Cutting Edge
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Blossom-end clearing in grapefruit

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Blossom-end clearing may not be familiar to all South-African grapefruit growers, but it has been observed in some seasons in certain areas, sometimes even on the tree. Fruit showing symptoms cannot be packed but even fruit without any external symptoms but with internal bruising will eventually result in a high incidence of decay.

What is blossom-end clearing?
Blossom-end clearing (BEC) is a postharvest physiological disorder that normally occurs on late harvested (mature), pigmented grapefruit with a thin rind, subjected to normal packhouse handling practices, but the disorder is not limited to these conditions. Although BEC seldom occurs while fruit are still on the tree, it has been observed. Rough handling, especially in the packhouse, is the major cause of BEC, even in fruit picked very carefully in the field. The fruit appears blemished, to a point where the fruit develops off-flavours and becomes susceptible to decay. The disorder is also known as stylar-end clearing, waterlog, water bottom, wet bottom or wet wick.

Symptom development. Although the symptoms can be seen anywhere on the fruit, BEC normally appears as a wet, water soaked and translucent area on the bottom (blossom- or stylar-end) of grapefruit (Fig.1). The impact due to drops or bumps on these aging fruit, ruptures the segment membranes and juice vesicles and allows juice to leak through the open central core to the bottom of fruit into the albedo and eventually into the flavedo resulting in a wet, water soaked or clear area, on the blossom-end or bottom of the fruit.

Figure 1. External symptom progression of blossom-end clearing of grapefruit on the stylar-end (bottom) of fruit from light (left) to severe (right).

Internal bruising is normally visible in all fruit where BEC symptoms develop (Fig. 2). However, some fruit show no external symptoms due to an unaffected flavedo, but have a juice soaked albedo and severe internal bruising, which will eventually result in off-flavours and decay caused by both latent pathogens such as Anthracnose, Diplodia and Phomopsis, as well as wound pathogens. Affected fruit normally show deterioration of the internal spongy core and most segments are open towards the center. These segment membranes and juice vesicles are fragile and cannot withstand a lot of pressure. The deterioration of the spongy core normally occurs naturally as fruit mature and age,

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resulting in a hollow, open central core that can weaken the segment juncture (Fig. 2). In contrast, fruit with an intact spongy central core seem to be more resistant to breaking of the segment membranes and juice vesicles and can absorb the leaked juice much easier than fruit with an open central core.

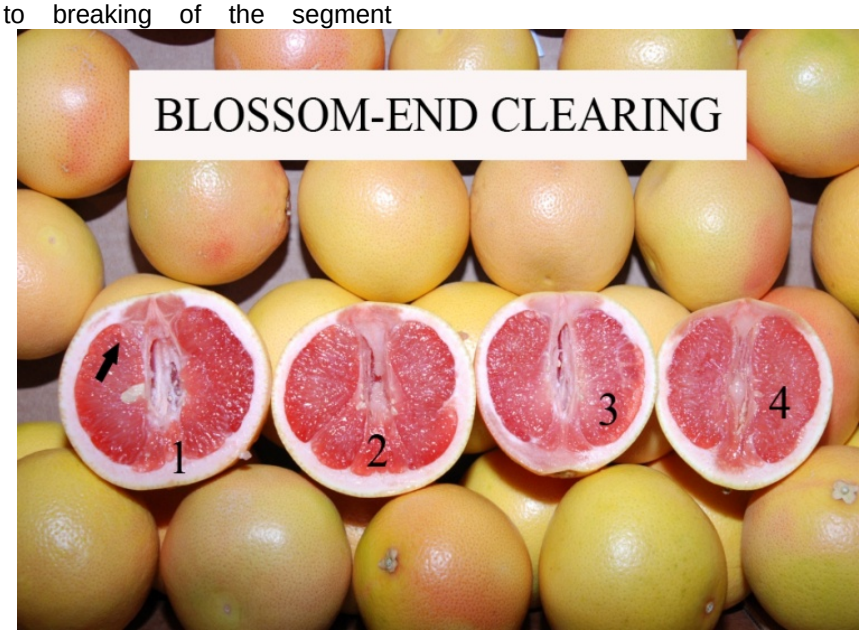

Figure 2. Internal symptom progression of blossom-end clearing of grapefruit from light (left) to severe (right). The blossom- or stylar-end of fruit are on top with the stem-end on the bottom.

Visible symptoms can develop within 24 hours of harvest or impact, a few days after harvest, within 15 minutes or in less than 5 minutes after impact. Faster symptom development may lead to earlier detection of BEC fruit which can then be sorted and culled prior to further handling in the packhouse. The symptoms appear to be similar to stylar-end breakdown of 'Tahiti' limes.

Severity. The incidence of blossom-end clearing differ from season to season and in different areas on the same cultivars. Blossom-end clearing incidence as low as 0.5% or as high as 90% has been reported on Florida grapefruit.

Factors associated with blossom-end clearing and ways to reduce it

Cultivar. BEC is reported more often on red than on white grapefruit cultivars and seedless or nearly seedless grapefruit seems to be more sensitive to BEC, whereas seeded cultivars are seldom affected. In South Africa, BEC occurs mainly on Star Ruby grapefruit with Marsh being affected periodically.

Fruit size. Smaller grapefruit are more susceptible to BEC development compared to larger fruit, especially when fruit are harvested in the hot afternoon. Selective picking of larger fruit, or at least separating small and large fruit at picking can reduce BEC development.

