

SELECTION OF AVOCADO SCIONS AND BREEDING OF ROOTSTOCKS IN SOUTH AFRICA

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INTRODUCTION

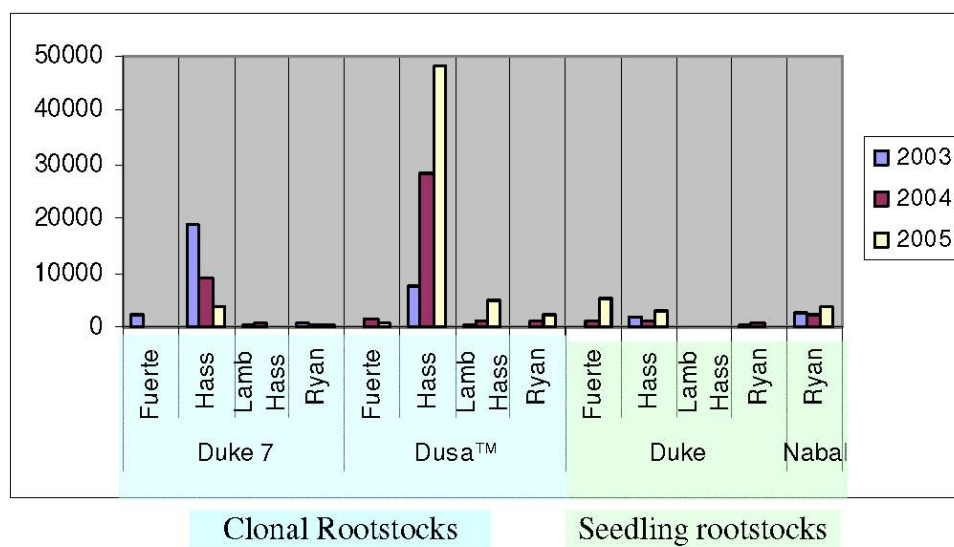
The cultivation of avocado in South Africa has been practiced for just over one hundred years and was initially limited to the coastal areas of Natal, where West Indian race seedlings were first grown in the vicinity of Durban. To date, seedling avocado trees remain a backyard crop in the coastal areas of Natal and the fruit is sold locally by street vendors. In the mid 1920's, Dr Hans Merensky's interest in superior avocado cultivars prompted the first importation of grafted avocado trees from California, which were established at Westfalia Estate situated in the North Eastern part of South Africa (W.E. Maddison, personal communication, 1995). The grafted plant material imported in the 1920's consisted of various Mexican, Guatemalan and hybrid cultivars which grew well in the subtropical climate of the Tzaneen area. The first Fuerte tree ever planted in South Africa is still alive at Westfalia Estate and is locally known as the "Merensky tree". It was used as a budwood source for many years to establish the later flourishing Fuerte based avocado industry of that region. However, avocado growing remained a very limited industry right into the 1960's, with a national annual production of less than 5000 t. For a long time, major obstacles to increased avocado production were the difficult transport of fresh avocados to distant markets, *Phytophthora* root rot and low yields. The local markets of Pretoria and Johannesburg were basically the only outlets for the small avocado yield. However, it is interesting to note that 40 years ago a wide range of avocado cultivars was cultivated at Westfalia Estate, grown at different altitudes and microclimates, thus achieving year-round harvesting and continuous market supply (Table 1). Some of the cultivars grown for the domestic market were local selections, e.g. Hamaboya, a late maturing green skinned avocado believed to be a Collinson seedling (W.E. Maddison, personal communication, 2005).

In the last 25 years, technology allowing the export of avocado to distant markets has allowed the South African avocado industry to grow substantially (national production increased about 20 fold compared to the 1960's). In terms of the spread of cultivars, however, a strong trend towards a Hass-focused business has been observed in recent years. Where South African avocado nurseries previously sold large numbers of Fuerte trees, over 75% of all new avocado trees delivered are now grafted to Hass (Figure 1). Furthermore, the long term prospects of decreasing returns for avocados has necessitated the formulation of a strategy concerning avocado breeding and selection, in order to remain financially competitive in the future. In that respect, different approaches have been followed in South Africa regarding the dealing with scion cultivars as opposed to rootstocks.

Table 1. Cultivars and total yield of avocados grown at Westfalia Estate in 1967.

Cultivar	Origin	Description	Cartons (5 kg)
Anaheim	California	Green skin, large	200
Dickey 'A'	California	Dark skin	-
Edranol	California	Green skin, medium size	500
Hass	California	Black skin, medium size	1000
Ryan	California	Green skin, medium size	1000
Collinson	Florida	Dark green, medium size	1000
Lula	Florida	Light green, big fruit	500
Itzamna	Guatemala	Green skin, medium	3000
Linda	Guatemala	Dark red, large	100
Fuerte	Mexico	Green skin, medium size	14000
Hamaboya	South Africa	Similar to Collinson, later	200
Lydia	South Africa	Large	200
Makaya	South Africa	Large	200
Westfalia1-3	South Africa	Large	300

Figure 1. Avocado tree sales of leading South African avocado nursery (2003-2005)



AVOCADO SCION CULTIVAR BREEDING AND SELECTION

As avocado is characterized by a high level of heterozygosity resulting in unpredictable hybrids and a long juvenile phase, very large areas would be required for a meaningful assessment of hybrids (Lahav & Lavi, 2002). The total time elapsing from making a cross until the release of a new cultivar is in the order of 20 years, which renders a breeding program very costly and of long duration. In the 1990's the Institute for Tropical and Subtropical Crops was involved in an avocado scion cultivar breeding program (Bijzet, 1998) but it was discontinued. There are presently no attempts to breed avocado cultivars in South Africa.

