Preliminary investigation into the causes and control of freeze injury and grey speckle in avocado fruit

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ABSTRACT

Unusually low orchard temperatures that prevailed during May 2007 resulted in significant losses in certain areas due to orchard cold damage. At the same time, the incidence of grey speckle dramatically increased in the Fuerte cultivar. A series of cross sectional surveys were subsequently performed with the Hass and Fuerte cultivars. The results indicated that 'Hass' orchards with a low nitrogen status are most susceptible to orchard cold damage. In contrast, 'Fuerte' orchards with a low calcium status were more inclined to develop grey speckle symptoms. Experimental trials were therefore launched aiming to increase the canopy density of 'Hass' trees through increased nitrogen fertilizing. In a similar fashion, an attempt is being made to increase the calcium content of 'Fuerte' fruit by means of additional calcium nitrate applications in trenches.

INTRODUCTION

During May 2007, severe cold temperatures were recorded in various avocado growing regions. These caused considerable losses to most cultivars due to freeze damage. It further highlighted a second problem, grey speckling, which annually occurs in 'Fuerte' fruit from orchards located in cold areas. A project was subsequently launched to determine the most important contributing factors and to develop mitigation strategies for both problems.

Characterization of the disorders

Freeze damage

The classical freeze injury is a brown streak that runs along the longitudinal axis of the fruit. The symptom is easily observable when performing a longitudinal section through the fruit (**Figure 1**).

Grey speckle

In the case of grey speckling, the symptom is less conspicuous in immature fruit and is only observable in cross section (**Figure 2**). However, later in the season the symptom becomes more prominent in longitudinally section. In severe cases the speckles may coalesce to form a smudged pattern (**Figure 3**).

Relationship with fruit maturity

In order to establish if a relationship exists between the prevalence of the two disorders and the maturity of the avocados, moisture content analysis was performed of one hundred 'Fuerte' fruit from an orchard in a cold area. The results indicated that both freeze damaged and grey speckled fruit have lower moisture contents than healthy fruit (**Table 1**).

Figure 1. Freeze damage symptoms in longitudinally and cross sectioned 'Fuerte' avocados.

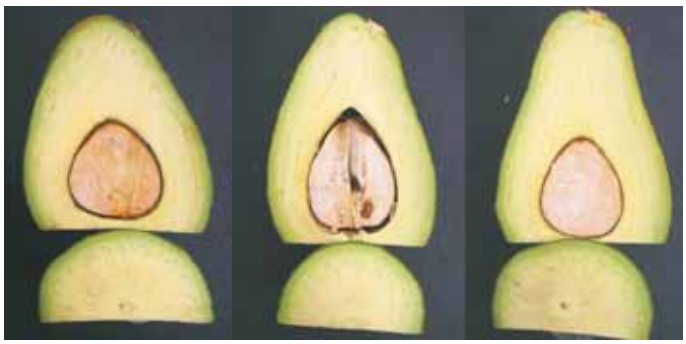

Figure 2. Grey speckle symptoms in longitudinally and cross sectioned early season 'Fuerte' avocados.

In the case of freeze damage, it is our opinion that the tissue damage caused by freeze injury initiates fruit ripening. This is the reason why a proportion of freeze damaged fruit drop after the cold spell has occurred.

In this case of grey speckling, we are of the opinion that the affected fruit are indeed more mature than healthy fruit. We base this inference on the observation that the speckle becomes more conspicuous as the fruit matures. In order to establish if a relationship exists between fruit size and grey speckling, the incidence of the disorder was scored in samples of 'Fuerte' fruit from two pack houses. The results indicated that, at both pack houses, grey speckling was more prevalent in bigger avocados than in smaller fruit (**Table 2**).

Symptom expression and fruit symmetry

When viewing an avocado fruit laterally, most specimens have a "ball", "neck", "long side" and "short side". In order to measure the maturity of the various sections, we conducted moisture content analysis of 'Fuerte' fruit sectioned into quarters (**Table 3**). The "neck" and "ball" were found to have similar moisture contents. This is unexpected as the distal end (ball) of less mature fruit is known to ripen faster than the proximal end (neck). (In contrast with more mature fruit, less mature fruit may therefore possibly reveal a moisture content differentiation between "neck" and "ball".)

