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Avocado Rootstocks with Resistance or Tolerance to **P. cinnamomi**

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Germplasm Collection and Screening

Since the last reporting date a year ago, we have collected nearly 2500 seed of avocado or related species. Of this total, approximately 50 survived the initial tests with *P. cinnamomi.* Further testing and selection is in progress.

Propagation and Germplasm Increase

Germplasm that has survived the screening process undergoes further propagation in the greenhouse. Finally it is planted in our germplasm resource at SCFS. This year approximately six new selections were propagated in this manner.

Experimental Release Program

In the last year we have released 5 new rootstocks for testing under experimental cooperative agreements with California Nurserymen. These are designated:

UCR 2001
UCR 2002
UCR 2009
UCR 2011
UCR 2014

UCR 2001 and 2002 are Duke 7 and Duke 6 seedlings, respectively, from our ongoing "Duke" selection program. UCR 2011 is a collection from Guatemala. UCR 2009 and UCR 2014 are selections received from the Westfalia Estate in South Africa. They were recently released from the 2-year quarantine period and increased to provide limited amounts of budwood.

Another two selections, UCR 2008 and UCR 2010, are projected for experimental release in 1990, dependent entirely on there being sufficient availability of budwood at that time.

Field Evaluations with Hass Scions

Field tests with avocado rootstocks are of two types. First, the rootstocks are inoculated with *P. cinnamomi (P.c.)* and are grown under good cultural conditions, but without fungicides. Control trees, not inoculated with *P.c.* are included in such a test, if such an experimental condition is feasible. The first test of this type was set up just 2 years ago, in April 1986, at South Coast Field Station (SCFS). The early results of this critical test are given in the next section (SCFS Results).

Second, trees are planted in commercial situations where root rot is present and subjected to fungicide treatment such as Ridomil® at label rates. Approximately 10 plantings were made in 1984 with over 2000 trees, with good representation in the following selections: Duke 7, G6, Barr Duke, Toro Canyon, G755a, G755b, G755c and Thomas. Of these plantings, only two were of sufficient quality to provide a statistically significant data base. Eighty percent of the plantings suffered from less than adequate cultural care (see Biological and Cultural Control Report).

Data from the largest successful planting made in 1984 at Embarcadero Ranch, Goleta, is presented in Table 1:

Thomas was the best rootstock in the first 3 years of this field assessment, both in terms of increase in trunk girth and visual rating. Barr Duke and Duke 7 had equivalent performances and were similar to Thomas in their visual ratings. G6 and G755b were similar in performance after 3 years, just behind Thomas. Borchard is susceptible to root rot.

Data from the other successful planting at the Betty Spaulding Ranch in Carpinteria is presented in Table 2.

Table 1. Embarcadero Ranch Results. Comparison of visual ratings and percent growth increase (trunk girth measurement) after 3 years for 6 rootstock selections with Hass scions at the Embarcadero Ranch, Goleta. Planting made in 1984 and trees have received Ridomil® at label rate until now.

Rootstock selection	Visual rating (0-5)	Percent growth increase
Thomas	0.9 A	579 A
G6	1.3 B	555 AB
Martin Grande (G755b)	1.7 B	505 ABC
Barr Duke	0.7 A	490 BC
Borchard	2.9 C	457 C
Duke 7	0.9 A	450 C

Means with the same letter are not significantly different according to Duncan's new multiple range test (P = 0.05).

Table 2. Spaulding Ranch Results. Comparison of growth increase in trunk girth after 3 years for 5 rootstock selections with Hass scions at the Betty Spaulding Ranch, Carpinteria. Planting made in 1984 and treated for 2½ years with Ridomil®.

Rootstock selection	Percent growth increase	mm growth increase
G755c	311 A	57.0 A
Toro Canyon	306 A	45.7 B
Duke 7	186 B	36.0 C
G6	169 B	36.0 C
Duke 6	273 A	34.2 C

G755a and Toro Canyon are the best rootstock performers at this time.

SCFS Results

Twenty replicates of 12 rootstocks were clonally propagated and planted in a field plot at the South Coast Field Station (SCFS) Irvine on April 30, 1986, in a Completely Randomized Design. Rootstocks were planted in a 30 cm diameter hole, 45 cm deep, and surrounded by field soil. The rootstocks were spaced 4.6 M within a row and 6 M between rows, and were irrigated with minisprinklers twice a week on average. Ten trees of each selection were inoculated with *P. cinnamomi* 4 wks after planting. The inoculum consisted of a *P. cinnamomi* isolate grown on millet seed and mixed with U.C. mix to a concentration of 30 propagules per gram. Rootstocks were inoculated by boring two 4 cm diameter and 15 cm deep holes opposite each other, beside the root ball. 250 ml of the inoculated soil was placed in each hole and covered with 2.5 cm of ground soil.

Ten trees of each selection were uninoculated controls, and were additionally treated with Aliette consisting of 1 L per tree of a preplant drench (3000 ppm a.i.), and a foliar spray (0.3% a.i.) at monthly intervals from April to October in 1986, and then every three months thereafter.

All rootstocks had Hass scions. A reference point on the trunk of each rootstock was marked with paint and was used for measuring girths. Visual ratings were made during the summer each year using the standard scale for root rot (0 to 5).

Rootstocks which gave the best performance against root rot were G755a, G755b, G755c and Thomas (Tables 3, 4 and 5). Thomas was a superior rootstock among these

twelve selections based on girth measurements and visual ratings. Barr Duke had a visual rating similar to the G755 selections (Table 3). The data base is less than two years old, however.

