

# Lessons and Laboratories

## Plant Diseases

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### Background

Since the beginning of agriculture, farmers have had to develop means for managing weeds, insect pests and diseases. Because of the significant impact of pests and diseases –on both human and animal health it is important for those interested in growing plants to develop a firm understanding of weed science, entomology (study of insects) and plant pathology (study of plant disease) and how to manage or minimize losses caused by these important plant pests.

All plants-native and cultivated-can get sick (are susceptible to disease) and are prone to injury. Disease is defined as suboptimal plant growth brought about by a continuous irritant such as a pathogen (an organism capable of causing disease) or by chronic exposure to less than ideal growing conditions. In contrast, injury is loss of plant vigor resulting from an instantaneous event such as a lightning strike, hail damage, chemical burn or mechanical damage. Because of the instantaneous and “cause-and-effect” nature of injuries, they are often easy to diagnose. In the case of disease, the source of continual irritation may be abiotic (non-living) or biotic (caused by a pathogen). Abiotic diseases are also referred to as non-infectious diseases as they do not spread from plant to plant. Examples can include nutrient deficiencies growing under too much or too little light, and air pollutants such as automobile exhaust.

Biotic diseases are caused by pathogens and are often referred to as infectious diseases because they can move within and spread between plants. Plant pathogens are very similar to those that cause disease in humans and animals and include viruses, bacteria, fungi, and nematodes. Pathogens may infect all parts of the plant including leaves, shoots, stems, roots, fruit, and seeds. For an infectious disease to develop there must be a susceptible host, a pathogen capable of causing disease, and a favorable environment for the pathogen to grow. If any one of these factors is absent, disease will fail to develop. In the case of infectious plant diseases, practices that favor plant growth over pathogen activity tend to decrease the amount of disease observed. For example, plants that are fertilized and watered correctly will be less likely to get sick.

Regardless of the type of pathogen, the development of visual disease symptoms on a plant requires that the pathogen must: (a) come into contact with a susceptible host (referred to as inoculation); (b) gain entrance or penetrate the host through either a wound, a natural opening on plant surface (stomata, lenticels) or by direct penetration of the host; (c) establish itself within the host; (d) grow and multiply within or on the host; and (e) be able to spread to other susceptible plants. Successful pathogens must also be able to survive prolonged periods of unfavorable environmental conditions and in the absence of a susceptible plant host. Together, these steps are referred to as the disease cycle. If this cycle is broken, the disease will be less powerful or fail to develop.

Two terms that are often used when discussing plant disease and injury are sign and symptom. The word sign is used when the pathogen or part of the pathogen is observed in or on an infected plant. Examples include: fungal hyphae or mycelium, spores, fruiting bodies, bacterial cells, or virus particles. Symptoms are visual or noticeable changes of a plant as the result of disease or injury. Disease symptoms are often invisible early after infection and take time to develop. Examples of common symptoms are: yellowing of leaves; wilting of leaves; dropping of leaves or fruit; and stunting of plant parts or the whole plant.

### Areas of Interest

- ✚ Locate reference books and websites on plant diseases
- ✚ Define plant disease terms and give examples
- ✚ Learn about the history of plant diseases
- ✚ Research the social and environmental issues surrounding plant diseases
- ✚ Explore some common diseases of plants in your area
- ✚ Experiment!

### Things to Do

#### Books and Websites

- ✚ Locate books and websites that you can reference about plant diseases. Things to look for are: the history of plant diseases, famous plant pathologists (doctors of plant medicine), the different social and environmental issues of plant diseases, basic terminology of plant diseases, common diseases of plants, management or control of plant diseases, etc.
- ✚ Examples of books and websites: *Plant Pathology* by George N. Agrios; *Poisons of the Past: Molds, Epidemics, and History* by Mary Matossian; *Principles of Plant Disease Management* by William Fry; *Plant Pathology: Past to Present* by Frank Tainter; American Phytopathological Society, [www.aspn.org](http://www.aspn.org), etc.

