PHYSIOLOGICAL DISORDERS

Creasing

Fruit splitting and bursting

Sheepnose in grapefruit

Oleocellosis

Rind pitting

Granulation and core-drying of oranges

Stem-end rind breakdown

Peteca spot in lemons

Endoxerosis in lemons

CREASING

Creasing has been a major problem in navels in the Eastern Cape (particularly in the Sundays River Valley) in recent years. Creasing losses in some orchards often exceed 50% towards the end of the harvest season. Losses in Valencias may also be considerable. Creasing in other production areas does not generally reach the same proportions as in the Eastern Cape but can be significant.

Creasing incidence is low at the start of the harvest period for a cultivar. It increases as the picking season progresses and the peel matures and becomes over mature. Creasing incidence is usually worse on trees on trifoliate and trifoliate hybrid rootstocks (e.g. Troyer and Carrizo citranges, Swingle citrumelo) than on rough lemon or Volckameriana rootstocks. Sweet orange and mandarin rootstocks give intermediate creasing. Creasing is usually greater on trees bearing a good crop particularly if the average frit size is small and the peel thickness relatively thin. More creasing fruit are found on the northern side of the trees (sun side) than the southern side and the area of the fruit surface facing towards the inside of the trees shows the most creasing.

Besides crop load and fruit size, many other factors influence the amount of creasing that develops. Insufficient water or extended intervals between irrigations between early December and harvest undoubtedly play a role in creasing development. If the irrigation water is saline, stress is aggravated. In production areas with severe creasing, salinity is usually a factor. High nitrogen, high phosphorus and low potassium leaf analysis values are associated with more creasing development. The underlying genetic make-up of the scion material in each particular orchard also plays a role in determining how much creasing will develop. This is illustrated by the extreme susceptibility of the Mediterranean Sweet, a midseason orange cultivar and, to a lesser degree, by the greater susceptibility of nucellar scion selections such as the Palmer navel and the Olinda and Frost Valencia compared with old line selections.

Creasing incidence varies from year to year; in some years there is considerable creasing while in others it is hardly seen at all. Sudden changes in climatic conditions (particularly temperature) in the November to March period determine how much creasing will develop from year to year. A sudden change from cool day and night temperature conditions over three to four days to high maximum day temperatures, particularly when these are accompanied by a hot, dry wind, leads to increased creasing potential.

1. Creasing at cellular level

Creasing is a peel disorder in oranges in which the albedo (the white pithy part of the peel) is torn at one or more places inside the peel. The tears do not appear in the flavedo (the orange-coloured part of the peel) or in the epidermis (the outer cell layer of the peel). The torn (creased) albedo makes the fruit more liable to splitting and bursting during handling. Creased fruit are also more likely to develop decay.

Creasing arises as a result of the tangential stretching of the peel tissue during fruit growth after cell division has ceased in the albedo. Cell division ceases in this region about 63 days after full-bloom and further expansion depends on the capacity of the cell walls to stretch. The flavedo and epidermal cells continue cell division and can easily accommodate the tremendous pressures that arise from growth and development of the endocarp (the fleshy edible part of the fruit). The albedo cells are considerably stretched. They change their shape from a slightly greater radial than tangential measurement to having a much greater tangential dimension. The capacity of the albedo cell walls for stretching determines whether creasing will develop. If the cell walls cannot stretch easily creases or tears appear under the oil cells first and then later spread. Changes in temperature and moisture availability cause fluctuations in the rate of fruit growth and this in turn affects the extent and speed the cell walls of the albedo have to stretch. This will determine whether the potential for creasing imparted early in fruit development will be exhibited or not.

2. Measures for reducing creasing losses

There are six steps that should be followed by growers with a creasing problem. When the creasing losses are not severe (less than about 10% export cull at the packhouse) the action suggested in the first five steps detailed below is probably sufficient because a gibberellic acid spray (the sixth step) would not be economically justified. The six recommendations for reducing creasing are:

2.1 Irrigation frequency

The trees must not be allowed to suffer severe water stress between August and February.

2.2 Potassium

Potassium levels as measured on leaves picked in the previous February to May should be raised to at least 0.9% K by application of potassium chloride or potassium sulphate to the soil or with potassium nitrate foliar sprays. Both soil and foliar applications are made in the spring to early summer period. Full recommendations are presented in the section "Fertilization of Citrus" also in this volume.

2.3 Nitrogen

High nitrogen levels have been found to be associated with high creasing incidence – probably because of its role in inducing larger yields and smaller fruit. Fertilizer applications must be aimed at achieving nitrogen leaf levels within the following ranges:

	Optimum leaf nitrogen range %
Navels	2.4 – 2.6
Valencias – hot areas	2.3 – 2.6
- cool areas	2.1 – 2.3
Midseason oranges	2.1 – 2.3

2.4 Nematodes

Nematodes interfere with the ability of the roots to absorb potassium and other nutrients; also water. Trees with excessive

citrus nematode levels (root counts greater than 1 000 per 10 grams roots or soil counts greater than 10 000 per 250 ml soil) should be treated with a nematicide.

2.5 Soil conditions

Soil conditions for healthy root growth and development are essential. Soil layers into which the roots cannot penetrate within the top 600 mm of soil need to be broken up; saline soil conditions should be avoided by regular controlled leaching; clay soils should be avoided; and *Phytophthora* root problems should be treated with metalaxyl (Ridomil), fosetyl-Al (Aliette) or phosphorous acid (phytofos).

2.6 Gibberellic acid (GA)

GA is effective in reducing creasing but the spray has to be applied long before any creasing is evident on the fruit. (Treatment details and dosages are given later). Growers have to decide whether to spray GA on the basis of the previous creasing history of each orchard and the status of the orchard in relation to the following aspects that promote creasing development:

i) A heavy crop of small-sized fruit. Orchards bearing more than seven fruit per fruit counting frame (0.5m x 0.5m x 0.5m frame) on average are creasing-prone if other factors are unfavourable.

ii) Extended periods between irrigations during the December to February period leading to water stress; hot, dry weather during this period; hot, dry winds, saline soil and saline water.

iii) A sudden change from cool night temperature conditions over three to four days in the November to January period to high maximum day temperatures.

iv) High leaf nitrogen (>2.6% N) and low leaf potassium (<0.9% K) values.
v) An excessive citrus nematode population level (nematode root counts greater than 1 000 per 10 g roots or soil counts greater than 10 000 per 250 ml soil) influencing potassium uptake and general root activity.
vi) Fruit from trees on trifoliate or trifoliate hybrid rootstocks develop more creasing than fruit on trees of rough lemon.
vii) Nucellar scion selections such as Palmer navel and the Olinda and Frost Valencia develop more creasing than the old line selections.
viii) Close-planted orchards generally have more creasing owing to a greater proportion of the fruit being borne on the upper sun-exposed portion of the canopy.
ix) When it is possible to harvest early it may not be profitable to spray GA. Creasing incidence increases as the picking progresses but is usually very low during the first two weeks. It is often preferable to avoid applying GA to trees that are planned to be picked during the first two weeks. Fruit colour development is delayed by the GA and may cause a delay in picking if there is cool overcast weather in this period. Furthermore, the fruit treated with GA is more susceptible to oleo damage in this period because it is greener.

A laboratory technique for predicting creasing is presently under investigation.

3. GA spray application

3.1 Spray timing

i) The spray is applied during the period mid January to early February. In creasing-prone areas, creasing is usually not a cull factor during the first one to two weeks of the normal packing period (NPP) of each cultivar and no GA treatment is therefore needed for the fruit packed during this period. Creasing incidence after this increases rapidly on trees on susceptible rootstocks such as Troyer and trifoliate, and less rapidly on the less susceptible rootstocks such as rough lemon and Volckameriana. It is therefore advisable to treat all of the remainder of the former category in each cultivar with GA and pick them first after the first one to two weeks of the NPP (exception to this; do not spray trees close to large windbreaks). Creasing usually develops more severely in trees close to windbreaks. These should preferably be picked in the first two weeks of picking and not treated with GA. The spray treatment for the susceptible rootstock category is applied in January to February (see GA strategy below). The remaining fruit on the less susceptible rootstocks that is picked at the end of the NPP may also benefit from GA treatment.

