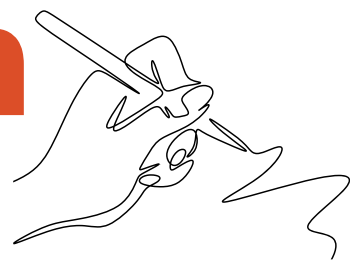


Extension briefs

APRIL AND
MAY 2026



By the Citrus Research International Extension Team

Integrated pest management

(S.D. Moore, and A. Manrakhan)

Phytosanitary pests All the recommendations made in the Extension Briefs for February and March apply to this period. Control of insect pests that are of phytosanitary concern is critical. At least once a week, growers must conduct sanitation of split, stung or infested fruit in the trees, and all fallen fruit on the ground.

Additionally, growers should continue to monitor infestation of fallen fruit every second week, according to the pre-harvest fruit infestation monitoring protocol. This is a mandatory practice for the last 12 weeks before harvest, for participation in the False Codling Moth Systems Approach (FCMSA, previously known as the FMS). Once the required information has been entered, PhytClean will report the calculated FCM infestation per week per tree, and whether the threshold has been surpassed or not. A final spray for FCM is recommended at least four weeks before harvest, using a product listed on PhytClean with a pre-harvest interval that is within that time.

Fruit fly control initiated in mid-summer should continue and be adjusted according to trap catches. If trap thresholds are exceeded, control actions must be increased. Control actions for fruit flies include the use of registered protein bait sprays and/or bait stations and orchard sanitation. Where Oriental fruit fly (OFF) is present, growers should also apply a registered methyl eugenol-based Male Annihilation Technique (MAT) (e.g., Invader-b-Lok – a block impregnated with Chempac ME lure

and malathion – or Static Spinosad ME).

During harvesting, pre-sorting of any potentially infested fruit must be conducted in the orchard. Under the FCMSA and Fruit Fly Management System (FFMS) for citrus – other than lemons and limes – pack houses must get trained inspectors to conduct inspections for FCM and fruit fly infestation on samples from all orchards, on delivery to the pack house. On the pack line all fruit with blemishes that could be associated with FCM or fruit fly must be graded out. Sorting tables must be very well lit to facilitate optimal sorting.



Hannes Bester



MC Pretorius

As with pack house delivery inspections, only trained and competency-evaluated personnel may conduct this sorting and grading process. Fruit must be thoroughly and regularly inspected for mealybug infestation, both pre- and postharvest, as described in *Cutting Edge* no. 298 and 327. If any mealybug infestation is found on fruit destined for the South Korean market, at the time of harvest, a pre-export diagnostic procedure is strongly advised. This will prevent the export of fruit infested with mealybug species of phytosanitary concern, as described in *Cutting Edge* no. 369. The pre-export procedure consists of a first visual screening of mealybug species on infested citrus by either the scout or inspector.

Colour plates and a key for identification of the different mealybug species are available to order from CRI. Samples of mealybug found should then be collected and sent to participating laboratories for identification, as described in *Cutting Edge* no. 369. If the identified species is not citrus mealybug, the find is actionable.

Thus, fruit from the affected orchard may not be packed for export to South Korea.

Blemish factor analysis The analysis of fruit blemish factors on the tree just prior to harvest, or once fruit have been harvested, provides the grower with an evaluation – in commercial terms – of all control programmes implemented during the season. It also guides pest management decisions for the following season.

This practice is growing in importance, with increasing pressure from markets for integrated pest management (IPM) implementation and reduction in chemical residues. The collected data enables educated decision-making on the need,

or otherwise, for control measures against a particular pest, thus potentially reducing input costs and pesticide residues. With the trend towards selective picking and a variable degree of culling occurs in the orchard, it is more accurate to conduct the final analysis of fruit blemish factors before picking starts. Do include fruit from inside the tree and all blemish factors or pest infestations should be recorded, whether they warrant culling of the fruit from export quality or not.

Having taken the sample, it is important to record separately, each pest or other blemish factor that is severe enough to downgrade fruit. With this procedure, a particular fruit in the sample may show more than one justification for culling from export.

