4. E7 Plant Diseases and Disorders

L. Pink snow mold (winter), R. Fusarium patch early fall

Plant Diseases and Disorders

Introduction

- **Plant disease or disorder** a harmful change in the growth or function of a plant.

- **Abiotic** non-living causes unfavorable growing conditions and poor cultural practices, e.g. temperature extremes, improper fertilization or watering or injury from machines or chemicals.

Plant Diseases and Disorders

Introduction

Plant disease or disorder a harmful change in the growth or function of a plant.

Causes of plant diseases and disorders

- **Abiotic** non-living causes.
- **Biotic** caused by plant pathogens, such as fungi, bacteria, viruses, nematodes and phytoplasmas.

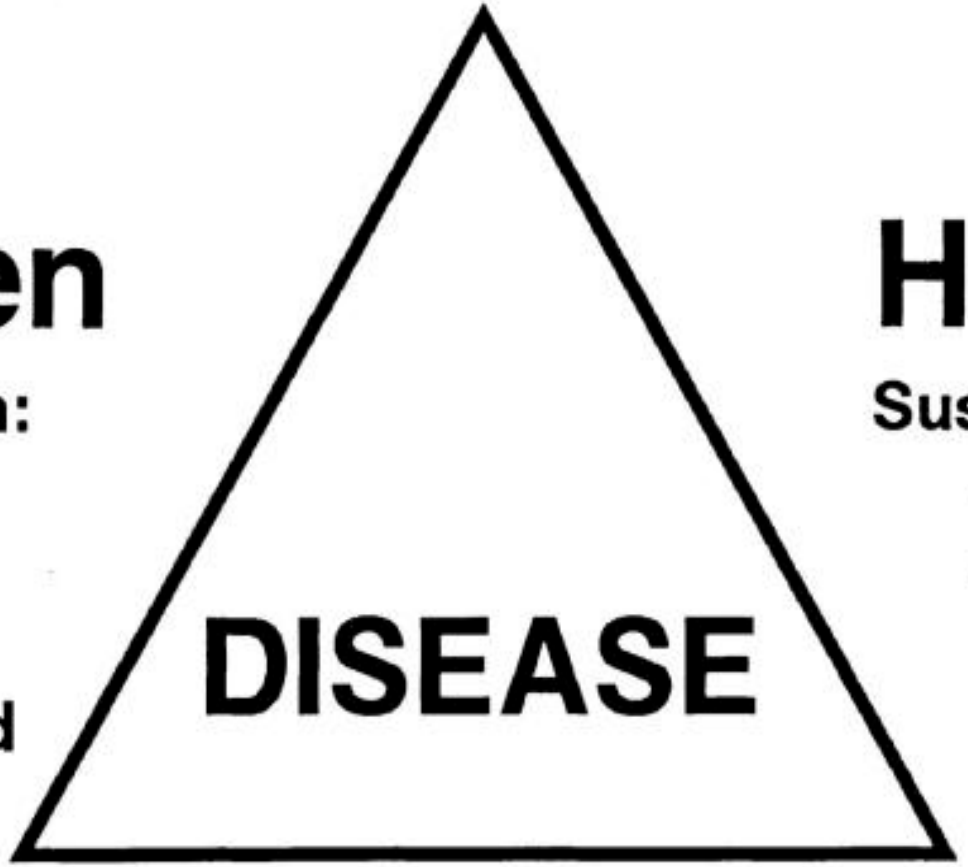
Plant Diseases and Disorders

The Plant Disease Triangle Conceptual Model

A plant disease will not develop without a

- **Susceptible host**
- **Virulent pathogen**
- **Favorable environment**
- **All three are required**

Plant Disease Triangle



Pathogen

Virulent pathogen:
Fungi, Bacteria,
Viruses,
Nematodes,
Mycoplasmas and
Spiroplasmas

Host

Susceptible
-crop
-cultivar

Favorable Environment

Air temperature
Soil temperature

Soil fertility
Soil type
Soil pH

Rainfall
Relative humidity
Soil moisture

Plant Diseases and Disorders

Plant Disease Triangle Pathogen

- For a disease to develop a plant pathogen must come into contact with a susceptible plant under the right environmental conditions.
- Plant pathogens disease causing agents; fungi, bacteria, viruses, phytoplasmas, and nematodes.
- Some pathogens are naturally present but others are brought in on infected tools, with infected plants or through environmental factors e.g., rain or wind.

