

Rootstocks affect quality of 'Hass' avocado fruit after storage

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Abstract

Rootstocks can influence avocado fruit characteristics, including fruit resistance to postharvest rots and internal disorders. To evaluate the potential of selected rootstocks in Australia to improve fruit quality after cold storage, avocado fruit were harvested at commercial maturity from Hass trees grafted to several commercial and proprietary rootstocks at 3 sites in Queensland (Childers, Hampton and Walkamin) and one site in Western Australia (Pemberton) over 3 seasons. Fruit were held at 5°C for 4 weeks, and then ripened at 20°C with no ethylene, and quality assessed at eating ripe. Rootstocks significantly affected ripening time and flesh internal disorders, with the response varying depending on location and season. The proportion of sound fruit (i.e. <10% of the flesh affected by all internal defects) was also affected by rootstocks and varied by as much as 64% among rootstocks within one location and season. Diffuse discolouration, followed by vascular leaching were generally the main causes of quality loss.

Pies de injerto afectan la calidad del fruto en aguacates 'Hass' después de su almacenamiento

Los pies de injerto pueden influir en las características del fruto del aguacate, incluyendo la resistencia del fruto a la pudrición y otros trastornos internos pos cosecha. Para evaluar el potencial de los pies de injerto seleccionados, en Australia, y mejorar la calidad de la fruta después de su almacenamiento refrigerado, se cosecharon aguacates maduros de árboles 'Hass' comerciales y no comerciales en tres sitios de Queensland (Childers, Hampton y Walkamin) y un sitio en Australia Occidental (Pemberton) durante tres estaciones. La calidad del fruto maduro fue evaluada después de mantenerlos a 5°C durante 4 semanas y madurada 20°C sin etileno. Dependiendo de la localización y estación en la cual se encuentren los pies de injerto afectaron significativamente el tiempo de maduración y trastornos de la pulpa. La proporción de fruta sana (<10% de la pulpa afectada por defectos internos) fue afectada por los pies de injerto y varió hasta el 64% dependiendo de la localización y la estación. La principal causa de pérdida de la calidad del fruto se debieron a la decoloración de la pulpa.

Key words: avocado, rootstocks, storage, fruit quality

Introduction

In addition to its known effects on tree productivity and resistance to root diseases, rootstocks can affect avocado fruit characteristics and quality, including fruit size (Arpaia et al. 1993), oil content (Gregoriou and Economides 1991), and resistance to postharvest diseases (Marques et al. 2003; Willingham et al. 2001) and physiological disorders after cold storage (Marques et al. 2003). Fruit resistance to rots and internal disorders following cold storage is an important quality attribute as it can allow fruit to be transported more effectively (especially for export and/or long distances) and provide the industry with storage options in times of supply-demand imbalances.

A national project ('Rootstock Improvement for the Australian Avocado Industry') led by Dr Tony Whiley established a number of field sites across Australia in 2004-2005 aimed at evaluating growth and yield of 'Hass' and 'Shepard' trees grafted to a range of rootstocks. As part of that project, fruit quality was assessed over the last three avocado seasons to evaluate the potential of selected rootstocks in Australia to improve fruit quality after harvest and cold storage. This paper reports the results during the 2010/11 season in 'Hass' fruit harvested from four of the above sites, three in Queensland (Childers, Hampton and Walkamin) and one in Western Australia (Pemberton). Fruit sampled from all locations were stored at 5°C for 4 weeks, and then ripened at 20°C with no ethylene. The days from removal to ripe were determined, and external and internal fruit quality assessed at eating ripe.

Materials and methods

Fruit were harvested at commercial maturity from 'Hass' trees on 6-10 selected rootstocks at four sites across Australia during 2010/11 as shown in Table 1. Ten (Childers) or six (other sites) individual tree replications for each rootstock were used.

Table 1: Clonal (C) and seedling (S) rootstock selections with 'Hass' scion at each of four locations during 2010/11.

Location	Childers (QLD)	Hampton (QLD)	Pemberton (WA)	Walkamin (QLD)
Harvest date	19/5/10	12/7/10	1/12/10	7/2/11
Rootstock	C ¹ -A10	C-A10	C-A10	C-A8
	C-Duke 7	C-Duke 7	C-Barr Duke	C-A10
	C-Nabal	C-Hass	C-Duke 7	C-Duke 7
	C- SHSR-03	C-Reed	C-Reed	C-Reed
	C-Velvick	C-SHSR-03	C-Velvick	C-Velvick
	C-Zutano	C-Velvick	C-Zutano	C-Zutano
	S ² -A10			
	S-Nabal			
	S-SHSR-02			
	S- SHSR-03			
S-Velvick				

Twenty fruit per tree were harvested at each site, placed directly into trays and road freighted to the laboratory on the Sunshine Coast (DEEDI, Maroochy Research Station). Fruit arrived within 24-48 hours of picking for most locations, except Walkamin which was transported in refrigerated (about 7°C) truck and arrived within 72 hours of harvest. All fruit quality assessments were based on the 'International Avocado Quality Manual' (White et al. 2009). Twenty fruit per tree were held at 5°C for four weeks, then ripened at 20°C until the soft-ripe stage (firmness stage of 5 based on a 0 to 7 scale, from hard to very overripe), with no ethylene treatment. The days from removal to ripe were recorded for each fruit. Skin colour at ripe was visually assessed on a 1 to 6 (green to black) scale. Each fruit was then cut in halves, peeled, the seed removed, and the severity of flesh diseases and internal disorders assessed as the percentage of flesh volume affected. Flesh diseases were described based on the location of the disease on the fruit, for example stem-end rots or body rots. The percentage of sound fruit (based only on flesh appearance) was calculated based on the number of fruit with 10% or less of all flesh defects combined in relation to the total number of fruit per treatment per farm.

