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PLANT HEALTH PROBLEMS

Introduction and Historical Impact of Plant Health Problems

Plants in landscapes, gardens, production fields, forests, and interiorscapes are subject to a wide variety of problems that threaten their health. These problems can affect the aesthetics of the plant or can pose more serious consequences which result in plant disfigurement, crop loss due to reductions in yield and quality, and plant death. Throughout time, plant diseases have had profound effects on the history of human civilization and culture and plant health problems continue to impact our daily lives. Plant diseases affect food, fiber, and ornamental plants as well as those in natural areas. Notable among these diseases is potato late blight. This disease, caused by *Phytophthora infestans*, was responsible for widespread epidemics throughout Ireland and Europe in the 1840's. This devastating disease not only resulted in famine, but was also responsible for the emigration of 1.5 million people from Ireland to the United States and Canada. Late blight continues to threaten potato production in many regions of the U.S. as new strains of the fungus develop.

Another interesting but less dramatic example which illustrates the impact of a plant disease on human culture is the disease coffee rust. This fungal disease, caused by *Hemileia vastatrix*, appeared in coffee plantations in Ceylon (presently Sri Lanka) in the 1860's and subsequently destroyed the coffee industry in that nation. As a part of the British Empire, Ceylon was one of the primary sources of coffee for England, a nation whose citizenry drank coffee as their favorite boiled beverage. However, as a result of the coffee rust epidemic, tea was planted in its place and coffee became very difficult to obtain. Thus, the English had to modify their drinking habits and as a result of a plant disease, England became known as a nation of tea drinkers.

Plant diseases have also changed the composition of the forest and landscape. Until the early 1900's, the American chestnut was one of the most dominant and important hardwood tree species in the forests of the eastern United States. It was prized for its commercial value as a source of lumber, pulpwood, poles, tannins, railroad ties, and edible nuts. With the introduction of the fungus *Cryphonectria parasitica*, a species which was not native to the U.S., chestnut trees became infected with the chestnut blight fungus and the tree was almost completely eliminated from the forest. Today, sprouts continue to grow from old stumps although they usually succumb to disease.

Dutch elm disease is another example of a disease that changed our city and town streets and greens. The fungus *Ophiostoma ulmi*, along with one of the insects that transmits it, were introduced to the U.S. on logs imported from Europe. The American elm, *Ulmus americana*, was highly susceptible to these exotic pests and quickly succumbed to infection. Since many of the elm trees were planted in rows along city streets and parks, the fungus easily spread from tree to tree through root grafts and feeding activities of the beetle.

Because of the diversity of plant health problems and causal factors, it is important to learn to recognize them, understand what causes them, and why and when they occur. It is also helpful to understand their importance or relative impact. This information is helpful in order to prevent the problems from occurring or when they do occur, to properly manage them.

What is Disease?

Plant disease can be defined in many ways but one of the simplest definitions describes disease as any condition in a plant caused by living and non-living agents that interferes with its normal growth and development. Diseases or plant health problems can impact plants in many ways since all parts of a plant can be affected including flowers, leaves, fruits, seeds, stems, branches, growing tips, and roots.

Many different factors can cause plant health problems. These factors can be divided into two groups based on whether they are living or non-living. Non-living disease agents, often called abiotic agents, include factors such as environmental stress or cultural care. Living disease agents, called biotic agents or plant pathogens, include microorganisms such as fungi and bacteria. Both abiotic and biotic agents will be described in greater detail in the section "Types of Disease Agents."

How Does Disease Occur?

In order for disease to occur, three factors must be present. Because of this, disease is often pictured as a triangle having three equal sides. Each side of the triangle is necessary in order for disease to occur. One side of the triangle represents the host plant, the second side represents the causal agent or factor, and the third side represents the environmental conditions that are necessary in order for the other two sides to interact (Figure 1). When one or more sides of the triangle are missing, the triangle collapses and disease will not occur (Figure 2). For example, scab of crabapple is a very common disease in the Connecticut landscape. The "disease triangle" for this disease consists of the host plant, a susceptible variety of crabapple, the causal factor, the fungus *Venturia inaequalis*, and the proper environment, typically a cool, wet spring during which the young, emerging leaves stay wet for extended periods of time. When all three of these factors are present, scab will develop. If one component is missing, perhaps the spring weather is hot and dry and not favorable for disease development, disease will not occur since one side of the triangle is not present and the triangle collapses.

