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

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### PROJECT OBJECTIVE

Ultimately, the control of Avocado root rot will be accomplished with resistant rootstocks. Our goal is to find rootstocks that will eliminate *Phytophthora cinnamomi* as a serious pathogen on avocado. Our ability to find such a rootstock has been enhanced as a result of our breeding blocks where we focus on crossing already resistant rootstocks. Our objectives over the life of this project have been to collect, select, breed and develop avocado germplasm that exhibits resistance to *Phytophthora* root rot of avocado. This project has already produced several new tolerant rootstocks (Zentmyer, Uzi, and Steddom), which are greatly improving the yields of avocado on land infested with *Phytophthora cinnamomi* (Figure 1). The UC Administration has recently given us the approval to release these new rootstocks, which I am currently working on.

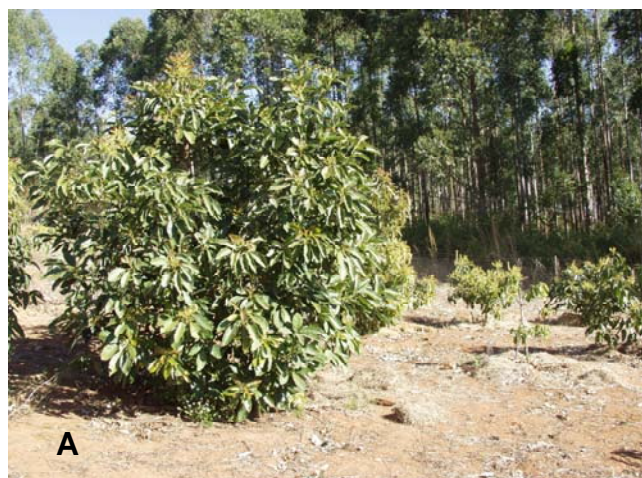


Figure 1. A) Zentmyer rootstock grafted to Hass (left) growing vigorously in root rot infested soil in South Africa next to unknown, but susceptible rootstocks, grafted to Hass. B) Uzi rootstock grafted to Hass (left) growing vigorously in root rot infested soil in Southern California next to Spencer rootstock grafted to Hass that is showing symptoms of *Phytophthora* root rot.

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## PROGRESS:

This past year we have rated 12 plots and harvest data has been collected from two plots. Two years ago we planted four plots and one particular plot has heavy *Phytophthora* inoculum and two newer varieties, Brandon and Eddie, are showing great promise (Table 1; Fig. 1). In the second year, both varieties were still doing well but many trees in general have been killed due to *P. cinnamomi*. However, additional years of testing will be required as well as testing these varieties at additional locations in the avocado production areas. We also have for the first time a plot in Santa Paula where we have a phosphoric acid treatment with Thomas versus a non treated control with Thomas which demonstrates how many of our advanced lines are performing well in root rot infested soil where no control measures were taken (Table 2). However, this particular plot was hit hard by the freeze two years ago and also has some *Dothiorella* present. This year we set up four new plots; 640 trees from Brokaw and 200 from C & M nursery.

Table 1. Tree rating from a plot in Rancho California after year one (above) and year two (below).

Rootstock	Tree rating (0-5; 5=dead)	Canopy vol (cu ft)	Trunk diam (cm)	Salt damage (0-5; 5=heavy)	Dead trees (%) <sup>1</sup>
Brandon	0.763g	27.40a	2.537a	2.026a	0
Eddie	0.947fg	24.03ab	2.390a	1.263bcd	0
Dusa	1.175efg	18.93bc	2.510a	1.175cd	0
Farwell 1	1.417def	19.70bc	2.383a	1.189ab	0
Campbell	1.658cde	16.21c	2.184ab	1.868ab	0
Farwell 2	1.833 cd	13.42cde	2.350a	2.139a	0
VC241	1.868cd	17.91bc	2.179ab	1.553abc	0
Gray	2.028cd	7.57e	1.917b	1.878d	0
Thomas	2.075bc	15.23cd	2.190ab	2.105a	5
Balou 1	2.700ab	7.36e	1.960b	0.778d	10
Balou 2	2.763a	8.84de	1.821b	1.625abc	16

<sup>1</sup> Dead trees were isolated for root rot and all were positive for *P. cinnamomi*

Rootstock	Tree rating (0-5; 5=dead)	Canopy vol (cu ft)	Trunk diam (cm)	Salt damage (0-5; 5=heavy)	Dead trees (%) <sup>1</sup>
Dusa	0.42af	56.92a	3.60ab	1.28de	5
Brandon	0.842ef	57.51a	3.69a	2.82a	11
Eddie	1.105def	58.18a	3.40ab	1.22de	16
Farwell 1	1.306cdef	38.11b	3.00abc	1.38cde	11
Farwell 2	1.444cdef	30.17bc	2.88abcd	2.13ab	11
VC241	1.790cde	25.68bcd	2.44cd	1.67bcd	21
Campbell	2.026cd	23.54bcd	2.41cd	2.06bc	16
Thomas	2.150bcd	31.54bc	2.77bcd	2.27ab	25
Gray	2.250bc	16.62cd	1.99de	1.08de	28
Balou 1	3.194ab	11.50d	1.39e	0.80e	45
Balou 2	3.605a	12.07d	1.21e	1.13de	58

<sup>1</sup> Dead trees were isolated for root rot and all were positive for *P. cinnamomi*

