

BREEDING AND FIELD EVALUATION OF NEW ROOTSTOCKS FOR INCREASED 'HASS' YIELDS AND RESISTANCE TO ROOT ROT IN SOUTH AFRICA

S. Köhne, S Kremer-Köhne and M L Mukhumo

Merensky Technological Services. P O Box 14. Duivelskloof 0835. South Africa.

E-mail: stefankylviek@hansmerensky.co.za

ABSTRACT

Vegetatively propagated rootstock selections grafted with 'Hass' were evaluated for their root rot tolerance and yield potential in an orchard heavily infested with *Phytophthora cinnamomi*. These were compared to the commercial standard rootstock Duke 7. The first orchard (established 1996) contained rootstock selections from Israel, while the second orchard (established 1998) contained root rot tolerant rootstock selections from Westfalia Estate, South Africa. Tree condition declined in general, and the ranking order of the rootstocks remained consistent during the period 1999 to 2002. In the first orchard, 'Hass' trees on various rootstocks were rated from the healthiest to the poorest: VC 805, VC 256, VC 801, VC 207, VC 218, VC 241, Duke 7, Edranol seedlings and VC 225, with rootstocks VC 805, VC 256 and VC 801 being significantly healthier than Duke 7. However yields were extremely low for 6-year-old 'Hass' trees and the evaluation was therefore discontinued in 2002. In the second orchard, 'Hass' trees on various rootstock selections were rated from the healthiest to the poorest: Merensky 2, Merensky 3, V100, Duke 7, Edranol seedlings, Merensky 4, Gordon and Jovo. Merensky 2, Merensky 3 and V100 out-performed the Duke 7 rootstock in terms of yield and root rot resistance. In the avocado rootstock breeding program, so far three root rot resistant seedlings were selected for field evaluation. These were propagated, grafted with 'Hass' and planted in new orchards in 2000 and 2003 respectively.

INTRODUCTION

Root rot of avocado, caused by *Phytophthora cinnamomi*, is the most important avocado disease in South Africa. Currently, the South African avocado industry relies on chemical control of root rot with phosphite compounds, and the use of the Duke 7 rootstock which is moderately tolerant to root rot. The long term aim of this project is to select and evaluate high yielding avocado rootstocks with resistance to root rot. To achieve this aim, this project includes a rootstock breeding program, and a field evaluation in which various vegetatively propagated

rootstock selections are evaluated for their root rot resistance and yield in comparison with the Duke 7 rootstock.

MATERIALS AND METHODS

Breeding program.

This ongoing program was initiated in the early 1990s. The avocado rootstock breeding block contains 20 different rootstocks which have shown superior performance under *Phytophthora cinnamomi* pressure (e.g. Duke 7, Merensky 1, 2 and 3, G755A). These trees undergo open pollination. Pollen from commercial avocado cultivars is excluded from the breeding block by the remoteness of the breeding block from commercial orchards.

Seedlings from this block (between 1500 to 3500 per annum, depending on the yields) are screened for resistance to root rot by exposure to a virulent strain of *Phytophthora cinnamomi* in a mistbed. The seedlings are planted in *Phytophthora* infested vermiculite and evaluated for root health after six weeks. Selected seedlings are then cloned and re-tested (10 of each) in the mistbed as described above. Only the best rootstocks selected in the second mistbed screening are propagated and grafted with 'Hass' for field trials in which they are evaluated for yield and resistance to root rot over a period of six years.

Field evaluation.

The experimental orchards are situated at Westfalia Estate in the Limpopo Province of South Africa (latitude 24°S). This is a summer rainfall area (average 1300 mm per year). The soil type is a fine-loamy, red, mixed paleudult with a clay content of approximately 40%. Irrigation is scheduled by means of tensiometers and applied by micro sprinklers. The rootstocks were evaluated in an orchard heavily infested with *Phytophthora cinnamomi*, and no root rot control treatments were applied. Two experimental blocks were planted which contained 270 (Block 1) and 210 (Block 2) trees on various clonal rootstocks, interplanted with 250 (Blocks 1 and 2) trees on root rot susceptible Edranol seedling rootstocks. For comparison, the current commercial standard rootstock, the tolerant Duke 7, was also included. Thirty clonal trees were used per rootstock and were planted in a randomised block design. All trees were grafted with Hass'. Block 1 was planted in October 1996, and contained the following rootstock selections from Israel: VC 207, VC 218, VC 225, VC 241, VC 256, VC 801 and VC 805 (Zilberstaine & Ben Ya'acov, 1999). Block 2 was planted in February 1998, and contained South African rootstocks. These rootstocks originated from productive trees, which survived root rot, and were selected at

Westfalia Estate (Botha, 1991): Merensky 2 (Dusa), Merensky 3 (Evstro), Merensky 4 (W 14), Jovo and Gordon. A Velvick selection from Australia was also included in Block 2.

Tree condition was rated annually in July, according to a disease index of zero (healthy) to 10 (dead) as described by Darvas, Toerien & Milne (1984). Tree yields were recorded annually. For tree size determination, trunk circumference was measured 20 cm above the ground level in June. Data on yield, tree condition and tree size were analysed by ANOVA; LSD's at the 1% or 5% significance level were used to compare rootstocks.

In 2002, no fungicidal sprays were applied in the test orchards to evaluate the rootstock effect on post harvest disease susceptibility of 'Hass' fruit. 'Hass' fruit grown on various rootstocks from the first and second orchard were stored for 28 days at 5.5°C to simulate sea shipment and were ripened at 18°C before being subjected to a post harvest evaluation.

RESULTS AND DISCUSSION

Breeding program.

