



# 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.

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.



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

### 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.

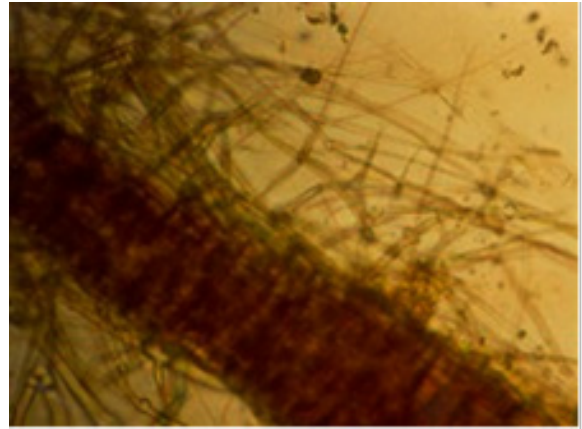


Figure 4. The appearance of the strand in Fig. 3 as seen under the compound microscope. The cruciform hyphae with pointed ends are diagnostic of *P. omnivora* and used to confirm identification of the fungus.



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

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 fruticosa* (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 illinoensis*); 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
<i>Agave</i> spp.	all Agaves
<i>Aloe</i> spp.	Aloe
<i>Arundo donax</i>	Giant reed
<i>Asparagus sprengeri</i>	Sprenger asparagus
<i>Aspidistra elatior</i>	Cast-iron plant
<i>Bambusa</i> spp.	Bamboo
<i>Cordyline australis</i>	Fountain dracaena
<i>Crinum</i> spp.	Spider-lily
<i>Crocus</i> spp.	Crocus
<i>Ensete ventricosum</i>	Abyssinian banana
<i>Gladiolus</i> spp.	Garden gladiola
<i>Hyacinthus orientalis</i>	Garden hyacinth
<i>Iris</i> spp.	Iris
<i>Lilium longiflorum</i>	Trumpet lily
<i>Liriope muscari</i>	Lilyturf
<i>Musa paradisiaca</i>	Banana
<i>Narcissus tazetta</i>	Narcissus
<i>Narcissus jonquilla</i>	Jonquil, daffodil
<i>Phyllostachys aurea</i>	Golden bamboo
<i>Tulip gesneriana</i>	Tulip
<i>Yucca</i> species	all species of Yucca
<i>Zantedeschia</i> spp.	Calla-lily

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

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

## EXAMPLES OF PLANTS TOLERANT TO COTTON ROOT ROT (cont'd)

<i>Reseda odorato</i>	Garden mignonette
<i>Rorippa nasturtium aquaticum</i>	Watercress
<i>Rosmarinus officinalis</i>	Rosemary
<i>Salvia azurea</i>	Blue sage
<i>Salvia farinacea</i>	Mealy-cup sage
<i>Sambucus caerulea var. arizonica</i>	Arizona elderberry
<i>Simmondsia chinensis</i>	Jojoba
<i>Tropaeolum majus</i>	Garden nasturtium
<i>Tropaeolum minus</i>	Dwarf nasturtium
<i>Verbena hybrida</i>	Garden verbena
<i>Vinca major</i>	Big-leaf periwinkle
<i>Viola odorata</i>	English violet
<i>Viola tricolor</i>	European wild pansy



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