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

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PROJECT OBJECTIVE:

Ultimately, the control of Phytophthora root rot (PRR) of avocado 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 rootstocks 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*. The Office of Research is currently processing these rootstocks for release.

PROGRESS:
This past year we have rated 17 plots and harvest data has been collected from 4 plots. Three years ago we planted 4 plots and one in particular had very heavy disease pressure, and 2 newer varieties, Brandon and Eddie, are showing great promise. Unfortunately, the land was recently sold and we lost this research plot. This year we are planting 4 plots consisting of 200 trees each; 600 trees from Brokaw and 200 from C & M nursery.

A total of 1,118 seeds have been screened from the 2008 crop year with about half coming from our advanced lines in our germplasm block at South Coast Field Station (SCFS) and the rest were from our breeding blocks on campus. Four new advanced selections have been made; making a total of 124 advanced selections since the program began (28 in the last 5 years). We have also made selections in recent years from 12 additional maternal parents compared to the 8 original maternal parents when this project began, demonstrating that the breeding and selection process is moving forward. From the 2009 crop, 3,158 seeds were collected with 2,162 seeds from SCFS and 996 from our breeding blocks on campus. We are also planning on establishing new breeding blocks this year using advanced lines that have good tolerance and are heavy producers, because some of the advanced lines rarely produce fruit. For example, Eddie produces heavily whereas Zentmyer generally does not produce well. We will also use the genetic data we acquired, as described below, to choose which varieties to place in these blocks.

This Spring we are planning on setting up a large experiment at the Ag Ops facility on campus where we will test some of our advanced lines and 6 new lines from South Africa that have demonstrated

good tolerance to PRR under South African conditions. Moreover, 3 of the new SA selections have been shown to become heavy producing trees when grafted to Hass. 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 with much more salinity problems than South Africa. The experiment will consist of three treatments; an uninoculated control, a *P. cinnamomi* inoculated treatment, and an inoculated treatment with phos acid applied for control of PRR.

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 and not genetically diverse (Fig. 1) 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.

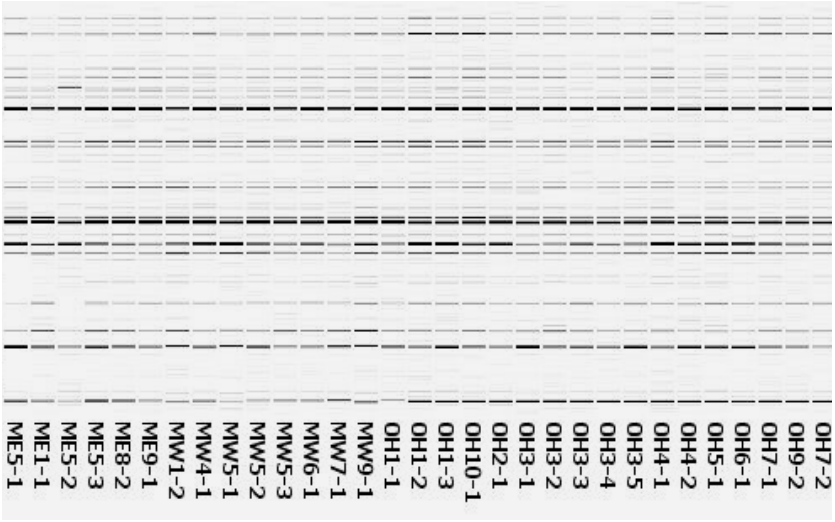

Figure 1. Genetic fingerprints of 31 isolates of *P. cinnamomi* collected from 3 avocado groves in southern California. Each name in the bottom row indicates a different isolate. Note the general uniformity in the banding patterns that demonstrates a lack of genetic diversity in the pathogen population.

Given the growing concern of salinity issues in our agricultural water, we have also conducted a preliminary greenhouse experiment recently to investigate how salinity affects pathogenicity of *P. cinnamomi* on avocado. We hypothesized that increased salinity in the soils would increase disease. However, we found no significant differences among the treatments (low to high salt conditions) but further investigations and replication of the experiment are needed to substantiate this preliminary result.

We have also completed a study on genetically characterizing many of our advanced lines using molecular techniques (Fig. 2). Based on the analysis, none of the rootstocks tested were the result of self-pollination and extensive diversity was found. Ten clades (A –J) (groups of closely related rootstocks) were found, one consisting of West Indian types (clade J) and the remaining with affinities to Mexican types. In some cases, tolerant to highly tolerant selections based on field data clustered together with selections where no field data is available, suggesting there may be a potential correlation with future field performance of untested rootstocks. For example, rootstocks in clade B consisted of some tolerant to highly tolerant rootstocks along with several that have not been tested. Therefore, it will be important to monitor these rootstocks in the future. However, in a few cases the opposite was found where susceptible and tolerant selections clustered together, indicating that in

some cases no obvious correlation exists. This type of data is important though because it now will allow us to combine the these best-performing and most genetically diverse rootstocks in future breeding efforts to potentially pyramid diverse sources of resistance into future selections.

