Evaluation of different atmospheric conditioning treatments to synchronize the ripening of SmartFresh^{SM} 'Hass' avocado fruit

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ABSTRACT

When exporting avocados under regular atmosphere, the fruit often start to soften during storage. Treatment with SmartFresh^{SM} (1-methylcyclpropene) successfully delays ripening and prevents "soft landings". However, it sometimes happens that a batch of SmartFresh^{SM} fruit may ripen unevenly, which may create problems for pre-packers. Three atmospheric conditioning trials were carried out during the 2008 season, aimed at synchronising the ripening of SmartFresh^{SM} fruit. The atmospheric conditioning treatments were applied for 24 hours, following 28 days of cool storage. During one of the trials, CO_2 treatments of 10, 15 and 20% were applied. Only the 20% CO_2 atmospheric conditioning treatment was found to partly synchronise ripening. During another trial, atmospheric conditioning treatments of 20% CO_2, 2% O_2 and 2% O_2 + 20% CO_2 were carried out. The best synchronisation of ripening was obtained with the 2% O_2 + 20% CO_2 treatment.

INTRODUCTION

It sometimes happen that SmartFresh^{SM} treated fruit ripens unevenly, which is a problem for European pre-packers who need the fruit to ripen in a synchronized manner for "ready to eat" programs. Kruger (1996) measured the respiration rates of avocado fruit in closed containers and found that the climacteric peaks of fruit subjected to severe atmospheres are often synchronised. The aim of the present trial was to establish what effect ultra low O_2 and high CO_2 conditioning treatments have on the ripening of SmartFresh^{SM} treated 'Hass' avocado fruit.

MATERIALS AND METHODS

During the 2008 season, three trials with different atmospheric conditioning treatments were carried out on SmartFresh^{SM} treated 'Hass' avocados. The fruit for the first trial was obtained from the Hazyview area, those for the second from Nelspruit, while the third trial was performed in the Wartburg area. SmartFresh^{SM} was applied at the registered rate for 16 hours where after the fruit were stored at 5°C for 28 days. After cool storage the avocados were placed in airtight drums and treated with different atmospheric conditioning treatments for 24 hours at 5°C (**Table 1**) and then ripened at 20°C (**Table 2**). The evaluation parameters included the number of days to ripen (DTR), diseases (anthracnose, stem-end rot and vascular browning) and physiological disorders (diffuse mesocarp discolouration or grey pulp, chilling injury and pulp spot). Fruit for all trials had a moisture content of ca. 65%.

The first trial consisted of 72 replicates (4 boxes with

Table 1. Atmospheric conditioning treatments applied to SmartFresh^{SM} fruit during three different trials

Trial 1	Trial 2	Trial 3
Control	Control	Control
SF$^{\#}$	SF	SF
SF & 10% CO_2	SF & 2% O_2	SF & 2% O_2+20% CO_2
SF & 15% CO_2	SF & 20% CO_2	
SF & 20% CO_2	SF & 2% O_2+20% CO_2	

$^{\#}$SF = SmartFresh^{SM}

Table 2. SmartFresh^{SM} application, storage and conditioning dates for the trials carried out during 2008

Action	Trial 1	Trial 2	Trial 3
SmartFresh^{SM} application and into cold storage	24 June 2008	19 August 2008	27 October 2008
Atmospheric conditioning treatments	22 July 2008	16 September 2008	24 November 2008
Moved from cold storage to 20°C	23 July 2008	17 September 2008	25 November 2008

18 fruit each) per treatment, the second trial had 80 replicates (5 boxes with 16 fruit each) per treatment, and the third trial 240 replicates (15 boxes with 16 fruit each) per treatment. Statistically significant differences were calculated using a student's t-test. The data recorded for anthracnose, stem-end rot, vascular browning and grey pulp did not display a normal distribution and were therefore subjected to logarithmic transformation before applying the student's t-test.

