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Extension briefs for

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(Citrus Research International)

Integrated pest management Mealybug (S.D. Moore)

To determine the percentage of infested fruit, growers should be scouting for mealybug regularly by inspecting underneath calyces. Where mealybug is under good biocontrol, infestation should peak during December or January in the northern production areas, and during February in the Cape production areas. If mealybug infestation does not decline during January, February and March, respectively, suppression with a corrective chemical treatment is advisable on early maturing cultivars. The available corrective options are sulfoxaflor (Closer), spirotetramat (Tivoli) and fenpyroximate (Lesson), with the first two mentioned being the most effective. These products may not have a specific corrective registration, but their withholding periods do permit late-season use. Although registered, methomyl is not a preferred option, as it is not effective at the dose generally registered for mealybug, and methomyl is the only registered corrective option for red scale. It would be wise to restrict corrective usage to red scale alone, so the onset of resistance is not expedited. Ensure compliance with the pre-harvest interval of any product used.

Another very important consideration in achieving and maintaining good mealybug control is diligent exclusion of ants from the tree canopy.

The species of mealybug present should also be determined, as it appears that the biocontrol complexes of mealybug species other than citrus mealybug, might not be

as effective as that of citrus mealybug. Therefore, treatments can be applied more readily when other species are identified as being dominant. The phytosanitary status of certain species must also be borne in mind. Note that colour plates and a key for identification of the different mealybug species are available to order from Citrus Research International (CRI). If applicable, please also bear in mind the molecular identification service offered by the CRI diagnostic laboratory in Nelspruit, and the DALRRD Plant Health Diagnostic Laboratory in Stellenbosch.



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MC Pretorius

A mealybug infestation can also attract a carob moth infestation. Therefore, if the fruit are to be exported to a market that is sensitive to carob moth, mealybug must be effectively controlled well before harvest.

Finally, if the fruit is to be exported to a mealybug-sensitive market, clear guidelines for pre- and postharvest management – as provided in Cutting Edge 298 – must be followed. This includes stringent inspections, with zero tolerance for infestation with any quarantine species.

False codling moth (S.D. Moore)

All growers intending to export to Europe should be fully compliant with the False Codling Moth Systems Approach (FCMSA) for export of citrus to the European Union (EU) and, consequently, the Good Agricultural Practices (GAP) described in CRI's Production Guidelines for the Control of FCM on Citrus. For phytosanitary reasons, false codling moth (FCM) must be controlled throughout the season to as close to a non-detectable level as possible, using a combination of orchard sanitation and various effective registered control measures. Weekly monitoring of fruit infestation, as described in the FCMSA, will provide an accurate indication of how effective the control programme has been and the level of compliance amongst the export (shipping) options described in the FCMSA.

The following sprayable insecticides are registered and available for use against FCM: the granulovirus products (Cryptogran, Cryptomax, Cryptex and Gratham), Methoxyfenozide (several trade names), Delegate, Coragen, emamectin benzoate (Warlock, Emperor, Conflict Granule), Broadband, Eco-Bb, Mycoveria and Metacide [the last four being entomopathogenic fungi (EPF)], ensuring compliance with market-specific restrictions. The granuloviruses and EPF can be used up until the day of harvesting. However, note



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that according to label recommendations, the EPF are not suitable corrective options for FCM – thus, they are not listed as such by PhytClean. A virus application should be applied shortly after a peak in FCM activity, determined by the use of a pheromone trap. However, this may be difficult to determine late in the season when FCM levels are low and generations are overlapping.

Methoxyfenozide, Delegate and Coragen are all registered to be applied once or twice per season and all have withholding periods of 30 days or less for most markets. Emamectin benzoate has a 14-day withholding period and can be applied at seven- to 10-day intervals (Warlock, Emperor) or 14-day intervals (Conflict Granule), if required (refer to label registration). Therefore, these products are suitable for a final application against FCM before harvest. Ideally, they should not be applied later than three to five weeks before harvesting begins. Such a practice is strongly recommended.

Other chemical options are triflumuron

(Alsystin), teflubenzuron (Nomolt), fenpropathrin (Meothrin) and Cypermethrin. However, there are some difficulties associated with these products, such as prohibitive maximum residue levels (MRLs) for certain markets, development of resistance by FCM, or secondary pest repercussions. Hence, they are not preferred as options for FCM.

