

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

Continuing Project; Year 7 of 20

John A. Menge
Department of Plant Pathology,
UC Riverside

Cooperating Personnel: G. A. Zentmyer, B. Mckee, F. Guillemet, E. Pond, G. Bender, M. Arpaia, B. Faber, M. Crowley, M. Clegg, M. Kobayashi, P. Mauk

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 manifold 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

No resistant rootstocks were imported from outside the US in 1998. However, we have requested rootstocks # 28, 49, 55, 801, 803, 804, 805, 811, and 821 from Israel and Wilg from South Africa. These rootstocks have shown promise as root rot resistant rootstocks in those countries. 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., the

Hibbard tree at South Coast and the Keenon tree from San Diego. All of these trees exhibit valuable traits.

Breeding Program

We have screened 2535 seeds from the breeding blocks for resistance to *Phytophthora cinnamomi* in 1998. While we can handle up to 12,000 seeds per year, we have begun to revamp one of the 9 breeding blocks every year. Resistant frees will be planted in the blocks instead of grafting resistant buds into existing frees. This will allow more uniform plantings, the establishment of replicated frees 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. Like the first year, the second year's results indicate no significant alterations in the flowering times or fruit set due to these treatments. We have decided to continue the girdling program but to discontinue the Uniconazole-P sprays. We will cover trees and use bee hives in an attempt to get more crossing in the future.

From the material screened this year, we retained 16 seedlings which showed excellent resistance to *P. cinnamomi* in the initial screening. These seedlings have maternal parents of Spencer (10), UC2001 (1), G6 (1), D9 (2), Toro Canyon (1), Barr Duke (1) and Thomas (1). This is the first year the Spencer trees have fruited prolifically and the high number of resistant seedlings is noteworthy. The maternal parentage of all rootstocks kept in the UCR avocado breeding program 1994-1998 are shown in Table 1. Spencer (escape tree Pauma Valley) appears to be the best parent for resistant rootstocks. Other parents which have provided significant progeny for the breeding project include UC2001 (Duke 7 seedling), D9 (irradiated Duke seedling) Toro Canyon (Brokaw Selection), G6 (Guatemala), Barr Duke (selfed Duke 6 seedling) and Thomas (escape tree Escondido). We now have 25 possible crosses from the breeding program which have shown exceptional resistance to *P. cinnamomi* after extensive testing. For three of these, field testing began in 1998. Three others will be field tested in 1999 and 10 more have been increased and are ready for field testing. Nine new varieties will be grafted for increasing budwood in 1999.

We are cooperating with Dr. 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.

The breeding blocks are now made up of G755A, Thomas, G810, G875, G1033, Toro Canyon, Spencer, Barr Duke, UC2001, CRI-71, Duke 7, G6, and D9. We have removed one breeding block consisting of Thomas and Toro Canyon and will replace it in 1999 with a block consisting of Spencer, Toro Canyon, Thomas and PP 4 (Zentmyer).

Screening and Greenhouse Evaluation of Rootstocks

Extensive greenhouse evaluations were done on clones Rio Frio (Guatemala),? 14 (maternal parent G6), PP 19 (maternal parent 2001) and PP24 (maternal parent Toro Canyon). Borchard served as the susceptible control and most plants died. Rio Frio did not grow well and most seedlings died. *Phytophthora cinnamomi* reduced top growth of Borchard 33%, PP 14 3%, and PP 19 8% and PP24 6%. *Phytophthora cinnamomi* reduced root weight of Borchard 25%, PP14 6%, PP19 6% and PP24 18%. Percent root health and total root length was not significantly different among all of the rootstocks.. However, soil populations of *P. cinnamomi* around the roots was highest with PP19, and Borchard. It would appear that all three of the PP rootstocks should be considered for field testing. Rootstocks selected for intensive testing in 1999 include Aguacate de Mico (Guatemala), VC 256 West Indian from Israel), PP 15 (maternal parent Thomas or Barr Duke), PP19 (maternal parent UC2001) and Poly N (polyploid from UCLA). Plants being grafted for intensive studies in 2000 include VC 239 (Israel), VC 241 (*P. nubigena* from Israel), PP18 (maternal parent Thomas) PP21 (maternal parent D9), PP22 (maternal parent Thomas) Thomas and Borchard.

Field Evaluation

In an 8-year-old rootstock trial at South Coast without heavy root rot pressure, the trees yielded poorly and there were no significant differences among the rootstocks. However for the four year average (1995-1998) the rootstocks yielded in the following order from greatest yield to least yield: Duke 7, Dusa (South Africa), Borchard, UC2003 (Escondido), Queretaro (Mexico), Thomas, D9 (irradiated Duke), UC2011 (Duke-Statom), Spencer (Pauma Valley), CR 1-71(Costa Rica).The Dusa and the UC 2003 should be studied in future tests. Only the CR 1-71 (Costa Rica) is performing poorly enough to be eliminated from study,

In a 9 year trial at South Coast without heavy root rot pressure the trees yielded in the following order from the greatest yield to the least yield: Parida (Brokaw), UC2009 (Jovo South Africa), UC 2002 (Bar Duke seedling), Toro Canyon, UC 2001 (Duke 7 seedling) and Thomas. The average yield (95-98) was in the following order of greatest to least yield: Parida (Brokaw), UC 2002 (Bar Duke seedling), UC2009 (Jovo South Africa), Thomas, UC 2001 (Duke 7 seedling) and Toro Canyon). All of these rootstocks are performing adequately.

