1997 California Avocado Research Symposium pages 35-37
California Avocado Society and University of California, Riverside

Screening and Evaluation of New Rootstocks with Resistance to *Phytophthora cinnamomi*

Continuing Project; Year 5 of 20

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Benefits to the Industry

Ultimately, the control of Avocado root rot will be accomplished with a resistant rootstock. This project has already provided the industry with several new tolerant rootstocks which are greatly improving the yields of avocado on land infested with *Phytophthora cinnamomi.* The goal is to find a rootstock that will eliminate *Phytophthora cinnamomi* as a serious pathogen on avocado. Our ability to find such a rootstock has been enhanced many fold as we focus on crossing already resistant rootstocks.

Objectives

To collect, select, breed and develop avocado germplasm which exhibits resistance to Phytophthora root rot of avocado.

Summary

Collection and Selection of Germplasm.

Two new promising root rot resistant rootstocks were imported from South Africa in 1996. We still intend to locate one last avocado species- the Aguacate de Anise from Costa Rica, in order to test its resistance to avocado root rot. Attempts are being made to force budwood from the Rocky tree in San Diego Co. and the Hibbard tree at South Coast. Both of these trees exhibit valuable traits.

Breeding Program

We have screened 4569 seeds from the breeding blocks for resistance to *Phytophthora cinnamomi.* While we can handle up to 12,000 seeds per year, the decision has been made to revamp some of the 16 breeding blocks every year. Resistant trees will be planted in the blocks instead of grafting resistant buds into existing trees. This will allow more uniform plantings, the establishment of replicated trees and prevent shading and suppression of slower growing germ plasm.

We are attempting to synchronize the flowering in the avocado breeding blocks so that varieties flowering at different times have a higher probability of crossing. We therefore have implemented a program of girdling late varieties *(Persea steyermarkii,* CRI-71, G810, G755) and spraying early varieties (Thomas, Toro Canyon, Barr Duke, Duke 7, and UC2011) with Uniconazole-P. The first years results indicate no significant alterations in the flowering times or fruit set due to these treatments. We will continue the treatments another year and increase the rates of Uniconazole-P.

From the material screened this year, we retained 20 seedlings which showed excellent resistance to *P. cinnamomi* in the initial screening. We also have 20 possible crosses from previous screens which have shown exceptional resistance to *P. cinnamomi* after extensive testing. Three of these have been clonally produced and are scheduled for field testing in 1997 and 9 others have been increased and are ready for field testing. Seven new promising rootstocks will be grafted on avocado stumps in the field for increasing budwood in 1997.

We are cooperating with Dr. M. Clegg to determine how many of our rootstocks from the breeding blocks are actually crosses and how many are selfs. We are also determining the complete parentage of the selected rootstocks from the breeding blocks which show a high degree of resistance. This involves the development of molecular markers, called microsatellites, which will uniquely identify each of the varieties used in the breeding program. From leaf material collected from the varieties, DNA is presently being extracted and will be used in the production of an unique microsatellite marker for each of the varieties.

The breeding blocks are now made up of G755A, Thomas, G1033, Toro Canyon, Barr Duke, UC2001, CRI-71, Duke 7, G6, D9, UC2011, and *P. steyermarkii.*

Screening and Greenhouse Evaluation of Rootstocks

Extensive greenhouse evaluations were done on clonals W-14 (South African), UC 2076 (Avocate mico from Guatemala), Poly-N (haploid avocado from UCLA)and Gordon (South African). Thomas and Borchard served as the resistant and susceptible controls. *Phytophthora cinnamomi* reduced growth of Borchard 34%, Thomas 31%, Gordon 30%, Poly-N 20%, UC2076 18% and W-14 0%. Percent root health and total root length was also greatest with W-14. It appears that W-14 and perhaps UC2076 and Poly-N should be tested further in the field. Rootstocks already grafted for intensive testing in 1997 include PP4 (UCR breeding program; maternal parent Barr-Duke), PP5 (UCR breeding program; maternal parent D9), Huntalas (viroid free), Thomas and Borchard. Plants to be grafted for intensive testing include D9 seedling, Barr-Duke seedling, Rio Frio

(Guatemala), VC241 *(Persea nubigena* selection from Israel), Borchard and Thomas.

