1999. Revista Chapingo Serie Horticultura 5: 251-253.

INTEGRATION OF STRATEGIES FOR CONTROLING ROOT-ROT IN AVOCADO IN ISRAEL

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SUMMARY

Planting avocados on resistant rootstocks is the most effective way to cooperate with *Phytophthora cinnamomi* Rands. In this exclusive research project, rootstocks from 4 different genetic sources were selected, with 17 additional rootstocks showing potential for *P. cinnamomi* resistance and high yield.

1. Israeli rootstocks with excellent high yield potential: VC 69; VC 66; VC 55; VC 49; VC 28.
2. Rootstocks from germplasm: VC 256; VC 241; VC 239; VC 225; VC 218; VC 207.
3. Rootstocks originating from surviving trees – Givat Chaim plantations: VC 812; VC 811; VC 805; VC 804; VC 803; VC 801.
4. Rootstocks selected for resistance in California, with no success in Israel.

In productive plantations where the *P. cinnamomi* infection has been detected, use of a chemical agent may be effective. Two agents showing equal efficacy are ‘Foli–O–Fos 400’ and ‘Canon 50’ – *in vitro* and *in vivo* (on young plants) testing.

INTRODUCTION

Root rot disease, caused by the *Phytophthora cinnamomi* Rands. pathogen, causes death of avocado trees and engenders a financial problem in commercial avocado growth the world over. In Israel, the fungus was first isolated in the autumn of 1982, in a limited number of avocado plantations and imported ornamental plants. Drastic steps were taken immediately to prevent its spread. A comprehensive survey of nurseries, conducted by the late Dr. Y. Pinkas and his associates and elimination of all infected plants discovered, was performed simultaneously with implementation of the policy of eliminating all plantations in which infected trees were found. These practices served to greatly stem the spread of the fungus in Israel. Since 1983 a few other infected plantations have been found. Today it can be confidently asserted that the spread of the disease in Israel′s conditions is limited to a small number of areas which share the common denominators of drainage problems, poor aeration and particular soil characteristics. The focus of these infected areas: Emek Hefer (Givat Chaim, Kfar Hogla, and the plantations of Gan Shmuel and Ein Iron), Mishmar Ha′emek, a small

area in the Western Galilee (Idmit plantation) and Mevo Horon. Some of these areas have ceased being used for the growth of avocado because of *P. cinnamomi* infection, despite the fact that horticulturally, these areas are ideally suited for avocado.

Preventing the spread with the use of chemical and/or biological agents is never effective in the long run. Moreover such an approach, overuse of chemicals, is inconsistent with a growing world–wide concern for ecology. Therefore, particular importance is given to the search for rootstocks more resistant to the disease as the most effective long–term alternative.

Over the course of 16 years′ research, emphasis has been placed primarily on development of resistant rootstocks, as well as finding appropriate treatments to rejuvenate infected mature plantations.

Research Objectives

1. Selection of avocado rootstocks resistant to the *P. cinnamomi* pathogen.
2. Horticultural assessment of the selected rootstocks for resistance.
3. Determining the most effective strategy for treating avocado plantations infected by *P. cinnamomi* pathogen, testing different chemical agents.

Research Management

The research is done in several ways.

1. Selection of resistant avocado rootstocks obtained from different genetic sources. (A. Ben-Ya′acov′s research provided the basis).
2. Horticultural assessment of resistant rootstocks done on a number of sites (Kfar Hogla, Givat Chaim Ichud and Mishmar Ha′emek).
3. Establishing management policy for plantations infected with the root rot disease. This process is implemented primarily through experiments and monitoring in infected commercial plantations.

MATERIALS AND METHODS

Selection of resistant rootstocks

When the disease was first identified in Israel in 1982, research was concentrated on locating rootstocks resistant to *P. cinnamomi*. This selection process was carried out in a plot which was established for this purpose at Givat Chaim Ichud in the hub of a commercial plantation which had been eliminated following *P. cinnamomi* infection. In this 1.2 hectare plot, the preliminary selection process are: examine the rootstocks′ ability to survive under *P. cinnamomi* conditions (not using horticultural parameters). To this end, the planting was closely spaced. From each type designated for selection assessment, 3 pairs were planted. These plants were all monitored in their development (size, health and occurrence of leaf burn). Once a year they were examined for the presence of *P. cinnamomi*. ‘Topa Topa’ plants, prepared from a seedling population were used as a sensitive control population. When places were vacated by the death of one of the plants, they were replaced by new types throughout the selection process. Taking into account that grafted trees respond differently from non–grafted trees, most

of the types of rootstocks were grafted onto ‘Wurtz’, a dwarf variety, which is appropriate for dense planting. Starting in 1989, the rootstocks were grafted onto commercial varieties: ‘Ettinger’, ‘Hass’ and ‘Fuerte’.

In the selection plot, 4 groups, differentiated by their genetic sources were examined:

1. Israeli rootstocks which were superb horticulturally (From Ben–Ya′acov′s selections) (about 40 rootstocks).
2. Collection of primitive germplasm sources from countries in which avocado originated (Collected by Ben-Ya′acov) (50 rootstocks).
3. Trees which survived from infected plantations (25 rootstocks).
4. Rootstocks selected for resistance in California (Introduced by the late Dr. Y. Pinkas) (3 rootstocks).

These selection procedures, under field conditions, continue for 12–16 years.

