Development of storage protocols for ultra-late season 'Lamb Hass' and 'Reed' avocado fruit

FJ Kruger, D Lemmer and O Volschenk

Lowveld Postharvest Services
PO Box 4001, Nelspruit 1200, SOUTH AFRICA
E-mail: fjkruger58@gmail.com

ABSTRACT

The 'Lamb Hass' and 'Reed' cultivars are cultivated in certain late production areas with the specific aim of stretching the local market window and servicing certain late export markets. During 2014, a study was launched with the aim of developing appropriate harvest and storage procedures for the two cultivars. To do this, fruit samples were harvested during, respectively, October, November and December 2014 as well as during January 2015. In each case the fruit were treated with one of four 1-MCP concentrations (0, 200, 300 and 500 ppb) and stored at three temperature settings (2, 4 and 6°C) for a one month period before being ripened. The most important limiting factor was shown to be stem-end rot infections. There was a direct correlation between the length of the ripening period and the incidence of stem-end rot infections.The post-storage incidences of stem-end rot infections were considerably higher in 'Reed' than in 'Lamb Hass'. The latter cultivar had no stem-end rot infections when harvested during October, November and December and stored for one month at 6°C without a 1-MCP treatment. The fruit harvested during January did, however, have around 18% stem-end rot after two weeks of storage at 6°C. In the case of 'Reed', stem-end rot was prevalent from October onwards. The most important cosmetic flaws were found to be bruising and vascular hardening. Based on the results, it was recommended that 'Reed' should only be stored for a couple of days under local market conditions while 'Lamb Hass' can be stored for a one month period during October and November and for two weeks during December. Two containers of 'Lamb Hass' were subsequently successfully exported under controlled atmosphere at 6°C during the 2015 season. An orchard based trial aimed at establishing what effect the late hanging of the fruit has on the alternate bearing pattern of 'Lamb Hass' trees was also launched.

INTRODUCTION

The present study intends to develop procedures to improve the quality and storage potential of ultra-late season 'Reed' and 'Lamb Hass' avocado fruit. The aims of the study are:

- To determine for what period after the conventional harvest season fruit from high altitude orchards can still be harvested, stored and ripened.
- To develop appropriate harvest and storage protocols.
- To launch a trial aimed at establishing what effect the late hanging of the fruit has on tree health and alternate bearing.

MATERIALS AND METHODS

Before the start of the first set of trials, the maturation rate of 12 'Reed' orchards and 6 'Lamb Hass' orchards was plotted as from week 25 to week 49. The maturation rates of the orchards were found to be quite comparable and one 'Reed' orchard (Olyfberg 7) and one 'Lamb Hass' orchard (Olyfberg 1) were subsequently selected for the trials. Both orchards are located at an altitude of 1400 meters above mean sea level.

Samples of 360 fruit each were sampled from the two orchards during mid-October 2014, mid-November 2014 and mid-December 2014. In the case of 'Lamb Hass', an additional sample was taken during mid-January 2015.

In each case, the samples were split into 12 sub-samples containing 30 fruit each that were treated with, respectively, 0, 200, 300 or 500 ppb 1-MCP and stored at either 2, 4 or 6°C. The samples collected during the first three dates were stored for one month while the 'Lamb Hass' sample collected during mid-January was stored for two weeks only.

After storage, the fruit were ripened in the laboratory at 20°C. The number of days required to ripen each fruit was recorded, after which they were dissected and the incidence (%) and intensity (0-3) of the following characteristics/disorders scored:

