## Lesson C10–3:

# Managing Crop Diseases

**Unit C.** Plant and Soil Science

**Problem Area 10.** Integrated Pest Management

**Lesson 3.** Managing Crop Diseases

**Learning Goal:** Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

**Learning Standard:** Know and apply the concepts, principles and processes of scientific inquiry.

**Learning Benchmark:** Report, display and defend the results of investigations to audiences that may include professionals and technical experts.

**Occupational Skill Standard:** Spray a 20-acre row crop field with pesticides. Scout row crop field and record pest and/or cultural disorders on appropriate scout forms.

**Workplace Skills:** Identify work-related terminology. Identify the problem. Identify solutions to a problem and their impact. Evaluate options. Set priorities. Select and implement a solution to a problem.

**Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

1. Define plant disease and identify the conditions necessary for a plant disease to develop.
2. Describe the classification of plant diseases.
3. Explain the scouting, identification, and diagnosis of plant diseases.
4. Explain the control of plant diseases.
5. Identify strategies used in disease management.

## List of Resources.

The following resources may be useful in teaching this lesson:

***Recommended Resources.*** One of the following resources should be selected to accompany the lesson:


Lee, Jasper and Biondo, Ron. *Introduction to Plant and Soil Science & Technology*. Danville, Illinois: Interstate Publishers, Inc. 2003 (Textbook, Chapter 12)

*Field Crop Scouting Manual*. University of Illinois, Urbana, Illinois: University of Illinois: Cooperative Extension Service.

*Corn & Soybean Field Guide*. Purdue University, Lafayette, Indiana: Purdue University. Cooperative Extension Service. 2000

Cooper, Elmer L. and Burton, L. Devere. *Agriscience Fundamentals & Applications*. Albany, New York: Delmar. 2002 (Textbook, Unit 13)

Waldren, Richard P. *Introductory Crop Science*. Edina, Minnesota: Burgess Publishing. 1998 (Chapter 14)


## List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheet
Diseased plants

## Terms.

The following terms are presented in this lesson (shown in bold italics):

Abiotic disease
Bacteria
Biotic disease
Cultural disease control
Disease avoidance
Disease resistance
Disease tolerance
Fungi
Infectious diseases
Localized infection
Nematodes
Noninfectious disease
Pathogen
Plant disease
Plant pathology
Systemic infection

Viruses

**Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

*Display to the students a healthy plant and one that has a disease problem. Ask students to identify differences between the two. Lead a discussion that introduces the lesson.*

# Summary of Content and Teaching Strategies

**Objective 1:** Define plant disease and identify the conditions necessary for a plant disease to develop.

***Anticipated Problem:*** What is a plant disease and what conditions are necessary for it to develop?

I. A ***plant disease*** is a harmful alteration of the normal physiological and biochemical growth of the plant, or as a condition in which a plant differs from a normal (healthy) plant in appearance, structure, or function.

   A. ***Plant pathology*** is the study of plant diseases.

      1. Plant diseases differ from nonparasitic injury in the length of time during which they affect the plant. A disease usually consists of a series of harmful processes that occurs over a fairly long period of time. Injuries are disorders that occur over a short period of time.

      2. Four conditions necessary for a plant disease to develop are: a susceptible host plant, a disease-producing agent, a favorable environment, a time for the disease to develop. If any one of these conditions is not met, a disease will probably not occur.

*Use TM: C10–3A and C10–3B as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 14 in Introduction to Plant and Soil Science & Technology and Unit 13 in Agriscience Fundamentals & Applications are recommended.*