3.1.1 GA strategy against creasing

The navel NPP is usually about nine weeks.

Fruit packed during first two weeks – pick fruit from trees on susceptible rootstocks and close to windbreaks. No GA needed.

Fruit packed during the next three weeks – pick fruit from trees on susceptible rootstocks that have been treated with GA in January/February.

Fruit packed during the next two weeks – pick fruit from trees on less susceptible rootstocks. No GA needed.

Fruit packed during the last two weeks of NPP – pick fruit from trees on less susceptible rootstocks that have been treated with GA in January.

3.1.2 Spray application

The spray is applied 70 to 100 days after petal drop when the fruit is 35 to 55 mm diameter (table tennis to golf ball diameter).

In the Eastern Cape this corresponds to mid January until the end of the first week in February. Earlier spray application is less effective. A later spray is effective but will cause poor fruit colour at harvest time, particularly during the earlier part of the picking period. (Note also point (iii) in the section "Orchards suitable for GA application" presented later).

The recommended GA spray concentrations are as follows:

Navels	Rough lemon rootstock	10 ppm GA + surfactant
	Troyer and Carrizo rootstocks	20 ppm GA + surfactant
Valencias	All rootstocks	20 ppm GA + surfactant

The surfactant is added at a rate of 25 ml per 100 litres of spray mixture. Surfactants that have been used successfully include Agral 90, Agricura G49, Citowett and Agrowett.

Consider acidifying the GA spray. See the chapter "Crop Manipulation" for further details.

Poor spray coverage on the fruit and foliage gives poor results. GA does not translocate readily.

3.2 GA spray on Valencias

In Valencias creasing also frequently causes substantial losses in particularly the saline areas of the Eastern Cape but also in other production areas in Southern Africa. Creasing is mainly found in Valencias on Troyer rootstock and can be reduced to a minor problem by the application of a GA spray in January.

3.3 Spray application

The quantities of the commercial formulations needed per 100 litres for a 10 ppm GA spray are shown below. The spray should be applied to wet the trees fully at 1x strength. Note that poor wetting gives ineffective results. The GA spray mixture is compatible with all spray materials that are not alkaline or physiologically alkaline. It is most important that the spray is not applied to wilted trees and that the trees are not subjected to water stress after spraying.

There have been problems when GA has been used with a narrow range spray oil (e.g. Cipron, Bac-oil) applied during December to January for red scale control, i.e. at oil concentrations of 1% and higher. Mixing of GA and oil is therefore not recommended at concentrations of 1% and higher. The GA must be applied before the oil or at least two weeks after the oil spray.

3.4 Spray cost

The chemicals in the spray mixture cost about 5.6 cents per litre for a 10 ppm spray (September 1994). The cost of spraying a tree needing 10 litres will therefore be 56 cents for materials and about 20 cents for equipment and labour costs, altogether 76 cents per tree. At 20 ppm GA the cost for a similar sized tree would be R1.32. GA spraying is expensive but an export yield improvement of just one carton per tree should make GA spraying a profitable proposition. This is easily achieved by improving pack-out by 20% or thereabouts.

3.5 Orchards suitable for GA spray application

i) There should be a good yield of small or medium-sized fruit on the trees. When there is a low yield the fruit is usually large-sized and the creasing incidence is low.

ii) Packhouse cull for windscar and thrips should not exceed about 20% of the total yield. GA sprays cause darkening of the thrips and windscar marks on the fruit surface. Packhouse cull for these factors is increased by about 50%. Thus, if the windscar-thrips cull without a GA spray would have been 20%, it will be 30% following a GA spray.

iii) Water stress on trees after treatment with GA nullifies any favourable effect on creasing. Growers in areas that may have shortages of irrigation water and periods of heat during the late summer after applying GA (i.e. in February to March) should consider applying GA in May. This applies particularly to areas such as the lower Olifants River north of Citrusdal where water supplies in the river are often low in the late summer. Do not spray tree rows close to large windbreaks because these often develop periodic water stress.

Active ingredient	Quantity commercial formulation per 100 litres	Company
10 ppm gibberellic acid	31 ML Pro-Gibb liquid OR 1 tablet – Berelex	Abbott Laboratories Zeneca
0.025% surfactant	25 ml Agral 90	Zeneca

FRUIT SPLITTING AND BURSTING

Fruit splitting and bursting has caused considerable losses in Valencias in the Malelane and other Transvaal and Natal areas during recent years. Losses of 3 to 5 % are common. In some orchards 25 to 30% of the fruit split and drop off the trees. Heavy losses may also occur in Tambors, Ellendales, Novas, Lane Late navels and Midknight Valencias. Splitting in the latter group is largely stylar-end splitting whereas in Valencias the splits occur on the cheek of the fruit as well as at the stylar-end.

Splitting pattern. Comparatively few Valencia fruit split and then drop in the first few weeks of the harvest period. Splitting incidence increases as the fruit becomes more mature on the tree. The split fruit normally hang on the tree for a few weeks and then drop off. Other cultivars have a different splitting pattern. Most splitting in the Ellendale, for example, occurs approximately two months before harvesting starts (in April in Swaziland) and tapers off to zero about one month before harvest.

Decay. In addition to the fruit that are lost through splitting in the orchard, there are further losses due to the decay that develops from the fruit that split after packing. The fruit split at weak point sin the rind when they are subjected to pressure in the packed carton in a stack. Splitting after packing may account for the unusually high decay suffered by certain packhouses in some seasons.

High splitting incidence is associated with orchards bearing high yields of small thin-skinned fruit. Rootstocks (e.g. Cleopatra mandarin) and scion varieties (e.g. old line Valencias) that tend to give this combination are more prone to splitting. Splitting is not usually a problem in low-yield orchards where the fruit is large and comparatively thick-skinned. There is a large tree-to-tree variation in all orchards with a splitting problem. This is not associated with the visual condition of the trees. Trees with a considerable splitting loss stand right next to similar trees with no sign of splitting. Recent research has nevertheless shown that management practices are an important aspect and that irrigation is probably a vital factor.

Fruit development and splitting. Potential for splitting is determined during early fruit development. Splitting has many similarities to creasing and was originally thought to be simply an extreme form of creasing. New information indicates that this is not so although potential for splitting also occurs within the first few weeks after petal fall. Splitting does not respond to the gibberellic acid (GA) spray treatment as recommended for creasing.

A survey of 26 Valencia orchards in the Malelane area during 1980 showed that all the orchards with severe splitting had a **low leaf potassium level** (<0.8% K), and that all the orchards with a leaf K level above 0.9% did not have high splitting levels. All the orchards with a low leaf K did not have a splitting problem, only some did. This seems to indicate that adequate potassium helps the tree withstand the conditions leading to splitting development in the fruit. Potassium nitrate sprays applied in low-K splitting-prone orchards at various timings were however, **not** successful in reducing splitting in a two year trial series. GA sprays at up to 20 ppm concentration at various spray timings were also unsuccessful. The only treatment which gave some reduction in splitting incidence was the application of a nematicide where the nematode count indicated this was necessary (root counts greater than 1000 per 10g roots or soil counts greater than 10000 per 250ml soil). Splitting incidence reduction occurred in the second season after treatment began. This might have been associated with improved root growth and an enhanced ability to withstand a high evaporative demand.

