THE OHIO STATE UNIVERSITY EXTENSION

FACT SHEET

Agriculture and Natural Resources

PP401.05

This is the fifth 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.

Viral Diseases of Plants

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Overview

Viruses are intracellular (inside cells) pathogenic particles that infect other living organisms. Human diseases caused by viruses include chickenpox, herpes, influenza, rabies, smallpox, and AIDS (acquired immunodeficiency syndrome). Although these are the viruses most of us are familiar with, the first virus ever described and from which the term was eventually derived was tobacco mosaic virus or TMV (the term virus was derived from the original description of the causal agent of TMV—a "contagium vivum fluidum" or contagious living fluid). TMV was discovered by Martinus W. Beijerinck, a Dutch microbiologist, in 1898.

Morphology

Virus particles are extremely small and can be seen only with an electron microscope. Most plant viruses are either rod-shaped or isometric (polyhedral). TMV, potato virus Y (PVY), and cucumber mosaic virus (CMV) are examples of a short rigid rod-shaped, a long flexuous rod-shaped, and an isometric virus, respectively. Viruses consist of an inner core of nucleic acid (either ribonucleic acid [RNA] or deoxyribonucleic acid [DNA]) surrounded by an outer sheath or coat of protein (referred to as the capsid). The capsid is further enclosed by a membrane in most human and animal viruses that helps the virus pass through the cell membrane in these types of cells. Since the cell membrane in plants is surrounded by a rigid cell wall, plant viruses require a wound for their initial entrance into a plant cell. Wounds in plants can occur naturally, such as in the branching of lateral roots. They may also be the result of agronomic or horticultural practices, or other mechanical means; fungal, nematode, or parasitic plant infections; or by insects. In some cases, the organism creating the wound can also be carrying and can pass or transmit the virus. Organisms that transmit pathogens are called ***vectors***. Mechanical and insect vector transmission are the two most important means by which plant viruses spread. The activity of humans in propagating plants by budding and grafting or by cuttings is one of the chief ways viral diseases spread. In fact, plant virologists use grafting and budding procedures to transmit and detect viruses in their studies. The seedling offspring of a virus-infected plant is usually, but not always, free of the virus, depending on the plant species and the kind of virus. Insect transmission is perhaps the most important means of virus transmission in the field. Insects in the order Homoptera, such as aphids, planthoppers, leafhoppers, whiteflies, and mealy bugs—that have piercing sucking mouthparts—are the most common and economically important vectors of plant viruses. Some plant viruses can also be transmitted in pollen grains or by seed.

Figure 1. Symptoms of impatiens necrotic spot virus on pepper leaves. *(Image courtesy Rayapati A. Naidu, copyright the American Phytopathological Society)*

Figure 2. Symptoms on pepper produced by tomato spotted wilt tospovirus. *(Image courtesy H. R. Pappu, copyright the American Phytopathological Society)*

Pathogen Biology

Viruses are obligate parasites; that is, they require a living host in order to grow and multiply. Once in a wounded cell, the virus particle sheds its protein coat and the nucleic acid then directs the production of multiple copies of itself and related proteins leading to the development of new virus particles. Cell-to-cell movement of plant viruses occurs through the cytoplasmic "bridges" between cells called ***plasmodesmata*** and move systemically throughout infected plants via the phloem. Although the details of plant virus replication are complex and beyond the scope of this fact sheet, the general idea is that plant viruses cause disease in part by causing a reallocation of photosynthates and a disruption of normal cellular processes as they replicate. Interestingly, many kinds of plants are infected with viruses and show no symptoms. Such infections are referred to as being ***latent***. Some viruses, such as cucumber mosaic virus (CMV) and cowpea mosaic virus (CPMV), occur as a complex of multiple component particles, each containing different nucleic acid cores. In multi-component viruses, all components have to be present in a plant for infection and replication to take place.

Figure 3. Rose mosaic virus. *(Image courtesy J. Lotz and P. Lehman, copyright the American Phytopathological Society)*

Viruses are difficult to classify and, for want of anything better, they are given descriptive (and sometimes colorful) names based on the disease they cause—for example, tobacco ring spot, watermelon mosaic, barley yellow dwarf, potato mop top, citrus tristeza, sugar beet curly top, lettuce mosaic, maize dwarf mosaic, potato leaf roll, peach yellow bud mosaic, African cassava mosaic, carnation streak, and tomato spotted wilt. Many of these viruses also infect plants of other species. For example, tobacco ring spot virus causes a bud blight in soybeans; maize dwarf mosaic infects sorghum, Sudan grass, sugarcane, and Johnson grass in addition to corn, but it still retains its original name.

Control

Once plants are infected, little can be done to free them from the virus.

1. Genetic Host Resistance

- Since different cultivars and species show different degrees of resistance to some viruses, resistant types should be planted whenever they are available. Recent advances in plant cell molecular biology and virology have lead to the development of genetically modified plants with superior resistance to some viruses.

2. Cultural Practices

There are numerous cultural practices that can be used to reduce plant losses due to virus infection.

- Scouting and removal of symptomatic plants or known alternative weed or volunteer plants that may serve as a reservoir for a given virus
- The use of clean or sanitized tools and equipment
- Hand washing
- The use of disposable overgarments
- Rotations to non-host crops
- Geographic isolation of production facilities may also help avoid losses caused by plant viruses
- The isolation of newly received plant material prior to its introduction into the rest of a production system can also minimize the unintentional introduction of pathogens.

Some viruses are permanently inactivated by prolonged exposure of infected tissue to relatively high temperatures—for example, 20 to 30 days at 38 degrees C (100 degrees F). This procedure, called heat therapy, frees individual plants or cuttings of the virus. The clean tissue is then used as a propagative source, allowing large-scale production of virus-free plants. This has been done with many cultivars of fruit and ornamental species. If insect vectors and infected plant material are kept out of the new virus-clean plantings, subsequent reinfection is unlikely, particularly if the planting is at a distance from virus-infected plantings. For orchard, ornamental nursery, and floricultural crops, the best management approach is the planting of stock that has been propagated from known virus-clean or certified sources. The citrus industries in both Florida and California, for example, have set up certification and registration programs to assure that citrus nursery stock is propagated from the most pathogen-free propagative materials available. A similar certification program exists for seed potatoes. Another successful way to eliminate viruses, particularly from herbaceous plants, is to use meristematic tip culturing techniques and tissue culturing to develop virus-free callus tissue that can then be used to generate new virus-free clones of the original plant. This procedure is based on the fact that virus is usually not present in the actively growing shoot tip of an infected plant. This procedure has been used to clear many herbaceous cultivars of viruses.

3. Chemical Applications and 4. Biological Control

- There are no chemical sprays or biological control approaches to eradicate viruses, although insecticides and biocontrol products can be used to control insect vectors.

4. Government Regulatory Measures

- Management of insect vector populations in the field can be difficult to impossible unless coordinated on a regional basis but may be highly effective in closed production systems such as greenhouses or interiorscapes.

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 Virus Disease Fact Sheets

Mosaic Virus Diseases of Vine Crops: http://ohioline.osu.edu/hyg-fact/3000/3109.html

Virus Diseases of Greenhouse Floral Crops: http://ohioline.osu.edu/hyg-fact/3000/3065.html

Wheat Yellow Mosaic: http://ohioline.osu.edu/ac-fact/0003.html

Barley Yellow Dwarf of Wheat, Oats, and Barley: http://ohioline.osu.edu/ac-fact/0005.html

Tobacco Mosaic Virus: http://www.apsnet.org/education/LessonsPlantPath/TMV/default.htm