

Update of Canary Islands Research on West Indian Avocado Rootstock Tolerance/Resistance to *Phytophthora* Root Rot

Luisa Gallo Llobet

Dept. of Plant Pathology, Centro Investigacion y Tecnologia Agrarias, Apartado 60, La Laguna 38080 Tenerife (Canary Islands), Spain

Abstract. West Indian avocado rootstocks from various sources were tested for root rot resistance/tolerance: Local (Canary Islands), Israel (cv. Maoz), Cuba, and hybrid West Indian x Guatemalan (cv. Gema). *Persea indica*, cv. Topa Topa (Mexican race), and cv. Orotava (Guatemalan race) were used as controls, as they are considered highly susceptible. West Indian seedling trials were done using nutrient solution tank and natural infested soil, resulting in 29.38% tolerance/resistance for the former and 28.76% for the latter. *Persea indica* showed 19.04% resistance for the nutrient solution trial and 19.09% resistance for the soil trial. In both tests, it showed tolerance/resistance, with a survival rate considerably higher than that of the other two control plants although slightly lower than that of the West Indian seedlings.

The Canary Islands Archipelago is located off the northwestern coast of Africa (between latitudes 29°37' and 29°25' N and longitude 13° and 18° W). Of its seven islands, 5 have commercial avocado groves: Tenerife, La Raima, Gomera, Hierro, and Grand Canary, on around 900 ha, with a yearly production of 12,000 metric tons. Spain's other avocado area is on the mainland Mediterranean coast around Malaga. Combining both areas, Spain has 4,838 bearing ha (from 7,200 ha planted with avocado) currently yielding approximately 43,000 metric tons, of which 16,824 are exported (Ministerio de Agricultura, Pesca y Alimentacion, 1988). The main cultivars used are Hass, Pinkerton, Reed, and Fuerte.

Spain recently joined the EEC and foresees a considerable increase in its tropical fruit export potential. Current avocado expansion rates for the mainland are estimated to be some 300 ha/year; suitable areas in the Islands are obviously more limited but new groves are being developed.

Phytophthora root rot is present throughout both areas and constitutes the main threat to present and future trees. Studies to determine disease extent and etiology began in 1978 (Gallo Llobet *et al.*, 1978; Gallo Llobet *et al.*, 1987a). The goal of the present work is to find tolerant/resistant rootstocks, centering the search on West Indian material which is well-adapted to local conditions and thus the rootstock preferred by nurserymen and growers, particularly in coastal groves where salinity is further aggravated (Zentmyer, 1961; Coffey, 1987; Gallo Llobet *et al.*, 1987b; Gallo Llobet, 1990a).

Materials and Methods

Trials were done using 4 sources of seedlings: local (Canary Islands) West Indian, WIL; Israeli cv. Maoz, WIM; West Indian from Cuba, WIC; and West Indian x Guatemalan hybrid seeds cv. Gema, GEMA. Controls used *Persea indica* seedlings, cv. Topa Topa (Mexican race), and cv. Orotava (Guatemalan). All seeds were disinfested in a hot water bath (49-50C) for 30 minutes prior to planting in a heated greenhouse (average 21C), using volcanic ash as a substrate in the heated seed beds (30-32C). After germination, 2 main blocks of greenhouse trials were set up.

Nutrient solution tank trials. This trial followed the method developed by Zentmyer and Mircetich (1965). Each test lasted up to 2 months, as symptoms only begin to appear some 20 days after inoculation. Ten *P. cinnamomi* cultures were used: PC302, 304, 305, 306, 312, 314, 319, 325, 330, and 331; the first 6 were typified as A2. Isolations were made using the avocado cv. Fuerte as fruit-trap; mediums were CMA + A, PARH, and P10VP + T (Tsao and Ocana, 1969), culturing at 23C during 3 to 5 days in total darkness. Twelve different inoculations were done throughout the trial, which ran from 1986 to 1990.

