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FIELD TRIALS FOR RESISTANCE TO PHYTOPHTHORA ROOT ROT

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A program for obtaining resistance to Phytophthora root rot of avocado was initiated on the Riverside campus of the University of California in 1950. With this type of disease it was felt that a resistant rootstock would provide the best control, hence this program has received the primary emphasis in research on this disease. Several publications have described the collections of avocado types and related species in Latin America (2, 3, 4, 5), the testing procedures in the search for resistance (6), and preliminary reports have been presented of the resistance of some of the plant materials (6, 7). All plants are now first screened for resistance in the nutrient solution tank test in the greenhouse, which provides a rapid and severe trial (6).

High resistance was reported early in the development of this program in several small-fruited species of the genus Persea, based on tests in the greenhouse and lathhouse and a few preliminary field trials (7). Similar high resistance has been found in additional collections made in Latin America by the senior author within the past few years. Unfortunately to date all of the high resistance occurs in species which are not graft compatible with avocado (1) and hence cannot be used directly as rootstocks, as had been hoped. The first indications of resistance in graft-compatible types were reported by Zentmyer and Thorn in 1956, in the Duke variety of avocado (9).

This paper summarizes the numerous field plots that have been established over the past 10 years to provide further tests of resistance of the various collections under conditions of natural infection. To date 27 plots are involved, with 1,901 trees, in Los Angeles, San Diego, Santa Barbara and Ventura counties. In addition to observing relative performance of the various types under field conditions, an important concern was to' determine correlation between performance of the varieties and species in the greenhouse tests and in the field.

The field plantings to test resistance have emphasized seedlings and cuttings of the Duke variety, because of the indications of at least some resistance in this graft-compatible type. For purposes of comparison other varieties and species have been planted, including the highly resistant species, even though none of these species is graft compatible with avocado and none of them has edible fruit. There are possibilities of hybridizing these species with the avocado: Dr. B. O. Bergh at Riverside, is investigating this phase. Work is continuing by E. F. Frolich at U.C.L.A. on methods of rooting cuttings and on budding and grafting techniques for compatibility tests.

The types of materials planted, number of plots and number of individual trees involved are summarized in Table 1. In addition to the varieties and species listed, limited

numbers of several other types have been planted, making a total of 1,901 trees on 27 plots. In rootstock-scion combinations involving commercial scions, yield records are being maintained to determine any effects of rootstock on production, in addition to the effects on root rot resistance.

*TABLE 1. Summary of field plantings for Phytophthora root rot resistance in Southern California.

Variety —	No. of Plots	No. of Trees
Topa Topa Seedlings	12	132
Fuerte/Topa Topa	17	111
Hass/Topa Topa	10	77
Duke (open pollinated) Seedlings	7	142
Fuerte/Duke (open pollinated)	15	118
Hass/Duke (open pollinated)	4	110
Duke (self pollinated) Seedlings	5	61
Fuerte/Duke (self pollinated)	2	17
Hass/Duke (self pollinated)	4	27
Fuerte/Duke Parent cutting	1	10
Fuerte/Duke No. 3 cutting	4	6
Fuerte/Duke No. 6 cutting	10	22
Fuerte/Mexican cutting	10	15
Duke Parent cutting	14	46
Duke No. 3 cutting	17	49
Duke No. 6 cutting	15	50
Mexican No. 1 cutting	11	24
Persea skutchii	7	20
Persea caerulea	4	5

* *Table does not include all varieties or species planted, merely most of major plantings; totals include* 1901 *trees in* 27 *plots.*

Plots are located in San Diego, Santa Barbara, Ventura and Los Angeles counties.

The field plots, as might be expected, have varied considerably in development of Phytophthora root rot following planting. Two principal methods have been used in an attempt to secure as uniform conditions as possible with respect to infestation of the soil with the avocado root rot fungus. **Phytophthora cinnamomi**, at the time of planting. On some of the plots the planting sites were treated with the soil fungicides Vapam or Mylone prior to planting, to enable the young trees to become established before the fungus moved back into the area. In other cases, grains of wheat and oats on which **P. cinnamomi** had been growing in the laboratory were placed in each planting hole, to assure a uniform infestation of the fungus. In plots not treated or inoculated prior to planting, tree sites have been tested for the root rot fungus. Periodic tests of roots and soil of trees in all plantings are made to obtain data on the occurrence of the fungus.

This paper is presented primarily as a progress report, since most of the plots have not been established sufficiently long to permit conclusive results. However, some interesting trends are apparent, and these will be pointed out with the aid of the accompanying graphs.