## Definitions

- ✚ After finding websites and books on plant diseases, define the following terms: disease, injury, sign, symptom, pathogen, susceptible host, resistant host, environment, deficiency, toxicity, biotic, abiotic, fungus, bacteria, virus, nematode, parasite, pesticide, aflatoxin, aerobic, anaerobic, spore, cell membrane, cell wall, inoculation, etc. Here's an idea: read the first chapter of a plant disease book. If there are some odd looking words in there that you have never seen before, look them up in the dictionary. They will be helpful to know. Also, give examples of each. You can also visit this website to find an illustrated glossary of plant pathology terms; American Phytopathological Society Glossary, <http://www.apsnet.org/education/IllustratedGlossary>.

## Plant Disease History

- ✚ The impact of plant diseases is an important component of human culture and history. However, very few people know much about plants, food, or pathogens.
- ✚ Explore the world's history and find an epidemic that was caused by a plant disease. Examples include: Irish Potato Famine; Dutch Elm Disease; Chestnut Blight; Citrus Canker; Ergot and the Salem Witch Trials.
- ✚ Find out about the world's first plant doctors. "Who were they?" "What did they discover?" "When did they discover it?" Examples include: Thomas Taylor; Pierre Marie Alexis Millardet; Hieronymus Fracastorius; Anton deBary; Johanna Westerdijk; T. J. Burrill; Erwin F. Smith; Berkley.
- ✚ Also explore plant diseases in other countries and cultures. For example you could explore plant pathology in India that was influenced by religious-mythology and the practice of medicine or plant pathology in China, unlike its Indian counterpart, which recognized specific diseases and came up with methods of control and prevention.

## Social and Environmental Issues

- ✚ Research three areas concerning issues in plant pathology. These issues may be genetically modified organisms, organic versus non-organic crops, agricultural bioterrorism, pollution, acid rain, pesticide use, or the legislative impact of plant diseases. Some questions to ask may be: "What is the problem?" "Who is involved or who does it affect?" "How did it affect human life?" "What are we trying to do about it?" "Why did it happen?" "How can we control plant diseases to avoid future events?"
- ✚ Find an article (print or web-based) that relates to a "hot issue" (like the ones above) in plant pathology in Ohio or the Midwest. Write a paragraph based on the following: "What was the point of the article?" "What was the link between the article and the other materials you have read, seen or heard?" "Do you think the author fairly covered the subject?" "Why or why not?"

## Explore Common Plant Diseases

- ✚ Research different plant diseases. If you live in the city you may want to learn about lawn, flower, shrub, and tree diseases. If you are from the country perhaps corn, soybeans, alfalfa, or wheat diseases might be more interesting.
- ✚ Look at diseases that occur in Ohio, but also worldwide.
- ✚ There are many plant diseases in the world. Here are a few examples: Powdery Mildew; Corn Smut; Dollar Spot; Apple Scab; Coffee Rust; Tobacco Mosaic Virus; Verticillium Wilt; Leaf Spot; Crown Gall; Citrus Canker; Ergot; Fireblight; Leaf Rust.

## Experiments

Note: When completing each exercise note observations and data in a journal and take pictures before and after.

### Exercise 1: Disease Plant Walk

- ✚ It is important to be able to recognize between healthy and diseased plants. It is also essential to know the difference between a sign and a symptom.
- The objective of this exercise is to go outside and find some plant diseases. The first step in this process is to familiarize yourself with diseased plants that may be in your area. Look online (<http://ohioline.osu.edu>) or in a plant disease book beforehand to find some possible plant diseases that may be in your area. Pictures can be saved for reference later.
- Materials needed: pen or pencil, paper, and a 10X hand lens or magnifying glass. (Hand lens' can be found at the bookstore or online.)
- ✚ Procedure: Now go outside and begin walking around, whether it is in your backyard, a field, or a park. Look at the plants around you from the grass on the ground to the trees in the sky. Begin by looking at healthy plants. It is important to know what a healthy plant looks like to help determine when you have a sick one. Once you have found a healthy plant look for one that is out of the ordinary, such as one that is wilted or has yellowing leaves. Wilting can be associated with the plants inability to move water in the vascular system (xylem). Note the differences between the healthy and sick plants. Be sure to examine many different plant types. As you study these plants, list 5 symptoms you observed and 5 signs you examined. If you have a hand lens, look very close at the plant specimen (maybe a leaf or stem). You may be able to see fruiting bodies and if you see fruiting bodies then you have found a sign of the disease.