In addition to the insecticides, there are now four mating disruption products – Isomate, Checkmate, Splat and X-Mate – and Last Call FCM (an attract-and-kill product). However, all of these products are most effective when their use is initiated early in the season, while FCM levels are still low. If this has not been done, initiation of their use late in the season is not recommended. Additionally, as the weather cools towards autumn, these pheromone-based products may become less effective due to a reduction in release rate. In such a case, it may be necessary to follow up these treatments with a spray for FCM.

Bud mite (T.G. Grout)

The period February–May is the optimal time for bud mite sprays, and fenpyroximate (Mitigate or Lesson) can be used during this period at 150 ml per 100 l water. The pre-harvest interval (PHI) is 28 days, except for CODEX (A) country groupings where it may not be applied later than 90% petal fall on oranges and mandarins. In trials with fenpyroximate this product was found to have similar efficacy to Acarol against bud mite. Fenpyroximate will also suppress citrus red mite when sprayed during autumn for bud mite, and the Lesson product is also registered against all other citrus mites and mealybug.

Fruit fly (A. Manrakhan)

Fruit flies are pests of phytosanitary concern. There is a zero tolerance for fruit fly eggs and larvae in fruit consignments for export. The fruit fly pests affecting citrus are *Ceratitis capitata* (Mediterranean fruit fly or Medfly), *Ceratitis rosa* (Natal fly) and *Bactrocera*

dorsalis (Oriental fruit fly). The latter is present in the provinces of Limpopo, Mpumalanga, North-West, Gauteng and KwaZulu-Natal (excluding the magisterial districts of Amajuba, uMgungundlovu, uMzinyathi, uThukela and Zululand) and in Sundays River Valley in the Eastern Cape Province.

For export of citrus to the EU, growers must implement the Citrus Fruit Fly Management System (Citrus FFMS) that consists of two Fruit Fly Systems Approaches (FF SA): one for lemons and limes (FF-SAL) and one for other citrus types (FF-SAO). For both FF-SAL and FF-SAO PhytClean registration are as prescribed by the FMS. In FF-SAL there are two independent measures that mitigate the risk of fruit flies: (1) non-host status of commercial export-grade lemons and limes for fruit fly pests of citrus and (2) Perishable Products Export Control Board (PPECB) phytosanitary inspections of fruit packed for export. In FF-SAO there are three independent measures that mitigate the risk of fruit flies: (1) Fruit Fly Good Agricultural Practices (FF GAP) with Packhouse Delivery Inspections as the end point, (2) packhouse grading and PPECB phytosanitary inspections of fruit packed for export and (3) postharvest shipping conditions as determined by the FMS.

FF GAP consists of two components: monitoring and pre-harvest control. Monitoring of all fruit fly pests of citrus should be carried out using registered traps, as recommended in the CRI Production Guidelines. Thresholds exist for all registered trapping systems and these should be adhered to, particularly when fruit are susceptible to attack (at and after colour break). The threshold levels in all registered trapping systems are provided in the CRI Production Guidelines. Monitoring of Oriental fruit fly per production unit code (PUC) is a requirement for phytosanitary registration of citrus, deciduous and subtropical fruit for export to the special markets i.e., US, Japan, South Korea, China and the EU. Each PUC should have at

least one ME baited trap for monitoring of Oriental fruit fly. Monitoring of Oriental fruit fly should be carried out throughout the year. Trapping guidelines for surveillance of Oriental fruit fly in fruit production areas should be followed. Guidelines are available either at <https://old.dalrrd.gov.za/> under Plant Health, Early Warning Systems, or at [https://www.citrusres.com/public-downloads/\(Market access\)](https://www.citrusres.com/public-downloads/(Market%20access)). All trapping results should be supplied to the Department of Agriculture, Land Reform and Rural Development at the end of each export season. Monitoring of Medfly and Natal fly should start before peak fruit fly activity in citrus orchards, usually between January and May. In regions with historically high fruit fly populations, such as the Western and Eastern Cape, monitoring of Medfly and Natal fly should be initiated from October. Monitoring should continue until completion of harvest. All fruit fly traps must be checked weekly and trapping



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Natasha Jackson

records should be documented. Lures and insecticides inside traps must be replaced every six to eight weeks. Detection of suspect Oriental fruit fly specimens in areas considered free of this pest should be reported immediately to the relevant surveillance co-ordinator (Citrus: Aruna Manrakhan: aruna@cri.co.za).

