

## **Bitter pit article for DFPT pamphlet**

### **Pre- and post-harvest management of bitter pit on apples**

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#### **Introduction**

There is an ongoing need to utilise management practices that create a balance in orchards such that the effects of the many interacting internal and external factors that contribute to bitter pit are minimised. (Wooldridge, 2001)

This article summarises the main pre- and post-harvest management factors that can be manipulated in order to reduce the risk of bitter pit, and further actions are suggested. Additional information can be accessed in the articles listed in the references.

#### **Pre-harvest management**

The fundamental principle of bitter pit control is that of avoidance. As a starting point, records should be consulted in order to establish past trends in cultivar and orchard susceptibility. Bitter pit is positively correlated to fruit size, tree vigour, fruit N, fruit K and fruit Mg. Bitter pit develops in the parts of the fruit where the tissues contain inadequate levels of calcium. The focus of bitter pit management is therefore on the provision of adequate levels of calcium, and the avoidance of factors such as irregular irrigation or excessive thinning that lead to large fruit. The latter may cause calcium either to be withdrawn from the fruit or excessively diluted during fruit growth.

#### Orchard nutrition

Since the principle site of mineral nutrient uptake is the root system, soil conditions for calcium uptake must be optimised before planting, and then maintained in that state throughout the life of the orchard. This practice does however not replace, and in no way detracts from, the necessity for calcium sprays. Young trees should get smaller applications, more regularly, with relatively higher nitrogen applications, in order to promote growth—while a balance between nutrients is maintained. In bearing trees, from the combined viewpoints of production and bitter pit control, the most important activities are the following: the application of nitrogen and potassium in spring, the application of nitrogen in autumn, calcium sprays during the fruit expansion phase and the correction of pH and soil phosphorus levels in autumn. Long-term fertilisation, irrigation and herbicide use will lead to acidification. The purposes of applying lime (liming) are, firstly, to neutralise those chemical constituents of the soil that cause acidity and, secondly, to achieve the correct balance between base cations, notably calcium, magnesium and potassium.

Guidelines concerning soil and orchard parameters for the control of bitter pit have been long established (Terblanche et al., 1980). The aim is to produce fruit

which are bitter-pit-free at harvest, and which have the best possible chance of surviving storage and transport, to reach the consumer in prime condition. Both soil and leaf analysis are essential aspects of this process, and the establishment of guidelines from these analyses has reached a high level of refinement (Kotze, 1996). Because the shoots compete with the fruit for calcium, and because vegetative growth is exacerbated by excess spring nitrogen, the application of nitrogen should be balanced between spring and autumn. The nitrogen requirement of bearing apple trees is calculated on a basis of anticipated production for the coming season, using the equation:

$$\text{Kg N / ha} = (1.5 \times \text{yield}) + 5$$

where anticipated yield is expressed in metric tons / ha.

Maximum and minimum nitrogen application rates for apples are 80 and 35 kg / ha, respectively. A critical factor is the adjustment of this application rate to accommodate differences in vigour. When growth is vigorous, the calculated amount of nitrogen should be applied at full bloom and again after harvest. When vigour is normal, the nitrogen should be applied at full rate at flowering and after harvest, plus a further application, at half the calculated rate, six weeks after flowering. In the case of weakly growing trees, the root systems should be inspected to identify any detrimental factors. The irrigation system should also be checked. Any problems should be immediately rectified. Thereafter, nitrogen should be applied at the full calculated rate at flowering, six weeks after flowering, and after harvest.

#### Plant stress

Factors that reduce plant stress i.e. a reasonably constant, adequate supply of water, good soil aeration, moderate air temperatures and low wind velocities, will reduce the risk of bitter pit. The effect of overhead cooling on bitter pit incidence has not been conclusively established. However, frequent wetting of the canopy is likely to reduce the rate of transpirational water loss from the leaves, thereby reducing the tendency for water and dissolved salts to be withdrawn from the fruit via the xylem, creating zones of localised calcium depletion.

