THE OHIO STATE UNIVERSITY EXTENSION

FACT SHEET

Agriculture and Natural Resources

PP401.06

This is the sixth fact sheet in a series of ten designed to provide an overview of key concepts in plant pathology. Plant pathology is the study of plant disease including the reasons why plants get sick and how to control or manage healthy plants.

Bacterial Diseases of Plants

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Overview

Although considered structurally simple, bacteria are extremely diverse from a metabolic standpoint and are found almost everywhere on Earth in vast numbers—from living in jet fuel and on the rims of volcanoes to thriving in hydrothermal vents deep on the ocean floor. There are both beneficial and pathogenic bacteria. Beneficial bacteria are involved in such diverse processes as digestion in animals, nitrogen fixation in the roots of certain legumes, the decomposition of animal and plant remains, and sewage disposal systems. Pathogenic bacteria, on the other hand, cause severe and often fatal diseases in humans, animals, and plants. The first bacterial disease ever discovered was anthrax (caused by *Bacillus anthracis*) of cattle and sheep in 1876. The discovery of anthrax in cattle was immediately followed by the discovery of fireblight of pear and apple (caused by *Erwinia amylovora*) by T. J. Burrill from the University of Illinois (1877–1885).

Another group of bacterial pathogens are difficult or impossible to culture in the laboratory and are called fastidious vascular bacteria. They grow in either the xylem or phloem tissues and interfere with the transport of water and nutrients in the plant. Many of them are vectored by sucking insects such as leafhoppers, planthoppers, and psyllids. Studies of corn stunt provide evidence that once the insect vectors establish the infective particles in their bodies, the insects retain the ability to transmit them the rest of their lives. Until their discovery in 1967, most of the diseases now known to be caused by fastidious vascular bacteria were believed to be caused by viruses and were initially described by virologists.

Morphology

Bacteria are microscopic, single-celled prokaryotic organisms, without a defined nucleus, that reproduce asexually by binary fission (one cell splitting into two). They occur singly or in colonies of cells. Bacteria are classified into two main groups based on cell wall structure, which can be determined by a simple staining procedure called the Gram stain. Gram negative bacteria stain red or pink and Gram positive bacteria stain purple. The difference in color is directly related to the chemical composition and structure of their cell walls. The cells can be rod-shaped, spherical, spiral-shaped, or filamentous. Only a few of the latter are known to cause diseases in plants. Most bacteria are motile and have whip-like flagella that propel them through films of water.

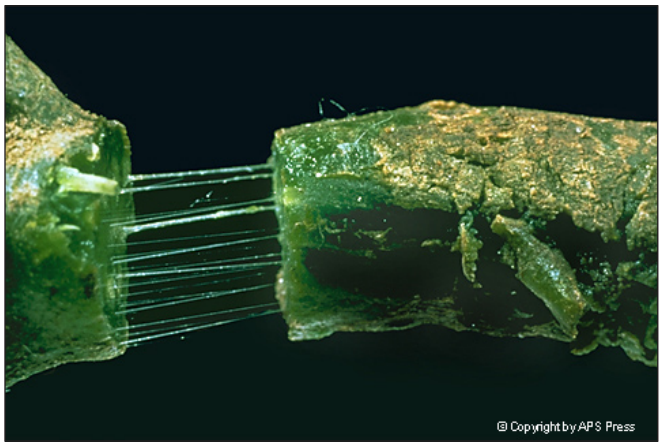

Figure 1. Bacterial strand test on cut stems, with bacterial slime streaming from xylem tissues. *(Image courtesy M. P/ Hoffman, copyright the American Phytopathological Society)*

Phytoplasmas and spiroplasmas are bacteria that lack rigid cell walls, and infect plants. Phytoplasmas are round or ovoid. As with viruses, many diseases caused by fastidious bacteria are named after the most important host plant or the one where the disease was first characterized, but some can also infect many other plants. For example, the aster yellows phytoplasma also affects other ornamentals, such as gladiolus and phlox or tomato, spinach, onion, lettuce, celery, carrots, and strawberry, and many weeds.