**Objective 2:** Describe the classification of plant diseases.

***Anticipated Problem:*** How are plant diseases classified?

II. Plant diseases can be divided into two broad categories.

   A. Plant diseases are classified as either noninfectious or infectious, depending on their cause.

1. ***Noninfectious disease*** or ***abiotic disease*** is not caused by a pathogen, but rather by elements in a plant's environment that are damaging to it. They cannot be transmitted from plant to plant. They occur very quickly in a wide variety of plants and do not continue to damage the plant throughout the season. They are caused by unfavorable growing conditions, such as extremes in weather, air pollutants, nutrient deficiencies or excesses, and toxic chemicals.
2. ***Infectious diseases*** or ***biotic diseases*** are caused by a living organism or pathogen. A ***pathogen*** is a living, disease-producing agent. The pathogen can multiply and be transmitted from plant to plant. They may invade the entire plant (***systemic infection***) or only affect certain plant parts (***localized infection***). Pathogen groups include bacteria, fungi, nematodes, viruses, and parasitic seed plants.
3. ***Bacteria*** are microscopic one-celled organisms that reproduce by simple division. Assuming cell division every 20 minutes, one bacterium can produce up to 70 billion offspring in hours. Bacteria cannot move by themselves and depend on splashing rain, wind, animals, insects, farm implements, seed, and other means to get to host plants. Bacteria usually enter through wounds in the plant and cause local or systemic infections. Symptoms of bacterial infection are wilting, soft rots, leaf blights, and spots. Mycoplasmas and spiroplasmas are bacterial forms that lack cell walls. They are transmitted by leafhoppers or plant propagation, and are often the causal agents of the yellows and witch's broom type of diseases, formerly thought to be caused by viruses.
4. Fungi are the most common causes of infectious plant diseases. ***Fungi*** are small, many-celled plants that lack chlorophyll. Most reproduce by spores. Fungi enter the plant and destroy or disrupt parts of it, making it unsuitable for human use. The organisms are spread by rain, wind, insects, seeds, farm implements, and runoff water or runoff soil. Symptoms of fungal diseases included wilting, yellowing, blotching, spotting of leaves, and rotting of roots, stalks, stems, or fruit.
5. ***Nematodes*** are microscopic roundworms that live in the soil and feed in the root system of plants. Nematodes are obligate parasites in that they can survive only on or in living plants. They reproduce by eggs and are spread by anything that moves nematode-infected plant parts or nematode-infested soil. Plant-parasitic nematodes have a hollow feeding tube, called a stylet, that is inserted into roots to draw out plant juices. This weakens the plant, causing it to turn a yellowish color and stunting its growth. Nematodes do not usually kill the plant; they reduce plant vigor and growth. They may also interact with soil-inhabiting fungi to cause a root-disease complex, which results in a more severe disease than either the nematode or fungus could cause when acting alone.
6. ***Viruses*** are tiny pathogens that can be seen only with special microscopes. Viruses usually enter plants and cause systemic infections. Viruses cannot move on their own, and are commonly spread by insects and seed. Symptoms of viral diseases include discoloration, stunted or unusual growth, and poor development of normal plant parts. Parasitic seed plants such as dodder, the true mistletoes, and witchweed

are obligate parasites. They reproduce by seed and are spread by animals, wind, soil, water, or equipment.

*Use TM: C10–3C and C10–3D as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 14 in Introduction to Plant and Soil Science & Technology and Unit 13 in Agriscience Fundamentals & Applications are recommended.*

## Objective 3: Explain the scouting, identification, and diagnosis of plant diseases.

***Anticipated Problem:*** How are plant diseases scouted, identified, and diagnosed?

III. Plants react to pathogens by producing symptoms, indications of disease that affect the external or internal appearance of the plant.

A. As a field is spot-checked for insects, the severity of diseases can also be noted.

1. Examine roots, stalks, and leaves, and collect samples for positive identification. Some pathogens cause localized infections; others may infect the entire plant. It is important to inspect the entire plant when diagnosing a plant disease problem.
2. Fields are normally spot-checked in five different areas. In those areas, carefully examine all plants within a 20-foot section of random selected row for row crops or within a 1 by 10 foot area for forage and small grain crops.

B. Determine the severity of the disease and the percentage of plants displaying disease symptoms. Symptoms are used to help identify the pathogen and may ultimately help determine the exact cause of the disease.

1. Some common symptoms of plant pathogens are wilting, yellowing, leaf spots, blights, dropping leaves, and necrosis or death of plant tissue.
2. The pathogen itself may also produce signs. Signs of plant pathogens are structures or parts of the pathogen itself, the host plant does not produce them. Examples of signs may include fruiting or spore-producing structures, a mat of fungal tissue, over-wintering structures, nematode galls or cysts, and bacterial exudates.

C. To identify plant diseases correctly, you must carefully observe the symptoms of the disease and the signs of the pathogen itself. The symptoms are usually of three types.