Plant Diseases and Disorders

Plant Disease Triangle

To prevent disease one or more of the sides of the triangle can be modified.

- **Fungicides can be applied to prevent fungal infections.**

- **Cultural practices can be changed to improve environmental conditions.**

Plant Diseases and Disorders

The Plant Disease Concepts

- **Plant disease** reduced or abnormal growth or development of a plant caused by plant pathogens.

- **Plant disorder** reduced or abnormal development caused by abiotic, non-living factors such as unfavorable growing conditions, air pollutants, wind water and temperature.

Plant Diseases and Disorders

The Plant Disease Concepts

- **Host** a plant that supplies food and favorable living conditions for a parasite.

- **Symptom** Host plant response or alteration of appearance due to a pest or problem e.g., galls, stunting leaf spots and tissue death.

Plant Diseases and Disorders

Plant Disease Triangle

Susceptible Host Plants

Pathogen host range **the group of plants that can be infected by the pathogen. Host ranges can be broad or very narrow e.g. Rhizosphaera Needle Cast, *Rhizosphaera kalkhofii* the most common spruce disease in MN especially Colorado blue spruce.**

Short Summary

A plant disease will not develop unless there are a virulent pathogen, a susceptible host, and favorable environmental conditions.

Plant pathogens are disease causing agents fungi, bacteria, viruses, phytoplasmas, and nematodes.

The host range of a pathogen is the group of plants that can be infected by the pathogen.

Quick Questions

What is a virulent pathogen?

A pathogen capable of infecting a susceptible host plant.

What is a plant disease symptom?

A symptom is a host plant response or alteration of appearance due to a pest or problem

Plant Diseases and Disorders

Plant Disease Triangle

Susceptible Host Plants

- Plants outside the pathogen's host range are immune to the disease.

- Knowing a pathogen's host range will help diagnose and manage plant disease problems.

Plant Diseases and Disorders

Plant Disease Triangle

Susceptible Host Plants

Some pathogens can only cause disease in stressed plants but many more can cause disease in vigorously growing host plants.

Plant Diseases and Disorders

Plant Disease Triangle

Some pathogens can only cause disease in stressed plants but many more can cause disease in vigorously growing host plants

Stressors include

- **Drought**
- **Mowing too short**
- **Excess fertilizer**
- **Poor planting practices**
- **Cool temps**
- **Low light**
- **Poor air circulation**

Plant Diseases and Disorders

Plant Disease Triangle

Environmental Conditions

Pathogen development is influenced by

- **Light**
- **Temperature**
- **Moisture is needed for reproduction, spread, germination, and infection of many disease-causing fungi. Wet weather keeps moisture on turf blades longer than dry weather, increasing the probability of disease.**

Plant Diseases and Disorders

Plant Disease Triangle

Environmental factors

- Pink snow mold fungi are active in cold weather.

- The same fungi causes fall *Fusarium* patch.

Plant Diseases and Disorders

Plant Disease Triangle

Environmental factors

Indoor ornamentals are often infected with powdery mildew in conditions of low light, poor air circulation and cooler temps because reproduction of the pathogen is favored by these conditions.

Plant Diseases and Disorders

Disease Causes

Pathogen	Biology
Fungi	Grow in filaments, reproduce by spores
Bacteria	Single cell microbes, reproduce by division
Viruses	Tiny, genetic material surrounded by protein coat
Phytoplasmas	Very small bacteria w/o cell wall
Nematodes	Tiny non segmented round worms

Plant Diseases and Disorders

Pathogen Causal Agents Fungi

- Fungi are the most common cause of plant diseases. They are in the Fungi plant kingdom of over 300,000 species.

- There are more diseases caused by fungi than all other types of pathogens combined.

