Peteca spot of lemons

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During 2004 a high incidence of peteca spot of lemons was reported in all citrus production areas of South Africa. The following article is a review of the available literature followed by a summary of the information gathered during a CRInet survey.

INTRODUCTION
Peteca spot of lemons, also called "rumple" (Knorr, 1963), was identified as early as 1917 in the USA lemon industry (Coit, 1917). This disorder can affect over-mature fruit on the tree but mostly develops 3 to 4 days after fruit has been picked (Oberbacher and Knorr, 1965; Khalidy et al., 1969). Fruit hanging in the east side of trees, as well as large, mature fruit were found to be more susceptible than small, immature fruit (Salerno, 1963; Knorr and Koo, 1969; Grierson, 1981). Mineral nutrition, particularly relating to Ca and B metabolism, and insufficient irrigation during the critical growth period have been identified by Khalidy et al. (1969) to play a role in the development of the disorder. There are also claims that it is exacerbated by heavy oil sprays (Klotz and Fawcett, 1941; J.H. Warrington, pers. comm.). Peteca spot is thought of as a postharvest disorder but is most probably the result of sub-optimal production and environmental factors that could result in high occurrence.

SYMPTOMS AND DEVELOPMENT OF THE DISORDER

Symptoms
Peteca is characterised by deep depressions with round edges on the peel surface (Fig. 1). The symptoms appear after the collapse of an oil gland (situated in the flavedo), leaking the oil into the lower flavedo and albedo cells. The visible browning of the rind (Fig. 2) is probably the result of changes in the gas exchange from the albedo due to the oxygen depletion more than enzymatic browning. The containment of oil within the gland is thus very important, as the release of oil has been implicated in disorders such as pitting and oleocellosis. The cells in the depression are free of abrasions and signs of mechanical injury. Secondary infection may occur in such pitted areas (Labuschagne et al., 1977; Nobel, 1999; Knight et al., 2001).

Mineral nutrients
Lemons with peteca spot had ≥30% decline in Boron (B) compared with unaffected lemons and the affected tissue had ≥23% increase in Calcium (Ca) levels (Storey and Treeby, 2002). Although the results are the opposite to what is expected, the relationship between higher Calcium levels and the increased incidence of peteca spot can be explained as follows. Cells surrounding the oil glands were found to be broken as well as having an abundance of calcium oxalate crystals in peteca spot-affected tissue (Khalidy et al., 1969).

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food (bacteria) and host fruit. Oecologia 87: 394-400.
Rebacker, D.C., Martinez, A.I., Garcia, J.A. and Bartelt, R.J. 1998. Volatiles attractive to the Mexican fruit fly (Diptera: Tephritidae) from eleven bacter-
Gland rupturing could be the result of slow compression and impact loading during the postharvest period, allowing the crystals to puncture the oil glands (Underhill et al., 1988). Alternatively, Ca-oxalate crystals could form as a result of peteca spot development (Storey and Treeby, 2002). Carrying the argument further, it could mean that a cold treatment could be a trigger for Ca-oxalate formation as Artés et al., (1983) showed a higher peteca spot incidence in cold storage and peteca spot development.

Irrigation
Changing the irrigation regime in Lebanon from once every 15 days to once every 20 days, aggravated by relatively shallow soil, resulted in smaller fruit and a higher occurrence of peteca spot. Khalidy et al. (1969) relate this incidence to a water shortage coinciding with the critical growth period of ‘Eureka’ lemons as later varieties showed no symptoms of peteca spot. They concluded that a build up of Ca in the rind and a sudden Ca availability following irrigation could cause the Ca imbalance.

POSTHARVEST PRACTICES
From a comprehensive study of all the different aspects of postharvest citrus handling (Wild, 1991) the following conclusions were drawn:

- The fungicide guazatine had no significant effect on peteca spot development. Due to reports of chemical burns attributed to this fungicide it was the only one used as a treatment.
- Brushing significantly increased peteca spot with the highest incidence of peteca spot occurring when fruit were brushed two or more times (60 or 90 sec) and waxed. [The number of brushes was not specified.]
- Timing of the waxing was significant; the highest incidence of peteca spot occurred when fruit were waxed immediately upon arrival in the laboratory (24 hour delay) and the lowest incidence if waxing was delayed for 3 to 5 days.
- Storage temperature did not significantly affect peteca spot development, but there was a significant wax by temperature interaction. Carnauba (16% solids) wax produced less peteca spot, particularly at storage of <20°C, compared with polyethylene wax (16% solids).

The reason for the higher peteca spot incidence in waxed
lemons is not clear, but could be due to a physiological stress produced by increased internal CO₂ concentrations associated with wax application on citrus fruit (Hasegawa and Iba, 1980). Increased internal CO₂ is known to result in increased organic acid content and could affect availability of Ca, causing a Ca imbalance in the rind (Young and Biale, 1968; Khalidy et al., 1968).

The best quality retention in stored 'Primofiori' lemons was obtained with intermittent warming cycles of 2 weeks at 2(C + 2) weeks at 13(C and RH > 95%). This regime, not previously reported for lemons, prevented the development of Alternaria rot, peteca spot, oleocellosis, rind pitting and reduced the incidence of red blotch Artés et al. (1993). The distinction made by Artés et al. (1993) between pitting and peteca spot was, however, somewhat vague.

**PETECA SPOT SURVEY**

During the May harvest of 2004, which is the major lemon harvest in South Africa, there was a very serious incidence of peteca spot.

The occurrence was not confined to one production area, and reports were received from the northern provinces as well as the Eastern and Western Cape, therefore reducing localised microclimate as a major factor. Following a visit to the Eastern Cape where meetings were held at various packhouses, a questionnaire was sent to producers over CRINet to obtain more information. The table on the previous page is a summary of this information from peteca spot-affected areas.

**CONCLUSION**

Not only is the mechanism responsible for peteca spot poorly understood but the triggers that release the symptoms are also not known. The biggest problem regarding research on peteca spot has been the erratic occurrence of the disorder with sudden huge losses in one year followed by small or no losses the following year. Several researchers in South Africa are currently undertaking various preharvest and postharvest approaches to peteca spot research.

**REFERENCES**