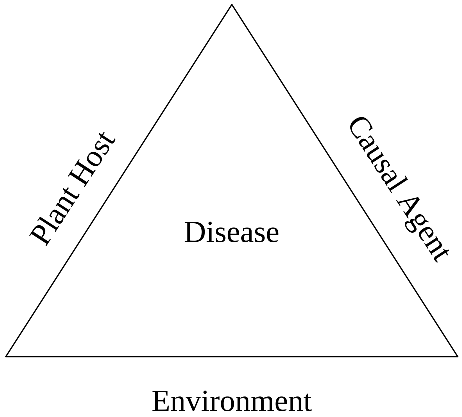

Figure 1. The Disease Triangle: All components are present and disease occurs.

Plant Host

Environment

Figure 2. The Disease Triangle: One of the components is missing (Causal Agent) so disease does not occur.

Types of Disease Agents

As previously mentioned, the two main categories of agents capable of causing plant disease are abiotic and biotic, non-living and living factors, respectively. In natural settings, it is not uncommon for plants to be affected by both abiotic and biotic problems and it is often difficult to determine which came first. However, in many cases, plants which are initially stressed by abiotic factors will be weakened and therefore predisposed to biotic problems. For example, rhododendrons whose roots have been weakened by drought stress are more susceptible to the fungal root rot caused by *Armillaria* than their healthy counterparts.

Biotic Agents

Unlike abiotic agents, biotic agents are able to spread from plant to plant. This is an important attribute since the number of diseased plants can increase over time as a direct result of the growth, multiplication, and movement of the causal agent.

Fungi

The majority of plant diseases are caused by fungi. There are well over 100,000 different species of fungi and only a surprisingly small portion of them are capable of causing plant diseases. Fungi are similar to plants but lack chlorophyll and the conductive or vascular tissues that are found in ferns and seed plants. Fungi are small, usually microscopic, organisms that consist of a mass of filaments or threadlike strands called hyphae. The primary means of reproduction and spread of fungi are by spores. Many fungi produce more than one type of spore during their life span and this often influences how diseases are spread.

The primary ways that fungi infect plants is through direct penetration of tissues although they also infect through natural openings such as stomates, hydathodes, and lenticels or through wounds. In most cases, fungi require free water on plant surfaces in order to infect. Because of this environmental criterion, fungal diseases are frequently more common after periods of wet weather or when overhead irrigation is used. Fungi are primarily spread by wind, splashing water (from rain or irrigation), insects, and through cultural practices (e.g., on pruning shears, on pots, or in contaminated soil).

Bacteria

Bacteria are very different than fungi and are single-celled microorganisms that do not have an organized nucleus. As with fungi, only a small percentage of bacteria found in nature are capable of invading living plants and causing plant disease. Bacteria have cell walls and most plant pathogenic bacteria are rod-shaped. Bacteria reproduce primarily by cell division. This can occur in a short period of time and their initial presence or growth within a plant is usually not visible.

Unlike fungi, bacteria cannot invade plant tissues that are intact and healthy. As a consequence, most infections occur through wounds. Bacteria also infect through wounds made by insects during their feeding activities and through natural openings in a plant such as nectaries or stomates. Bacteria are spread from plant to plant by splashing water (from rain or irrigation), by insects, and through a variety of cultural practices (e.g., as contaminants on pruning shears, in plant or soil debris in pots). Bacteria can also be transmitted by seeds from infected plants.

Phytoplasmas

Phytoplasmas are a relatively new type of disease agent which are closely related to bacteria but they lack a rigid cell wall. These organisms used to be called mycoplasma-like organisms or MLO's. As with bacteria, phytoplasmas have no organized nucleus and are microscopic and unicellular. They can be irregular and amoeba-like or spiral in shape. Phytoplasmas are tissue-specific and only live in the phloem or the nutrient-transport system of their plant hosts. Most phytoplasmas are incapable of living outside of their plant host or insect vectors.

Since phytoplasmas can't survive as free-living microorganisms, they are incapable of infecting plants without "outside" assistance, through insect vectors or mechanical means of transmission. As a consequence, the primary way that phytoplasmas are spread is through the activities of phloem-feeding insects such as leafhoppers. Phytoplasmas can also be spread mechanically by grafting infected plant parts onto healthy plants.

Viruses and Viroids

Viruses are unique plant pathogens since they consist of nucleic acid and a protein coat and have no cellular structures. Additionally, viruses are unable to replicate or reproduce without the aid of the components of the plant host cell. Viroids are even more simplistic than viruses since they lack a protein coat and only consist of nucleic acid.