RESULTS AND DISCUSSION

Trial 1
The ripening patterns of the fruit are shown in **Figure 1**. In case of the regular atmosphere control, approximately 5% of the fruit were already at the ready to eat stage two days after removal from 5°C (**Figure 1**). Under commercial conditions, these fruit would have landed soft. The SmartFresh[SM] treatment on the other hand delayed ripening effectively for six days where after some fruit started to ripen (**Figure 1A**). Both the control treatment and the SmartFresh[SM] fruit displayed two distinct peaks. The first peak of the control treatment was larger than the second peak, while the reverse was true for the SmartFresh[SM] treatment (**Figure 1A**). The 10 and 15% CO_2 conditioning treatments were ineffective in synchronizing the ripening patterns of the avocados (**Figure 1B** and **C**). However, with the application of a 20% CO_2 conditioning treatment, the second ripening peak was significantly reduced, while the first ripening peak was significantly increased (**Figure 1D**). From these results it could be deduced that synchronization in ripening may occur at relatively high CO_2 concentrations.

The occurrence of internal diseases was significantly lower in the SmartFresh[SM] fruit compared to the con-
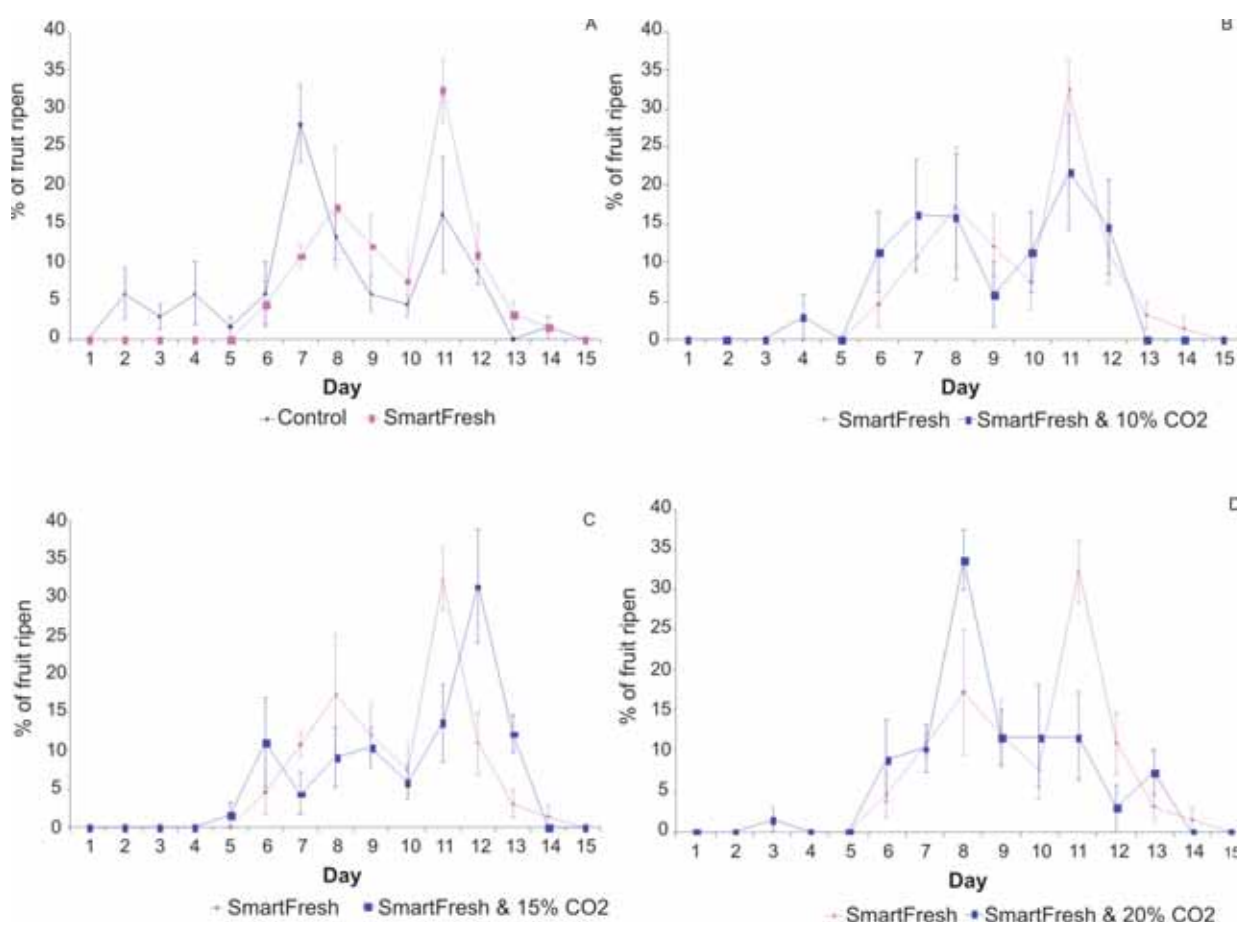