Crop and fruit quality management (P.J.R. Cronjé)

General Stage II of fruit development is ending, and stage III commencing with little or no increase in fruit size expected as the fruit matures, i.e., increase in juice content, total soluble solids (Brix°) and reduction of titratable acidity (TA). Lower autumn temperatures will affect rind colour but GA3 (Progibb®) and Nitrogen applications later than five months prior to harvest, can or will result in retarded colour development.

Maturity indexing Commence maturity indexing on early and mid-season cultivars to harvest at optimal maturity and facilitate an adequate shelf life. Start taking weekly samples from 10 representative trees four to six weeks before the expected harvest date. TA is determined by titration with sodium hydroxide, sugar content (Brix°) is determined by a refractometer, and the fruit colour and sugar-to-acid ratio calculated should be read from a colour chart. Results should be recorded and used in comparison with previous seasons to identify and manipulate possible problems with internal and external quality parameters.

Pickers' training and monitoring Training of pickers is important. The workers should be familiarised with important protocols



Coenraad Fraenkel



André Combrink

during picking and handling of fruit. Picking bags should always be carried on the side of the waist to avoid crushing of fruit between the body and the ladders, bins, or trees. Picking bags must be free of leaves, shoots or sand and kept dry throughout. To avoid lesions on fruit, pickers' fingernails should be short, and clippers and ladders handled correctly, i.e., no long stems, and contact between ladders and fruit must be limited. Low-hanging fruit very close to the ground, or touching the ground, or dropped fruit should be removed a day or two before harvesting an orchard. This is to lower the risk of sour rot and brown rot development in export cartons. Position glove-wearing sorters at each bin, to monitor fruit quality.

Pruning For early cultivars (Satsuma and Clementine), pruning should be done during this period, directly after harvest. Prune more heavily after a light crop, if a heavy crop is expected, and if the orchard has a history of alternate bearing. Old twigs and

dead shoots should also be removed to limit wind damage on the next season's crop. Effective pruning will ensure sufficient light distribution and spray penetration into the centre of the canopy.

Postharvest foliar urea application A foliar application (low biuret urea at 1%) can be applied on early cultivars (Satsuma and Clementine) directly after harvest.

Citrus black spot disease management (P. Moyo and P.H. Fourie)

General By this stage, most growers should have completed all their scheduled pre-harvest sprays for citrus black spot (CBS).

Since CBS symptoms only appear on mature fruit, absence of pre-harvest symptoms is not necessarily indicative of successful CBS control. Thus, assess the CBS risk of orchards to exclude export from high-risk orchards to CBS-sensitive markets.

Suggested criteria

- **CBS history of orchard:** older orchards tend to have more CBS, but various factors (including cultivar susceptibility, topography, orchard condition, canopy density and efficacy of spray deposition) can influence the disease pressure. If monitoring records have been kept, growers would be able to identify orchards with a higher CBS incidence. Orchards where CBS disease incidence was high in the previous two seasons can be expected to have a higher inoculum pressure in the current season.
- **Inoculum management:** monthly removal of all fallen leaves from late winter through the fruit susceptibility period has been shown to be as effective as full CBS spray programmes. Conversely, pruning debris that is left in the orchard will contribute to increased inoculum pressure. The extent to which shredding of pruning debris will limit ascospore production on leaves is unclear, but growers are advised to at least shred pruning debris to a very fine particle size (< 5 cm²).

Likewise, removal of all out-of-season fruit is important to limit pycnidiospore inoculum.

• **Prevailing weather conditions:** the CBS pathogen can only infect fruit in warm and wet conditions during the fruit susceptibility period. A comparison of suitability of weather conditions for CBS, experienced in the past season with previous seasons, will be indicative of the relative risk. Growers are also encouraged to register on CRI-PhyRisk to compare the CBS infection forecasts for the season with the spray programme followed. The CBS risk should be lower if all infection periods were protected.

This is assuming that sprays were effectively applied during weather conditions suitable for spraying (this can also be observed from CRI PhyRisk), and effective fungicide coverage and deposition were achieved.

Grondgedraagde siektes (MC Pretorius en J. van Niekerk)

Phytophthora- en aalwurmbeheer: Winterreënvalgebiede soos die Wes-Kaap moet nou *Phytophthora*- en aalwurm-ontledings laat doen.

