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Summary of known management practices to reduce common citrus fruit rind disorders

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Opsomming

Fisiologiese skildefekte het jaarliks 'n negatiewe impak op die Suid Afrikaanse sitrus bedryf. In dié skrywe is vier algemene skildefekte, nl. petekakol van suurlemoen, skilafbraak van Nules Clementine mandaryn, gepokte skil (nie geassosieer met koueskade nie), asook koueskade van verskeie sitrus tipes bespreek. Die faktore wat die vrugte vatbaar maak asook die hantering praktyke om die voorkoms van die defekte te vermy of verminder is bespreek. Die eerste fundamentele beginsel in risiko vermindering van skildefekte is om met rypheidindeksering van alle kultivars ten minste 'n maand voor oes te begin. Dit sal die vasstel van die optimale oesvenster vergemaklik en verhoed dat oorryp vrugte vir die uitvoermark gepluk word. Die tweede aspek is om die vogverlies vanuit die skil tot 'n minimum te beperk in die periode van pluk tot verpakking deur die vrugtempertuur so laag as moontlik te hou (verwyder van veldhitte). Derdens, moet die impak van die paklyn verminder word deur spesifiek aandag te skenk aan alle bewegend dele bv. rollers en borsels asook die waks-tipe en aanwendings metode. Die laaste faktor nl. bestuur van die koueketting, is van kardinale belang in nie net die vermyding van skildefekte nie maar ook in die algemeen om 'n hoë klas vrug suksesvol uit te voer.

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Peteca spot of lemon fruit

The collapse of oil glands 5 to 10 days after harvest or packing resulting in dark depressions on the fruit surface.

1. Factors predisposing fruit to peteca spot

- Warm/dry climatic conditions during the last stages of fruit development, followed by a sudden cold and or wet front, can increase the fruit sensitivity to development of peteca spot.
- A higher incidence of peteca spot occurs earlier on in the harvest window ("immature", green fruit). End-of-season fruit can also be more susceptible due to over maturity, but the incidence is less than at the start of the season.
- Differences can exist between orchards in a production area.

2. Picking and packhouse treatments that influence fruit sensitivity

- Packhouse processes can contribute to higher peteca incidence, i.e. avoid over-brushing and excessive heat in drying tunnels. Brushes should be soft and in good condition.
- Avoid wax with unknown properties (permeability), ensuring movement of CO_2 out of and O_2 into the fruit, while reducing the water loss. Shellac type wax is thought to aggravate peteca spot.

3. Risk management

- Avoid leaving picked fruit in the orchard in direct sunlight, and transport the fruit as soon as possible to the packhouse. Use drenching to reduce the field heat from the fruit. Fruit with a high temperature will have a higher rate of moisture loss from the rind.
- To test for peteca spot sensitivity, sample fruit from 7-10 days prior to planned harvest. Place 10 fruit in a closed transparent plastic bag and check daily as described below for peteca spot incidence to determine the orchard's sensitivity.
- After harvest, place 10 fruit in a closed plastic bag from each batch of bins being received at the packhouse.
- Store at ambient temperature (cool, <20℃) in a well ventilated area to

prevent build-up of CO_2. Check every day for peteca spot incidence and delay packing fruit for another 2-3 days if high incidence is recorded
- Maintain control over ALL factors in the degreening room. Low humidity and high temperature will result in high moisture loss, which negatively affects rind condition. High CO_2 can delay the degreening process. It's thought that high CO_2 concentrations aggravate peteca spot.
- Ethylene treatment on its own is not responsible for peteca spot and has been found to reduce peteca spot.
- Get fruit into the cold chain as soon as possible after packing. Do not break the cold chain, as it will result in a rise in respiration, dehydration and reduced quality.

Non-chilling rind pitting of citrus fruit

Round, randomly-distributed depressions occurring on the fruit surface at storage temperatures above 4℃. Normally it becomes visible between picking and shipping (<15 days).

