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VERTICILLIUM WILT OF ORNAMENTAL TREES AND SHRUBS

Verticillium wilt is a common disease of a wide variety of ornamental trees and shrubs throughout the United States and Connecticut. Maple, smoke-tree, elm, redbud, viburnum, and lilac are among the more important hosts of this disease. Japanese maples appear to be particularly susceptible and often collapse shortly after the disease is detected. Plants weakened by root damage from drought, waterlogged soils, de-icing salts, and other environmental stresses are thought to be more prone to infection.

Verticillium wilt is caused by two closely related soilborne fungi, *Verticillium dahliae* and *V. albo-atrum*. Isolates of these fungi vary in host range, pathogenicity, and virulence. *Verticillium* species are found worldwide in cultivated soils. The most common species associated with Verticillium wilt of woody ornamentals in Connecticut is *V. dahliae*.

SYMPTOMS AND DISEASE DEVELOPMENT:

Symptoms of Verticillium wilt vary by host and can be characterized as acute or chronic. Plants or branches with acute infections may wilt and die suddenly (Figure 1).

Figure 1. Japanese maple with acute symptoms of Verticillium wilt.

They also develop a variety of symptoms that include wilting, curling, browning, and drying of leaves. These leaves usually do not drop from the plant. In other cases, leaves develop a scorched appearance, show early fall coloration, and drop prematurely (Figure 2).

Plants with acute infections start with symptoms on individual branches or in one portion of the canopy. This symptom is often called “flagging.” Symptoms are often located on one side of the plant, which can be diagnostic for this vascular wilt disease (Figure 3). As the fungus grows and spreads within the plant from year to year,

symptoms appear in more of the canopy. Symptoms are usually most obvious in mid to late summer or fall--frequently after stressful periods of hot, dry weather. In some cases, infected plants suddenly die the season following initial symptoms.

Figure 2. Verticillium-infected Japanese maple leaves with marginal scorch symptoms.

Figure 3. Maple with a portion of the canopy exhibiting symptoms of premature fall coloration.

Plants with chronic infections usually show general decline, as exhibited by sparse canopies consisting of undersized, off-colored leaves, poor growth and vigor, and branch dieback. Infected plants can occasionally produce heavy crops of seeds or samaras. Plant death can be slow or sudden, depending upon the extent of infection and general plant health.

Another diagnostic characteristic of Verticillium wilt is distinctive discoloration or streaking in the sapwood. The color of the discoloration varies by host. For example, it is dark olive-green in maple (Figure 4), chocolate brown in redbud, and brown in elm. Streaking can be random in infected wood--it is not reliably present in small-diameter branches or twigs. However, discoloration is more consistent near the bases of larger, symptomatic branches. Since many other fungi can cause similar discolorations of sapwood, positive diagnosis of Verticillium wilt requires culturing sapwood tissue in the laboratory.

Figure 4. Diagnostic vascular discoloration in sapwood of maple infected with Verticillium wilt.

Verticillium dahliae is soilborne and persists for indefinite periods of time in the soil as resting structures called microsclerotia. Germination and growth of these structures is stimulated by exudates from a host plant

or from decaying organic matter. The fungus enters the roots and the water transport system (xylem) of the plant. It then grows, sporulates, and moves systemically throughout the plant. Spores (conidia) are ovoid and are borne on specialized hyphae (phialides) in a whorl around a conidiophore. Verticillium is named for this verticillate or whorled arrangement of the phialides on the conidiophore (Figure 5). The presence of the fungus in the xylem restricts movement of water and nutrients by its physical presence as well as through production of enzymes and toxins. As the fungus grows in the xylem, the plant responds in both physical and biochemical ways to contain or compartmentalize the fungus. This results in plugging and gumming of water-conducting vessels, which further restricts water in the host.

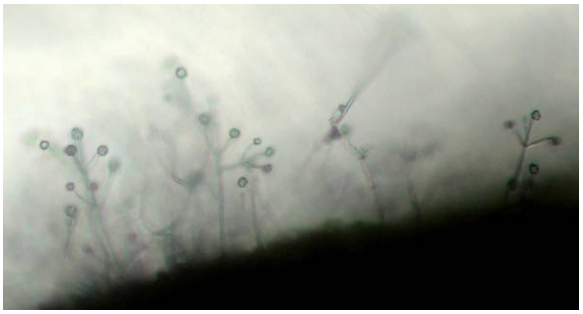

Figure 5. Verticillate spore-bearing structures on conidiophores.

