Phytophthora in Arizona Citrus

Finding ways to stop a killer isn't easy. Ask UA plant pathologist Mike Matheron. Every month for the last three years he has studied infested soil and taken soil temperatures to determine what attracts a deadly fungal disease to Arizona's citrus groves.

Nearly 90 percent of the 37,700 acres of lemons, grapefruits, and varieties of oranges grown in Yuma and Maricopa counties are infected with Phytophthora. Arizona's citrus growers fight to keep fungus levels low by applying fungicides. Yet, reductions in yields continue to occur in the state. Citrus trees grow in different areas of Arizona, but are cultivated for commercial shipping in Yuma and Phoenix.

"Phytophthora is a killer," Matheron said. "It will kill a citrus tree if it is not stopped in time. " Phytophthora affects a variety of plants worldwide from vegetable and ornamental plants to mature citrus and forest trees. It is a serious and severe fungal disease infecting citrus orchards today. "There are few so-called healthy orchards," Matheron said. "Phytophthora is an important factor limiting tree health," he continued. "If you have a fungus destroying the roots of a citrus tree, it's reflected in less vigorous growth of the tree and a reduction in yield. That means not only the quality but the quantity and the size of the fruit is affected."

Recently, Matheron completed a three-year study, sponsored by the Arizona Citrus Research Council, on how soil temperature affects the activity and the amount of Phytophthora in the soil. In Arizona there are two known pathogens infecting citrus orchards, *P. citrophthora* and *P. parasitica*. They work in the same manner by causing a root rot in a tree's small feeder roots and then move onto the larger secondary roots.

Irrigation, which is essential in Arizona citrus groves, activates the fungus. "When a grower irrigates an orchard it stimulates the release of zoospores or the part of the fungus that will attack the root," Matheron said. "The zoospores actually move through the water and can swim, which causes a more rapid spread of the disease from tree to tree. " Matheron believes the fungus can attack the trunk of the tree at or below the soil surface, especially if a grower uses flood irrigation.

M. Matheron

Gummosis, a Phytophthora-induced condition, on a lemon trunk.

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Because the fungus resides in the soil, it is difficult for most growers to know when Phytophthora has infected a tree. "You need a microscope to see the zoospores," Matheron said. "If you grow Phytophthora in the laboratory it looks like white cotton, but in the field the fungus is not visible. "

"Trees don't look as vigorous when there is Phytophthora," Matheron added. "They will grow well for the first 5 to 10 years, but if the pathogen is there it can cause a condition called gummosis on the trunk. By the time you see the decline on the top of the tree, the root system is usually severely damaged." Early findings in his study suggested that there is no particular time of year when the fungus is less present in the soil. But Matheron did find that both pathogens are inhibited when soil temperatures are high.

Matheron used orange trees in commercial orchards in Phoenix and Yuma for the study. Cooperating growers allowed him to check the roots and surrounding soil for samples of 15 trees in each location.

"At each test site, we divided the samples into five groups of three trees," Matheron said. "We took a core sample of the soil at depths of 10, 30, and 60 cm (4, 12, and 24 inches) within the drip line for each tree. "The drip line is the outer boundary of the leaf canopy that forms the shade area under the tree. In other words, it is the area of ground that does not get wet when it rains. According to Matheron, most feeder roots lie within the drip line and grow from 0-12 inches beneath the soil. This is also the area where Phytophthora is concentrated.

"Zoospores are very sensitive to the amount of oxygen in the soil," Matheron said. "The deeper you go, less oxygen is available in the soil water. We wanted to learn where the population of the fungus was highest in the soil profile. "

For the study, soil temperatures were recorded inside the drip line area to determine the values under the larger tree canopy of a mature orchard. Measurements also were taken outside the drip line to record soil temperatures

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that could occur around small trees of a newly planted orchard without a shading leaf canopy. The temperature was recorded hourly and soil samples were taken each month, five to six days after the groves were irrigated.

