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INFLUENCE OF SOIL SOLARIZATION ON *PHYTOPHTHORA CINNAMOMI* RANDS IN AVOCADO (*PERSEA AMERICANA* MILL.)

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Abstract

Two field trials were conducted to evaluate soil solarization effectiveness in controlling avocado (*Persea americana* Mill.) root rot caused by *Phytophthora cinnamomi* Rands. The soils at the experimental site have shown a high degree of infection for the last 20 years.

In the first trial solarization was applied to 80 diseased adult trees and 60 were used as control. Disease severity index (DSI) was measured visually on a scale from 0 (healthy plant) to 5 (dead plant). All trees were indexed as DSI 3-4 at trial commencement, improving to DSI 2-3 during the first year of solarization; a second treatment further improved trees to DSI 1-2. Maximum temperatures measured at 5 cm depths were 40ºC under tree canopy and 45ºC in the sun, higher than those described as effective for pathogen elimination.

In the second trial, two plots were used to test 450 West Indian race avocados and 78 *Persea indica* (L.) K. Spreng, the latter as control due to reputed susceptibility to *P. cinnamomi.* DSI was recorded over a three-year period. Results showed 88% of avocado and 92 % of *P. indica* survived in the solarized plot; control showed 21 % for avocado and 8 % for *P. indica* survival. The DSI for plants from the solarized plot were consistently better than those of the control.

Both trials show the high efficacy of this technique for control of *P. cinnamomi.*

1. Introduction

Root rot caused by *Phytophthora cinnamomi* Rands is the main disease of avocados (*Persea americana* Mill.) throughout all the producing areas of the world. In Spain, root rot has caused serious losses in the Canary Islands as well as in the plantings along the Andalusian coast.

P. cinnamomi is a moderate temperature species with an *in vitro* maximum growth in the range 30-36ºC with few isolates growing slightly at 36ºC (Zentmyer, 1980). South African trials (Barbercheck and Broembsen, 1986), using soil solarization in nursery greenhouses to control both parasitic nematodes and *P. cinnamomi,* showed that three weeks of solarization were sufficient to eliminate 91 % of the *P. cinnamomi* population, achieving total elimination after six weeks. Previous trials in Israel (Pinkas *et al.,* 1984) established that after soil solarization capable of sustaining 36ºC during 4 h only 10% of *P. cinnamomi* inoculum. survived.

In this work we studied the effectiveness of solarization for the control of *P. cinnamomi* in naturally-infected avocado plots in the subtropical conditions of the Canary Islands.

2. Materials and Methods

Field trials were performed in a seriously infected plot of adult trees in Valle Guerra (Tenerife), where *P. cinnamomi* was first diagnosed over 20 years ago. The existence of *P. cinnamomi* in the soil was confirmed by avocado fruit trap. The plots were lightly tilled, irrigated until soil saturation and finally covered with transparent polyethylene film of 30-37.5 pm of thickness. The soils were solarized for 4-6 weeks between the months of August and September. Temperatures of the solarized areas were recorded during five years. In 1994 temperature sensors were installed at 5 and 20 cm. depths, placed in sun and shade tree-canopy areas in the solarized treatment and in the control treatment only in the sun.

Given that inoculum density was difficult to quantify, two trials were set up to compare the effect of solarization on the symptoms of the disease. In the first trial between three and six rows of trees (5 x 5 in planting distance) were solarized per year, covering all ground between the trees and up to each trunk. Plants in solarized soil were not irrigated during the treatment. Disease severity index (DSI) was evaluated on a scale of 0 to 5, where 0 = healthy and 5 = dead. The diseased trees, all about 15 years old, had an initial DSI of 3-4. Eighty trees were solarized and 60 were used as control for the whole trial. Solarizations were begun in 1988 and continued up to 1994. In the second trial a plot from which diseased trees had been removed was solarized, after which I-year-old seedlings of 135 West Indian avocado rootstocks and 28 viñátigos (*Persea indica* L.) were planted. A further 315 avocados and 50 viñátigos were planted as control. Viñátigo was used due to its reputed susceptibility. Results were expressed as percentages of living trees and DSI.