Fruit fly control should be initiated in mid to late summer (either January or February, depending on the region). However, for farms with either mixed fruit crops (such as mangoes or deciduous fruit) or near fruit types prone to high fruit fly infestation, fruit fly control should be implemented by December. Fruit fly baiting and good orchard sanitation form the core of fruit fly control practices. Bait spray products and bait stations registered for fruit fly control in citrus orchards are provided in the CRI Production Guidelines. In areas affected by the Oriental fruit fly, the Male Annihilation Technique (MAT) must also be used. MAT products registered for *B. dorsalis* control in SA are also provided in the CRI Production Guidelines. All fruit fly control products should be applied correctly. Instructions provided on labels of control products must be followed strictly. Fruit fly control products are now optional in lemon and lime orchards, and control must always be combined with proper management of insect pests such as FCM, which also damage mature fruit. All records of fruit fly control practices need to be kept, including MAT application.

In all *B. dorsalis* infested areas, a removal permit is required for movement of fruit outside those areas. To apply for a removal permit, e-mail to RemovalPermits@Dalrrd.gov.za.

Grondgedraagde siektes

(J. van Niekerk en MC Pretorius)

Grond- en wortelmonsters behoort elke drie jaar geneem te word om sodoende die

sitrusaalwurm- en *Phytophthora*-status in sitrusboorde te bepaal. Resultate sal dien as 'n bestuurshulpmiddel wat gebruik kan word om grondpatogene effektief te beheer.

Phytophthora bruinvrot/wortelvrot

Weens die gevaar van fitotoksiteit op gevoelige sitruskultivars tydens hoë temperature wat gedurende Februarie/ Maart kan voorkom, moet die gebruik van fosfonaatblaarbespuiting streng volgens die etiket geskied (geen sagtesitruskultivars behoort weens hul gevoelige skille gedurende hierdie tyd van die jaar met hierdie produkte gespuit te word nie). Hoë dagtemperatuur, tydelike vogstremming en warm bergwinde kan veroorsaak dat fosfonate swart stippeltjies soortgelyk aan koperskade, op vrugte veroorsaak. Bome moet daarom nie gespuit word as toestande nie optimaal is nie. 'n Wortelvrotbeheerprogram (blaarbespuiting) sal bruinvrot ook effektief kan beheer.

Bruinvrot ontwikkel slegs wanneer die klimaatstoestand gunstig is vir die patogeen (*Phytophthora*) om te infekteer en te ontwikkel. Indien dit dus h droë najaar is en geen – of slegs ligte – reënbuie voorkom nie, is voorkomende fosfonaatblaarbespuitings nie nodig nie. Indien dit egter h nat najaar is, kan bome met kontakmiddels soos koper of mancozeb (let op beperkings na markte) asook sistemiese produkte soos fosfonate (let op etiket-aanbevelings vir weerhoudingstydperk en waarskuwings) gespuit word om bruinvrot te beheer. Bo en behalwe droogte en hitte, kan h oormaat vogtige toestande (baie reën) ook bome onder tydelike verwelkte toestande plaas wat h gevaar inhou vir blaarbespuitings. Bome moet dus nie tydens of kort ná sulke toestande gespuit word nie. Laastens beïnvloed drag ook h boom se gevoeligheid vir droogtespanning. Hoe hoër die drag, hoe gevoeliger is die boom vir uitdroging en hoe groter is die risiko vir fitotoksiteit.



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Jan Landman

Sitrusaalwurm

Wortelmonsters kan enige tyd van die jaar getrek word om die status van die sitrusaalwurmpopulasies in boorde te bepaal. Wyfietellings word gebruik om te bepaal of die toediening van h aalwurmdoder geregverdig is. Die drempelwaarde voordat h aalwurmdoder oorweeg word is 1 000 wyfies/10 g wortels. Daar word aanbeveel dat aalwurmdodertoedienings 'n aanvang neem tydens die begin van die reënseisoen. Dit sou daarom die regte tyd wees vir produsente in die Wes-Kaap om hulle aalwurmonsters in Maart te trek, sodat hulle weet watter boorde om te behandel wanneer die winterreëns begin.

Residuweerhoudingstydperke moet in ag geneem word. Dit is belangrik om h aalwurmbeheerprogram te volg soos op die produketiket aangedui, ten einde optimale onderdrukking van die aalwurmpopulasies te verkry.