- External colour
- Shriveling
- Black cold damage
- Grey pulp
- Bruising

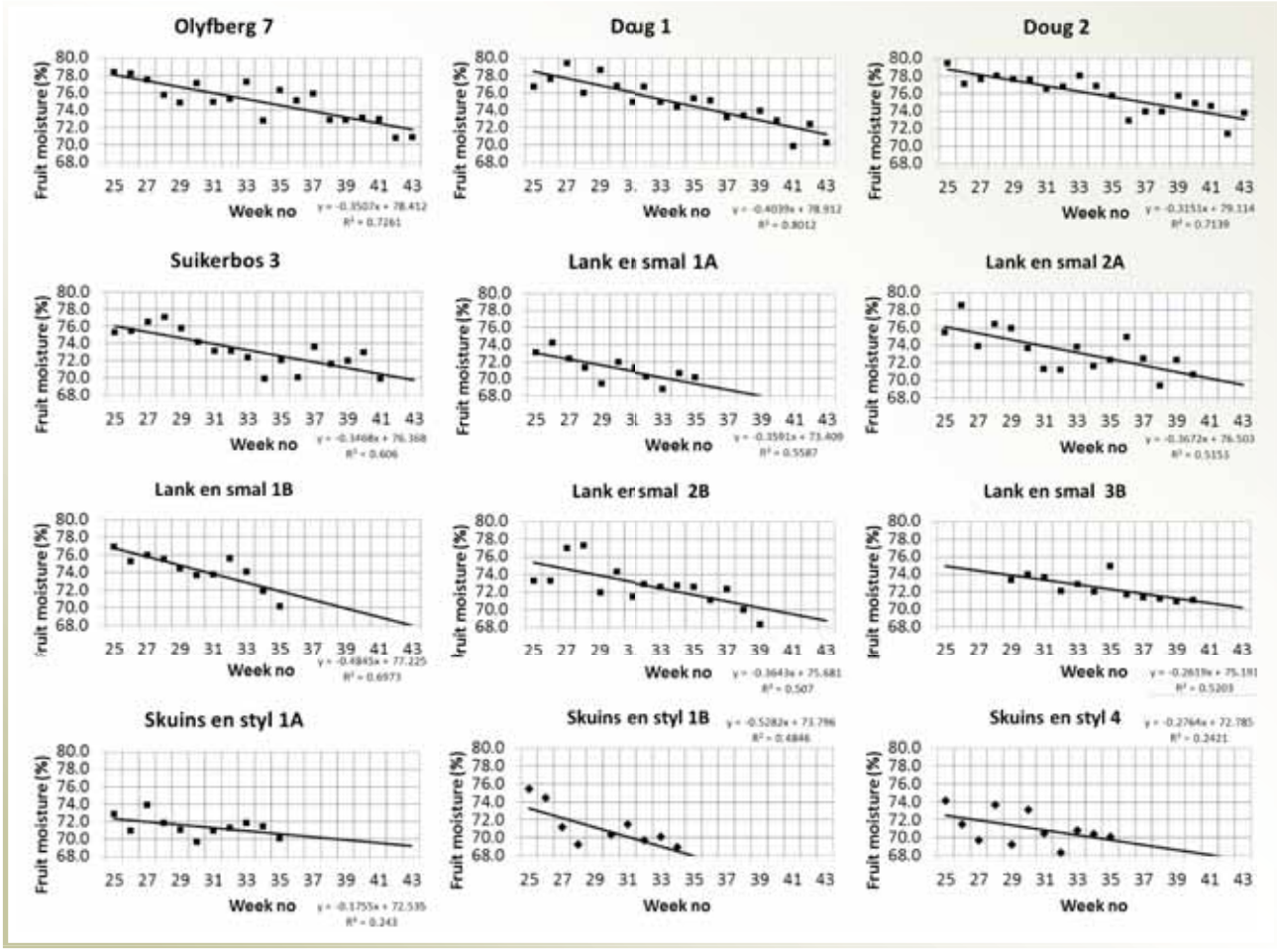

Figure 1. Maturation rate of 12 high altitude 'Reed' orchards located near Mooketsi during the 2014 season.

- Vascular hardening
- Stem-end rot
- Vascular browning
- Anthracnose.

RESULTS AND DISCUSSION

Fruit maturity

The maturation rates of the 12 'Reed' orchards, as recorded during 2014, are shown in Figure 1. As may be deduced from the graphs, the maturation rates of the various orchards did not differ significantly from each other. The Olyfberg 7 orchard was subsequently selected for the trials. The moisture content of the experimental fruit, as recorded during the mid-October, mid-November and mid-December sampling dates, can be deduced from Figure 2. The fruit were at approximate moisture content levels of, respectively, 72%, 71% and 69% during the three dates.

The maturation rates of the 6 'Lamb Hass' orchards, as recorded during 2014, are shown in Figure 3. With the exception of the Roma 1 orchard, the maturation rates of the various orchards did not differ significantly from each other. The Olyfberg 1 orchard was subsequently selected for the trial. The moisture content of the experimental fruit, as recorded during the mid-October, mid-November, mid-December and mid-January sampling dates, can be inferred from Figure 4. The fruit were at approximate moisture content levels of, respectively, 74%, 72%, 71% and 69% during the four dates.