- Fungi include molds, mildews, rusts , yeasts and mushrooms.

Plant Diseases and Disorders

Pathogen Causal Agents Fungi

- **Fungi grow in filaments and reproduce by spores. Fungi are incapable of producing their own food.**

- **Fungal spores can spread by wind, water, lawn equipment, and infected grass clippings.**

Plant Diseases and Disorders

Pathogen Causal Agents

Fungi

- A few fungal pathogens can affect multiple plant parts but many affect specific plant parts.
- Symptoms of fungal infections vary depending on the type of plant and the plant part

Leaf anthracnose on maple leaf.

Short Summary

Fungi are the most common cause of plant diseases

There are more diseases caused by fungi than all other types of pathogens combined.

Some pathogens can only cause disease in stressed plants but many more can cause disease in vigorously growing host plants.

Quick Questions

What pathogen is active in cold weather?

Pink snow mold

How do fungal spores spread?

Fungal spores can spread by wind, water, lawn equipment, and infected grass clippings.

Can fungi produce their own food?

No

Plant Diseases and Disorders

Pathogen Causal Agents

Bacteria

- **Bacteria** single-celled microbes that reproduce by dividing.
- Bacteria infect plants at wound sites or at natural, openings i.e., stomata.
- There are hundreds of bacterial plant diseases including fire blight crabapples, crown gall, and bacterial leaf spot

Bacterial Fire Blight on Mountain Ash

Plant Diseases and Disorders

Pathogen Causal Agents

Viruses

- Viruses are not visible with a light microscope.

- Viruses are comprised of genetic material surrounded by a protein coating. Viruses can multiply only in living tissues (a living host) and cause many plant and animal diseases

Hosta Virus X

Plant Diseases and Disorders

Pathogen Causal Agents

Viruses

Once a plant is infected by a virus it cannot be cured. Plant removal is often recommended for plants infected by viruses.

Plant Diseases and Disorders

Pathogen Causal Agents

Viruses

- Plant disease **vector** an animal e.g., insect, nematode, mite or plant e.g., parasitic dodder that can carry and transmit a pathogen from one plant to another.
- Many sap sucking insects can vector diseases e.g., aphids and thrips.
- Viruses can also be vectored on garden tools like pruners and survive in perennials, insects, nematodes, or in seeds.

Plant Diseases and Disorders

Pathogen Causal Agents

Phytoplasmas

- **Phytoplasmas** small bacteria that lack a cell wall and can cause plant diseases.
- Most phytoplasmas are vectored by leaf hoppers or psyllids

Aster yellows phytoplasma on Cosmos.

Plant Diseases and Disorders

Pathogen causal agents

Phytoplasmas

- Diseased plant symptoms may include: yellowing of leaves, reduced leaf size, stunting, or growth of auxiliary buds ‘witches brooms.’

- Once infected, plants with phytoplasmas cannot be cured. Infected plants should be disposed of.

Plant Diseases and Disorders

Pathogen Causal Agents. Nematodes

- **Nematodes** microscopic, non-segmented round worms that either feed on living organisms or non-living organic matter.
- Most nematodes live in soil or underground plant parts but there are some foliar nematodes that live above-ground.
- Seed gall nematodes form galls.
- Symptoms of root feeding nematodes may include wilting, stunting, yellowing and symptoms of nutrient deficiency.

Plant Diseases and Disorders

Pathogen Causal Agents Nematodes

- There are some sprays to control foliar nematodes.
- Nematodes are transferred through insect vectors, machinery, boots, plant propagative parts, and water or movement through water films.
- Foliar nematode infestation results in a wedge-shaped area of discolored cells between leaf veins.

Plant Diseases and Disorders

Abiotic Disorder

- Not all problems are caused by pathogens
- Most abiotic plant problems are preventable with proper knowledge and good cultural and management practices.
- Plants stressed by abiotic events are more prone to secondary problems from insects and disease.

