Effect of N and Fe fertilizer treatments on the incidence of chilling injury in 'Fuerte' and 'Hass' avocados

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ABSTRACT

Previous surveys have indicated that increased susceptibility to chilling injury may be associated with reduced fruit iron content. Two trials were subsequently conducted. The aim of the first trial was to establish to what extent the addition of iron would reduce the incidence of chilling injury. During September 2005, 400 grams of EDDHA was applied to 'Fuerte' trees in the Kiepersol area. As the iron content of neither the pulp nor skin were found to increase by the beginning of December 2005, 300 g of LAN was applied to half of the experimental trees. As from January to July 2006, the iron content of these trees was found to be significantly higher than that of the control and the EDDHA only treatments. During a series of storage trials conducted from May to July 2006, it was found that the prevalence of chilling injury was significantly lower in fruit from trees that received the EDDHA + LAN treatment. The second trial was performed with the Hass cultivar during 2007. This trial confirmed the importance of maintaining adequate fruit pulp Fe content from an early stage of fruit development. As a benchmark, it would appear that the iron content of avocado fruit must still be higher than 60 ppm by March.

INTRODUCTION

During the late nineties, a series of trials were conducted with the Pinkerton cultivar aimed at reducing the incidence of grey pulp (Kruger *et al*., 2000; Kruger, *et al*., 2001). One of the important recommendations made at the time concerned a reduction in the pulp nitrogen content of the fruit. The project was later extended to the other export cultivars (Snijder *et al*., 2003; Kruger *et al*., 2004).

During the above studies it was noticed that, in certain orchards where the nitrogen content of the fruit was considerably reduced and grey pulp consequently effectively controlled, the incidence of chilling injury was unacceptably high. Mineral analysis indicated that the increased susceptibility to chilling injury may be associated with reduced fruit iron content.

Two trials were subsequently conducted over two seasons. The aim of the first study was to determine what effect iron supplements in a low nitrogen status 'Fuerte' orchard have on the incidence of post-harvest chilling injury. The second study aimed to establish what effect late nitrogen applications have on iron uptake and the risk of developing chilling injury. The study was performed with the 'Hass' cultivar and the fruit were stored at phytosanitary temperatures.

MATERIALS AND METHODS

This first (pilot) trial was performed during 2005 in 'Fuerte' orchard J5 located on Frankfort Farm. Fe chelate (EDDHA) @ 400 g/tree was applied to ten 'Fuerte' trees in September. Upon noticing that the pulp iron content of the fruit had not increased by the beginning of December, 300 g LAN/tree was applied to five of the Fe chelate trees in December.

Fruit sampling for mineral analysis took place on a monthly basis from December 2005 to July 2006. Sampling for storage purposes was done on a weekly basis from April to July 2006. Small and big fruit were sampled separately and assigned to three storage temperature treatments (2, 4 and 7°C).

The second trial was conducted with 'Hass' fruit in orchard H13-2 of Oudewerf Farm in the Kiepersol area. The trial consisted of five different treatments (Control, Horticote @ 50 g/tree applied in March, Horticote @ 100 g/tree applied in March, LAN @ 100 g/tree applied in March and LAN @ 100 g/tree applied in April). Each treatment consisted of two replicates of seven trees, each of which the five middle ones served as data trees.

During this season, sampling took place on a weekly basis from mid-April until the end of the season. On each sampling date a total of 17 fruit per replicate was harvested, of which 7 were used for maturity and mineral content analysis and 10 were stored at phytosanitary temperature (1°C for 28 days).

RESULTS AND DISCUSSION

The skin N content of the 'Fuerte' fruit from Frankfort is shown in **Figure 1**, while the Fe content is shown in **Figure 2**. Certain interesting trends were observed. There was no difference between the iron content of the control and the EDDHA treatments, until the additional 300 g of LAN was applied to half of the EDDHA trees in December. A month after the LAN application the iron content of this

treatment was significantly higher than that of the other two treatments. This indicated that the nitrogen application facilitated the uptake of iron from the soil. With nitrogen content a similar increase was observed. However, the divergence between treatments was smaller. In addition fruit nitrogen content steadily declined as the season progressed and the fruit matured.