Beheerprogramme moet na die eerste goeie winterreëns begin. Beheermaatreëls moet streng toegepas word volgens die etikette van die gekose aalwurmmiddel. Noukeurige toepassing van die etiketaanbevelings sal effektiewe beheer verseker. Let op residuweerstandstydperke (vooroesintervalle) van aalwurmdoders en lees die etikette van die verskillende produkte deeglik.

Wortel- en kraagvrot *Phytophthora*-wortel- en kraagvrotbeheerprogramme in die Wes-Kaap kan in die herfs begin.

Mefenoxam-wortelsonebehandeling (2.1 mL/m²) en fosfonaatblaarbespuitings kan gebruik word. Drie fosfonaattoedienings (twee maande uitmekaar) behoort gedoen te word. Let op weerhouingstydperke (vooroesintervalle).

Baie belangrik Lees die etikette van die verskillende produkte deeglik, veral die waarskuwings. Vermoed die gebruik van die fosfonate indien toestande voorkom wat bome onder enige vorm van stremming plaas. Bo en behalwe droogte en hitte kan bergwindtoestande ook bome onder tydelike verwelkte toestande plaas, wat 'n gevaar vir blaarbespuitings inhou.

Bome moet dus nie tydens, of kort na sulke toestande gespuit word nie. Laastens, beïnvloed drag ook 'n boom se gevoeligheid vir droogtespanning.

Hoe hoër die drag, hoe meer gevoelig is die boom vir uitdroging en hoe groter is die risiko vir fitotoksiseit.

Bruinvrot Herfsreëns kan tot ernstige naoesbederfverliese deur *Phytophthora*-bruinvrot lei. 'n Enkele vrug wat met bruinvrot besmet is, kan tydens verskeping die res van die vrugte in 'n uitvoerkarton laat bederf.

In die somerreënvalgebiede word bruinvrot deur die patogeen *Phytophthora nicotianae* veroorsaak, en affekteer dit vrugte op die onderste 1.5 m van die boom naaste aan die grondoppervlak. Dit behoort dus redelik veilig te wees om slegs hierdie onderste band vrugte te spuit in boorde waar die *Phytophthora*-voorkoms nie hoog is nie. *Phytophthora citrophthora* kom ook in die winterreënvalgebiede voor. Hierdie patogeen versprei hoër op in die boom en kan vrugte tot bo in 'n sitrusboom besmet. In hierdie streke moet die totale blaaroppervlak gespuit word. Bruinvrot ontwikkel slegs wanneer die klimaatstoestande gunstig is vir die patogeen (*Phytophthora* spp.) om te infekteer en te ontwikkel. Gedurende 'n droë najaar met ligte of geen reënbuie, is voorkomende bespuitings nie nodig nie. En tydens 'n nat winter of najaar, moet bome gespuit word.

Kontakswamdoders soos koper (200 g/100 l) of mankoseb (200 g/100 l) kan bruinvrot beheer.

Daar is egter beperkinge t.o.v. mankoseb vir sekere markte.

Beide hierdie produkte is slegs kontakmiddele wat deur reën en besproeiing afgewas

kan word. Belangrik: indien die koper-toedienings en proteïenvrugtevlieglokase te na aan mekaar toegedien word, kan fitotoksiseit ("stippeling") op die skille voorkom. Dié risiko is hoër tydens kleurbreek. Sistemiese fosfonaatswammiddels is uiters effektief vir die beheer van bruinvrot. Verskeie fosfonate is geregistreer vir die gebruik teen bruinvrot.

Raadpleeg etikette waar nodig om te bepaal watter produkte hiervoor geregistreer is. Die fosfonate is ook effektief teen bruinvrot indien dit in 'n wortelvrotprogram as 'n blaarbespuiting gebruik word. Geeneen van die fosfonaatstam-aanwendings is effektief teen bruinvrot nie.

Water management/waterbestuur (C. Fraenkel en P. Raath)

Irrigation scheduling/ besproeiingskedulering

Mature citrus trees require between 7 000 and 10 000 m³ water per hectare per annum. Water is lost through evaporation, run-off, leaching and transpiration. Transpiration and in some instances (i.e., saline soils) leaching, are beneficial to the trees and, therefore, not viewed as a loss. However, non-beneficial losses should be kept to a minimum.

