COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

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Cotton (Texas) Root Rot

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Pathogen

Fungus, *Phymatotrichopsis omnivora (Phymatotrichum omnivorum)*

The most important disease of woody dicotyledonous plants in Arizona is *Phymatotrichopsis* root rot (Cotton or Texas root rot) caused by a unique and widely distributed soil-borne fungus, *Phymatotrichopsis omnivora*. The fungus is indigenous to the alkaline, low-organic matter soils of the southwestern United States and central and northern Mexico.

Hosts

Many dicotyledonous trees and shrubs are hosts, but monocots are immune. The fungus has one of the largest host ranges of any known fungal pathogen, and most of the introduced dicotyledonous ornamentals in Arizona are susceptible to some degree.

Distribution of disease in Arizona

Disease occurs in different soil types and in areas as diverse as the low lying flood plains of rivers and washes of central and western Arizona and the higher grassland hills of southern Arizona. Heavily infested areas of *Phymatotrichopsis* root rot include the flood plains and certain tributaries of the Gila River (Safford, Duncan, Solomon, Thatcher, Fort Thomas, Pima, Eden, Florence, Sacaton, Buckeye, Gila Bend, Agua Caliente, Growler, Roll, Mohawk, and Dome Valley); the Santa Cruz River (Sahuarita, Tucson, Cortaro, Avra Valley, Rillito, Marana, Red Rock, and Eloy); the San Pedro River (Hereford, St. David, Benson, Pomerene, Redington, Mammoth, and Winkelman); Colorado River (Parker, Poston, Ehrenberg, Yuma, Somerton, and Gadsden) and certain locations of the Salt River and Queen Creek. Other infested areas include Chandler, Aguila, San Simon, Bowie, McNeal, Douglas, and Elfrida. The "mesa" (land at elevations above the influence of the Colorado River) in Yuma County seems to be free of the disease, whereas many "valley" sites are infested.

Phymatotrichopsis root rot occurs at elevations as high as 4,700 feet near Elgin and Sonoita in Santa Cruz County, in the Nogales area and Sierra Vista. Disease has never been detected in the Bonita area north of Willcox, but in the Sulfur Springs Valley, the disease is found near Elfrida, McNeal, and Douglas.

Disease does not occur uniformly in local situations. Two distribution patterns are common. In one situation disease may occur in many small scattered circular areas, a "shot-gun" scenario. In other situations, the infested areas are large and few in number. The disease may occur in one small area of a landscape or throughout the property.

Symptoms/signs

Cotton (Texas) root rot often causes a rapid wilt and death of the host in the late spring, summer and early fall when temperatures are high (Figures 1a - c). Dead and dying leaves remain attached to the plant. However, infected plants also may decline more slowly, especially at cooler temperatures and when plants are well cared for. The roots of dying or declining plants are rotted.

Most woody trees and shrubs show no symptoms during the first few years after planting into infested areas. This is in contrast with certain tap rooted crop plants such as cotton and alfalfa that become infected and die the first summer after planting. The fungus is deep seated in the soil, and it may simply be that roots of many susceptible plants do not grow into the deeper, infested areas for a number of years.

Figure 1a. Symptoms of cotton root rot of peach trees. Note the dead trees with attached foliage.

Figure 1b. Symptoms of cotton root rot in African sumac. Note living young Aleppo pine (very tolerant) and fountain grass (immune) nearby.

Figure 1c. Symptoms of cotton root rot of Heritage oak. Note healthy oak nearby.

In grapes, for example, symptoms usually first appear two to four years after planting. Some trees show no symptoms for five or more years after planting. Symptom development and fungal activity is different in plantings in low elevations in Arizona as compared to plantings above 3,600 feet. Symptoms at low elevations consist primarily of initial stress, wilting of foliage and death of the entire plant within a few days after initial symptoms. This death usually occurs from late May through September. At higher elevations, plants may not wilt suddenly, but die more slowly.

During the summer rainy season, the fungus may occasionally produce a white to light tan spore mat on the surface of the soil near the host (Figure 2). Fresh spore mats look like pancake batter on the soil surface. The spores produced in these mats are not considered important in the disease cycle since they have never been observed to germinate. Spore mats are not common and may be confused with other fungi that grow over the soil surface or in decaying litter so they should be positively identified before using them in a diagnosis.

