# Further investigations into the rind lesion problems experienced with the 'Pinkerton' cultivar

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**ABSTRACT**
Before the start of the 2012 season, a set of storage temperature recommendations were made for the 'Pinkerton' cultivar. It was proposed that early season fruit be exported at a 9.5°C to 9°C to 8.5°C storage regime while mid-season fruit should be exported using a 9°C to 8.5°C to 8°C protocol. It was further recommended that the latter regime also be used for late season fruit with the addition of further steps until a final temperature of 6°C is reached. Analyses of industry based and laboratory generated data during the 2012 season indicated that the above recommendations generally gave acceptable results in so far as chilling injury (black cold damage) is concerned. Rind senescence was found to predominantly occur in fast maturing fruit from late season orchards. It is essential that producers and exporters conform to the pre-harvest maturity and mineral content norms formulated for this cultivar during the late nineties. It is also important that current postharvest fungicide recommendations be closely followed.

**INTRODUCTION**
During the last number of seasons certain pack houses have reported an increase in the incidence of lesions occurring on the rind of the 'Pinkerton' cultivar. Fruit from one particular pack house that pack late season fruit, were particularly prone to these disorders. A survey conducted at this pack house during the 2011 season (Kruger, 2012) revealed two types of lesions to be present, namely chilling injury and rind senescence.

In order to reduce the incidence of chilling injury, two new storage temperature regimes were introduced during 2012, namely AVK (9.5°C to 9°C to 8.5°C) and AV9 (9°C to 8.5°C to 8°C). It was further recommended that the storage temperature of late season 'Pinkerton' fruit be further stepped to 6°C in order to slow down rind senescence during storage.

During the 2012 season, two research approaches were followed. The AVK and AV9 temperature regimes were firstly evaluated under experimental conditions. Secondly, quality control (QC) feedback, obtained from the most important 'Pinkerton' exporters, was analysed.

**MATERIALS AND METHODS**

**Late season experimental trials**
Fifteen 'Pinkerton' orchards were selected in the Schagen area. Moisture content (MC) analyses were performed at regular intervals during a one month period prior to harvest. This was followed by storage trials with fruit from five orchards (three cartons per treatment) over a 30 day period. The storage regimes followed are shown in Table 1. The fruit were evaluated for rind lesions directly after storage and again after ripening.

Fruit mineral analyses were conducted during November 2012. (Although this was performed on the following season's fruit, it still served as a useful indicator of fruit quality.)

**Exporter survey**
The QC records of five export companies were analysed. Particular attention was paid to chilling injury and rind lesions. Attention was also paid to the temperature recordings made during storage. Where possible, pack house records of the fruit cooling rate directly after packing were also scrutinised. An attempt was also made to trace the consignments back to orchard level.

**RESULTS AND DISCUSSION**

**Late season experimental trials**
The maturation rates of the fifteen experimental orchards are shown in Fig. 1. Thirteen of the orchards matured at a preferred slow maturation rate (approximately 1% per two week period), while two or-

chards (orchards 1 and 14) matured at a faster rate (approaching 1% per week).

Fruit from the above two fastest maturing orchards, as well as the three slower maturing orchards, were used for the storage trials. The harvest dates of the five orchards are plotted in relation to fruit maturity in Fig. 2. As may be deduced from the figure, the two fastest maturing orchards were harvested at MC levels between 70 and 71%, while the three slower maturing orchards were harvested between 73 and 76%.

In Fig. 3 the five orchards are ranked according to the incidence of rind lesions (1 represents the best orchards and 5 the worst). The two fastest maturing orchards had the most rind lesions (orchards 4 and 5), especially when stored at the higher storage temperature regimes. The reason for this is that fruit from the more mature orchards were more susceptible to rind senescence, while the less mature orchards exhibited chilling injury symptoms only.