3. Results

In the first trial, the adult avocados from solarized plots with an initial DSI of 3-4 improved to 2-3 and their foliage was comparatively greener. After the second solarization DSI decreased to 1-2. In the second trial, percentage of dead plants and average DSI were higher for non-solarized soil compared to solarized soil (Table 1 and Figure 1). Three years later, 88 % of avocados and 90 % of viñátigos survived in solarized soils, whereas only 21 % of avocados and 8% of viñátigos survived in the non-solarized soil.

Temperature evolution during solarization is given in Figure 2. At 5 cm depth, compared to control, solarization temperatures were 10ºC higher in the sun and 6ºC higher in the shade. The maximum temperatures reached at 5 cm were 46ºC in sun and 41ºC in shade. At 20 cm, maximum temperatures of 34ºC in the sun and 30ºC in the shade were registered.

4. Discussion

Several authors have cited reduction in inoculum density of natural population or artificially introduced *P. cinnamomi* after solarization (Pinkas *et al.*, 1984; Barbercheck and Broembsen, 1986; Juárez-Palacios *et al.*, 1991). Our results for both trials seem to confirm the effectiveness of this practice for the control of the avocado root rot. Increased health and vigour of woody perennials following transparent mulching have been previously described (Ashworth and Gaona, 1982; Stapleton and De Vay, 1985). This coincides with the results of our solarization trials, as disease expression in naturally-infected plots was clearly reduced and established adult avocado trees did not experience further damage. On the other hand, the percentage of dead

avocado and viñátigo seedlings planted on solarized soils is very low compared to non-solarized plots. In addition, the DSI for plants from the solarized plot were consistently better than those of the control.

According to the results of Zentmyer (1980), Pinkas *et al.* (1984), Barbercheck and Broembsen (1986) and Juárez-Palacios *et al.* (1991), the intervals of maximum temperatures registered in our trials (41-46ºC) will either eliminate the pathogen or reduce its viability in those soil depths where most of the avocado root system is located. These results show the effectiveness of solarization in controlling *P. cinnamomi* in naturally-infected avocado plantings in the subtropical climate and in the soil conditions of the Canary Islands.

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Table 1. DSI[a] for plants grown in solarized and non-solarized soils infected with *Phytophthora cinnamomi*

	Solarized		Non-solarized	
	All plants[b]	Surviving plants	All plants[b]	Surviving plants
Avocado	1.8	1.4	4.3	2.4
Viñátigo	0.8	0.4	4.7	1.5

[a] Disease severity index (DSI) was evaluated on a scale of 0 to 5, where 0 = healthy and 5 = dead.

[b] Dead plants included

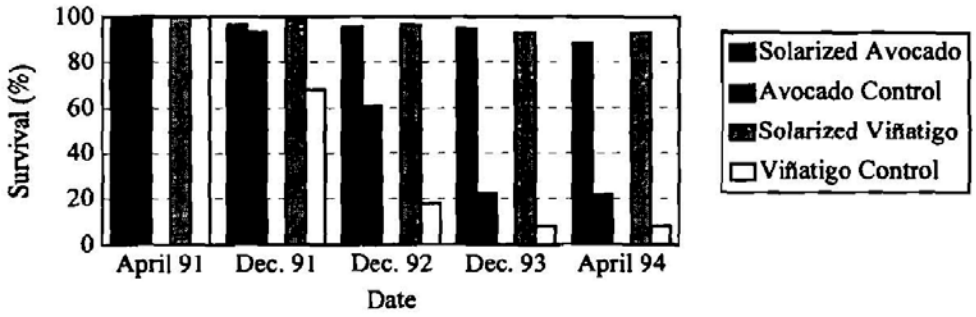

Figure 1. Comparison of the effect of solarization and non-solarization on soils infected with *Phytophthora cinnamomi.*

