

Pre- and post-harvest treatments on 'Fuerte' avocados to control anthracnose (*Colletotrichum gloeosporioides*) during ripening

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ABSTRACT

Avocado exports from South Africa require extended low temperature shipping. This may enhance post-harvest disease incidence. Anthracnose (*Colletotrichum gloeosporioides*) as a latent infection may cause considerable losses. Antifungal compounds in the fruit decline during fruit ripening. The objective of the work was to use systemic resistance inducers to enhance antifungal compounds and thus decrease post-harvest diseases, decreasing the need for other measures such as copper sprays. Fruit were treated post-harvest with phosphorous acid (500 ppm a.i.) and potassium silicate (1000 ppm a.i.). Fruit were ripened immediately or stored for 28 days at either 5.5°C or 2°C before ripening. Exocarp was sampled during ripening and fruit condition was evaluated. Exocarp was analysed for potential antifungal compounds and PAL activity. Post-harvest treatments showed both potassium silicate and phosphorous acid decreased presence of anthracnose in stored fruit. Both compounds also influenced PAL activity, with potassium silicate having greater effects. Antifungal diene concentrations are still to be determined. It is suggested that sufficient stimulation of antifungal activity occurred to consider the treatments for post-harvest disease control.

INTRODUCTION

South Africa exports avocados over a long distance and may have storage times of up to 30 or more days at temperatures of about 5.5°C. This extended storage period may result in poor fruit quality that includes physiological disorders such as grey pulp and vascular browning (Leclereq, 1990). An additional problem often occurring is early softening, which can increase post-harvest disease incidence (Eksteen, 1990).

Anthracnose (*Colletotrichum gloeosporioides*) infects unripe fruit and once infected, the fungus remains dormant until ripening begins (Crane, 2001). Antifungal compounds are concentrated in the outer layers of the fruit and in the skin, and act as the first line of defence. This reduction in antifungal concentrations has been found to correspond with an increase in the fruit susceptibility to disease. Once the concentration of antifungal compounds has declined past a certain level, anthracnose is able to resume development to produce symptoms (Prusky *et al.*, 1991). Anthracnose is usually found in conjunction with other fungi and therefore disease severity is much worse (De Villiers, 2001). Anthracnose can, therefore, cause a great economic loss in the avocado industry.

Control of this disease is therefore important. It

can be controlled through various copper fungicides (McMillan, 1970), which although shown to control the disease, do have certain disadvantages. Phosphorous acid has been used to achieve control against Phytophthora root rot in avocados. It does this in part by inducing plant defences. Phosphorous acid acts as a fungal growth inhibitor at high concentrations while at low concentrations it acts as a defence elicitor (Guest *et al.*, 1995). Silicon has been found to offer protection against fungal infections in various crops by strengthening cell walls and thus making it difficult for the fungal penetration and colonisation within the plant (Fawe *et al.*, 2001). It is also thought that silicon plays an important role in enhancing host resistance to plant diseases by stimulating defence reaction mechanisms (Kaluwa *et al.*, 2010).

The objective of the work was to use systemic resistance inducers to enhance antifungal compounds and thus decrease post-harvest diseases, decreasing the need for other measures such as copper sprays.

MATERIALS AND METHODS

Fruit

Fruit were obtained from Wartburg and Howick in KwaZulu-Natal. Fruit were subjected to post-harvest



dips and pre-harvest treatments and were either stored at 5.5°C or 2°C for 28 days or remained to ripen immediately without storage.

Fruit softness

Fruit softness was determined using a densimeter. Fruit softness was measured on a scale whereby fruit were deemed hard at a measurement of 90-100, medium at 68-75 and soft at 50-55.

Fruit sampling

Exocarp was sampled at five different stages of fruit softness and was immediately freeze dried and ground before later analysis for potential antifungal compounds, total phenolics and phenyl-alanine ammonia lyase (PAL) activity.

Extraction and analysis of PAL

PAL was extracted according to the methods of Lister, Lancaster and Walker (1996) and activity was assayed according to Jiang and Joyce (2003).

Extraction and analysis of total phenolics

Total phenolics were analysed according to Serafini, Maiani and Ferro-Luzzi (1998), and Böhm, Kühnert, Rohm and Scholze (2006), with slight modifications.

Statistical analysis

The data was analysed in the form of a factorial design with each treatment having 20 fruit replicates. A general analysis of variance was done using Genstat 12th edition.

RESULTS

No significant differences were seen when fruit were visually assessed for disease incidence. Control fruit did, however, have a tendency to slightly higher disease incidence than treated fruit.