Horticultural Testing of Resistant Rootstocks

The selected rootstocks have been planted in 3 commercial plantations. In these grafted trees, the degree of influence on the yield potential will be tested. The sites on which these were planted commercially are: Givat Chaim Ichud, Kfar Hogla, and Mishmar Ha′emek. In these plantations the horticultural indicators of trunk size, leaf burn and chlorosis are being closely followed. Yield data will be collected as soon as the trees reaches the 5^{th} year.

Growth practices aimed at rehabilitating mature infected plantations

In this research, we tested the efficacy of
1) ‘Foli–R–Fos 400’, manufactured by ″U.I.M. Agrochemicals″ (Aust.) Pty, Ltd. It contains 400 grams per liter of phosphoric acid (H_3PO_3) pH 5.7 – 6.0.
2) ‘Canon 50’ manufactured by ″Luxembourg″, containing 50% phosphoric acid (K_2HPO_3) in salt form.

The efficacy of these agents was examined *in vitro*, on *P. cinnamomi* selective media (Kannwischer and Mitchell,1978) and *in-vivo*, on Degania 117. The plants underwent, testing both in artificial lab conditions as well as in field conditions among infected young potted tree plants within the plantation.

RESULTS AND DISCUSSION

Selection of resistant rootstocks

What sets this selection apart is the fact that it is based on field conditions where infection is present. At the end of 12 years of selection examination (1984 – 1996) 17 resistant rootstocks were selected and sent on to be checked for horticultural parameters in commercial plantations. Details as follows:

1. Israeli rootstocks with excellent fertility rates: VC 69; VC 66; VC 55; VC 49; VC 28.

2. Rootstocks originating from germplasm: VC 256; VC 241; VC 239; VC 225; VC 218; VC 207.
3. Rootstocks originating from trees which had survived in Givat Chaim′s plantation: VC 812; VC 811; VC 805; VC 804; VC 803; VC 801.

These rootstocks are currently being monitored in commercial plantations throughout Israel. In addition, the rootstocks have been sent to South Africa and California where they are being tested for resistance.

Horticultural Testing of Resistant Rootstocks

All of the rootstocks in the first group (the Israeli rootstocks) have been proven as high yielding in various regions throughout Israel. The yield potential of the other groups remains to be tested. In this preliminary examination it is quite noticeable that the survived trees, originating in Givat Chaim (Series number 800) have a higher incidence of leaf burn than do the other rootstocks. In rootstock VC 256 there are also a small number of trees with leaf burn. To this end the trees are still young; during the next years will carry commercial yield.

Growth practices aimed at rehabilitating mature infected plantations

It is recognized world wide that agents based on phosphoric acid (H_3PO_3) are very effective in treating *P. cinnamomi*. These chemical agents counter *P. cinnamomi* at the tree′s feeder root system by simultaneously stimulating growth of new roots while depressing the fungus′ activity (Zilberstaine, 1988, Coffey, 1987). In the past ‘Aliette’, a French product, was in common use (Rhone–Poulenc, Sanitaire, Lyon). Today other agents, which function in a similar manner are in use, like Foli–R–Fos 400 (used in Australia).

Table 1. The efficacy of chemical against *P. cinnamomi.*

Chemical concentration. ($mg \cdot liter^{-1}$)	*P. cinnamomi* growth rate[z] Diameter (% of control)	
	Canon	F. J. 400
0.001	78.1	72.2
0.005	65.6	68.1
0.01	44.3	39.1
0.05	56.3	58.1
0.1	33.5	48.0
0.3	12.2	12.3

[z]Hyphae growth rate on *P. cinnamomi* selective media, 48h, 24°C.

In this research, the efficacy of the 2 examined agents – 'Foli–R–Fos 400' and 'Canon 50', on *P. cinnamomi* was similar, *in vitro* experiments (Table 1) as well as *in vivo* ones (Table 2). In these experiments, both agents were shown to be effective in hampering the development of the fungus as compared with the control groups′ treatments.

Table 2. Agents′ effect on the incidence of infected roots in avocados with *P. cinnamomi.*

Treatment	Infected roots (%)
Control	73.6 + 9.5
F.J. 400	0
Canon - 50	0

In the last 15 years, the practices of injecting tree trunks during vegetative root growth periods has taken place. (Kaiser et al, 1998). This practice however is quite costly and is thought to cause damage to the trees′ vitality if used over a period of several years. In Israel, an alternative method, spraying the trees′ foliage rather than injecting the trunk, is being tested. This method is being observed on avocado plantations at Mishmar Ha′emek and Givat Chaim Ichud. It has been found to be highly effective in Australia (Jan Toerien, as reported orally).

Treatment Policy

When one or more trees are found to be infected within a plantation, several steps should be taken in order to a) prevent the disease′s spread within the plantation or to neighboring plantations, and b) treat infected trees and rejuvenate them, including treatments to improve soil drainage. Details of these procedures can be found in ″Protocol of Avocado Growing″ under the heading ″Diseases″, 1998.

ACKNOWLEDGEMENTS

Warm thanks to the staffs who have participated over the years: Lionel and Joel from Givat Chaim Ichud, Aryeh and Shavit from Mismar Ha′emek, Dani from Kfar Holga and Nabil from Adamit plantation. Also to Ehud Yogev of "Luxembourg Industries Ltd." and Dvori–Or Nurseries. I wish to thank "Luxembourg Industries Ltd." for their support for this research work.

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