Because of the nature of these disease agents, wounds are necessary in order for viruses and viroids to infect. Therefore, the primary means of spread is through the feeding activities of a number of insects, predominantly aphids, whiteflies, and leaf hoppers. Viruses can also be spread by nematodes and in infected pollen. Human activities are also very important for spread of these disease agents. Included among these are grafting and mechanical transmission associated with the handling of infected plant material.

Nematodes

Nematodes are tiny, translucent roundworms, oftentimes just barely visible to the naked eye. As with fungi and bacteria, only a small portion of nematodes found in nature are parasitic to plants. Most nematodes have three life stages: egg, larva, and adult. The latter two stages are most damaging to plants. Plant parasitic nematodes are obligate pathogens and have developed specialized structures called stylets that allows them to pierce plant cells and extract cell contents.

Nematodes can infect plants through direct penetration. This usually occurs at the tip of a root. They also infect through wounds, through natural openings, and through the activities of vectors such as some insects. Nematodes are also spread by infected plant material and by contaminated soil and plant debris.

Abiotic Agents

Plant health problems attributed to abiotic agents can also be referred to as disorders rather than diseases. Both terms are used to describe the same types of abnormalities in a plant although disorder usually implies the causal factor is non-living whereas disease usually implies the causal factor is a living agent. Abiotic disease agents can be categorized as being cultural or environmental. These types of agents are often overlooked as probable causes of plant health problems because they are very difficult to identify since they cannot be cultured or viewed microscopically. As a consequence, the ability to pinpoint the causal factor requires close review and examination of the cultural and environmental history of the plant in question.

Environmental Factors

Many types of environmental factors cause plant diseases. Among these are unusual precipitation patterns resulting in drought or water-logged soils, limited snow cover, excessive winds, lightning, hail, late spring or early autumn frosts, and extreme temperature fluctuations, especially during the winter. Air pollution is another important factor. Among the pollutants encountered in Connecticut are ozone, hydrogen fluoride, sulfur dioxide, ethylene, and peroxyacyl nitrate. Some of these compounds are more problematic in glasshouses and others primarily occur outdoors.

Environmental disease agents result in a wide variety of symptoms. For example, drought or dry soil conditions result in root damage and death. Non-woody feeder roots, usually located in the top 15 inches of soil, are particularly sensitive and are the first ones affected. Without moisture, these roots shrivel and die. When these roots become nonfunctional, a water deficit develops since the roots cannot provide water to the top of the plant. Symptoms of drought vary with the plant species and the severity of the water deficit but are often not evident until some time after the event has occurred- even as much as one or two years later! Symptoms include loss of turgor in needles and leaves, drooping, wilting, yellowing, premature leaf or needle drop, bark cracks, and twig and branch dieback. Leaves on deciduous trees often develop marginal scorch and interveinal necrosis whereas needles on evergreens turn brown. Drought-stressed trees and shrubs can also exhibit general thinning of the canopy, poor growth, and stunting. In extreme cases, drought can result in plant death.

Cultural Factors

Cultural factors associated with plant health problems are quite diverse. Among the common factors are site and soil attributes (e.g., pH, organic matter, drainage, soil type), planting practices (e.g., preparation of the rootball and planting hole, planting too deep or to shallow), plant hardiness, construction activities resulting in soil compaction or severing of roots, and mechanical injuries from lawn mowers and string trimmers. Other types of problems result from incorrect or improperly timed pruning, incorrect mulching, fertilizing practices (e.g., incorrect timing, inappropriate applications resulting in toxicities or deficiencies), and watering practices (e.g., time of day, too much or too little, frequent, shallow watering).

Another type of cultural agent that can result in plant damage and death involves chemicals. Included in this category are deicing salts and misapplied pesticides, particularly herbicides. For example, when misapplied, herbicides can result in damage which varies with the particular compound and plant species. Symptoms can develop several days to weeks after exposure or in some cases, not until the following spring. Symptoms include chlorosis, necrotic spotting, marginal scorch, twisting, growth abnormalities, leaf/needle drop, dieback, general decline, and plant death.

As with environmental factors, cultural factors can affect plant health in many ways and result in a wide range of symptoms. For example, when mulches are applied too close to the base of a plant and too thick, they can result in root and crown rots and asphyxiation of roots, respectively. This can cause plant decline and death.

For more detailed information on many of these abiotic disease agents, please refer to Fact Sheets available upon request or on the CAES website (www.ct.gov/caes).