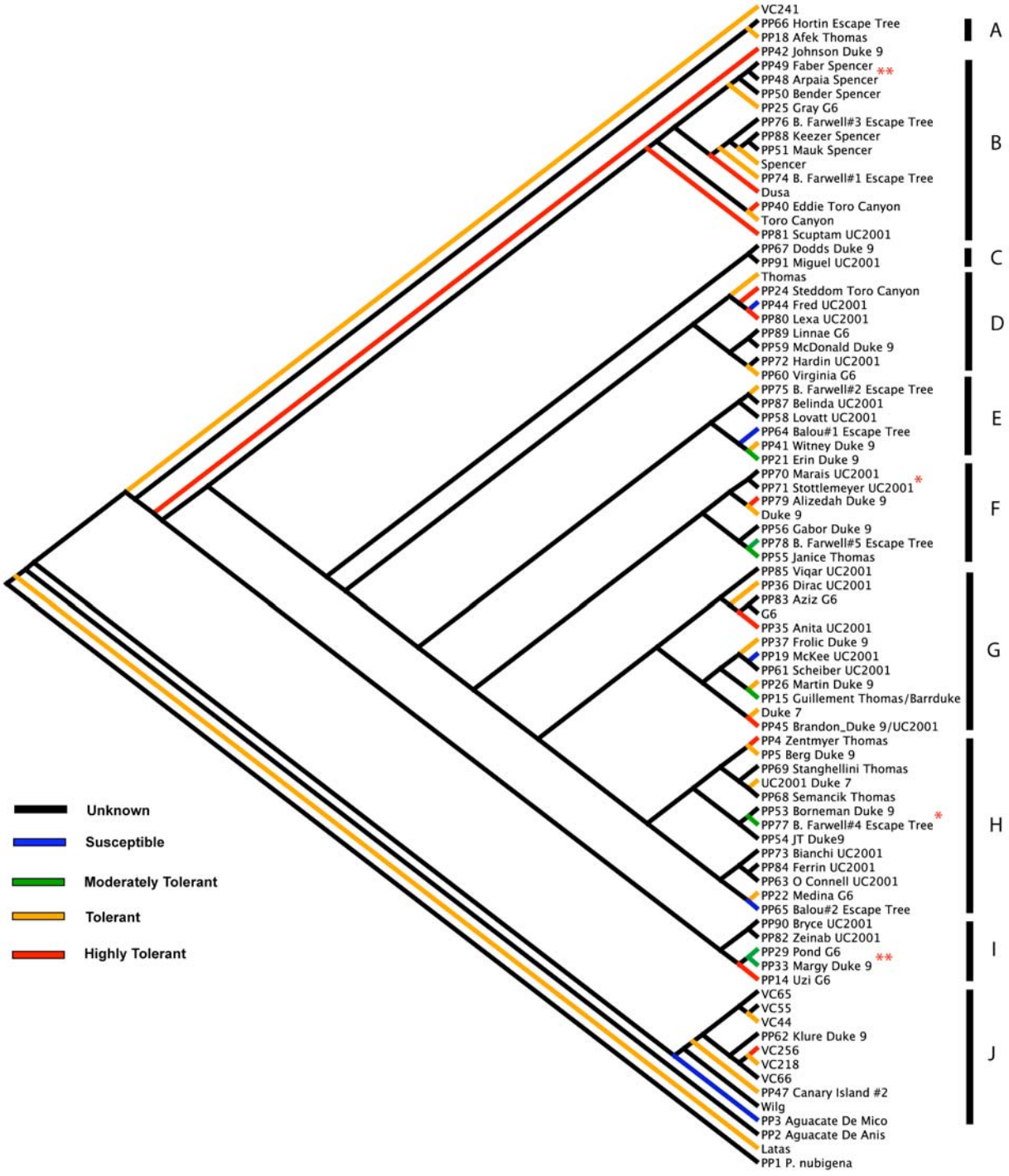

Figure 2. Phylogenetic analysis of avocado rootstocks (*n* = 83) based on amplified fragment length polymorphisms. Rootstocks clustered together on shorter 'branches' indicates that they are more genetically similar than rootstocks separated by longer 'branches'. Rootstocks with PP numbers are germplasm material from the UCR collection and they are further labeled with the name given to the collection followed by the name of the maternal parent if known. The collections not labeled with a PP number are additional cultivars used in the breeding program. Terminal branches are colored based on PRR field performance.

CONCLUSIONS:

This project continues to move forward in developing 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, salinity problems, grove topography, as well as management practices. The program thus far has produced rootstocks that are far superior to other rootstocks that UCR has developed and we are committed to continuing our efforts towards developing more tolerant avocado rootstocks for California avocado growers.