Control of Phytophthora root rot in container-grown citrus

Howard D. Ohr □ Margaret K. Murphy □ Gary Bender

Diseased trees can be restored to health by either of two fungicides

Max Clover

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Container-grown citrus trees affected by Phytophthora root rot become unsalable because of poor growth and appearance, and they sometimes die. Diseased trees on resistant rootstock can be restored to health and grow well, even when planted in infested soil.

The wholesale citrus industry in California supplies trees to a variety of customers ranging from growers who plant large acreages to wholesalers and retailers who sell trees for home gardens. These are normally either field-grown and sold as balled trees, or they are grown in containers ranging in size from one to several gallons. Another segment of the industry supplies specimen-size trees to landscapers and to homeowners who prefer to start with a larger tree. The containers range from 19 to 57 liters (5 to 15 gallons) up to boxes that may be 91 cm (36 inches) square.

Unlike field-grown trees, which are normally grown in fumigated soil, or small-container trees grown in pasteurized soil and sold in a relatively short time, boxed trees must either be grown in their containers for long periods or be field-grown and then transferred into boxes. Some nurseries may use pasteurized soil, but generally they grow boxed trees in nonfumigated soil.

In such conditions, there is a high probability of contamination by *Phytophthora* fungi resulting in root rot of the trees. In the limited environment of the boxes, root rot can become severe and growth-limiting, even on root rot-resistant rootstocks. Trees affected by root rot become unsalable because of overall poor growth and appearance, and sometimes they die. Because healthy citrus trees on resistant rootstocks often grow well in *Phytophthora*-infested soil, restoration of the diseased boxed trees to a healthy condition before planting may result in trees that grow well even though they are infected.

From June 1984 to June 1985, we tested two fungicides, metalaxyl (Ridomil 2E) and fosetyl-Al (Aliette 80W), for their control of root rot, using 66 trees: 47 'Washington' navel orange and 19 grapefruit.

TABLE 1. Effect of fungicide treatments on *Phytophthora*-infected container-grown trees, on 'Troyer' rootstock, as indicated by tree measurements and ratings and by *Phytophthora* populations

Treatment	Change in diameter*	Rating of dead twigs present‡		Visual rating§		Propagules per gram**
	Grapefruit†	Orange	Grapefruit	Orange	Grapefruit	Orange††
	mm					
Metalaxyl						
Broadcast	1.90 ab	0.88 a	1.33 a	2.25 ab	3.00 a	0.50 a
Emitters	2.45 ab	1.38 ab	2.33 ab	2.38 ab	3.33 ab	9.25 a
Fosetyl-Al						
Broadcast	2.08 ab	1.13 ab	1.33 a	2.13 ab	3.00 a	3.50 a
Emitters	2.55 a	0.88 a	2.00 ab	1.88 a	3.00 a	0.75 a
Water control	0.58 b	2.14 b	3.01 b	3.00 b	4.00 c	42.75 b
Nontreated control	1.91 ab	1.75 ab	2.33 ab	2.75 ab	3.67 bc	44.57 b

* Average change in scion diameter. Measurements made at average height of 15 cm above the budunion. Numbers followed by different letters are significantly different at the 1% level using Duncan's Multiple Range Test (DMRT).
† No significant differences in scion diameter were observed in any of the treatments of orange trees.
‡ Average rating on a scale of 0 to 4: 0 = healthy canopy; 4 = dead tree. Statistical significance determined at 5% level, DMRT.
§ Average visual rating on a scale of 0 to 5: 0 = healthy; 5 = dead. Statistical significance determined at 5% level, DMRT.
** *Phytophthora* propagules. Statistical significance determined at 1% level, DMRT.
†† No significant differences in *Phytophthora* populations were observed in any of the treatments of grapefruit trees.

All trees were on 'Troyer' rootstocks. The trees were field-grown in soil infested with *Phytophthora parasitica* and *P. citrophthora*, then budded to the selected cultivar, and, when large enough, transferred to 51-cm (20-inch) boxes containing infested soil from the same site.

