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SELECTION OF *PHYTOPHTHORA* TOLERANT AVOCADO ROOTSTOCKS

P J J Koekemoer, H J Breedt, B Q Manicom and Zelda Bijzet
Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200, RSA

ABSTRACT

Development and selection of Phytophthora *tolerant avocado rootstocks is one of the major research objectives of the avocado breeding program of the ITSC. During 1992 and 1993, a total of 27* Phytophthora cinnamomi *tolerant avocado rootstocks were selected in primary screening trials,* Phytophthora *tolerance of these selected rootstocks will be verified in second phase laboratory tests.*

INTRODUCTION

Yield improvement requires a multidisciplinary approach. Wallace & Wallace (1993) described general strategies for yield improvement, which can be grouped into three different, but interrelated categories:

a. genetic,
b. physiological, and
c. management.

Concerning the genetic category, plant breeding will be a continuing need in yield improvement programs because it interfaces with every new cultural development. In general, the importance of plant breeding and the supportive role of biotechnology pertaining to yield improvement are well documented (Way *et al.,* 1983; Wallace & Wallace, 1993).

Evans (1980) described significant contributions of plant breeding in crop production. Five main performance areas were identified:

a. adaptation of the crop to local environmental conditions and stresses,
b. genetic resistance to pests and diseases,
c. suitability to changing horticultural practices,
d. development of progressively higher yield potential, and
e. improved fruit quality.

Concerning breeding and selection of avocado rootstocks, performance areas a, b, and d, are of particular interest. However, for the plant breeder, the end result is of importance the rootstocks bred or selected should be more tolerant to root rot than existing commercial rootstocks. At this stage the genetic inheritance and mechanism of resistance is of lesser importance.

Avocado root rot, caused by *Phytophthora cinnamomi* Rands, is probably the main yield

limiting factor in avocado production (Zentmyer, 1980; Kotzé & Darvas, 1983; Coffey, 1987; Menge *et al.,* 1992). This paper reports on the selection of *Phytophthora* resistant avocado rootstock seedlings.

MATERIALS AND METHODS

a) Rootstock breeding

The breeding and evaluation procedures of the avocado rootstock development program were described by Bijzet *et al.* (1993).

Open pollinated seed

Open pollinated seed of avocado rootstocks listed in Table 1, were collected and screened for *Phytophthora* tolerance.

TABLE 1 Avocado rootstocks (open pollinated seed) included in a *Phytophthora cinnamomi* tolerance screening trial.

Rootstock	Horticultural Race
Duke	Mexican
Duke seedling	Mexican
Duke 9	Mexican
Duke 7	Mexican
Barr Duke	Mexican
Teague	Mexican x Guatemalan
G6	Mexican
Zutano	Mexican
Martin Grande (c)	*Persea americana* x *P. schiedeana*
West Indian seedling	West Indian
GA 13	Mexican
Addo selection	Unknown

Self pollination

One tree each of Duke, Duke 7, Duke 9, and Teague was covered with 70% plastic shade net before anthesis. Bees were kept in the cages in order to enhance self pollination.

Cross pollination

Four year old avocado trees (Duke 7 rootstock) were top worked with two selected rootstocks to each tree. The combinations of breeding parents on single trees are described in Table 2.

b) Screening techniques

Open pollinated seed of avocado rootstocks listed in Table 1, were collected and germinated in soil naturally infected with *P. cinnamomi.* The first screening trial was conducted in 1992. Seedlings were inoculated once with a locally isolated *P. cinnamomi* culture. Sixteen weeks after inoculation, seedlings were selected by visual assessment of root lesions. Selected seedlings were then dipped in a 2 $g.\ell^{-1}$ dicarboximide (Captab

Sanachem) solution for approximately one minute, before being transplanted into uninfested pine bark in 128 plastic bags. Seven days after transplant, seedlings were treated with fosetyl-Al (Rhône-Poulenc). A balanced nutrient solution (Chemicult) was applied at weekly intervals at $2g\ell^{-1}$

TABLE 2 List of avocado rootstocks topworked to Duke rootstocks in order to establish breeding parent combinations.

Combination no.	Breeding parent A*	Breeding parent B*
1	Thomas	G6
2	Thomas	Toro Canyon
3	Thomas	Wurtz
4	Thomas	Duke 7
5	Thomas	Lancefield
6	Thomas	Duke 9
7	Thomas	Barr Duke
8	Colin V33	G6
9	Colin V33	Toro Canyon
10	Colin V33	Thomas
11	Colin V33	Duke 7
12	Colin V33	Lancefield
13	Colin V33	Duke 9
14	Colin V33	Barr Duke

* Breeding parents A and B were top worked on the same rootstock.