Pathogen Biology

The taxonomy of plant pathogenic bacteria is currently in flux based on recent advances on how bacteria are classified. Most plant pathogenic bacteria belong to the following genera: *Erwinia, Pectobacterium, Pantoea, Agrobacterium, Pseudomonas, Ralstonia, Burkholderia, Acidovorax, Xanthomonas, Clavibacter, Streptomyces, Xylella, Spiroplasma,* and *Phytoplasma.* Plant pathogenic bacteria cause many different kinds of symptoms that include galls and overgrowths, wilts, leaf spots, specks and blights, soft rots, as well as scabs and cankers. In contrast to viruses, which are inside host cells, walled bacteria grow in the spaces between cells and do not invade them. The means by which plant pathogenic bacteria cause disease is as varied as the types of symptoms they cause. Some plant pathogenic bacteria produce toxins or inject special proteins that lead to host cell death or they produce enzymes that break down key structural components of plant cells and their walls. An example is the production of enzymes by soft-rotting bacteria that degrade the pectin layer that holds plant cells together. Still others colonize the water-conducting xylem vessels causing the plants to wilt and die. *Agrobacterium* species even have the ability to genetically modify or transform their hosts and bring about the formation of cancer-like overgrowths called crown gall.

Figure 3. Crown gall, caused by *Agrobacterium tumefaciens*, on a burning bush. *(Image courtesy Robert L. Forster, copyright the American Phytopathological Society)*

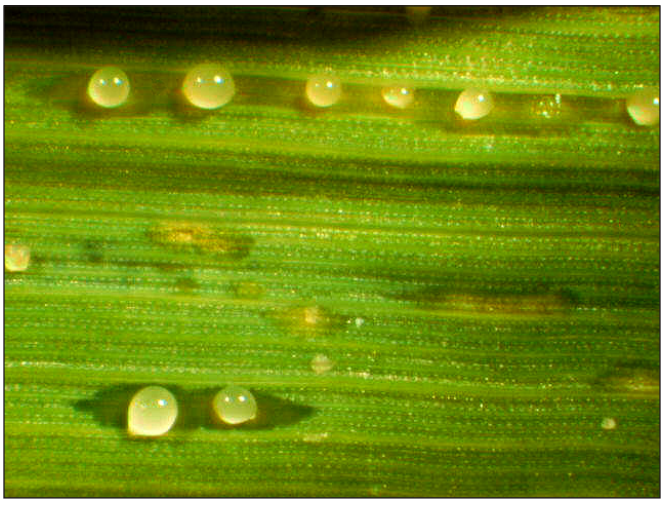

Figure 2. Bacterial leaf blight on wheat. Note the bacterial ooze. *(Image courtesy Sam Livingston, copyright the American Phytopathological Society)*

Bacteria that cause plant diseases are spread in many ways—they can be splashed about by rains or carried by the wind, birds, or on insects. People can unwittingly spread bacterial diseases by, for instance, pruning infected orchard trees during the rainy season. Water facilitates the entrance of bacteria carried on pruning tools into the pruning cuts. Propagation with bacteria-infected plant material is a major way pathogenic bacteria are moved over great distances. No matter how the bacterial pathogens are disseminated,

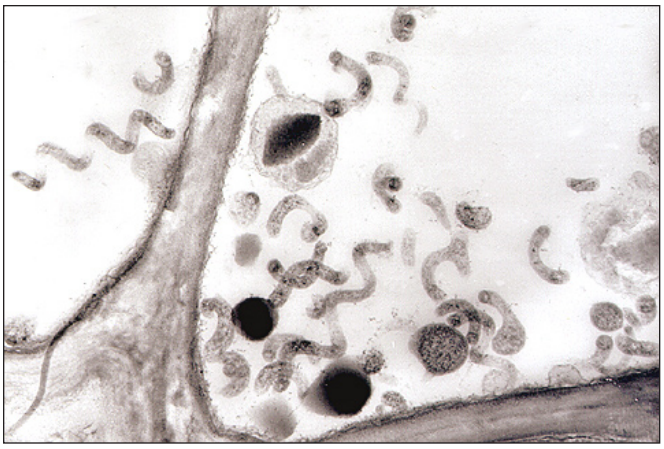

Figure 4. Spiroplasmas in the phloem of an infected corn plant. *(Image courtesy R.E. Davis, copyright the American Phytopathological Society)*

Figure 5. Citrus canker symptoms on fruit. *(Image courtesy Dr. Shabbir A. Rizvi, copyright the American Phytopathological Society)*

they require a wound or natural opening, such as stomates, to get inside a plant host. Once inside they then kill host cells, by the means describe above, so that they can grow. Between hosts they may grow harmlessly on plant surfaces and then can overwinter or survive unfavorable environmental periods or the absence of a susceptible host by either going dormant in infected tissue, infested soil or water, or in an insect vector.

