Root Diseases of Pistachio Trees in New Mexico

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There is good news and bad news about diseases of pistachio trees. The good news is that relatively few diseases occur on trees grown in New Mexico. The bad news is that the diseases that can occur are generally deadly. Disease problems occurring on New Mexico pistachio trees are associated with soil-borne fungi—*Verticillium dahliae, Phymatotrichopsis (= Phymatotrichum) omnivorum,* and *Phytophthora* spp.—which attack roots. Foliar diseases that occur in other pistachio-growing areas, such as California, are rarely a problem in New Mexico because of its dry climate.

VERTICILLIUM WILT

Verticillium wilt of pistachio is caused by the soil-borne fungus, *Verticillium dahliae*. The fungus is found worldwide in all types of soils, but is most devastating in temperate regions of the world. *V. dahliae* has a wide host range, infecting over 200 different plant species including vegetables, flowers, fruit crops, ornamentals, and agronomic crops. Some important hosts in New Mexico include cotton, alfalfa, fruit and nut trees, chile, and many ornamentals.

Fungal fruiting bodies (microsclerotia) formed in the soil enable the fungus to multiply and persist for many years. Approximately 75 percent of the microsclerotia are found in the top foot of soil, but micro-sclerotia found up to 5 ft deep remain viable and are capable of infecting trees. The microsclerotia germinate in the soil, and the resulting hyphae (fungal threads) infect roots. Fungal hyphae move through the plant tissue to the xylem (water-conducting tissue). Once in the xylem the fungus blocks the movement of water and nutrients. The fungus can produce toxins, which may contribute to the discoloration seen in the vascular tissue.

V. dahliae exists in different races or strains that vary in virulence (aggressiveness or ability to cause disease), host range, and symptom expression. Symptom development in trees infected with a mild strain of the fungus is generally slow, and often only a portion of the tree will exhibit symptoms of marginal or one-sided chlorosis. Severe strains of the fungus move rapidly within the tree, causing irregular chlorosis, necrosis, wilting, and sometimes defoliation. With time, infected trees become stunted and the vascular tissue becomes discolored. Whether the plant is infected with a mild or severe strain of the fungus, the final outcome is usually death. Trees generally die from the base of the tree or branch outward.

Control of Verticillium wilt begins before the trees are planted. Site location is an important consideration. Old cotton and alfalfa fields should be avoided,

DIAGNOSIS AT A GLANCE: VERTICILLIUM WILT

Causal Agent
Soil-borne fungus, *Verticillium dahliae*

Symptoms
- Chlorosis or one-sided chlorosis (yellowing)
- Wilt
- Vascular discoloration
- Defoliation (some *Verticillium* strains)
- Death

Mode of Action
The fungus germinates in the soil and infects roots. Fungal hyphae move through the plant tissue to the xylem vessels (water-conducting tissue). Once in the xylem the fungus blocks the movement of water and nutrients. The fungus can produce toxins, which may contribute to the discoloration seen in the vascular tissue.

Control
- Avoid planting trees in old cotton and alfalfa fields.
- Use *Verticillium*-tolerant rootstock: 'UCB1', 'Pioneer Gold II'
- Soil solarization
- Soil fumigation

as observations show that trees planted in these locations are more likely to have problems associated with *V. dahliae* than trees planted in newly cultivated soils.

Choice of rootstock is also important. When choosing rootstock for New Mexico orchards, several factors should be taken into consideration including rate of growth, cold hardiness, ease of budding, and tolerance to *Verticillium*. Other tree characteristics, such as nut yield, degree of shell splitting, blank nut production, and alternate bearing, are also influenced by rootstock. Early research on pistachio rootstocks indicated that trees produce and grow better on *Pistacia atlantica* rootstock than on *P. terebinthus*. Additionally bud take on *P. terebinthus* tends to be more difficult in comparison with *P. atlantica*. However, *P. terebinthus* has more cold hardiness. Both of these common rootstocks are susceptible to Verticillium wilt. *P. integerrima* 'Pioneer Gold' rootstock exhibits a high tolerance to this fungus. However, it possesses only light tolerance to cold. A hybrid between *P. integerrima* and *P. atlantica* named 'Pioneer Gold II' is somewhat more cold hardy, but also possesses tolerance to *Verticillium*. A vigorous, potentially cold hardy, *Verticillium*-tolerant hybrid has been developed at the University of California. This is a hybrid between *P. integerrima* and *P. lentiscus* called 'UCB1'. All of the commonly used rootstocks are tolerant to root knot and lesion nematodes, though severe problems associated with nematodes in pistachio orchards are rare.