This ongoing interaction between the host and the fungus can help to explain reports of symptom "remission" in some infected plants. Symptoms appear to stop and start for a year or so, although in most cases they reappear and encompass more of the plant canopy. This can be understood as an external expression of what is happening inside the infected plant--symptoms disappear after the plant has successfully compartmentalized the fungus to keep it from spreading. Symptoms reappear when the fungus breaks through the compartmentalization barriers and begins to grow and move again in the host.

Verticillium wilt occurs on a wide range of woody and herbaceous hosts. However, to date, all gymnosperms and monocots appear to be resistant or immune to this disease. A fact sheet "Verticillium Wilt of Vegetables and Herbaceous Ornamentals" has more information on the effects of the disease on nonwoody hosts.

MANAGEMENT STRATEGIES:

Managing Verticillium wilt is most successful using a multifaceted strategy. There are no satisfactory controls for this disease once plants are infected.

- Fungicides are not effective for control.
- For plants that exhibit mild symptoms, it can help to maintain vigor by following sound cultural practices. These include pruning symptomatic branches, watering during periods of drought, and fertilizing (based on a soil test). Mulching is also helpful since it helps maintain soil moisture, moderate soil temperatures, and minimize chances for mechanical injuries. Although infected plants cannot be cured, these practices can sometimes delay the progression of disease for several years.
- *Verticillium* fungi can survive for many years as microsclerotia in the soil. Therefore, it is necessary to avoid planting susceptible species in the areas known to be infested. In such cases, gymnosperms and resistant or immune species should be planted (Table 1).
- Since microsclerotia can be present in soil or debris, it is important to avoid moving soil or debris from areas of known infection.
- As a precaution against spread, all tools should be disinfested between cuts with

a 10% solution of household bleach, 70% alcohol, or one of the commercial products such as Physan 20.

- Several studies have demonstrated that microsclerotia can be found in fresh wood chips from infected trees. Although the studies are inconclusive, it is probably best to avoid using fresh chips to mulch susceptible hosts. It is suggested that chips be composted for at least one year prior to use.

Table 1. Resistance of Selected Woody Ornamentals to Verticillium Wilt

Resistant or Immune	Susceptible
Apple *(Malus)*	Ash *(Fraxinus)*
Arborvitae *(Thuja)*	Azalea *(Rhododendron)*
Beech *(Fagus)*	Barberry *(Berberis)*
Birch *(Betula)*	Black Locust *(Robinia)*
Boxwood *(Buxus)*	Box Elder *(Acer negundo)*
Butternut *(Juglans)*	Boxwood *(Buxus)*
Crabapple *(Malus)*	Catalpa *(Catalpa)*
Dogwood *(Cornus)**	Cherry, other stone fruits *(Prunus)*
Fir *(Abies)*	Coffee tree, Kentucky *(Gymnocladus)*
Firethorn *(Pyracantha)*	Currant *(Ribes)*
Gingko *(Gingko)*	Dogwood *(Cornus)**
Hackberry *(Celtis)*	Elm *(Ulmus)*
Hawthorn *(Crataegus)*	Honeysuckle *(Lonicera)*
Hickory *(Carya)*	Lilac *(Syringa)*
Holly *(Ilex)*	Linden *(Tilia)**
Honey Locust *(Gleditsia)*	Magnolia *(Magnolia)*
Hornbeam *(Carpinus)*	Maple *(Acer)*
Juniper *(Juniperus)*	Redbud *(Cercis)*
Katsura tree *(Cercidiphyllum)*	Rose *(Rosa)*
Larch *(Larix)*	Russian Olive *(Elaeagnus)*
Linden *(Tilia)**	Serviceberry *(Amelanchier)**
Mountain Ash *(Sorbus)*	Smoke tree *(Cotinus)*
Mulberry *(Morus)*	Spirea *(Spirea)*
Oak *(Quercus)*	Sumac *(Rhus)*
Pear *(Pyrus)*	Viburnum *(Viburnum)*
Pine *(Pinus)*	Weigela *(Weigela)*
Poplar *(Populus)*	Yellowwood *(Cladratis)*
Serviceberry *(Amelanchier)**	
Spruce *(Picea)*	
Sweet Gum *(Liquidambar)*	
Sycamore *(Platanus)*	
Walnut *(Juglans)*	
Willow *(Salix)*	
Yew *(Taxus)*	

* The resistance or susceptibility of these plants will depend upon the cultivar of the tree and the strain of *Verticillium* present in the soil.

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