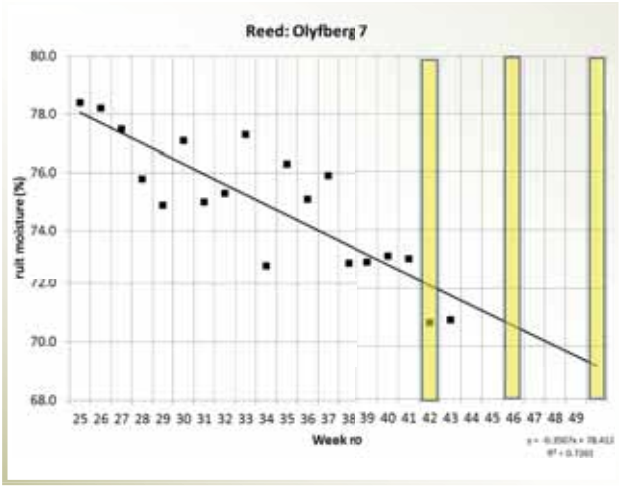

Figure 2. Week number and approximate maturity stage at which the 'Reed' samples from the Olyfberg 7 orchard were harvested.

Stem-end rot

Stem-end rot (Fig. 5, top) was shown to be the most limiting postharvest disorder. In both cultivars there was a direct correlation between the ripening

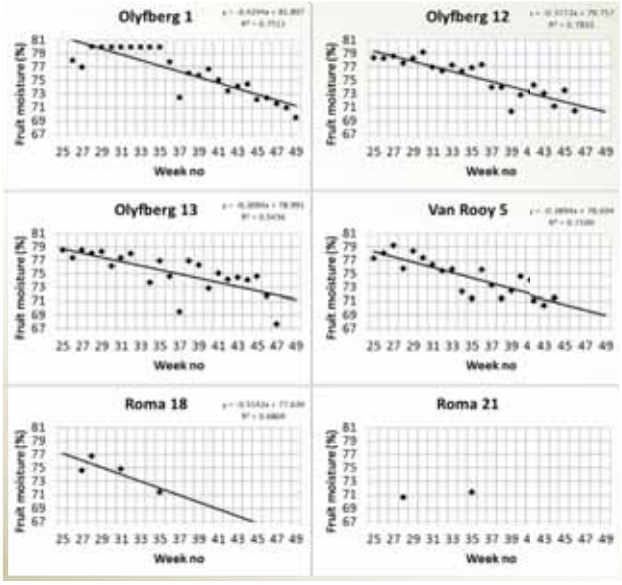

Figure 3. Maturation rate of 6 high altitude 'Lamb Hass' orchards located near Mooketsi during the 2014 season.

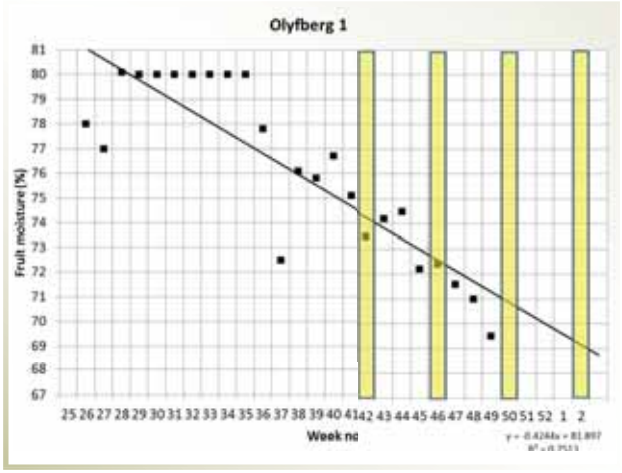

Figure 4. Week number and approximate maturity stage at which the 'Lamb Hass' samples from the Olyfberg 1 orchard were harvested.

Figure 5. Typical examples of stem-end rot infections that occurred in 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage and ripening.

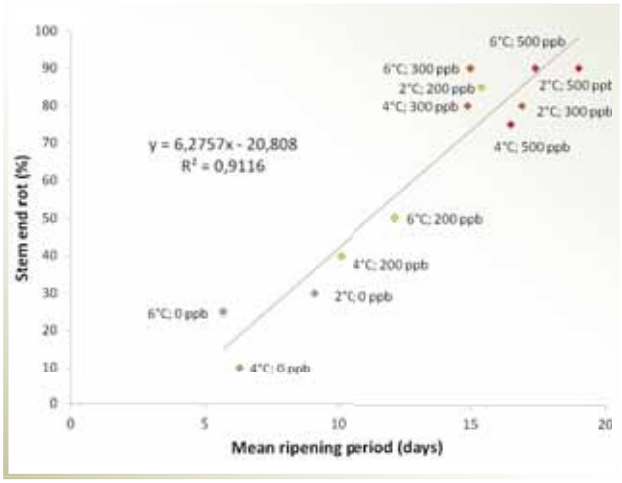

Figure 6. Relationship between the mean ripening period and the incidence of stem-end rot infections of 'Reed' fruit that were sampled during October 2014 and treated with four 1-MCP rates, followed by storage at three different temperature settings for 4 weeks.