When trees become infected with *Verticillium*, it is difficult to control the disease. There are no fungicides that can be applied to infected trees. In established orchards in growing regions with high summer temperatures, soil solarization may help to reduce the disease's severity. This procedure requires complete tarping (using clear polyethylene) of the orchard floor. Tarping applied after irrigation will raise the soil temperature, reducing soil inoculum (microsclerotia and hyphae). When the tarp is left for over four weeks, *Verticillium* will be killed to a depth of about 4 ft. Soil solarization is expensive, but may be worth the cost in mature orchards where many trees are showing symptoms of disease.

In replanting areas where trees have died as a result of Verticillium wilt, the planting site should be fumigated with sodium methyldithiocarbamate (Vapam®) before replanting. After fumigating, replant the site with a tree budded on *Verticillium*-tolerant root stock.

PHYMATOTRICHUM ROOT ROT

Phymatotrichum root rot, also known as Texas root rot or cotton root rot, is caused by the soil-borne fungus, *Phymatotrichopsis (= Phymatotrichum) omnivorum*. There are no nice words to use when describing this disease. This fungus has developed surefire survival techniques. Perhaps more important, there is no real control for the disease other than avoiding land infested with the fungus.

This fungus is restricted to the southwestern United States and northern Mexico in alkaline soils with low organic matter content. It is typically found in relatively small areas. However, it can spread between plants through root grafts. It persists indefinitely in soil. Much of the fungus is found in the top 2–6 ft of soil, but sclerotia (fungal survival structures) have been found over 12 ft deep. *P. omnivorum* has an extremely wide host range, infecting over 2,000 species of dicotyledonous (broadleafed) plants. Furthermore, the fungus is capable of surviving on roots of native vegetation, such as mesquite, without causing any disease symptoms. This is an important disease of cotton, alfalfa, fruit trees, and many ornamentals.

DIAGNOSIS AT A GLANCE: PHYMATOTRICHUM ROOT ROT

Causal Agent
Soil-borne fungus, *Phymatotrichopsis omnivorum*

Symptoms
- Slight yellowing and bronzing of leaves
- Wilt
- Reddish lesion on crown
- Rapid death (leaves remain firmly attached)

Signs
- Fungal threads on roots (strands)
- Spore mats around infected trees

Conditions for Disease
- Alkaline soils
- Soils low in organic matter

Control
Avoid infested locations.

Symptoms first appear during the summer when air and soil temperatures are high. The first evidence of disease is a slight yellowing of the leaves. Quickly the leaves turn to a bronze color and begin to wilt. Permanent wilting of the branches can occur very rapidly, as little as two weeks from the first expression of disease. The tree dies with the leaves remaining firmly attached. In some cases the tree wilts so quickly that the leaves hardly change color, though they will become dry and brittle. A reddish lesion around the crown of the tree develops on trees killed by this fungus. The fungus also produces signs (development of the pathogen on the host) on or near infected trees. *P. omnivorum* produces fungal strands on the surface of infected roots. These strands are visible with a good hand lens. When strands are observed under a microscope, cruciform (cross-shaped) hyphae unique to this fungus can be seen. Another sign is the formation of a white- to tan-colored spore mat on the surface of the soil around infected plants. Spore mats develop during periods of high moisture. The spores in these mats have never been germinated, and are considered to have no function in survival or infection of the pathogen. Therefore, spore mats do not spread disease, but are merely evidence of the presence of the fungus.

