Avocado rotstock research: principals and practises

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ABSTRACT

The value of a reliable clonal rooting technique has been reported. A direct correlation between the quality of a rooting system and tree uniformity has been illustrated. Clonally propagated rootstocks is the only way to express certain outstanding tree characteristics of the scion, such as precocity and production. However, seedling rootstocks are predominantly still used in many countries as the preferred rootstock. The effect of temperature and growth medium to improve root quality and quantity as well as the influence of different rootstocks on the field performance of 'Hass' and 'Maluma', has been studied. Using the Allesbeste micro cloning technique with coco peat as growth medium and a rooting temperature of between 20 – 28°C ensures superior clonal root development. With 'Hass' as the fruiting cultivar, 'Duke 7' outperformed 'Duke 7'-seedling rootstocks on production and uniformity, while on production 'Duke 7', 'D9' and 'Barr-Duke' outperformed 'Thomas'; 'Dusa' (Merensky 2) and 'Velvick' outperformed 'Duke 7'. Comparing horticultural characteristics of the scion, rootstock research with rootstocks grafted to 'Hass' has shown to merely improve certain inherent genetically limiting factors, while new generation cultivars have shown to maximise genetically existing attributes. Therefore Allesbeste Nursery decided to discontinue the use of 'Hass' and replace it with 'Maluma', as the standard for further rootstock evaluation. Under high density (808 trees/ha), the highest yield was recorded with 'Dusa', while 'Bounty' established best in a replant situation. An ultra-high density trial with 1600 trees/ha grafted on 'Dusa', 'Duke 7' and 'Bounty' is under evaluation. An extensive trial with 24 different clonal rootstocks is to be planted soon.

Key words: Clonal rooting technique, Tree uniformity, Clonal rootstocks, Micro cloning, 'Maluma'.

INTRODUCTION

According to Webber (1926), "no factor of the avocado industry is more important than rootstocks, and there is no problem that we know less about, or which requires a longer time to solve." De Villiers & Ernst (2007) reported on the importance of a proper and reliable clonal rooting technique in avocados that will guarantee a good clonal root system. Combining a good cloning technique with the most suitable growth medium will result in a superior clonal rooting system. It has also been confirmed that when buying clonal avocado trees, each plant must have a well-developed and distributed clonal root system with good quality and quantity of roots. The direct correlation between a good clonal rooting system and uniformity in any avocado orchard is a known fact. Brokaw (1987a) concluded that if variability among clonal trees exists it might be explained by differences induced in the nursery.

According to De Villiers & Ernst (2007) a well-developed, evenly distributed and healthy clonal root system ensures maximum utilization of the tree's genetic potential. Due to the genetic variability in seedling plants, clonal propagation of avocados is the only way to conserve and utilize certain outstanding tree characteristics like precocity and production (Hartman & Kester, 1975).

Notwithstanding the above mentioned, seedling rootstocks are predominantly still worldwide and more specific in certain countries used as the preferred rootstock. According to Ben-Ya'acov and Michelson (1995) most seedling rootstocks are chosen for their rapid and uniform germination as well as ease of propagation in the nursery while the horticulture value of the rootstock was never properly studied. This is the main reason why non-uniformity and poor production in seedling rootstock orchards still remains a major concern. Although seedling rootstocks are still widely used, clonal avocado rootstocks are the rootstocks of the future (Wolstenholme 1988).

Ben-Ya'acov *et al.* (1992) concluded that developed avocado industries were shifting to clonal rootstocks and indicated that over a million such trees had already been planted.

The objective of this study is therefore to compare the production potential of seedling- and clonal rootstocks as well as the production potential of different clonal rootstocks grafted with 'Hass' and 'Maluma'.

MATERIALS AND METHODS

Experiment 1.

The effect of temperature and growth medium to improve clonal root quality and quantity has been studied in the nursery. The Allesbeste micro-cloning technique was used and an average temperature of 20 – 28 °C inside the rooting greenhouse was obtained with the introduction of two 150 x Btu diesel fuel heaters. Two different growth mediums were used to evaluate root quality and quantity:

1. 100 % cocopeat.
2. 50:50 mixture of peat moss and perlite.