The trees were watered by drip irrigation with two emitters per box. Each tree received 10 minutes of irrigation every three days and was fertilized with a complete fertilizer plus trace elements administered through the drip system. All trees used in the trial were selected for the presence of *Phytophthora* root rot symptoms, including small or chlorotic leaves, poor general growth, some defoliation, and sparse, rotting roots.

The study included a total of six treatments: four fungicide treatments applied every other month, a monthly water drench, and a nontreated control. All orange treatments were replicated eight times except for the water control, which had seven replicates. All grapefruit treatments were replicated three times except for the water control, which was replicated four times.

Metalaxyl was applied at a rate of 5.3 ml (0.18 fluid ounces) per container and fosetyl-Al at 12.6 grams (0.44 ounce per container. Treatments were either spread evenly over the container and watered in with enough water to reach the bottom of the container (broadcast), or divided into two equal portions and placed under the two emitters in each box (emitters). The monthly water drench consisted of adding water to the top of each box until it flowed freely from the bottom. The nontreated control received water according to the nursery's irrigation practices.

We collected data on rootstock and scion diameters, rated the dead branches present, made an overall visual rating, and counted *Phytophthora* propagules. At the time of the final evaluation, there were no significant differences in rootstock diameters. We observed differences in scion diameters, dead twigs, visual ratings, and *Phytophthora* populations (table 1).

The results indicate that both fosetyl-Al and metalaxyl fungicides were similar in performance with only minor differences. These differences were due to the mode of application, tree cultivar, and statistical significance level used. Both fungicides were consistently superior to the nontreated and water controls. Fosetyl-Al is not presently registered for this use in California, but metalaxyl does have registration.

Howard D. Ohr is Extension Plant Pathologist, and Margaret K. Murphy is Staff Research Associate, Department of Plant Pathology, University of California, Riverside. Gary Bender is Farm Advisor, San Diego County.

Attitudes about pesticide safety

Glenn R. Hawkes □ Martha C. Stiles

Citizens and specialists differ in their views of risks and benefits

Since 1980, infestations of the Mediterranean, Mexican, Caribbean, and Oriental fruit flies, the gypsy moth, and the Japanese beetle have represented potential economic losses to California's agricultural, floral, and forest industries. These infestations have occurred in densely populated areas (Los Angeles and the Santa Clara Valley), exacerbating problems in developing eradication strategies.

After considerable debate about the political, environmental, health, and economic implications of urban pest eradication, the California Department of Food and Agriculture (CDFA) began aerial and ground application of pesticides for some insects, such as the medfly and Mexican fruit fly. These eradication measures led to public discussion, scientific dispute, and, in most instances, community dissent. Past research indicates that, as uncertainty about the consequences of an action increases, so does anxiety, and so this conflict was predictable. The use of pesticides alone is often enough to stimulate community concern, and the use of aircraft in densely populated areas caused enough uncertainty to generate alarm.

Debate among scientists and government entities about risks associated with pesticide use in these situations heightened community apprehension. Such disagreements among specialists, as well as differences between the public and the experts, have been viewed as misinformation or miscommunication, rather than as the cause of community apprehension.

We compared risk perceptions of five groups of specialists with those of citizens involved in the California pest eradications. This study identified beliefs about pesticide safety, fundamental agreements and disagreements on risk and safety.

Behavioral science research on risk has explored social, demographic, and situational factors of individual events that influence how the public responds to risk. Studies have shown that sex and age differences affect risk perception. Education, proximity to the threat, whether or not exposure is voluntary, and perceived benefits are also influences. The amount of media coverage and its ideological emphasis contribute to changes in the perception of a threat. Others have discovered that differences in attitude are primarily due to the previously formed beliefs of various subgroups in the population about the risks and benefits of specific technologies.

One limitation of the research to date is the scarcity of information on perceptions, beliefs, and attitudes of the decision-makers involved in hazard management and risk analysis. Some such studies suggest, however, that scientists, government regulators, and other experts who implement technologies like pesticide use are subject to the same biases as citizens. Well-versed experts use the same mechanisms as the less knowledgeable public in responding to risky events. Past research suggests that specialists in, for instance, pesticides have a significant bias in favor of chemical use. This positive predisposition has been used to explain specialists' aversion to opposition and special-interest groups. We attempted to identify additional factors influencing polarization of