

Field experiences with clonal rootstocks

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SYNOPSIS

Clonal rootstocks have been commercially available in California for 10 years, with Duke 7 being the justified popular choice. Newer, more Phytophthora-tolerant clonal rootstocks are vying to replace it, and some are apt to become future standard offerings.

This year, 1987, marks the tenth anniversary of significant production of clonally-rooted avocado trees in California. The purpose of this paper is to share some observations on what has been produced over these past 10 years. The presentation will be somewhat personal in nature; that is, from author's non-scientific viewpoint as a nurseryman and grower.

Just ten years ago Brokaw Nursery delivered 4 000 trees for two new plantings. The trees were Hass, Pinkerton, and Bacon on Duke 7. Both plantings were on clean soil, but very near orchards infected with *Phytophthora cinnamomi*. Both orchards are intact today.

From these beginnings 500 000 clonally-stocked trees have been delivered to date. Rooted clones, as distinct from seedling rootstock trees, make up 95 per cent of current sales.

Avocado root rot (*P. cinnamomi*) is the death threat that first induced the author to raise clonally-stocked trees. Shortly thereafter, there were other reasons for producing them, such as salt and lime tolerance, tree size control and fruit production. Thus far, trees have been selected only for *P. cinnamomi* or lime tolerance, as well as general tree performance and production.

The comments which follow are based on observations of the field performance of clonal rootstocks currently in use and new, promising candidates. In all cases, reference to 'variety' or 'cultivar' means a rootstock clone. Unless otherwise stated, the rootstock has a Hass scion graft. Trees grafted to Hass are regarded as ideal for testing purposes, since these seem more vulnerable to the ravages of root rot than Zutano, Bacon or Fuerte.

DUKE 7 - THE FIRST REAL ADVANCE

When first produced, Duke 7 was regarded with considerable scepticism for a number of reasons, one being cost. Nursery trees on clonal Duke 7 sold for \$8,80 in 1977, while

seedling rooted trees cost \$5,30. Furthermore, the young clones were often planted in adverse conditions with shallow soils, in boggy areas and among older trees in established orchards. The growing procedures at that time also resulted in smaller, weaker trees than the accepted standard. Some used to say, 'Duke 7's don't grow, don't bear, and aren't root-rot resistant'. That evaluation has all but disappeared and most growers recognise the variety for what it is - imperfect, but significantly superior to most of its seedling relatives.

Here is how it stacks up:

Has Duke 7 been root-rot proof?

Absolutely **not**.

Has Duke 7 been root-rot resistant?

Yes.

Conditions under which it has been a solid performer are the following:

- (a) In deep and well-drained soil,
- (b) When not planted in swales where water runs and seeps.
- (c) When properly started during the first few months. At this time Ridomil® helps, mounding helps, and frequent light irrigations are requisite.

When do Duke 7s perform poorly?

- (a) When planted too close to large, infected trees. They often can not stand continual infection from large, older trees.
- (b) When planted among older infected trees and not separately irrigated. Too often the grower tries to stretch his regular irrigation. The young trees then suffer from a toowet soil (common in *P. cinnamomi* infected orchards) and dryness -in the ball, where all the young roots are.
- (c) When in a swale and fighting continuously against re-infection.
- (d) When planted in soil of greater than average acidity, such as some of the less loamy soils in San Diego county.

The experience of the author is that when the conditions are right, the trees well-started and management tuned in to special requirements, trees survive and perform well under *P. cinnamomi* threat. In *P. cinnamomi*-free conditions, the Duke 7 has been a model performer. The tree is vigorous, has borne large crops of fine Hass fruit and produces remarkably uniform orchards. It survives well under limey conditions and salt tolerance is better than average.

WHAT ABOUT OTHER ROOT-ROT RESISTANT ROOTSTOCKS?

A number of new rootstocks, which show promise of being more tolerant of *P. cinnamomi*, are now available. The University of California has introduced most of them - a few came from private sources. Leading the field at present are the G755s, recently renamed the Martin Grande. Close behind, and being watched, are Thomas, Barr Duke, Toro Canyon and P1. Below are the author's impressions:

G755A, B, and C: No rootstocks have been observed with a greater tolerance for *P. cinnamomi*. It is definitely more tolerant than Duke 7 and probably also more tolerant than most of the other contenders. As with any special purpose stock, though, there have been some troubling occurrences:

- (a) It has a history of chlorosis where not expected. Chlorosis has shown up in sand culture and in some of the new young plantings. Hass on G755 is also of a detectably lighter shade of green than other cultivars in the nursery.
- (b) While its trunk girth is probably greater than the other cultivars, when grafted to Hass, the foliage is sometimes rather sparse - not always, but noticeable.
- (c) Some troubling episodes occurred during its first summer in the orchard. One customer, who planted G755 for the first time last year, lost about 5 per cent of his trees because of a peculiar dieback of the Hass graft to the rootstock. It does not occur in all plantings, but has been repeated elsewhere.