Post-harvest treatments

Total exocarp phenolic concentrations of fruit showed no major significant differences related to treatment (Figure 1, 2 and 3). However, there was some indi-

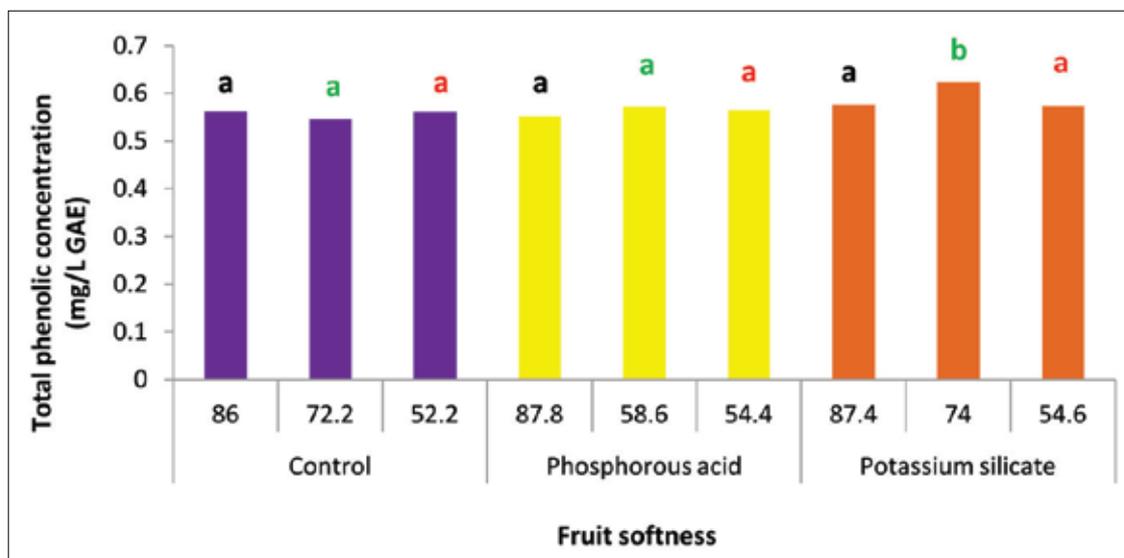


Figure 1. Total phenolic concentration at specific fruit softness of 'Fuerte' avocados kept at room temperature.

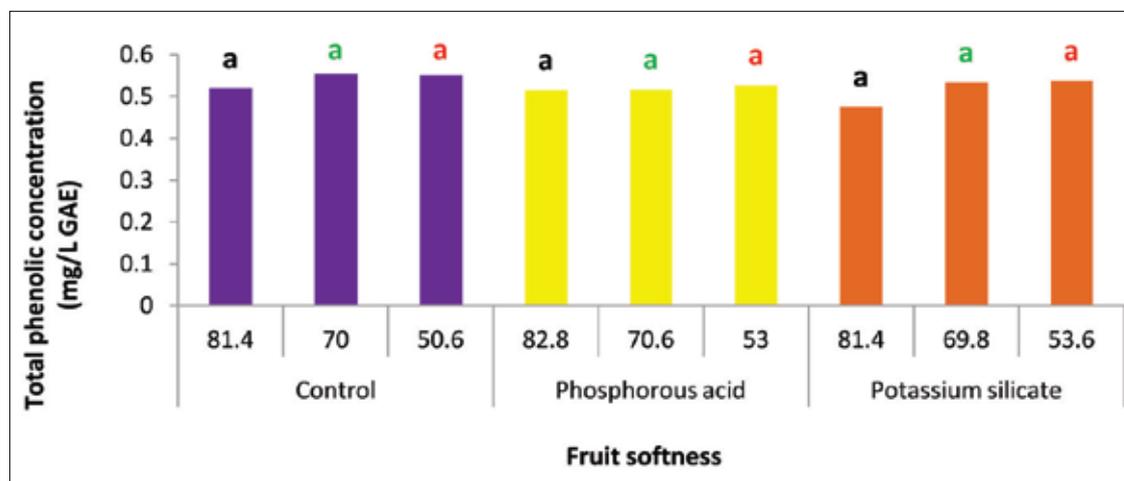


Figure 2. Total phenolic concentration at specific fruit softness of 'Fuerte' avocados stored at 5.5°C.

cation of an increase in phenolic concentration during softening for phosphorous acid and a significant increase for potassium silicate for fruit stored and ripened at room temperature but not at lower temperatures.