Plant Diseases and Disorders

Table 7.1 Potential Causes of Abiotic Plant Problems

Cultural	Mechanical	Chemical	Weather	Site and plant conditions	Construction damage
Improper planting depth	Girdling due to ropes, wires, vines	Excess fertilizer	Flooding	Transplant shock	Exposed roots
Over-mulching	Damage from mowers, string trimmers, and other equipment	Road salt and other deicers	Drought and heat injury	Sun exposure	Compaction
Poor soil drainage		Herbicide phytotoxicity	Frost and freeze injury	Moisture conditions	Mechanical damage
Soil com-paction		Improper pesticide application	Winter injury	Soil nutrients or pH	
Cultivat-ing too close			Wind or hail damage	Root girdling	
Improper pruning			High/low temperatures	Improper site	

Source: Adapted from Michigan State University Ornamental Pest Management manual (draft manual)

Category E Turf and Ornamentals Pesticide Safety Education Manual

Short Summary

Once a plant is infected by a virus it cannot be cured. Plant removal is often recommended for plants infected by viruses.

Most abiotic plant problems are preventable with proper knowledge and good cultural and management practices.

Plants stressed by abiotic events are more prone to secondary problems from insects and disease.

Quick Questions

What is the first step in treating a plant disease?

Identifying the disease

What are nematodes?

Nematodes are microscopic, un-segmented round worms that either feed on living organisms or non-living organic matter.

What are plant disease vectors?

An animal e.g., insect, nematode, mite or plant e.g., parasitic dodder that can transmit a pathogen.

Plant Diseases and Disorders

Diagnosing Plant Diseases and Disorders

- The first step in properly treating a plant disease or abiotic disorder is to identify the cause.
- Several plant health problems can cause similar symptoms.
- The UofM Extension website is an excellent source of information and the Plant Disease Clinic is available to diagnose problems.

Plant Diseases and Disorders

Action Thresholds

- Management actions such as the use of pesticides may be taken if the cost to control the disease or disorder is less than the potential economic loss.
- The potential cost financial, environmental, or other, of managing the disease must be considered relative to the expected benefits of managing the disease or disorder.
- The threshold is the point at which there is economic, aesthetic, or environmental harm.
- Tolerance of the potential harm disease or disorder will differ

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

- IPM strategies include doing nothing, cultural control and sanitation, biological control, chemical control, and genetic control (use of resistant varieties).
- Many of the diseases or abiotic disorders will not kill the plant but can seriously weaken the plant, reduce growth, reduce flowering , increase winter injury, increase susceptibility to secondary pests or other effects

Plant Diseases and Disorders

Managing Diseases and Disorders

- Management actions such as the use of pesticides may be taken if the cost to control the disease or disorder is less than the potential economic loss.
- The potential cost (financial environmental, or other) of managing the disease must be considered relative to the expected benefits of managing the disease or disorder.
- The threshold is the point at which there is economic, aesthetic, or environmental harm.