1. Over-development of tissues: galls and swellings.
2. Underdevelopment of tissues: stunting, lack of chlorophyll, or incomplete development of organs.
3. Death of tissues: leaf or flower blights, leaf spots, root rots, cankers, wilting.

D. Examine all parts of the injured or diseased plant. Root problems may produce wilting, stunting, dieback, or nutrient deficiencies. Determine whether the problem is localized or systemic.

1. Some pathogens infect only certain parts of the plant. These diseases cause localized infections and include many leaf blights, leaf spots, stem cankers, galls, and root rot.

2. Diseases that affect the entire plant are called systemic infections. Once inside the plant, the pathogen moves throughout and causes wilting, yellowing, and stunted growth. Systemic diseases often kill the plant. When diagnosing diseases the entire plant must be examined. Notice where diseases occur in the field and how they have developed. Some diseases are more severe in low areas, while others can be found throughout the field.

D. Steps to follow for diagnosing diseases.

1. Scout the field and note problem areas.
2. Examine the plants and note the plant parts affected, symptoms of disease, and signs of pathogens.
3. Observe the field and note the infestation pattern, field conditions, field history, and weather conditions for the past 10 to 14 days.
4. Consult references to assist you in disease identification or consult your county extension adviser.

*Use TM: C10–3E and C10–3F as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 14 in Introduction to Plant and Soil Science & Technology and Unit 13 in Agriscience Fundamentals & Applications are recommended.*

## Objective 4: Explain the control of plant diseases.

***Anticipated Problem:*** How are plant diseases controlled?

IV. The cost of the treatment and life cycle of the pathogen must be considered when selecting a control measure.

A. The methods used to control crop diseases are many but can be grouped into three main categories. Genetic control, or host plant resistance, is the most common and important method of disease control. Three general classes of disease resistance have been designated.

1. ***Disease avoidance*** is when crop plants may have morphological structures such as sunken stomata or a thick cuticle that discourages penetration of inoculum. Crops escape disease inoculation by reaching maturity before the level of inoculum is great enough to infect a large area.
2. With ***disease tolerance*** an infection may occur, but the crop host is able to withstand the invasion, continue to grow, and produce satisfactory yields. The degree of parasitism is so slight that no detectable loss of dry matter production occurs. While in other tolerant crops the infection is limited by mechanical or chemical exclusion. There is no evidence of incubation and/or infection even though inoculation has occurred with true ***disease resistance***.

3. ***Cultural disease control*** involves any change or manipulation of field operations that alters either the life cycle of the pathogen or the host, so that inoculation or infection does not occur.

B. Optimum plant density, timely cultivation and fertilization, and proper water management are all practices that promote vigorous crop growth. Healthy plants are less disposed to disease while stressed plants are more likely to suffer disease infection and damage.

1. Crop rotations change the crop host and also reduce the level of the primary inoculum.
2. A change in planting date, either earlier or later, often helps a crop escape or withstand disease infection.
3. Tillage and cultivation reduce the source of primary inoculum of some diseases by burying crop residues.
4. Weed control of all kinds often eliminates the alternate disease host but always reduces the competition of weeds for light, water, and nutrients.
5. Chemical disease control may be effective but it is not always feasible on field crops. Chemical control must be applied before inoculation and remain on the plant or be reapplied as long as there is a threat of inoculation. Once a pathogen has entered the plant, chemical control is difficult, if not impossible. Chemical control of plant diseases is strictly preventative. There are no treatments to reduce the symptoms once a plant has the disease.

*Use TM: C10–3G as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 14 in Introduction to Plant and Soil Science & Technology and Unit 13 in Agriscience Fundamentals & Applications are recommended.*

## Objective 5: Identify strategies used in disease management.

***Anticipated Problem:*** What strategies are used in disease management?

V. Successful management of field crop diseases is based on a thorough understanding of factors influencing disease development and expression. Strategies should include measures to reduce losses in the current crop as well as considerations for future plantings.

A. The interaction of four factors influences the development of all plant diseases. Plant disease management is directed toward disrupting one or more of these factors. The presence of a susceptible host crop. A pathogen, disease-causing agent, capable of colonizing the host. An environment that favors the pathogen and not the host. Adequate time for economic damage and loss to occur.