Statistical analyses were performed by Genstat® 11 for Windows™ (VSN International Ltd., UK). Analysis of variance used the 'General Analysis of Variance' model, with rootstocks as 'treatments' structure and tree/fruit as 'block' structure. The protected least significant difference (LSD) procedure at P = 0.05 was used to test for differences between treatment means.

Results and discussion

Rootstocks significantly affected fruit ripening (days to ripe) after removal from cold storage in tree of the locations, with differences of up to almost 2 days between the fruit that took the longest to ripen and those that took the shortest (Table 1). There were no significant differences among rootstocks at Childers, with an average of 8.8 days across all treatments (data not shown).

Table 1. The effect of clonal rootstocks on days from removal to ripe of 'Hass' avocado fruit harvest from three locations in 2010/11. Fruit were held at 5°C for 4 weeks and then ripened at 20°C with no ethylene till the soft-ripe stage.

Clonal rootstock	Days from removal to ripe at 20°C		
	Hampton (QLD)	Pemberton (WA)	Walkamin (QLD)
A10	5.5 ^{ab}	6.2 ^{ab}	8.1 ^{bc}
Duke 7	4.3 ^c	5.7 ^{bc}	7.5 ^c
C-Reed	5.0 ^{bc}	6.3 ^a	9.4 ^a
C-Velvick	5.5 ^{ab}	6.2 ^{ab}	8.3 ^{bc}
A-8	---	---	8.8 ^{ab}
Barr Duke	---	5.5 ^c	---
Hass	5.0 ^{bc}	---	---
SHSR-03	5.8 ^a	---	---
Zutano	---	5.9 ^{abc}	8.5 ^b

Means in columns with different letters are significantly different (P = 0.05) as tested by least significant difference (LSD).

Fruit skin colour at eating ripe was not affected by rootstocks on most locations except Pemberton, where fruit from trees on clonal Barr Duke were greener than fruit from trees on the other rootstocks (data not shown).

Rootstocks significantly affected flesh disorders after cold storage at Hampton and Pemberton, particularly diffuse discoloration (Figure 1), which was the main quality factor followed by vascular leaching (data not shown). At Hampton, fruit from trees on clonal rootstocks A-10, Velvick and S-SHSR-03 generally had less diffuse discoloration after cold storage than fruit from trees on clonal Reed (Figure 1). At Pemberton, fruit from trees on clonal Velvick had more flesh diffuse discoloration than fruit from trees on most of the other rootstocks (Figure 1). Rootstock effects on internal disorders confirm earlier work in which ripe 'Hass' fruit harvested over two seasons from trees on clonal 'Velvick' had less diffuse discoloration and vascular browning than fruit from trees on clonal 'Duke 7' after four weeks at 5°C (Marques et al. 2003). There were no rootstock effects on flesh disorders after storage in ripe fruit from Childers or Walkamin (data not shown). Average severity of diffuse discoloration across all treatments was 1.0% (Childers) and 1.2% (Walkamin).