- ✚ Over the next few days note in your journal any changes with the diseased plants that you saw on your walk. Ask yourself some questions. “Have they changed in color or shape?” “What do you think the cause of the sickness is?” “Is it related to weather, such as being too cold or too hot?” “Is only one plant sick or many plants?” Be sure to also take pictures throughout the exercise to help show what the plant looked like when you first saw it and what it looked like a few weeks later.

### Exercise 2: Light Stress

- ✚ The most difficult challenge in diagnosing the cause of a sick plant is not figuring out which pathogen is responsible for the disorder, but rather is the disorder abiotic or biotic. In cases where no evidence of a pathogen is found, most plant pathologists assume the disorder to be caused by an abiotic factor. This exercise will focus on the impact of light versus shade.
- ✚ Materials needed: 4 Styrofoam pots or cups, 10 corn seeds, 10 soybean seeds, 4 labels, potting soil and a large plastic container (dark in color) or cardboard box. If you do not have soybean seeds cucumber or pea seeds work great too.
- ✚ Procedure: First, poke holes in the bottom of the Styrofoam pots/cups for drainage purposes. Then fill each pot with potting soil leaving about ½ inch of space at the top of the pot. Plant five seeds per pot (two pots with five corn seeds each and two pots with five soybean seeds each). Label the pots as follows: 1- corn light, 2- corn dark; 3- soybeans light, 4- soybeans dark. Include the date on each label. Place the two pots for light on a windowsill or in a place where there is direct sunlight. Place the two pots labeled dark in the same area but with the plastic container/box covering them to block the sunlight. Water the plants as needed. Be sure to have something under the pots to collect the extra water the plants do not absorb. Write in your journal how you think the dark plants will differ from the plants in the sunlight.
- ✚ Observe your plants twice a week for two weeks. Measure and record the plant height and color and any other data you believe would be useful at determining the role of light on plant growth. At the end of the initial two-week period, move the dark plants to the same location as your light plants (remove the plastic container/box) and continue making observations for an additional week. Record your observations and conclusions regarding the influence of light on plant health.

### Exercise 3: Water Availability

- ✚ Plants need water and are actually made up of 70% of water. Plant roots pick up or absorb water and transport it to the stems and leaves. When plants are watered too much they will become weak and bend over. If plants are not watered enough they will wilt and dry up. This is why it is essential that plants receive the proper amount of water.
- ✚ Materials needed: One small clay flower pot (4 inches in diameter) with holes in the bottom, planter box or 9 in. x 12 in. baking pan, potting soil, lima beans, string, one paper towel, and water.
- ✚ Procedure: Fold the paper towel and place it in the bottom of the clay flowerpot. This will help to reduce the flow of water out of the pot. Place the clay flowerpot in the corner of the planter box or baking pan. The clay flowerpot will be empty but fill the rest of the box/pan with around 2 inches of tightly packed potting soil. With the string mark off four rows with the first being very close to the clay pot. Each additional string will be around 3 inches apart from one another. Plant the first row of seeds very close to the clay pot by pushing the seed with your finger into the soil. Plant each additional row between the string lines. Now fill the clay pot with water. Do NOT water the potting soil. Keep the clay pot filled with water so that the soil next to the pot is moist.
- ✚ Predict what will happen by taking notes in your journal. Ask yourself a few questions. “Which row of seeds will grow and which will not?” “Why is this?” Take pictures and keep a record in your journal of what happens each day for the next few weeks.