B. Measures used to manage plant diseases are crop rotation, genetic resistance, fungicides, and cultural or agronomic practices.

*Use text material to strengthen student understanding of concepts. Chapter 14 in Introduction to Plant and Soil Science & Technology and Unit 13 in Agriscience Fundamentals & Applications are recommended.*

**Review/Summary.** Use the student learning objectives as a guide to summarizing the lesson. Have students explain terms, processes outlined in the lesson, and the content associated with each objective. Student responses can be used in determining which objectives require greater review or whether further instruction is necessary. Questions at the end of each Chapter 1n the recommended textbooks may also be used in the review/summary.

**Application.** The accompanying lab sheet will be helpful to students in applying the lesson's content.

**Evaluation.** Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student performance on classroom participation, laboratory assignments, and written tests or quizzes.

## Answers to Sample Test:

### *Part One: Matching*

1 = c, 2 = e, 3 = b, 4 = g, 5 = f, 6 = a, 7 = d, 8 = h

### *Part Two: Completion*

1. Noninfectious disease
2. Plant disease
3. rotation, genetic, agronomic

### *Part Three: Short Answer*

1. Susceptible host plant; disease-producing agent; favorable environment; time for the disease to develop.
2. Scout the field and note problem areas; examine the plants and note the plant parts affected, symptoms of disease, and signs of pathogens; observe the field and note the infestation pattern, field conditions, field history, and weather conditions for the past 10 to 14 days; consult references to assist you in disease identification or consult your county extension adviser.

**Sample Test** Name_____

# Test

## Lesson C10–3: Managing Crop Diseases

### *Part One: Matching*

*Instructions.* Match the term with the correct response. Write the letter of the term by the definition.

a. Bacteria
b. Fungi
c. Infectious diseases
d. Nematodes
e. Pathogen
f. Plant disease
g. Plant pathology
h. Viruses

_____ 1. Caused by a living organism or pathogen.

_____ 2. A living, disease-producing agent.

_____ 3. Small, many-celled plants that lack chlorophyll.

_____ 4. The study of plant diseases.

_____ 5. A harmful alteration of the normal physiological and biochemical growth of the plant.

_____ 6. Microscopic, one-celled organisms that reproduce by simple division.

_____ 7. Microscopic roundworms that live in the soil and feed in the root system of plants.

_____ 8. Tiny pathogens that can be seen only with special microscopes.

### *Part Two: Completion*

*Instructions.* Provide the word or words to complete the following statements.

1. _____ _____or abiotic disease is not caused by a pathogen, but rather by elements in a plant's environment that are damaging to it.
2. _____ _____ management is directed toward disrupting one or more of the factors.
3. Measures used to manage plant diseases are crop _____, _____ resistance, fungicides, and cultural or _____ practices.

### *Part Three: Short Answer*

*Instructions.* Provide information to answer the following questions.

1. What four conditions are necessary for a plant disease to develop?

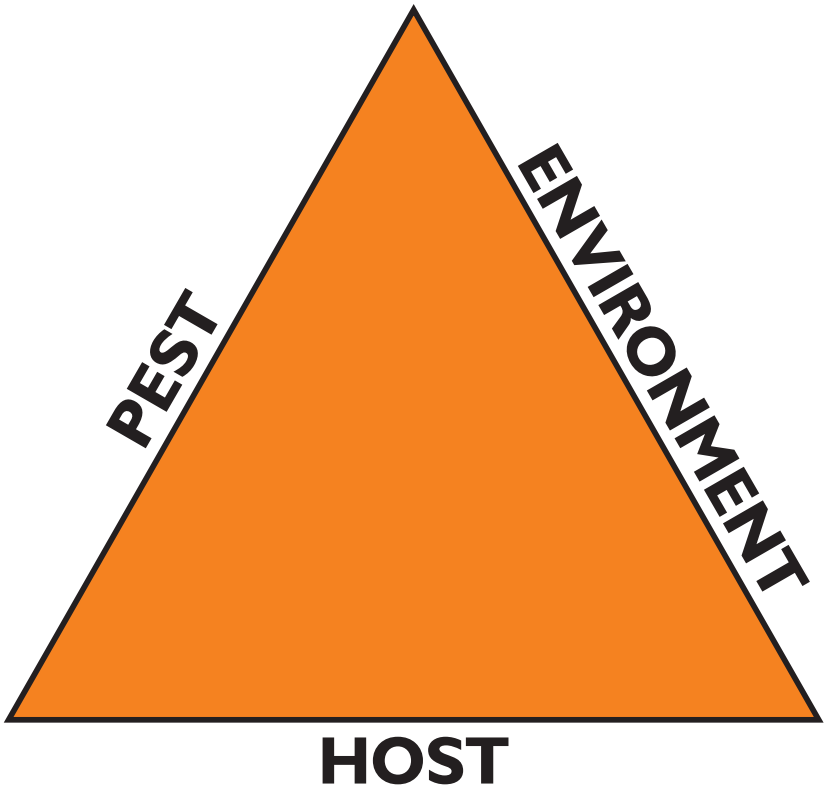
2. What steps should be followed for diagnosing plant diseases?

