CHAPTER 4
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The organisms which cause plant disease can destroy crops from the time the seed is put into the ground until the crop is harvested and during storage. Some diseases are capable of totally destroying a crop, while others may cause only cosmetic damage. However, cosmetic damage may be equivalent to total destruction in the case of ornamental plants, certain fruits and vegetables.

While many biological organisms can cause plant diseases, the vast majority are caused by fungi. Disease control with chemicals is tricky because it involves killing the fungus, without killing the host, and proper timing of applications is essential.

A basic understanding of diseases and how they develop will give an appreciation for the complexity of the problem and demonstrate the importance of cultural practices in management of plant diseases.

Plant Diseases In History

Certain diseases have had tremendous impacts on our society. Perhaps foremost among these is potato late blight which caused the potato famine in Ireland (1845); as a result, approximately 2 million people either starved to death or emigrated to the United States.

Downy mildew ruined the French wine industry until Bordeaux mixture was accidentally discovered as a control against the fungus.

Two forest tree diseases which caused great economic losses in America are Dutch elm disease and chestnut blight. Both were introduced accidentally to the United States. Chestnut blight completely destroyed the most valuable trees in the Appalachians, while Dutch elm disease continues its destruction today.

These examples are prominent because they caused so much damage. However, plant diseases cause variable amounts of damage from year to year, often depending upon weather patterns.

Disease Defined

Plant disease is the rule rather than the exception. Every plant has disease problems of one sort or another. Fortunately, plants either tolerate these maladies, or they are not very serious in most years. Plant pathologists consider almost any abnormal growth pattern by a plant to be a ‘disease’.

Plant diseases are caused by a large array of biotic (living) agents such as fungi, nematodes, bacteria, and viruses. Plant diseases are also caused by a large array of abiotic (nonliving) factors such as nutrient deficiencies and water or temperature stress; or sometimes by a combination of factors. Both groups of agents are capable of causing abnormal and harmful physiological processes in the host plant.

One must distinguish between infectious diseases, caused by biotic agents, and noninfectious disorders (abiotic agents).

Infectious organisms can be defined as follows:

Fungus:	an organism with no chlorophyll, that reproduces by means of structures called spores, and usually has filamentous growth; e.g., molds, yeasts, mushrooms.
Bacterium:	a single-celled, microscopic organism with cell walls and no chlorophyll; reproduces by fission.
Phytoplasma:	a microscopic, bacteria-like organism that lacks a cell wall, and therefore appears filamentous.
Virus:	a submicroscopic, subcellular particle consisting of nucleic acid and protein that requires a host cell in which to multiply. (It is not known if a virus is a living or nonliving agent).
Viroid:	a virus-like particle that lacks the outer protein coat of a virus particle.
Nematode:	a microscopic roundworm, usually living in soil, which feeds on plant cells.
Parasitic Seed Plant:	a higher plant with chlorophyll that lives parasitically on other plants, e.g., mistletoe, dodder

Fungi and bacteria cause plant diseases such as leaf spot and fruit, stem, or root rot. Plant viruses, viroids, and mycoplasmas often cause growth distortion, stunting, and abnormal coloration. Nematodes can cause stunting and root distortion. Parasitic seed plants cause a general weakening of the host plant.

Conditions Necessary for Disease

In order for disease to occur, three conditions must be met. First, it is necessary to have a susceptible host plant. Each species of plant is capable of being infected by only certain organisms (pathogens). The plant must be in a stage of development susceptible to infection by the disease agent.

The second requirement is the presence of an active pathogen in a stage of development conducive to infecting the host plant. If there is no pathogen present, there can be no disease.

The third condition is an environment suitable for the pathogen to infect the plant. Temperature and moisture are important factors.

Symptoms, Signs, Syndromes

A **symptom** is the physical expression of disease by the plant. Examples of symptoms are:

blights:	sudden, often widespread death of twigs, foliage, flowers
cankers:	dead places on bark and cortex of stems; often discolored and raised or sunken
galls:	abnormal, localized swellings on leaf, stem, or root tissue
rots:	general decomposition and destruction of tissue
necrosis:	death of tissue
spots:	circular or irregular lesions on above-ground tissue