Experiment 2.
The yield potential of seedling rootstock versus clonal rootstock trees was investigated. The production of an orchard with 'Hass' grafted to 'Duke 7' clonal- and 'Duke 7' seedling rootstock trees was recorded over a six year period(2010-2015) and evaluated (Figure 2 and Figure 3). This block was planted in 1987 on the farm Humor in the Tzaneen area. The different rootstock trees were planted alternately in the row and on the diagonal, at a density of 204 trees per hectare.

Experiment 3.
The influence and field performance of 'Hass' grafted to different clonal rootstocks was evaluated in two separate trail blocks. In the first trail, planted in 1993, 'Hass' grafted to 'Duke 7', 'D9', 'Barr-Duke' and 'Thomas' clonal rootstocks, the production was recorded for five years (2004-2008) and evaluated (Figure4). With the second trail, planted March 2003, the production of 'Hass' grafted to six different clonal rootstocks, 'Dusa', 'Vevick', 'Duke 7', 'Bounty', 'Hass' clone & 'Martin Grande' was recorded over a four year period (2006-2009) and evaluated (Figure 5).

Experiment 4.
Due to the 'Maluma' cultivar's attributes and potential as a new generation scion cultivar, Allesbeste nursery decided to conduct all future clonal rootstock research with 'Maluma' as scion. A phase 1 high density planting (808 trees/ha) with 'Maluma' grafted to 'Dusa', 'Bounty' and 'Duke 7' clonal rootstocks was planted in October 2009. This trail is on the farm Allesbeste in the Tzaneen area. Again the production potential of each combination was recorded for four years (2012-2015) and evaluated (Figure 6).

Experiment 5.
The growth vigour and production of an ultra-high density planting of 2.5m x 2.5m (1600 trees/ha) with 'Maluma' grafted to 'Dusa', 'Bounty' and 'Duke 7' clonal rootstocks was monitored and recorded (Figure 7). This phase two trail block was planted in May 2012 on the farm Avondshoek in the Tzaneen area. This is a replant site previously planted with Ryan on 'Duke 7' seedling rootstock trees.
Field observations with specific reference to tree uniformity and growth vigor were made in each trail block of the different experiments.

RESULTS

The findings of the different experiments were as follows:
Experiment 1.
As illustrated in Figure 1, using cocopeat as rooting medium with the rooting temperature managed between 20 – 28°C, superior quality and quantity clonal root development is clearly visible. A peat moss: perlite mixture (50:50) at the same rooting temperature of 20 – 28 °C could not develop the same quality or quantity clonal roots.

Figure 1. Rooting in peat moss: perlite (50:50) and cocopeat medium.

Experiment 2.
'Hass' on clonal 'Duke 7' rootstock outperformed 'Hass' on 'Duke 7' seedling rootstocks substantially over a six year period (2010-2015). As illustrated in Figure 2, the individual tree production records of the two different rootstocks indicated the clonal rootstock trees to deliver a consistent and higher yield than seedling rootstock trees. The clonal rootstock trees averaged a production of 67 kg/tree compared to 35 kg/tree for the seedling rootstock trees.

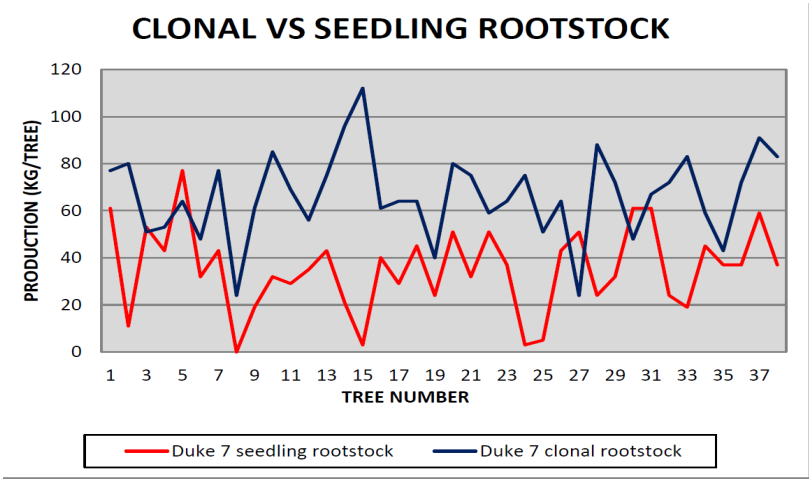

Figure 2. Individual tree production of clonal and seedling rootstocks.

