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The use of calcium for fruit quality improvement in Pinkerton avocados

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ABSTRACT

Over the past two seasons the question of poor fruit quality in Pinkerton avocados has received much attention. There is considerable reluctance to abandon the cultivar, due to its ability to produce large yields of good sized fruit. However, the ongoing occurrence of internal quality problems is leading to consumer resistance to this cultivar on the European market. Intensive studies have shown that a number of factors contribute to this problem, including fruit maturity, soil types, climate, tree age and mineral nutrition. Initially, it was thought that calcium may play an important role in avocado quality and this received considerable attention. In the previous season it was shown that both pre-harvest and post-harvest calcium applications can improve fruit quality. It was also shown that some of the calcium-containing products are more effective than others and that application timing seems to play a significant role. Furthermore, there were indications that other factors, such as correct harvesting time, interact with calcium application to affect fruit quality. In the current season, these factors were all examined in more detail. In addition, a number of new products were tested. This publication examines the findings of the current season and examines the areas which still need some attention in order solve the 'Pinkerton problem'.

INTRODUCTION

While a number of factors play a role a role in fruit quality, many instances of poor quality can be related back to deficiencies of certain minerals during fruit development. Although a range of minerals have an effect on fruit development and quality, the one that has received the most attention in this field is calcium. It was first shown in the 1930's and 1940's that low calcium levels were directly associated with a variety of internal disorders in certain fruits and vegetables (Shear, 1975). Since then, low calcium levels have been positively linked with disorders such as bitter pit, cork spot, internal breakdown and lenticel breakdown in apples; blossom-end rot in tomatoes, watermelons and peppers; blackheart in celery; internal browning in Brussels sprouts and cracking in cherries and prunes – as summed up in a review of this topic by Shear (1975).

Calcium has two main functions which impact on fruit quality:

1. Calcium stabilises cell membranes
2. Calcium strengthens cell walls (Poovaiah *et al.*, 1988).

According to Kirkby and Pilbeam (1984), tissues high in calcium have stronger cell walls and resist infection more readily. They are also more resistant to membrane leakage, which would otherwise allow ortho-dioxy-phenols from the vacuole to leak into other cellular compartments where they undergo oxidation, giving the brown flesh colour seen in poor quality fruit (van Rensburg & Engelbrecht, 1986; Bangerth *et al.*, 1972).

A review by Bower & Cutting (1988) indicates that low calcium levels may play a role in the internal disorders seen in avocados. The primary disorder occurring in post-harvest fruit is a discoloration of the mesocarp, referred to as grey pulp. This condition is aggravated by cold storage. The relationship between fruit quality and calcium is further supported by a survey carried out in New Zealand (Thorp *et al.*, 1997). This study showed that fruit with the lowest calcium levels had the highest incidence of internal disorders. Further evidence is provided by Cutting *et al.* (1992), who established a relationship between late harvesting, low calcium and poor post-harvest quality in South African fruit.

A number of researchers have shown that post harvest calcium applications in avocados can increase fruit calcium levels, resulting in lower respiration and ethylene production rates, better fruit quality and longer ripening times (Tingwa & Young, 1974; Wills & Tirmazi, 1982; Eaks, 1985). Furthermore, van Rensburg and Engelbrecht (1985) have shown that post harvest calcium applications decrease the levels of the components responsible for flesh browning. Trials carried out in recent years (Penter, 1999; Penter & Stassen, 1999; Penter & Stassen, 2000) have shown that both pre-harvest and post-harvest applications of calcium can improve fruit quality. These trials made use of organically complexed calcium products, formulated to give improved calcium uptake and minimal phytotoxicity. The results indicated that these products could reduce grey pulp and vascular browning, increase fruit firmness and even reduce the extent of anthracnose infection. The current report examines the ongoing work involving these products.

METHODS AND MATERIALS

Orchard applications

This trial was carried out in an orchard planted on high potential soils in the Kiepersol area of Mpumulanga province.