In a three-year-old trial in Camarillo, CA under heavy root rot pressure, trees were rated as follows from the healthiest to the poorest: Spencer (Pauma Valley), VC 256 (Israel), Halma Duke, UC 2014 (W-14 South Africa), Borchard, UC 2023 (G755 C seedling), Evstro (South Africa), Gordon (South Africa) and Thomas. Tree size from largest to smallest was: Borchard, VC 256 (Israel), UC 2014 (W-14 South Africa), Thomas, UC2023 (G755 C seedling), Evstro (Australia), Spencer (Pauma Valley), Halma Duke and Gordon (South Africa). Only Gordon (South Africa) appears to be failing.

A 2-year-old trial at Carpinteria, CA with G755A (*P. schiedeana* x *P. americana* seedling), Evstro (Australia), Velvick (Australia) and Spencer (Pauma Valley) has not yet been evaluated.

A 2-year-old trial in Somis, CA under heavy root rot pressure, was rated as follows from the healthiest to the poorest: Thomas, Evstro (South Africa), Spencer (Pauma Valley), and Velvick (Australia). Tree sizes from largest to smallest were: Thomas, Evstro (South Africa), Spencer (Pauma Valley), Velvick (Australia). Thomas is doing considerably better in this trial than the other rootstocks.

A 1-year old trial in Somis, CA under heavy root rot pressure was rated as follows from healthiest to the poorest: PP4 (Zentmyer, maternal parent Barr Duke), PP5 (maternal parent D9), Thomas, Evstro (South Africa), G755A(*P. schiedeana* x *P. americana* seedling) and Duke 7. Tree sizes from largest to smallest were: PP4 (Zentmyer, maternal parent Barr Duke), PP5 (maternal parent D9), G755A(*P. schiedeana* x *P. americana* seedling), Thomas, Evstro (South Africa), and Duke 7. This is the first plot with rootstocks which are growing better than Thomas.

In a 1-year old trial in Escondido, CA which compares Spencer (Pauma Valley) as a seedling rootstock with Topa Topa, it was found that the Spencer is much healthier and larger than the Topa Topa.

A new trial was established in Carpinteria CA on root rot infested soil. It contains: Dusa (South Africa), VC 207 (Day -Israel), VC 256 (Israel), PP4 (Zentmyer, maternal parent Barr Duke), VC 241 (*P. nubigena*, Israel), Spencer (Pauma valley) and Thomas. This trial has not yet been rated.

A new trial was established in Carpinteria, CA on root rot infested soil. It contains: Spencer (Pauma Valley), G755A (*P. shiedeana* x *P. americana* seedling) and Thomas. This trial has not yet been rated.

A new trial was established in Goleta CA on root rot infested soil. It contains: VC 256 (Israel), Thomas, PP15 (maternal parent Thomas), Latas (South Africa), Halma Duke (Duke seedling), and PP5 (maternal parent D9). This trial has not yet been rated.

Several new field trials will be established in 1999 in sites in San Diego County. These trials will include: PP4 (Zentmyer, maternal parent Barr Duke), Spencer (Pauma Valley), Dusa (South Africa), Latas (South Africa), Evstro (South African), G775A (*P. schiedeana* x *P. americana* seedling), Rio Frio (Guatemala), Poly-N (polyploid from UCLA), VC 241 (*P. nubigena* from Israel), W14 (South Africa), Bailey (Brokaw), Aguacate de Mico (Guatemala), PP14 (maternal parent G6), PP19 (maternal parent 2001), PP24 (Maternal parent Toro Canyon), PP15 (maternal parent Thomas) Parida (Brokaw selection) Halma Duke (Duke seedling), and Leo (Brokaw selection).

Avocado varieties being propagated for 2000 field trials include Dusa (South Africa), Latas (South Africa), Evstro (South Africa), PP4 (Zentmyer, maternal parent Barr Duke), PP15 (maternal parent Thomas or Barr Duke), PP19 (maternal parent UC 2001), PP24 (maternal parent Toro Canyon), G775A (*P. schiedeana* x *P. americana* seedling), UC 2023 (G755 seedling), VC 256 (Israel West Indian), VC 207 (Day-Israel West Indian), Thomas and Parida (Brokaw selection).

Conclusions

It appears we may have a rootstock which surpasses Thomas as the most root rot resistant. It is PP4 (maternal parent Barr Duke), which we propose to name the Zentmyer. Other material from the breeding block continue to look very good and more of these varieties are being evaluated in field trials. We are continuing study on other promising rootstocks including Dusa (South Africa), Spencer (Pauma Valley), G755A (*P. schiedeana* x *P. americana* seedling), Parida (Brokaw selection), VC 256 (Israel West Indian), UC2023 (G755 seedling), and PP5 (maternal parent D9). Rootstocks which have performed well under greenhouse conditions include Latas (South Africa), Poly-N (polyploid from UCLA), Huntales (w/o sunblotch), Aguacate de Mico, PP 14 (maternal parent G6), PP 19 (maternal parent UC2001), PP24 (maternal parent Toro Canyon) and W14 (South Africa). Because of the success of our first UCR breeding plot material we are increasing our efforts with these varieties.

Table 1. Maternal parentage of root rot-resistant seedlings screened and/or retained in the UC Avocado Breeding Program, 1994 - 1998.

Variety	Total screened	Number retained	Percent retained
Barr Duke	518	1	0.19
CR1-71	24	0	0
D 9	2349	14	0.60
Duke 7	151	0	0
Evestro	8	0	0
G 6	2145	6	0.28
G 810	108	0	0
G 1024	108	0	0
G 1033	159	0	0
G 1038	139	0	0
G 371	20	0	0
Kidd Duke	102	0	0
Poly N	24	0	0
Rollie	137	0	0
Spencer	351	10	2.85
Thomas	2823	6	0.21
Toro Canyon	1173	4	0.34
UC 2001	1788	15	0.84
UC 2011	314	0	0
UC 2020	187	0	0
UC 2054	134	0	0
Unknown	108	0	0
Total	12,870	56	