According to the results reflected in Figure 3, the average production (kg/tree) monitored from 2010 to 2015 clearly shows that 'Hass' on clonal rootstock trees outperform 'Hass' on seedling rootstock trees and substantially between 2013 and 2015. The clonal rootstock trees are more uniform and healthier in appearance than the seedling rootstock trees.

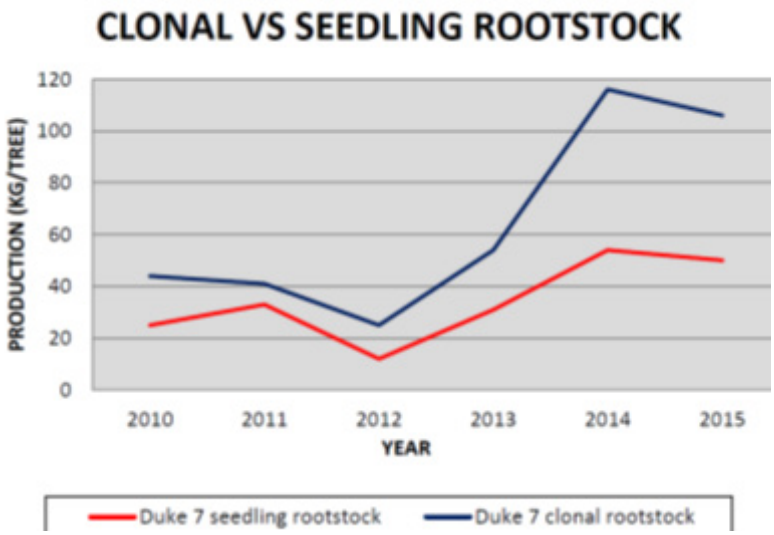

Figure 3. Average production of clonal and seedling rootstock trees.

Experiment 3.
In a rootstock trail with 'Hass' grafted to 'Duke 7', 'D9', 'Barr-Duke' and 'Thomas' clonal rootstocks, the production was monitored for five years (2004-2008). The results as presented in Figure 4 shows that the best yields were obtained by 'Duke 7', 'D9' and 'Barr-Duke'.

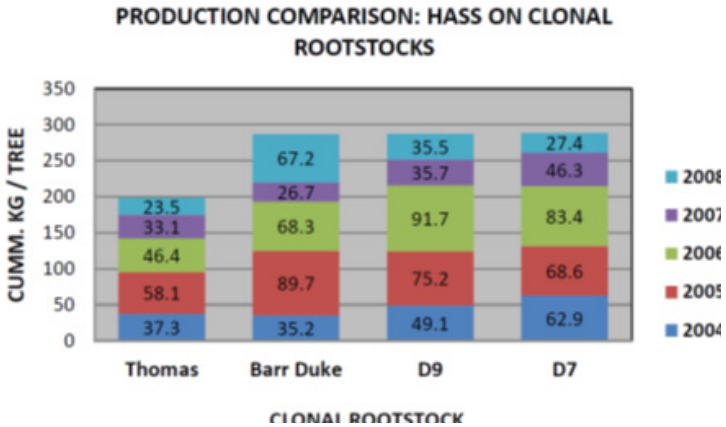

Figure 4. Production of 'Hass' grafted to four different clonal rootstocks.

With the second rootstock trail where 'Hass' was grafted to six different clonal rootstocks (Figure 5), 'Dusa' and 'Vevick' substantially outperformed 'Bounty' and 'Duke 7'. The cumulative results (kg/tree) respectively for 'Dusa' and 'Vevick' were 96kg and 89kg compared to 62kg for 'Bounty' and 55kg for 'Duke 7'.