Evaporation is largely determined by climatic factors such as radiation, temperature, relative humidity, and wind. Run-off is determined by the infiltration rate of the soil, the slope of the terrain and the application rate of the irrigation system. Non-beneficial leaching occurs when water penetrates beyond the root zone.

Verdamping kan verminder word deur te verseker dat druplyne bo-op riewe vasgemaak is om te verhoed dat water teen die kante van die riewe afloop. Sodoende word die oppervlakte verminder waarvandaan water kan verdamp. Die grondoppervlak kan ook met organiese materiaal bedek word om verdamping te verminder. Afloop kan verder beperk word deur seker te maak dat die toedieningstempo van die besproeiingsstelsel nie hoër as die infiltrasietempo van die grond

is nie. Die periode van besproeiing moet genoegsaam wees om die wortelsone tot by veldwaterkapasiteit te benut sonder om die wortelsone te versadig en sodoende 'n oormaat logging of afloop te veroorsaak. Die instandhouding van die besproeiingsstelsel is belangrik om te verseker dat die toerusting in 'n goeie toestand is, sonder lekkasies.

The difference between field water capacity and the actual soil water content is called "soil water depletion". Irrigation timing and the amount of water to be applied are determined by monitoring or estimating soil water depletion and applying water when the depletion reaches a pre-selected level, called the "management of allowable depletion".

Grondvoogsensors wat die grondwaterinhoud in kombinasie met veldwaarnemings (voeltoetse) meet is 'n beter aanduiding vir wanneer en hoeveel besproei moet word.

Dit is beter as die uitsluitlike gebruik van gewasfaktore of die sogenaamde kalendermetode, waar besproeiing op 'n voorafbepaalde tyd plaasvind, bv. elke Dinsdag en Vrydag.

Tensiometers are installed in pairs. The ceramic cup of the first tensiometer must be placed in the root zone, and the second cup below the root zone. For most soils, the reading should be between -5 and -20 kPa at field water capacity. No tensiometer should remain on zero or even at -5 kPa for too long, as this is an indication of water-saturated conditions. As the soil dries out, the tension slowly increases (readings become more negative) up to a certain inflection point.

This point is characteristic of the soil and lies between -30 and -70 kPa. The tension increases rapidly after the inflection point has been reached.

For sandy soils, irrigation should probably commence at a tension of -30 kPa and in clay soils at -40 to -50 kPa. Importantly, these values are characteristic of the soil and should be determined for each irrigation block. Irrigation is scheduled according to the readings of the shallow tensiometer



Natasha Jackson



Jan Landman

that is placed in the root zone. The deeper-placed tensiometer monitors over- and under-irrigation.

Constant low readings indicate potential over-irrigation. However, increasingly high readings despite irrigation, indicate possible under-irrigation. So, do calibrate the tensiometer readings with field observations in and below the root zone.

Kapasitans "probes" meet op verskillende dieptes die relatiewe waterinhoud van die grond. Hierdie metings geskied op 'n kontinue basis (elke 30 of 60 minute). Die sagteware maak voorsiening dat 'n versadigingspunt, 'n hervulpunt en 'n droë punt geselekteer kan word. Indien die grafiek tot by die hervulpunt daal, kan met besproeiing begin word. In gronde met 'n hoë klei-inhoud is dit moeiliker om die verandering in die waterinhoud van die grond waar te neem.

'n **Profielgat** in die wortelsone van die bome kan weekliks of selfs twee-weekliks gegrawe word. Die waterinhoud van die

grond word dan visueel waargeneem en die besproeiingskedulering word daarvolgens beplan. Die voordeel van hierdie metode is dat probleem-areas geïdentifiseer en geïnspekteer kan word.

Postharvest pathology - waste prevention checklist

(L. Mamba and W. du Plooy)

The origin of decay All the postharvest citrus diseases are present in the orchard. Around 1% of the fruit harvested will have established green mould or sour rot infections. The pack house must deal with this swiftly.