Figure 3. Grey speckle / streak symptoms in longitudinally sectioned mid / late season 'Fuerte' avocados.

Table 1. Mean moisture content of avocado fruit from a 'Fuerte' orchard with both freeze damage and grey speckling symptoms.

Fruit sample	Moisture content (%)
No symptoms	71.4 a
Freeze damage symptom	67.1 b
Grey speckling symptom	68 b

Table 2. Incidence of grey speckling in different counts of 'Fuerte' fruit from two pack houses.

Count	Grey speckle (%)	
	Pack house 1	Pack house 2
10	60	46
12	27	27
14	17	9.5
16	35	6.2
18	12.5	2.1
20	12.5	3.3

The "short side" of the fruit was found to be significantly more mature than the "long side". This is probably due to the fact that the "short side" faces outward (it is thus exposed to more sunlight) while the "long side" faces inward.

When studying the freeze damage symptoms shown in **Figure 1**, it is clear that the symptom is more prevalent in the flesh of the "short side" of the fruit. Considering the above maturity related measurements, this is possibly due to the outward facing, "short side", being more exposed to cold air draining from the canopy of the tree.

In contrast with freeze damage symptoms, grey speckling was more apparent in the pulp of the inward facing, "long side" of the fruit. At the beginning of the season, the symptom was only visible in cross section. The cells adjacent to the vascular bundles would seem to have been particularly susceptible (**Figure 2**) to greying. The symptom became more apparent in both sides of the fruit as it matured. The fruit size and symmetry observations seem to indicate that bigger cells are more susceptible to greying.

Relationship between the disorders and fruit mineral content

Mineral analysis of freeze damaged 'Hass' fruit revealed that they have lower nitrogen contents than healthy fruit (**Table 4**). According to the authors, this may be due to healthy fruit from denser foliated trees, with a higher nitrogen status, being less exposed to the cold. This is also reflected by the magnesium content of the fruit. Undamaged fruit were found to have a higher magnesium contents than freeze damaged fruit. Magnesium is a constituent of chlorophyll and we have previously found the concentration of this element to be higher in inside fruit than in outside fruit.

Mineral analysis of grey speckled fruit revealed very clear cut results. The calcium content of fruit affected by speckling was found to be six times lower than that of healthy fruit (**Table 5**). Calcium therefore would seem to play a vital role in preventing the disruption of organelle

Table 3. Mean moisture content of 'Fuerte' fruit dissected into quarters.

	Moisture content (%)	
	Neck	Ball
Long side	67,1 a	67.1 a
Short side	65.4 ab	64.9 b

Table 4. Nitrogen and magnesium content of 'Hass' fruit (pooled samples) from a freeze damaged orchard.

Pulp content	No symptom	Freeze damage symptom
N (%)	0.611	0.413
Mg (mg/kg)	0.112	0.088

Table 5. Calcium content of 'Fuerte' fruit (pooled samples) from an orchard exhibiting grey speckle symptoms.

Intensity of symptom	Pulp Ca content (%)	
	Speckle symptom	Streak symptom
None	0.06	
Light	0.03	0.02
Medium	0.01	0.01
Heavy	0.01	0.01

membranes in the largest cells on the longer side of the fruit adjacent to the vascular bundles.

Development of control strategies

We are presently performing a number of trials aimed at reducing the incidence of both freeze damage and grey speckling.

In terms of freeze damage, we are applying additional applications of nitrogen to a number of replicate trees in two susceptible 'Hass' orchards. The rationale is that a denser canopy will reduce the incidence of freeze damage. If this strategy is shown to be effective, producers should take into consideration that the higher nitrogen status of the orchard may result in a shorter harvest window due to an increased risk of grey pulp towards the end of the season.

In an attempt to reduce grey speckling, we are presently applying additional calcium (various formulations) to 'Fuerte' orchards located in a cool production area. One of the procedures involves the application of calcium nitrate applied in trenches along the drip line of the trees. (A pilot trial conducted during 2007 has indicated that this procedure may contribute towards attaining higher Ca levels in avocado fruit.)

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