

Inherent Influence of Rootstock Race on Avocado Fruit Maturity

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Abstract. Field observations since 1984 have demonstrated earlier fruit maturity of between 3 to 5 weeks and 8 to 12 weeks, respectively, for 'Fuerte' and 'Hass' when grafted to Mexican race seedling rootstock in comparison to local Guatemalan and Guatemalan x Mexican race hybrid (GxM) seedling rootstock.

This paper is based on personal observations by the author while employed by the Department of Primary Industries, Horticulture Branch, as a Horticultural Extension Officer from 1969 to 1980 and as owner/proprietor of Birdwood Nursery Fruit Trees 1978 to 1991. It is a non-technical paper derived from field observations, grower field experiences and comments, and of a telephone survey of relevant growers whose orchards are planted to documented and recorded rootstock race/scion combinations. It is hoped this paper will act as a catalyst for future research on rootstock/scion evaluation comparing clonal rootstocks of local South East Queensland selections and imported selections to determine the influence of avocado rootstock races on fruit maturity time using standard fruit dry matter testing.

Field observations to date have centered on the South East corner of Queensland, Australia, the oldest and largest commercial avocado growing area in Australia with a well documented history and a wealth of grower experience.

Climatology of the observation area is listed in Table 1. The climatic data has been recorded at the Maroochy Horticultural Research Station situated on the coastal foothills, east of the Great Dividing Range at Nambour in the heart of the South East Queensland (SEQ) avocado growing area. Climatic data is not available for elevated coastal ranges of 550 to 9100 m where avocado maturity is 6 to 8 weeks later compared to that of the warmer coastal foothills. However, mean maximum and minimum temperatures are generally 2 to 4C cooler, average daily sunshine hours 0.5 to 1 hour less and rainfall 15 to 25% higher.

To compare the influence of Guatemalan and Mexican race rootstocks on fruit maturity we must first understand the origins and brief history of each race used in the Australian avocado industry.

Table 1. Summary of climatic data for Nambour, southeast Queensland.

	Rainfall		Pan	Temperature (C)			
	Mean Monthly (mm)	Mean Number Rain Days	Mean Monthly (mm)	Air Mean. Max.	Air Mean Min.	Mean Grass Min.	Soil at 15cm Depth at 0900 h
Jan	277	15	170	28.3	18.9	17.0	25
Feb	250	16	131	29.3	21.8	19.3	25
Mar	242	17	129	28.6	18.1	15.3	24
Apr	132	13	110	28.5	15.0	12.3	22
May	130	10	83	23.3	12.5	8.9	18
Jun	92	9	74	21.2	8.6	5.1	15
Jul	97	8	76	21.1	8.0	4.3	14
Aug	50	8	98	22.4	6.7	3.2	14
Sep	47	8	124	25.0	10.7	8.5	17
Oct	114	11	147	25.1	12.1	10.8	20
Nov	152	12	152	28.2	18.9	15.9	23
Dec	175	13	177	29.6	18.7	18.7	25
Annual Total	1758	140	1471				
Mean				25.8	14.1	11.8	20

Source: Meteorological data recorded since 1953 at the Maroochy Horticultural Research Station (Lat. 26° 37' S.: Long. 152° 57' E. Height above MSL, 29m).

Local Southeast Queensland (SEQ) Australian Rootstock History

The avocado industry of SEQ has traditionally used local seedling rootstock from isolated trees planted during the past 20 to 70 years around the Nambour area. The origin of avocados first introduced into Australia pre-1920's is not accurately known but it is thought to be from the Pacific Islands and Central America. These introductions are the forerunners of our current rootstocks and have had to contend with:

- (a) acid soils, pH 4.5 to 5.8
- (b) infertile sandy loam soils low in all nutrients
- (c) well drained soils but sometimes heavily saturated for extended periods during wet season summer monsoons
- (d) heavy *Phytophthora cinnamomi* (Pc) infestation considered endemic to SEQ

Through a natural selection period of some 50 to 100 years, a hardy avocado seedling type has evolved which is better able to tolerate very low soil fertility including major and minor trace elements deficiencies with some PC tolerance. Seed planted from selected trees shows excellent uniformity and perfect graft/scion compatibility producing trees with moderate to high vigor with high productivity.

Most local seedling types are thought to be of Guatemalan origin with some influence from both the Mexican and West Indian race evident in individual trees.

There are two recognized Guatemalan hybrid rootstock selections in Australia, namely Plowman and Velvick although there are many more used by the nursery industry.