The **best approach to reduce losses through splitting in Valencias** is probably to avoid it by applying a **calcium arsenate** spray. This will give earlier maturity and the opportunity to pick the fruit before serious splitting occurs. Details are presented in the section on crop manipulation. Calcium arsenate is applied commercially in many orchards with a splitting problem.

Research is in progress to determine the best approach to reduce losses from splitting on a direct basis. Some success has been achieved with calcium nitrate spray applications but no recommendation is possible at this stage. It is however possible to predict the potential for split soon after petal fall such that appropriate arrangements for early harvest can be made.

"SHEEPNOSE" IN GRAPEFRUIT

1. Description

Sheepnose is the term used to describe pyriform-shaped or "necked" grapefruit. In its more extreme form it is an export fruit cull factor. Sheepnose becomes more pronounced during the harvest period. Fruits with little or no sheepnose at the start of the harvest season gradually become more pyriform-shaped as the season progresses until at the end of the packing period there is a substantial cull. The final degree of sheepnose development is determined at a very early stage for each individual fruit. It is possible to predict that individual fruit will become sheepnosed four to six weeks before flowering by examining the flower buds. The floral apices of buds which form pyriform fruit have wider and more robust gynoecia. The sheepnose fruitlets also have a different shape in the following few months of fruit development.

2. Factors influencing sheepnose

Weather conditions during the winter preceding flowering play a role in how much sheepnose develops. Observations have shown that the greater the difference between day and night temperatures during the pre-bloom period, the less sheepnose is found in the following season.

Another factor that plays an important role is the carbohydrate-reserve level in the tree at the time of blossom bud formation and early fruit development. Fruit from trees with high carbohydrate reserves are relatively free from sheepnose.

3. Methods for reducing sheepnose

Various methods can be tried to reduce the incidence of sheepnose.

i) **Early** picking each season in sheepnose-prone orchards gives the trees the opportunity to build up their carbohydrate reserves in the period between harvest and flowering. Early picking also avoids the later part of the harvest period when sheepnose becomes more pronounced.

ii) **Late** picking gives less opportunity for carbohydrate build-up, often leading to an increased sheepnose cull in the following season.

iii) Extending the grapefruit harvest season with GA sprays should be avoided in sheepnose-prone orchards.

iv) Pre-blossom girdling has been claimed to reduce sheepnose but has not been tested in South Africa.

OLEOCELLOSIS

1. General Description

Oleocellosis (oleo) is a common peel injury occurring during harvest and packing. The injury arises when oil cells on the peel surface are ruptured during picking or subsequent handling in the field or the packhouse. The oil released on to the peel surface destroys all surface cells with which it comes into contact except unruptured oil glands. Irreversible damage is done within a very short time. The result is a blemish with a slightly sunken surface dotted with unbroken and protruding oil cells. The colour of the blemish can be green through orange to brown or black, depending on the fruit condition when the damage was done and the ambient temperatures afterwards. The first blemishes are recognisable 24 hours after the mechanical injury has taken place and all spots develop within four days. The blemished areas generally become softer than the rest of the fruit and are susceptible to invasion by decay organisms.

2. Conditions for susceptibility to oleo

The fruit are susceptible to oleo damage when:

i) **the cells on the surface of the peel are fully turgid** (the cells full of liquid and their cell walls tightly extended). When they are fully turgid even the most gentle handling will result in oleo. The peel surface cells are fully turgid during two periods:

   a) for a few days after rain or irrigation, the length of time depending on the weather conditions and the soil type; and
   b) in the morning during the period before ambient temperatures rise to the level where transpiration reduces full turgidity in the surface cells. This corresponds roughly to the time before the dew on the leaves of the trees has evaporated. (See the next section "Measures for avoiding oleo" for more details).

ii) Even when the fruit is not fully turgid it is susceptible to oleo when:

   a) the tree is producing a leaf flush or just before a leaf flush;
   b) the fruit is green (or greenish);
   c) there is cold and wet weather;
   d) the nitrogen leaf analysis levels are too high or there have been soil or foliar applications of nitrogen made too close to harvest-time (i.e. within three months); and
   e) when pesticide oil and gibberellic acid sprays have been applied too close to harvest.

3. Measures for avoiding oleo

Avoiding oleo involves following a series of procedures which will reduce the chances of damage.

3.1 Correct nitrogen levels

Adjust the leaf nitrogen level of the trees to within the recommended range.

For mature trees (eight years old and older) the optimum levels for samples taken in February to May are:

	Optimum leaf % N range
Navels	2.4 – 2.6
Valencias – hot areas	2.3 – 2.6
- cool areas	2.1 – 2.3
- young trees (<8 years)	2.4 – 2.6
Midseason oranges	2.1 – 2.3
Tangelos	2.3 – 2.5
Satsumas	2.1 – 2.3
Clementines	2.1 – 2.3
Grapefruit	2.3 – 2.5

When the N level is above this range it should be reduced by cutting on the soil application of nitrogen in July (normally limestone ammonium nitrate (LAN) or ammonium sulphate). A reduction of about 250g LAN per tree less than the dosage given in the past is usually recommended but this depends on individual circumstances. When potassium nitrate sprays are applied as two 4% sprays in October to December a further reduction of the July soil application is recommended. A reduction of 250 g LAN per tree for each potassium nitrate spray is normally sufficient.

3.2 Fruit colour

If possible pick the better-coloured orchards first and avoid picking trees with a heavy leaf flush. If such orchards must be picked for some reason, consider application of a pre-harvest Ethrel spray (see 3.7 below).

3.3 Irrigation

Stop irrigating at least two to three weeks before picking. The trees should be under a light water stress at harvest-time. This is very important in orchards planted with the rows running east to west. The south side of the trees in these orchards dry out very slowly so the last irrigation on the south side of the trees needs to be done far ahead of picking.

3.4 Climatic conditions

Fruit are particularly susceptible to oleo damage after rain (more than 6 mm) because the surface cells of the rind become fully turgid. The fruit from trees on a sandy soil remain susceptible for about one day after rain while fruit from tree son heavier soils may remain susceptible for up to four days. Two alternatives may be followed after rain: either wait for one to four days, depending on soil type and weather conditions, before starting to pick again; or else continue picking as soon as the trees are dry but wilt the fruit for 24 to 48 hours at the packhouse before packing and remove oleo-damaged fruit on the sorting belt.

The fruit are usually susceptible to oleo damage when picked in the early morning. The oil cells on the surface of the rind become fully turgid overnight and are easily ruptured. As temperatures rise and the relative humidity falls, the surface cells become less turgid. Their susceptibility to oleo is reduced and finally disappears. Various approaches are used to determine when it is safe to begin picking.

iii) The simplest is to start only when the morning dew has evaporated completely and the trees and any orchard grass and weeds are dry. But this procedure is no good when there is no dew – and even if there is dew, it is not reliable under all circumstances (e.g. in overcast and cool weather).

iv) Some co-ops and large estates start picking when the relative humidity is less than 70%, and they claim this method works well. But the hygrometer is often at the office and does not give a reflection of conditions in the orchard.

v) Some authorities recommend picking when the air temperature exceeds 12°C. This advice may reduce the danger of oleo but it certainly does not eliminate it.

vi) The best method that works well under all conditions is described in 3.5.

3.5 Oleocellosis susceptibility measurement

The determination of whether the fruit in an orchard are susceptible to oleo damage depends on two separate tests. They involve the use of a sling hygrometer, a thermometer (a meat thermometer with a pointed tip is easiest) and an Effigi Model FT 011 fruit pressure tester. The tests are carried out sequentially. Conditions must be satisfactory according to the first test **before** the second test is carried out.

