Managing the 'Maluma' avocado's response to storage, ripening and post-ripening temperature settings

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ABSTRACT

'Maluma' is known as a fast ripening cultivar with good post-ripening storage potential. The fruit are of lower firmness than 'Hass' after harvest, probably because of the higher moisture/oil content and lower fibre content. Its respiration rate is further higher than that of 'Hass' and it needs to be placed into cool storage as soon as possible after harvest. However, the rate at which 'Maluma' loses firmness during storage is lower than that of 'Hass', especially at lower storage temperature settings. Our extrapolations have shown that the faster commercial ripening rate of 'Maluma' is due to its lower firmness after harvest, while its good post-ripening storage potential is a reaction to the low temperature used for the storage of ripened fruit. It is recommended that 'Maluma' be stored at a lower temperature than 'Hass' during export, but it is essential that the temperature only be brought down during the second half of the export period. The reason for this is that chilling injury (black cold damage) at the beginning of the storage period may cause an increase in the respiration rate, which may result in soft landings.

INTRODUCTION

The 'Maluma' avocado cultivar is a 'Hass' selection from the Limpopo province in South Africa. It has been exported to Europe for the last decade with variable results. Its most favourable attribute, speedy ripening, makes it vulnerable to soft landings. The present report aims to characterise the storage related respiration and firmness characteristics of the cultivar, identify problematic aspects and make recommendations based on the experimental results generated thus far.

General respiration and firmness trends recorded with South African avocados

When stored at a relatively high temperature (7-8°C) under regular atmosphere conditions, the respiration rates of most South African export avocado cultivars remain constant or slightly decrease during the first three weeks of storage (Lemmer *et al*., 2009; Lemmer *et al*., 2010; Lemmer & Kruger, 2011; Kruger & Lemmer, 2012). The respiration rate then rapidly increases in a curvilinear fashion (Fig. 1). Over the same period, the firmness of the fruit decreases at a constant, linear rate (Fig. 1).

Respiration rate and firmness of 'Maluma' during the first two weeks of storage

Directly after harvest, the respiration rate of 'Maluma' is considerably higher than that of 'Hass'. When comparing the results generated by Lemmer *et al* (2009) with those of Kruger & Lemmer (2012), it would appear that, when stored at a relatively high temperature (7-8°C), it takes nearly two weeks to bring 'Maluma' to a respiration rate that is comparable to that of 'Hass' (Fig. 2).

In the above trials, the firmness of the 'Hass' and 'Maluma' fruit were also taken at two-day intervals with a Sinclair non-destructive firmness meter. On day 2 the mean firmness of the 'Hass' fruit was 67 iq units while that of the 'Maluma' was significantly lower at 55 iq units. This is most probably because 'Maluma' (data not shown), together with 'Edranol' and 'Fuerte' (Kruger & Claassens, 1996), may be classified as cultivars that are high in both water and oil contents while being lower than 'Hass' in the non-oil dry component, which includes fibre (Fig. 3).

The above observations confirm the importance of placing 'Maluma' into cool storage as soon as possible after harvest (Kruger *et al*., 2017). The same applies to controlled atmosphere (Kruger *et al*., 2019). It further implies that the storage temperature must be set as low as possible.

We would, however, like to draw attention to the fact that the induction of chilling injury (generally referred to as black cold damage in South Africa) may increase the respiration rate of the fruit. The respiration rates of 'Hass' fruit stored at four different temperature settings (Lemmer *et al*., 2009) are shown

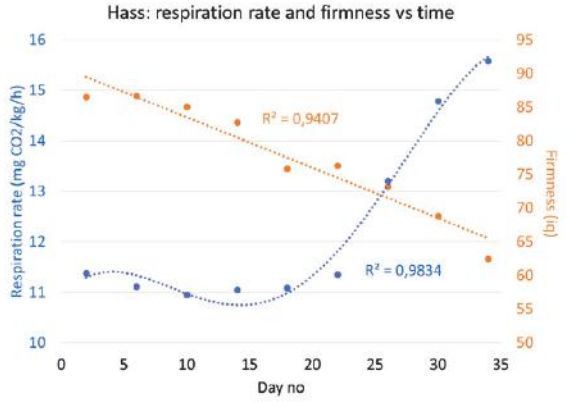

Figure 1. Respiration rate and firmness of 'Hass' avocado fruit over a one-month storage period at 7°C.