Figure 1. Ripening patterns of the control, SmartFresh[SM], and SmartFresh[SM] + atmospheric conditioning treatments applied during trial 1

Table 3. Diseases and disorders recorded during trial 1

Treatment	Anthracnose (0-5)	Stem-end rot (0-5)	Vascular browning (0-5)	Grey pulp (0-5)
Regular atmosphere (control)	0.53 a[#]	0.68 a	0.50 a	0.07 a
SmartFresh[SM]	0.03 b	0.03 cd	0.03 c	0.00 a
SmartFresh[SM] & 10% CO_2	0.00 b	0.00 d	0.01 c	0.00 a
SmartFresh[SM] & 15% CO_2	0.02 b	0.14 c	0.08 bc	0.00 a
SmartFresh[SM] & 20% CO_2	0.03 b	0.25 bc	0.18 b	0.00 a

[#]Means followed by the same letter do not differ significantly at P = 0.05

trol (**Table 3**). This can most probably be ascribed to the partial softening of the fruit during the 28 days cold storage period. No grey pulp occurred in this trial (**Table 3**).

Trial 2

In this trial, the control fruit ripened as a single peak on day 7, while the SmartFresh[SM] fruit displayed two larger and two smaller ripening peaks (**Figure 2A**). Again, SmartFresh[SM] fruit ripened significantly later than regular atmosphere (control) fruit (**Figure 2A**). The addition of a low O_2 (2%) atmospheric conditioning treatment caused significantly more fruit to ripen on days 7 to 9, implying slightly earlier ripening (**Figure 2B**). With the application of the 20% CO_2 atmospheric conditioning treatment, slightly earlier ripening was obtained again, but no synchronisation of ripening was induced with this treatment (**Figure 1C**). When a com-

bination of 2% O_2 + 20% CO_2 was used, very effective synchronisation of ripening was obtained (**Figure 1D**). Approximately 55% of the fruit ripened on day 10 and approximately 90% within a five day period (**Figure 1D**). This application was therefore the most promising treatment and it was decided to repeat it for the third trial. Due to the high quality fruit used in this trial, virtually no diseases occurred and grey pulp was absent (**Table 4**).