Treatments were as follows:

1. Control
2. Calcium Dextrolac 2 L/ha
3. Calcimax 1%
4. Basfoliar Calcium 4 L/ha
5. Caltrac 4 L/ha
6. Stopit 0.5%
7. Calcium Metalosate 1%
8. Lignofeed calcium 1%

Application rates were approximately 1000 L/ha of spray solution. A Wetter (Foliwett 9000) was used at 15 ml/100L. Each treatment comprised 16 single-tree replicates.

Applications were made at the following times:

1. Full flower
2. Early set
3. Six weeks after set
4. Ten weeks after set
5. Four weeks before harvest

Fruit were harvested at two dates – one near the beginning of the harvesting season and one near the end. The first harvest coincided with a fruit moisture content of 78%, and the second with a fruit moisture content of 74%. After harvest, fruit were washed, waxed and stored at 6°C for 28 days. They were then ripened at room temperature and evaluated when ripe.

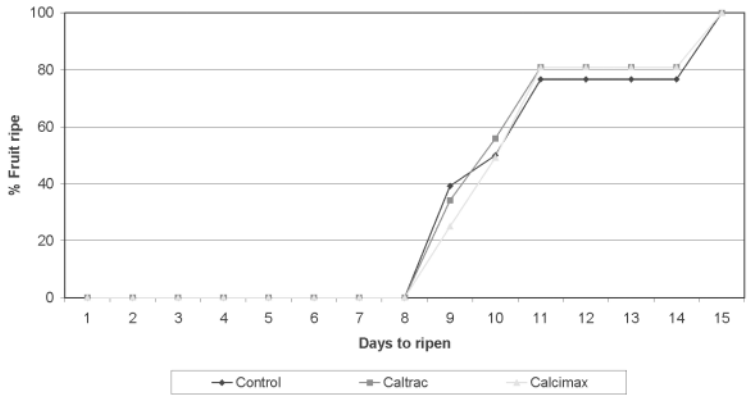


Figure 1 The effect of calcium on ripening in Pinkerton fruit (78% moisture)

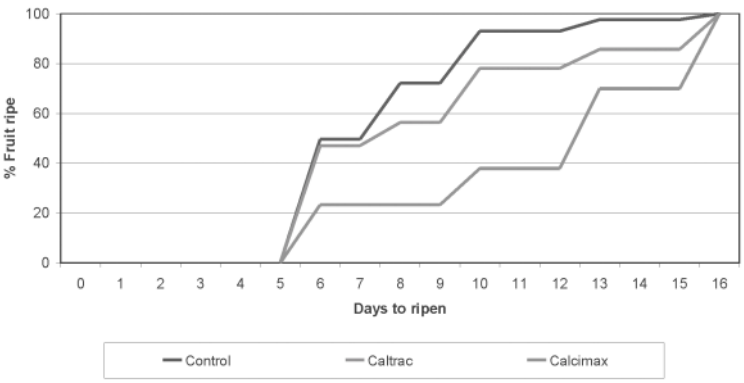


Figure 2 The effect of foliar calcium applications on fruit ripening in Pinkerton avocados (74% moisture)

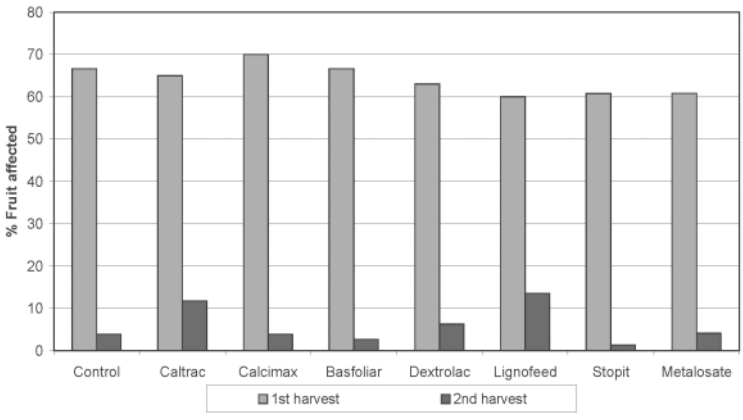


Figure 3 Incidence of black cold in Pinkerton fruit treated with various calcium-containing products