Tydens die toediening van aalwurmdoders is dit uiters belangrik dat ten minste 40 mm besproeiing toegedien word nadat produkte

toegedien is. Dis om te verseker dat die middels in die grondprofiel ingewas word. Die meeste aalwurmdoders loog baie stadig. Die effektiwiteit van die middels word dus belemmer indien hulle nie behoorlik deur die wortelsone versprei word nie. Geen aalwurmdoder behoort deur drupbesproeiingsstelsels toegedien te word nie. Indien toedienings in boorde met druptoediening gedoen moet word, behoort die middels as h bandplasing (halwe meter aan beide kante van die drupperlyn) óór die drupperlyn gedoen te word. Dit kan wel deur mikro-besproeiingstelsels toegedien word.

Indien daar beplan word om 'n boord te verwyder, behoort 'n aalwurmonster en Phytophthora grondmonster geneem te word voordat die boord verwyder word. Dis om te bepaal of sitrusaalwurms en Phytophthora spp. teenwoordig is. Dit dien as 'n bestuursriglyn om 'n geskikte onderstam en berokingsmiddel te kies in gevalle waar 'n herplantstrategie uitgewerk moet word.

Citriculture
Fruit production and quality (P.J.R. Cronjé)
Internal quality If properly timed, regulated deficit irrigation can result in increased total soluble solids (TSS) and an increase, or no response, in titratable acidity. Deficit irrigation retards the breakdown of acid and can influence the solids:acid ratio at harvest for better or worse, depending on cultivar characteristics. It is mainly aimed at early cultivars like Satsuma. But other early-maturing cultivars with low internal quality could also benefit. Less water is applied, and at longer intervals. Therefore, irrigation is continued, but at a reduced level. Trees should be irrigated lightly two weeks prior to harvest. No water stress should be imposed during the initial growth phase of the fruit, i.e., during and after flowering, but only during the final maturation phase, i.e., the last two months prior to harvest (January for

Satsuma). Any water stress earlier than the end of January could lead to reduced fruit size and loss of rind integrity. In high rainfall areas, regulated deficit irrigation may not be successful. The deficit should be imposed slowly, so that the trees can adjust without symptoms of drought. Severe water stress can have adverse effects on tree health, fruit size and fruit quality. High nitrogen is antagonistic to the effect of deficit irrigation. Management of this technique is much easier when trees are planted on ridges and when the right scheduling equipment is used. Additionally, regulated deficit irrigation imposed in the last two months prior to harvest also enhances the rate of colour development. Selective harvest of outside fruit and delaying harvest of inside fruit will result in a higher proportion of fruit with higher TSS and better colour.

Maturity indexing on early cultivars like Satsuma, should commence. Maturity indexing is done to predict the rate of change in fruit maturity, to harvest fruit at optimal maturity, to maintain acceptable commercial shelf life. The aim is to define changes or rate of change in acids and sugars, and to build up a database over several years for comparison. Random sampling of fruit every week from each of 10 representative trees should start four to six weeks before the expected harvest date. Titratable acidity is determined by titration with sodium hydroxide. Sugar content (Brix) is determined using a refractometer, the sugar:acid ratio calculated and fruit colour should be read from a colour chart. All the parameters mentioned above should be plotted on a graph over time. Once plotted, trends will become apparent, harvest dates can be estimated, and problem areas in internal and external quality parameters can be identified and manipulated.

Fruit growth and size during this time is important, to achieve optimum size at harvest. Fruit growth is in the peak of phase II, in which most fruit size increases takes place for most cultivars (Figures 1 and 2).