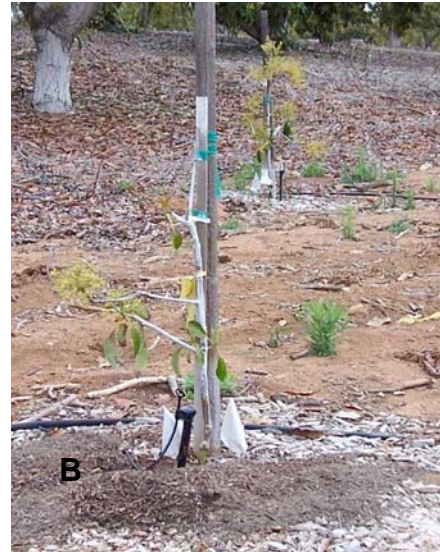


Figure 1. A) Eddie rootstock (left) grafted with Hass and Dusa rootstock (right) grafted with Hass growing under heavy root rot conditions. B) Thomas rootstock grafted with Hass showing significant symptoms of avocado root rot. C) Brandon rootstock grafted to Hass growing under heavy root rot conditions.

Table 2. Tree rating from a two-year-old plot in Santa Paula.

Rootstock	Tree rating (0-5; 5=dead)	Canopy volume (cu ft)	Trunk diameter (cm)	Salt damage (0-5; 5=heavy)	Dead trees <sup>1</sup> (%)
Johnson	0.00d	77.01a	4.79ab	0.50cdef	0
Medina	0.00d	70.65ab	4.69abc	0.64abcdef	30
Thomas/Fungicide	0.00d	64.51abcd	4.85a	0.94ab	20
Brandon	0.00d	69.10abc	4.42abcd	0.72abcd	0
O'Connell	0.10cd	46.82defg	3.77def	0.45defg	0
Dusa	0.10cd	68.66abc	4.68abc	0.10gh	44
Eddie	0.11bcd	54.13bcdef	4.22abcde	0.22fgh	10
Gabor	0.17abcd	59.45abcde	4.20abcde	0.67abcde	40
Afek	0.19abcd	44.47efg	3.88cdef	0.88abc	20
Lovatt	0.22abcd	40.33fg	3.28f	0.78efgh	10
Erin	0.28abcd	54.54bcdef	3.97bcdef	0.11gh	10
Zutano	0.29abcd	35.06g	3.54ef	1.00a	30
Thomas	0.35abc	46a.79defg	3.90cdef	0.55bcdef	0
Topara	0.39ab	50.72cdefg	4.11abcdef	0.78abcd	10
Lansfield SA	0.40a	45.61efg	4.72abc	0.00h	0

<sup>1</sup> Trees probably died from *Dothiorella* or freeze. Only 10 blocks rated.

A total of 4,320 seeds have been screened from the 2007 crop year with most of the seeds (2,448) coming from our advanced lines in our block at South Coast Field Station. The remaining seeds were taken from our breeding blocks at the UCR campus. Seeds from the 2008 crop are now being screened (total of 1,296 collected). Four new GDS selections have been added to the 16 prior selections and 8 more are still being evaluated; these are the advanced lines selected since I took over the program. A new breeding block consisting of 16 trees has been planted at the UCR campus consisting of 4 trees each of Zentmyer, Steddom, Uzi, and Anita and another breeding block has recently been planted consisting of Dusa, Anita, Eddie, and Brandon.

Next year we are planning on setting up a large experiment at the Ag Ops facility on campus where we plan on testing some of our advanced lines and new lines from South Africa that have demonstrated good tolerance to PRR under South African conditions. For example, we have been told by our South African colleagues that one rootstock in particular is much better than Dusa. However, we do not know how these rootstocks will perform under California conditions since our climate is much drier and we have higher alkaline soils and much more salinity problems than in South Africa. The experiment will consist of three treatments; an uninoculated control, inoculated treatment, and an inoculated treatment with phos acid applied for control of PRR. Since this experiment will likely be very large, we may not plant any additional field trials next year. However, this will serve as a good field trial since we will be in control of the water and have the ability to inoculate the soil with the pathogen and will be able to address phos acid versus no phos acid control measures on the various rootstocks abilities to resist the pathogen.

Over the past year we have also collected new isolates of *P. cinnamomi* to determine how diverse the population is so that appropriate isolates can be used in the initial screening process. Thus far, it appears that the *P. cinnamomi* population is highly clonal (not genetically diverse) so the past initial screening in the greenhouse using a single isolate is likely still a good technique. However, we may use this data to investigate the virulence of unique *P. cinnamomi* isolates in the greenhouse to test

this. My graduate student finished collecting the genotypic data on our advanced lines, which revealed that we have genetically diverse germplasm which is good for our breeding purposes. She also demonstrated that all our lines are unique, i.e., we do not have any progeny that were from self-fertilization. This is also important information so that we now know that we are not testing identical rootstock genotypes and can combine the most diverse lines in newer breeding blocks. I have also submitted a USDA grant to work on the parentage analysis of our advanced lines as well as continue to work on genetically characterizing avocado rootstocks. However, I have not heard back from the funding agency at this present time.

## **Conclusions**

This project continues to move forward to develop rootstocks that are tolerant to *P. cinnamomi* so that California growers have 'options' when it comes to choosing which clonal rootstock they would like to grow. For example, we consistently get feedback from our grower collaborators and many seem to have a favorite rootstock that does best under their particular growing conditions. This is not surprising given the variability of soil types, grove topography, as well as management practices. The program thus far has produced rootstocks that are far superior to other rootstocks that the UC has worked on with yields up to 2 to 3 times that of older varieties such as Thomas. We are committed to continue to move forward on rootstock development for the California avocado growers.