Preliminary Survey of Southern California Desert Lemon Groves for Detection of *Coniophora* spp.

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In 1992, a species of *Coniophora, C. eremophila*, was reported to be associated with a brown heartwood rot in lemons in Yuma, Arizona. Since then, this fungus has been attributed to the recent decline of lemon trees and is considered to be the most important production problem in Arizona. The decay has been associated with a progressive dieback and decline, as well as with reduction in yield of infected trees.

Species of *Coniophora* have a simple life cycle. The fungus produces spores from a fruiting body. To survive, these spores must be disseminated to a wood-exposing wound of a tree, germinate, and infect the tissue. As the fungus grows in the wood, it causes a brown-rot decay. The decayed wood is brown, easily crumbled, and the strength of the wood is compromised. The fungus grows as thread-like mycelium within the wood and generally, once a large amount of wood is colonized, it will produce a fruiting body from which spores are released. No other structures are formed to produce spores. On citrus in Arizona, this fungus has not been found fruiting. Bigelow et al. (1996) identified the fungus causing a grown rot in branches of living trees and associated with decline of lemons as *C. eremophila*. Their identification was based on the cultural characteristics of the fungus, including high growth rate, yellow mycelium, and multiple clamp connections, as well as the lack of any other known species of wood decay fungus with these characteristics that causes a brown rot of wood in native woody plants. Additionally, fruiting bodies of *C. eremophila* occur on native host plants in desert areas where lemons are grown. Still, fruiting bodies of the fungus would need to be collected from lemon or genetic studies conducted with isolates from lemon and native plants for positive identification of the pathogen.

In preliminary field trials in California and Arizona, attempts to induce fruiting of the *Coniophora* sp. on lemon wood have not been successful, and we are currently conducting a genetic comparison of lemon isolates from California to isolates and fruiting bodies collected from native plants in Arizona.

As stated above, *Coniophora* decay is considered to have a large impact on lemon production in Yuma, Arizona, and this has caused growers to be concerned that this disease may be contributing to lemon decline in California. Surveys conducted by us in 1997-98 confirmed the presence of a *Coniophora* species in the Coachella Valley and in the Borrego Springs areas of California. Incidence of total wood decay in selected groves was as high as 92% in a 22-year-old Lisbon/Macrophylla (scion/rootstock) in Borrego Springs and 90% in a 30-year-old Eureka/Macrophylla in the Coachella Valley. Confirmation of *Coniophora* decay was through isolation of the fungus from decayed wood.

As in Arizona, the fungus has not been found fruiting on citrus in California. Therefore, it is uncertain how the fungus spreads from tree to tree. It has been reported that on native plants

the fungus produces fruiting bodies with spores that are apparently short-lived and do not travel long distances. Furthermore, high incidences within a grove would imply that a local source of the fungus exists within the grove or adjacent to the grove. In addition to surveys for *Coniophora* sp. in lemon groves, a survey of native vegetation in adjacent areas to lemon groves was conducted. No fruiting bodies of any wood decay fungi, however, were found on Tamarisk, desert willow, or creosote.

In 1998-99, surveys were also conducted to determine if the occurrence of *Coniophora* decay was associated with specific types of wounds. Surveys were conducted in a Lisbon lemon/Macrophylla grove with 37% incidence of decline. This survey included the examination of pruning wounds on the scaffold branches, as well as wounds from hedging cuts at the tops of the trees. Trees were hedged 12 inches below the previous hedging height. In this grove, we observed an unacceptable amount of shredding of wood from hedging at high speeds with dull blades from mechanical pruning equipment. To determine locations of fungal entry into lemon trees, pruning sections were collected from the ground and examined for decay after the treetops had been hedged. Wood that had decay on the most terminal tip of the branch but not at the newly cut surface was considered to have originated from inoculum introduced into pruning wounds. The number of pieces of wood on the ground with decay was approximately 20%, however, only 20% of those hedged wood sections had wood decay that had come from the previous years pruning wounds (top of the tree) and not from the lower scaffold decay. This indicated that the majority of infections were introduced through wood-exposing wounds on the branches in the lower canopy. Approximately 5% of the infections originated from improper hedge cuts.