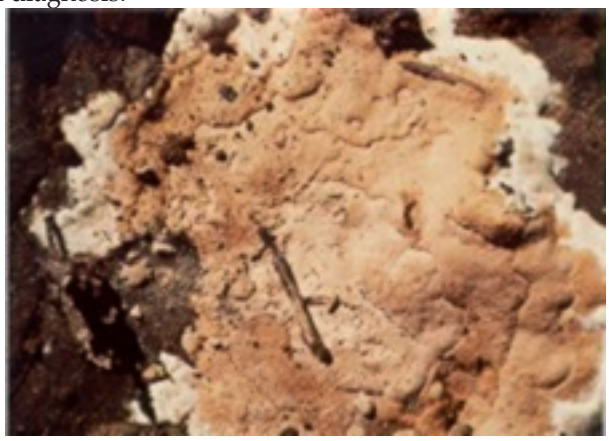

Figure 2. A typical spore mat of *Phymatotrichopsis omnivora.* These fungal structures occur on the soil surface during the summer "monsoon" season.

Biology of *P. omnivora*

The fungus occurs in the soil in localized patches. *P. omnivora* has no aerial or soil-borne spores that spread the fungus. It produces interwoven masses of hyphae known as strands (Figure 3a and 3b) that are probably the main mechanism of survival in Arizona soils. Once strands grow and colonize root tissue, extensive root infection results in wilting and plant death. Strands, utilizing infected root tissue as an energy source, grow short distances through the soil to infect healthy roots. The fungus produces survival structures called sclerotia in other locations such as Texas and Mexico, but they are rarely found in Arizona soils or on infected roots.

Growth of strands from one host to another is probably the only available method of spread for the fungus and explains a typical pattern of kill in home landscaping situations where susceptible trees or shrubs are planted adjacent to each other. The fungus may kill one plant 2 or 3 years after the initial

Figure 3a. Young, light brown strands of *Phymatotrichopsis omnivora* growing on the surface of an infected root.

Figure 3b. Strands of *Phymatotrichopsis omnivora* growing on the surface of an infected root.

planting. Spread occurs in later years by strand growth from infected to healthy root tissue. Eventually, an entire group of plants may succumb to the disease.

Identification

A positive identification of the pathogen on roots is essential for a diagnosis. With careful examination under at least 10X magnification, light to dark brown strands or hyphal webs of the fungus can be observed on the root surface. When the strands or webs are observed using a compound microscope at 100-200X, the characteristic cruciform shaped hyphae with pointed (acicular) terminals can be observed. These structures are unique to *P. omnivora.*

Because plants may die during the summer for reasons other than *Phymatotrichopsis* root rot, it is necessary to examine root tissue for the presence of the fungus. The only positive proof of death caused by *P. omnivora* is to examine the cortical tissue of rotted, decayed roots and to identify the

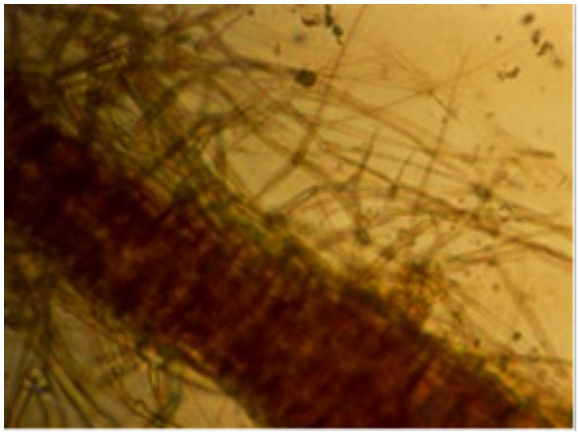

Figure 4. The appearance of the strand in Fig. 3 as seen under the compound microscope. The cruciform hyphae with pointed ends are diagnostic of *P. omnivora* and used to confirm identification of the fungus.

characteristic mycelial strands and hyphae that are produced by the fungus (Figure 3a, 3b and 4). An experienced person often can make this examination with the use of a hand lens. However, the strands, which are masses of vegetative hyphae that are unique to this pathogen, are more easily identified in the laboratory under a dissecting and compound microscope.