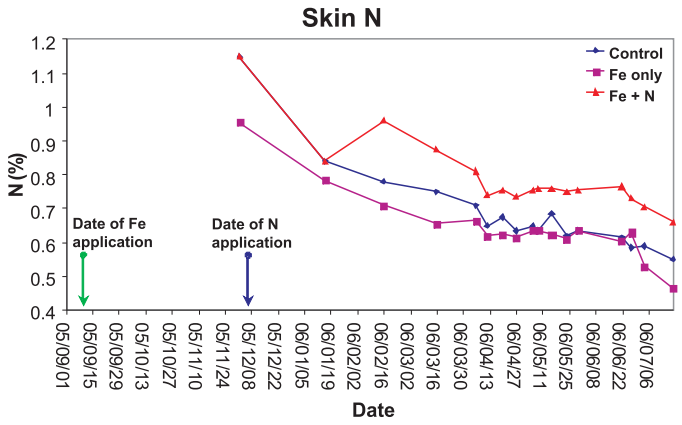

Figure 1. Skin nitrogen content of 'Fuerte' fruit sampled on 17 dates from December 2005 to July 2006.

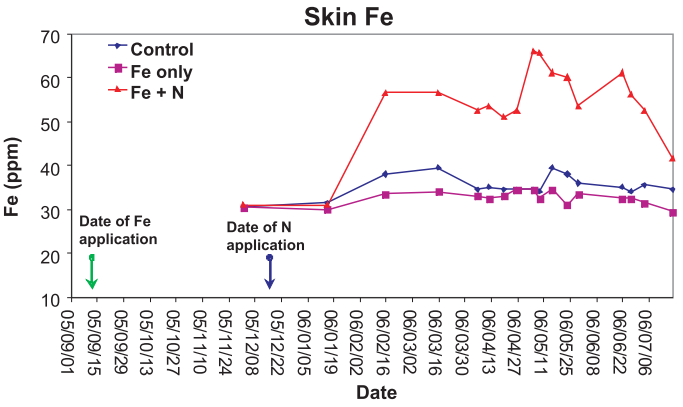

Figure 2. Skin iron content of 'Fuerte' fruit sampled on 17 dates from December 2005 to July 2006.

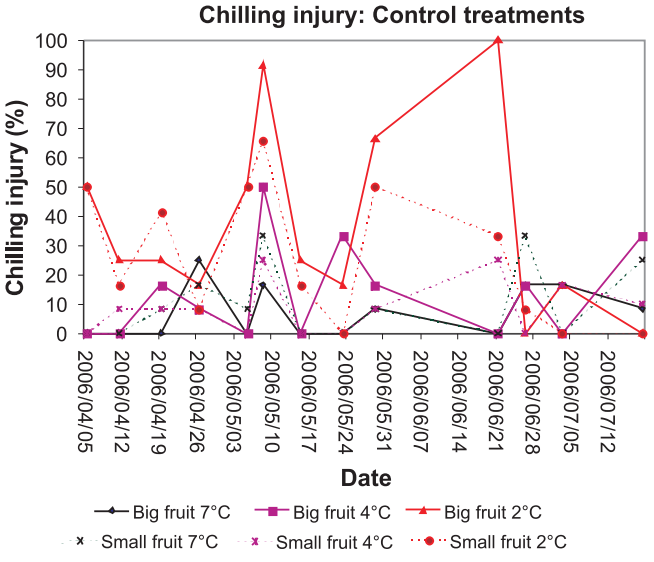

Figure 3. Incidence of chilling injury in control fruit sampled on 13 dates during 2006 and store at 2, 4 and 7°C for 30 days.

The mean chilling injury scores recorded during the 'Fuerte' trial are portrayed in **Figures 3** to **5**. Storage results revealed that the incidence of chilling injury was significantly reduced in fruit from trees that received EDDHA in September and additional LAN in December. The incidence of chilling injury in fruit from this treatment (**Figure 5**) fluctuated at a lower level against time when compared to control (**Figure 3**) and EDDHA only (**Figure 4**) treatments. The storage results also revealed that bigger fruit were more susceptible to chilling injury than smaller fruit, especially at lower temperatures.