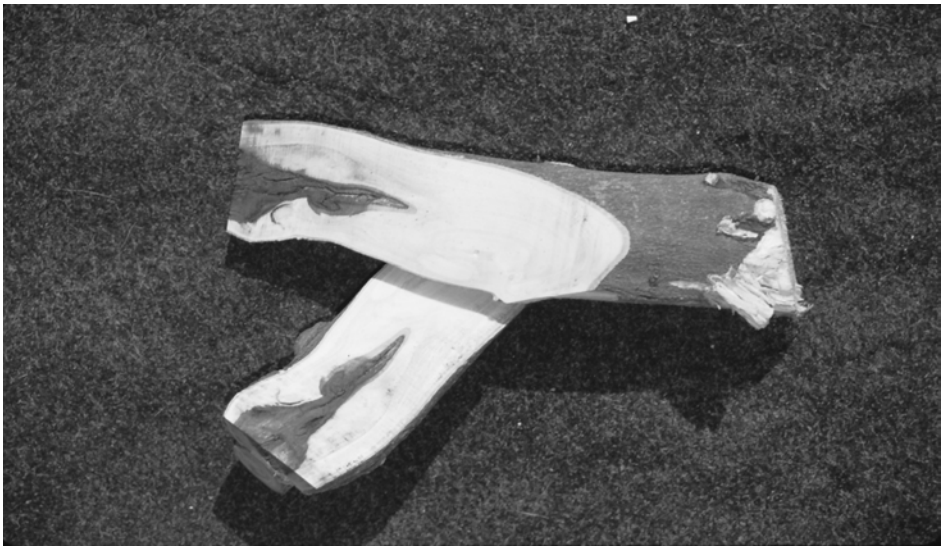
Thus, the fungus may enter trees through pruning wounds at the tops of trees from improper mechanical hedging. The fungus probably entered these wounds from aerial disseminated spores or from mycelium transferred by pruning equipment. Wood that is cut by a shredding action does not heal properly or heals poorly. Cleanly cut wounds generally heal rapidly and thereby prevent or reduce the chance of infection by opportunistic pathogens such as wood decay fungi. Shredded wood can also retain high amounts of moisture creating an environment conducive to fungal spore germination and mycelial growth. Thus, proper pruning would help reduce the introduction of *Coniophora* and other wood decaying organisms. In addition to proper mechanical pruning, limbs with stress cracks from excessive fruit load provide a wood-exposing wound for infection by wood decay fungi and therefore should also be removed.

Still, we have not decisively attributed the decline of lemon groves in California to decay caused by the *Coniophora* species isolated. The problem was also correlated with lemons grown on Macrophylla rootstock and a problem called lemon sieve tube necrosis (also known as Macrophylla decline). This is a genetic incompatibility between rootstock and scion. Possibly, the *Coniophora* fungus is merely opportunistic on trees predisposed to colonization after being weakened from other stresses. Lemon sieve tube necrosis may impede proper nutritional flow between scion and rootstock. Other factors that could predispose trees to infection by *Coniophora*, as well as other wood rotting pathogens are improper cultural practices such as fertilization, irrigation, and canopy management programs. Furthermore, in our surveys, some orchards were not irrigated properly.

Summary:

The cause of decline of some lemon groves in the desert production areas of Southern California is still unclear, but we have positively associated the presence of a brown rot wood decay caused by a species of *Coniophora* with lemon tree decline. We did not observe the

Coniophora decay in groves with healthy trees of comparable age and rootstock/scion combinations. We have not determined, however, the etiology of lemon tree decline in California groves. The problem was also correlated with lemon trees with lemon sieve tube necrosis and to improper nutrition, pruning, and irrigation practices that stressed trees.



Wood decay caused by Coniophora

Regardless of the cause of lemon tree decline, *Coniophora* decay like other wood decays can predispose trees to environmental factors, and the decay should be prevented. Species identification is needed to determine the potential sources of inoculum for lemon trees. Currently, we are identifying the fungal species through a comparison of DNA isolated from known cultures and fruiting bodies of *Coniophora* eremophila from Arizona and cultures of *Coniophora* sp. from lemon in California.

Standard management practices that promote good tree vigor and health should be utilized. These include: 1) Proper pruning practices that allow wound healing and prevent the entry of wood decay fungi; 2) Good irrigation practices that prevent water stress in trees; and 3) Adequate fertilization programs that prevent deficiencies or toxicities. Lastly, to prevent the potential spread of *Coniophora* decay of lemon into other production regions, wood branches larger than "pencil-size diameter" should not be transported from one location to another especially when transporting fruit from orchards to packinghouses.