The external appearance of a set of fruit from one of the faster maturing orchards is shown in Fig. 4. When closely studying the figure, it is apparent that chilling injury only occurred at the 6°C storage temperature, while rind senescence predominantly occurred at the higher storage temperature regimes. It is extremely important to take note that the photo was taken directly after storage and that the fruit from the storage regimes that did not show any lesions, *e.g*. 8°C, did develop significant lesions during ripening. This implies that a lower storage temperature regime only serves to slow down the rate at which rind senescence symptoms develop and do not prevent them. The primary problem at late season 'Pinkerton' pack houses is thus that they harvest the fruit too mature. Storage temperature is thus only of secondary importance when it comes to rind senescence. In order to reduce rind senescence and grey pulp symptoms, it is essential that producers apply the pre-harvest maturity and fruit mineral content

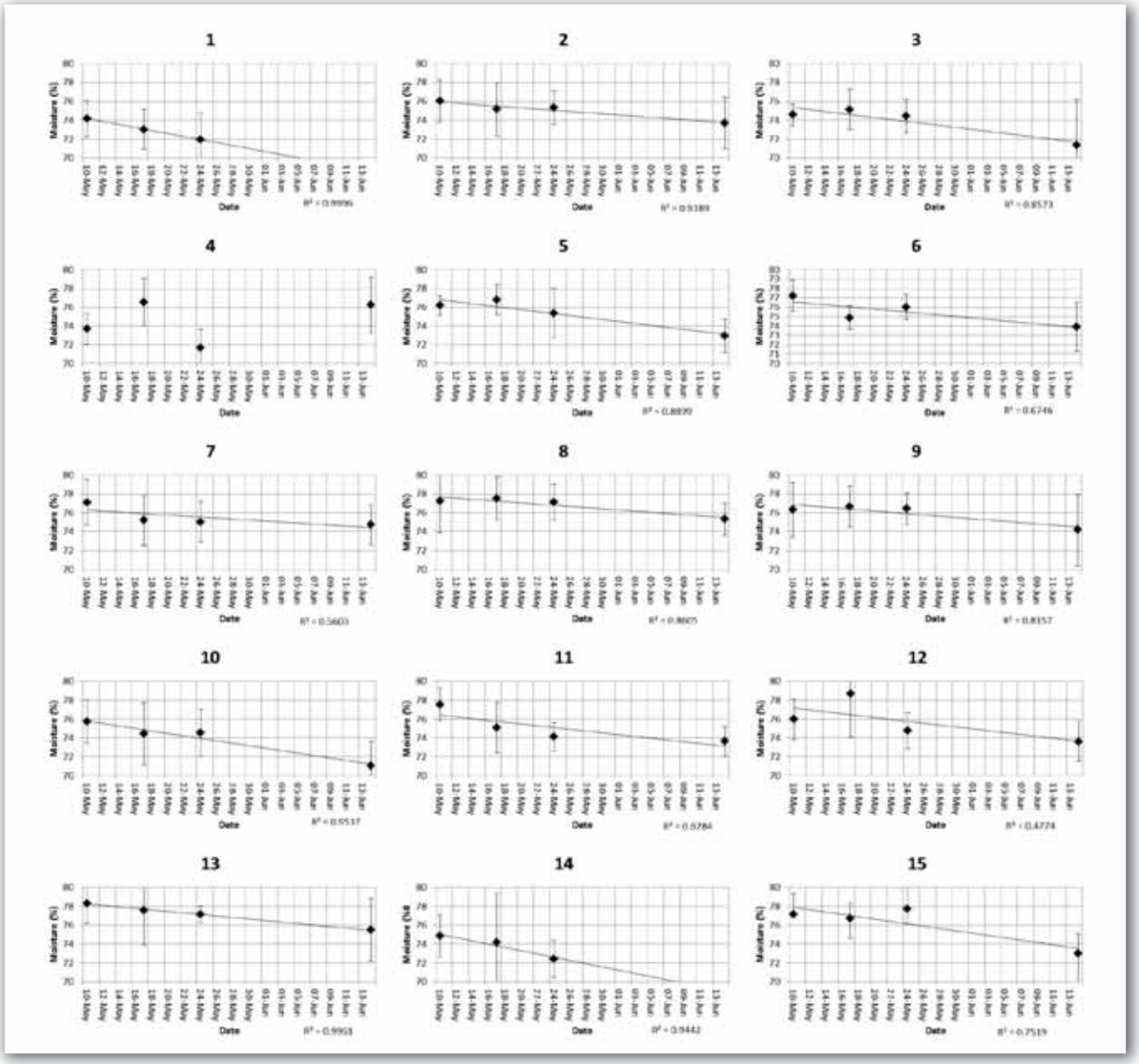


**Figure 1.** Maturation rate of 15 'Pinkerton' orchards in the Schagen area during the 2012 season.

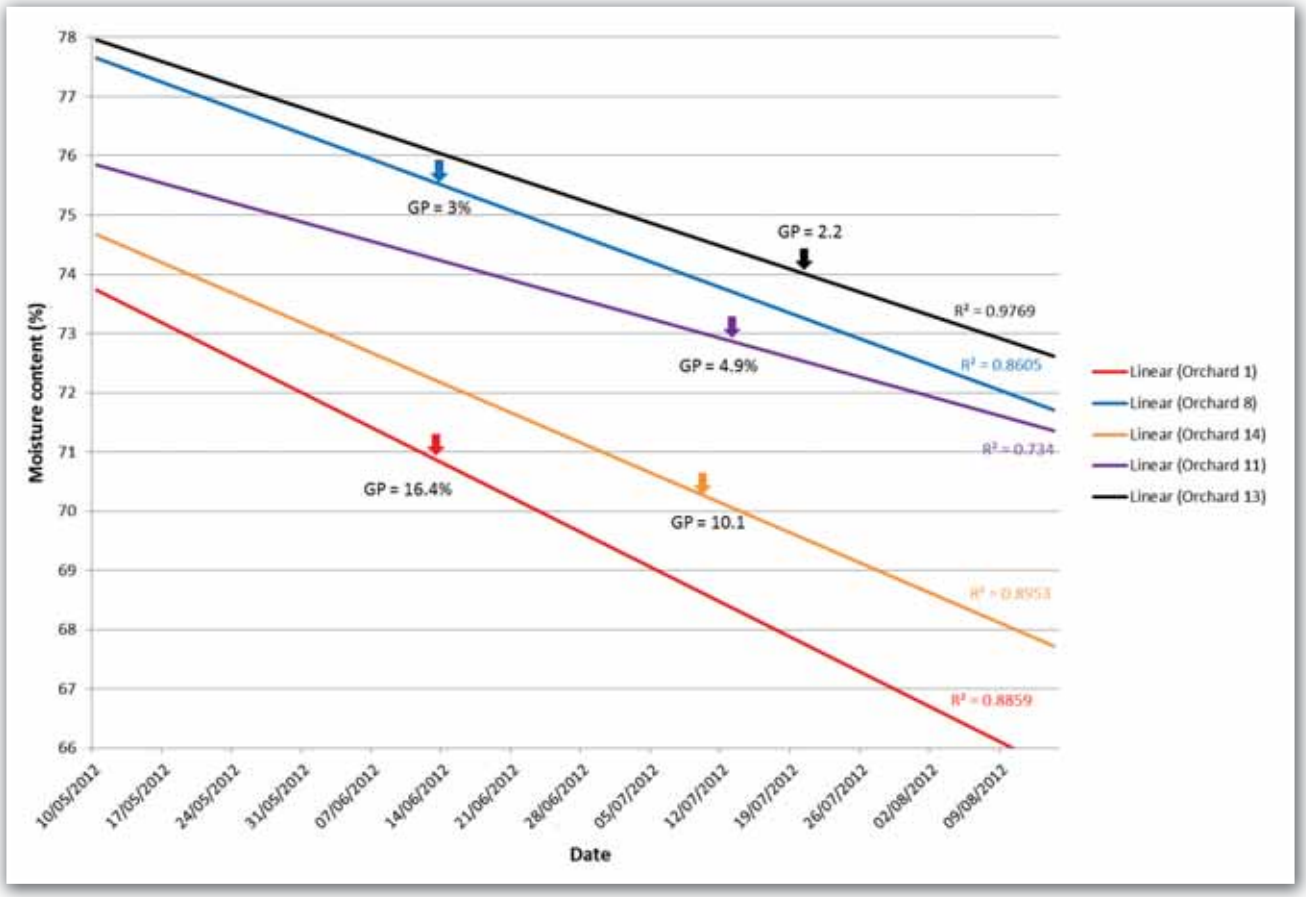


**Figure 2.** Harvest date (arrows) and grey pulp (GP) incidence in relation to maturation rate of five 'Pinkerton' orchards in the Schagen area during the 2012 season.