Types of Plant Health Problems

A significant factor which influences the ability to manage plant health problems lies with the ability to recognize a problem when it occurs. One of the most important ways to identify a problem is by the symptoms that are produced by the affected plant. A symptom is defined as the response of the plant to the presence of a disease agent, regardless of whether it is non-living or living, abiotic or biotic. Symptoms are the external and internal reactions of a plant as a result of disease. The presence of a symptom on a plant distinguishes the diseased plant from its healthy counterparts. Plants can exhibit a variety of symptoms, some of which are associated with a specific causal factor, but more commonly, can be associated with many different factors. Symptoms can also occur on many different parts of a plant. Additionally, it is not uncommon for a diseased plant to exhibit more than one type of symptom. For example, the initial symptoms of Septoria leaf spot of tomato appear as distinct spots approximately ¼ inch in diameter with dark margins and tan centers. These spots are usually scattered over the surface of the leaf. However, as the disease spreads, the leaves quickly develop a blighted appearance as the leaves turn completely brown and shrivel.

Some of the common symptoms that we encounter on diseased plants are listed and defined in this section. These terms provide the vocabulary or terminology to describe what we see when a plant does not appear healthy or normal.

Common Symptoms of Plant Disease:

Leaf spot- dead, discolored or injured areas of tissue which usually have distinct margins; spots often appear on leaves or fruit

Blight- rapid yellowing, browning, collapse, and death of leaves, shoots, stems, flowers, or the entire plant

Chlorosis- yellowing of leaves and stems which are normally green

Necrosis- browning or blackening of areas on a plant indicative of the death of plant cells

Wilt- loss of turgor or drooping of leaves, shoots, or the entire plant due to lack of water

Distortion- twisting or other abnormal traits of leaves, stems, and shoots

Mosaic- uneven pattern of yellow, light green or dark green, usually on leaves

Canker- dead area on a stem or branch; can be sunken, swollen, or discolored and are usually distinguished from adjacent healthy tissues by color
Rot- breakdown and decay of plant tissue, often used to describe conditions in roots and fruit
Dieback- death of the tips of leaves, shoots, and stems; failure of branches to develop, especially in the spring
Witches' broom- abnormal proliferation of shoots from the same point on a plant resulting in a bushy, broom-like appearance
Gall- a swelling or abnormal growth of plant tissues; can develop on leaves, stems, and roots
Stunt- abnormally small sized plant parts due to the failure of those plant parts to grow to full size; often used to describe an entire plant

Strategies for Managing Plant Health Problems

Regardless of the plant host or particular type of disease that you encounter, the concepts of disease prevention and management are fundamentally the same. Management of plant diseases involves a two step process that first requires accurate diagnosis and assessment of the severity of the problem. This is followed by implementing strategies to minimize the impact of the disease.

1. Disease Diagnosis:
The first step in disease management is knowing what you're trying to control- is it a disease caused by a fungus or is it associated with the weather, the site, or your cultural care? Accurate diagnosis is very important since it determines two things: the need for control and the type of control. Some plant diseases are merely aesthetic and under normal circumstances don't require control measures. On the other hand, there are diseases which can be fatal if left uncontrolled. For example, tar spot of maple is usually not serious enough to require control measures even though it can result in premature defoliation. In contrast, Phytophthora root rot of zucchini is a disease which interferes with water-uptake and can seriously debilitate and eventually kill the plant if left unchecked.

Another part of diagnosis involves assessing the severity of the problem. This assessment is made by gathering information about the nature of the problem: is it a foliar or a root problem, is it localized to one part of the plant or is it systemic? It is also helpful to determine the level of the disease: how many plants are involved or how long have they been symptomatic?

Disease diagnosis based solely on symptoms can sometimes be misleading and can lead to improper, ineffective controls. In circumstances where different causal agents incite the same or similar symptoms on a host plant, accurate diagnosis requires identification of the causal agent. Since most biotic agents are microscopic, accurate identification is not possible without the necessary equipment. In these cases, samples may be submitted to the Plant Disease Information Office of the Experiment Station for diagnosis. Diagnosis can involve light microscopy and histochemical staining, isolation on artificial media, soil extraction, electron microscopy, studies of host range, and indicator plants. The office also utilizes serological tests and a variety of other procedures as necessary. Information about the Plant Disease Information Office and about how to prepare and submit samples can be obtained by calling the Office or can be found on the CAES website.