From 1993 through 2002, 76 seedlings with healthy roots were selected for further evaluation after undergoing the mistbed screening process for root rot resistance. Until 2002, three superior rootstocks were identified after the second mistbed screening. These were propagated, grafted with 'Hass' and planted in new orchards in 2000 and 2003 respectively for field evaluation.

Field evaluation.

In the first and the second orchards (Blocks 1 and 2), tree condition declined in general. The ranking order of the rootstocks (from the healthiest to the poorest) remained consistent during the period 1999 to 2002. Tree condition ratings and yields of 'Hass' trees on rootstocks originating from Israel are presented in Table 1.

Trees were rated from the healthiest to the poorest: VC 805, VC 256, VC 801, VC 207, VC 218, VC 241, Duke 7, Edranol seedlings and VC 225, with rootstocks VC 805, VC 256 and VC 801 being significantly healthier than Duke 7. Although trees on rootstock VC 801 were relatively healthy, crown rot was observed on 10% of the trees. No other rootstock was affected by crown rot. Yields were extremely low for 6-year-old 'Hass' trees and the evaluation was therefore discontinued in 2002. Tree condition ratings and yields of 'Hass' trees on rootstocks originating from South Africa are shown in Table 2. Trees were rated from the healthiest to the poorest:

Merensky 2, Merensky 3, V100, Duke 7, Edranol seedlings, Merensky 4, Gordon and Jovo. Merensky 2 and V100 yielded significantly better than Duke 7 over the three-year period 2000 through 2002. 'Hass' trees on Merensky 2 rootstock also provided excellent yields in Californian field trials (Menge, 2002). In Blocks 1 and 2, the vigour of 'Hass' trees as determined by trunk circumference measurements was in general higher in trees with good condition (Table 2, data for Block 1 not shown).

Rootstock	Tree condition		Yield (kg/tree)			
	2001	2002	2000	2001	2002	Cumulative
VC 805	3.6 d ¹	4.0 f ²	0.13	3.56 b ⁴	1.97 ⁵	5.66
VC 256	3.7 d	4.1 f	0.43	2.34	0.22	2.99
VC 801	4.0 d	4.3 f	1.77	10.11 a	4.93	16.81
VC 207	4.3 d	4.9 bcdef	0	0.34	0	0.34
VC 218	4.4 d	5.1 bcde	2.68	6.31	3.01	12.00
VC 241	5.8 bc	6.0 abcd	1.80	3.74	2.02	7.56
Duke 7	6.0 b	6.4 abc	0	0.22	0	0.22
Edranol seedlings	5.8 bc	6.5 ab	0.73	1.78	1.77	4.28
VC 225	7.3 a	7.6 a	0.14	0.03	0	0.17
Level of significance	<0.001	<0.001	NS ³	0.099		

¹ Mean separation in columns by LSD, 5% level. Means followed by the same letter are not significantly different.

² Mean separation in columns by LSD, 1% level. Means followed by the same letter are not significantly different.

³ NS=non-significant

⁴ Due to a high number of trees on various rootstocks producing either no crop or a very small crop, only rootstocks VC 805 and VC 801 could be tested at the 10% level.

⁵ Due to a high number of trees on various rootstocks producing either no crop or a very small crop, no ANOVA possible.

Table 2. Condition (2001-2002), yields (2000-2002) and trunk circumference (2002) of 'Hass' trees on various vegetatively propagated rootstocks (Block 2, planted 02/1998). Tree condition was rated on a scale of 0 (healthy) to 10 (dead)

Rootstock	Tree condition		Yield (kg/tree)			Trunk circumference (cm)
	2001	2002	2000	2001	2002	2002
Merensky 2	2.2 f ¹	2.1 e ²	2.01 abc ¹	8.56 ab ¹	11.80 a ¹	27.51 abc
Merensky 3	2.3 ef	2.4 de	2.23 ab	8.56 ab	6.74 abc	29.61 ab
V100 ³	2.7 ef	2.9 de	1.97 abcd	10.72 a	10.07 ab	31.04 a
Duke 7	3.3 de	3.5 cde	0.51 e	2.79 c	2.18 c	22.33 de
Edranol seedlings	4.0 cd	4.2 bcd	1.25 abcde	3.41 c	5.16 bc	26.63 abc
Merensky 4	4.9 bc	5.2 bc	2.36 a	4.83 bc	6.61 abc	22.69 de
Gordon	5.5 b	5.7 b	1.05 bcde	2.25 c	2.57 c	20.05 e
Jovo	7.6 a	8.8 a	0.53 e			
Level of significance	<0.001	<0.001	0.014	0.009	0.043	<0.001

¹ Mean separation in columns by LSD, 5% level. Means followed by the same letter are not significantly different.

² Mean separation in columns by LSD, 1% level. Means followed by the same letter are not significantly different.

³ Velvick selection

The post harvest evaluation showed that the 'Hass' fruit grown on various rootstocks were of good quality. The incidence of anthracnose was low and there were no differences between rootstocks (data not shown). This is in contrast with rootstock studies conducted by Willingham *et al.* (2001) finding that rootstock race had a significant impact on postharvest anthracnose susceptibility.

CONCLUSIONS

The health condition of 'Hass' trees on various vegetatively propagated rootstock selections declined in general. The ranking order of the rootstocks remained consistent during the period 1999 to 2002. In the first orchard, the Israeli rootstocks VC 805, VC 256 and VC 801 were significantly healthier than Duke 7, however yields were disappointingly low for 6-year-old 'Hass' trees and testing was therefore discontinued. In the second orchard, rootstocks Merensky 2, Merensky 3 and the Velvick selection V100 out-performed the Duke 7 rootstock in terms of yield and root rot resistance.

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