Table 3. Comparison of visual ratings of 12 selected avocado rootstocks 55 wks postinoculation with *P. cinnamomi*. Visual rating on a scale of 0-5.

Rootstock	Mean Visual Rating
Borchard	4.390 A
Topa Topa	4.35 A
G6 parent	3.65 AB
G1033	2.90 BC
D9	2.83 BC
Toro Canyon	2.55 BCD
Duke 7	2.22 CD
G775c	2.15 CD
Barr Duke	1.80 CDE
G755a	1.70 CDE
G755b	1.40 DE
Thomas	0.65 E

Means followed by a different letter are significantly different according to Duncan's new multiple range test (P = 0.05).

Visual ratings for the uninoculated rootstocks were not significantly different according to Duncan's new multiple range test (P =0.05).

Table 4. Comparison of percent increase in girth measurements of 12 selected avocado rootstocks both uninoculated and inoculated, 79 wks postinoculation with *P. cinnamomi*

Rootstocks	Inoculated	Noninoculated
Thomas	199.80 A	322.88 A
G755c	98.00 B	159.40 CD
G775b	96.20 B	152.80 CD
G1033	80.90 BC	227.00 BC
G755a	80.70 BC	149.60 CD
Toro Canyon	79.70 BC	209.11 BCD
Duke 7	68.33 BC	205.40 BCD
Barr Duke	61.70 BCD	153.63 CD
D9	60.56 BCD	135.40 D
G6 Parent	46.80 CDE	287.50 AB
Topa Topa	19.40 DE	219.10 BCD
Borchard	12.10 E	228.20 BC

Means followed by a different letter are significantly different according to Duncan's new multiple range test (P = 0.05).

Table 5. Comparison of percent reduction in girth growth directly due to *P. cinnamomi* infection, of 12 selected avocado rootstocks, 79 wks postinoculation with *P. cinnamomi*

Rootstocks	Percent reduction
Topa Topa	63.30 A
Borchard	62.40 A
G6 Parent	62.29 A
Toro Canyon	44.82 B
G1033	43.91 B
Duke 7	43.38 B
Barr Duke	38.44 BC
D9	32.98 BC
Thomas	32.06 BC
G755a	28.17 C
G755b	25.07 C
G755c	24.40 C

Means followed by a different letter are significantly different according to Duncan's new multiple range test (P = 0.05).

Research Directions

The number of individual rootstock selections which will have to be tested in the future is currently around 90 (April 1988). In addition, an effort should be made to step up the screening program. The current number of seedlings screened per year is only around 2500. Shortage of funding has precluded more effort in this direction. A realistic target for screening should be about 6000 per year.

Many more experimental plantings of rootstocks such as Thomas, Barr Duke, Martin Grande (G755a, G755b, G755c), Toro Canyon and recent experimental selections (OCR 2001, UCR 2002, UCR 2009, OCR 2011, OCR 2014, Parida 1, Parida 3) are needed. We hope to be able to work with progressive nurserymen to speed up this vital process. Major targets are to establish plantings of all these rootstocks in:

1) Severe root rot tests without fungicides at SCFS, Irvine.
2) Large-scale plantings in several areas of Riverside and San Diego counties, in cooperation with UC farm advisors.
3) In frost-prone sites.
4) In saline soil situations.
5) In acid (pH 5) and alkaline (pH 7.5 upwards) soils.

Fruit Production

The ultimate value of a resistant rootstock depends entirely on its ability to sustain good quality fruit production in root rot areas. In the next few years several plantings will hopefully come into initial production. The planting sites, rootstocks, year of planting and estimated year of first good production are given in Table 6.

Plantings with sufficient numbers of trees of the different rootstocks are very scarce at present. A major effort should be made to remedy this deficiency. In more general terms, large numbers (~ 40,000) of the Martin Grande (G755) selections have been planted commercially since 1985, especially in 1986 and 1987. We hope to obtain access to some of the better established Martin Grande plantings made in root rot situations, from 1991 onwards. Fruit production data from some of these plantings would add immeasurably to our knowledge of rootstock performance.

Summary

Rootstock research is surely at the center of the future good health of the avocado industry. Progress made since 1982 in the testing and evaluation of resistant rootstocks has been highly significant. Thomas is a new rootstock candidate showing early promise both in terms of resistance and general horticultural properties. The rootstock program could be improved still further if more money was available to:

1) Increase the amount of screening for *P.c.* resistance of new seedlings. The current level of - 2500 a year could be increased to a maximum capacity of 6000 or year if more funding was available.

2) Increase the number of experimental plantings by a factor of 5 or more. Current rootstock evaluation is based on an extremely limited data base obtained from only two commercial plantings. Again increased resources would permit a much larger number of plantings to be made.

3) Production data is vital. Current decisions on rootstock selection are not based on production figures. A major effort should be made over a ten-year-period beginning in the early 1990s to obtain reliable fruit production data for all rootstocks showing promise with regard to general horticultural and *P.c.* resistance properties.

Table 6. Available Avocado Trials and Projected Dates.

Planting site	Rootstock(s) under evaluation	Year of Planting	Estimated Year of First Good Production
Plot 57 Rancho California	Duke 7	1983	1988
Embarcadero Ranch, Goleta	G755b Thomas G6 Duke 7 Barr Duke Toro Canyon	1984	1989
Spaulding Ranch, Carpinteria	G755c Toro Canyon G6 Duke 7 Duke 6	1984	1990