# Postharvest treatments aid control of Citrus Black Spot (CBS)

Citrus Black Spot is a fungal disease causing black lesions on fruit. Apart from this cosmetic defect, it has no other harmful effects on citrus fruit. However, due to the quarantine status of the disease in certain countries, CBS is a very important disease to control on citrus for fresh fruit exports.

Citrus Research International (CRI) conducts research with a wide range of collaborating research organisations. The work reported on here is from the MSc. study of Wouter Schreuder Jnr., whose thesis at Stellenbosch University was titled: Singular and combined effect of postharvest treatments on viability and reproductive ability of *Phyllosticta citricarpa* infections. The work studied the effect that postharvest packhouse treatments have on citrus black spot.

## Why this project?

Citrus black spot (CBS) is caused by *P. citricarpa* and whereas preharvest fungicide treatments can provide high levels of control, EU phytosanitary regulations for the import of citrus fruit require the fruit to be completely CBS-free. Previous research has shown that postharvest treatments and cold conditions can make an important contribution to CBS control. However, postharvest treatment programmes have changed over time, and it was important to re-evaluate the effects of postharvest handling on CBS infections.

## How was this project done?

Eureka lemons and Valencia oranges were harvested from infected orchards that had not received preharvest CBS sprays. Only fruit that showed no symptoms were harvested and brought back to the lab, because asymptomatic fruit will typically be exported. The fruit were then subjected to the various treatments and associated fungicides that are commonly used in commercial citrus packhouses in South Africa. These treatments were a chlorine wash; a pre-packhouse drench (pyrimethanil, thiabendazole, 2,4-D, and guazatine or propiconazole); a heated fungicide dip (imazalil at 25, 35, 45 and 55°C); and a wax application (thiabendazole, imazalil, and 2,4-D). These treatments were applied individually, as well as in sequential combination as would happen in a citrus packhouse. Additional treatments included dip-treatments in suspensions of propiconazole, a mixture of pyrimethanil and propiconazole, fludioxonil, potassium sorbate, sodium bicarbonate, and Fortisol Ca Plus.

The effects of simulated shipping and cold storage conditions (five weeks at 7°C for lemons and 4°C or -0.5°C for Valencias) were evaluated, both on their own and in combination with the packhouse treatments.

After the five week storage period, the fruit were moved into an incubation room (25 – 27°C) with constant light to stimulate lesion

VERVOLG VAN BLADSY 74 verwysings. Inligting aangaande die metode van monsterneming kan verkry word van die Diagnostiese Sentrum in Nelspruit. Monsters kan ook na die Diagnostiese Sentrum gestuur word vir ontledings.

## FRUIT AND FOLIAR DISEASES

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Growers are reminded that mancozeb may not be sprayed later than December on fruit destined for the Canadian market and not later than the end of January for Japan. There are also severe restrictions for citrus other than soft citrus going to the USA. Mancozeb has a 25 day protection period when applied on its own, but when sprayed in conjunction with a strobilurin spray programme, the first tank mixture application thereafter should be within 21 - 24 days depending on the strobilurin product used. Carbendazim and any other breakdown products of the benzimidazole fungicide group that result in carbendazim residue (Benlate, Spotless, Bavistin, Bendazid, Knowin) may again be sprayed on fruit intended for the EU and countries that abide by the CODEX MRL system (refer to Recommended Usage restrictions document); it however remains the growers' responsibility to determine the benzimidazole resistance status of their orchards before applying these products. Copper fungicides or strobilurins in tank mixtures with copper or mancozeb are also options for January. If a spray mixture containing copper will be used, then a copper spray less than 60 days prior to this is not recommended as it will cause stippling. However, it is important to mention that copper is the only residue permitted when lemon fruit is processed to produce citrus rind oil while copper and strobilurin sprays are permitted when used for juice processing. Never allow gaps to occur in and during the susceptible period from October to January, especially where contact fungicides are chosen for control. Problem periods are usually over Christmas and New Year. Follow-up treatments are necessary where rainfall occurred within six hours after applications.

WOUTER SCHREUDER[A], WILMA DU PLOOY[B], ARNO ERASMUS[B], CATHERINE SAVAGE[B], ELAINE BASSON[B], CHERYL LENNOX[A] AND PAUL H. FOURIE[A,B]

[a]*Department of Plant Pathology, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa*
[b]*Citrus Research International, P.O. Box 28, Nelspruit 1200, South Africa*

development. Fruit were inspected after one and two weeks, and CBS lesions that developed were counted and recorded. Lesions that developed pycnidia (fruiting bodies that produce reproductive spores) were also recorded. Realtime PCR was used to positively confirm that the lesions were indeed CBS lesions.

## What was found:

Statistical analysis of the results showed several interesting findings:

• More than 93% of the observed lesions tested positive for genetic material of *P. citricarpa* (CBS).

• On average, only 10 - 15% of untreated lesions developed fruiting bodies, and this low reproductive capability was in most cases further diminished by the combination of treatments followed by cold storage, with < 0.8% of new lesions forming pycnidia in most trials.

• Shipping and storage under cooling (7°C, 4°C and -0.5°C) on their own resulted in low to moderate, but variable levels of control of CBS infections (23 – 69%).

• Individual dip-treatments of additional products led to inconsistent levels of control.

• The combination of postharvest treatments demonstrated consistent levels of control: Eureka lemons (average 65%) and Valencia oranges (average 76%).

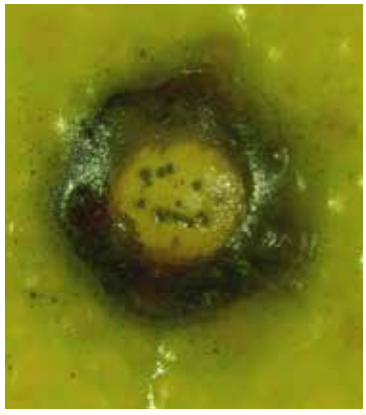
• Cold storage subsequent to packhouse treatments (as is common shipping procedure) further improved the levels of control to 81% on Eureka lemons and 94% on Valencia oranges.

• Lesions covered in wax did not release spores, indicating that wax creates a physical barrier over the spores.

## Conclusion:

This study confirmed previous studies (Agostini et al., 2006; Korf et al., 2001; Rappussi et al., 2009, 2011; Seberry et al., 1967; Yan et al., 2016) that CBS lesions on fruit have very low reproductive ability and that high and consistent levels of CBS control can be achieved by standard packhouse treatments and cold storage. These findings, considered on their own and especially in combination with the epidemiological requirements for spore release and dispersal from fruit and subsequent infection (i.e. wetness, water dispersal over short distances, and long wetness periods on susceptible host tissue for infection) (Kiely, 1948; McOnie, 1965; Spósito et al., 2008, 2011), support the previous CBS pest risk assessments (South African CBS PRA, 2000-2009; USDA-APHIS, 2010) that fruit, especially fruit produced and harvested for commercial export, is not a likely pathway for the spread of CBS.

*Citrus fruit with CBS lesions*



*CBS lesion with pycnidia.*

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**Read the full published article: Schreuder, W., du Plooy, W., Erasmus, A., Savage, C., Basson, E., Lennox C. and, Fourie, P.H., 2018. Postharvest fungicide treatments and cold storage control citrus black spot infections. Crop Protection, 112, 332-342.**