1. Factors predisposing fruit to rind pitting

- Fruit from trees on heavy clay soils are thought to be more prone to rind pitting
- Fruit from trees on citrange rootstock are more prone than those on rough lemon.
- Fruit picked when trees are flushing or flowering can aggravate pitting.
- Cultivar differences (genetic factors) play a vital role in susceptibility, *viz.* Turkey Valencia has a higher sensitivity to rind pitting than Delta Valencia.
- Picking of fruit before their historical harvest window for a specific production area could lead to more sensitive fruit (fruit rind still immature). An immature (green) fruit is more susceptible to mechanical damage during postharvest handling.
- Small fruit with weak colour development from inside the canopy are more susceptible to rind pitting.
- A heavy crop load year after year could increase the incidence of rind pitting.
- Insufficient sunlight in the canopy, due to inadequate pruning will increase the risk of rind pitting due to a weak rind condition (low carbohydrate and pigment content in the rind).
- Heavy water stressing of trees in the weeks before harvest will reduce rind moisture content and negatively affect rind condition. This will result in a dehydrated rind with insufficient moisture content.
- Below optimum irrigation, especially during conditions of high evapo-transpiration (high temperature, wind speed and low RH%), could negatively influence the water balance of the fruit rind, which is suspected to be detrimental to rind condition.
- The development of rind staining at the stem-end area of the fruit, as well as pitting (sunken "chocolate spots" between 0.5-1 cm in diameter) of late mandarins (e.g. Nadorcott), are suspected to be related to the rind moisture balance. A higher incidence of rind disorders have been reported in mature Nadorcott orchards on single-line drip irrigation systems**.**
- Late nitrogen applications and high N levels are thought to result in fruit being more sensitive to rind pitting.

2. Picking and packhouse treatments influencing fruit sensitivity

- Sudden changes in relative humidity (RH) after picking and prior to packing can result in the development of rind pitting, e.g. harvesting at low RH followed by a high RH (e.g. 45% and 90%) can cause rind pitting. This change influences the moisture balance in the rind, which is thought to lead to cellular collapse in the rind.
- Dry windy conditions, leading to dehydration of the rind, may increase the risk of postharvest rind pitting.

- Temperature management is vital to reduce the loss of moisture from the flavedo during low RH conditions.
- Reduce the temperature of the fruit (field heat) as quickly as possible directly after harvest. The rate of moisture loss after harvest is directly related to fruit temperature and a high temperature will increase the rate thereof.
- By reducing the rate and therefore amount of moisture loss from the rind, disorders such as SERB, zebra skin of Satsuma, rind pitting of Navel and Valencia and rind staining of late mandarin, could be avoided or reduced.

3. Risk management

- Start and finish picking within the cultivar's optimal harvest window.
- Determine this window by monitoring maturity parameters (°Brix, acid, ratio and colour development) and compare this with historical optimum harvesting dates for the cultivar in the area: early harvesting of "immature" fruit will increase rind susceptibility. Fruit hanging beyond the optimal window could be highly susceptible due to respiration depleting the rind carbohydrates.
- Avoid harvesting immediately after a cold front, the dramatic temperature changes will increase the incidence of rind pitting.
- Postharvest thiabendazole (TBZ) applications at the recommended postharvest concentration can reduce the incidence of rind pitting.
- Waxing of sensitive fruit will aggravate the incidence of rind pitting, but this is not the cause. Use waxes with good gas exchange capability.
- It is critical that the fruit should be placed into the cold chain as soon as possible.
- Do not break the cold chain once it has started.

Rind breakdown of Clementine (progressive)

The occurrence of random dark spots which increase during storage. Rind breakdown is related to oil gland collapse.

1. Factors predisposing fruit to rind breakdown

- Fruit from the inside of the tree canopy have a significantly higher incidence of rind breakdown (RBD).
- Smaller fruit with weak colour development (yellow) are very susceptible to RBD.
- Fruit from dense, insufficiently pruned orchards that receive less direct sunlight are more susceptible.
- Low Mg and Ca levels in the tree can lead to more susceptible fruit.
- Fruit with lower acid (from warmer areas or post-optimum maturity) have a higher risk of RBD.
- Fruit from orchards receiving late nitrogen applications could be more sensitive.

2. Picking and packhouse treatments influencing fruit sensitivity

- Delaying the time before starting cold storage will increase the occurrence of RBD.
- Degreening increases the incidence of RBD, but it is not the causal mechanism of RBD.
- All packhouse handling practices influence fruit rind condition. Reduce the physical impact of the pack line on fruit by limiting the number of brushes, decreasing brush speed as well as the high temperature exposure in drying tunnels.