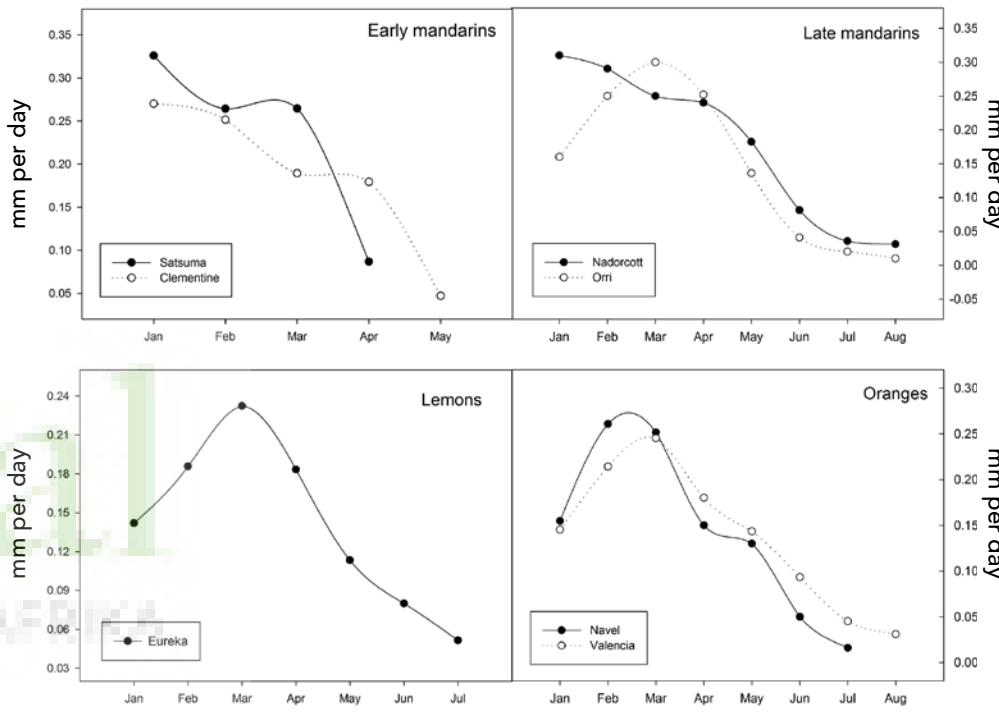


Figure 1: Historical fruit growth rates (mm per day) of different citrus cultivars in the Western Cape region

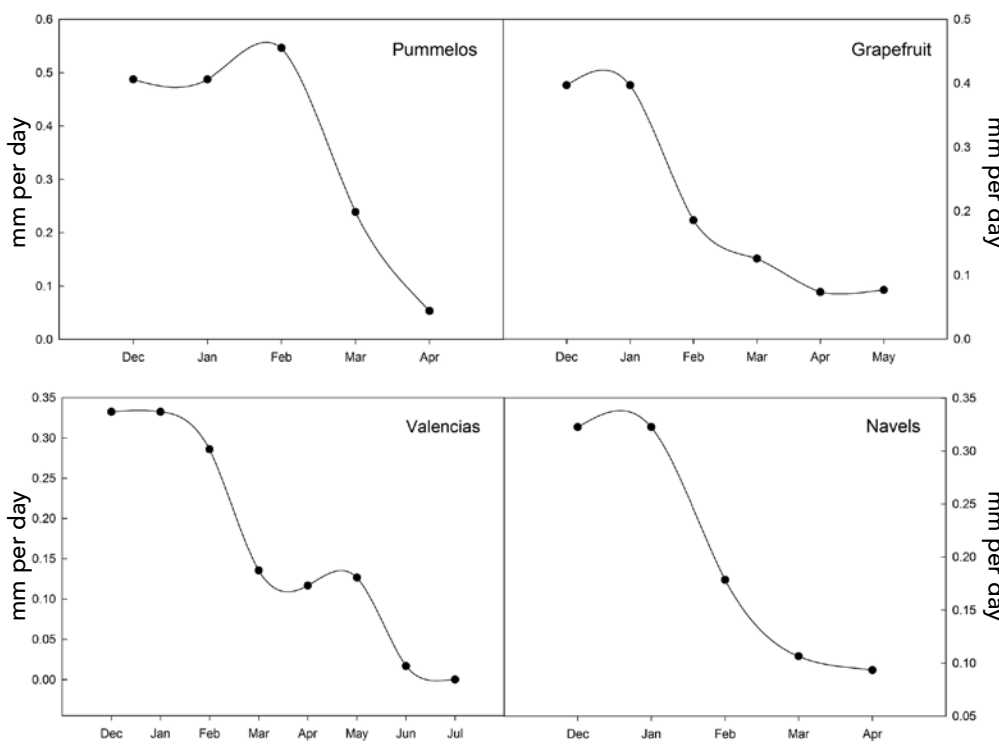


Figure 2: Historical fruit growth rates (mm per day) of different citrus cultivars in Limpopo

Ensure optimal irrigation and try to avoid stress conditions, as this might have an adverse effect on fruit size. Fruit thinning plays a critical role in fruit size (see Cutting Edge no. 32: Fruit size improvement). Correct pruning practices are the most effective way to manipulate the number of fruit per canopy volume and the eventual fruit size. For more information, refer to the *SA Fruit Journal* Oct/Nov 2015: The reproductive phenology of Citrus III: Morphogenesis from flower to fruit.