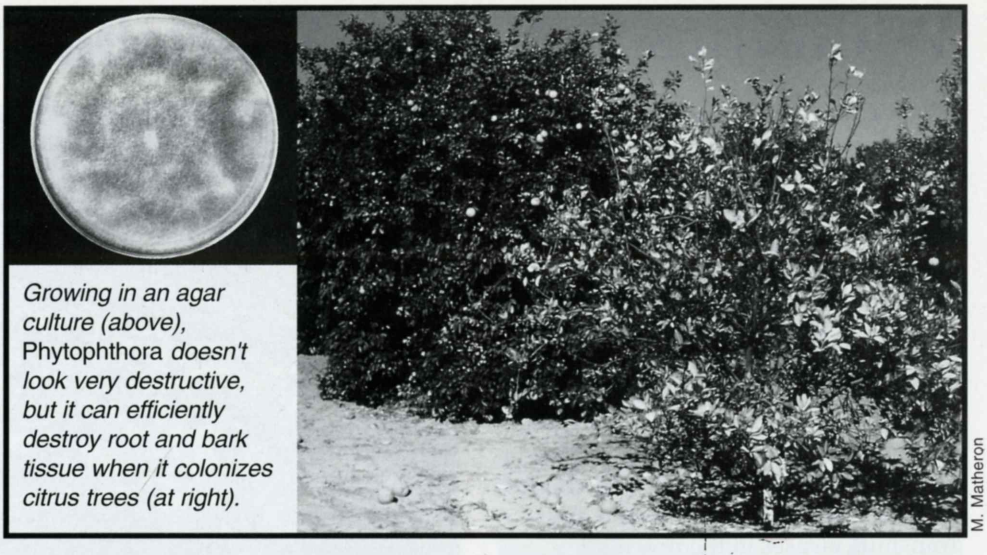
"With *P. parasitica* we found no seasonal differences in amounts in the soil," Matheron said. For two of the three years with *P. citrophthora*, there was a higher population of the pathogen from January to June than in the last six months of the year. "However, during the last year of our study this did not seem to hold true," he said.

Despite previous research findings outside Arizona that *P. parasitica* went dormant in the winter, Matheron found that not to be the case in Arizona. "Each and every month we could find both pathogens," Matheron said. "This will be helpful in the future for diagnosis purposes when growers want to know if either of these pathogens are in their groves. Now we can determine the best control procedures to follow without waiting until certain times of the year to analyze the soil. "

Earlier, growers were limited to sampling the soil in the summer when other researchers found the fungus was most active, according to Matheron. "But now we can sample in January as well as July and get the same results," he said.

After determining temperature levels in the orchard, the researchers tested the amount of Phytophthora activity at these temperatures. "We took soil infested with each pathogen and planted small trees into it at specific temperatures to learn when the fungus was most active and when it is not," Matheron said. "It turns out there are certain times of the year when the soil temperature is so high that it actually stops the fungus from infecting tree feeder roots."

"In a new orchard where the tree is very small and has a very small leaf canopy, high soil temperatures could inhibit infection of roots by *P. parasitica* between July and September,"



Growing in an agar culture (above), Phytophthora *doesn't look very destructive, but it can efficiently destroy root and bark tissue when it colonizes citrus trees (at right).*

M. Matheron

Matheron explained. "Under the same conditions, from late April to early October, root infection by *P. citrophthora* could be inhibited as well."

Soil temperatures at 80°F and above for *P. citrophthora* and above 92°F for *P. parasitica* sent both pathogens into a dormant state, according to Matheron. Feeder root infecting is inhibited at these temperature levels. Thus, higher soil temperatures help protect the tree for a time. For growers this means they would not have to apply fungicide treatments during the summer months, Matheron said.

Learning how to control Phytophthora is an ongoing process. Matheron and Glenn Wright, extension citrus specialist, hope to find rootstocks that are more tolerant of the disease. Wright has collected several rootstocks which may have promise here in Arizona. Some of these are now being tested. But when evaluating Phytophthora tolerant rootstock, the overall benefits to the grower must be considered.

"The average life of an orchard is a minimum of 30 years," Matheron said. "Growing citrus is a long-term investment. Realistically if we could identify new tolerant rootstocks, growers could use them as new orchards are being planted. "

Developing rootstocks also means ensuring that they are commercially viable for Arizona growers. "Our research on these rootstocks should tell us if a grower can expect high yields and large fruit," Wright said. "And it should answer questions like whether the tree yields at a young age (precocity), if the sugar level and the acid level of the fruit are well balanced and if the rootstock is susceptible to other diseases.

"Evaluating a rootstock is a long process from the greenhouse to the field," Wright admitted. "It could be five to ten years before we would be able to see if the fruit quality is good and yields are acceptable."

Matheron and Wright believe growers are willing to endure the wait to end Phytophthora's destructive path.

— Crystal Renfrow

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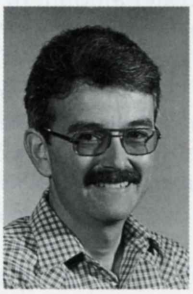

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