Soil-Borne Plant Pathogens

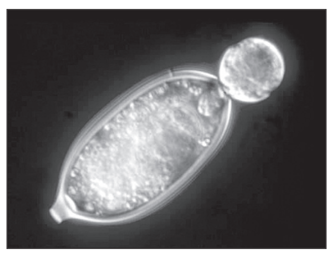
(Phytophthora, Pythium, Rhizoctonia, Armillaria, Fusarium, and Verticillium)

Host/Site

These disease organisms are widely found in soil. As a group, they can affect a wide range of plants, including fruits and vegetables, ornamental plants, trees, and shrubs. The occurrence of disease in plants depends on pathogen population levels, quantities of disease-suppressing organisms, plant resistance to disease, and environmental factors such as drainage, organic matter, soil compaction, weather conditions, and others. In summary, disease in a plant requires presence of the pathogen, a susceptible host, and environmental conditions conducive to the pathogen's growth.

Identification/Appearance

Frequent above-ground symptoms of root diseases include wilting, dieback, browning or rotting of tissues, and cankering. Common names for plant disease often reflect the visual damage to the plant but do not necessarily indicate the pathogen responsible for the disease. For example, seedling damping-off, the condition when seedlings die or fall over, can occur in most vegetables and can be caused by *Pythium*, *Phytophthora*, *Rhizoctonia*, *Fusarium*, or any combination of these. Root rot, such as that caused by *Phytophthora* in blueberry (see photo) also occurs widely in vegetables, bushes, and trees and can be caused by different root-infecting pathogens. Similarities in symptoms caused by different pathogens makes accurate diagnosis impossible without a laboratory analysis.



*Top: Leaf symptoms in blueberry (*Vaccinium corymbosum sp.*) caused by a* Phytophthora *root infection. Photo by Philip Dickey; Bottom:* Sporangium of Phytophthora infestans *from which a zoospore is germinating. Photo by B.G. Turgeon, Cornell University.*

Life Cycle

Pathogen life cycles vary. *Phytophthora* and *Pythium* can produce two kinds of spores: one that moves through the soil when there is sufficient moisture, and a second that can survive in plant tissue and drier soil for many years. These diseases are encouraged by excessive moisture but once established can remain viable even when soil conditions change. In the absence of living plants, *Rhizoctonia* can feed on dead organic material, which can make control difficult. *Armillaria* can also survive either on dead organic matter or living plants. It infects plants by mycelia, which can move into adjacent plants by root contact, and also forms mushrooms that spread spores. *Fusarium* and *Verticillium* invade plants and block the xylem vessels with their mycelia and spores, preventing normal water movement. Eventually the entire plant can become filled with the pathogens and their spores, which are spread by wind, water, insects, or human activity.

Natural Enemies

The most important natural enemies of soil-borne pathogens are other microbes in the soil, which compete for food, chemically inhibit pathogens, or actually attack the pathogens themselves. Disease prevention can be increased by building healthy soil that keeps pathogens under sufficient pressure from beneficial organisms so that they cannot thrive. Certain soil biota have been found to be useful as control agents that are applied to control specific diseases. (See list of available biological control agents.)

Monitoring

Symptoms of root diseases are often confused with drought stress or nutrient deficiency. A wilting disease, such as those caused by *Fusarium* or *Verticillium*, actually blocks the xylem tissue and causes drought stress. Symptoms of nutrient deficiency or excess vary depending on which nutrient is involved. For instance, a lack of nitrogen will generally cause yellowing of lower, older leaves or vein clearing of the leaves. In contrast, pathogen-induced leaf dieback generally starts from the tips of the newer leaves.

Action Threshold

If a root disease is confirmed, take action to correct the underlying conditions that are favoring the disease. Improve drainage, avoid overwatering, and avoid excessive quick-release nitrogen. Sometimes

(continued/over)

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plant removal is justified, followed by rotation to a resistant plant or variety. Amending with compost, mycorrhizae, or other biological control agents will probably not reverse a severe disease but may slow the spread of the pathogen and improve the plant's health. These amendments contribute to a diverse microbial community and the long-term health of the soil.

Cultural/Physical Controls

With all of these soil-borne pathogens, disease prevention is usually more successful than treatment. The best disease-prevention strategies employ exclusion, plant resistance, and environmental modification in combination.

Exclusion: Choose disease-free seeds and transplants that are healthy, vigorous, and free of disease. Remove infected plants promptly and avoid spreading contaminated plant material to other parts of the landscape. Be careful not to spread contaminated soil on tools or boots.

Resistance: Select disease-resistant varieties whenever possible.

Environment: Ensure a diverse community of beneficial soil microorganisms, in part by adding organic matter such as compost to soil. Avoid over fertilizing with quick release nitrogen. Correct drainage problems. Avoid soil compaction from vehicles, foot traffic, or hard rain, which inhibits oxygen availability. Mulch with compost or use cover crops to protect bare soil, and mulch to soften soil and delineate buffers around trees. Create clear pathways through the landscape to minimize traffic over root zones.

Biological Controls

Compost and compost tea can be used to inoculate soil with beneficial microbes that are capable of suppressing plant pathogens. The disease-suppressive abilities of compost have been demonstrated most clearly against *Pythium* and *Phytophthora*. *Rhizoctonia*, *Fusarium*, and *Armillaria* are harder to control with compost because of their ability to live off dead organic matter. A number of specific biological control agents that show unusual capacity to prevent disease have been registered for use to control soil-borne pathogens (see Selected Soil-Applied Biological Control Agents).

Mycorrhizae are beneficial associations between plants and specific fungi. Depending on the species, mycorrhizae either enter the roots of host plants or cover the root in a sheath to absorb leaked plant sugars. They increase the plant's nutrient uptake, water absorption, and resistance to pathogens. Mycorrhizae occur naturally but can be disrupted by flooding, burning, liming, and some chemical fertilizers or systemic fungicides. In such cases, inoculation of soil with mycorrhizae can be beneficial.

Selected Soil-Applied Biological Control Agents

Product	Labelled For
SoilGard™	*Pythium* *Rhizoctonia*
Mycostop™	*Fusarium* *Pythium* *Phytophthora*
MicroGro™	*Fusarium* *Pythium* *Rhizoctonia*
Rootshield™	Root pathogens
Compete™	Growth promotion
Vesicular-arbuscular mycorrhizae (VAM)	Growth promotion for many plant species
Ectomycorrhizae	Growth promotion for forest nurseries and urban trees

Chemical Controls

Never treat root diseases without a proper diagnosis. There are no fungicides that will cure infection by *Armillaria*, *Verticillium*, or *Fusarium*, though some may reduce the severity of the disease. Fungicide applications to soil will kill many important beneficial fungi and water molds. If fungicides are used, they should be combined with the beneficial environmental improvements discussed earlier.

Plant Disease Clinics and Labs

Plant Disease Clinic; Cordley Hall, Room 1089, Oregon State University, Corvallis, OR 97331-2903; Tel: 541-737-3472; putnamm@bcc.orst.edu

Washington State University Plant & Insect Diagnostic Lab, 7612 Pioneer Way East, Puyallup, WA 98371-4998; Tel: 253-445-4582; email to: glass@puyallup.wsu.edu or http://www.puyallup.wsu.edu/

Ribeiro Plant Lab, Inc. 10744 NE Manitou Beach Drive, Bainbridge Island, WA 98110; Tel: 206-842-1157; fungispore@aol.com or http://www.ribeiroplantlab.com