Sampling

When sampling roots for diagnosis of disease, select roots with discolored, rotted outer bark. If *P. omnivora* is present, microscopic examination will reveal the unique strands of the fungus on the outer bark. Strands are most easily identified on fresh material. However, they may sometimes be seen on the surface of old, dead roots.

If the plant is dead or dying, remove as much of the root system as possible when taking it out. In a disease situation, all roots may not be infected, so take several samples of rotted and discolored roots on which the outer or cortical tissue still remains attached. The samples should be at least ½ inch thick and 6 to 9 inches in length. Leave soil attached, and store the roots in a plastic bag under refrigeration. Do not add water or wet paper towels. Submit the sample to your County Extension Office or to the Extension Plant Pathology Laboratory on The University of Arizona campus in Tucson. Please send samples early in the week to avoid delays in transit.

Control

It should be emphasized that the fungus is only a pathogen of mature roots of dicotyledonous plants. The only effective method of control is to plant immune or highly resistant species in infested areas. See Tables 1 and 2 for lists of immune and resistant plants.

All monocotyledonous plants are immune to this disease. This includes large numbers of ornamentals in the Amaryllidaceae, Liliaceae, Iridaceae, Palmaceae, and the large

grass family, Gramineae. Important immune plants from these plant families that are commonly grown in Arizona include palms in the genera *Washingtonia* (fan palms), *Phoenix* (date palms), and *Arecastrum* spp., (Queen palms), *Agave* and *Yucca* spp., bamboos and many perennial ornamental grasses).

Many dicotyledonous desert plants, although not immune to the disease, are tolerant and usually grow normally in infested areas. They include species in the genus *Cercidium, C. floridum* (blue palo verde), *C. microphyllum* (foothills palo verde), *C. praecox* (Sonoran palo verde); the genus *Prosopis, P. velutina* (honey mesquite), *P. chilensis* (Chilean mesquite); *Simmondsia chinensis* (jojoba); *Parkinsonia aculeata* (Mexican palo verde), *Condalia lycioides* (greythorn) and *Chilopsis linearis* (desert willow), *Amorpha fruiticosa* (false indigo), *Celtis* spp. (hackberry), *Acacia greggii* (catclaw), *Larrea tridentata* (creosote bush), *Fouquieria splendens* (ocotillo) and members of the Cactaceae (the large family of cacti). There are probably many other native plants in this category.

Some commonly planted non-native dicotyledonous trees and shrubs such as Aleppo pine and citrus are rarely affected by the disease. Winter annuals escape the disease because *P. omnivora* is not active in cold soils. The list of susceptible plants is more reliable than plants in the resistant list. This is due to the fact that plants that succumb to the disease can be easily catalogued whereas plants that appear resistant may appear so simply because they have not been exposed to the pathogen. A list of known susceptible plants would be very long, but some of the most susceptible are: *Prunus* spp. including almonds, apricots, cherry, sweet cherry, sour cherry, nectarines, plums, peaches; *Fraxinus* spp. including Arizona ash (*F. velutina*); cottonwood, (*Populus deltoides*), *Ulmus* spp. including Chinese elm (*U. parvifolia)* and siberian elm (*U. pumila*); *Ficus* spp. (figs); honey locust (*Gleditsia* spp.); magnolia (*Magnolia grandiflora*); pear (*Pyrus communis*); pecan (*Carya illinoinensis*); pistachio (*Pistacia* spp.); pomegranate (*Punica granatum*); American sycamore and American plane tree, and London plane tree (*Platanus occidentalis x P. acerifolia*); chinaberry tree (*Melia azedarach*); willow, weeping and golden (*Salix babylonica* and *S. alba*); bottle tree (*Brachychiton populneus)*, silk oak (*Grevillea robusta*); pepper tree, Brazilian and California (*Schinus terebinthifolius* and *S. molle*); Japanese privet (*Ligustrum japonicum*); African sumac (*Rhus lancea*), xylosma (*Xylosma congestum*), oleander (*Nerium oleander*), carob (*Ceratonia siliqua*) *Cassia* spp., *Vitis* spp. (grape), *Ilex* spp. (holly), *Cotoneaster* spp. (cotoneaster), *Malus sylvestris (crabapple*), *Juglans* spp. (walnuts).