Trial 3

As mentioned in the materials and methods section, a mixture of 2% O_2 + 20% CO_2 was supposed to be used in this trial. The gas mixture was prepared by a local gas company and the cylinder transported from Nelspruit to Wartburg. When measuring the concentrations at the pack house in Wartburg, the actual concentrations were 13.5% CO_2 and 2.4% O_2. The substantially
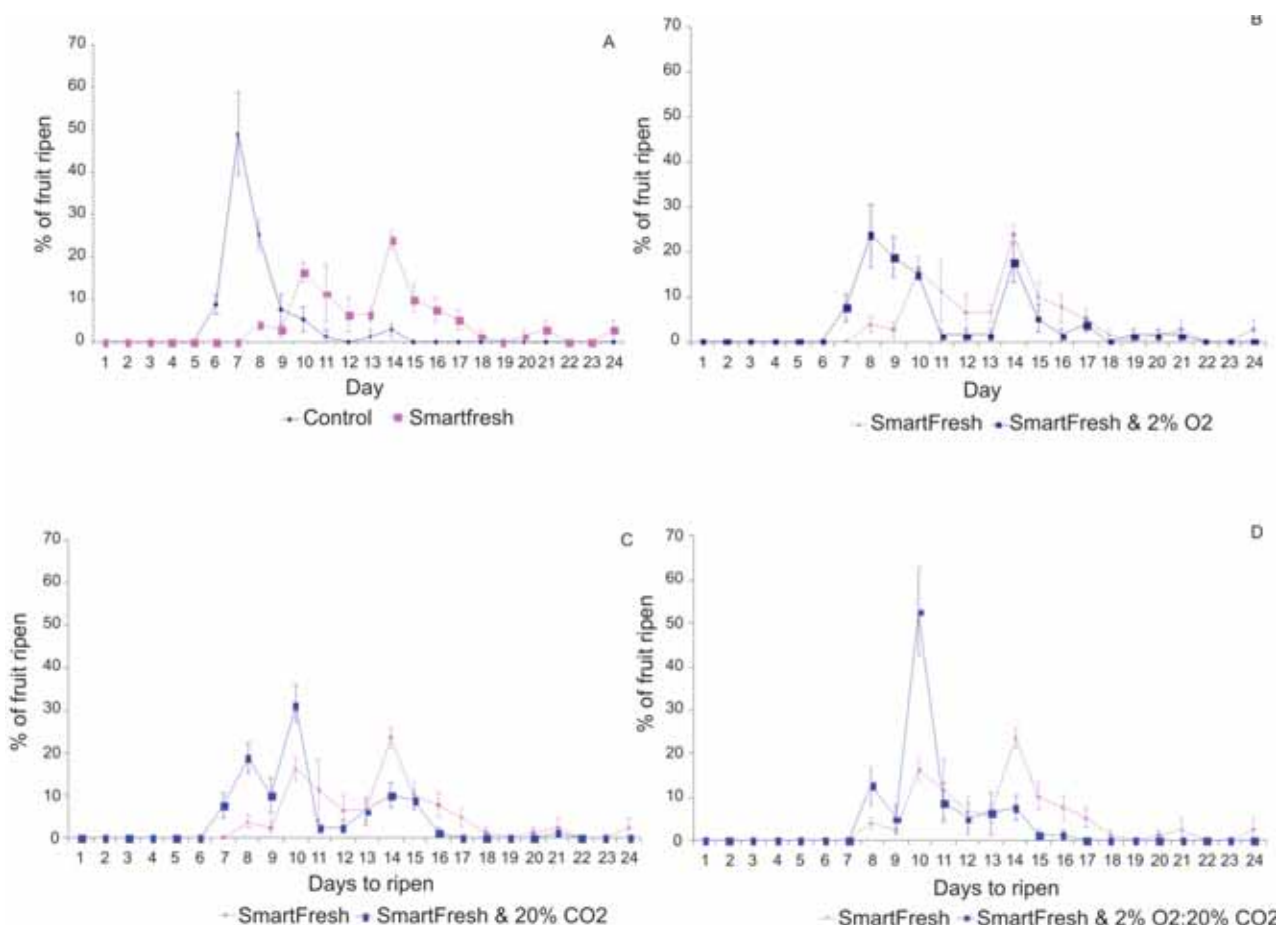

Figure 2. Ripening patterns of the control, SmartFresh[SM], and SmartFresh[SM] + atmospheric conditioning treatments applied during trial 2

Table 4. Diseases and disorders recorded during trial 2

Treatment	Anthracnose (0-5)	Stem-end rot (0-5)	Vascular browning (0-5)	Grey pulp (0-5)
Regular atmosphere (control)	0.01 a[#]	0.00 a	0.00 a	0.00 a
SmartFresh[SM]	0.01 a	0.00 a	0.00 a	0.00 a
SmartFresh[SM] & 2% O_2	0.00 a	0.00 a	0.00 a	0.00 a
SmartFresh[SM] & 20% CO_2	0.01 a	0.00 a	0.00 a	0.00 a
SmartFresh[SM] & 2% O_2:20% CO_2	0.00 a	0.00 a	0.01 a	0.00 a

[#]Means followed by the same letter in each column do not differ significantly at P = 0.05

lower CO_2 and slightly higher O_2 concentrations in this prepared mixture could have resulted in the reduced effect recorded in this trial (**Figure 3**).