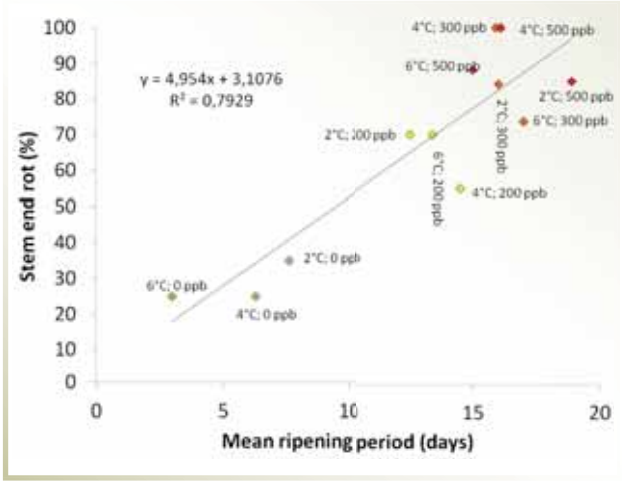

Figure 7. Relationship between the mean ripening period and the incidence of stem-end rot infections of 'Reed' fruit that were sampled during November 2014 and treated with four 1-MCP rates, followed by storage at three different temperature settings for 4 weeks.

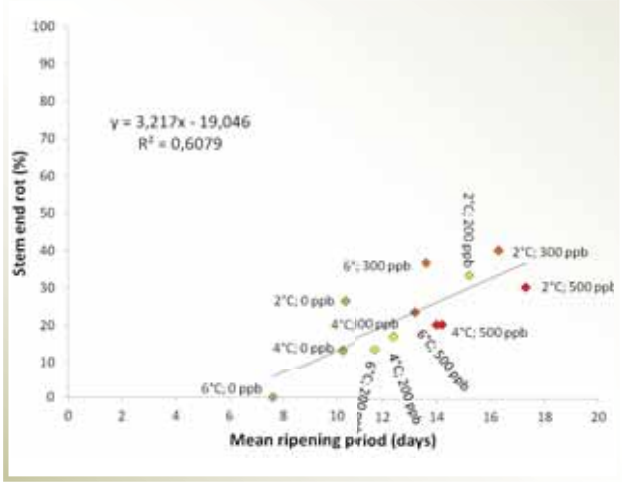

Figure 8. Relationship between the mean ripening period and the incidence of stem-end rot infections of 'Lamb Hass' fruit that were sampled during October 2014 and treated with four 1-MCP rates, followed by storage at three different temperature settings for 4 weeks.

rates of the fruit and the incidence of the disorder. With 'Reed' (Figs. 6 and 7), the high incidence of the disorder essentially disqualifies it as an export or extended local market storage candidate. Even the fastest ripening samples still had high incidences of stem-end rot.

A similar trend existed with 'Lamb Hass' (Figs. 8 and 9), with the exception that the fruit stored at the highest temperature (6°C) without any 1-MCP were free of stem-end rot infections during October, November and December. The disorder then increased to 18.5% during January 2015 (Fig. 10).

Ripe colour

Since 'Reed' is a green skin cultivar, this quality parameter has bearing on 'Lamb Hass' only. In general, 'Lamb Hass' fruit stored at 6°C had acceptable rind colour upon reaching the ready to eat stage (Fig. 11). Slightly underdeveloped external colour was noticed in the October samples stored at 2°C (Fig. 12).

Black cold damage

A relatively high prevalence of black cold damage occurred in both cultivars when stored at both 2°C and 4°C. However, when stored at 6°C, it was prevalent in about 20% of the fruit of both cultivars during October, but at a low intensity (Fig. 13). The incidence then decreased to zero percent during the subsequent three sampling dates.

In the case of 'Lamb Hass', the affected fruit completely degreened and the lesions were thus not conspicuous at the ready to eat stage.

Shriveling

Shriveling was problematic in 'Reed' fruit (Fig. 14), especially when treated with 1-MCP (up to 80% of fruit affected). It was at more acceptable levels (5-15%) when stored at 6°C without the use of 1-MCP.

The disorder was virtually non-existent in the 'Lamb Hass' cultivar when harvested on the above dates and stored at the listed temperature settings.

