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CONTROL OF *DEAMTOPHORA NECATRIX* AND *PHYTOPHTHORA CINNAMOMI* IN ESTABLISHED AVOCADO ORCHARDS BY SOIL SOLARIZATION

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Abstract

Soil solarization in avocado orchards in the Coastal areas of Andalucia increased average maximum soil temperatures 5-7 C in the unshaded areas specially at shallower depths, whereas shaded areas reached temperatures lower than those in unshaded areas of control plots. Solarization periods of 5-8 wk determined a drastic or complete loss of viability of mycelium, of *D. necatrix* infecting avocado roots as well as a significant reduction of viability in roots sampled from shallow soil layers in the unshaded control. Although those solarization periods achieved a good control of *P. cinnamomi* infecting rootlets and in the 10-20-cm-upper soil layer, but this pathogen remained viable in deeper layers from which a recolonization process would probably initiate. This would account for the reinfestation of the upper layer of soil noticed after ca. 1 yr since the beginning of solarization.

Additional index words: inoculum density, soilborne fungi, *Rosellinia necatrix,* avocado root rot, avocado white rot.

1. Introduction

Avocado White Rot (AWR) caused by *Deniatophora necatrix* Harting (anamorph *Rosellinia necatrix* Prill.) and Avocado Root Rot (ARR), which causal agent is *Phytophthora cinnamomi* Rands, are the most important diseases of avocado in the Coastal areas of Andalucia (Southern Spain) since the early eighties (López-Herrera and Garcia-Rodríguez, 1987; López-Herrera and Melero-Vara, 1991).

This work is aimed at determining the effectiveness of soil solarization in avocado fields naturally infested with either *D. necatrix* (1991, 1993 and 1994) or P. *cinnamomi* (1993 and 1994) in different orchards of Andalucia.

2. Material and methods

Treatments of soil solarization were performed in four orchards affected by AWR and two other affected by ARR. These orchards consisted of trees 10-20 years old. Transparent polyethylene (TPE) films 75 um thick were laid down at both sides of trees, covering completely the road, by mid July of every year and TPE films were removed after 5 or 8 wk.

Mean hourly temperatures were recorded during the solarization period at the different depths and locations considered in each plot.

Nylon nets containing 10 segments of roots naturally infected by *D. necatrix,* were buried at different soil depths (15, 20, 30, 45 and 60 cm) in two locations (unshaded and shaded) of each plot. These roots, buried in both solarized and control plots, were recovered immediately after the 5-wk solarization period in 1991, at 4 and 8 wk in 1993, and at 3, 6 and 8 wk after initiation of the treatment in 1994. Mycelial viability of the pathogen and the effectiveness of soil solarization in eradicating *D. necatrix* from infected trees were assessed by incubating the root segments on PDA at 24 C in the dark and by incubating 10 root segments taken from each avocado tree both in a chamber of saturation humidity and in PDA plates, respectively. Assessments of viability were conducted both immediately before and immediately after the total period of solarization.

In the case of *P. cinnamomi,* the effect of the treatment was evaluated by: a) determining isolation frequency from avocado roots before and after solarization, by plating onto CMA, b) determining inoculum density (propagules/g) in soil sampled around avocado roots (Gees and Coffey, 1989), c) isolating the pathogen from avocado roots of plants grown in soil sampled before and after solarization, and d) determining the survival of inoculum grown on a nutrient substrate (Juárez-Palacios *et al.* 1991) buried at the different depths and locations in the orchards of 1994, 3, 6 and 8 wk after initiating solarization.

3. Results

Average maximum hourly soil temperatures in the unshaded areas of solarized plot were 40.3-32.0 C at the 20-45 cm depth in 1991 and 1993. In contrast, temperatures in shaded areas of the solarized plots were 27.0-29.2 C, only slightly higher than their controls and lower than in the unshaded areas of the control plots, particularly for the shallower (20 cm) depth (table 1). In 1994, soil solarization determined a temperature increase over the control which was more pronounced at depths of 15 and 30 cm and in the unshaded location. Whereas for unshaded solarized locations maximum hourly temperatures reached 40 and 38 C at 30 and 45 cm depth, respectively, for shaded areas those were only ca. 29 C, i.e. ca. 5 C higher than their control plots.