A typical situation with regard to root rot resistance is illustrated in Fig. 1 which shows

the development of the disease in an experimental planting in Fallbrook involving eight different combinations of scions and rootstocks with eight replicates of each combination. In this case each planting hole was infested with **Phytophthora cinnamomi** at the time of planting, and subsequent infection in general was uniform and severe. Trees showing the most significant resistance here are the Duke cuttings, with Hass on Duke seedlings from self-pollinated seed next in resistance.

A general summary of all field plots, with major rootstock and scion combinations utilized, is presented in Fig. 2. In obtaining these data all plantings of the combinations given were grouped together, regardless of age and planting, and initial or subsequent treatment. Again the cuttings (Duke and Mexican type) show the most resistance of the compatible types, with indications of some resistance when Fuerte or Hass scions were grafted on Duke seedlings as well. The other species of Persea, showing very high resistance, are the non-graft compatible types, **P. skutchii, P. caerulea,** and **P. borbonia.**

It should be emphasized that Fig. 2 presents a composite picture of trees planted under many different conditions, including amounts of **P. Cinnamomi** in the soil varying from none to heavy infestation, and including trees of various ages. The data are presented because of the interesting trends in the large numbers of trees, which are similar to those in smaller plantings where conditions for development of root rot are quite uniform (see Fig. 1).

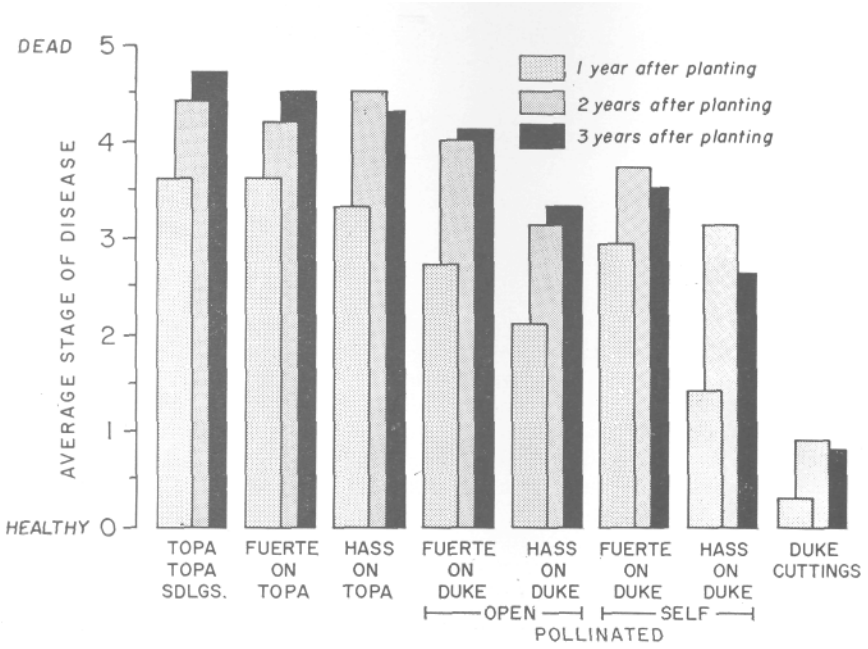

FIGURE 1. Summary of a root rot resistance plot in Fallbrook. Average stage of disease (ranging from 0.... healthy to 5 .... dead) is summarized for the various root-stock and scion combinations at intervals of one, two, and three years after planting. "Duke cutting" column includes cuttings from Duke variety and from selected Duke seedlings. All planting sites received inoculation of Phytophtora cinnamomi, avocado root rot fungus, at time of planting.

