

## RESISTANCE TO PHYTOPHTHORA ROOT ROT

G. A. Zentmyer, F. B. Guillemet, M. K. Harjung, and A. I. Zaki

This is a progress report of our research on finding and developing rootstocks resistant to Phytophthora root rot, in relation to collections, and to testing in the greenhouse and field. Results with our many rootstock plots in the various counties are encouraging, with the great increase in number of trees planted during the past four or five years in our experimental plots, and also new rootstocks are being found that appear to have significant resistance.

During the past year, collections of potentially resistant rootstocks have continued, in southern California and in Latin America. Dr. Eugene Schieber, plant pathologist based in Guatemala, has continued the collections on a part-time basis in that area during 1977. Species collected were: *Persea americana* (the edible avocado), and several other wild species closely related to the avocado — *Persea scheideana*, *P. steyermarkii*, and *P. nubigena*. Approximately 80 collections were made during the year: the *P. americana* collections included a wide variety of Guatemalan types, from rather primitive, small-fruited criollo types to larger typical Guatemalans. Also a few of the *P. americana* collections were of the Mexican type, locally called "Matul-oj" in Guatemala; these have typical small Mexican fruit, usually purplish to black when mature and usually with anise odor in the leaves although we have found some of this type in Guatemala that do not have this odor. Our G6 collection from Guatemala several years ago, is of the Mexican type; this is showing considerable resistance to root rot.

One common center in Guatemala for *P. schiedeana* is near Coban in Alta Verapaz; this species is common in the hills surrounding this village. A number of additional collections were made in this area. This species has fruit very similar to the avocado, with an elongate neck (in Guatemala and Mexico); fruit is generally not of good quality but is edible and known locally in Guatemala as "Chucte" or "Coyou." One recent collection of this species has at least moderate resistance to *P. cinnamomi*, and the first grafting tests indicate that it is compatible with avocado. An earlier collection from the Coban area appears to be a hybrid between *P. americana* and *P. schiedeana*; it has some of the characteristics of each and is very vigorous. This collection also has moderate resistance to root rot, based on our first greenhouse tests; this is being propagated for further tests and for field trials. This "hybrid" is also compatible with avocado.

*Persea steyermarkii* is a primitive type of Guatemalan avocado relative that grows in the cloud forests in the mountains of north central Guatemala. The first tests with seedlings of this species show that they have moderate resistance to root rot and also are graft compatible with avocado. In one test, in heavily infested soil in the greenhouse, for example, Topa Topa seedlings had only 9 per cent healthy roots at the conclusion of

the experiment while *P. steymarkii* seedlings had 54 per cent healthy roots. This is another collection that we are propagating for further tests.

Seven old avocado trees have been found in southern California that are growing well in areas where most of the other trees have died from Phytophthora root rot. Four of these trees are in San Diego county, and one each in Los Angeles, Orange, and Ventura counties. These are grafted trees, so we are attempting to recover the rootstock from them to propagate and test its resistance. The rootstocks have been recovered from two of these trees, by forcing sprouts from the rootstock and rooting these in our avocado greenhouse at Riverside.

One of our earlier California collections with at least moderate resistance, the Huntalas rootstock, still carries sunblotch. Dr. P. R. Desjardins and R. J. Drake, in this Department at Riverside, are attempting to rid the clone of sunblotch so that it will be more useful in the resistant rootstock program. This has proven to be very difficult but continuing trials are being made, using shoot-tip grafting with etiolated shoots and meristem tissue culture. One hundred Hass trees on Huntalas rootstock were planted at the South Coast Field Station for observation to see if any of the selections had possibly escaped carrying sunblotch. Thirteen of these trees are showing sunblotch, with some sunblotch showing in each of the original selections made by E. F. Frolich.

During the past year many more seeds were obtained from our G6 and Duke 7 selections, additional tests were run to determine the resistance of the seedlings to root rot, and some of the seedlings, grafted and ungrafted, were planted in field plots for further testing. Seedlings of G6 and Duke 7 also show significant resistance in the initial greenhouse tests, which is encouraging; if appreciably high resistance can be maintained in the seedling population it would not be necessary to use the time-consuming and more expensive process of rooting cuttings to propagate the resistant material. Seed sources will, of course, be a problem until more seed trees are established and come into bearing.

As an example of the relative resistance of Duke 7 and G6 seedlings as compared to the susceptible Topa Topa seedlings, the following table gives results from a recent greenhouse experiment. In this test, all of the seedlings were grown for 9 months in soil heavily infested with *P. cinnamomi*.