PAL enzyme activity of non chilled fruit showed a significant increase during softening for both the phosphorous acid and potassium silicate treatments, indicating that these compounds had stimulated the activity (**Figure 4**). However, fruit stored at low temperature had slightly different patterns of activity. Phosphorous acid enhanced activity in fruit stored at 5.5°C (**Figure 5**). In fruit stored at 2°C only the potassium silicate resulted in a significant increase in PAL activity. This increased during softening and did not decrease towards the point of eating ripeness, unlike the situation in non-chilled fruit (**Figure 6**).

DISCUSSION

The maturity of fruit influences the natural resistance that plants have against fungal attacks (Prusky, 1996). Ripening of avocado fruit eventually becomes a senescence process once the climacteric peak has been reached (probably just prior to the point of eating softness). It can therefore be expected that anti-fungal compounds will change with ripening.

Prusky *et al.* (1992) found that the lipoxygenase enzyme might be involved in the decrease of the antifungal diene compound, which decreases as fruit ripens. They found that the activity of the enzyme in avocado extracts increased during fruit ripening. Activation of the disease results from the decrease of the antifungal diene, which is catalysed by lipoxygenase activity and regulated by the decline of its inhibitor epicatechin. It is likely that PAL activity affects the levels of epicatechin, and therefore by implication, where higher PAL activity was found, levels of anti-fungal compounds are likely to also be higher.

Both phosphorous acid and potassium silicate (and especially the latter) appeared to enhance PAL activity if applied post-harvest. This may be especially important as fruit softens. However, storage temperature appears to affect the process, with storage

at 5.5°C seeming to negate the effects of potassium silicate, but not phosphorous acid. At lower temperature of storage (2°C) phosphorous acid had no effect on PAL activity, but potassium silicate did enhance activity.

Prusky *et al.* (1990) found that diene concentrations in fruit peel decreased between the first and third day after harvest but the initial levels were regained thereafter and it was regained faster in more mature fruit. This could explain why in some instances, control fruit phenolic concentrations and enzymatic activities appeared to decrease slightly and then increase again towards ripening. Where the opposite was happening for treated fruit, the treatments could be having an effect on the diene concentrations. Further work will be necessary to check actual diene concentrations. Total phenolic content may not be definitive, because only some phenolics may have changed, and these may be a small proportion of the total, or some may have decreased, thus masking the possible increases in critical components of the anti-fungal compounds.

The different treatments had positive effects on phenolic and enzymatic concentrations, therefore showing it could have positive results in decreasing disease incidence by prolonging diene concentrations in avocados.

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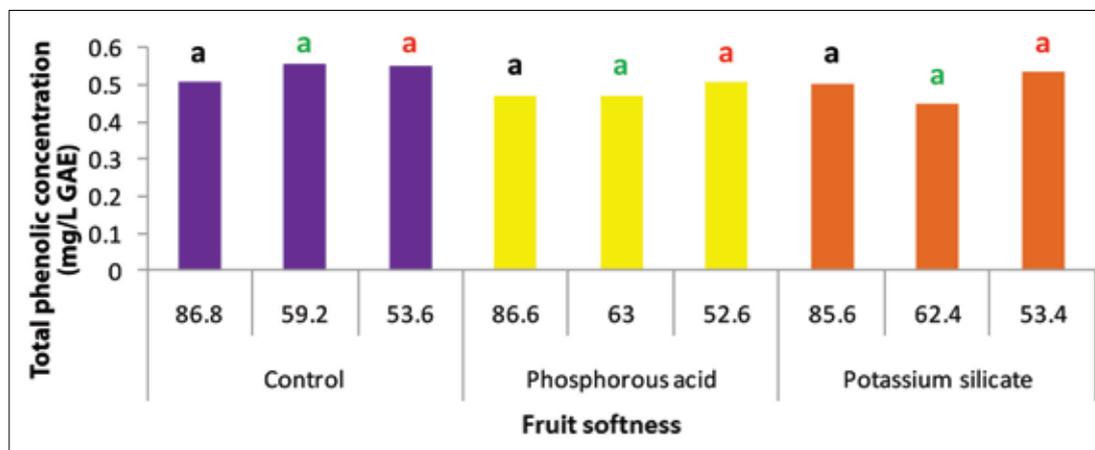


Figure 3. Total phenolic concentration at specific fruit softness of 'Fuerte' avocados stored at 2°C.