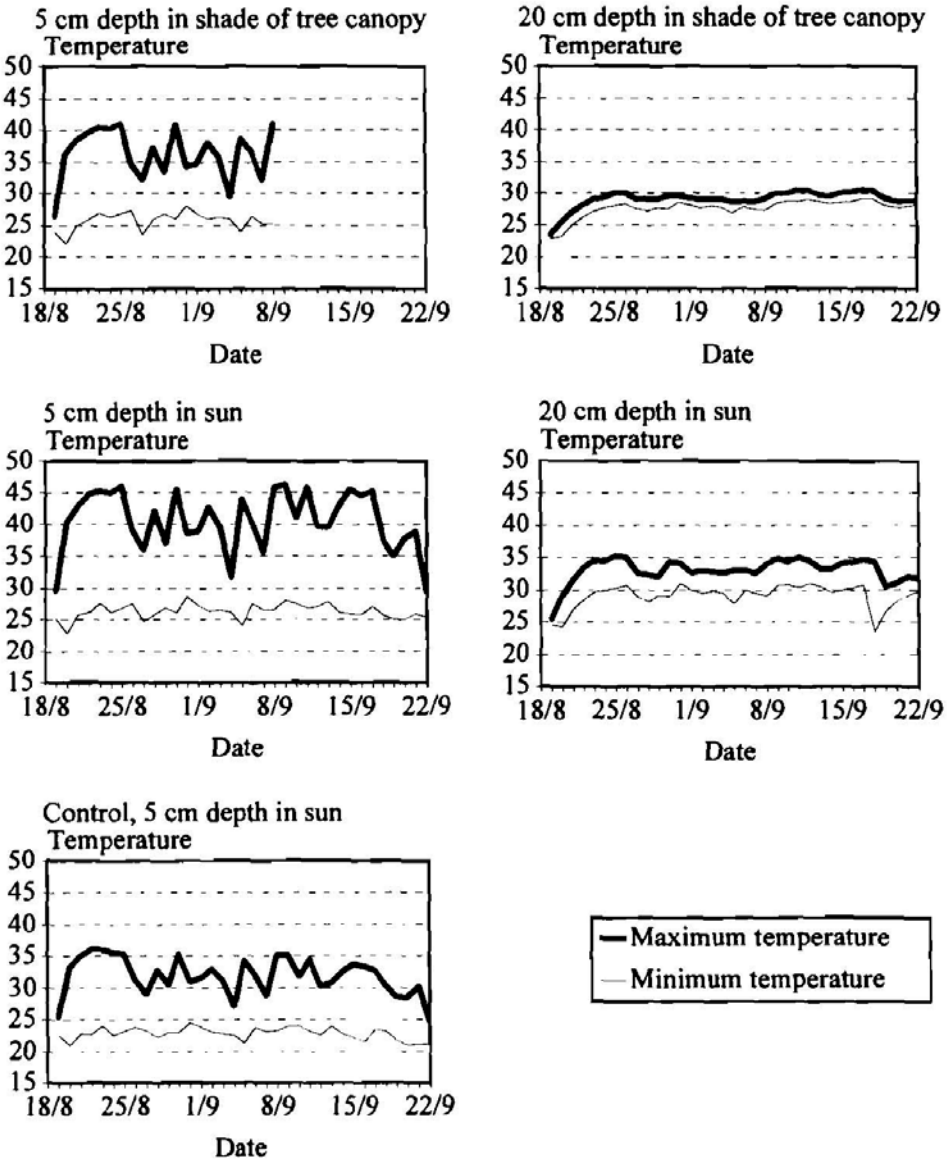

FIG. 2. Maximum and minimum temperature evolution of solarized soil (18 August to 21 September 1994) (°C)