Greenhouse experiments in "Natural Infested Soil" (NIS). Experiments were done using clay-loam soil collected in Valla Guerra (island of Tenerife). Soil infested with *P. cinnamomi* (296 UCR Culture Collection) came from a grove of 16 year-old avocado trees infected with root rot (and periodically reisolated). Prior to use, soils were qualitatively analyzed for *P. cinnamomi* presence using cv. Fuerte traps (Zentmyer, 1980). Uninfested soil was collected from an adjacent area. The purpose of this phase was to evaluate West Indian seedling behavior after exposure to *P. cinnamomi* in NIS during 9 to 12 months, after which all surviving seedlings were transplanted to uninfested soil to continue under observation for 2 to 3 years.

The experiment was divided into 7 trials (labelled A through G) all of which used a 1:1 ratio of NIS as well as one-half and one-third NIS dilutions for trials C, F, and G. The number of plants surviving to date is recorded.

Trial A: Begun July, 1987; 19 seedlings (WIL and WIM).

Trial B: Begun July, 1987; 112 WIL and 14 *P. indica*; 16 pots were planted with seven WIL each and 2 pots with 7 *P. indica* each.

Trial C: Begun July, 1988; 126 WIL and 6 *P. indica*; 7 pots were planted with 6 WIL seedlings in each, with treatments 1:1, one-half and one-third; 1 pot with 6 *P. indica* seedlings. Controls were 42 WIL and 6 *P. indica*.

Trial D: Begun November, 1988; 126 WIL and 6 *P. indica*; 18 pots were planted with 7 WIL seedlings each, and 1 with 6 *P. indica*. Controls were 12 WIL and 6 *P. indica*.

Trial E: Begun August, 1989; 54 WIL seedlings and 54 *P. indica*; 9 pots were planted with 6 WIL seedlings each and 9 with 6 *P. indica* seedlings each. Controls were 12 WIL and 12 *P. indica* seedlings.

Trial F: Begun November, 1989; 7 pots were planted with 7 WIL seedlings for each of the treatments 1:1, one-half and one-third. Control was 28 WIL seedlings.

Trial G: Begun April, 1990; 42 WIL seedlings, 42 WIC seedlings, and 42 *P. indica*. Seven pots were planted with 6 seedlings (2 WIL, 2 WIC, 2 *P. indica*) for each of the treatments 1:1, one-half and one-third. Controls were 14 WIL, 14 WIC, and 14 *P. indica*.

Results

The nutrient solution tank trial results are given in Table 1, showing that of the 214 WIL seedlings, 64 survived inoculation, and one of these is currently under clonal propagation using both the etiolation technique (Frolich and Platt, 1971; Fernandez Galvan and Galan Sauco, 1986) and in *vitro* culture (Lopez Encina and Pliego Alfaro, 1986). Of the 47 WUM, 12 survived. The only Cuban seedling tested (WIC) also passed the trial. All 13 West Indian x Guatemalan hybrids, the Mexican plant material (4 'Mexicola' and 12 'Topa Topa') and the 10 'Orotava' seedlings died.

Regarding *Persea indica*, of the 63 seedlings tested, 12 passed. This shows a higher tolerance/resistance compared to Mexican and Guatemalan plants. This species is indigenous to the Canary Islands in relic forests which existed during the Miocene and Pliocene periods some 5 million years ago, in the south of Europe and north of Africa. The fact the test material was from its area of origin may explain the possibility of a greater tolerance/resistance (Gallo Llobet, 1990b).

Results of the NIS experiments are given in Table 2. Summing up the seedlings surviving inoculation (or showing tolerance/resistance): 167 of the 608 WIL seedlings; 4 of the 16 WIM; 28 of the 42 WIC; and 20 of the 110 *Persea indica* seedlings.

Table 3 gives a summary of all data analyzed. The percentages given are for the West Indian race globally, rather than separately for each of the 3 types studied. Trials A, B, D, and E (1:1 NIS) were analyzed separately from C, F, and G, as the latter dealt with different quantities of inoculum. The former showed 7.35% tolerance/resistance for West Indian plants and 4.83% for *Persea indica*. The latter group showed 47.89% tolerance/resistance for West Indian plants, and 37.5% for *P. indica* (trials C and G) (Fig. 1).

Conclusions

The percentage of tolerance/resistance to *P. cinnamomi* for West Indian seedlings was 29.3% in the nutrient solution tank trials and 28.76% in the natural infested soil trials.