1st Test – a positive vapour pressure gradient from the fruit to the surrounding air is needed. To test when this is achieved proceed as follows:

a) Inset the thermometer (a sharpened probe can be purchased for most digital thermometers) into the rind of a fruit on the south side of the tree at about knee-height. The bulb of the thermometer should be in the rind, not into the vesicles.
b) Determine the wet-bulb temperature using a sling hygrometer standing on the south side of the tree in the shade (out of full sunshine). The wet-bulb sleeve must be fully saturated with distilled water before the determination, and the sling hygrometer must be turned vigorously for at least 30 seconds.
c) It is safe to pick when the fruit temperature exceeds the wet-bulb temperature by 3°C.
d) The basis for the recommendation is that when this condition is reached there is a vapour pressure gradient from the fruit to the surrounding air. The fruit is able to lose moisture and excess turgidity to the surrounding air. A difference of 3°C is safe for green fruit (T4 and greener) while 2°C is safe for fruit that have developed a better colour (T2 and T3).

2nd Test – Rind Oil Release Pressure (RORP). As mentioned previously, the fruit in some orchards are susceptible to oleo even when atmospheric conditions allow the fruit to lose excess turgidity (the first test). The reason may be that the tree is able to replace the water lost by transpiration easily because the roots readily take it up from supplies in the soil. This is easily tested by determining the RORP in the orchard with an Effegi Model FT 011 (Effegi, 48011 Alfonsine, Italy).

a) The test is carried out at a time in the day when atmospheric conditions are suitable for picking (i.e. the fruit temperature exceeds the wet bulb temperature by 3°C). It cannot be done before this time as the RORP values change early in the day due to moisture transfers within the tree. Earlier readings tend to give higher RORP values producing a false sense of security.
b) The test is done on any fruit that has not been exposed to the sun that day. Preferably select inside fruit or south side fruit.
c) **RORP test procedure**. Use the 6mm diameter tip (the small tip in the Effegi pack) and attach it to the Effegi penetrometer or fruit pressure tester. Place a single sheet of toilet paper on the fruit surface and hold the penetrometer at right angles to the fruit surface at the fruit equator. Press the tip against the fruit, slowly increasing the pressure until an oil cell bursts and the toilet paper becomes wet. Release the pressure immediately the rind oil is seen on the toilet paper. The pointer on the pressure gauge dial will record the highest pressure reached and this is the RORP for the fruit tested, shown in kilograms. The test can be carried out with the fruit still attached to the tree.
d) **Evaluation of the test results**. The RORP test is repeated on a minimum of 20fruit in each uniform orchard unit not exceeding approximately 500

trees. The result of each test is recorded. The threshold RORP value below which oleo may be expected on any individual fruit is 3 kg. Fruit giving readings above 3 kg will not develop oleo; fruit with readings below 3 kg may develop oleo, depending on the actual threshold RORP in that particular orchard and the roughness with which the fruit is handled.

For each fruit in the 20-fruit sample that gives a RORP reading of 3 kg or less, the grower can expect to find about 5% (1 fruit in 20) showing oleo following picking. The severity of the oleo on each fruit will not necessarily be enough to classify that fruit as an oleo reject, but it could be, depending on how roughly the fruit is handled during picking.

e) **Sample size**. The fruit to fruit variation in RORP values on the tree and in an orchard is rather high (coefficient of variation is usually 15 to 20%). Within a 20-fruit sample with a mean of 3 kg it would be normal to expect RORP readings between 1.7 and 4.3 kg – this is for a fruit sample taken as specified using inside-fruit not exposed to the sun, or fruit on the southern side of the trees. The wide variation emphasizes the importance of taking the sample from the correct lace on the trees (RORP values on sun-exposed fruit are always higher) and taking sufficient numbers of fruit in the sample. A 20-fruit sample is a minimum number to obtain a reliable result.

3.6 Handling

Avoid rough handling during picking. Damage often occurs at the time the fruit is tipped from the picking bag into the trailer. Pickers should not run with full bags. The fruit must be gently tipped into the trailer from the top-opening of the bag and any sticks or debris removed. Long stems should be avoided. Dye testing can be used to detect “rough” pickers.

No sand or dirt must be allowed in the picking bags or trailers. Empty trailers returning to the orchards must be carefully swept before any fruit is packed into them. Picking bags must not be allowed to get damp as grit and sand then stick on their surface.
Fruit dropped on to the ground during picking must be left there. Low-hanging fruit, which have sand adhering to their surface, should be picked separately and stored for two to three days apart from the other fruit. It is then graded for oleo.

Many growers line the inside of the picking trailers with a heavy brown kraft paper (self-adhesive). This is recommended as the paper absorbs any oil released by the fruit as a result of friction against the trailer sides.

With lemons, the fruit should stand in the orchard in the trailer for at least 12 to 24 hours after picking without being moved. If this is not possible, a 24 to 36 hour “wilt” at the packhouse before packing is advisable so that any oleo that has developed may be graded out. During the trailer-wilt period a canvas sail or shade cloth should be draped over the trailer to keep the fruit cool. Avoid contact between the shade cloth and the top layer of fruit.

A wilt period is not normally necessary for other citrus cultivars.

The fruit should be moved from the orchard to the packhouse over a graded road. Air pressure in the trailer tyres should be reduced.

In the packhouse, the following are potential areas where oleo can be caused or aggravated:

i) **High pressure water descaling unit**
Reduce the water pressure for oleo-susceptible fruit. Brush speed on the white brushes should not exceed 145 ppm.

ii) **The hot bath**
The water temperature should not exceed 40°C.

iii) **Doughnut and brass-rollers**
Maximum speed, 60rpm.

iv) **Black polisher brushes and waxing unit brushes**
Maximum speed 145 rpm.

v) Avoid a **heavy wax** application.

vi) Remove **wax nodules** and other potential damage points in the packhouse line (e.g. on belts, guides, rollers, etc.).

vii) Use of a **UV lamp over the grading belt** will pick out oleo marks (also false codling moth and fruit fly damage) very clearly.

3.7 Ethrel pre-harvest spray

In orchards with a vegetative growth flush in progress a pre-harvest spray with ethephon (active ingredient in Ethrel) has been successful in dramatically reducing oleo incidence in commercial trials with Valencias, Tomangos, Clementines, grapefruit and lemons involving large amounts of fruit. Full details of the pre-harvest spray procedure are given in the chapter, "Improvement of Fruit Colour".

NB. This treatment is not yet registered specifically for oleocellosis reduction. The matter is receiving attention.

3.8 Pruning

Light hand-pruning makes access easier for the pickers to reach and climb into the trees and leads to less mechanical damage to the fruit and less oleo. Removal of dead wood and many of the small branches and twigs inside the canopy (the Infunti pruning method is described more fully in the section on fruit size improvement) can be done by hand or with pneumatic equipment. Pruning is carried out after harvest and before fruit drop of the following year's crop, (i.e. for navels, between June and October, and for Valencias, between August and October).

RIND PITTING

1. General description

Rind pitting is a post-harvest rind disorder in grapefruit and oranges that has been responsible for heavy crop losses. In some seasons large amounts of export fruit are rejected at the ports for rind pitting, whereas in other seasons the malady does not make an appearance. It is usually associated with the fruit from close-planted orchards with large windbreaks. The close-planting and windbreaks promote a humid atmosphere in the orchard. Rind pitting often follows a cold weather spell, particularly if this is accompanied by rain.

The conditions which favour oleocellosis also promote rind pitting. Both rind pitting and oleocellosis develop following the rupture of an oil gland under stress and the release of its contents. In the case of oleocellosis the contents of the oil gland are expelled through the epidermis and spread over the rind surface. The oil spreads over a relatively wide area and causes an extensive but superficial blemish. With rind pitting, the damage arises from the rupture of a more deep-seated oil gland. Its contents are released between the flavedo cells surrounding it, without release on the surface. The cells contacted plasmolyse and collapse, leaving a necrotic space under the surface cell layers. Thee soon collapse into the empty space to form a sunken hollow with abrupt walls.