Bruising

The occurrence of bruising (Fig. 15) was random in both cultivars and no discernible trends were apparent. Interestingly, during the last number of seasons we have noticed that the incidence of the disorder is higher in laboratory ripened fruit compared to fruit from trials that were ripened at commercial ripening facilities. This observation certainly requires further attention.

Vascular hardening

In the 'Reed' cultivar, the vascular bundles entering the distal end of the seed tended to become fibrous as early as October, when 5% of the fruit exhibited the symptom (Fig. 16). It then increased to 45% by November.

In 'Lamb Hass' (Fig. 16), the vascular bundles only started to harden in December when 10-20% of the fruit started to exhibit the symptom.

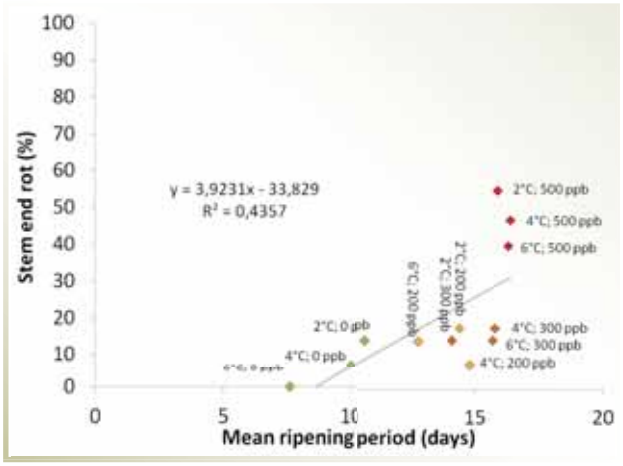

Figure 9. Relationship between the mean ripening period and the incidence of stem-end rot infections of 'Lamb Hass' fruit that were sampled during November 2014 and treated with four 1-MCP rates, followed by storage at three different temperature settings for 4 weeks.

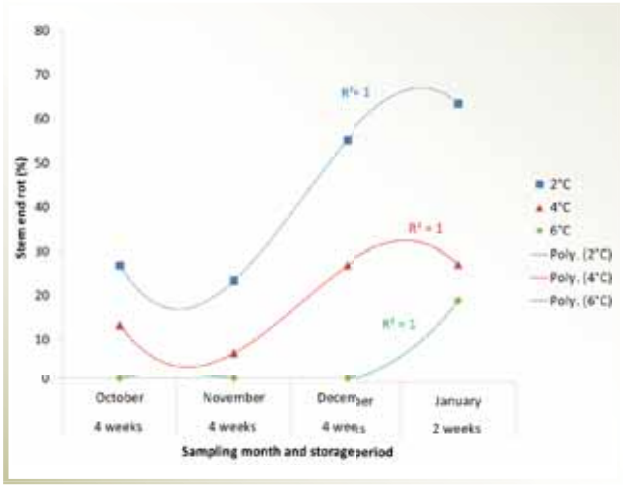

Figure 10. Stem-end rot infection rate of 'Lamb Hass' fruit that were sampled from October 2014 to January 2015 and stored at three different temperature settings.

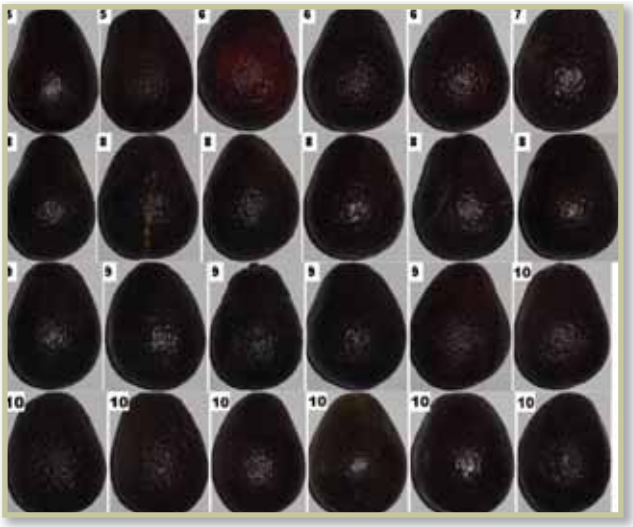

Figure 11. External appearance of ripened 'Lamb Hass' fruit that were sampled during October 2014 and stored at 6°C for four weeks.

Vascular browning
The prevalence of the disorder was low in both cultivars. As far as it could be determined, it only occurred in conjunction with stem-end rot and/or anthracnose infections (Fig. 17).