A drastic or complete reduction of the viability of *D. necatrix* was observed after 5-8 wk of solarization at any of the depths and locations in the solarized plots. In unshaded areas, the pathogen lost the viability even after solarization periods as short as 3 wk and at depths up to 60 cm, the maximum considered in our studies. There was also a significant reduction in pathogen viability in the samples buried at the shallower depth in the unshaded control plots.

Inoculum density was nil after solarization whereas a reduction of ca. 50% in the frequency of isolation of *P. cinnamomi* from avocado rootlets occurred in 1993 (table 2). The frequency of isolation of *P. cinnamomi* from naturally infected avocado rootlets was reduced to negligible

levels for 6 months after the end of solarization although it greatly increased after 14-18 months (figure 1).

4. Discussion

The effect of soil solarization on temperature increase is considerable when unshaded areas are compared, whereas soil solarization of shaded areas has little effect on temperature increase. As a consequence, the use of soil solarization is suggested for young orchards with a reduced canopy or else pruning of older trees is recommended in order to maximize the area of effective soil solarization.

In agreement with previous studies (Sztejnberg *et al.*, 1987), *D. necatrix* shows a very high thermal sensitivity. This explains the loss of effectivity at deepest soil layers and under short periods of soil solarization. Even in shaded areas of solarized plots, the control of the pathogen was quite good, as well as in the upper 15 cm of soil in the unshaded control plots.

The control of *P. cinnamomi* achieved by soil solarization was similarly observed by the different determination procedures using root and soil samples taken at 10-20 cm depth. However, this effect is not persistent, since *P. cinnamond* was isolated with a similar frequency to that of the control plots when sampling was conducted 14 mo after the end of the solarization (figure 1). This could be related to a rapid recolonization process from lower soil layers.

Acknowledgements

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5. References

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Table 1 - Effect of soil solarization on the average maximum hourly temperatures at different soil depths, locations and years.

Year*	Depth (cm)	Treatment			
		Control unshaded	Control shaded	Solarized unshaded	Solarized shaded
1991	20	33.2	--	40.3	27.5
	30	29.9	--	34.9	27.0
1993	30	--	27.6	34.9	29.2
	45	--	26.3	32.0	27.9

* the period of soil solarization was 5 and 8 wk starting 24 July, 1991 and 1993, respectively.

Table 2 - Effect of soil solarization (SS) on inoculum density (p/g) and on the frequency (%) of isolation of *P. cinnamomi* from avocado rootlets.

Treatment	Inoculum density		Isolation frequency	
	before SS	after SS	before SS	after SS
Control	4.0	6.0	71.4	73.3
Solarized	2.6	0.0	65.0	33.3

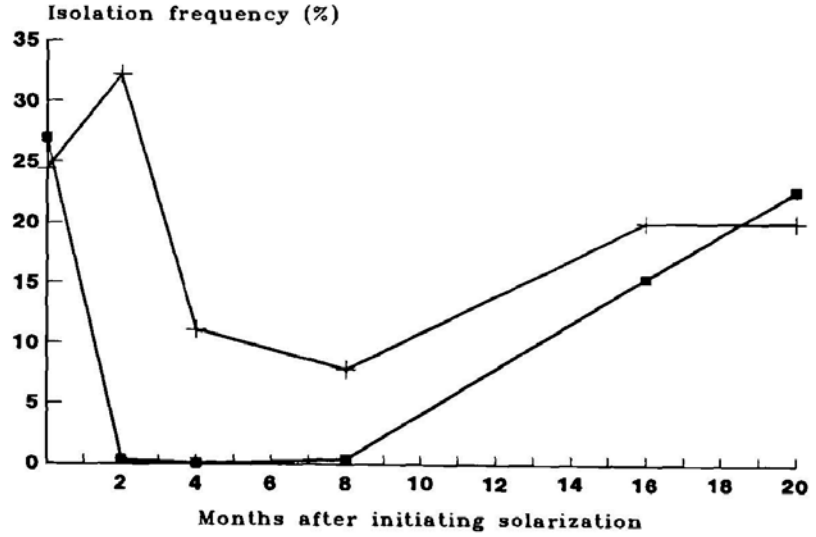

Figure 1 - Effect of solarization on the isolation of *P. cinnamomi* from avocado rootlets
+ Cont-CMA ■ Solar-CMA