Postharvest applications

This trial was set up using Pinkerton fruit from an orchard adjacent to the one where the spraying trials were conducted. Treatments were incorporated into the standard post-harvest protocols as follows:

1. Wash in HTH bath
2. Rinse in water
3. Immerse in calcium solution
4. Allow to air dry
5. Wax fruit
6. Store at 6°C for 28 days
7. Ripen at room temperature and evaluate when ripe

Treatments were as follows:

1. Control
2. 0.5% Calcimax 5 minutes
3. 0.5% Calcimax 10 minutes
4. 1.0% Calcimax 5 minutes
5. 1.0% Calcimax 10 minutes
6. 3.0% Calcimax 5 minutes
7. 3.0% Calcimax 10 minutes

Each treatment comprised six replicates of twelve fruit.

RESULTS AND DISCUSSION

The most noticeable differences in the current trial were those between different harvesting dates. Figures 1 and 2 show the effect of calcium on ripening rate for the first and second harvest respectively. In Figure 1 it can be seen that the less mature fruit started to ripen after 8 days at room temperature. Once ripening started, there was not much difference between the treatments. After 1 week all of the fruit were ripe. For the more mature fruit (Figure 2), ripening started after 5 days at room temperature. In this batch of fruit, the effect of calcium was apparent. By day six 50% of the control fruit were ripe, while 90% were ripe by day 10. In contrast, it took 13 days for 50% of the fruit treated with Calcimax to ripen and 15 days for 90% to ripen. The fruit treated with Caltrac had a ripening curve between those of the controls and Calcimax-treated fruit. Thus, calcium treatments gave a clear increase in shelf life for fruit picked at a more mature stage.

In terms of internal disorders, fruit maturity again played an important role. As shown in Figure 3, black cold injury was much more prevalent in the

less mature fruit than in the fruit harvested at 74% moisture. For each harvesting date, the incidence of black cold varied slightly between treatments. However, the differences were small and none of the calcium products gave a clear reduction in the disorder relative to the controls. Figure 4 shows the incidence of grey pulp amongst the various treatments. As for the previous season (see Penter & Stassen, 2000), Caltrac and Calcimax seemed to give the best results, with a 30% reduction in the incidence of grey pulp in the more mature fruit. Again there was a difference between the fruit of differing maturity, this time with the more mature fruit having a higher incidence of the disorder. In the less mature fruit, none of the treatments offered any significant improvement over the controls.

For the post-harvest treatments, there were no significant trends in the data with regard to either the length of dipping time or the strength of the dipping solution. Figure 5 shows the incidence of grey pulp in fruit dipped in various solutions. It can be seen that there is considerable variation in the data, with none of the dips giving a significant improvement in fruit quality. Figure 6 shows that there was also considerable variation in the incidence of cold injury, with only one treatment giving a marked improvement in quality. In both of these figures, it must be noted from the vertical scale that the extent of the disorders was much lower than the fruit used in the spraying trial.

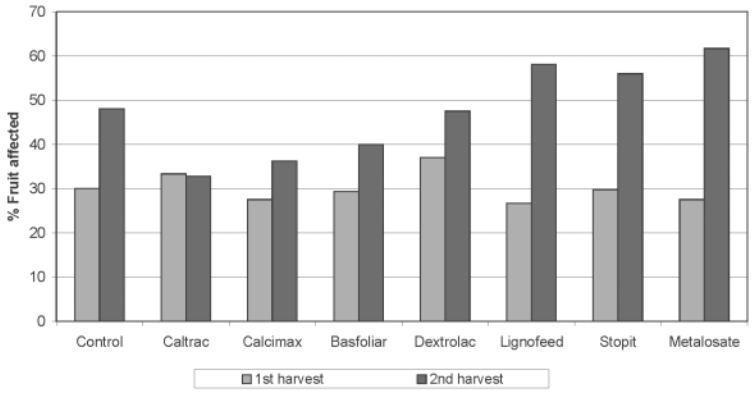


Figure 4 Incidence of grey pulp in Pinkerton fruit treated with various calcium-containing products