Although the total number of *Persea indica* seedlings tested was less than the total of West Indian seedlings tested, the percentages obtained in both experiments; 19.04% in the nutrient solution and 19.09% in the natural infested soil; indicated that *P. indica* should not continue to be considered as a highly susceptible species, based on collections from indigenous trees in the Canary Islands. One West Indian seedling from

the nutrient solution tank experiment is currently being propagated, using *in vitro* culture and etiolation, for further work.

Literature Cited

- Coffey, M.D. 1987. *Phytophthora* root rot of avocado: an integrated approach to control in California. Calif. Avocado Soc. Yrbk. 71:121-137.
- Fernandez Galvan, D. and V. Galan Sauco. 1986. Adaptabilidad de distintos patrones de aguacates (*Persea americana* Mill.) a la proagacion clonal. Actas, II Congress Nac. Soc. Espanola de Ciencias Hortícolas VI:51-58. Cordoba.
- Frolich, E.D. and R.G. Platt. 1971. Use of the etiolation technique in rooting avocado cuttings. Calif. Avocado Soc. Yrbk. 55:97-109.
- Gallo Llobet, L. 1990a. Search for resistance to *Phytophthora* root rot in West Indian avocado rootstocks in the Canary Islands. OEPP/EPPO Bull. 20:95-99.
- Gallo Llobet, L. 1990b. Tolerance/resistance of *Persea indica* (L.) K. Sprang ("vinatigo") to *Phytophthora cinnamomi* Rands. Proceedings 8th Congress, Mediterranean Phytopathological Union, pp. 457-458.
- Gallo Llobet, L., J. Hernandez Hernandez, and M.C. Jaizme Vega. 1987a. Podredumbre de raiz en aguacate causada por *Phytophthora cinnamomi* Rands. Fruticultura Profesional 7:14-23.
- Gallo Llobet, L., M.C. Jaizme Vega, and J. Hernandez Hernandez. 1987b. Resistance of West Indian avocado rootstocks to *Phytophthora cinnamomi*. Proceedings 7th Congress, Mediterranean Phytopathological Union, pp. 26-27.
- Gallo Llobet, L., F. Miralles Ciscar, and F.J. Alvarez de la Pena. 1978. La podredumbre de las raices del aguacate. Hojas Divulgadoras, Ministerio de Agriculture, Madrid.
- Lopez Encina, G. and F. Pliego Alfaro. 1986. Selecccion de patrones de aguacate. Uso de alt tecnica de doble fase para multiplicacion *in vitro* del material seleccionado. II Congreso Nac. Soc. Espanola de Ciencias Hortícolas. Resumenes. Cordoba. Ministerio de Agricultura, Pesca y Alimentacion. 1988. Anuario de Estadística Agraria, Año 1988:337. Madrid.
- Tsao, P.H. and G. Ocana. 1969. Selective isolation of species of *Phytophthora* from natural soils on an improved antibiotic medium. Nature 223:636-638.
- Zentmyer, G.A. 1961. Collections for *Phytophthora* root rot resistance in Mexico and the Caribbean. Calif. Avocado Soc. Yrbk. 45:59-62.
- Zentmyer, G.A. 1980. *Phytophthora cinnamomi* and the diseases it causes. Phytopathological Monograph 10, Am. Phytopathol. Soc. St. Paul, Minnesota, 96 pp.
- Zentmyer, G.A. and S.M. Mircetich. 1965. Testing for resistance of avocado to *Phytophthora* in nutrient solution. Phytopathology, 55:487-489.
- Zentmyer, G.A. and H.D. Ohr. 1978. Avocado root rot. Calif. Agric. Exp. Stn. Leaflet No. 2440. Univ. Calif. Div. Agric. Sci., Berkeley, CA, USA. 15 pp.

Table 1. Tolerance/resistance to *Phytophthora cinnamomi* of avocado rootstocks of several horticultural races. Based on tests in tanks with nutrient solution 22-24C, pH 6.5.

Horticultural race	Rootstock selection	# of seedlings tested	# of plants plants currently growing
West Indian	Local	214	64
	'Maoz'	47	12
	Cuban	1	1
Mexican	'Mexicola'	4	0
	Topa Topa'	12	0
Guatemalan	'Orotava'	10	0
West Indian x Guatemalan hybrid	'Gema'	13	0
<i>Persea indica</i> (control)	63	12	

Table 2. Tolerance/resistance to *Phytophthora cinnamomi* of a West Indian race avocado and *Persea indica* planted in naturally infested soil.

