Etiology, Epidemiology, and Management of Hyphoderma Gummosis

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Hyphoderma gummosis, caused by the Basidiomycota fungus *Hyphoderma sambuci,* was first observed in Tulare County in 2000. In surveys done in collaboration with farm advisors Ben Faber and Neil O'Connell, the disease was subsequently found in numerous lemon orchards in Ventura, Tulare, as well as Riverside and San Luis Obispo Counties.

Symptoms include wilting and dieback of branches that ultimately results in tree death. Cream- to salmon-colored fruiting bodies often first appear at the presumed infection sites, e.g., on branch stubs and along bark cracks and may later cover large areas of trunks and major limbs. Extensive gumming is often observed at this stage.

Viable fruiting bodies, as assessed by spore production in the laboratory, were found in orchards in Tulare Co. from February/March through June. *H. sambuci* was consistently isolated from diseased tissues. After re-inoculation of healthy branches, disease symptoms were reproduced and the pathogen was re-isolated. Thus, Koch's postulates were fulfilled. The disease has not been found on citrus other than lemons. Greenhouse inoculation studies with different citrus species and varieties are ongoing to determine the host range of the pathogen.

Laboratory studies using mycelium as inoculum indicated that *H. sambuci* cannot infect its host through the intact bark but depends on wood-exposing injuries such as pruning wounds. In studies on environmental conditions for growth and infection, optimum mycelial growth occurred at 25° C, little growth occurred at 5° and 35° C, and at 40° C growth was negligible. Lemon wood was not infected at 35° C.

Survival studies were conducted with basidiospores, the only known natural dissemination propagule of *H. sambuci*. Spores germinated over a wide temperature range. At 36° C, however, spores quickly died. Basidiospores also did not survive well at low relative humidity values (24-34%) at 20° C, whereas at a high relative humidity ($\geq$95%) and at 20° C ca. 50% of the spores were still viable after 72 hours. This indicates that the fungus can germinate and grow over a wide temperature range, but high temperatures of 35-36° C and low relative humidities that occur in California in the summer are not conducive for fungal survival. These conditions, however, will rarely be found inside shaded host tissues within the tree canopy. Thus, fungal mycelium inside the host will survive until the following spring when conducive conditions for fruiting body formation are again present.

For disease management, the in vitro sensitivity of mycelial growth of *H. sambuci* to selected fungicides was evaluated. EC_{50} values for azoxystrobin, pyraclostrobin, boscalid, fenbuconazole, propiconazole, and tebuconazole were determined to be 0.1-0.2 ppm, 0.1-0.4 ppm, 0.2-0.3 ppm, 2-6 ppm, 1-1.5 ppm, and 0.08-0.2 ppm, respectively. For the biocontrol agents *Trichoderma viride* and *T. harzianum,* a competitive growth interaction was observed on agar plates, suggesting that they might be antagonistic to *H. sambuci* by preventing its colonization of treated host substrates.

Selected fungicides (propiconazole, pyraclostrobin-boscalid, and azoxystrobin) and the two biocontrols were evaluated as pruning wound treatments in the field and were applied 1 or 14 days before inoculation. When inoculations with *Hyphoderma*-colonized wood pieces were done one day after treatment, none of the treatments reduced the incidence or severity of branch colonization by the pathogen. The two biocontrols could be re-isolated from treated branches but apparently they were not able to effectively compete with the aggressive pathogen that grew up to 25-40 cm/month inside the lemon wood. When branches were inoculated 14 days after treatment, disease severity, but not incidence, was only significantly reduced by *T. viride*. When treatments with the biocontrols were followed after one day by inoculations with basidiospores, however, a significant reduction in pruning wound colonization was found for both biocontrol treatments. Because basidiospores are the only known natural infection propagules of the pathogen, these results on pruning wound protection are very promising and may lead to new management strategies. Field studies will be repeated in the spring of 2006. Based on our results, a Section 24C for a commercial product of the biocontrol *T. harzianum* is being pursued.

Currently recommended control measures include cultural practices that maintain vigorous tree growth. Irrigation water should not hit the trees. Large pruning wounds (>1 inch in diameter) should be minimized for at least one month prior to or following wet weather. Because of early spring rains, presence of viable fruiting bodies throughout the spring, and of the high-temperature susceptibility of the pathogen, a late-spring (i.e., June) pruning is recommended in orchards that harbor infected trees. Orchard sanitation is critical. Diseased trees should be vigorously pruned as symptoms developed and prunings (sources of inoculum) should be removed from the orchard.

Fig. 1.

Fig. 2.

Figure 1. Field symptoms of Hyphoderma gummosis on a lemon tree. Wilting foliage and dieback of scaffold branches infected with Hyphoderma sambuci.

Figure 2. Close-up of scaffold branch with gumming occurring adjacent to several fruiting bodies of Hyphoderma sambuci. *The fruiting bodies are basidiomes and produce only known air-borne spores (i.e. basidiospores).*