In 1993 the method was modified as follows:

Seeds were germinated in vermiculite in the greenhouse and then transplanted into vermiculite in a concrete bin with dimensions of 12m x 0,9m x 0,4m (length x width x depth). Seedlings were inoculated twice by dispersing peas *(Pisum sativum)* infected with *P. cinnamomi* mycelia, between seedling trees and on the vermiculite surface, followed by light irrigation.

c) Clonal propagation

Plant material for laboratory evaluation of *P. cinnamomi* resistance of selected seedlings, was vegetatively propagated (Frolich & Platt, 1971).

Laboratory evaluation/screening resistance of excised root tips from the vegetatively propagated selected seedlings to *P. cinnamomi* was assessed according to the technique described by De V. van der Merwe (1992).

RESULTS AND DISCUSSION

a)Rootstock breeding

During the past two seasons limited numbers of open pollinated seeds were available as substitute for new rootstock hybrids produced by controlled pollination techniques. The first seed batch of the 1993 self pollination effort of Duke, Duke 7, Duke 9 and Teague parent trees, will be available in 1994 to be included in *P. cinnamomi* screening trials.

Establishment of a rootstock breeding orchard is a high priority. Several trees were topworked at Nelspruit for this purpose (Table 2). Thomas is one of the important breeding parents in this orchard. Results of horticultural trials reported by Gabor *et al.* (1990), Menge *et al.* (1992), and Smith (1993) support the choice of Thomas as breeding parent.

b) Screening of open pollinated seed for *P. cinnamomi* resistance

Results of the *P. cinnamomi* resistance screening trials for 1992 and 1993 are summarized in Table 3.

During 1992, a total of twelve *P. cinnamomi* tolerant seedlings were selected. These plants were propagated vegetatively and included in a second laboratory assessment of *Phytophthora* tolerance. Final laboratory results are not yet available.

During 1993, the development of *Phytophthora* symptoms was slow. However, after a second inoculation and flooding the bin, a total of 15 *Phytophthora* tolerant seedlings were selected. The problems encountered with vermiculite as growing medium is reflected in the mean percentage of seedlings selected (3,86% in 1993 vs. 0,58% in 1992 in naturally infected soil). However, further elimination from the 27 selected seedlings will follow in second phase laboratory screening trials.

The slow development of disease symptoms and low seedling mortality necessitate adaption of the selection procedure. During the 1994 screening, emphasis will be placed on the physical condition of the growing medium and also on inoculum dispersion.

Concerning physical condition of the growing medium, the vermiculite will be replaced with natural infected soil. The main physical factors governing the germination of sporangia (Duniway, 1983) and dispersion of zoospores (Carlile, 1983), are soil moisture and temperature. Flooding seems to be essential to enhance spore germination and dispersion, and according to Ploetz & Schaffer (1992), the inhibition of CO assimilation in *Phytophthora* infected plants can be useful in order to increase seedling mortality.

Concerning inoculum dispersion, Sterne *et al.* (1977) demonstrated 100% mortality of *Persea indica* seedlings when ten *P. cinnamomi* chlamydospores per gram of soil were mixed into the soil. Hwang & Ko (1978) recommended much higher concentrations of inoculum when suspensions are poured on the soil surface. In this respect future screening trials will focus on application of documented *P. cinnamomi* baiting techniques (Tsao, 1983) in conjunction with the serial dilution end point method (Marks *et al.,* 1975; Weste & Ruppin, 1975). The objective is to quantify dispersion of *P. cinnamomi* inoculum.

CONCLUSION

A total of 27 *P. cinnamomi* tolerant avocado rootstocks were selected in primary screening trials at the ITSC. It is expected that the number will decrease with second phase laboratory screening. In order to achieve the objectives of this project the current primary screening techniques must be modified and more than 10,000 seedlings must be screened annually.

TABLE 3 Percentage of selected open pollinated avocado rootstock seedlings after inoculation with *P. cinnamomi.* Nelspruit, 1992 & 1993.

Rootstock	Seeds planted 1992	Germination 1992	Selected 1992	Seeds planted 1993	Germination 1993	Selected 1993
Duke	2017	61,9%	0,08%	184	63,0%	0,86%
Duke sdl.	617	29,8%	1,63%	85	58,8%	10,0%
Duke 7	2104	50,1%	0,57%	5	80,0%	25,0%
Duke 9	146	69,9%	0,98%	-	-	-
Barr Duke	379	33,3%	0,79%	156	66,7%	4,81%
G6	128	30,5%	0%	2069	58,6%	0,17%
Teague	326	43,3%	0%	120	55,0%	0%
Zutano	-	-	-	122	51,6%	1,59%
Martin Grande (c)	-	-	-	15	40,0%	0%
W.I. sdl.	-	-	-	11	63,6%	0%
GA 13	-	-	-	12	91,7%	0%
Addo sel.	-	-	-	20	45,0%	0%
TOTAL	5717	2894	12	2799	1648	15
MEAN		45,5%	0,58%	-	61,3%	3,86%

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