

LOCAL AND IMPORTED AVOCADO ROOTSTOCKS IN SOUTH AFRICA

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Abstract

South African avocado production areas are in the subtropical summer rainfall regions of the eastern escarpment. Soils are mostly deep, well drained and conducive to rapid growth. Older avocado plantings were established mainly on Guatemalan seedling rootstocks. The current avocado industry standard rootstock in South Africa is Duke 7 due to its relatively good tolerance to *Phytophthora cinnamomi* and good yielding potential. A large number of new orchards have also been planted using Duke seedling rootstocks. More recent rootstock imports include, *inter alia*, Barr Duke, Thomas, D9, G6 and G755. In this paper, a brief history of the different rootstocks, their characteristics, and import sources are given. Performance data of Hass and Fuerte on clonal rootstocks, and current status of these rootstocks in the South African avocado industry, are presented. Recent promising results of trials conducted at Westfalia Estate regarding dwarfing rootstocks and interstocks are also presented.

Keyword: Avocado, *Persea americana*, rootstocks, South Africa

I. Introduction

The choice of avocado rootstocks in South Africa has mainly been aimed at reducing root rot, caused by *Phytophthora cinnamomi*, the major avocado disease in the country. The main commercial avocado-growing areas of South Africa are located in parts of the eastern and north eastern escarpment and the midlands of Kwazulu-Natal. In these areas, avocado production is limited mainly to those areas which are frost-free, and soils are deep, well drained, red or brown apedal oxisols and inceptisols. These soils have a lower *P. cinnamomi* threat than in more anaerobic soil types. High rainfall is usually experienced in these areas, which falls mainly during the warm summer months. The warm, wet conditions with good soils contribute to a most favourable environment for vegetative growth (as well as *P. cinnamomi*) during summer, sometimes at the expense of production, resulting in excessively large trees which are difficult to manage. The climatic conditions are unlike those experienced in California and Israel, the major avocado rootstock developers and rootstock choices may therefore sometimes be different from those countries. The discovery of phosphorous acid trunk injections at Westfalia Estate to control root rot (Darvas *et al.*, 1978; Darvas *et al.*, 1983), has led to a wider choice of rootstocks, and other factors such as level of management inputs, soil type, irrigation water quality, the intended fruiting cultivar, tree size management, etc., have become more relevant in rootstock choice. In this paper the seedling and clonal rootstocks used in South Africa, both on experimental and

commercial bases, their origins, characteristics, status in the industry, and yield data where available, are presented.

2. Seedling rootstocks

Seedling rootstocks are still used in South Africa but to a much lesser extent than is the case with clonal rootstocks. Their use is mainly due to their relatively low prices ($\pm 60\%$ of clonal rootstocks) and deep tap root systems which are more efficient than clonal rootstocks at taking up water during periods of drought (which is the current situation in most SA avocado growing areas). Some of the seedling rootstocks which have been in use throughout the years are listed below according to horticultural race.

2.1. Mexican

Seedlings of Mexicola were first used in South Africa during the late 1920's and it was considered the first recognised rootstock to be used commercially in this country. Its advantage was lower vigour than the existing West Indian seedling trees at that time. However, the Mexicola seedlings had a high incidence of Avocado Sunblotch Viroid (ASBV) and the seed also soon became hybridised with the Guatemalan and West Indian races and high seedling variability resulted. This rootstock is not currently used on a commercial scale in South Africa.

Seedlings of Duke 7 (also called Duke seedlings) started gaining popularity by the 1970's. It is presently the most popular seedling rootstock sold by Westfalia Estate nursery because of mild tolerance to *P. cinnamomi*, although there is genetic variability.

2.2. Guatemalan

In approximately 1948, the Guatemalan cultivars Edranol and Nabal were imported as fruiting scions, but they were also used as seedling rootstock due to the high incidence of ASBV in the 'Mexicola' population at that time. These seedlings had uniform germination and vigorous, uniform growth, a distinct advantage to nurserymen. However, they are more susceptible to root rot than those of the Mexican race (Gaillard, 1987). Guatemalan seedling rootstocks remained popular well into the 1960's, but at that stage orchards were in poor condition due to the high *Phytophthora* incidence. At that stage, expected avocado orchard life on Guatemalan rootstock was about 12 years before replanting was necessary (Maddison¹, pers. comm., 1995). Trees with Edranol seedling rootstocks are still sold on fairly large scale by nurseries in South Africa. The highest yielding orchard at Westfalia Estate over a number of years has been a combination of Ryan on Nabal rootstock (Westfalia farm records).