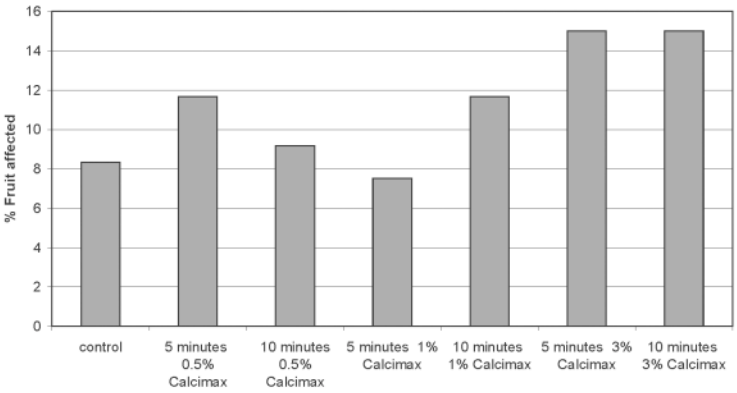


Figure 5 Incidence of grey pulp in fruit dipped in various calcium solutions

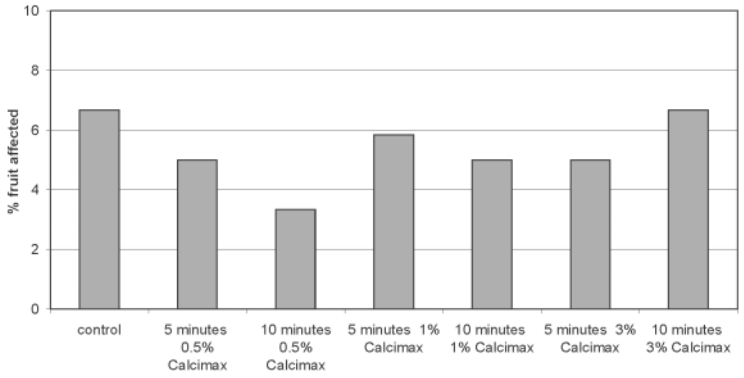
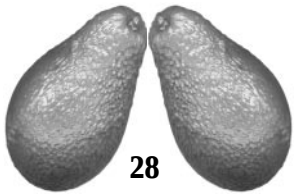


Figure 6 The incidence of cold injury in Pinkerton fruit dipped in various calcium solutions

CONCLUSIONS

1. There are clear benefits to be derived from calcium applications in terms of shelf life after cold storage. This is particularly true for fruit that is harvested at a more mature stage. One drawback to this longer shelf life is that it allows more opportunity for fungal diseases to establish. If calcium applications are to be used for extending shelf life, it is recommended that strict sanitation be applied in both the orchard and the packhouse.
2. In the current season it was noted that fruit maturity has a much more marked effect on quality than does calcium application. This is in agreement with the findings of Kruger *et al.* (2000).
3. In contrast to the previous season calcium applications produced no clearly defined improvement on fruit quality. There was considerable variation in the data, with some of the treatments actually having a negative effect. It appears that there are other factors affecting fruit quality which may override the effect of calcium applications. One possible factor is the lighter crop load experienced relative to the previous season. Another factor is high nitrogen levels in the fruit used in the trial. The effect of nitrogen is discussed by Kruger *et al.* (this publication), and certainly warrants further attention.

The effect of calcium on avocado quality is currently under further investigation and it is hoped that a clearer picture will emerge in the forthcoming harvest.



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