Regrowth control should be done, especially after heavy pruning earlier in the season. A lot of regrowth adversely affects fruit size, and is antagonistic to fruit colour development, particularly for early-maturing cultivars.

Oleocellosis dictates that late summer vegetative growth of bearing trees be kept to a minimum. Excessive vegetative vigour during this period is associated with high incidence of oleo at harvest.

Rind colour development is hindered by late nitrogen application and the use of high concentrations of heavy summer oil sprays after January.

Geïntegreerde bemesting/ integrated fertilisation (P. Raath)

Neem van blaar- en grondmonsters

Die periode van Februarie tot einde April moet gebruik word vir jaarlikse blaar- en grondontledings. Blaarmonsters behoort jaarliks geneem te word, terwyl grond elke twee tot drie jaar gemonster kan word, afhangende van grondtekstuur. Omdat die waarde van die ontleding geheel en al afhang van die mate waartoe die monster die blok se voedingstatus verteenwoordig, moet baie moeite gedoen word met die monsternemingsproses. Standaardiseer die monsternemingsprosedure.

Monster blare elke jaar:

- 1) **Rondom dieselfde datum:** Pluk blaar-monsters elke jaar vir elke spesifieke

blok gedurende 'n bepaalde week vanaf Februarie tot einde April.

2) Vanaf dieselfde groep bome

(sogenaamde “indeksbome”): Verdeel boorde in monsternemings-eenhede wat nie groter as 5 ha is nie. Kies dan drie tot vier indeksrye wat verteenwoordigend van die hele boord is. Merk die rye en gebruik elke jaar dieselfde rye vir monsterneming. Swak of geil kolle moet egter afsonderlik gemonster en gemerk word.

3) Op dieselfde posisie in die bome:

Slegs blare agter 'n vrug wat in die lente op dieselfde takkie as die vrug ontwikkel het, word gemonster; d.w.s. blare wat tussen vyf en agt maande oud is agter 'n vrug (**Figuur 3**) – monster blare tussen heup- en skouerhoogte.

Pluk tussen 75 en 100 blare van beide die ooste- en westekant van die ry, plaas dit in 'n skoon plastieksakkie of “veggie net sakkie”. Steek gaatjies in die sakkie om seker te maak dat dit nie sweet nie. Knoop die sakkie toe en hou koel, maar nie gevries nie. Merk die monster duidelik – moet nie direk op die sakkie skryf nie, aangesien selfs permanente ink geneig is om af te kom. Moet nie papiertjies met nommers binne-in die sakkies plaas nie. Gebruik eerder 'n etiket en bind dit aan die sakkie vas.

Sample soil at least every three years:

1) When fertilisation has ceased or

application rates are low e.g., late summer to autumn (February to June).

2) From the same position (e.g., the index

trees): Use the same three to four index rows that are used for leaf sampling – they must be representative of the whole unit. Take samples according to the fertiliser application pattern/wetted zone – micro-irrigated blocks must be sampled under the tree canopy, while drip-irrigated blocks are sampled either between the dripper and the perimeter of the wetted zone, or if the wetted zones of adjacent drippers overlap, take it halfway between two drippers. Ten to 15 sub-samples must be taken and mixed in a bucket, from which a 500 g representative sample is then sent to the laboratory. Poor or vigorous areas must be sampled separately. Remember to note the coarse fraction (%) of the sample. Especially, if the coarse fraction is too large to be placed in the bag with the soil sample.

3) **At the same depth:** Remove organic debris from the soil's surface and take the sample from the top to 30 cm depth. If occurrence of soil acidity or salinity is suspected, an additional sample must also be taken from the 30–60 cm layer.

Use either an auger or spade to take the samples over the full top 30 cm. Put the sample in a plastic bag that can be thoroughly sealed and mark it with a tag (do not write directly on the plastic bag).