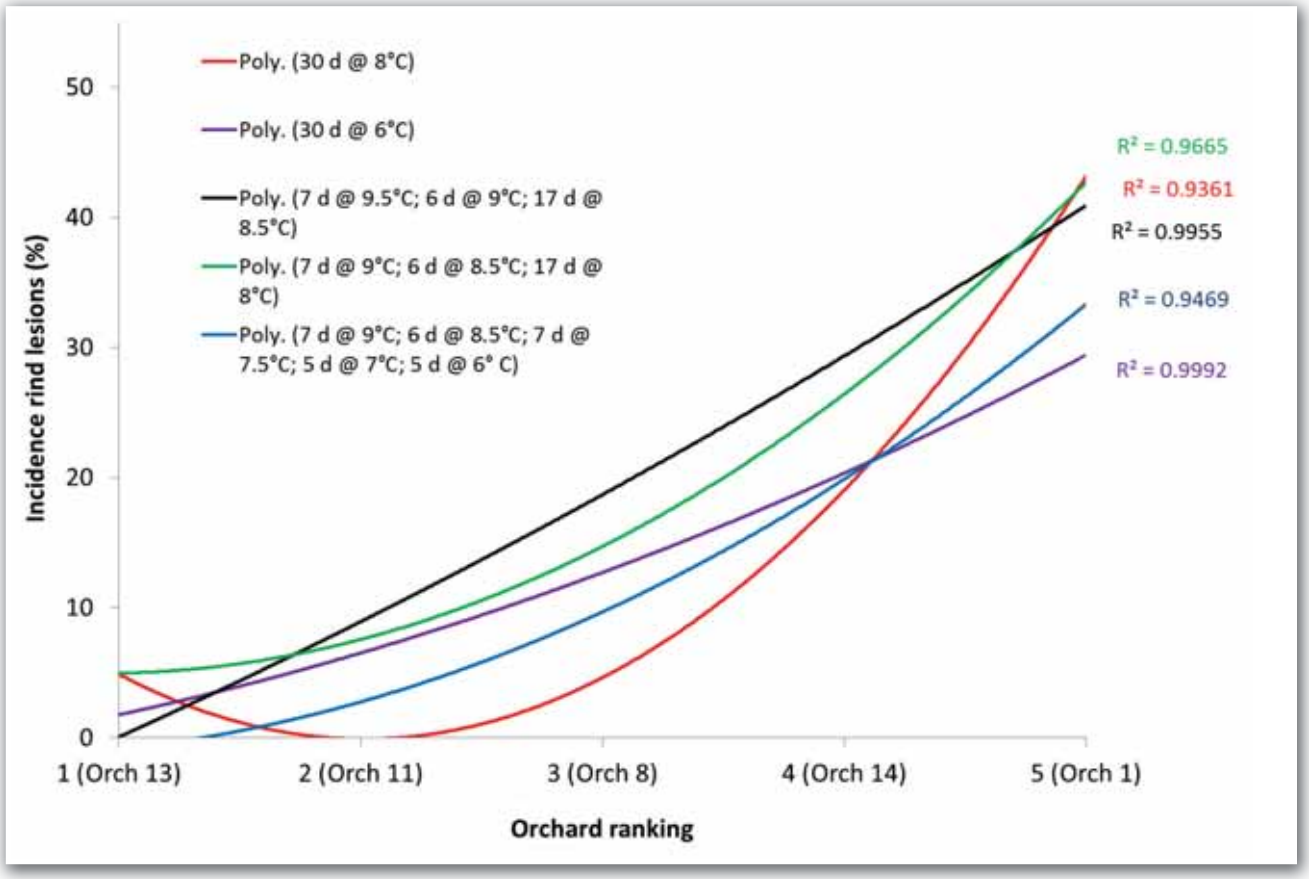


**Figure 3.** Relationship between orchard ranking and incidence of rind disorders of 'Pinkerton' fruit when stored at five different storage temperature regimes.

recommendations formulated for this cultivar at the turn of the century.

The mineral analysis data revealed that all orchards were within the prescribed fruit pulp nitrogen bracket. The reason why fruit from the two problematic orchards matured at a faster rate, was most probably due to the tree load being lower. Since the senescence lesions were often associated with fungal infections, it is critical that current postharvest fungicide recommendations be closely observed.

**Exporter survey**

Since detailed pre-harvest background information was available for the above late season pack house, special attention was paid to its QC records. An effort was made to identify Reefers that contained identical fruit loads and were packed on the same date but exported under different temperature conditions. A case study complying with these prerequisites is shown in Table 2. Fruit from four high quality pre-monitored orchards were exported under the regimes shown in Table 2. The most important difference between the two storage regimes concerns the initial cooling rate. Container 1 was stepped from 15 to 10°C on the first day and from 10 to 8°C on the second, while container 2 was directly cooled from 17 to 6°C on day one. In terms of the rest of the voyage it is interesting to note that, in both cases, the exporter gradually adjusted the setting to reach a final holding temperature of 4.5°C, which is exceptionally low for the 'Pinkerton' cultivar. In the case of Container 1 this was done at regular intervals, while it was a gradual process with Container 2. In container 1, chilling injury was below 3% in the fruit of all four orchards. With container 2, three of the orchards were below 3%, while the fourth was as high as 10%. This would seem to confirm the beneficial effect attained by gradually cooling 'Pinkerton' fruit directly after packing.