The rind pits in rind pitting are sunken spots on the rind about 0.3 to 0.6 cm in diameter. Individual pits often coalesce to form larger pits. When they first appear there is little or no discolouration in the sunken area but this later becomes a light-brown to tan colour, or a dark-brown to black colour. In grapefruit the pits often have a pinkish colour in the early stages.

The pits start appearing about four days after packing and most have developed within ten days. After this any additional pits appear on fruit that already have rind pits. The delayed symptom expression of rind pitting makes it impossible to cull the affected fruit in the packhouse. They are found at the port during the routine quality control inspection and the entire consignment has to be repacked.

The extent of development and the colour of the rind pits are determined by the storage temperature during the ten-day period after packing during the time most fruit is on rail to the port. Under cool storage conditions (10°C) it has been found that rind pitting incidence in Tomango oranges is greater and the pits darker ten days after packing than under warmer storage conditions (21°C). Thus rind pitting develops further and the lesions are darker in Eastern Transvaal Valencias railed across the Highveld in winter than in fruit railed directly to Maputo.

Rind pitting has been found to develop more readily when the fruit is waxed heavily in the packhouse than following light waxing. The hot bath temperature should not exceed 40°C. The other packhouse treatments (washing, brushing and fungicide treatments) do not appear to affect rind-pitting development.

2. Control measures

The grower has three courses of action when he is faced with the possibility of rind pitting development in his fruit during the picking season:

i) Move his picking activities to orchards with the best fruit colour. Close-planted humid orchards should be avoided until their fruit has developed good colour.

ii) Avoid application of any treatment that is likely to retard colour development, especially those made after Christmas. Late application of nitrogen fertilizers and pesticide oil sprays promote delayed colour development.

iii) Reduce the wax application rate in the packhouse. The hot bath temperature should not exceed 40°C.

iv) Apply a pre-harvest ethephon spray when sensitive orchards cannot be avoided. The pre-harvest spray procedure is fully described in the chapter on "Improvement of Fruit Colour". This procedure has been very successful in large-scale commercial tests.

NB: This treatment is not yet registered specifically for rind pitting. The matter is receiving attention.

GRANULATION AND CORE-DRYING OF ORANGES

1. Description

Granulation is a physiological disorder in oranges and most other citrus species. It is a condition associated with fruit that have begun to age internally and have a low sugar and a low acid content in their juice. The juice vesicles at the stem-end of the fruit become enlarged, hardened and nearly colourless. The cell walls in the granulated vesicles are thicker than normal and the cell contents form a gel. Cells in the interior of the vesicles collapse leaving gas-filled cavities that look like small bubbles. Granulated fruit have a lower TSS, lower acid, higher pectinmethyl-esterase and a higher pectin concentration in their juice than normal fruit. The gel formed is thought to be a low-methoxyl calcium gel. The stem-end of the fruit is affected first because the TSS and acid concentrations are lowest in this part of the fruit.

Granulation develops further after harvest, particularly in fruit that show either light or severe granulation at picking time. Further development after harvest is enhanced by cold storage followed by ambient storage (as in overseas shipping and subsequent handling), compared with the ambient storage for the same period. The amount of granulation that develops in fruit exported overseas is correlated significantly with the amount of granulation present in the fruit in the packhouse, and its TSS and acid levels in the packhouse.

Because granulation is closely associated with low TSS and low acid levels, it is more likely in fruit from young vigorous trees than in fruit from older trees. It is also more prevalent in large fruit than in the smaller fruit and on trees grown on the more vigorous rootstocks such as rough lemon (that induce low fruit internal quality) than on the less vigorous stocks such as *P. trifoliata* and its hybrids (inducing a higher internal quality).

Core-drying is a disorder that is found in granulated navel orange fruit and in the fruit of a few other citrus cultivars. The vesicles around the central core of the fruit from the button zone down to the stylar-end zone shrivel and dry out (leading to the description "navel drying-out" that is often used). Core-drying is seldom found in fruit on the tree but develops after harvest, usually in fruit that were granulated, or had started to granulate at picking. It is very rare to find fruit with core-drying in the core zone, but no granulation in the button zone. The amount of core-drying that develops after harvest and is found overseas is highly correlated with the amount of granulation and the TSS and acid levels at packing.

Core-drying does not occur in Valencias or Tomangos because there is a sharp gradient in acid levels in the juice between the button and core zones in these cultivars. By contrast there is only a weak gradient in Palmer navels and Hamlins and thee cultivars are subject to core-drying.

Granulation and core-drying incidence is high in some years but not in others. Much granulation and core-drying has been found in South African export navels overseas in seasons when there is a combination of:

i) warm weather, particularly warm nights, just before and during blossom-time; and
ii) heavy rain in the late-summer period.

Granulation in Valencias is associated with heavy late-summer rains and is relatively unaffected by weather conditions at flowering.

In navels, warm weather during June to August gives rise to an extended blossom period. Flowering may continue for 10 to 14 weeks because there has been no cold-temperature stress. In cooler winter seasons it is completed within seven weeks. Fruit from the earlier blossom during an extended blossom year are on the tree longer and are usually larger and more advanced in maturity at harvest. These fruit are particularly prone to develop granulation and core-drying.

Heavy rain in the January to March period affects granulation – core-drying levels strongly. For navels in the Transvaal it has been found that rainfall in excess of 175 mm during February leads to high granulation – core-drying incidence, particularly when preceded by a warm winter. The rainfall in January and March is also important but the rain falling in February seems to exert the greatest influence on granulation – core-drying incidence. The important period for navels in the Cape is probably mid February to mid March. For Valencias, the amount of rain falling in March is important for predicting granulation levels.

2. Practical steps for reducing granulation and core-drying

2.1 Promote a uniform blossom in the orchard

This is particularly important with navels; flowering in Valencias is usually uniform. The blossom should appear more or less simultaneously in all trees in the orchard. The time over which there is a fresh appearance of "green bud" stage blossom should not exceed five weeks; if the first green bud blossom appears in the first week of August, the last of this blossom stage should have disappeared under usual climatic conditions by the end of the second week of September. The blossom on the southern side of the tree appears first, followed about a week later by the blossom on the northern side. Under normal circumstances, blossom growth and development is more protracted during cool weather and is speeded up by warm weather so it is difficult to set time limits within which flowering should be completed. Nevertheless it is important to avoid a scattered blossom in which green bud stage blossom continues to appear over a six to 10 week period. Blossoming over a short time period avoids producing "early" fruit that are larger and more mature at harvest (and hence more granulation-prone) than the "later" fruit in the same crop.

Uniform appearance of the blossom is promoted by stress conditions during the month before flowering begins. Stress may be induced by low moisture availability or by low night temperatures. Night temperatures below 13°C (the minimum temperature usually accepted at which growth ceases) are common in the Cape areas and normally persist long enough to induce a uniform flowering. The period actually needed has not been determined. In the Transvaal Lowveld, night temperatures during June to July are often not low enough or do not persist long enough to induce sufficient stress and it is necessary to develop a moisture stress. This is produced by arranging that the trees go into a light wilt (about a 10 'clock wilt) during the first part of July. It has been found that this can be achieved on normal sandy loam soils in the Lowveld by withholding irrigation after picking the crop in April to May. The trees use very little water during the cool winter months and only start going into a wilt at the end of June. They then receive a heavy irrigation in mid July and most of their nitrogen fertilizer allowance, and this usually ensures a heavy and uniform blossom. On sandy soils it may be necessary to give one or two light irrigations between picking and flowering so as to avoid extreme water stress. Winter oil sprays for red scale control are applied at bud swell to budburst so their timing does not clash with the idea of producing a moisture stress.