The chilling injury results for the second (late nitrogen) 'Hass' trial are presented in **Figure 6**. During a series of storage trials conducted from April to September 2007, the incidence of chilling injury fluctuated considerably between sampling dates. However, Rep 2 of the LAN April

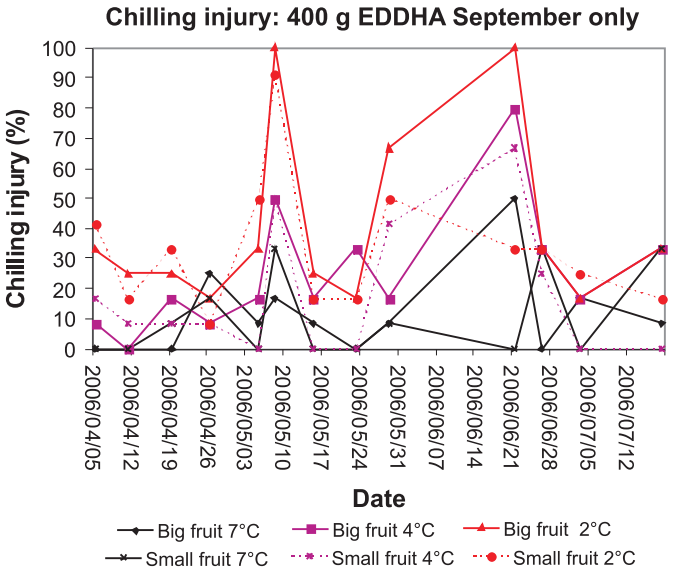

Figure 4. Incidence of chilling injury in 'Fuerte' fruit which received 400 g of EDDHA in September 2005.

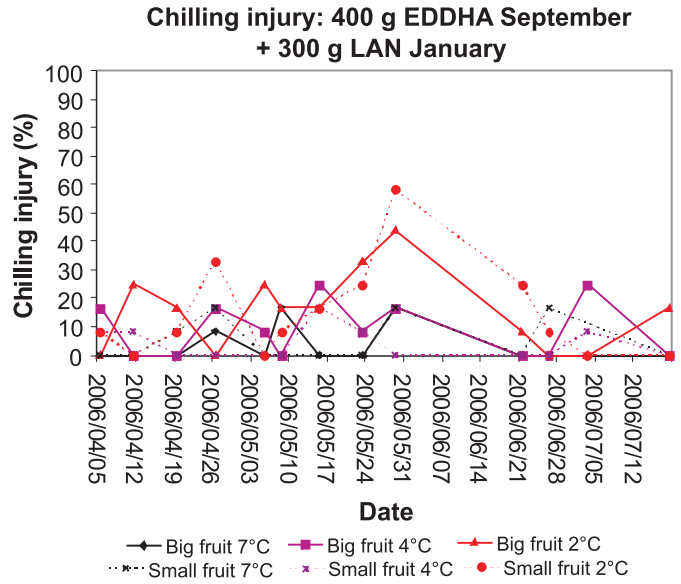

Figure 5. Incidence of chilling injury in 'Fuerte' fruit which received 400 g of EDDHA in September and 300 g LAN in December 2005.

treatment was the only treatment which consistently had a low incidence of chilling injury throughout the sampling period. This trend is summarized in **Table 1**, where chilling injury is expressed as a percentage of the maximum reading on each date over the sampling period. The mean percentage chilling injury of LAN Rep 2 April was significantly lower than that of other treatments.

The nitrogen and iron contents of the fruit pulp are presented in **Figures 7** and **8** respectively. There was no specific relationship between the nitrogen content of the different treatments and the incidence of chilling injury. In terms of iron, it was interesting to note that the pulp content of the treatment that had the lowest incidence of chilling injury was the highest at the beginning of the sampling period. In the light of these observations it is fair to assume that nitrogen by itself does not play a significant role in the reduction of chilling injury. It would appear that iron plays a crucial role. As a benchmark it would seem that the iron content of avocado fruit must still be higher than 60 ppm by March. Detailed trials are presently being executed with the Hass and Pinkerton cultivars.

Table 1. Mean chilling injury expressed as a percentage of the maximum incidence on each sampling date.