In so far as the other exporters are concerned, the

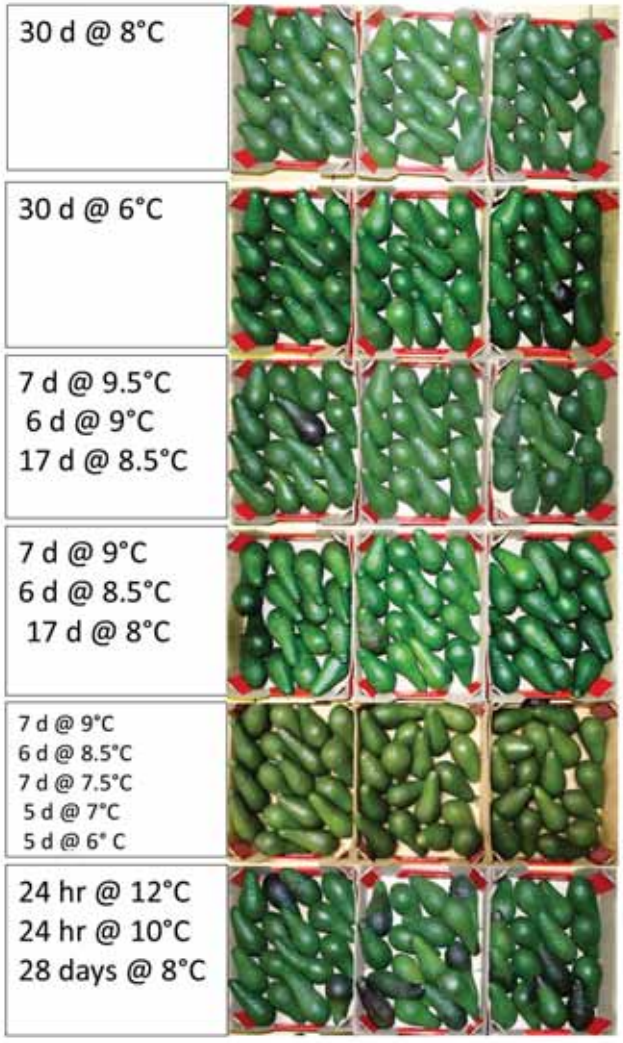


**Figure 4.** External appearance of 'Pinkerton' fruit from a fast maturing orchard (Orchard 14) directly after storage at six different storage temperature regimes.

**Table 1.** Storage temperature regimes under which late season 'Pinkerton' fruit were stored.

| Storage regime no | PPECB code | Temperature and period details |
|---|---|---|
| 1 | AVD | 30 days at 8°C |
| 2 | AVB | 30 days at 6°C |
| 3 | AVK | 7 days at 9.5°C<br>6 days at 9°C<br>17 days at 8.5°C |
| 4 | AV9 | 7 days at 9°C<br>6 days at 8.5°C<br>17 days at 8°C |
| 5 | AV9 with further steps | 7 days at 9°C<br>6 days at 8.5°C<br>7 days at 7.5°C<br>5 days at 7°C<br>5 days at 8°C |
| 6 | AVD with pre-cooling | 24 hours @ 12°C<br>24 hours @ 8°C<br>28 days @ 8°C |

**Table 2.** Incidence of chilling injury in two shipping containers packed with the same fruit and on the same day and exported on the same ship (Lars Maersk 125b) at two storage temperature regimes during August 2012.

| Storage regime per container | Chilling injury (%) | | | |
|---|---|---|---|---|
| | Orchard A | Orchard B | Orchard C | Orchard D |
| First day from 17°C to 6°C<br>Gradual steps from 6°C to 4.6°C over next 3 weeks | < 3 | < 3 | < 3 | < 10 |
| First day from 15°C to 10°C<br>Second day from 10°C to 8°C<br>Gradual steps from 8°C to 4.6°C over next 3 weeks | < 3 | < 3 | < 3 | < 3 |

records of five exporters operating from seven pack houses were studied. A great deal of variation existed regarding the selection of temperature regimes. One pack house used the newly formulated AVK and AV9 regimes, whilst another exported everything at 8°C. A third company used a step down from 8 to 7°C, while a fourth exporter stepped the fruit from 7 to 6°C. The results were quite variable and the higher storage temperatures did not necessarily result in less chilling injury. One aspect that was shown to require further research, concerns the rate at which the fruit is cooled directly after packing. From the survey it would appear that pack houses that cooled the fruit at the slowest rate, had the best results.

**FURTHER RESEARCH**

The research to be conducted during the 2013 season will focus on the cooling rates at which the fruit are cooled by the different pack houses. To do this, pack house managers must ensure that temperature recorders are inserted in the cartons directly after packing and not, as is presently the case, prior to loading the pallets into the refrigerated truck/container. By doing this, the initial cooling rate will be recorded. The researchers will work in close co-operation with all exporters and record the chilling injury feedback throughout the season.

**ACKNOWLEDGEMENTS**

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**REFERENCES**

KRUGER, F.J. 2012. Investigation into the current rind lesion problems experienced with the Pinkerton cultivar. *South African Avocado Growers' Association Yearbook* 35: 42-44.