The Australian selected rootstock, Velvick, was imported in 1989. It apparently produces uniform seedlings which are said to be fairly true-to-type and have moderate tolerance to salinity and root rot. This rootstock has not been tested in South Africa yet.

2.3. West Indian

Rootstocks of the West Indian race have received little attention in this country. Their main advantage is their relative tolerance to salinity (Gaillard, 1987). During the first quarter of this century, seedlings of the race were used as rootstocks but they were found to be vigorous with low uniformity and high root rot susceptibility (Maddison, pers comm., 1995). There has been

renewed interest during the present drought, since irrigation water in some areas became more saline and sodic; and leaf burn and abscission led to crop losses and severe sunburn of fruit and bark.

2.4. Hybrids (Guatemalan x Mexican)

A number of older Fuerte orchards were established on Fuerte seedling rootstock after vigorous selection, and this combination has produced acceptable crops. However, Maddison (pers. comm., 1995) reported that Fuerte seedling was only successful as a rootstock when planted in optimal avocado soils, and that it generally failed elsewhere. No recent commercial plantings on Fuerte seedlings have been made.

3. Clonal rootstock

With the discovery of reliable clonal propagation techniques for avocado (Frolich & Platt, 1972) the rootstock situation was revolutionised worldwide. The predictability of genetically uniform, root rot tolerant, productive trees was a major advantage for growers and researchers in South Africa as they could investigate other factors without the added variability of seedling rootstocks.

3. 1. Mexican

The majority of clonal rootstocks tested and used in South Africa belong to the Mexican race. Duke 6 was imported from California in 1962 (Bijzet, unpubl.), and it was only in the late 1970's that this clonal rootstock was planted on a commercial scale. It was said to have moderate tolerance to *Phytophthora* and was non-vigorous. During the early 1980's Duke 6 was planted on commercial scale at Westfalia Estate, but after 2 to 3 years the trees started dying, with stem pitting and gumming in the branch forks being the symptoms (Maddison, pers. comm., 1995). To date, this disease remains to be identified. Possibly, infected budwood was imported, but the rootstock has never been tried since. Hectares of orchards and all mother trees were destroyed in an attempt to eradicate all sources of budwood, and therefore this rootstock no longer exists in South African orchards.

Duke 7, which was imported together with Duke 6, turned out to be the most successful and widely planted rootstock in South Africa, especially for the Hass cultivar. The major advantages of this rootstock are its moderate tolerance to root rot and its uniform, productive Hass trees. It presently dominates Hass (about 50% of all trees planted during the last 9 years are Hass (SAAGA, 1995) plantings and has proven itself under South African conditions (Kremer-Köhne & Köhne, 1992) and in California (Brokaw, 1987). It is included in all the rootstock trials at Westfalia Estate as the comparative control.

Budwood of Thomas, an escape tree in a diseased orchard (Coffey, 1987) developed by UC, was imported in 1987 and has undergone testing at Westfalia Estate for the last four years. From California, it is reported to have good *Phytophthora* tolerance (as high as Martin Grande (Coffey *et al.*, 1988), but is a bit weak regarding salt tolerance (Brokaw, 1987). It has performed satisfactorily in rootstock trials in California (Menge *et al.*, 1991; Arpaia *et al.*, 1993) but in a Westfalia semi-commercial rootstock trial (Fig. 1) it has not performed up to expectations. Its production of Hass fruit has been lower than Duke 7, and it imparted greater vigour to Hass than did Duke 7, an undesirable characteristic these days when dwarfism is the buzzword in the industry. As a consequence, its commercial use in South Africa has not yet been recommended.