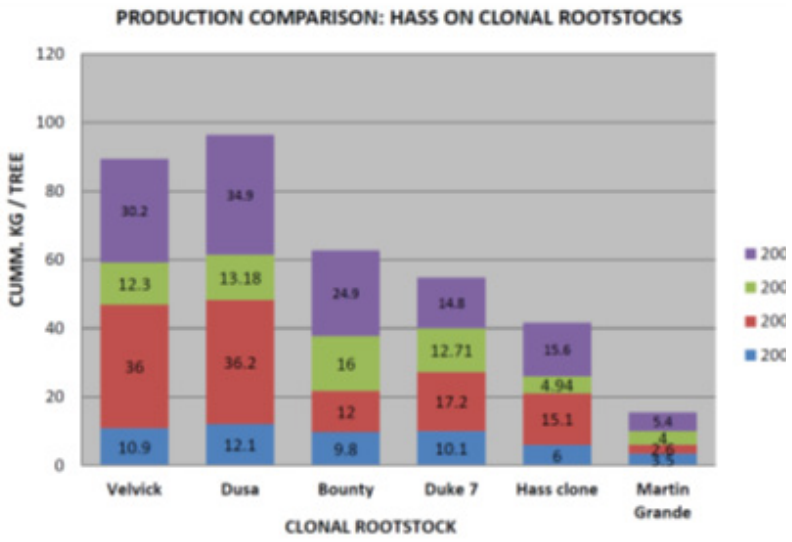

Figure 5. Production of 'Hass' grafted to six different clonal rootstocks.

Experiment 4.

According to the results as illustrated in Figure 6 with 'Maluma' grafted to clonal 'Dusa', 'Bounty' and 'Duke 7', the highest cumulative yield was recorded with 'Dusa' as rootstock. The production was monitored from 2012 to 2015 and 'Bounty"s production consistently improved every year and outperformed the other two rootstocks in 2015.

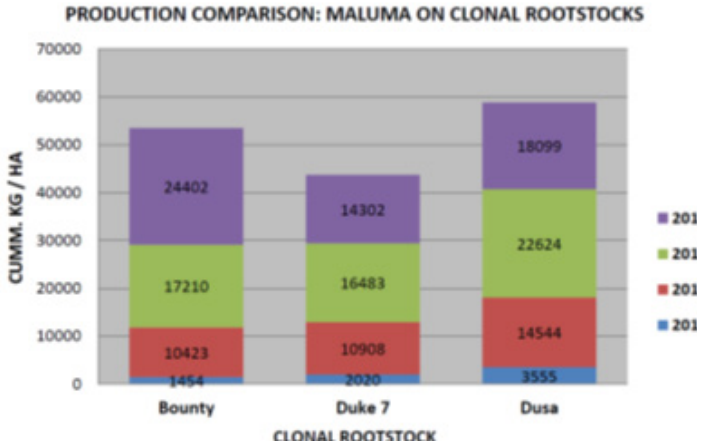

Figure 6. Production of 'Maluma' grafted to three different clonal rootstocks (808 trees/ha)

Experiment 5.

In an identical phase two trail planting with an ultra-high density of 1600 trees/ha, the results as presented in Figure 7 shows that 'Dusa' again outperformed 'Bounty' and 'Duke 7' clonal rootstocks. This trail planting is a replant and field observations made has shown that 'Bounty' established the best of the three rootstocks.

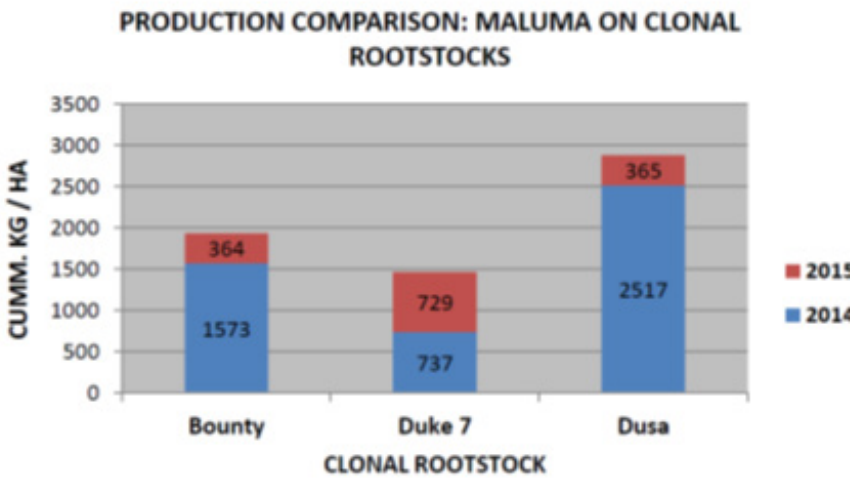

Figure 7. Production of 'Maluma' grafted to three different clonal rootstocks (1600 trees/ha)