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

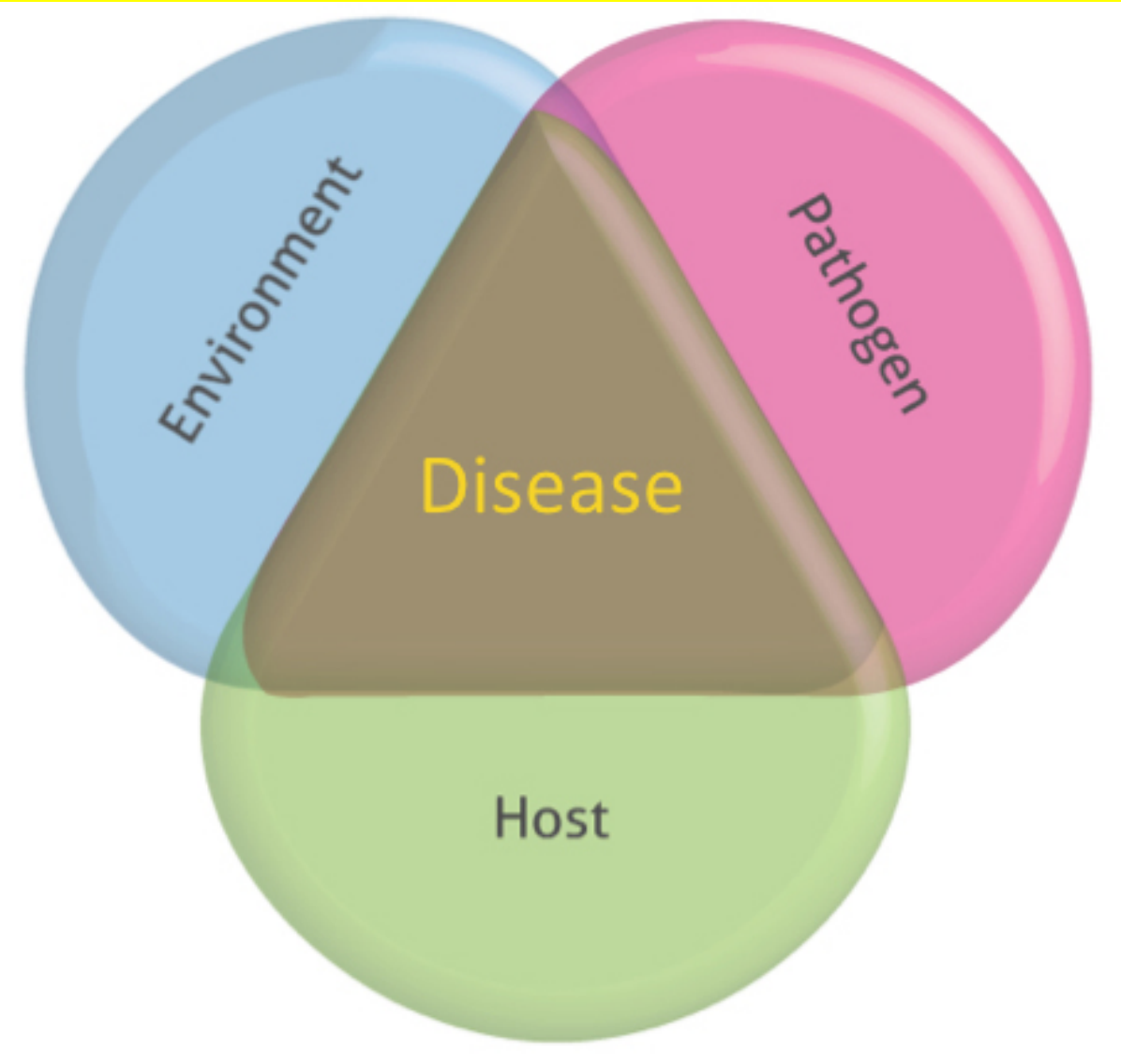
- Resistant varieties
- Cultural control
- Sanitation
- Pesticides

Plant Diseases and Disorders

Managing Plant Diseases and Disorders Resistant Varieties

Resistant plant varieties

- **Have a genetic makeup that enables defense against the pathogen.**
- **Will not become infected or will have a lower levels of disease even if the pathogen is present**



Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Resistant Varieties.

- When possible chose resistant plant varieties.

- ‘Rose Queen’ bee balm is a Monarda cultivar that is resistant to powdery mildew—many other cultivars are not resistant and can become heavily infected.

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Cultural controls to help prevent diseases and disorders

- **Prune to permit sunlight and air circulation.**
- **Proper plant spacing.**
- **Adjust soil pH if necessary.**
- **Avoid excess fertilization.**
- **Protect plants from winter injury.**
- **Minimize stress on plants.**

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Sanitation and eradication refer to removing the pathogen from the site.

- **Eradication** the complete elimination of a pathogen is nearly impossible.

- **Sanitation** the removal of infected plants and plant parts, can reduce the disease problem.

Short Summary

Management actions such as the use of pesticides may be taken if the cost to control the disease or disorder is less than the potential economic loss.

Cultural controls help prevent plant diseases and disorders.

When possible, chose disease-resistant varieties.

Quick Questions

Can plant diseases be eradicated?