Anthracnose
In 'Reed' (Fig. 18, top), this infection was prevalent at around 5% when harvested in October. Similarly to stem-end rot, the incidence increased as the fruit matured, especially when stored at lower temperatures and treated with 1-MCP. For example, when harvested in November, fruit treated with 300 ppb 1-MCP and stored at 2°C had an incidence of over 90%.

With 'Lamb Hass' (Fig. 18, bottom), the incidence during October, November and December was around 5% but with a low intensity (±1 on a scale between 0 and 3) when stored at 6°C in the absence of 1-MCP for 30 days. It then increased to over 30% in January.

Grey pulp
The incidence of grey pulp (Fig. 19) was surprisingly low (0-5%) in 'Reed' during October and November. The December measurements were confounded by the high incidence of stem-end rot.

With 'Lamb Hass', both the incidence (< 5%) and intensity (< 1 on a scale between 0 and 3) were low in samples stored at 6°C during October and November. In the absence of 1-MCP the incidence increased to over 40% during December (4 weeks storage) and January (2 weeks storage).

Overall impression
The internal appearance of the 'Lamb Hass' fruit sampled from October to January that were stored at 6°C without 1-MCP, are shown in Figure 20. The figure demonstrates the harvest date dependent quality decline. It also emphasises the cosmetic importance of bruising. As mentioned, the disorder is more prevalent in laboratory ripened fruit compared to fruit ripened at commercial ripening facilities. We will therefore ripen all future trials at a commercial ripening facility.

In Figure 21, the internal appearance of 18 'Lamb Hass' fruit from the mid-November sample that was stored at 6°C, is compared with the corresponding sample that was treated with 300 ppb 1-MCP and stored at 2°C. The figure clearly demonstrates the increased

Figure 12. External appearance of ripened 'Lamb Hass' fruit that were sampled during October 2014 and stored at 2°C for four weeks.

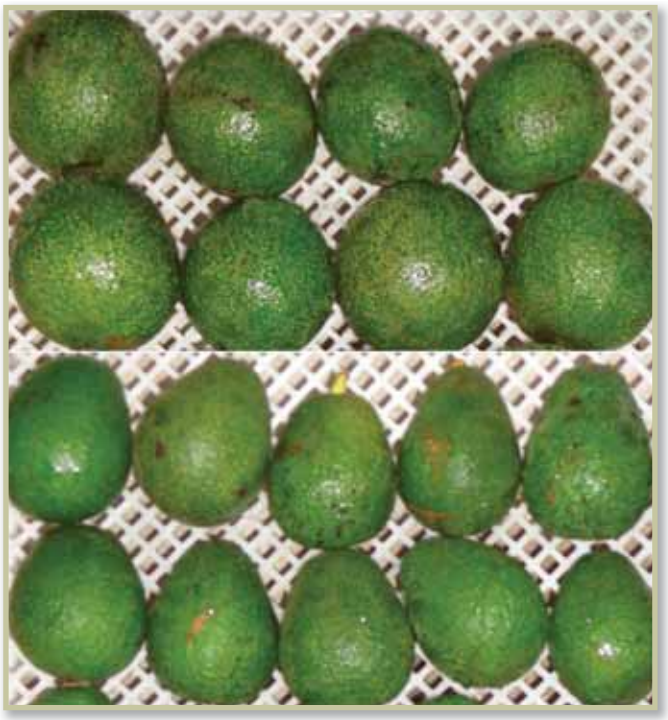

Figure 13. Typical examples of black cold damage lesions that occurred on 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage at 6°C.

Figure 14. Typical example of shrivelling that developed in 'Reed' fruit during storage.

Figure 15. Typical examples of bruising that occurred in 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage and ripening.

Figure 16. Typical examples of vascular hardening that occurred in 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage and ripening.

Figure 17. Typical examples of vascular browning infections that occurred in 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage and ripening.

Figure 18. Typical examples of anthracnose infections that occurred in 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage and ripening.