Important practices to be highlighted to orchard management by the pack house

- sanitation to minimise the inoculum (spore) load in the orchard
- establishing protocols to minimise wounding of fruit during harvesting; prevention of wounds will dramatically reduce the incidence of infections
- optimising FCM and fruit fly control to minimise wounds and risk of decay
- treating the fruit within 24 hours of harvesting; this will enable the postharvest fungicide/s to curatively control established infections.

Pack house urgency Diligence can reduce waste risk in the short time between the tipping of fruit and wax application.

Chlorine treatment

- measure ORP – it should be ± 800 mV
- if ORP is too low, adjust pH and concentration
- pH should be 6.5–7.5
- concentration should be 75–100 ppm (active chlorine) or 100–200 ppm (total chlorine):
 - The concentration needs to be monitored continuously; an automatic dosing system is highly recommended.

Pre-pack-house drench

- The CRI factsheets list all the recommended fungicide options for the pre-pack-house drench and must be consulted. The factsheets are available to members on the CRI website.
- Importantly, adequate waterflow will thoroughly drench the fruit in all the bins – drenches must deliver at least 250 ℓ drench mixture/bin/min.
- Pre-suspend fungicides in warm water and add to the tank while agitating, using the order SC > EC > SL. Then fill the tank to the correct level.
- Exposure time is 1–3 minutes.
- Replace the mixture after 150 bins (1 000 ℓ tank), 200 bins (2 000 ℓ tank), or 300 bins (3 000 ℓ tank).
- **Constant agitation**
 - The system must be in operation for at least 15 minutes before use.
 - Never let the fungicide mixture stand still, as the chemicals will settle out and be unavailable for fruit treatment.

Fungicide dip tank and in-line drench

- The fungicide of choice for use in the aqueous applications is imazalil sulphate for all markets. No market restrictions are predicted for the immediate future, although CRI is investigating alternatives.
- The imazalil sulphate concentration should be managed continuously by means of titration and maintained at 500 ppm.
- The pH level of the imazalil solution should be kept stable to ensure consistency in terms of residue loading.
 - Recommended automatic dosing system for pH:
 - ◻ pH 3 will result in lower residue levels (around 1 ppm) but can still give excellent curative control if the exposure time is 60–90 seconds, and fruit is treated within 24 hours of infection.
 - ◻ pH 6 will result in higher residue levels (around 2–3 ppm), but the exposure

time needs to be limited to 45 seconds to prevent MRL exceedance.

- The CRI factsheets list all possible options for the fungicide bath or in-line drench and need to be consulted.
- If not replaced daily, the fungicide solution should be pasteurised every evening by increasing the temperature to no less than 60°C, keeping it there for 20 minutes, and then letting the solution cool down overnight.

Wax application

- Fruit should be dry before entering the wax applicator – wet fruit will hamper the efficacy of this treatment.
- It is highly recommended to apply imazalil in the dip tank and thereafter in the wax. The wax application will ensure good protective control and sporulation inhibition of green mould, while the aqueous application provides excellent curative control.
- Wax containers/tanks containing fungicides should be gently agitated continuously (i.e., 24 hours a day, seven days a week) to ensure that thiabendazole and imazalil stay in solution and do not precipitate. Precipitated chemicals will result in MRL exceedance from wax lower down in the container, while the top layers will not have enough residue to give the desired protection. Containers should also be tightly sealed to prevent wax formulation from deteriorating.
 - Plus:
 - ◻ Do not use air bubbles as an agitation measure. They break down the wax formulation through liberation of the volatiles and oxidation of the solvent system.
 - ◻ Do not over-agitate the wax, as this also eliminates the volatiles that are an integral part of the wax during film formation after application.
- Fruit must be totally and uniformly covered in wax; if not, contact your wax suppliers for support.

- Protect the wax applicator against wind from the drying tunnel to prevent wax drying on the last brushes and hardening of the bristles. Hardened bristles hamper effective wax application and pose injury to the fruit rind.

Cold chain

- Promptly place fruit in cold storage.
- Maintaining the cold chain will reduce the incidence of green mould infections and physiological rind disorders.
- Never break the cold chain.

