

Impact of Preplant Soil Treatments on Survival of *Phytophthora* in Citrus Soils¹

Michael Matheron, Martin Porchas and Michael Maurer

Abstract

Several different approaches are used with respect to land preparation prior to replanting citrus in Arizona. A study was initiated to examine the effect of cultural preplant practices on the survival of *Phytophthora* in citrus orchard soils. In June, 1998, a 2-gallon volume of soil was collected from eight different sites within a mature lemon planting on a sandy soil in Yuma or a lemon planting on a heavier soil in Mesa, AZ. Each initial sample was pre-tested, found to contain *Phytophthora parasitica*, then thoroughly mixed and distributed into six 1-qt plastic containers, which were subjected to different environmental and cultural conditions. The soil in each container was tested for the presence of *P. parasitica* 1, 4 and 9 months after initiation of the study. The preliminary results of this ongoing study are as follows. Detection of *P. parasitica* was lower in non-irrigated as compared to irrigated soil. *P. parasitica* was not detected in non-irrigated soil subjected to a mean temperature of 38°C (100°F) for 3 months. During the 9-month period of time, detection of *P. parasitica* in soil planted to alfalfa was not reduced compared to soil planted to citrus. Of the treatments examined, dry summer fallow may be the most effective method of reducing the population of *P. parasitica* to below detectable levels; however, these preliminary findings must be validated by additional planned tests.

Introduction

In Arizona, several different methods are used to prepare land for replanting of citrus trees. One approach involves totally removing old trees including as many roots as possible, followed by replanting without any additional treatment of soil. An alternative procedure is to treat planting sites with a fumigant such as Vapam before planting trees. Additional practices include leaving the soil fallow for one or more years or planting the former orchard site to alfalfa for 1-3 years before returning to citrus.

During the life of a citrus orchard, the population of pathogens such as *Phytophthora* and the citrus nematode can increase dramatically. When an orchard is removed and replanted, resident populations of these pathogens potentially could remain in the soil and attack the new trees, resulting in slow growth, delayed onset of commercial fruit yields and long-term decrease in yield and tree growth compared to non-infected trees. Utilization of fallow

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periods with or without a cover crop or soil fumigation are potential means of reducing populations of soil pathogens so that newly planted trees can grow without the influence of these organisms. Populations of citrus nematodes in soil are known to drop dramatically in the absence of live citrus roots; however, the fate of *Phytophthora* after orchard removal is not as well documented. The objective of this research is to examine the survival of *Phytophthora* in soil subjected to different preplant conditions.

Materials and Methods

In June, 1998, a 2-gallon volume of soil was collected from eight different sites within a mature lemon planting on a sandy soil in Yuma or a lemon planting on a heavier soil in Mesa, AZ. Each sample was pre-tested and found to contain *Phytophthora parasitica*. Each of these samples was thoroughly mixed, then distributed into six 1-qt. plastic containers and treated as follows for the following 6 months: 1) soil maintained in the laboratory and not irrigated; 2) soil placed outside, exposed to full sunlight and not irrigated; 3) soil kept in the greenhouse and not irrigated; 4) soil kept in the greenhouse and irrigated when treatments 5 and 6 received water; 5) a 1-year-old *C. volkameriana* seedling was planted into the soil, maintained in the greenhouse and watered every 2-4 days as needed; 6) a 1-year-old alfalfa plant was planted into the soil, maintained in the greenhouse and watered every 2-4 days as needed. Temperature probes were placed in the soil at the 4-inch depth in the various locations and soil temperature was recorded hourly.

At one (July, 1998) and four (October, 1998) months after the initiation of this study, a 10-gram sample of soil was removed from each container and tested for the presence of *Phytophthora* by the following procedure. Each 10-gram sample of soil was placed in a 1-pint container. An unblemished pear fruit was then added to each container along with enough water to submerge the bottom half of the fruit. The pear was then incubated for 48 hr at 25-27 °C in the laboratory. Each pear then was removed from each container and maintained for an additional 5 days in the laboratory. Detection of *Phytophthora* was considered positive when one or more firm brown lesions developed on the pear fruit. Confirmation that these lesions were caused by the pathogen was achieved by plating a small piece of the fruit lesion onto agar medium and identifying the fungus emerging from the tissue as *Phytophthora*.

At six months (December, 1998) after the initiation of this study, all soil samples were placed in the greenhouse and a 2-month-old rough lemon seedling was planted in each container. Alfalfa and citrus seedlings initially planted in some of the soil samples were removed and replaced with rough lemon seedlings as well. All plants were watered as needed and the soil in each container again was tested for *Phytophthora* in March, 1999.

Results and Discussion

Our ability to recover *Phytophthora* from soil subjected to various environmental conditions is summarized in Table 1. Detection of *Phytophthora* was lower in non-irrigated as compared to irrigated soils. Furthermore, *Phytophthora* could not be recovered from soil exposed to full sun and not irrigated for six months. In addition to being dry, the mean temperature of this soil at the 4-inch-depth was 38°C (100°F), a value much higher than that recorded for the other soil samples as well as the original collection sites of the initial soil samples (Table 2). For the 9-month duration of this study, the incidence of *Phytophthora* in soil planted to alfalfa was not reduced compared to soil planted to citrus. Likewise, irrigated soil that did not contain any plants appeared to maintain detectable levels of *Phytophthora* almost as well as soil planted to citrus.

The results presented here should be considered very preliminary in nature. Future studies are planned to gather more evidence concerning the effect of different cultural practices on the fate of *Phytophthora* in citrus orchard soils.

Table 1. Detection of *Phytophthora* in citrus orchard soil after placement in different environmental conditions.

Soil treatment *	Number of soil samples in which <i>Phytophthora</i> was detected ** (From June through Dec. 1998)		
	Jul. 98	Oct. 98	Mar. 99 *
Maintained in the laboratory - Not irrigated	1	0	1
Placed outside in full sunlight - Not irrigated	0	0	0
Kept in the greenhouse - Not irrigated	0	0	3
Kept in the greenhouse - Irrigated	1	3	3
Contained citrus seedling, in greenhouse - Irrigated	4	4	3
Contained alfalfa plant, in greenhouse - Irrigated	5	4	4

* These treatments were in place from June through December, 1998. In late December, all soil samples were placed in the greenhouse and a 2-month-old rough lemon seedling was planted in each container. Alfalfa and citrus seedlings initially planted in some of the soil samples were removed and replaced with rough lemon seedlings as well. All plants were watered as needed and the soil in each container again was tested for *Phytophthora* in March, 1999.

** Detectable levels of *Phytophthora* were present in all eight soil samples originally used to establish this trial in June, 1998.

Table 2. Soil temperatures in the summer of 1998.

Soil Location *	Soil temperature (°C) at the 4-inch depth *		
	Minimum	Maximum	Mean
In laboratory - Not irrigated	25	27	26
In greenhouse - Not irrigated	18	42	32
Soil outside in full sun - Not irrigated	26	49	38
In greenhouse with citrus seedling - Irrigated	19	42	30
Under citrus tree canopy - Yuma, AZ	24	33	30
Under citrus tree canopy - Mesa, AZ	22	31	27

* Recorded from Jun 22 to Sep 22, 1998.