Research results indicate that mild stress can also be induced with urea sprays. Good results have been obtained with two pre-bloom sprays. One or two (depending on nitrogen levels, expected crop situation and amount of time available) successive 1% low-biuret urea sprays are applied one week apart six to eight weeks before full bloom. This period corresponds with the time of bud swell and budburst.

1.1 Promote a heavy fruit set

This will result in medium-sized fruit on average at harvest. These are much less affected by granulation than large-sized fruit. Research on improving fruit set in navels is in progress. Present ideas are that any means by which a "green blossom" (each flower subtended by one or more leaflets on the flowering shoot) is encouraged will give a better fruit set. Depending on nitrogen levels in the tree one or two 1% low-biuret urea sprays at the timing mentioned above will achieve this.

Girdling will also improve fruit set on healthy vigorous trees. The trees are girdled with a single knife cut spiral-fashion around the trunk at the 50% petal drop stage of flowering. The cut is made through the bark to the wood but avoiding cutting into the wood. Yield is improved by 10 to 20%.

1.2 Irrigation practice

A no-stress irrigation regime is recommended between July and the end of December, followed by a light stress regime from then onwards to harvest. Every effort should be made to ensure that there is minimum fruit drop in the October to November period by irrigating to avoid stress. Water is applied at tensiometer readings of about 30 kPa. After Christmas the approach changes to allowing a light water stress (±70 kPa) to develop in the trees before water is given. This will lead to improved TSS and acid levels in the fruit at harvest.

1.3 Storm water removal

Water should not be allowed to stand in the orchard for extended periods after heavy rains, particularly in the time between Christmas and harvest. A furrow or contour system is needed to carry excess water out of the orchard. When basins are present they should be opened to allow the rainwater to escape.

1.4 Nitrogen fertilizer practice

Nitrogen fertilizer should be applied early in the season and leaf levels kept within the recommended ranges, i.e. 2.4 to 2.6% N for navels and 2.1 to 2.3% N for Valencias and Tomangos. This will contribute to satisfactory fruit colour at the start of the picking period. Application of kraal manure, guano or any nitrogen fertilizer should be avoided after September in orchards where granulation is likely.

1.5 Weed control

An excellent way to ensure the speedy removal of excess water and nitrogen fertilizer is to allow weeds and grass to grow unchecked in the orchard between the end of December and harvest. This was a system followed by many citrus growers in the period before weedkillers were available. In the Transvaal Lowveld those growers that used this system with navels in the “drying-out” years in the 1970’s did not have core-drying losses, in contrast to many of their clean cultivation neighbours.

1.6 Degreening with Ethrel

Picking is often delayed at the beginning of the season because the fruit has not yet coloured up sufficiently. During the harvest delay, acid levels drop and when picking is eventually started, the larger fruit are beginning to granulate. Fruit colour delays can be avoided with a pre-harvest spray or packhouse treatment with Ethrel. The procedure is described in detail in the section on “Improvement of Fruit Colour”.

Note that a pre-harvest spray with Ethrel cannot be applied on navels.

1.7 Cultivar differences

The Bahianinha tends to set more fruit than the Palmer and the Washington and has a smaller fruit size, and hence is less granulation-prone. The Navelina also produces a smaller fruit than the Palmer but less markedly so, and is less granulation prone. It matures earlier than the Palmer.

1.8 Rootstock differences

Cultivars on trifoliate, trifoliate hybrids and other rootstocks producing fruit with better internal quality have fruit that is less granulation prone. Cultivars on rough lemon, Volckameriana and other vigorous rootstocks producing lower internal quality fruit have fruit that is more granulation prone.

STEM-END RIND BREAKDOWN

1. Description

Stem-end rind breakdown (SERB) is a post-harvest physiological rind disorder of citrus fruit. It is a serious problem in Tomangos and Valencias in certain years but can be completely absent in other years.

SERB is characterised by small pits (6mm diameter or less) scattered about the surface of the rind. They are usually concentrated on the stem-end except for in a narrow ring of tissue immediately around the button. The pits rarely coalesce. The pits have abrupt sides. They are not discoloured at first, but later develop a tan, and later still, a brown colour. The entire surface cells in the lesion collapse (similar to rind pitting) in contrast to the oleo lesion which has some intact oil cells. Symptom expression begins four to seven days after picking and is complete, except for some darkening of the lesions, 10 to 14 days after picking. SERB is most prevalent on smaller sized and thin skinned fruit.

SERB development is normally associated with low temperatures and low humidity in the picking period and a delay between picking and packing. SERB is found in seasons that have been very hot during the late summer and autumn months and in orchards with a low leaf copper level. These are conditions that can be expected to interfere with soft wax production on the rind and to give a rapid post-harvest weight loss in the fruit, particularly under low humidity conditions.

2. Measures to avoid or reduce SERB

- i) Avoid delay between picking and packing, particularly under low humidity conditions.
- ii) Apply a good even layer of wax to the fruit as soon as possible after harvesting.
- iii) Avoid excessive brushing in the packhouse line.
- iv) Cover the fruit in the trailers with a sail after picking.
- v) Apply a copper spray if this element is deficient or low in the leaf analysis.
- vi) Avoid excessive nitrogen fertilisation, particularly late applications of nitrogen.

PETECA SPOT IN LEMONS

1. General description

Peteca spot is a physiological disorder that appears as pits on the peel surface of lemons after packing. It normally occurs early in the lemon packing period (February to April) and has caused losses to packers in all lemon-producing areas. Peteca is characterised by deep depressions with rounded edges on the peel surface. The pits form as a result of the sinking of the surface of the rind. The surface cells within the sunken area are normal at first and do not show any sign of mechanical injury; in mild cases of peteca, the surface cells remain healthy, but in more severe instances the surface tissue collapses and dries out, making the bottom of the pit dark and discoloured. The oil glands are often dark coloured. The cells immediately below the surface in the pitted area are dry, shrunken and dark in colour.

Under a microscope the epidermal cells in the pitted area are seen to be heavily cutinised and rough in structure. Hypodermal cells are dry, shrunken and dark in colour. The cell walls of the outer mesocarp (outer albedo) are indistinct and there are no intercellular spaces. Cells surrounding the oil glands are broken and calcium oxalate crystals are seen in abundance in the affected tissues. Typically, peteca affected trees have high calcium levels in their leaves and fruit.

Peteca pits usually form after packing, starting one or two days after the fruit is packed. All pits will probably have formed within 10 days from packing. Pitting has also been seen on the fruit before they are picked but this is unusual.

Peteca symptoms are similar to those of rind pitting in oranges and grapefruit and also to black pit in lemons in its early stages. No micro-organism has been linked with peteca, but the pits are subject to secondary infection since they are points of weakness. Black pit, by contrast, is caused by the bacterium *Phytomonas syringae* entering through thorn picks and other injuries during wet weather.

2. Conditions associated with peteca

Peteca is most commonly found in fruit picked in cold wet seasons. Peteca usually disappears when the weather becomes sunny and warm. Certain orchards are more prone to produce peteca than others. Peteca pitting is encouraged by:

i) **During the period one to two months before picking**
   a) heavy oil sprays; and
   b) water stress. It is particularly prevalent when the trees undergo water stress aggravated by high day temperatures and hot winds, followed by periods of freely available water.

ii) **At picking**
   a) cold damp weather;
   b) young flush on the trees; and
   c) green-coloured fruit.

iii) **During the post-harvest period peteca is encouraged by**
   a) heavy waxing;
   b) Insufficient removal of soap from the soap tank from the peel; and
   c) Inadequate ventilation in the packed cartons.

Peteca is probably simply rind pitting in lemons, i.e. mechanical damage in which the contents of the oil cells are released under the epidermis. It has, however, been attributed by some authorities to a disturbance in calcium nutrition arising from water stress, and to other causes.