TM: C10–3A

# CONDITIONS FOR PESTS

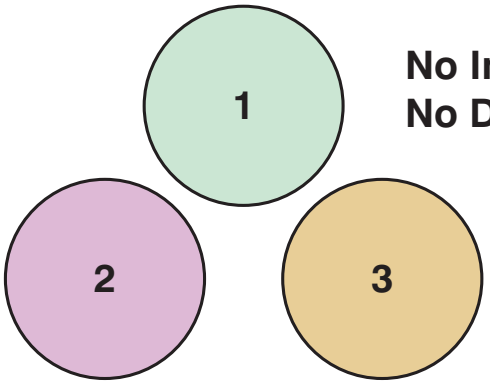
## Pest problems develop when three conditions are present:

- pest (insect, weed, disease, etc.)
- host (susceptible plant)
- favorable environment



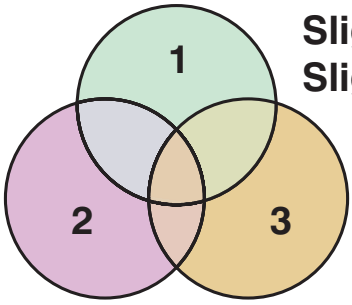
TM: C10–3B

# INTERACTION IN A DISEASE COMPLEX

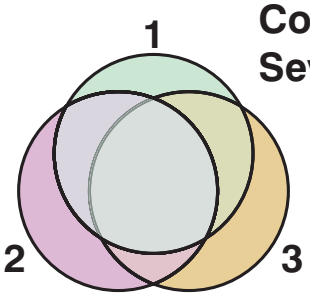



**No Interaction**
**No Disease**

1 Causal organism
2 Susceptible host
3 Favorable environment




**Slight Interaction**
**Slight Disease Development**



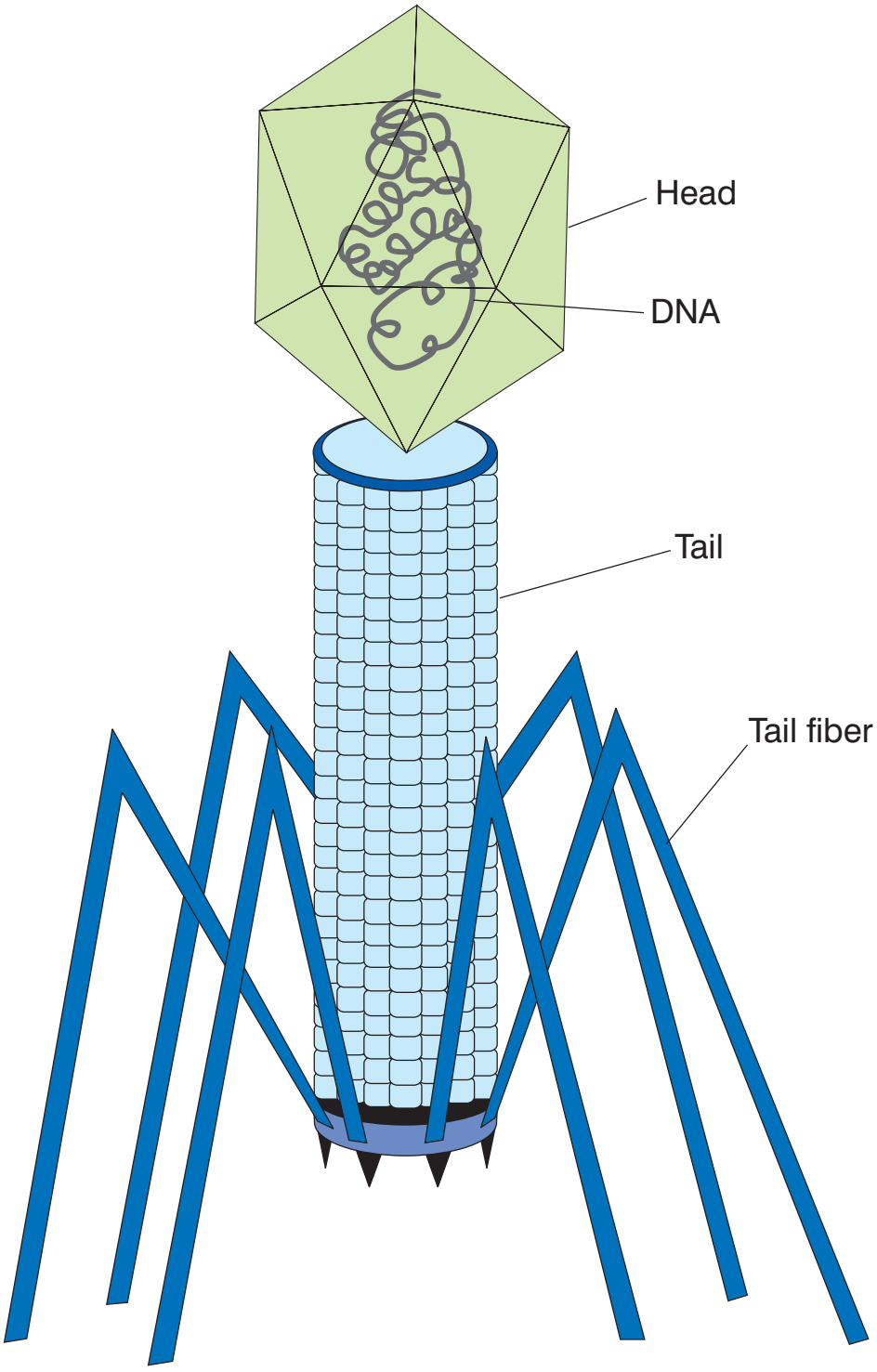

**Complete Interaction**
**Severe Disease Development**

TM: C10–3C

# EXAMPLES OF BIOTIC DISEASES

| BACTERIA | |
|---|---|
| wilt (bacterial) | corn, alfalfa, tomato, potato |
| gall | crown gall in trees and many crops |
| local infections | fire blight of pear, bacterial blight of snapbean, angular leaf spot of cotton |
| **FUNGI** | |
| anthracnose | cotton, cucumber, cantaloupe, bean, watermelon |
| downy mildew | grain crops, grape, onion, spinach, lettuce, cucumber |
| powdery mildew | grain, cucumber, rose, zinnia, chrysanthemum |
| leaf spot | apple scab, rose blockspot, many others |
| wilt (fusarium and verticillium) | cotton, tomato, sweet potato, watermelon |
| **VIRUSES** | |
| mosaic | tomato, potato, sugarcane |
| stunt | corn |
| streak | sugarcane |

# EXAMPLE OF A VIRUS



**TM: C10–3E**

# ALFALFA DISEASES

| Common Name and Pathogen | Description | Scouting | Comments |
|---|---|---|---|
| Phytophthora root rot, Phytophthora megasperma (fungus) | Occurs in low or wet areas. Taproots are brown or black or roots may have rotted off. New roots may appear above rotted areas. | All season long. | Always dig up plants for root examination. Plants may wilt and slowly decline. |
| Anthracnose, Colletotrichum trifolii (fungus) | Stems have diamond-shaped lesions and stem tips are crooked over. Black specks (fruiting structures) visible in lesions. | Mid to late season or when warm, humid conditions occur. | Diseased plants will be scattered throughout field. Infected plants turn straw colored. |
| Leaf spots, Leptosphaerulina, Pseudopeziza, Stemphylium (fungus) | Small to large, regular or irregular shaped spots or blotches appear on leaves. Leaves may turn yellow and fall. | Mid to late season, primarily after first cutting. | Diseases can increase very rapidly. Growers should cut on schedule. Defoliation can occur on overmature plants. |