The G-6 series consists of Guatemalan selections of Mexican type, introduced into California by Dr Zentmyer. It has tolerance to *Phytophthora* by a mechanism apparently different from Duke 7 (Brokaw, 1982). This rootstock has been tested in South Africa for the cultivars Fuerte (Kremer-Köhne & Köhne, 1994) (Table 1) and Hass (Köhne 1991) (Table 2), and is in the process of being tested for Ryan. Some doubt was cast over this rootstock at Westfalia Estate when a large number of trees on G6 died rapidly about 2 to 3 years after planting. At the time, isolations were done to determine the causal organism, *Verticillium* being isolated in only one case. Today G6 is still used on an experimental scale in South Africa, but there have been no recent plantings on this rootstock

Table 1. Effect of rootstock on 'Fuerte' production, planted at 7 x 7 m at Kiepersol (modified from Kremer-Köhne & Köhne, 1994)

Scion Cultivar	Rootstock	Yield (kg tree ⁻¹) Years after planting						Cumulative yield (t/ha)
		3	4	5	6	7	8	
Fuerte	Duke 7	2	15	30	103	75	111*	85.9
	G6	2	9	46	136	116*	122	74.5

* Year of tree thinning.

A seedling of Duke 6 which survived in a UCR infested site (Brokaw, 1982), Barr Duke was imported into South Africa in 1987. It is reported to be very vigorous by Brokaw (1982), but Menge² (pers comm, 1994), as well as our own results (Roe *et al*, in press), have found Barr Duke to have lower vigour than Duke 7. Its production has so far been slightly higher than Thomas (Fig. 1) and its smaller stature would be beneficial if first thinning of Hass; were delayed by at least a year. Status of Barr Duke in the South African avocado industry is experimental.

D9 is a product of Dr Bergh's irradiated Duke budwood (Menge *et al.*, 1991). It apparently establishes slowly and young trees are often smaller than other rootstocks (Menge *et al.*, 1991), a characteristic which is evident in rootstock trials at Westfalia Estate (Roe *et al*, in press). Production at Westfalia has been satisfactory compared to Duke 7 (Fig. 1), particularly when taking into account its slower growth rate. Status in South Africa is experimental.

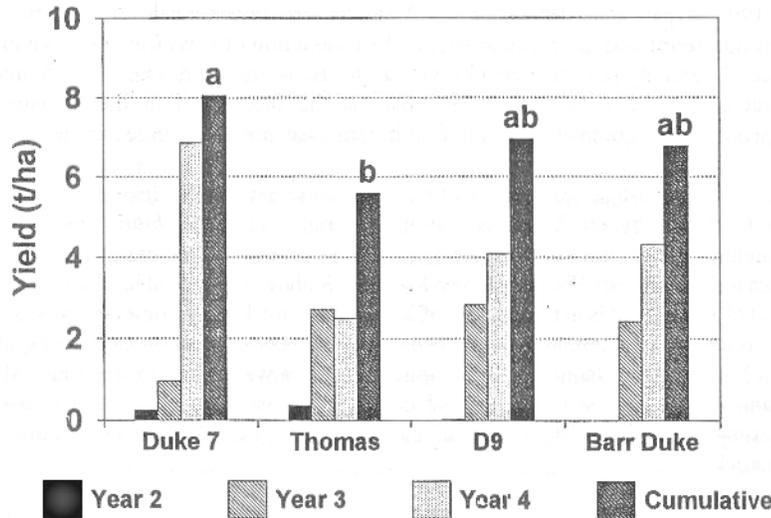


Figure 1. Annual and cumulative yields of Hass avocado trees on different rootstocks at Westfalia Estate.

Colin V-33 a dwarf scion cultivar from CICTAMEX, has been used successfully as an interstock to impart lower vigour to Fuerte avocado trees (Barrientos-Priego *et al.*, 1987). It was imported into South Africa in 1988 with the purpose of studying its interstocking effect on Hass trees. As mentioned previously, ideal growing conditions in the South African avocado growing areas result in excessively large trees which are difficult to pick. At Westfalia, three-year old Hass trees interstocked with Colin V-33 on Duke 7 have displayed little growth retardance compared to Hass on Duke 7 (Roe *et al.*, in press) although this may only become evident at a later stage. It is also being tested as a rootstock and has so far exhibited only slight reduction in vigour (Fig. 2). Colin V-33 is an experimental interstock.

3.2. Hybrids

G755 (Martin Grande), a hybrid between *Persea americana* and *P. schiedeana* from Guatemala (Coffey *et al.*, 1988) was imported in 1983 from California. It possesses moderate resistance to *Phytophthora* and was originally collected in the market at Coban in the Guatemalan highlands (Coffey *et al.*, 1988). However, it has fared disappointingly in terms of production (Table 1) and also caused excessive tree vigour of Hass in South Africa (Köhne, 1991; Kremer-Köhne & Köhne, 1992; Conradie *et al.*, 1994) and in California (Bender *et al.*, 1991). Small-scale plantings and topworks of Pinkerton on G755 have taken place recently.