3. Control measures

i) Avoid water stress in the period one to two months before harvest.

ii) Don not apply an oil spray within two months of harvest.

iii) Avoid picking peteca-prone orchards in cool, wet weather. Apply the measures recommended for avoiding oleocellosis. Attempts to show that a pre-harvest ethephon spray will reduce peteca pitting have been unsuccessful so far possibly due to the transitory nature of the disorder.

iv) In the packhouse, avoid allowing soap residues to dry on the fruit. Rinse well after the soap bath. Avoid excessive brushing. Keep the fruit moving along the packhouse line. Do not use hot water bath. Do not wax heavily – apply a diluted wax or one of the wax formulations specially prepared for use on green fruit (e.g. Green-top Citrashine).

Endoxerosis of Lemon Fruit: Proposed re-classification of inspection guidelines

Background

Endoxerosis of lemon fruit is a physiological disorder that develops post-harvest and can lead to rejections during inspections. The disorder occurs in all lemon production areas of South Africa and is more prevalent in the first part of the season. No specific cultural practice is known to effectively prevent endoxerosis, however, low potassium levels as well as water stress and high temperatures during fruit development, especially close to harvest, have been associated with a higher incidence of this disorder. In addition, overripe fruit should not be harvested for export as they are prone to this disorder.

The main difficulty with endoxerosis is to identify fruit with this disorder, as affected and non-affected fruit look similar externally. The only way to determine the presence of endoxerosis in a sample of fruit is to cut fruit open and grade these fruit on the degree of symptom development.

During 2012 a high incidence of lemon fruit were reported that developed preliminary symptoms of endoxerosis. This led to rejections of pallets in spite of the more classic symptoms normally used to implement rejections for endoxerosis, i.e. drying out of the sap vesicles and pink/brown discoloration of pulp at the stylar end, being absent. Fruit that showed these preliminary symptoms that were kept for an extended period did not develop any additional symptoms associated with this disorder and no negative quality feedback was received from the market. As a result of this experience it is proposed that the definition as well as the grading classification of endoxerosis should be reviewed in order to clarify rejection parameters by PPECB.

Symptom development of endoxerosis

External symptoms

Endoxerosis symptoms develop independent of rind colour, and it is only on very severe endoxerosis-affected fruit that a deep yellow rind colour is evident. In some fruit the disorders may lead to a partial loss of lustre at the stylar end. However, neither of these two external quality aspects are a sure indication of the internal development of endoxerosis.

Internal symptoms

- The preliminary symptom of endoxerosis is the brown vascular bundles at the stylar end of the fruit. As the severity of the disorder increases the bundles begin to be clogged with a pinkish to rust brown deposit of gum. Further development leads to a rust-brown rind colour near the stylar end.
- During the second stage of symptom development, the juice sacs of the pulp adjoining the rind at the stylar end become affected and lose water and collapse. The collapsed or dried out pulp does not normally develop a discoloration.
- In sever symptom development the vascular bundles in the central axis become discoloured and filled with brown gum. The water loss/drying out of the pulp, which started at the stylar end, progress down to the center of the fruit. The dried out pulp could develop into a pinkish or light brown colour.

Advised inspection procedure to identify endoxerosis symptoms

Endoxerosis is not normally visible externally; it is therefore advisable to cut the lemon fruit open at the stylar end and core of the lemon to see if endoxerosis is present (see figure below). It is important that the cut is made into the pulp and not only into the albedo of the stylar end in order to identify the symptoms occurring in the pulp/juice sacs (drying out and discolouration). It is advised that the inspector start to cut the fruit from the stylar end in 0.5cm increments in order to determine where symptoms start to develop. Normally the juice sacs at the stylar end and core of the fruit will lose water and dry out, appearing similar to granulation. The albedo at the stylar end will develop a pink to light brown colour. Juice sacs around the core of the lemon will develop a brown colour and be filled with gum.

Classification and grading of endoxerosis severity

Current grading of endoxerosis by PPECB standards:

Fruit must comply to a minimum standard of a 5% level for minor Endoxerosis and 1,5% for major endoxerosis:

"minor endoxerosis" means pink to light brown discolouration at the stylar end and core of the fruit together with drying out of the juice vesicles;

"major endoxerosis" means the dark brown to black discolouration stage affecting the albedo and core of the lemons with or without tissue collapse and water saturation;

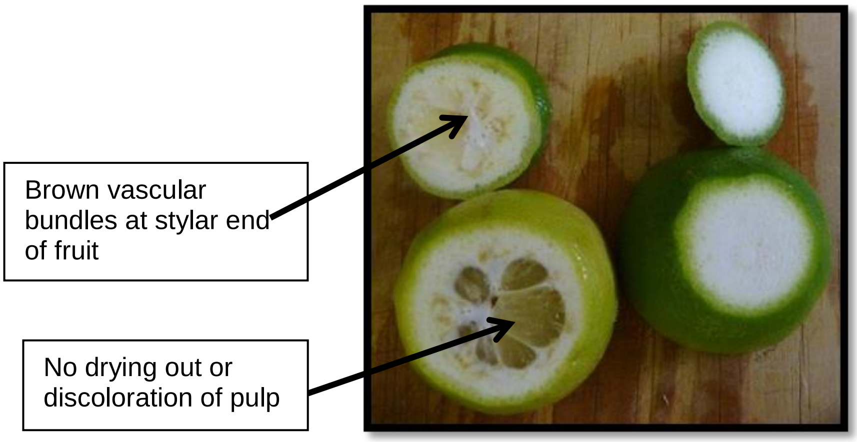
Proposed expanded endoxerosis grading standard:
It is proposed that an additional classification for endoxerosis be included in the PPECB grading system. This additional descriptive class will describe the first or preliminary symptoms of an endoxerosis sensitive fruit, before it develops minor or major symptoms that could lead to rejection of the fruit for export.

The three proposed classes are as follows:

1. Preliminary endoxerosis symptoms: no rejection on these symptoms.
2. Minor endoxerosis: Fruit rejected if 5% show these symptoms.
3. Major endoxerosis: Fruit rejected if 1.5% show these symptoms

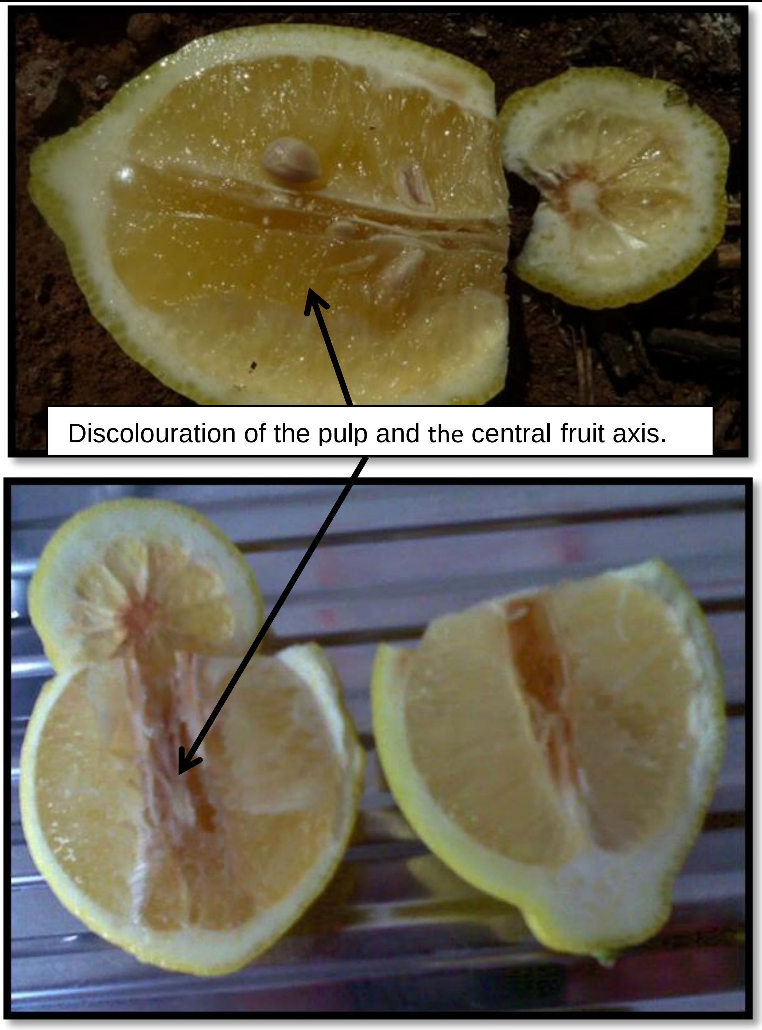
Fruit that show any preliminary symptoms will not be classified as endoxerosis, however fruit that show 5% of minor or 1.5% of major endoxerosis symptoms will be classified as such.