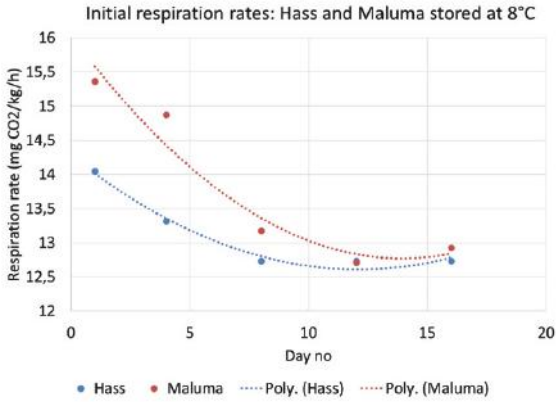

Figure 2. Comparison of the respiration rates of 'Maluma' and 'Hass' during the first two weeks of storage at 8°C.

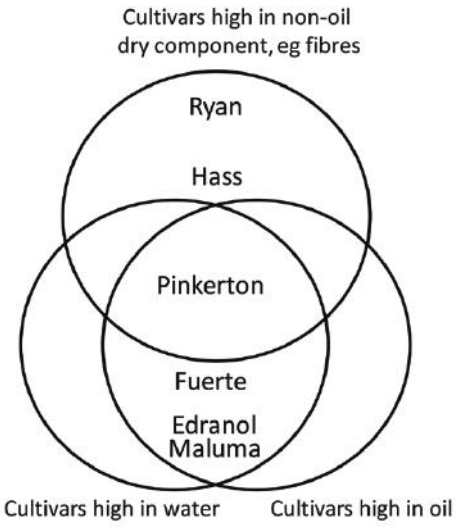

Figure 3. Grouping of 'Maluma' in relation to the other export cultivars based on its oil and moisture contents. The original classification was proposed by Kruger and Claassens (1996), while the 'Maluma' data was obtained from Dr Jurg Bezuidenhout.

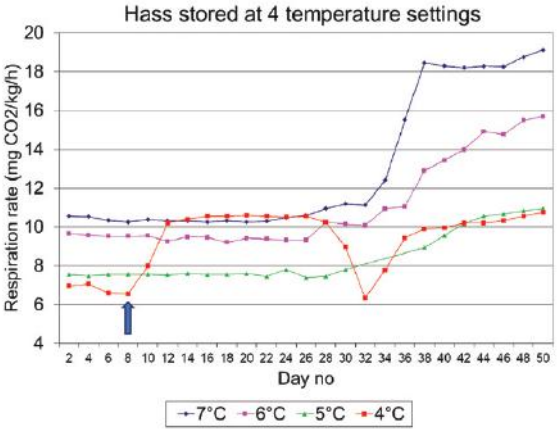

Figure 4. Respiration rates of 'Hass' stored at four temperature settings. The arrow indicates the day on which black cold damage was initiated in the 4°C treatment.

in Figure 4. The fruit stored at 4°C started to develop black cold damage symptoms after one week. At the same time, the respiration rates of the damaged fruit increased from below 7 mg CO_2/kg/h to above 10 mg CO_2/kg/h. The respiration rate only decreased to the original level after another 3 weeks of storage.

Considering the above, if black cold damage is to be induced in 'Maluma' fruit during the initial (high respiration) storage phase (Fig. 2), a further increase in respiration rate accompanied by faster softening is to be expected. During the 2018 season, certain South African exporters stored their 'Maluma' fruit at black cold damage inducing temperatures right from the start. These exporters had several soft landings.