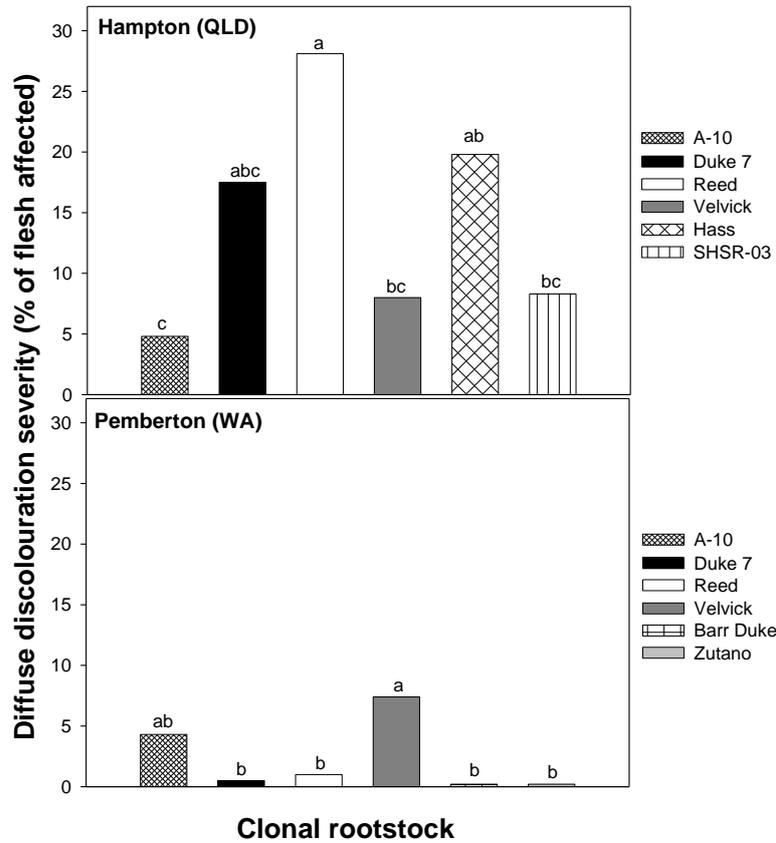


Figure 1: The effect of clonal rootstocks on diffuse discolouration severity (% of flesh volume affected) in ripe ‘Hass’ avocado fruit from two locations in 2010/11. Fruit were held at 5°C for 4 weeks and then ripened at 20°C with no ethylene until the soft-ripe stage. For each location, bars with the same letters on top are not significantly different ($P = 0.05$) as tested by least significant difference (LSD).

There were also no significant rootstock effects on the severity of flesh diseases (either body rots or stem end rots) after removal from cold storage in ripe fruit from any of the four locations (data not shown).

Reflecting the above effects of rootstocks on diffuse discolouration, the percentage of sound fruit (those with a severity rating of 10% or less of the flesh affected by all defects combined) at Hampton was higher in fruit from trees on clonal A-10 and Velvick rootstocks than fruit from trees on clonal Duke 7 and Reed rootstocks (Figure 2). At Pemberton, fruit from trees on clonal Velvick had a lower % of sound fruit than fruit from trees on most of the other rootstocks. There were no significant rootstock effects on the % of sound fruit at Childers or Walkamin (data not shown).

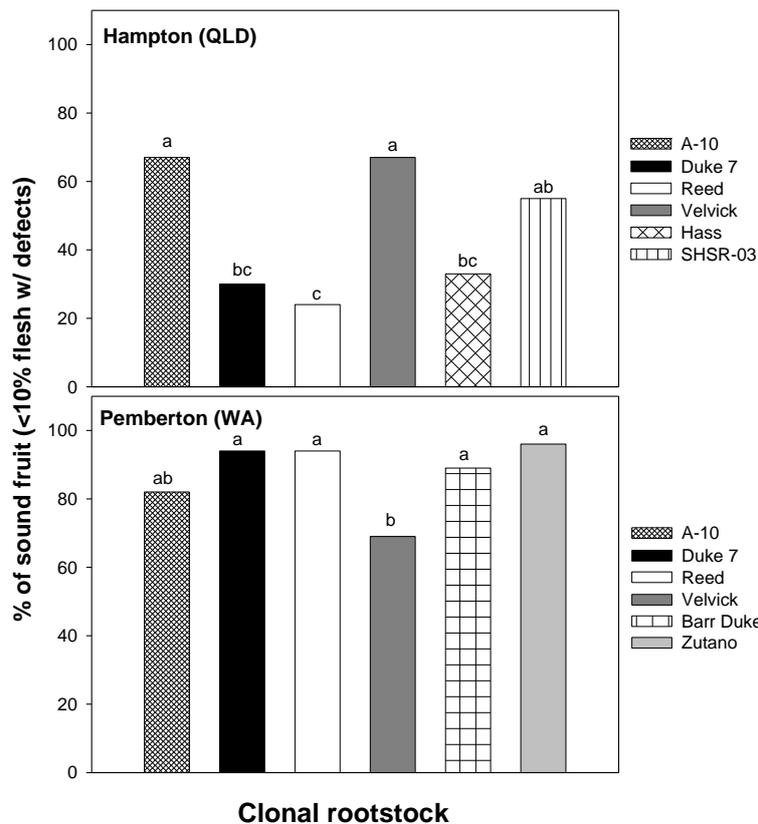


Figure 2: The effect of clonal rootstocks on the % of sound ripe ‘Hass’ avocado fruit (<10% of flesh affected by internal defects) from two locations in 2010/11. Fruit were held at 5°C for 4 weeks and then ripened at 20°C with no ethylene until the soft-ripe stage. For each location, bars with different letters on top are significantly different (P = 0.05) as tested by least significant difference (LSD).

Conclusions

Results presented from the third season of the project ‘Rootstock Improvement for the Australian Avocado Industry’ show that rootstocks significantly affected ripening time and flesh internal disorders after cold storage, with the response varying depending on location and season. As a result, the proportion of sound fruit (i.e. <10% of the flesh affected by all internal defects) was also affected by rootstocks and varied by as much as 64% among rootstocks within one location and season. Diffuse discoloration, followed by vascular leaching were generally the main causes of quality loss. Some rootstocks such as clonal A-10 and clonal SHSR-03 had a good performance in terms of fruit resistance to internal disorders across different sites and seasons, while some rootstocks perform well at particular locations (e.g. Velvick at Hampton).

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