep good records of the crops. Note when and where disease

problems first appear. Note disease development problems, disease severity, and recent cultural practices (e.g., use of pesticides or fertilizers). Don=t forget to record weather conditions and irrigation. 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.