The complete elimination of a pathogen is nearly impossible.

What is sanitation?

The removal of infected plants and plant parts, can reduce the disease problem.

What is the threshold?

The point at which there is economic, aesthetic, or environmental harm

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Sanitation and eradication refers to removing the pathogen from the site.

- **Herbaceous plants can be pruned at any time during the growing season to reduce disease but never remove more than 1/3 of the plant's tissue at any one time.**

- **Remove infected branches from woody ornamentals during the dormant season esp. February thru March.**

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Sanitation and eradication refers to removing the pathogen from the site.

- **Removal of infected branches from woody ornamentals during the growing season risks a wound introducing a different pathogen.**

- **Disinfect tools with a 10% solution of a registered pesticide bleach. Pathogens can survive on tools, trellises, pots, and stakes.**

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Sanitation

Black knot is a fungal disease of cherry and other Prunus species. The disease can be managed by pruning out the infected branches

Black knot on plum

Plant Diseases and Disorders

Managing Plant Diseases and Disorders.

Chemical Pesticides.

- **Pesticides** are applied to a plant to prevent, suppress, or kill a pest or prevent a pest from doing damage.
- **Most fungicides are preventative** and protective but few are curative. Fungicides are primarily used to protect tissues from fungal pathogens. Some fungicides have **'kick back action'** that can kill recently formed infections.

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Chemical Pesticides

- A limited number of **bactericides** are available to manage bacteria.
- **Nematicides** are used to kill nematodes.
- Chemical controls are not available for viral pathogens or phytoplasmas.

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Chemical Pesticides.

- Apple scab is a common disease of ornamental trees and shrubs.

- Fungicides can be effective when applied early in the spring but are ineffective in mid-summer after leaf spots have appeared.

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Biocontrol Biopesticides

- *Biological control* is the use of beneficial organisms to control pathogens.

- Foliar sprays made from the biopesticide *Bacillus subtilis* can be used against powdery mildew, leaf spot, downy mildew, and anthracnose.

Plant Diseases and Disorders

Managing Plant Diseases and Disorders

Biocontrol Biopesticides.

Biological control organisms are living and may have special storage and application requirements.

Plant Diseases and Disorders

Table 7.2 Disease Management Strategies

Pathogen/ Plant Disease	Important Biology	Management Strategy
Virus	Virus systemically infects all parts of the plant.	Disease cannot be cured; remove infected plants to prevent spread to healthy neighbors.
Phytoplasma	Phytoplasma infects the plant's vascular system and moves into all plant parts.	Disease cannot be cured; remove infected plants to prevent spread to healthy neighbors.
Fungal or bacterial leaf spot disease	Pathogens are spread from leaf spots to new leaves by splashing water and wind. Disease increases in wet conditions. The pathogen overwinters in infected plant debris.	Replace plants with resistant varieties or spray fungicides to protect healthy leaves. Reduce moisture in the bed by thinning dense perennials, removing weeds, mulching, and using drip irrigation. Remove all infected plant debris from the garden at the end of the growing season.
Branch cankers or galls	The pathogen overwinters in the gall or canker.	Prune out cankers and galls 4-8 inches below visible symptoms in early spring before tree buds have opened.
Vascular wilt (Verticillium wilt)	Fungi live in the soil, infect through roots, and move throughout the plant via the vascular system.	Plant disease-resistant varieties.
Root rots	Fungal pathogen infects roots, causing stunting, wilt, and death of stems and leaves.	Improve drainage and reduce compaction around plants. Consider applying a systemic fungicide as a soil drench.

Source: Michelle Grabowski, University of Minnesota Extension

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Short Summary

Biological control is the use of beneficial organisms to control pathogens.

Chemical controls are not available for viral pathogens or phytoplasmas.

Most fungicides are preventative and protective but few are curative.

Quick Questions

Should infected branches be removed from woody ornamentals during the growing season?

Removal risks a wound introducing a different pathogen

Can fungicides be applied during the entire growing season?

Fungicides can be effective when applied early in the spring but are ineffective in mid-summer after leaf spots have appeared.