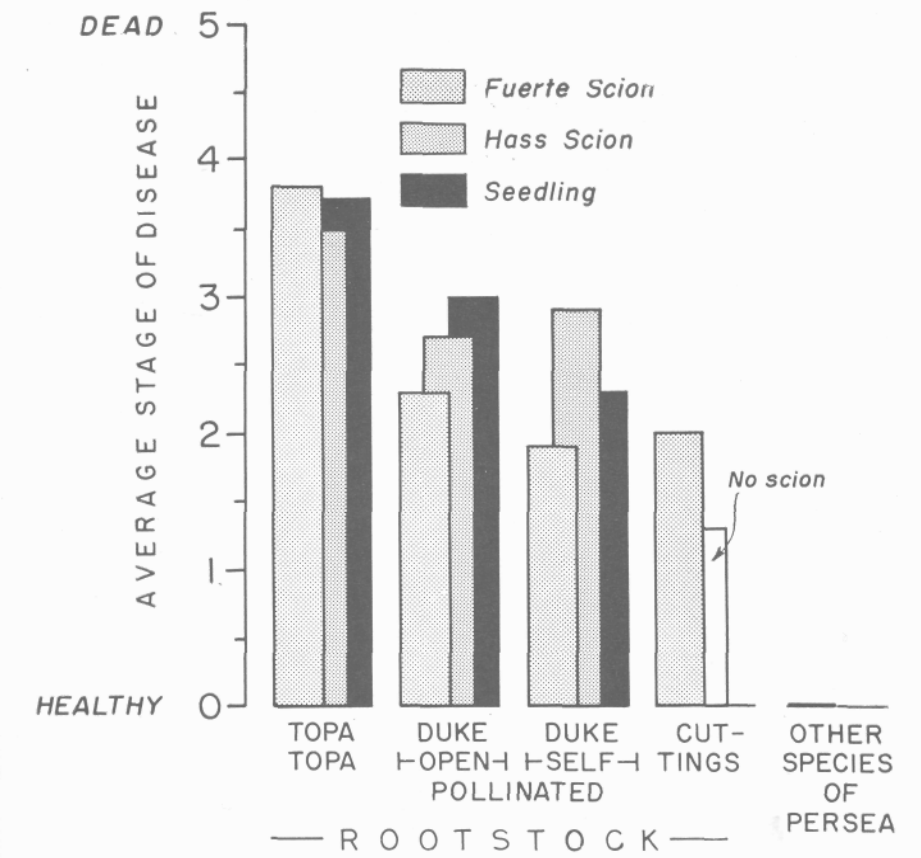

FIGURE 2. Summary of root resistance plots in four counties (Los Angeles, San Diego, Santa Barbara and Ventura). Data are from all test plantings, with above rootstock and scion combinations grouped together.

Preliminary indications from these field plots are: 1) seedlings of the Duke variety are in general more resistant than seedlings of Topa Topa, 2) cuttings of the Duke variety and cuttings of selected seedlings of Duke are more resistant to root rot and more consistent in their reaction than are seedlings of Duke; 3) seedlings of species such as **Persea skutchii** and **P. caerulea** show high resistance in the field as well as in greenhouse tests, based on small numbers to date; 4) grafted trees on Duke rootstock (seedling or cutting) are somewhat more resistant to root rot than grafted trees on Topa Topa rootstock; and 5) correlation is good between greenhouse and field tests.

Observations, disease readings and isolations to determine presence of the root rot fungus will be continued on these plots. Additional plantings are planned, to emphasize Duke cuttings and other Mexican cuttings —some to be grafted prior to planting, others to be grafted after establishment in the field. Also additional promising materials showing resistance in the greenhouse tests will be propagated for further trials under field conditions. By utilizing a combination of the rapid greenhouse test and field trials, to determine performance and production under normal growing conditions, it is anticipated that a resistant and compatible rootstock will eventually be found.

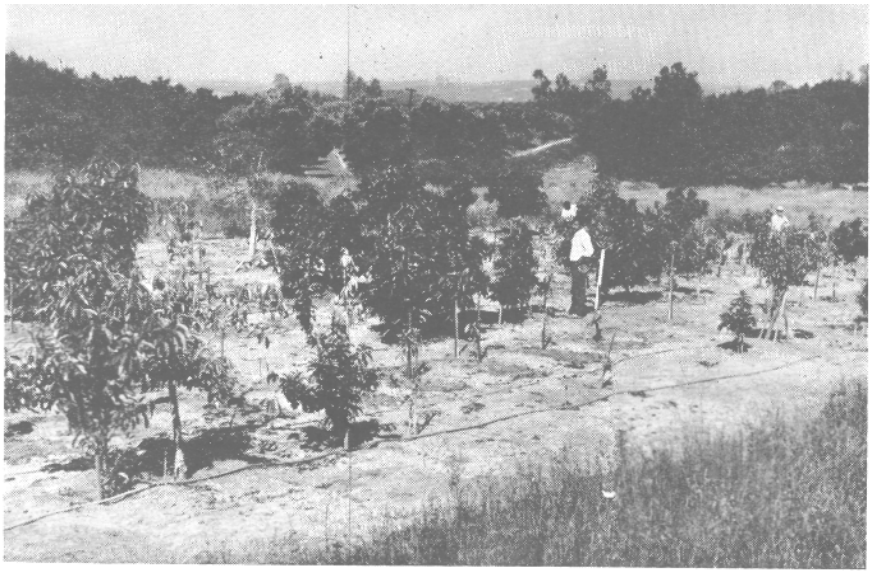

FIGURE 3. Root rot resistance planting in Fallbrook, showing trees of different ages and different condition. Many of the original trees have died from root rot and have been replaced by other experimental trees.

FIGURE 4. Young avocado planting in Fallbrook for testing resistance of various rootstocks by Phytophthora root rot. Soil is naturally infested with the avocado root rot fungus, Phytophthora cinnamomi.

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