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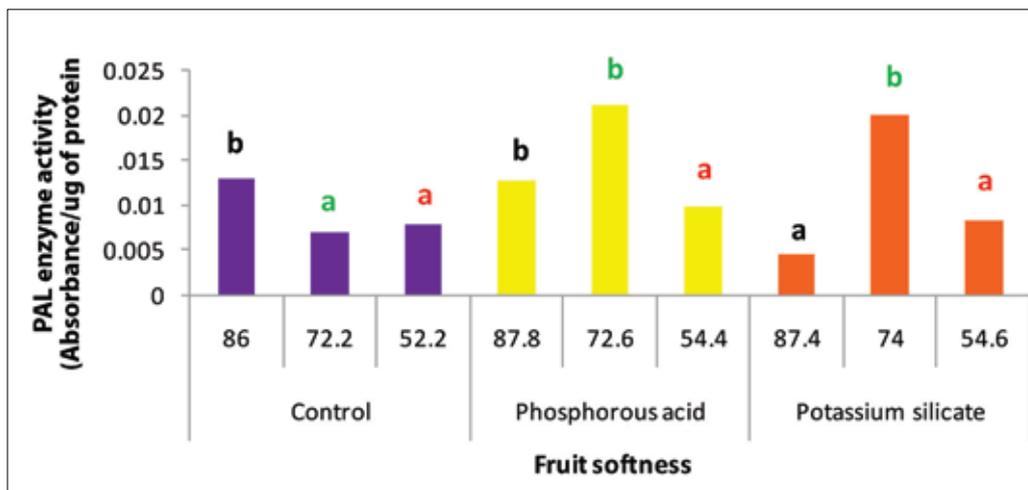


Figure 4. PAL activity at specific fruit softness of 'Fuerte' avocados stored at room temperature.

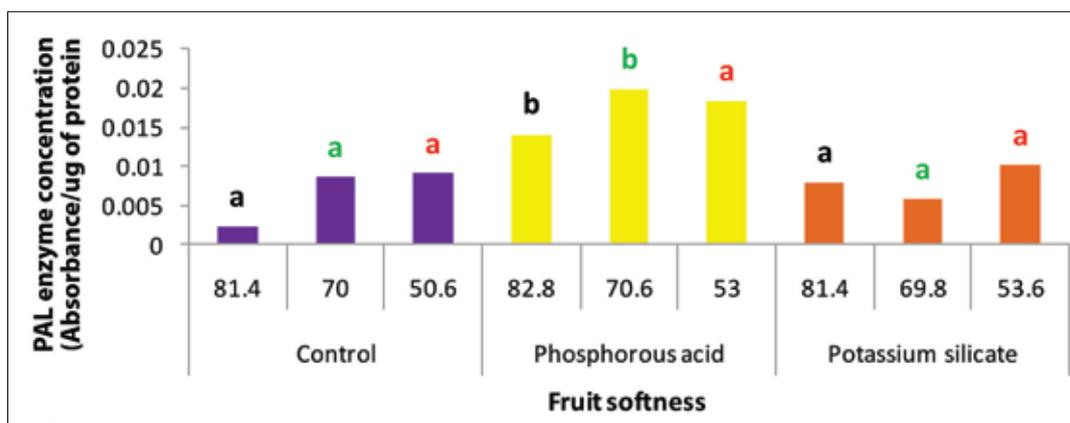


Figure 5. PAL enzyme activity at specific fruit softness of 'Fuerte' avocados stored at 5.5°C.

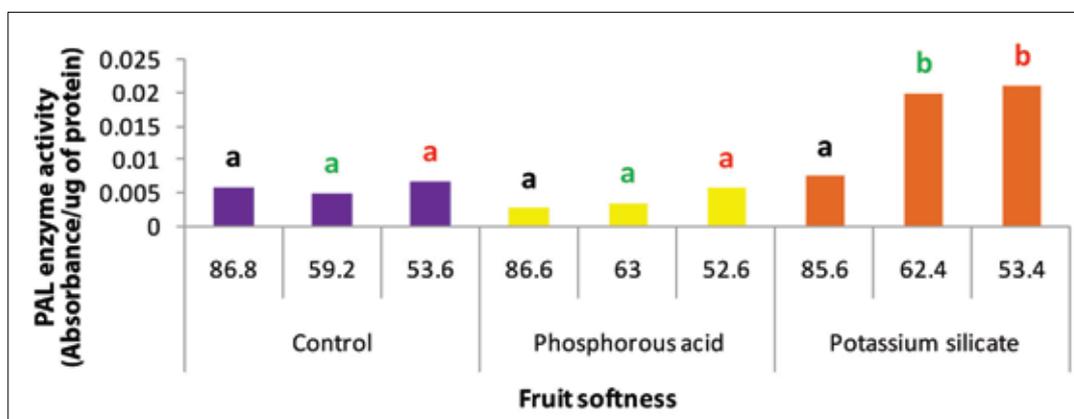


Figure 6. PAL enzyme activity at specific fruit softness of 'Fuerte' avocados stored at 2°C.



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