Trial	Race	# of seedlings tested	# of seedlings passed	Control: uninfested soil
A (07/87) NIS	WIL ^z	10	---	3
	WIM	9	3	3
B (07/87) NIS	WIL	112	6	14
	<i>P. indica</i>	14	---	7
C (07/88) NISD	WIL	120	47	28
	WIM	6	1	14
	<i>P. indica</i>	6	4	6
D (11/88) NIS	WIL	126	6	12
	<i>P. indica</i>	6	1	6
E (08/89) NIS	WIL	42	7	12
	WIM	1	0	---
	<i>P. indica</i>	42	2	2
F (11/89) NISD	WIL	147	86	28
G (04/90) NISD	WIL	42	15	14
	WIC	42	18	14
	<i>P. indica</i>	42	14	14

^z NIS = natural infested soil 1:1; NISD = natural infested soil 1:1 and dilutions 1/2 and 1/3;

WIL = West Indian from local population; WIM = West Indian from Israel, cv. Maoz; WIC = West Indian from Cuba

Table 3. Results of tolerance/resistance to *Phytophthora cinnamomi* tests and percentage of West Indian race avocado and *Persea indica* seedlings which passed tests.

Test	# of seedlings tested	# of seedlings passed test	% of seedlings passed test
<u>Nutrient solution</u>			
West Indian	262	77	29.38
<i>Persea indica</i>	63	12	19.04
<u>Natural infected soil</u>			
West Indian	657	189	28.76
<i>Persea indica</i>	110	21	19.09

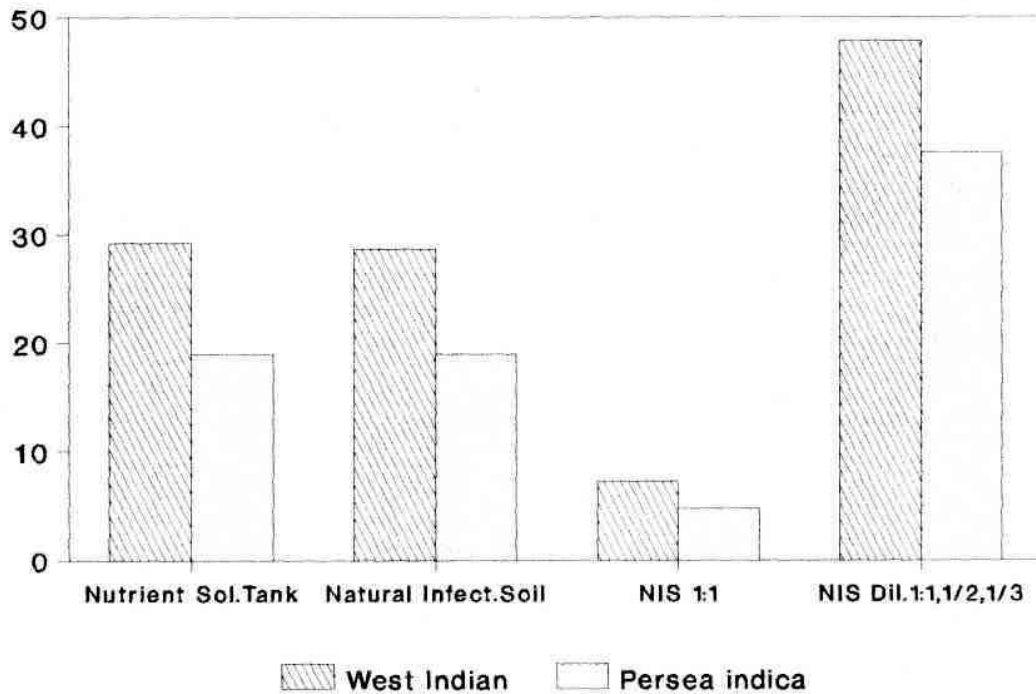


Fig. 1. Percentage of tolerance/resistance to *Phytophthora cinnamomi* of West Indian and *Persea indica* in nutrient solution tank and natural infested soil.