A disadvantage with this local Guatemalan rootstock race is that selected grafted trees often take some 5 to 7 years to produce worthwhile quantities of fruit for rootstock production. Velvick is the more precocious of the two popular rootstocks often producing 200 to 300 fruit in its second and third years.

Imported Mexican Race Rootstock History

In the mid to late 1970's the Australian Avocado Growers Federation (AAGF) with the Queensland Department of Primary Industries, Department Agriculture NSW and Committee of Direction of Fruit Marketing introduced the Avocado Nursery Voluntary Accreditation Scheme (ANVAS) and instigated the Sunblotch Viroid Free Registered Tree Program. The aim was to upgrade avocado propagation material available to the Australian industry and encourage nurseries to produce a Pc-free nursery tree of known viroid status and trueness to type of both rootstock and scion variety.

Scion material known to be viroid-free of both rootstock and fruit cultivars was introduced from California. Rootstock scion material included specially selected Mexicola, Topa Topa, Duke Parent, Duke 6 and Duke 7. The choice of Mexican race rootstock was based on their success in the Californian industry. Also Mexican race rootstock trees produce heavy crops at an early age every year thereby ensuring a quick build-up of sunblotch free seed for use as rootstock.

The avocado industry in Australia quickly accepted this clean viroid free seed and by 1980-81 season, the first large scale commercial plantings of mainly 'Hass' were made with lesser quantities of 'Fuerte' and 'Edranol'. Growers had difficulty establishing Mexican race Mexicola and Topa Topa rootstock trees and many problems were experienced with *PC*, low soil pH, trace element deficiencies, mainly boron and zinc, and apparent poorer tolerance of wet soil situations. A few orchards on elevated red krasnozem volcanic soils and virgin well-drained red earth alluvial soils in the Mary Valley did well and commenced commercial production in the 1984 season.

It is interesting to note that only two small nurseries in Australia currently persevere in using the Mexican race Mexicola, Topa Topa and Duke 7 seedling rootstocks.

Mexican/Australian Race Rootstock Fruit Maturity Comparisons

During the early 1970's variation in time of fruit maturity of individual 'Fuerte' trees was noticed on many farms throughout SEQ orchards and it was generally thought that this resulted from different strains of 'Fuerte'. Birdwood Nursery in the 1980-81 season

specially grafted the early "white" strain of 'Fuerte' from 3 selected trees that matured fruit in late summer (late February). Velvick seedling, which matures its fruit in autumn (late April), was used as root-stock and some 150 trees were planted on two separate orchards in the Nambour area. Fruit maturity to this day has been normal with fruit attaining 21 to 23% dry matter in mid April.

It was generally known that many older avocado nurseries operating in the 60's had used 'Fuerte' and 'Hass' seed for rootstock. It was suspected in the early 70's that such mixed-race seedling rootstock may produce an effect on time of fruit maturity of grafted scions.

In 1986, experienced growers began contacting Birdwood Nursery regarding indexed 'Hass' trees grafted to Mexicola and Topa Topa seedling rootstocks coloring fruit in early May (early winter). Adjacent 'Hass' trees of the same age and older trees grafted to Guatemalan seedling root-stock showed no signs of early fruit maturity. Towards the end of May some fruit drop commenced on 'Hass'/Mexican race trees and growers were forced to harvest mature fruit some 3 to 4 months earlier than normal.

Why did this early harvest occur? At first tree stress due to *PC* and low boron levels were blamed together with a very dry summer period. With the trial use of phosphorous acid and adjustment of boron levels to 70 ppm, the same early 'Hass' maturity occurred in 1987 and has occurred every year since. In 1987, it was realized that the rootstock was the variable factor. For the first time there was a planting of 300 trees on known Mexican race rootstock to compare with known local Guatemalan seedling rootstock. 'Hass' grafted to local Guatemalan race 'Plowman'¹ seedling rootstock commenced size picking in mid July and fruit did not commence coloring on trees until mid September, some 20 weeks after Mexican race rootstock trees have been harvested. Both types of rootstock trees are growing side-by-side on the same soil type and aspect and receive the same management with regard to *PC* treatment, nutrition and irrigation.

The same effect is experienced with 'Fuerte' on both rootstocks although fruit drop is not a problem. 'Fuerte'/Mexican race rootstock trees attain 23% dry matter content by early March (early Autumn). 'Fuerte' trees grafted to Guatemalan root-stocks commenced selective size harvest late March to early April with a dry matter of 21 to 22%. Harvesting does not commence in earnest until late April and continues through May until early June.