Firmness reduction rates of 'Maluma' at different storage and ripening temperature settings

Although we found 'Maluma' to have lower firmness readings shortly after harvest, the firmness reduction rate of 'Maluma' was (surprisingly) found to be lower than that of 'Hass' during storage. When stored at 8°C, the firmness of 'Hass' reduced by 0.8 iq units per day while that of 'Maluma' dropped by 0.68 iq units per day. At 4°C the firmness of 'Hass' decreased by 0.51 iq units per day while that of 'Maluma' reduced by 0.36 iq units per day (Fig. 5).

Kruger *et al*. (2016) reported that "ready-to-eat" 'Maluma' fruit soften at a slower rate than 'Hass' when stored at 1°C after ripening. At first glance this observation would seem to contradict the industry's experience that 'Maluma' is more prone to soft arrivals than 'Hass'. It would also seem to be contrary to ripeners' experience that 'Maluma' ripens at a faster rate than 'Hass'.

However, when extrapolating the softening rates of 'Hass' and 'Maluma' stored at, respectively, 4°C and 8°C (Fig. 5), an interesting pattern evolves (Fig. 6). According to the extrapolations, 'Hass' and 'Maluma' fruit would soften at a similar rate, when stored at 20°C (representing ripening temperature). However, when kept at 1°C, 'Hass' softens at three to

four times the rate that 'Maluma' does.

Bearing in mind the processes explained in the preceding paragraphs, it is quite possible that 'Maluma' may reach the ready-to-eat stage earlier than 'Hass' but retain its firmness better than 'Hass' when stored at 1-2°C after ripening.

FURTHER RESEARCH

One of the most important storage related aspects of the 'Maluma' cultivar currently requiring research is the storage temperature regime. It is essential that the trials include regimes with an initial temperature that is equivalent to that of 'Hass' of similar maturity, but that the temperature then be stepped to a lower level towards the end of the storage period.

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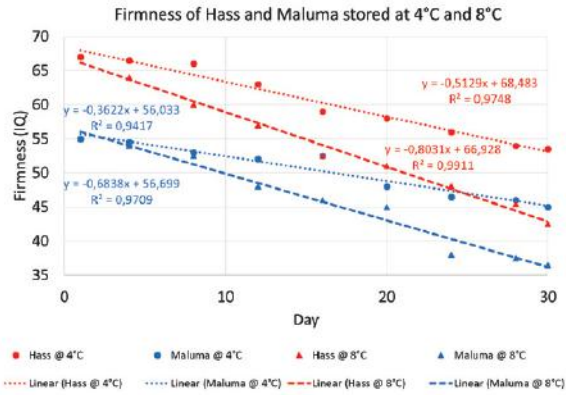

Figure 5. Firmness of 'Hass' and 'Maluma' fruit stored at two temperature settings for one month.

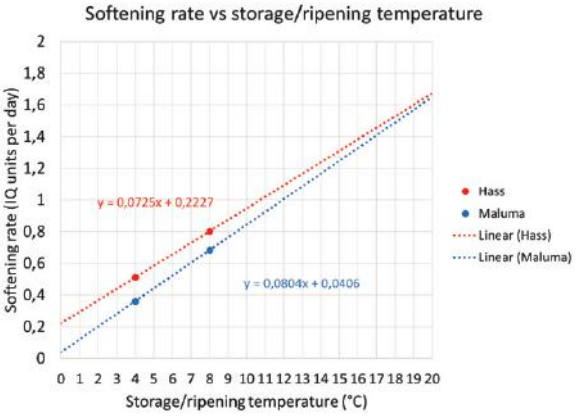

Figure 6. Extrapolation of the softening rates of 'Hass' and 'Maluma' fruit stored at, respectively, 4°C and 8°C.

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