<i>Rootstock</i>	<i>Increase in Height</i>	<i>Per cent Healthy Roots</i>	<i>Weight of Tops (grams)</i>	<i>Weight of Roots (grams)</i>
Topa Topa seedlings	7.2	0	31.5	26.5
G6 seedlings	56.4	42.5	101.3	67.0
Duke 7 seedlings	26.9	30.0	101.3	93.8

Thus, in this test, the G6 seedlings made eight times the growth that the Topa Topa seedlings did, had many more healthy roots, had tops three times as large, and roots also about three times as large as the Topa Topa seedlings. Duke 7 seedlings made

similar good growth, though the height increase was not as much as for the G6 seedlings.

In field plots established in all of the avocado-producing counties\* in previous years, in old root rot areas, some of our selections such as Duke 6 and Duke 7 cuttings, and some of the trees on Huntalas root-stock as well as a few G6 cuttings are showing appreciable resistance. This is shown in the following tables:

PLOT IN VISTA			
<i>Variety</i>	<i>Number of Trees</i>	<i>Number of Trees with Root Rot</i>	<i>Percent of Trees with Root Rot</i>
Hass on Topa Topa	15	13	86
Duke 6	24	3	12
Hass on Duke 6	26	10	38
Hass on Huntalas	26	9	35

  

PLOT IN FALLBROOK			
<i>Variety</i>	<i>Number of Trees</i>	<i>Number of Trees with Root Rot</i>	<i>Percent of Trees with Root Rot</i>
Nursery Trees	10	9	90
Duke 6	5	0	0
Duke 7	7	0	0
Hass on Duke 6	35	8	23
Hass on G22	3	0	0

PLOT IN FALLBROOK			
<i>Variety</i>	<i>Number of Trees</i>	<i>Number of Trees with Root Rot</i>	<i>Percent of Trees with Root Rot</i>
Huntalas	10	1	10
Duke 7	10	2	20
G-22	10	2	20
Hass on G-22	10	5	50
Hass on Topa	10	10	100

  

PLOT IN SANTA BARBARA			
<i>Variety</i>	<i>Number of Trees</i>	<i>Number of Trees with Root Rot</i>	<i>Percent of Trees with Root Rot</i>
Hass on Topa	15	10	67
Hass on Huntalas	15	3	20
Hass on Duke 7	15	2	13

In 1977, 503 additional trees were replanted in rootstock resistance plots in Riverside, San Diego, Santa Barbara, and Ventura counties; these included Duke 7 and G6 seedlings, Duke 7 and G6 seedlings grafted to Hass, Duke 6 and Duke 7 cuttings, and seedlings of three new Guatemalan collections with moderate resistance; G166, G335, and G592.

Several years ago it was found that species of *Persea* highly resistant to *Phytophthora* contained high amounts of an unusual organic chemical; the chemical was isolated and

identified here in this Department and given the name "borbonol" as it was first isolated from an avocado relative, *Persea borbonia*. During the past year, additional tests were run on the borbonol content of several additional species of *Persea* and varieties of the avocado, to determine if this chemical test could be used as a screening test for resistance. Three of four highly resistant species had high contents of borbonol. One very susceptible variety (Topa Topa) had variable amounts of borbonol; a very susceptible species (*P. indica*) had extremely low amounts of borbonol. Several types with moderate resistance, such as Duke 6, Duke 7, and G6 had moderate to high concentrations of borbonol. Other varieties and species are being tested to determine the usefulness of the test for screening collections for resistance to *P. cinnamomi*.

Thus, with the recent expansion of the research program on Phytophthora root rot, with substantial funds from the avocado marketing order (through California Avocado Advisory Board), results and future prospects appear very encouraging. Rootstock selections made a number of years ago (Duke 6. Duke 7) are showing good resistance in many field plots in comparison with standard rootstocks. More recent selections, G6 and Huntalas for example, appear to have similar resistance to the Duke selections; as more trees are planted in the field we will have a better idea of comparative resistance.

Another very encouraging aspect of the resistance program is that seedlings of Duke 7 and G6 to date are showing good resistance, with some variation in progeny as might be expected. A number of new collections also are now showing evidence of moderate to good resistance, including especially some of the Guatemalan collections that include *Persea steyemarkii*, *P. schiedeana*, and an apparent hybrid between *P. americana* and *P. schiedeana*.