# CORN DISEASES

| Common Name and Pathogen | Description | Scouting | Comments |
|---|---|---|---|
| Stewart's wilt, Erwinia stewartii (bacterium) | Long pale green or brownish streaks parallel to midvein. Stem interior is soft, rotted, and brown. | May appear as a seedling blight. Most common after tasseling. | Spread by flea beetles and is more severe when winters are mild and beetle survival is high. |
| Leaf blights and spots, Helminthosporium species (fungus) | Small spots on leaves; small to large lesions. | Mid-whorl to maturity, depending on disease. Northern leaf blight–silking to maturity. Southern leaf blight—mid-whorl to maturity. | Northern corn leaf blight has large, boat-shaped lesions while southern corn leaf blight has small (1/8 to 1/4 inch long) tan lesions. Diseases usually appear on lower leaves first. |
| Stalk rots, Gibberella, Macrophomina, Diplodia (fungus) | Lower portions of stem are soft and rotted when pinched. Plants break over easily when pushed about 6 inches from the upright position. | At maturity when corn is 30 to 40 percent moisture. | Split stalks and examine lower stem for rotting. Pinch lower two internodes when scouting. |
| Common smut, Ustilago maydis (fungus) | Small to large glistening whitish masses growing on stems, ears, or tassels filled with black spores. | Throughout the season. | Disease is usually not of economic importance. |

**TM: C10–3F**

# SOYBEAN DISEASES

| Common Name and Pathogen | Description | Scouting | Comments |
|---|---|---|---|
| Seedling blights and seed rots. Phythium, Phtophthora, Rhizoctonia, Fusarium (fungus) | Skips or gaps in rows; seedlings fail to emerge. Soft rot or lesions on seedling stems. | From planting until two to three weeks after emergence. | Most common when spring weather is cool and damp or when beans are planted early. |
| Phytophthora root rot, stem rot, Phytophthora megasperma (fungus) | Brownish-blackish discoloration of lower stem. Roots soft and rotted. | All season long. | May cause seedling blight or kill larger plants throughout season. |
| Brown spot, Septoria glycines (fungus) | Yellowish brown spots on leaves turning brown as plants age. | All season long. Most common just before bloom through maturity. | Usually occurs on lower leaves and moves upward. |
| Pod and stem blight, Phomopsis species (fungus) | Small black specks in straight rows on leaf stem and pods. | After mid season when pods are half-filled through maturity. | Most common late in the season. Check 30 leaf stems in five different locations. |
| Soybean cyst nematode, Heterodera glycines (fungus) | Stunted plants in oval to circular patches in fields. Washed roots show small white to brown nematodes. | From about four weeks after emergence until maturity. | Cysts on roots are about the size of a period. Always dig plants for root examination. |