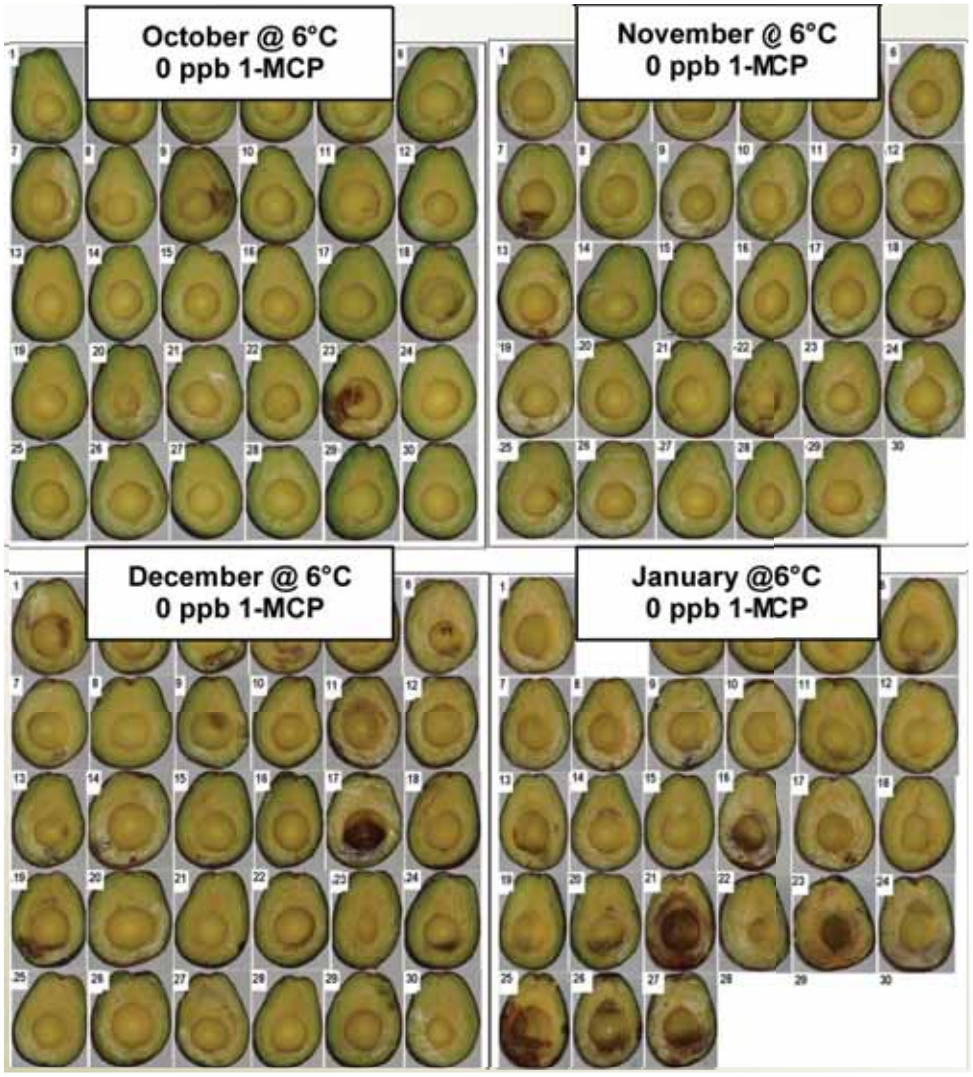

Figure 19. Typical examples of grey pulp symptoms that occurred in 'Reed' (top) and 'Lamb Hass' (bottom) fruit after storage and ripening.

Figure 20. The internal appearance of ripened 'Lamb Hass' fruit that were sampled from October 2014 to January 2015 and stored at 6°C without 1-MCP.

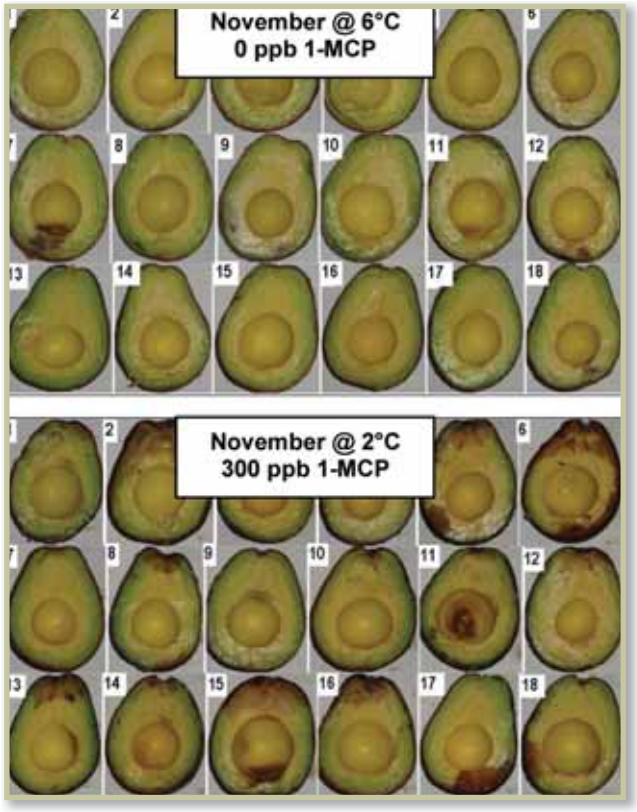

Figure 21. Internal appearance of 'Lamb Hass' fruit that were sampled during mid-November and stored at 6°C without 1-MCP compared to fruit that were treated with 300 ppb 1-MCP and stored at 2°C.

incidence and intensity of stem-end rot brought about by the lower temperatures and the 1-MCP treatment.