The present market requirement is focused on Hass or Hass-type fruit, of which various selections are being evaluated (Kremer-Köhne & Mokalabone, 2003). However, market preferences for a certain avocado cultivar or even a specific fruit size within a given cultivar may change so rapidly, that it is rather difficult to embark on a financially viable cultivar breeding program in South Africa.

Nevertheless, collecting, evaluating and conserving a very wide range of avocado scion cultivars from around the world, is regarded as an important measure to ensure that potentially important plant material, both newly selected as well as old material, is readily available should the market situation concerning the dominance of Hass change. Further, niche marketing opportunities may arise for distinctly different types of avocado fruit. Therefore, Westfalia Technological Services (WTS) is actively evaluating avocado cultivars, including parameters such as yield, fruit size distribution, time of maturity, susceptibility to cercospora spot and insect pests, external appearance, internal quality (physiological disorders, browning potential of the pulp), taste, shelf life as well as various other parameters concerning the avocado processing industry.

AVOCADO ROOTSTOCKS

In general, vegetatively propagated rootstocks are used successfully in many woody, perennial fruit crops to overcome certain problems related to productivity, soil factors, disease, growth habit, fruit quality, etc. and avocado is no exception.

The propagation and use of clonal avocado rootstocks in South Africa goes back to the late 1970s when first vegetatively propagated rootstocks were produced at Westfalia Estate (W.E. Maddison, personal communication, 2005). Many young avocado orchards were established in the 1980's and 1990's, commonly using the vegetatively propagated, root rot tolerant Duke 7 rootstock from California. During that period, approximately two million avocado trees on clonal Duke 7 rootstock were sold by Westfalia Nursery, South Africa's leading avocado nursery. Various other imported rootstocks were also tested in South Africa but generally did not out-perform Duke 7 (Köhne, 1991; Roe *et al.*, 1995 and 1997) and similar results were obtained in California (Arpaia *et al.*, 1993). However, in recent years the situation in terms of the preferred clonal rootstock has changed considerably in South Africa. Figure 1 gives an overview of the avocado tree sales of Westfalia Nursery over the past three years showing a rapid increase in the popularity of the Westfalia Avocado Rootstock Merensky 2 cv 'Dusa' TM and a strong decline in the popularity of Duke 7. Since 2002, Westfalia's newly released rootstock 'Dusa' has been made available to growers in several avocado producing countries. Many years of South African and Californian data show that the rootstock 'Dusa' is significantly more root rot tolerant and more productive than Duke 7 (Roe *et al.*, 1997; Roe *et al.*, 1999; Menge *et al.*, 2002; Kremer-Köhne & Mukhumo, 2003; Rose, 2003). 'Dusa' (a Westfalia chance seedling) was developed at Westfalia over a period of 20 years and is of Guatemalan / Mexican origin (T. Chao, personal communication, 2002); it also shows a good measure of tolerance to cold winters (D. Smith, personal communication, 2005) and saline irrigation water (Menge *et al.*, 2002; Crowley & Arpaia, 2002).

AVOCADO ROOTSTOCK BREEDING

In contrast to the somewhat shifting target experienced by avocado breeders when dealing with the selection of new fruiting scions (cultivars) the requirements for superior new rootstocks can be defined clearly as tolerance to *Phytophthora* root rot and potential to produce high yields. These are unlikely to change. A further advantage when breeding and selecting avocado rootstocks is that it is possible to devise screening systems for seedlings, whereby over 99% of the initial plant material can be culled within the first year. Due to the high probability that avocado rootstock breeding would bring about improvements in tree health and yield, a privately funded avocado rootstock breeding and selection program was launched at Westfalia Estate some 20 years ago. In the WTS rootstock breeding program new plant material is generated which is then screened for its root rot tolerance (Kremer-Köhne *et al.*, 2001). Seedling selections with healthy roots are included in field trials to confirm their root rot tolerance and evaluate their production potential as described by Kremer-Köhne and Duvenhage (2000). The first promising selections are presently in larger scale field tests (S. Kremer-Köhne, personal communication, 2005).

AVOCADO ROOTSTOCK SELECTION

Concurrently with the initiation of the WTS rootstock breeding project, a large scale selection program focusing on avocado productivity was undertaken at Westfalia Estate. In this selection program, individual tree yield data for all avocado trees on the Estate grafted on seedling rootstocks were recorded for several consecutive years. The productivity survey revealed huge differences in yield between trees. The best trees were found to bear approximately 500 kg of fruit year after year, with very little alternate bearing. Under the assumption that the specific seedling rootstock supporting the most outstanding trees would continue to produce these tree yields if clonally propagated trees were adequately spaced over a large orchard, sustainable yields of 50 t per hectare per annum should be obtainable under suitable climatic conditions (Smith & Köhne, 1992). Therefore, an attempt was made to recover the rootstocks of the identified superior trees, to propagate and to finally put these super rootstocks through the same screening and evaluation procedure as described above. While certain rootstocks were impossible to recover and/or root, others failed when exposed to high *Phytophthora* pressure. However, some selections remain very promising and are presently under field evaluation, grafted with Hass, and likely to produce a first crop in 2006 (S. Kremer-Köhne, personal communication, 2005).

CONCLUSION

While avocado scion breeding is presently not pursued in South Africa there is an active program at WTS in which a wide range of imported and local selections are collected and evaluated.

The WTS rootstock breeding program continues to produce and test new selections of rootstocks with the ultimate aim of increasing the profitability of avocado farming. Several promising new WTS selections are presently undergoing stringent field tests.

While the WTS researchers currently face the challenge of finding a rootstock that outperforms Dusa the good news to avocado farmers around the world is that there is at long last a clonal rootstock better than Duke 7.

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