The previous example is on one farm that shows the greatest root-stock race difference of any planting within SEQ. Soils are well-drained and very acid with very high manganese and at times there is a problem with boron and zinc uptake which is often poor in Mexican race rootstock trees. However, where rootstock race is known, and wherever the pure Mexican race rootstock trees are grown beside known local Guatemalan root-stock trees, earlier fruit maturity can be observed.

Under ideal growing conditions at Mapleton and Toowoomba on volcanic red krasnozem soils, 'Fuerte' maturity times are consistently 2 to 3 weeks earlier and 'Hass' 6 to 8 weeks earlier on trees grafted to Mexican race rootstock.

Birdwood Nursery has a sun-blotch indexed multiplication block planted in 1983 to 1984 on the Blackall Range (200 m elevation). Selected local Guatemalan race trees Plowman and Velvick, have been grafted to sunblotch indexed Mexicola and Topa Topa seedling rootstock trees as they were the only nuclear status viroid-free rootstocks available in 1983-84 for multiplication block establishment. Velvick fruit in this planting matured in late March to early April and Plowman trees in mid April on Mexican race rootstock.

On the warmer coastal plains the original Velvick seedling tree matured fruit in late April and the original Plowman seedling tree in late May to early June. This great difference in time at fruit maturity of local Guatemalan rootstock race trees grafted to Mexican race rootstock has only been evident in 1991 as this is the first major crop to be produced by these trees some 7 to 8 years from planting. This early maturity in cool growing areas under ideal conditions is further evidence that rootstock race has an influence on fruit maturity of the scion.

Table 2 shows the average influence of avocado rootstock race on fruit maturity time over 5 years of grafted cultivars 'Hass' and 'Fuerte' and also scions of Velvick and Plowman Guatemalan rootstock grafted on Mexican race seedling rootstock.

Rootstock Race and Flowering Time Influence

It has also been observed that cultivars grafted to Mexican race root-stock flower earlier than when grafted to local Guatemalan rootstock race. Table 2 shows the difference in flowering time and harvest time of grafted Mexican race and local Guatemalan trees grown for seed production for nursery use. Could this inherent difference in flowering and fruit maturity time be what is influencing flowering and eventual fruit maturity time of the grafted scions? If so it could also affect fruit shape as temperature differentials at flowering greatly influences pollination, ovule development, seed shape and resulting fruit shape. 'Newman Fuerte' scion material imported from California and grafted to Mexican race rootstock has a bad reputation for "necky" fruit. Birdwood Nursery has grafted 'Newman Fuerte' on Guatemalan race rootstock trees, Plowman, with no "necky" fruit apparent after 4 years commercial production.

Conclusion

Based on grower contact and grower phone surveys over the past 5 years, it would appear that the greatest influence of avocado rootstock race on fruit maturity of grafted scion occurs in the subtropical climate of eastern Australia between latitudes 25 to 31 °S. The climate within this latitude is characterized by hot humid summers with mild autumns, with sudden cool winters, cool mild springs and a sudden rise in temperature into hot summer temperatures. It is possible that in cool temperate climates, low

temperatures may suppress and override flowering time influence of rootstock race although fruit maturity testing may show an earlier harvest of fruit from trees grafted to Mexican race rootstock trees is possible.

Conversely, hot humid tropical areas in northern Queensland have not reported the same influence of avocado rootstock race. In this climate, high temperatures may overrule the late influence of the Guatemalan root-stock race by speeding up fruit development of early maturing cultivars. Hence scion fruit maturity testing needs to be carried out on known rootstock race trees to determine fruit maturity differences.

It is hoped that through understanding this influence, in the future the avocado industry may be able to extend specific cultivar fruit maturity times and be better able to supply top quality eating fruit at reasonable prices to world markets every day of the year.

Table 2. Flowering and maturity times of rootstock cultivars and their effect on time of fruit maturity of 'Fuerte' and 'Hass'.

Avocado Seedling Rootstock	Race	Seedling Flowering Time		Seedling Maturity Time		Grafted Scion Fruit Maturity Time (Average Range)			
		Month	Season	Month	Season	Hass	Fuerte	Velvick	Plowman
Mexicola	Mexican	April/May	Autumn	Dec	Early mid summer	May	Late Feb/ March	Late March Early April	Mid April
Duke 7 Clonal	Mexican	May/June	Late Autumn Early Winter	Jan	Late mid summer	June/July	March/April		
Velvick	Guatemalan Hybrid	Late June	Mid winter	Late April	Autumn	July/Oct	March/June		
Plowman	Guatemalan Hybrid	July/Aug	Late winter	Late May/June	Mid winter	Aug/Nov	April/July		