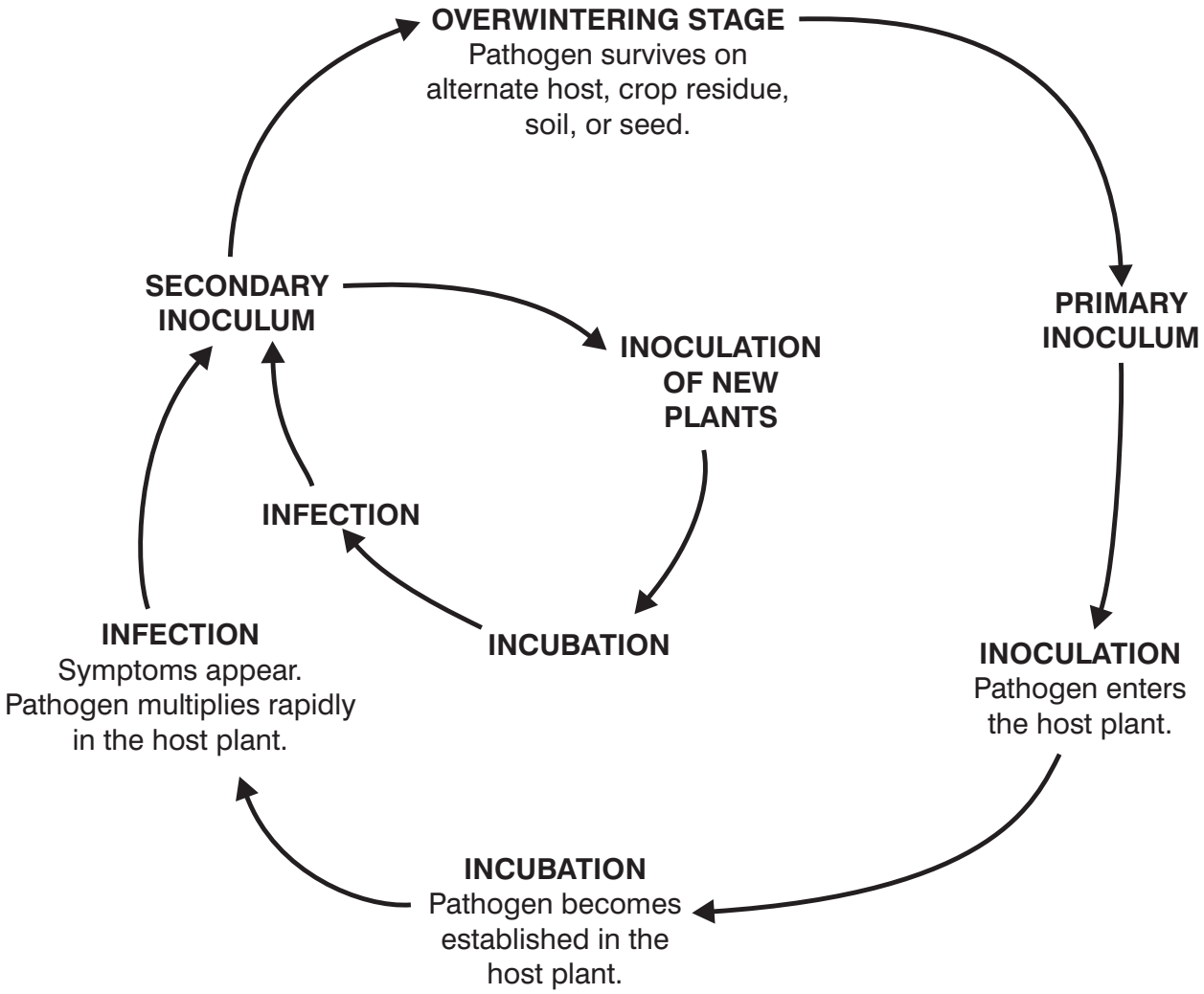
# WHEAT DISEASES

| Common Name and Pathogen | Description | Scouting | Comments |
|---|---|---|---|
| Scab or head blight, Fusarium roseum (fungus) | Spikelets turn prematurely white or straw-colored with pink or orange mold developing at the base of diseases spikelets (grain heads). | From flowering to maturity. | Disease is especially severe during warm, moist periods. |
| Septoria diseases, Septoria (fungus) | Tan to reddish-brown blotches on leaves with small black specks in centers of blotches. Glumes may have a chocolate-brown discoloration. | When last two leaves have expanded through maturity. | Disease is most damaging when infections occur on the flag leaf (last leaf to emerge). |
| Powdery mildew, Erysiphe graminis (fungus) | White to light grey patches with black specks on leaves. | Early season to maturity, especially during cool periods. | Disease usually begins on lower leaves and moves upward in cool, wet weather. |

TM: C10–3G

# STAGES OF DISEASE DEVELOPMENT

There are three pathogenic stages in the development of a disease that may occur only once or many times in the seasonal cycle of the disease. These stages are illustrated below.



 Name_____

# Lab Sheet

## Determining the Diseases of Crops

***Materials:***

Clip board, paper, pencil, and crop scouting guide or class notes, field or plant samples

***Procedure for corn:***

Using the specimen provided, determine the plant disease that is present.

***Procedure for soybeans:***

Using the specimen provided, determine the plant disease that is present.

***Procedure for wheat:***

Using the specimen provided, determine the plant disease that is present.