Field Evaluations

In a 9 year-old field trial at South Coast with *Phytophthora citricola* but little *Phytophthora cinnamomi,* the trees yielded in the following order from greatest yield to least yield-Toro Canyon, G6, G755A, Barr Duke, Thomas, Duke 7, G755C, G1033, and 755B. Even though differences in yield were large, the variability in this plot was such that little statistical significance could be found except between the greatest and least yielding varieties. In a second 3-year-old field trial at South Coast with heavy pressure from *P. cinnamomi,* the rootstocks performed in the following order from greatest growth to least growth as measured by canopy volume-Thomas, UC2011, Queretaro, Hibbard, D9, Duke 7, and CRI-80. In this trial Duke 7 and CRI-80 were significantly poorer than most of the other rootstocks and Thomas was significantly better than most of the other rootstocks. Notable in this plot was the recovery and rapid growth of Hibbard. In 1995 it was doing very poorly. Hibbard will be examined further as a possible rootstock for use in areas without root rot. Fruit yield from this young plot was very variable and no significant differences were found. In a 6-year-old rootstock trial at South Coast without heavy root rot pressure, the trees yielded in the following in order from greatest yield to least yield: Borchard, Dusa, UC2011, Duke 9, Queretaro, UC2003, Thomas, Spencer, Duke 7, CRI-71. Borchard, UC2011 and Dusa were significantly better than most of the other rootstocks. In a 7-year-old trial from South Coast without heavy root rot pressure, the trees yielded the following in order from the greatest yield to the least yield: Parida, UC2002, UC2009, Toro Canyon, UC2001, Thomas. Panda was significantly better than the other rootstocks. In a 2-year-old trial from Somis with heavy root rot pressure, the rootstocks performed in the following order from greatest growth to least growth, as measured by canopy volume: Thomas, Evstro, Duke 7, Topa topa, Golden, Velvick, Aguacate Mico.(See Table).

Somis Rootstock Trial Tree Ratings
March 1996

Rootstock	Tree Rating (0 - 5)*	Trunk Diam (mm)	Canopy Volune (cu ft)
Thomas	0.071 A	41.93 A	42.18 A
Evstro	0.275 A	34.55 B	38/61 AB
Duke 7	0.450 A	34.30 B	33.70 BC
Topa Topa	1.550 B	37.20 AB	28.72 C
Golden	2.050 BC	24.15 C	20.04 D
Velvick	2.763 CD	17.58 D	14.60 D
Aguacate	3.200 D	23.15 C	15.91 D

*Rating (0 = no damage; 5 = dead)
Means followed by same letter not significantly different according to Waller's k-ratio t test.

Thomas and Evstro had more than twice the canopy volume of Velvick and Aguacate Mico. In a 3-year old trial from Somis with heavy root rot pressure, Thomas appeared to grow better and was more resistant to root rot than either UC2011 or Duke 7. However, when these rootstocks were mulched on the same site, their performance was not significantly different. It appears that mulching benefits less resistant rootstocks more than resistant ones on soil infested with *P. cinnamomi.* Leaf analysis of trees on Thomas, Duke 7 and UC2011 indicated the following. UC2011 absorbs less Ca but more Zn than Thomas and Duke 7. Duke 7 absorbs more Mg than Thomas and UC2011. Thomas absorbs more K than UC2011 and Duke 7. There was no significant differences in the absorption of P, Na, Mn and Cu among the tree rootstocks. In a one-year-old field trial in Somis CA with heavy root rot pressure, Evstro and Thomas are growing significantly better than Spencer and Velvick. In a one-year-old field plot on root rot soil in Camarillo CA, UC2023((G755c seedling), and VC256(West Indian from Israel) are growing the best. Borchard, Thomas, Evstro, Gorden(South African), W14(South African) and Spencer were intermediate. Halma Duke(Duke 7 selection) was growing poorly.

Several field trials will be established in 1997 in root rot sites in Ventura and San Diego Co. These trials will include PP4 (UCR breeding block-maternal parent Barr Duke), PP5 (UCR breeding block-maternal parent D9), VC207 (West Indian from Florida via Israel), VC256 (West Indian Israeli selection), Evstro (Australian Selection), Thomas, G755A *(P. shiedeana x P. americana,* Guatemala), Duke 7.

Avocado varieties being propagated for 1998 field trials include Dusa (Duke 7 seedling from South Africa), Spencer (selection from Pauma Valley, San Diego Co.), G755A *(P. shiedeana x P. americana,* Guatemala), Latas (South African selection), Evstro (Australian selection), Rio Frio (Guatemalan selection), Poly-N (haploid avocado from UCLA), VC241 (*P. nubigena* from Israel), PP15 (UCR breeding block-maternal parent Thomas), W14 (South African selection).

Conclusions

It appears that Thomas is still the best rootstock to use in soil with heavy root rot pressure, but other rootstocks will out-yield Thomas when root rot is not severe or absent. Several promising new rootstocks will bear further field study before being released to growers. These include Parida, Dusa, Evstro, Spencer, and G755A. Rootstocks which have performed well under greenhouse conditions include Latas, Poly-N, W-14 and UC2076. Our first avocado varieties from the UCR breeding program will be placed in field tests this year.