A **sign** is the visible presence of the pathogen, such as a fungal fruiting body or bacterial discharge associated with the disease:

conks:	fungal fruiting structures formed on rotting woody plants (shelf or bracket fungi)
mycelia:	masses of fungal threads (hyphae) which compose the vegetative body of the fungus
ooze (flux):	viscid mass of juices composed of host and parasite substances found exuding from some diseased plants
pycnidia:	minute, fungal, asexual fruiting structures, usually globose and black, formed on plant surfaces
rhizomorphs:	string-like strands of fungal mycelia sometimes found under the bark of trees

A disease **syndrome** is the group of signs and symptoms which collectively characterize a disease. Familiarity with a disease's signs or symptoms is often not enough to diagnose a disease; it is necessary to know the syndrome and case history. Seeing a spot on a leaf does not tell much, but finding pycnidia in that spot and knowing the plant species and recent weather conditions might be sufficient information to diagnose the disease. Often, laboratory work is necessary for diagnosis.

Disease Development

It is important to understand how plant diseases develop in order to control them. By the time it becomes obvious that a plant has a disease, it is generally too late to do anything about it in that growing season. Plants cannot be cured in the way people expect their own ills to be cured. The process by which diseases develop can be broken into four distinct phases:

Inoculation: This is the introduction of the pathogen to the host plant tissue. Wind, or rain, or running water can move pathogens and introduce them to a host plant, as can birds, insects, people, or equipment. Some pathogens move themselves short distances, but most rely on other means. Inoculum is any part of the pathogen that comes in contact with the host plant.

Penetration: This is the process of getting inside the plant. It may be an active or passive process. Some pathogens produce enzymes to dissolve the cuticle and directly attack and penetrate plant cells. Some pathogens can swim through water on a plant's surface and enter the plant through natural openings (such as stomata, lenticels, or hydathodes) or through wounds. Some pathogens are introduced into the plant by insects, pruning tools, or driving rain.

Infection: When the pathogen invades the plant tissue and establishes a parasitic relationship between itself and the host, infection has occurred.

Disease: When the host plant responds to the presence of the pathogen, a "disease" exists. The host's response usually results in the development of symptoms of the disease, such as blight, spots or necrosis.

Control of Diseases

The importance of understanding the disease development process becomes obvious when considering control options. By the time symptoms are expressed, the pathogen (with few exceptions) is already inside the host plant. Therefore, control efforts, in most cases, must occur before penetration has taken place. The overall principle in effective disease control is to keep the inoculum density of the pathogen at very low levels.

Success in controlling plant disease will occur when a combination of the following methods of control are used:

Avoidance: A grower can avoid certain diseases by choice of geographic area or choice of planting site. Disease can also be avoided by planting at a time that does not favor disease development. Using disease-free planting stock or modifying cultural practices also helps to avoid disease.

Exclusion: A grower can inspect stock for signs of disease and reject or treat any which is suspect. Plant quarantines are designed to exclude certain pests from areas that are free of that pest. Elimination of carrier insects can help exclude disease-causing organisms.

Eradication: Once a disease is established in an area, eradication is unlikely. However, significant reduction in disease inoculum can be attained by destroying diseased plants or alternate hosts, by rotating crops, or by certain soil treatments.

Protection: Spraying or dusting plants with fungicides or bactericides can protect them from disease. Sometimes modifying cultural practices or the environment may protect the crop. Control of carrier insects will also protect plants.

Resistance: Breeding and selection are used to develop resistant crops. Resistance can be enhanced through proper culture of a crop. Resistance is not immunity; improper culture of a resistant variety may negate the resistance.

Therapy: There are a few diseases which can be treated with chemicals or heat to gain a degree of control.

Familiarity with crops and the diseases and insects that affect them is useful in planning management programs. Some diseases occur every season; others occur sporadically. Some can be managed easily by using proper cultural and/or chemical methods; others must be tolerated. Knowing which problem falls into which category comes with experience. Knowing the proper method to use at the proper time is a part of integrated pest management (IPM).

Summary

Plant diseases are to be expected. Fortunately, there are few truly devastating diseases in most years.

For disease to occur, there must be a susceptible host, a suitable environment, and a living pathogen. When all three conditions are met, disease occurs. Severity of the disease depends on the degree to which the conditions are met.

Disease development follows a precise course of events. Inoculation occurs first, usually followed by penetration of the host . Infection occurs when the pathogen invades the host tissue. Only when the host responds has disease occurred. By this time, it is usually too late to control the disease.

Disease management involves more than the use of chemicals for protection. Avoidance, eradication, exclusion, resistance, and therapy all have a role in disease management. A combination of these will give best results.