The occurrence of stem-end rot and vascular browning did not differ significantly between the treatments, but SmartFresh[SM] treated fruit had a slightly higher occurrence of anthracnose than the control (**Table 5**). A significantly higher occurrence of grey pulp was recorded in the control (**Table 5**). These were late season fruit and grey pulp is usually evident in late season fruit. The SmartFresh[SM] and the SmartFresh[SM] and 2% O_2 + 20% CO_2 treatments had no grey pulp, which implies that SmartFresh[SM] prevented the occurrence of grey pulp.

CONCLUSIONS

SmartFresh[SM] delayed the ripening of 'Hass' avocado fruit significantly when compared with the control.

However, SmartFresh[SM] fruit often ripened unevenly. Atmospheric conditioning treatments in the order of 2% O_2 and 20% CO_2 applied after the 28 day storage period, effectively synchronised the ripening of SmartFresh[SM] fruit. Although the results are promising, another season's trials are necessary to confirm these results.

LITERATURE CITED

KRUGER, F.J. 1996. Pilot study on the respiration patterns of the major South African export avocado cultivars. *South African Avocado Growers' Association Yearbook*, 19: 96-99.
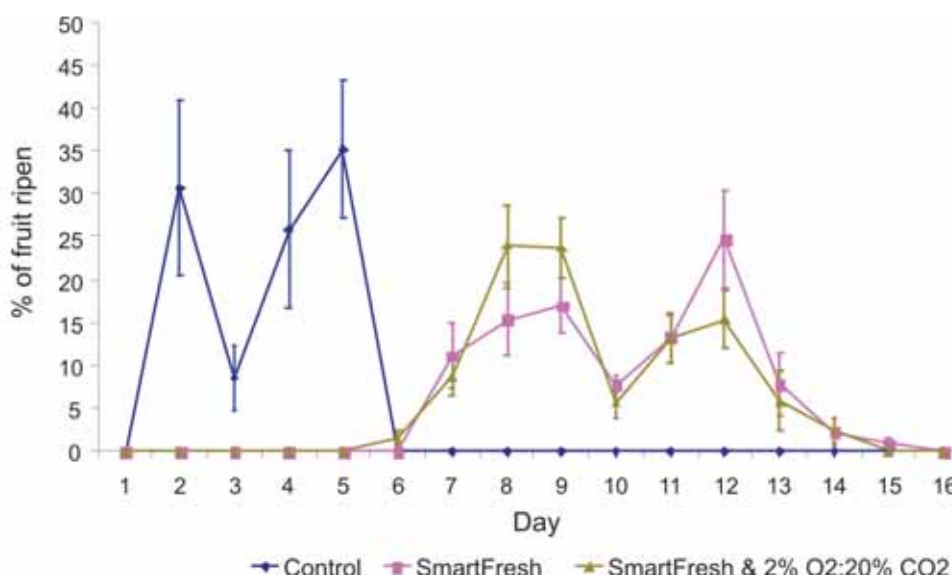
Figure 3. Ripening patterns of the control, SmartFresh[SM], and SmartFresh[SM] + atmospheric conditioning treatment applied during trial 3

Table 5. Diseases and disorders recorded during trial 3

Treatment	Anthracnose (0-5)	Stem-end rot (0-5)	Vascular browning (0-5)	Grey pulp (0-5)
Control	0.19 b[#]	0.42 a	0.23 a	0.31 a
SmartFresh[SM]	0.41 a	0.63 a	0.25 a	0.00 b
SmartFresh[SM] & 2% O_2:20% CO_2	0.32 ab	0.83 a	0.44 a	0.00 b

[#]Means followed by the same letter in each column do not differ significantly at P = 0.05