The reason for the poor production results in 2015 as reflected in Figure 7 was due to a severe hail storm in October 2014 that stripped almost all the fruit from the trees at a very early stage of development.

DISCUSSION AND CONCLUSION

It has been established that cocopeat as growth medium with a controlled rooting temperature between 20-28°C resulted in clonal root development of excellent quality and quantity, significantly better than the rooting achieved using the standard peat moss: perlite mixture. A superior clonal rooting system, as reported by De Villiers & Ernst (2007), not only resulted in uniformity in the orchard but ensures maximum utilization of the tree's genetic potential. There is also enough evidence that tree uniformity observed in the field directly relates to the rooting technique used in the nursery. Improving the clonal root system in the nursery will undoubtedly have a positive effect on tree performance in the field.

Through this study it is conclusive that 'Hass' on clonal rootstocks outperforms 'Hass' on seedling rootstocks and supports the remark of Wolstenholme (1988) that clonal avocado rootstocks are the rootstocks of the future. In principal the continued use of seedling rootstocks will diminish with time. This supports the findings by Ben-Ya'acov *et al.* (1992) that developed avocado industries were shifting to clonal rootstocks. It is evident that the avocado industry will in future rely more on clonal rootstocks, not only because of its higher production and resistance against Phytophtora root rot but more specifically due to its advantage in replant situations.

This study also confirms that the production potential of the scion will be optimised by the correct clonal rootstock-scion combination. De Villiers and Ernst (2007) reported that the difficulty to successfully root the 'Vevick' rootstock clonally resulted in the discontinuing of 'Vevick' in further clonal rootstock research. 'Thomas', another second generation rootstock has also been discontinued because of its poor performance and supports the observations of Coffey and Guillemet (1987a, b) that 'Hass' trees grafted on 'Thomas' only produced acceptable yield at one site in South Africa and it is not a recommended rootstock for that country.

Of the third generation clonal rootstocks 'Dusa' grafted with 'Hass' and 'Maluma' is still the best combination, especially on virgin soils. According to Retief (2011) 'Dusa' accounted for 50% of the nursery sales of the South African Avocado Nurserymens'Association member-nurseries during 2009-2010 and continues to gain popularity. Initial results indicate the 'Bounty' rootstock grafted to 'Maluma' to be the best performing rootstock for marginal soils and replant sites. 'Bounty' (Retief, 2011) is the third most popular clonal rootstock after 'Dusa' and 'Duke 7' in South Africa.

A new generation clonal rootstock not only has to be better than the current available clonal rootstocks but also have to support and enhance the genetically entrenched horticultural characteristics of the scion cultivar. Findings with this study also support the fact that the shortcomings of a scion cultivar cannot be addressed or rectified with a rootstock.

The two imperfections of 'Hass' namely fruit size and low production, with no substantial improvement through the use of different rootstocks, emphasizes the use of new generation scion cultivars such as 'Maluma' in rootstock research. As 'Maluma' possesses certain horticultural and marketing attributes superior to 'Hass' and since 'Maluma' is already accepted by the market as a commercial cultivar, it in practice justifies to in favour of 'Maluma', discontinue the using of 'Hass' as the standard in future rootstock research.

In the on-going search for a superior high productive clonal rootstock, a new trail where 'Maluma' grafted to 24 clonal rootstocks is in progress, to be planted by the end of 2015. This trail will be planted at a density of 1250 trees/ha (4m x 2m) and will include 'Dusa', 'Bounty', Duke7, Allesbeste nursery's own selections as well as some promising international rootstocks and selections.

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