Interpretation of leaf analyses

Leaf analyses are an indicator of the nutritional status of the trees. There is an established relationship between the concentration of the nutrient elements in the leaves and tree performance. The goal should be to achieve a plant nutrient status that falls within the optimal range for each nutrient. Use the *Fertilization of citrus in South Africa* handbook to see if your leaf concentration is in the norm, or needs adjusting.

Interpretasie van grondmonsters

Grondontledings verskaf inligting wat help om te besluit watter stappe geneem kan word om tekorte, wanbalanse en oormate in die voedingstatus van die bome reg te stel. Ongelukkig word interpretasie van die chemiese resultate dikwels gekompliseer deur die verskeidenheid ekstraksie-metodes en maniere waarop resultate uitgedruk word. Interpretasie van grondontledings moet dus met begrip van die ekstraksie-metodes gedoen word.

Postharvest pathology - pre-packing pointers (W. du Plooy)

Orchard sanitation: Sanitation is of crucial importance just before picking season starts. This practice is key for reducing fungal spore load, as well as keeping FCM and fruit fly under control. Orchard sanitation involves removing all fallen, decayed and injured fruit (including those on the trees) from the orchard and then burying or macerating the fruit. For macerating, the fruit should be cut into fine pieces and allowed to dry in the sun away from the orchards and packhouses. Fallen and injured fruit removed from the orchard can also be used as animal feed. Remember to follow the FMS guidelines and examine a sample of the sanitation fruit

if you export to the EU. The FMS can be found on the CRI website under “Member downloads” and all changes will be communicated via the CRI Cutting Edges.

Skirt trees for sour rot and brown rot control: Ensure that trees are adequately skirted before they start bearing. This prevents low-hanging fruit, especially for heavily laden trees where fruit will be touching the ground or be within range of water splash. The practice will reduce the risk of *Phytophthora* brown rot infection during the rainfall season as well as sour rot (*Galactomyces* spp.) infection. Keep in mind that no pre-harvest fungicides are available to adequately control sour rot, so orchard sanitation and skirting are crucial. Remove dead wood from all citrus trees to reduce the spore load of the latent citrus pathogens.

Prevent injuries: Ensure that picking teams are trained to focus on preventing injuries. Avoid snap picking, unless pickers have mastered the technique, and the fruit is not to be exported. Injuries are the number one cause of postharvest decay. Keep in mind that some markets may be stricter on the stem end length, so ensure pickers cut the stem end as short as possible, without damaging the rind.

Packhouse sanitation: Thoroughly clean the entire packhouse building and line before any fruit is brought to the packhouse in the new season. Use an appropriate sanitiser to clean everywhere from the roof to the floor, including walls and hard-to-reach nooks and crannies.

- Never allow any fruit – and more importantly, any fungicide-treated fruit – to lie around in the packhouse at any stage during the packing process.
- Spray the packhouse regularly with sanitisers, and immediately after finding even just a single rotten fruit.
- Constantly monitor concentrations of sanitisers in dump tanks, sprays, rinses, etc., and ensure that these sanitisers are being used according to the correct specifications (e.g., pH).

- Wash equipment such as trailers and / harvesting bins with a suitable sanitiser before they leave for the orchard.
- Ensure that packed cartons are cooled as soon as possible to prevent decay development.
- Store retention samples for each consignment and check them regularly for waste and other developing factors, such as pitting, rind break-down and latent pathogens. Keep track of other defects such as damage by wind, thrips and mechanical damage.

Selection of fungicides: For many packhouses, the chemicals that will be used during the upcoming season are being sourced and negotiated. Decide on a chemical programme that is in line with decay control and export market regulations. Make use of the CRI Postharvest Factsheets that are available online at www.citrusres.com under “Member downloads”. If using a new product, ensure that it is safe for use (possible phytotoxicity; MRL restrictions) and that it is applied correctly. Also keep in mind the cleaning protocol that must be followed, if you need to strip the line of residues that have been used but are no longer allowed. See Cutting Edge No. 314 published by CRI, available on www.citrusres.com.

Considering the increased cold-temperature shipping and FMS protocols, it is important that packhouses use thiabendazole (TBZ) for all fruit being exported. TBZ applied in the wax, provides protection against chilling injury and helps control latent pathogen infections. A high solid wax (20–22%) will also aid in preventing chilling injury. 🍊

Figure 3. Illustration of the position of the leaves that must be sampled for analysis