#### Tree vigour

Excessive vigour and low crop loads increase the risk of bitter pit. A long-term balance between yield, fruit size and vigour is essential. Thin fruit early and avoid severe winter pruning to reduce excessive early-season shoot growth and to minimise competition between fruit and shoots. Rootstocks must be selected based on their suitability for the cultivar, for the prevailing soil conditions, and for the desired management style.

#### Crop load

A relatively high crop loading, associated with the production of fruit of moderate size, will reduce the risk of bitter pit, relative to the cases where crop loads are small and fruit are large.

### Fruit size

Susceptibility to bitter pit tends to increase with fruit size, possibly as a result of a dilution effect of the available calcium. Thus any factor associated with large fruit size i.e. low crop load and alternate bearing will tend to increase the probability of bitter pit.

### Foliar calcium application

Pre-harvest calcium sprays reduce the probability of bitter pit and improve the resistance of the fruit to rotting and breakdown. Producers are required to apply at least six calcium sprays. It is nevertheless common practice to apply up to 12 sprays. Generally, with increasing number of calcium sprays, the fruit-calcium content tends to increase and the bitter pit incidence tends to decrease. Since very little calcium is transported from the leaves to the fruit it is essential that uptake of the spray-applied calcium through the fruit surface should be maximised. This necessitates wetting the entire surface area of the fruit—a process that is greatly facilitated by the use of effective adjuvants. Calcium nitrate is a highly effective calcium carrier, although a range of alternate products are available. Calcium sprays play an important role where cool, wet spring and early summer conditions limit calcium uptake and upward calcium transport in the transpiration stream.

The main disadvantage of calcium sprays is blemishing, caused by the build-up and drying of droplets on the apple skin, leading to “calcium spot”. Various forms of blemishing have been attributed to impurities in the water that is used to fill the spray tanks. Some cultivars appear to be more susceptible to this form of damage than others.

### Timing of calcium sprays

Recent work by Lotze & Theron (2005) suggests that calcium uptake peaks at approximately 40 days after full bloom, at about the time when cell division ends. A further uptake peak occurs at 90 days after full bloom, coinciding with the end of shoot growth. This latter event is probably the most significant in terms of its potential effect on bitter pit. Research aimed at improving the timing of calcium spray applications, and at the selection of those adjuvants that best promote calcium uptake, is currently being carried out. Early, frequent sprays with the correct calcium concentration and adjuvant are particularly necessary to reduce the incidence of bitter pit in high-risk situations and in the case of sensitive cultivars.

## **Post-harvest management**

### Fruit harvest maturity

Fruit which are picked prior to the optimum stage of maturity are more prone to bitter pit than those that are picked later. The lowest levels of bitter pit are usually associated with fruit picked after the climacteric. Optimum fruit maturity for picking is based on the change in specific indices as described by van der

Merwe (1996). Fruit is considered to have reached optimum ripeness when three or more indices change significantly from one week to the next.

#### Post-harvest dipping

Dipping in a solution of calcium chloride or calcium nitrate is an effective way of increasing the calcium content of the near-surface fruit tissues. However, blemishing of the fruit surface, and damage to the lenticels, is a common side effect. Dipping is seldom necessary when orchard factors are optimal and when an adequate number of calcium sprays were applied at appropriate intervals during maturation.

#### Storage

Senescence may be delayed by such post-harvest procedures as: low-temperature storage, which slows biological reactions, and by low oxygen-content storage atmospheres which lead to reduced respiration. Ultimately, however, fruit quality is determined in the orchard. Fruit from bitter-pit-prone cultivars, and from known high-risk orchards, should therefore be kept separate and marketed at the earliest opportunity.

#### Cold chain

Since such biological processes as senescence and the development of storage disorders are temperature dependent, it essential that cooling should take place as quickly as possible after picking, and that the cold chain should be maintained thereafter during all handling processes, as well as during storage and transport.

### **References / further reading**

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