Figure 22 shows the harvest date related quality decline in the 'Reed' samples stored at 6°C. It also shows the negative effects brought about by a low storage temperature and the use of 1-MCP.

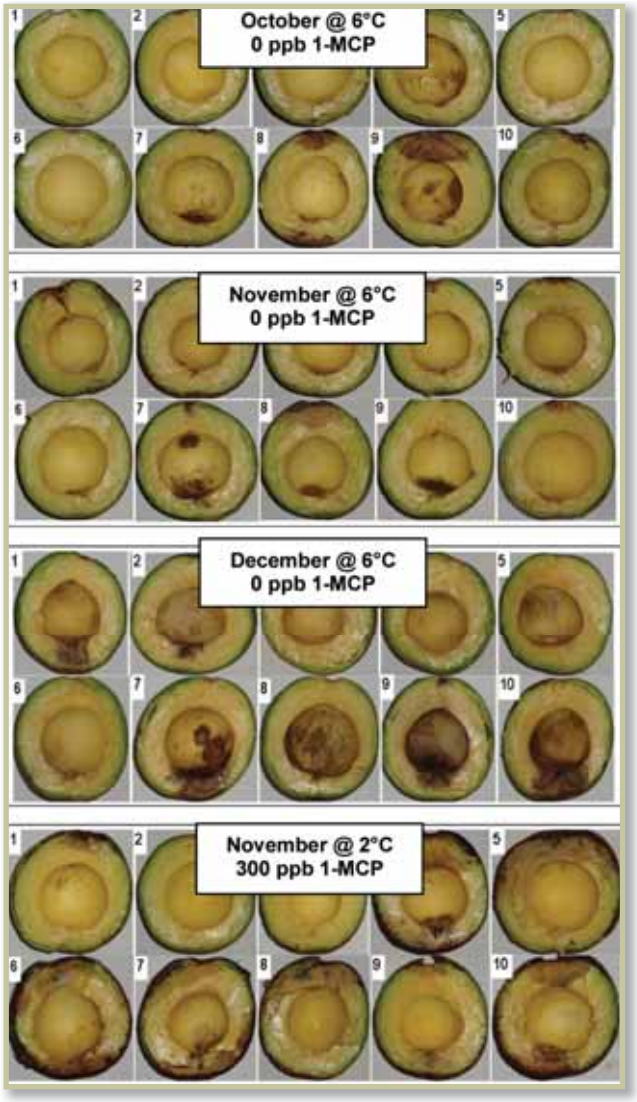

Figure 22. Internal appearance of ripened 'Reed' fruit that were sampled from October 2014 to January 2015 and stored at 6°C without 1-MCP. A sample of November fruit that were treated with 300 ppb 1-MCP and stored at 2°C is also shown for comparative purposes.

RECOMMENDATIONS

'Lamb Hass' avocado fruit from high altitude orchards:

- Can be stored for 1 month if harvested during October and November.
- The fruit must be stored at 6°C (which is a surprisingly high temperature setting for this time of season) under RA (local market) or CA (export) conditions.
- The avocados can probably be stored for 1 to 2 weeks if harvested in December and stored under local market conditions.

'Reed' avocado fruit from high altitude orchards:

- Must not be exported.
- Can be harvested during October and November, provided that they are only stored for a short period of time (a few days).
- It is recommended that the above short storage take place at 6°C or higher.

FURTHER RESEARCH

- Since completion of the current trials, two containers of 'Lamb Hass' were exported under CA conditions at 6°C to Europe during the 2015 season. Quality analyses was performed by European ripeners.
- A non-commercially-disruptive orchard trial was launched to establish what effect late hanging has on tree health and alternate bearing.
- The above trials will run for several seasons to establish what effect climatic conditions have on fruit quality.
- Feedback regarding the above trials will be presented at future SAAGA symposia and will be published in the SAAGA Yearbook.

ACKNOWLEDGEMENTS

The authors would like to thank SAAGA and the Postharvest Innovation Fund for funding the project. We are also grateful to ZZ2 for providing the fruit as well as Mark Penter for editing the manuscript.