Research to control this disease has been extensive, yet there are no good control methods available. There is no resistance or tolerance to this disease in pistachio rootstock. The best recommendation is to avoid land known to be infested with the fungus. Furthermore, orchards should not be planted in old cotton and alfalfa fields. If mesquite land is to be cleared for orchard planting, it may be worth the time and money to preplant the area in cotton. If the cotton is stressed for water, disease symptoms are generally noticeable in the first year. If no symptoms develop on the cotton, you can be relatively sure the land is safe for growing pistachio trees.

The ability of the fungus to survive deep in the soil has eliminated the possibility of using fungicides and fumigants to control the disease. Fumigating infested planting holes (where trees have died) will usually only delay the onset of disease.

Certain cultural practices can alter the soil environment so that it no longer favors *P. omnivorum*. These practices can help reduce the effectiveness of the pathogen; however, the procedure must be followed every year. Otherwise the soil environment returns to its typical state (high pH and low organic matter), and again favors the fungus. The procedure consists of loosening the soil (just beyond the drip line), creating a comparatively shallow basin around infected trees. The area is then covered to a depth of 2 in. with manure or similar organic matter. Layered on top of the organic matter is ammonium sulfate and sulfur, each at a rate of 1 lb/10 ft^2. Immediately flood the basin with enough water to wet the soil to a depth of 3 ft. This high level of soil moisture must be maintained for several weeks. If trees are treated before permanent wilting, they may recover. Remember that this treatment must be applied each year.

Some success in reducing the effect of the disease has been achieved by growing and incorporating a green manure cover crop over the orchard floor. This helps to stimulate vigorous rooting of the trees, enabling the trees to better withstand disease pressure. Additionally, the incorporation of the cover crop into the soil may help stimulate soil microflora that compete with *P. omnivorum*.

Finally, chemical barriers have been used to prevent the spread of disease from one tree to another. Using sulfur in trenches 4–6 in. wide and 4–6 ft deep around the outside of the drip line of infected trees has prevented the spread of *P. omnivorum* for over seven years.

CROWN ROT

Crown rot, caused by the soil-borne fungus *Phytophthora* spp., occurs only in areas with heavy, poorly drained soils. This fungus is related to a group of fungi known as water molds. When the soil remains saturated for a long time, the fungus is able to infect susceptible roots. Old trees are more susceptible to disease than young, vigorously growing trees.

DIAGNOSIS AT A GLANCE: CROWN ROT

Causal Agent
Soil-borne fungus, *Phytophthora* spp.

Symptoms
- Rapid decline of tree
- Chlorosis
- Wilt
- Death
- ***No*** vascular discoloration (as in Verticillium wilt)

Conditions for Disease
Water logged, heavy soil

Control
- Maintain vigorous trees.
- Soil fumigation.

This fungus causes crown and root rot, typically leading to the tree's death. Crown rot is often misdiagnosed as Verticillium wilt, as the above-ground symptoms are nearly identical. The disease is characterized by a rapid decline in plant vigor. Infected trees may turn yellow, wilt, and eventually drop their leaves. This disease can be distinguished from Verticillium wilt by examining the vascular tissue of infected plants. If the tree is infected with *Phytophthora* there will be no discoloration of the vascular tissue, which is typical of *Verticillium* infection.

Vigorously growing trees appear to have a tolerance to *Phytophthora*. Thus, selecting vigorous rootstocks can help to reduce the incidence of the disease. Additionally, maintaining healthy trees with good irrigation and fertilization practices is important in managing the disease. In locations where trees have died from this disease, soil fumigation can be effective in reducing the fungus in the soil and is recommended before replanting.

Reference

Crane, J.C. and J. Maranto. 1988. Pistachio Production. Cooperative Extension Service, University of California, Division of Agriculture and Natural Resources. Publication 2279. 15 p.

Additional Reading

For more information on pistachio production, see *Growing Pistachios in New Mexico*, NMSU Cooperative Extension Service Circular 532. This publication can be ordered from Dept. of Agricultural Communications–Bulletin Office / New Mexico State University / Box 30003, MSC 3AI / Las Cruces, NM 88003 / (505) 646-2701, or download the publication from our World Wide Web site at http://www.cahe.nmsu.edu/cahe/redtops/circ532.pdf.

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