Sanitation

- Pack house sanitation helps keep inoculum (spore) levels as close to zero as possible.
- Remove all fruit from the floor, including any waste fruit in bins.
 - Plus
 - ◻ Remove any waste fruit from the pack house and discard it in closed containers as soon as possible.
 - ◻ Do not allow fruit destined for processing to be anywhere near your pack house.
- Sanitation is an effective way of preventing fungicide resistance from developing.

Remember

Fresh citrus fruit is a perishable, high-risk commodity. The fruit is alive and, therefore, respiring. Thus, the shelf life and quality must be maintained. The packed export crop must be moved from the pack house into the cold chain as soon as possible, thereby reducing the risk of loss of quality and waste.



Colour plates and identification key



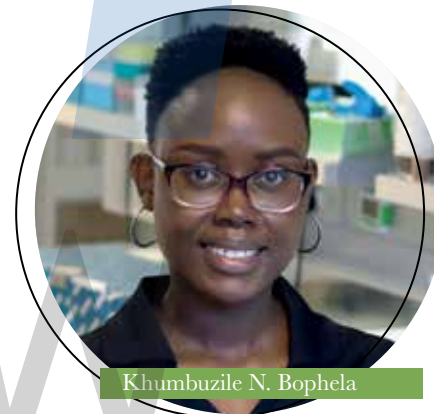
CRI-PhytRisk



South Africa is the world's second-largest exporter of citrus fruit (CGA, 2025). By **Jacquie E. van der Waals, Jason McNeil, Khumbuzile N. Bophela, Teresa A. Coutinho and Jan M. van Niekerk**



Jacquie E. van der Waals



Khumbuzile N. Bophela

HIDDEN SOURCES OF *Phytophthora* inoculum in South African citrus nurseries

Sustainable citrus production depends on a steady supply of healthy nursery trees for new orchards and replanting. Unfortunately, citrus nurseries can become reservoirs for soil- and water-borne pathogens, especially *Phytophthora* species such as *P. nicotianae* and *P. citrophthora*.

These oomycetes cause fibrous root rot, damping-off and seedling death, leading to serious losses in nurseries and poor establishment in orchards later.

Despite strict sanitation and application of oomycete-specific fungicides, occasional outbreaks of root rot still occur. This suggests that *Phytophthora* inoculum persists within nursery systems despite compliance with Citrus Improvement Scheme (CIS) nursery guidelines. The aim of this study was, therefore, to identify sources of *Phytophthora* inoculum in 12 commercial CIS-accredited citrus nurseries across the major production regions: Letsitele and Malelane (Limpopo and Mpumalanga), Sundays River Valley (Eastern Cape) and Citrusdal (Western Cape).

Materials and methods

After assessing standard operating practices at each nursery, a strategy was designed to sample potential contamination sites. These included:

- soil from dirt roads around tunnels and from walkways inside tunnels/netting structures
- unused potting media (from surface and deeper in the pile)
- potting media in use
- irrigation water sampled after flocculation, filtration or sterilisation

- surfaces sampled with sterile cotton swabs: wheelbarrows, tractor wheels, filled and empty seedling trays, worker boots and gloves, cement benches, shade netting, footbaths, and moss or plant debris in or around pots.

Soil samples were baited with citrus leaf discs on flooded slurries, then plated onto selective media. Putative *Phytophthora* isolates were purified, morphologically identified, and identities confirmed by Polymerase Chain Reaction (PCR) and sequencing of two Internal Transcribed Spacer regions. DNA was extracted directly from swab samples and subsequently screened with ITS primers to detect *Phytophthora* gDNA.

Results and discussion

All nurseries surveyed tested positive for *Phytophthora* inoculum in at least one sampled site. Notably, no oomycete-like organisms were isolated from any of the 110 water samples, confirming that the chlorination, flocculation, and filtration systems used in these nurseries are effective at eradicating oomycete species.

Phytophthora was recovered from soil on dirt roads surrounding tunnels (average 44% of samples positive across nurseries) and from tunnel walkways (41% positive). Inoculum was also present in potting media before use (17%), and in use (24%) at more than half of the nurseries sampled, despite nursery managers considering these media to be sterile due to composting, on-site treatment, or certified purchase.