Control

Bacterial diseases in plants are difficult to control. Emphasis is on preventing the spread of the bacteria rather than on curing the plant. Integrated management measures for bacterial plant pathogens include:

1. Genetic Host Resistance

- Resistant varieties, cultivars, or hybrids is the most important control procedure.

2. Cultural Practices

- Bacteria-free seed or propagation materials.
- Sanitation, particularly disinfestation of pruning tools.
- Cultural practices that can either eliminate or reduce sources of bacterial contamination, such as crop rotation to reduce over-wintering.
- Preventing surface wounds that permit the entrance of bacteria into the inner tissues.
- Propagating only bacteria-free nursery stock.
- Prolonged exposure to dry air, heat, and sunlight will sometimes kill bacteria in plant material.

3. Chemical Applications

- Applications of copper-containing compounds or Bordeaux mixture (copper sulfate and lime).
- Antibiotics: streptomycin and/or oxytetracycline may also help kill or suppress plant pathogenic bacteria prior to infection and reduce spread of the disease, but they will not cure plants that are already diseased.
- Antibiotics are also used to treat diseases caused by fastidious vascular bacteria. Phytoplasmas and spiroplasmas are susceptible to certain antibiotics, particularly tetracycline, which has been used to treat pear trees with the pear decline disease. Tetracycline must be injected into mature trees on a routine or therapeutic schedule to be effective and even then only appears to suppress the development of symptoms rather than curing the infected plant. Applications made during the early stages of infection tend to be more effective than in the later stages of disease development.
- Insect control will help to eliminate vectors or reduce feeding wounds that can provide points of entry.

4. Biological Control

- The use of antagonistic or biological control products such as Blight Ban and Agrosin K84 may also be effective for managing bacterial diseases of plants.

5. Government Regulatory Measures

- The implementation of strict quarantines that exclude or restrict the introduction or movement of fungal and FLO pathogens or infected plant material.

For detailed information on each of the IPM strategies, see the fourth fact sheet in this series, "Keeping Plants Healthy: An Overview of Integrated Plant Health Management" (PP401.04).

Introduction to Plant Disease Series

PP401.01: Plants Get Sick Too! An Introduction to Plant Diseases

PP401.02: Diagnosing Sick Plants

PP401.03: 20 Questions on Plant Diagnosis

PP401.04: Keeping Plants Healthy: An Overview of Integrated Plant Health Management

PP401.05: Viral Diseases of Plants

PP401.06: Bacterial Diseases of Plants

PP401.07: Fungal and Fungal-like Diseases of Plants

PP401.08: Nematode Diseases of Plants

PP401.09: Parasitic Higher Plants

PP401.10: Sanitation and Phytosanitation (SPS): The Importance of SPS in Global Movement of Plant Materials

These fact sheets can be found at OSU Extension's "Ohioline" web site: http://ohioline.osu.edu. Search for "Plant Disease Series" to find these and other plant pathology fact sheets.

Links to Bacterial Disease Fact Sheets

Fireblight of Apples, Crabapples and Pears: http://ohioline.osu.edu/hyg-fact/3000/3002.html

Bacterial Spot, Speck and Canker of Tomatoes: http://ohioline.osu.edu/hyg-fact/3000/3120.html

Bacterial Crown Gall of Ornamentals in the Landscape: http://ohioline.osu.edu/hyg-fact/3000/3054.html

Blackleg, Aerial Stem Rot and Tuber Soft Rot of Potato: http://ohioline.osu.edu/hyg-fact/3000/3106.html

Citrus Canker: http://www.apsnet.org/education/LessonsPlantPath/CitrusCanker/default.htm

Stewart's Wilt of Corn: http://www.apsnet.org/education/LessonsPlantPath/StewartsWilt/default.htm