Against these negatives, there is evidence of superb G755 performance in other infested locations. It also has an evident ability to set fruit well and produce large sizes in *P. cinnamomi*-infested soils.

Thomas: It is believed that this will be an outstanding cultivar. It has not done well in all locations, but on the whole it appears as consistent as any other cultivar. It may be a bit weak with regard to salt tolerance, but certainly handles *P. cinnamomi* well.

Thomas is a Mexican cultivar, a fact which is reassuring to Californians, who have traditionally preferred Mexican rootstocks. True to its heritage, it has a dark-green foliage and is perhaps the easiest of all to establish in the orchard.

Barr Duke: Unimpressed by early observations, the author did not pursue this Mexican variety. However, Dr Michael Coffey of the University of California has recently revealed some outstanding performance by this cultivar.

Toro Canyon: A Mexican -Guatemalan hybrid, this cultivar seems to possess an assortment of fine qualities. It has an excellent colour and foliage vigour, appears to be salt-tolerant and has produced good crops of fine fruit.

The Toro Canyon is probably not as *P. cinnamomi*-tolerant as the G755. It has, however, done very well in most locations and attracted a lot of attention without much advertising.

P1: This Mexican-Guatemalan hybrid may be a sleeper. Thus far, under severe *P. cinnamomi*-infested conditions, it has not been outperformed in terms of apparent vigour, defined by the author as lush foliage. Caution must be taken, however, for these observations are based on a very limited number of very small plots.

The P1 does not appear to be a fast, strong grower, the foliage is vigorous. The author has not seen it bear yet, but knows that its siblings have been precocious and prolific.

Borchard: Any review of field performance of avocado rootstocks would be incomplete without mentioning the Borchard. Although vulnerable to *P. cinnamomi*, it has nonetheless earned a place in California for its tolerance to limey conditions. Selected on the basis of its parents' continued verdancy when planted among other chlorotic seedlings, it appears to transmit this trait to a grafted Hass scion. Only a limited number of these rootstocks were produced, as they are needed in only a few locations. Their success has been phenomenal. Customer satisfaction has been greater with this variety than any other ever produced by the author.

WHAT IS THE BASIS FOR THESE OPINIONS?

The author relies on his -own observations and reports from growers who are trying out new cultivars. Part of the nursery programme is to search for trees that are performing well under adverse conditions, such as in *P. cinnamomi*-infested or limey soils. Rootstocks of these trees are cloned and distributed to interested growers along with University-developed ones. Typically the author suggested that 6-20 trees of assorted varieties are planted and then observed. The following are reports on two of these grower plantings in the Santa Barbara and Ventura counties:

Grant Plot

Mr Campbell Grant's original grove, planted on shallow acid soil, was destroyed by *P. cinnamomi*. His early replanting was accomplished with Huntalas*, Duke 7 and assorted seedlings of a survivor tree, which he called Parida. The best of his replants were Huntalas and assorted seedlings of Parida. (*The Huntalas variety is infected with sunblotch. Therefore it is not in common use in California.)

In May 1986, he was provided with an assortment of varieties to be planted in place of deceased Duke 7s. The best of these have been G755 and P1. Surprisingly, the Thomas has not been outstanding. In the following evaluation, the lower the score, the healthier the foliage:

Rootstock variety	Score
G755	1,0
P1	1,0
Thille	1,3
Thomas	1,3
Borchard	2,0
Parida parent	2,3
Oberman A	2,7
Oberman B	3,0

Wertz Plot (planted in October 1985) The author was looking for salt tolerance. Trees of nine cultivars were planted in pairs - two trees per hole in 21 holes where Duke 7 and/or G6 had died. Each tree was periodically compared to its partner. The current ranking of the trees is as follows (a high score is favourable in this case):

Rootstock variety	Score
G755A	+1,00
Toro Canyon	+1,00
Borchard	+0,83
G755B	+0,60
G755C	+0,40
D7	+0,40
G-1033	-1,00
Thomas	-1,50
G6	-1,50

This test is, of course, not significant because of the smallness of the sample. It does, however, give some basis on which to make hypotheses with regard to which cultivars are expected to survive salty conditions. An irrigation water analysis at this location is as follows:

	31/7/84 Milligrams per liter
Calcium (Ca)	220,00
Magnesium (Mg)	169,00
Sodium (Na)	520,00
Potassium (K)	20,00
Bicarbonate (HCO ₃)	683,00
Chloride (Cl)	800,00
Sulphate (SO ₄)	672,00
Nitrate (NO ₃)	2,00
Nitrate-N (NO ₃ -N)	0,42
Total Hardness (as CaCO ₃)	1245,00
Total Dissolved Solids:	
1 Summation	3084,00
2 Residue	180°

This water is from a variably salty source. It is characteristically sweet in spring and early summer, increasing to very high levels of saltiness in late summer and fall.

In addition to observing the plantings of Brokaw Nursery's customer-growers, some of the clonal rootstock experimental plots in southern California were also observed. Most information was gathered by University of California researchers Dr George Zentmyer and Dr Michael Coffey, some facts of which are also supported by the Californian

Avocado Society, while others are no longer maintained. Here are the results of the author's most recent review of two of these plots:

Embaracadero (planted in 1984)

One of Dr Coffey's plots was recently examined in a new way. The Embaracadero plot in Santa Barbara county comprises some 739 trees of 18 varieties. It is planted on a *P. cinnamomi*-infested plot where the former orchard was abandoned. Soil conditions are considered severe for root rot and trees are treated with moderate dosages of Ridomil®.

There are a few difficulties in the published analyses of this plot, for example, the soils are not uniform and the cultivars are not randomly distributed. There is a broad waterway running from northeast to southwest. The soils in this area are regarded to be saltier, with less aeration than other soils in the plot. At the head of the waterway is a swampy area that indicates an underground seep.

A quick, unscientific survey was conducted, leading to some interesting results. The procedure was to select the very worst areas of the plot - those areas which appeared to be most rootrot prone. Trees were then ranked in the selected areas in terms of apparently healthy foliage. Results were interesting and are tabulated below. The lower the score, the healthier the foliage:

Rootstock variety	Score
Thomas	1,18
P1	1,18
Toro Canyon	1,20
Huntalas	1,33
D9	1,33
P3	1,44
P6	1,50
G755A	1,50
D7	1,50
G6-Parent	1,50
DK6	1,50
G755B	1,57
G755C	1,64
P-Parent	1,75
Barr Duke	1,83
G6 No 1	2,00
Borchard	2,57
G1008	3,00

Goland Plot (planted in 1982)

This was one of Dr Coffey's early *P. cinnamomi* experimental plots. Twenty four Duke 7, 34 G755 ungrafted cuttings, 10 Toro Canyon and 10 Topa-Topa seedlings were planted. One year later, deceased trees were replaced with nine G6 cuttings and nine

Hass/G6. The G755s were topworked later than Hass. In subsequent years, deceased trees were replaced by citrus. Table 1 summarises the surviving trees.

G755C may be unfairly represented, because the grafting of it may have caused some of the trees to succumb.

What is clear, however, is that in this case a couple of newer Californian cultivars performed much better than Duke 7.

WHAT DOES THE FUTURE HOLD?

During the 1930s and '40s, there was a huge proliferation of candidate fruiting scion varieties in California. Fuerte held centre stage, but many rivals were trying to exploit the Fuerte's weaknesses and particular strengths. It was not until the 1970s that the industry effectively narrowed itself down to five or six fruiting varieties and this elimination processes still continues. New candidates still appear - such as Pinkerton and Gwen - but such newcomers are rare and face tough competition from the currently-reigning Hass.

The author feels that the current state of affairs will remain unchanged during the 1980s and '90s. For eight of the past 10 years, Duke 7 has been king among clonal rootstocks. Those appearing now are in his opinion, only the first of many would-be pretenders. G755 is currently the strongest challenger, but it will be surprising indeed if it is not supplanted by other, perhaps yet undiscovered, varieties.

This pursuit of the perfect rootstock requires the engagement of both the scientific researcher and the 'out-in-the-field' practitioner. In California, there is beneficial co-operation between university, nurserymen and growers. As the search continues and widens to include the use of cloned rootstocks to respond to problems other than disease, the sharing of experience between avocado-growing communities around the world will be of immense value.

Table 1 Summary of surviving trees

Rootstocks	No Orig Planted	Current Survivors	% Surviving
G6 cuttings	9	3	33
Hass/G6	9	1	11
Hass/G755C	34	25	74
Hass/Duke 7	24	7	29
Hass/Topa seedling	10	0	0
Hass/Toro Canyon	10	9	90