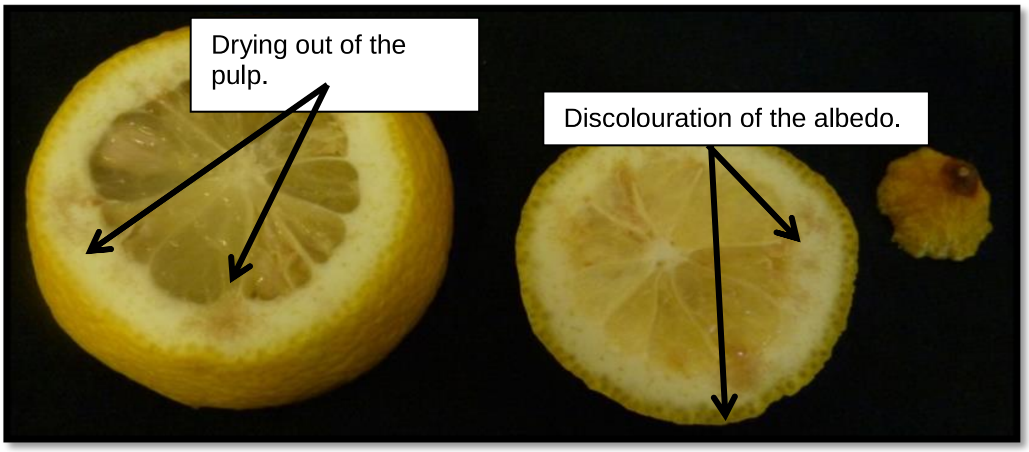
1. **Preliminary endoxerosis symptoms**: *"slightly brown discolouration of vascular bundles in albedo at stylar end. No further discolouration or drying out of the pulp at stylar end".*



Figures indicating the preliminary symptoms of endoxerosis: brown discolouration of the vascular bundles at the stylar end. No discolouration or drying out of the pulp has occurred.

2. **Minor Endoxerosis**: *"pink to light brown discolouration of the pulp at the stylar end and core of the fruit together with drying out of the juice vesicles at the stylar end"*

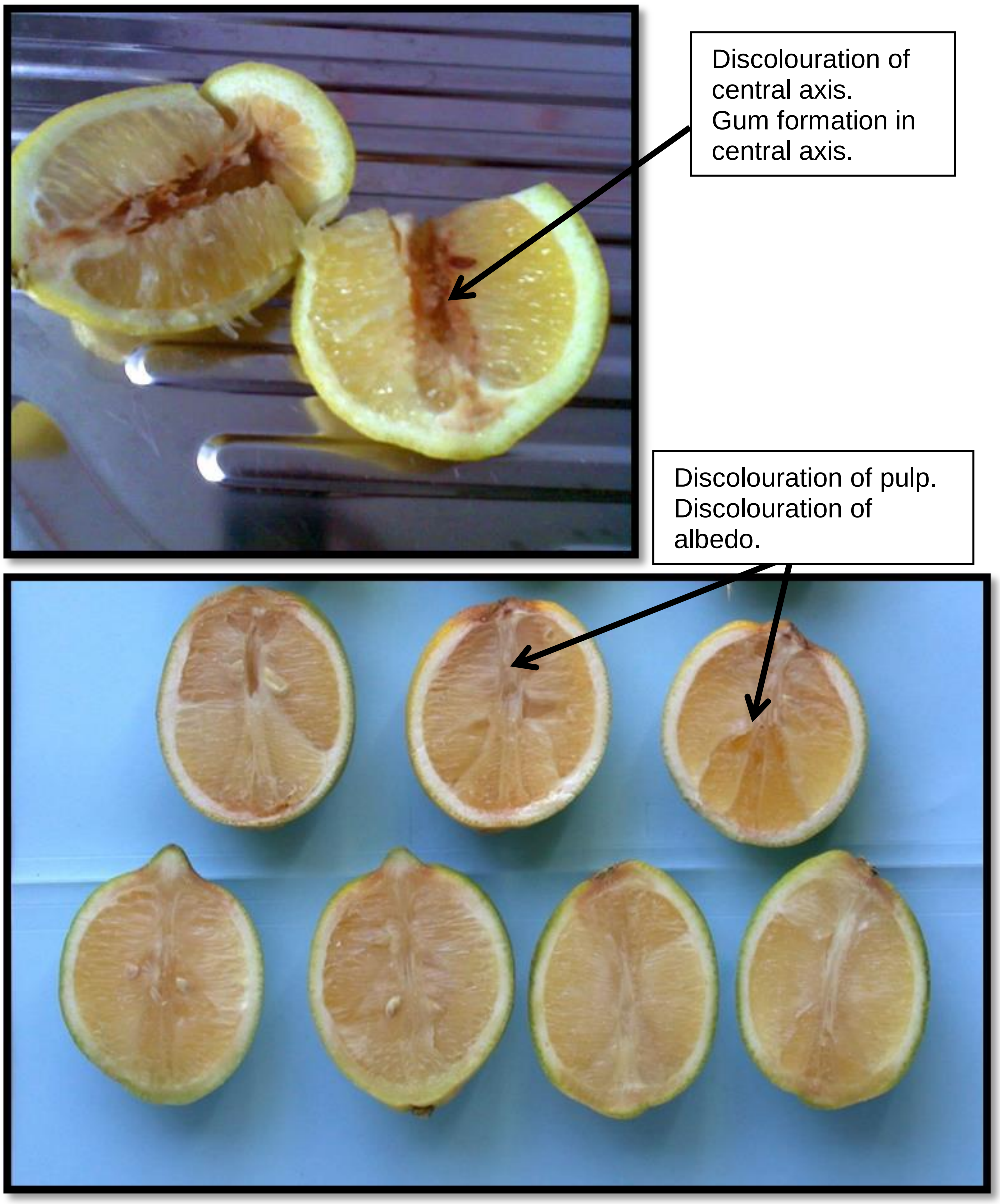




Figures indicate minor endoxerosis symptoms. Note the discolouration of the albedo (top) and the discolouration of the pulp to a pink brown colour (bottom). In the bottom photo drying out of some of the juice vesicles has occurred.

Paul Cronje & Hennie le Roux (CRI)
Cyril Julius & Jurgens Bence (PPECB)

3. **Major Endoxerosis**: "*dark brown to black discolouration occurring in the albedo as well as the core/central axis of the lemons with or without tissue collapse and water saturation. In addition the collapsed pulp tissue could include gum formation of the vascular tissue".*



Figures show lemon fruit with various symptoms of major endoxerosis *viz*. discolouration of pulp, albedo, the central axis as well as gum formation in the central axis.