Rind thickness. Fruit with thin rinds (normally smaller fruit) are more susceptible to BEC development than fruit with thicker rinds (normally the larger fruit). The difference in symptom severity between small and large fruit may be related to the amount of albedo tissue (rind thickness) available to absorb the juice released after fruit impact.

Tree condition. Older, weaker trees normally produce fruit that are more susceptible to BEC development compared to young and vigorous trees, most likely due to the production of smaller fruit with thin rinds under these conditions.

Fruit maturity. BEC incidence increases throughout the growing season as fruit becomes more mature and deterioration of the central core most likely occurs; therefore late harvested fruit are

normally more susceptible to the development of BEC. In addition, harvesting later in the season in the Northern Hemisphere (NH) coincides with higher fruit temperatures in the field. The rapid increase in BEC incidence later in the season in the NH coincides with an increase in ambient temperature above 25°C, but under South African conditions we would expect the effect of temperature to have a smaller effect on BEC incidence later in the season. However, a rapid increase in BEC incidence is normally not observed later in the season when fruit are stored overnight at 21°C and packed the following morning.

Time of day of harvesting and fruit temperature at harvest. Typically, temperatures rise and relative humidity (RH) falls as the day progresses. As the time of harvest progresses on a day from 9 am until 3 pm and field temperatures increase from <25°C to almost 35°C, BEC incidence increases, normally reaching a maximum during the hottest part of the day. However, when fruit are harvested during the hottest part of the day, stored overnight at 21°C and packed the next morning, BEC incidence is similar to fruit harvested at 9 am. Therefore, fruit harvested in the morning develop less BEC than fruit harvested later in the day, with the highest BEC incidence occurring when fruit are harvested during the warmest time of the day.

Storage conditions after harvest. Removing the field heat, by cooling warm fruit before packing, reduces BEC incidence, irrespective of the harvest date in the season. Maintaining a high RH during overnight storage even further reduces BEC incidence. Storing fruit overnight at 21°C can reduce BEC incidence significantly, especially when fruit are harvested during the hottest part of the day. Drenching the fruit upon arrival at the packhouse, even if fruit are not being degreened, also reduces the field heat of the fruit and will reduce BEC incidence. In addition, the drench will aid in protecting potentially damaged fruit in the bottom of heavily laden bins against decay. Decayed fruit coming out of degreening should be sorted and culled prior to being packed. Grapefruit that are not degreened can be drenched and allowed to dry and the BEC fruit should be sorted and culled on the packline prior to further packing.

Handling conditions during harvesting and packing. Even though BEC does not normally develop due to picking but as a result of rough handling in the packhouse, pickers and packers, especially outside contracted workers, should be trained before the start of a new season to handle the fruit properly from putting the fruit into picking bags, dumping fruit into bins and/or trailers and also transporting heavily laden trailers over rough roads to the packhouse. BEC incidence and decay will increase with an increased impact on fruit as dropping height from one level to another in the packline is increased. Fruit in the bottom of a bin will have more BEC than fruit taken from the top. Therefore, over-filling of bins and cartons also increases the impact on fruit and increases the BEC incidence and should be avoided.

Fruit temperature at packing. The incidence of BEC is higher in fruit with a higher fruit temperature at packing. BEC incidence can increase from just above 20% to 40% as fruit (storage) temperature at packing increases from 16°C to 37°C with 27°C resulting in an intermediate BEC incidence. Interestingly, fruit stored at 37°C and then cooled to 16°C before packing will have a similar BEC incidence to fruit stored at 16°C.

Relative humidity (RH) of storage. Fruit stored at a higher RH of >95% before packing are more resistant to BEC development compared to fruit at a lower RH of 40% at similar temperatures; possibly due to increased fruit turgidity at the higher RH.

Irrigation. Surprisingly, irrigating trees 24 hours before harvest in an attempt to increase fruit turgidity, had no effect on the BEC incidence compared to fruit from non-irrigated trees.

Recommendations

- At Harvest:
  - Smaller fruit with thin rinds are more susceptible to BEC development than larger fruit.
  - Fruit harvested during the hottest part of the day will result in a higher BEC incidence than fruit harvested on the morning.
  - Fruit harvested later in the season are more susceptible to BEC development than fruit harvested earlier in the season.
  - In a susceptible orchard, especially later in the season, selective picking of larger fruit in the hot afternoon can reduce BEC incidence, compared to picking smaller fruit under these conditions.
  - Separating large and small fruit at picking is also an option.

- Pickers and packers, especially contracted workers, should be trained to handle fruit properly to minimize impact on fruit.

- Postharvest:
  - Removing field heat from fruit before packing reduces BEC incidence and can be achieved by:
    - drenching of fruit upon arrival at the packhouse,
    - cooling fruit
    - overnight storage at ambient temperature

- In Packhouse:
  - A higher fruit temperature at packing will result in a higher BEC incidence.
  - The packing of overmature fruit later in the season can increase BEC incidence and should be avoided.
  - Rough handling in the packhouse and large drops in the packline will increase the impact on fruit and increase BEC incidence and should be avoided.
  - Fruit from susceptible orchards with a history of BEC should be cut regularly after packhouse handling, since internal bruising can occur without showing visible external BEC symptoms. Shipping of these fruit may lead to high levels of decay and should be avoided.

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