2. Management Options:

A common misconception to disease control is that chemical sprays, dusts, and soil drenches are the only effective means of reducing the effects of plant disease. However, chemical control is only one component of a multifaceted approach which includes: culture, sanitation, resistance, biological, and chemical components.

It is important to realize that the goal of disease management is not necessarily to completely eliminate diseases but to manage them such that they remain at acceptable levels. Additionally, in most cases, **prevention** is the best strategy for disease control.

Culture: A key opportunity for disease management focuses attention to cultural manipulations which help to minimize conditions favorable for disease development. These include numerous methods that modify the plant's growing conditions in order to optimize growth and vigor.

a. Plant and Site Selection
Hardiness- often an overlooked aspect of disease prevention; most of Connecticut is in USDA Zone 6 (some Zone 5); this is an important factor for consideration when trying new species
Plant Requirements vs. Site Characteristics-- it is important to match the conditions required by a particular plant with the attributes of the intended site as closely as possible; special attention should be given to soil type and pH, drainage, and light levels

b. Planting Practices
Spacing- use the correct spacing for the particular plant species; too-close spacing can promote disease by compromising plant vigor and by inhibiting drying and air circulation
Planting- dig and prepare the planting hole correctly, making sure the plant is not planted too deep or too shallow
Rootball preparation- for balled and burlapped stock, the burlap and wire basket should be removed, if possible; for container-grown stock, the rootball should be scored and teased apart before planting—this applies to both woody and herbaceous material
Crop rotation- it is helpful to purposefully alternate the crop species or closely related plants grown in a specific area, especially when the disease agent is soilborne

c. Plant care
Fertilizing- appropriately timed applications to maximize plant growth and vigor and to avoid plant stress due to deficiencies or toxicities
Watering- maintain adequate soil moisture for the plant species; this usually translates to approximately one inch of water per week; in the absence of natural rainfall, irrigation should be used and depending upon soil type, this is best delivered as a deep soaking; avoid overhead irrigation or water plants early in the day to allow foliage to dry before nighttime
Mulching (summer mulch)- properly applied mulch helps with weed control, soil temperature moderation, soil moisture retention, and spread of disease; summer mulches should not be applied too thick or too close to the stem or crowns of plants
Winter Protection- winter mulches, physical barriers, and applications of anti-transpirants or anti-desiccants can be effective in protecting plants from heaving during freeze-thaw cycles and from drying winds.

An example of cultural manipulations that help to reduce disease can be illustrated for winter injury and desiccation of rhododendron, a common problem in Connecticut. Rhododendrons are more prone to this type of injury as well as to fungal leaf spots when they are not properly maintained or when stressed by root injury from drought. These problems can be minimized by maintaining an acidic soil pH, fertilizing in early spring, and watering during periods of drought and just before the ground freezes in the fall.

Sanitation: This option for disease management focuses on minimizing the introduction of disease agents through plant selection and by eradication of diseased plants or plant parts as a means to reduce the potential for spread of biotic agents.
Plant Selection- use of healthy, disease-free seeds, seedlings, cuttings, and transplants;
Prune and Remove Infected Plants and Debris- symptomatic plants or infected plant parts should be promptly removed to minimize disease spread; it is also helpful to remove the debris of annual plants and to cut back the tops of perennials after they have been killed by frost at the end of each growing season; this practice helps to reduce the amount of overwintering inoculum;
Groom Plants- remove spent flowers and leaf debris during the growing season to minimize inoculum buildup and spread;
Use Clean Equipment- all pruning tools, pots, flats, and equipment should be thoroughly cleaned and disinfested with 10% household bleach (1 part bleach: 9 parts water), 70% alcohol, or a commercial compound such as Greenshield ®;
Scout- check plants on a regular schedule in order to monitor for buildup of diseases and plant abnormalities.
An example of sanitation as an essential component for disease control can be illustrated for Brown Rot, a common and destructive fungal disease of stone fruits in Connecticut. This involves removing and destroying mummied fruit on the ground or remaining on a tree and pruning and removing dead and/or cankered twigs. These practices significantly help to reduce the amount of overwintering inoculum which will be available to infect the newly emerging tissues in the spring.

Resistance: This management option utilizes resistant or tolerant cultivars or species of plants to minimize or avoid disease. When available, genetic resistance is probably the most desirable and effective management tool since it circumvents the need for additional controls. It is especially important for diseases caused by viruses, nematodes, and by soilborne and wilt pathogens since these are all extremely difficult to control with other means. Although genetically resistant plants are not available for all plant and all diseases, breeding programs are underway and the availability of these types of plants is expected to increase in the near future.