Table 1. Plants immune to *Phymatotrichopsis* root rot

EXAMPLES OF PLANTS IMMUNE TO COTTON ROOT ROT (MONOCOTS)	
Palms	all palms
True grasses and turfgrass	all species
Agave spp.	all Agaves
Aloe spp.	Aloe
Arundo donax	Giant reed
Asparagus sprengeri	Sprenger asparagus
Aspidistra elatior	Cast-iron plant
Bambusa spp.	Bamboo
Cordyline australis	Fountain dracaena
Crinum spp.	Spider-lily
Crocus spp.	Crocus
Ensete ventricosum	Abyssinian banana
Gladiolus spp.	Garden gladiola
Hyacinthus orientalis	Garden hyacinth
Iris spp.	Iris
Lilium longiflorum	Trumpet lily
Liriope muscari	Lilyturf
Musa paradisiaca	Banana
Narcissus tazetta	Narcissus
Narcissus jonquilla	Jonquil, daffodil
Phyllostachys aurea	Golden bamboo
Tulip gesneriana	Tulip
Yucca species	all species of Yucca
Zantedeschia spp.	Calla-lily

Table 2. Plants resistant to *Phymatotrichopsis* root rot.

EXAMPLES OF PLANTS TOLERANT TO COTTON ROOT ROT	
Antirrhinum majus	Snapdragon
Argemone spp.	Prickle poppy
Aster spinosa	Aster, Starwort
Atriplex spp.	Saltbush
Caragana arborescens	Siberian pea-tree
Catharanthus roseus	Madagascar periwinkle
Celosia argentea var. cristata	Cock's-comb
Celtis spp.	Hackberry
Cercidium floridum	Blue paloverde
Cercidium microphyllum	Foothill paloverde
Chilopsis linearis	Desert-willow
Coleus scutellariodes	Common coleus
Condalia lycioides var. canescens	Mexican condalia
Cupressus	all cypress and evergreens
Echinocystis lobata	Prickly cucumber
Eucalyptus camaldulensis	River redgum
Eucalyptus rudis	Western Australian floodedgum
Fragaria chiloensis	Strawberry
Gomphrena globosa	Globe-amaranth
Gypsophila paniculata	Baby's-breath
Helichrysum bracteatum	Straw-flower
Iberis amara	Rocket candytuft
Iberis odorata	Candytuft
Lagenaria siceraria	Bottle gourd
Lobularia maritima	Sweet-alyssum
Luffa acutangula	Angled luffa
Lycium spp.	Wolfberry
Malvaviscus conzattii	Malvaviscus
Marrubium vulgare	Horehound
Mentha rotundifolia	Round-leaf mint
M. spicata	Spearmint
Momordica balsamina	Balsam-apple
Nepeta cataria	Catnip
Opuntia arbuscula	Prickly-pear cactus
Oxalis rubra	Wood-sorrel
Parkinsonia aculeata	Mexican paloverde
Parkinsonia praecox	Sonoran paloverde
Pelargonium spp.	Geranium
Petunia hybrida	Garden petunia
Phlox drummondii	Annual phlox
Pinus halepensis	Aleppo pine
Polianthes tuberosa	Tuberose
Prosopis spp.	Mesquite
Prosopis velutina	Velvet mesquite
Prosopis chilensis	Chilean mesquite

EXAMPLES OF PLANTS TOLERANT TO COTTON ROOT ROT (cont'd)	
Reseda odorato	Garden mignonette
Rorippa nasturtium aquaticum	Watercress
Rosmarinus officinalis	Rosemary
Salvia azurea	Blue sage
Salvia farinacea	Mealy-cup sage
Sambucus caerulea var. arizonica	Arizona elderberry
Simmondsia chinensis	Jojoba
Tropaeolum majus	Garden nasturtium
Tropaeolum minus	Dwarf nasturtium
Verbena hybrida	Garden verbena
Vinca major	Big-leaf periwinkle
Viola odorata	English violet
Viola tricolor	European wild pansy

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