### Exercise 4: Grocery Store

- ✚ Pathogens are everywhere! They are in places that you would never guess. Because we cannot see most pathogens without a hand lens or microscope we often think there is nothing to worry about. This is not the case. Just look at your local grocery store.
- ✚ Materials needed: pen and pencil, paper, and a hand lens or magnifying glass.
- ✚ Procedure: This exercise will be much like the disease plant walk you did outside. Go to your local grocery store and head towards the produce section. Examine the different fruits and vegetables and look for symptoms and signs of disease.
- ✚ Record your observations, but also think of the big picture. What are some things that you do not see? You didn’t get to see how this food was grown in the field, who handled it, how it was shipped there, or where it came from. Most of the diseases you get on your produce are from cross-contamination from being handled by workers who have handled many different types of produce. There may be a vegetable that comes into the grocery that is healthy, but if a worker or other shoppers that have handled diseased produce handle it, then contamination occurs. This is why it is important to thoroughly wash all produce you get at the grocery store.
- ✚ Note in your journal any observations and also take pictures of your trip to the grocery store. Visit this website to gain information on food safety practices: <http://www.fightbac.org>.

### Exercise 5: Soft Rot

- ✚ Vegetables and fruits are often wounded during the harvesting, transportation, and storing processes. These wounds are entry points for bacteria that cause soft-rot. The soft rot bacteria causes plant cells to “slide apart” causing a soft, mushy feeling and a strong, unpleasant odor. The goal of this exercise is to determine the role of the environment in the development of bacterial soft rot.
- ✚ Materials needed (adult supervision): one carrot, one potato, one cucumber, water, paper towels, one paring knife, six one gallon Zip-lock bags, and an electric fan.
- ✚ Procedure: Cut each of the vegetables into six separate pieces. Place one piece of each vegetable (cut side up if possible) into each bag so that you have one carrot, one potato, and one cucumber section in each bag. Then dampen a paper towel and place one in each bag. Seal three of the bags and leave the other three open. Place one open bag and one closed bag on the kitchen counter at room temperature. Put one open bag and one closed bag in the refrigerator. Place the last open and closed bags on a counter or in another location at room temperature and place a fan in front of the bag so air is blown across the vegetables. Write in your journal your thoughts on which vegetables will rot the least. Those on the counter, in the refrigerator, or in front of the fan? What impact will sealing the bags have on soft rot?
- ✚ Over the next 7 days observe your vegetables and take notes in your journal. Use the following rating scale to show the amount of soft rot observed, in which 1= no rot and 5= complete rot. Display your results in a graph showing the amount of rot (vertical axis of graph) and time (horizontal axis of graph). List any characteristics you see. Ask yourself these questions: “What happened to each bag of vegetables?” “What do they look like?” “What could you do to help prevent soft rot?” Determine what the best storage conditions are for preventing bacterial soft rot and come to a conclusion. Take pictures when setting up the exercise and when rating the results.

### Related Web Pages

- The American Phytopathological Society: <http://www.apsnet.org>
- The Microbiology Information Portal: <http://www.microbes.info>
- United States Department of Agriculture- Animal and Plant Health Inspection Service (APHIS): <http://www.ars.usda.gov>
- Ohioline: <http://ohioline.osu.edu>
- Ohio Agricultural Research and Development Center: <http://www.oardc.ohio-state.edu>
- Plant Facts, Ohio State University: <http://plantfacts.osu.edu>
- Ohio Integrated Pest Management: <http://ipm.osu.edu>
- Ohio Department of Agriculture: <http://www.ohioagriculture.gov>
- Ohio State University Extension: <http://www.ag.ohio-state.edu/~extension/index.php>
- For a voice-overlaid PowerPoint on plant pathology that is downloadable to your MP3 player, I-Pod, or computer, visit:
  1. Introduction to Plant Pathology  
<http://www.ag.ohio-state.edu/~boehm/Intro%20to%20Plant%20Pathology/Intro%20to%20Plant%20Pathology.html>
  2. What is Plant Pathology?  
<http://www.ag.ohio-state.edu/~boehm/EllisFeb2008/EllisFeb2008.html>