Examples of effective use of genetic resistance include cultivars of crabapple with resistance to scab and rust, cultivars of rose with resistance to powdery mildew and black spot, and cultivars of tomato with resistance to Verticillium and Fusarium wilts, tobacco mosaic virus, and nematodes.

Biological: This management tool employs living agents (usually antagonists or competitors of the causal agent) to control plant diseases. Effective biological controls take advantage of the natural competition of living organisms for limited resources or ecological niches. Thus, two organisms cannot occupy the same space at the same time, they cannot consume the same resource (e.g., food source) at the same time, and in some cases, one organism produces compounds that are inhibitory to the growth and development of the other organism. The availability of biological controls is somewhat limited at present although this option for disease management shows considerable promise for the future.

An example of biological control is the introduction of hypovirulent ("less" virulent) strains of the chestnut blight fungus. These strains compete with virulent strains and keep them from causing killing cankers on infected trees. More detailed information on this topic can be found in numerous Fact Sheets about chestnut blight on the CAES website. Several commercial biological control agents have recently become available and are registered for control of some root rot and foliar diseases. Since these products contain living organisms, the directions for storage and use of these products are different than those for conventional pesticides. Thus, careful attention to the label particularly important.

Chemical (Pesticides): Although it is possible to successfully manage many disease problems without the use of pesticides, there are situations where pesticide usage is important and highly successful. Chemical disease control uses pesticides (fungicides, bacteriocides, and nematicides) to limit the effects of biotic agents. Fungicides are the most common chemicals used for disease control. In most cases, however, the degree of control depends upon the proper selection, timing, and method of application of the compound. In this regard, selection of the appropriate fungicide is contingent upon accurate diagnosis of the problem since fungicides vary in their efficacy; some fungicides are toxic to all or most kinds of fungi whereas others affect only specific types of fungi. Another way of looking at pesticides is as "plant medicines", these are compounds used to protect or cure plants from infectious agents.

Categories of Pesticides:

"Biorational" pesticides: these pesticides are defined as products that are considered to be environmentally friendly because they have minimal harmful effects on non-target organisms and the environment; they are frequently more "user friendly" than traditional pesticides; examples include neem oil, insecticidal soap, horticultural oil, and potassium bicarbonate.

Biological pesticides: these pesticides are living agents which are used to control specific pathogens which are also living organisms; the control agents can be antagonists (e.g., they secrete compounds or their by-products alter the environment and make it unfavorable for the growth of the pathogen) or competitors (e.g., they occupy the same niche or site or compete for the same food source) of the causal agent; examples include *Ampelomyces quisqualis* and *Trichoderma harzianum*.

"Chemical" pesticides: these are considered "traditional" pesticides with traditional modes of action; examples include strobilurins, sterol inhibitors, benzimidazoles, coppers, and sulfurs.

Protectant *vs.* Systemic Fungicides: Most fungicides are protectants and must be present on the surface of the plant in advance of the causal agent in order to prevent infection. Their primary mode of action is to inhibit fungus spores from germinating or to kill spores after they germinate. These compounds do not stop or cure a disease after it has started since they are not absorbed or translocated within the plant. On the other hand, systemic fungicides are absorbed through the foliage or roots and are translocated within the plant. These compounds have a therapeutic (curative) or "kickback" mode of action since they can kill or inhibit growth of pathogens after they have invaded the plant host.

Trade Name *vs.* Common Name: The common name of a pesticide is the name assigned to the active ingredient of the pesticide. In contrast, the trade name of a pesticide is the name assigned by the manufacturer or distributor of a particular product. For example, chlorothalonil is the common name of a fungicide which is sold by the trade names Daconil®, Bravo®, and Ortho Multipurpose Garden Fungicide®. Therefore, a single common name or active ingredient may be available under many different trade names.

When using pesticides for disease control, it is **very important** to thoroughly read and comply with the label. This applies to information on host plant, dosage rates, safety precautions, and days to harvest intervals, when applicable.

An example of effective fungicide applications can be illustrated for control of apple scab, the most troublesome disease of apples in Connecticut every year. For this disease, the fungus has two distinct cycles of infection- if the pathogen is essentially controlled with properly selected and timed fungicides during the first cycle of infection in the spring, the second cycle does not occur and fungicide sprays are unnecessary for the remainder of the season.

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