3. Risk management

- Ensure high levels of light penetration into the tree canopy by pruning. If the canopy is dense and the majority of fruit hang inside the canopy during fruit growth, a rind with pale (yellow) colour will develop.

- The risk of RBD is higher in small lightly coloured fruit and these should not be packed for export.
- Reduce the crop with thinning agents after fruit set as a heavy crop of small fruit could be more RBD sensitive.
- Start with maturity indexing in the weeks prior to the planned picking date. If internal quality (°Brix, acid, ratio) has reached cultivar specifications, pick as soon as the rind colour has developed adequately for effective degreening. Do not harvest over-mature fruit (low acids, prolonged colour development in warm areas) at the tail-end of the harvest window, these fruit are highly susceptible to rind disorders.
- Remove the field heat from fruit as soon as possible by drenching and storing in a cool, well-ventilated area prior to packing.
- Pick selectively to get uniform colour in the bin. Mixed colour and maturity leads to over and under-degreening.
- Maintain a high level of control over ethylene and CO_2 concentrations, RH and temperature in the degreening room.
- Place packed fruit into the cold chain as soon as possible after packing, and do not break the cold chain.
- Shipping temperatures of approximately 7°C increase the occurrence of RBD, shipping temperatures of approximately 4°C result in less RBD.
- Rind breakdown of Nules is progressive; if symptoms are visible prior to shipment, the incidence of RBD will increase. Repacking may thus not solve the problem of RBD developing further.

Chilling injury

Pitting or scalding of the rind when cold storage temperature is below 0°C.

1. Factors predisposing fruit to chilling injury

- Citrus fruit are susceptible to chilling injury (CI) if they are held at temperatures regarded to be below the cold tolerance threshold for the specific cultivar for a certain length of time.
- The severity of chilling injury is dependent on the duration of storage at a temperature below the critical threshold for a cultivar.
- Fruit maturity influences CI susceptibility, e.g. fruit harvested at the start and end of the picking window are thought to be more CI susceptible.
- Cultivars differ in susceptibility to CI, e.g. Clementine < Navels < Valencia < Grapefruit < Lemons < Limes (most sensitive).
- In addition, susceptibility differs within cultivar groups, e.g. Nules < Nova mandarin, Marsh < Star Ruby grapefruit, and Lisbon < Eureka lemon.
- Differences in CI susceptibility can vary between orchards of the same cultivar in a production area due to microclimatic influences, e.g. orchards lower in valleys can be more prone to CI.
- Seasonal differences in climate (rainfall, temperature and humidity) will result in year-to-year variation in CI susceptibility.
- Fruit with poor colour development are more CI susceptible.

2. Picking and packhouse treatments influencing fruit sensitivity

- Harvesting of immature or over-mature fruit increases the risk of CI. Do maturity indexing (°Brix, acids, ratio versus colour development).
- Harvesting citrus fruit after a long wet, cold front increases the CI risk.
- Dry windy conditions, leading to dehydration of the rind, may increase the risk of CI, rind staining and zebra skin.
- Packhouse treatments that can cause damage to the rind should be avoided, e.g. check number, softness, speed and time on the brushes.
- Insufficient wax application/coverage will result in more CI symptoms.
- Too fast pre-cooling or cold air blasting can lead to CI (scalding).

3. Risk management

- Do not pack fruit with poor colour development. Fruit developing inside the canopy have low pigment and carbohydrate content in the rind and are more susceptible to CI.
- Cull all fruit with a sunburn blemish before colour break (colour break could mask sunburn blemish). The rind around the sunburn lesion is highly susceptible to CI.
- Start maturity indexing at least 1 month before harvest (°Brix, acid, ratio and colour development). This will help to determine the cut-off dates for harvest.
- Ensure optimal wax application.
- Use a warm water fungicide bath (35-40°C).
- Grapefruit and lemons should be cured (wilted) at ambient temperature for 3 days prior to shipment for markets which require in-transit cold sterilisation.
- Use of postharvest TBZ can reduce CI susceptibility.
- Avoid any additional exposure to temperatures below 4°C in the logistical cold chain.
- ***CI severity is a factor of time x sub-optimal temperature, it must therefore be the primary focus to reduce the time that fruit will be subjected to chilling temperatures in the postharvest handling chain.***