Table 2. Effect of rootstock on Hass (planted at 5 x 5 m) production at Westfalia Estate (Köhne, 1991)

Cultivar	Rootstock	Yield (kg tree ⁻¹) Years after planting			Cumulative yield (t ha ⁻¹)
		2	3	4	
Hass	Duke 7	-	34	10	17.6
	G6	1	15	2	7.2
	G755	1	6	4	4.4

3.3 Local Selections

Dusa is a seedling of Duke 7 which survived heavy *Phytophthora* pressure and was selected at Westfalia Estate (Darvas³, pers. comm., 1995). In trials carried out by Botha (1991), young Hass on Dusa out-produced Hass on Duke 7, but was also much more vigorous. Dusa (as well as Thomas, G755 and Barr Duke) showed no signs of root rot, while -Duke 7 showed slight symptoms. This rootstock has been included in Dr Menge's rootstock evaluations at UC, Riverside, and has made it to the field evaluation stage. It is not used on commercial scale in South Africa.

The two rootstocks Latas and Jovo were selected at Westfalia Estate where they were growing in waterlogged conditions. Latas was named by Dr Joe Darvas and is the Hungarian word meaning 'vision'. Botha's (1991) evaluations showed that Latas is a more vigorous rootstock than Duke 7, and was similar to Dusa, G755, Thomas in its root rot tolerance. However, it tended to be vegetative at the expense of production. This rootstock is still under evaluation. Jovo is Hungarian for 'future'. It has not fared as well as Dusa and Latas in rootstock evaluations at Westfalia (Botha, 1991). It imparted lower vigour to Hass, but also had low production. It is currently being evaluated on larger scale at Westfalia but is still not a commercial rootstock.

'Wilg' was growing in a root rot infested orchard. It was a healthy tree with a growth habit similar to a weeping willow. This growth habit gave Wilg its name (meaning "willow" in Afrikaans). All tests for viroids have been negative. Hass has been significantly ($P < 0.05$) stunted on Wilg rootstock (Fig. 2) and this combination was also very precocious, with fruit borne during the first season from planting. However, there are problems with its propagation because of its willowy growth habit, and research is under way to rectify this.

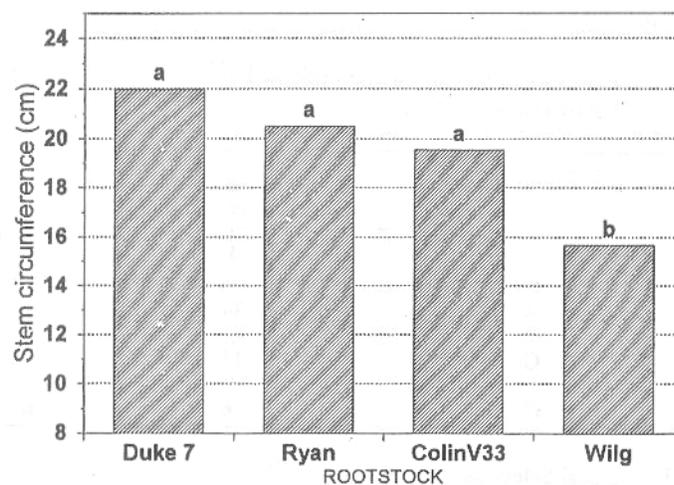


Figure 2. Rootstock effect on two-year old Hass vigour (reflected in stem circumference) at Westfalia Estate (Roe *et al.*, in press).

4. Conclusion

The South African avocado commercial rootstock scene is dominated by a small number of seedling and clonal rootstocks. Seedlings of Duke 7 are the most popular seedling rootstocks sold by South African nurseries. Duke 7 is by far the most planted clonal rootstock and performs well under good soil and management conditions. Future rootstock selection apart from the

obvious root rot tolerance, will lay emphasis on lower vigour rootstocks and interstocks, so that orchard efficiency is improved. Recent results from rootstock trials in South Africa should be seen in the light of an ongoing drought during the last six years, and *Phytophthora* pressure has not been as great as in years of normal rainfall.

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³Dr J M Darvas, Consultant, Letsitele South Africa (Former Plant Pathologist, Westfalia Estate).

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