Treatment	Chilling injury (% of max)
LAN April rep 2	22.9 a
Control rep 1	33.7 ab
LAN April rep 1	43.9 bc
Hort 50 rep 1	45.1 bc
Hort 50 rep 2	47 bc
Hort 100 rep 2	54.7 c
Control rep 2	58.8 cd
LAN March rep 1	61.8 cd
LAN March rep 2	65.1 cd
Hort 100 rep 1	75.2 d

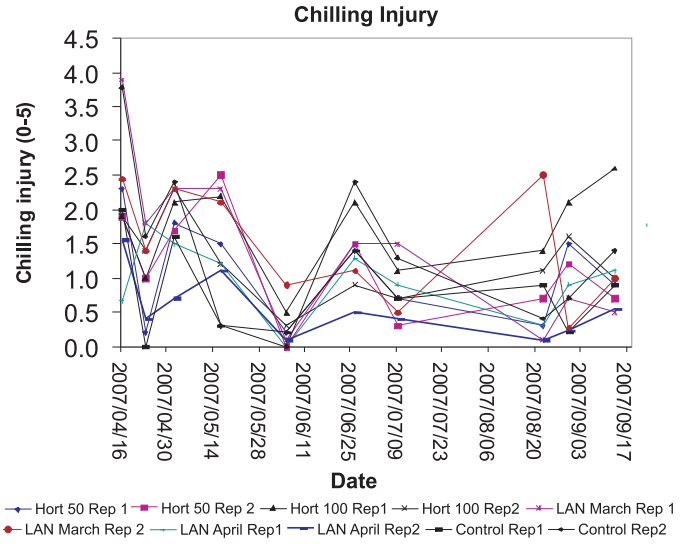

Figure 6. Incidence of chilling injury in 'Hass' fruit sampled on 10 dates during the 2006/07 season and stored at 1°C for 28 days.

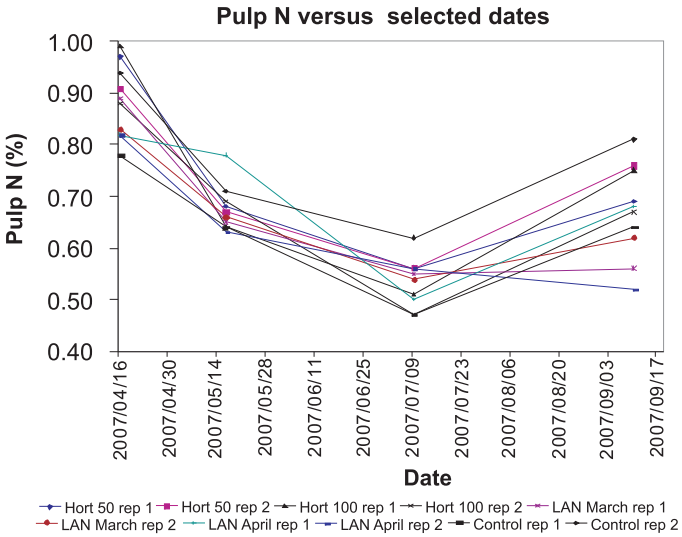

Figure 7. Pulp nitrogen content of 'Hass' fruit sampled on four dates during the 2006/07 season.

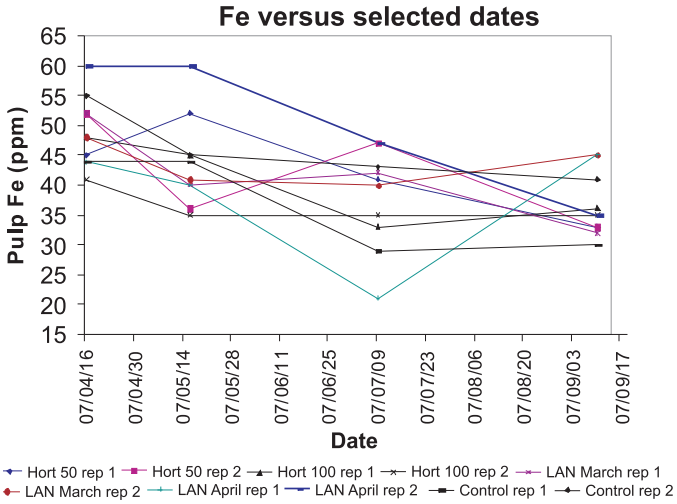

Figure 8. Pulp iron content of 'Hass' fruit sampled on four dates during the 2006/07 season.

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