PACKER NEWSLETTER

A newsletter for Australian citrus growers and packers

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Australian Citrus Postharvest Science Program (Hort Innovation CT15010)

Inside this issue

1. Launch of Citrus Postharvest Sanitation and Fungicide Resistance Service

A new sanitation and fungicide resistance testing service is now being provided by NSW Department of Primary Industries and Citrus Australia. This new service provides timely information to citrus packers on the levels of sanitation and technical resistance to postharvest fungicides in their packinghouses.

Recent surveys of the levels of sanitation (i.e. decay causing fungi) and potential fungicide resistance in citrus packinghouses were conducted in the last two seasons as part of the Australian Citrus Postharvest Science Program (Hort Innovation CT15010). The results showed there are varying levels of sanitation with some technical resistance to common postharvest fungicides in many packinghouses around Australia. The survey results are presented in previous *Packer Newsletters* (#116 and #118). This *Sanitation and Fungicide Resistance Service* is not related to the Hort Innovation project.

Postharvest fungicides are an important method to control decay and breakdown during handling and marketing. However, postharvest fungicides can sometimes fail to work due to the development of resistance by the decay fungi to the fungicide. Fungicide resistance is a serious and important postharvest problem which leads to the breakdown of the efficacy of the fungicide and out-turn problems. If unchecked, poor sanitation and resistance to postharvest fungicides will reduce the efficacy of fungicides leading to decay. Therefore managing fungicide resistance is critical to the managing fungicide use and out-turns.

Central to the management to improve sanitation and reduce fungicide resistance is knowing what is going on in your packinghouse. Without monitoring what is happening within your packinghouse, it is not possible to make informed management decisions on sanitation and postharvest fungicide programs.

This service provides timely information to allow growers to manage their packinghouse sanitation and fungicide programs. This is a not-for-profit service which is run through the Citrus Australia website with technical support and reports by NSW Department of Primary Industries. This service is not supported or related to Hort Innovation.

To access the citrus postharvest sanitation and fungicide resistance service visit the Citrus Australia website:

https://citrusaustralia.com.au/growers-industry/citrus-postharvest-sanitation-and-fungicide-resistance-service

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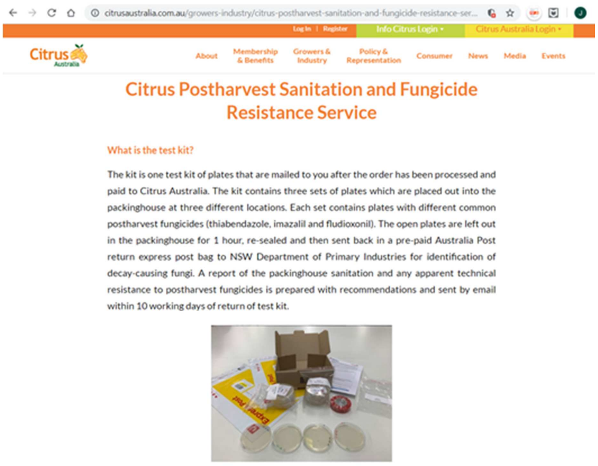
Citrus Postharvest Sanitation and Fungicide Resistance Service

What is the test kit?

The kit is one test kit of plates that are mailed to you after the order has been processed and paid to Citrus Australia. The kit contains three sets of plates which are placed out into the packinghouse at three different locations. Each set contains plates with different common postharvest fungicides (thiabendazole, imazalil and fludioxonil). The open plates are left out in the packinghouse for 1 hour, re-sealed and then sent back in a pre-paid Australia Post return express post bag to NSW Department of Primary Industries for identification of decay-causing fungi. A report of the packinghouse sanitation and any apparent technical resistance to postharvest fungicides is prepared with recommendations and sent by email within 10 working days of return of test kit.



https://citrusaustralia.com.au/growers-industry/citrus-postharvest-sanitation-and-fungicide-resistance-service

2. A review of chilling injury causes and control

Chilling injury can be a devastating postharvest disorder that can occur after low temperature storage which can result in significant downgrade or rejection of fruit in the market. The classical symptoms of chilling injury is pitting of the peel and superficial scald-like symptoms of the peel and browning of the skin (Figure 1).

Figure 1. Chilling injury symptoms on Navel orange

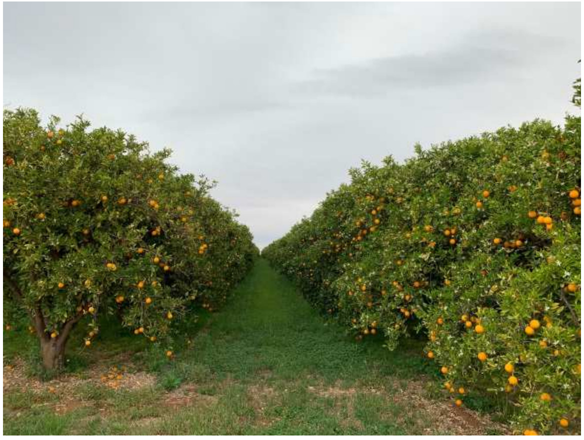
Chilling injury is a disorder that is not caused by a disease and is caused by exposure to cold temperatures, but not freezing temperatures during storage. Chilling injury is distinct from freezing injury as there is no development of ice crystals in the cells in chilling injury.

The severity of the chilling injury symptoms is related to both the storage temperature and the length of cold treatment, whereby symptoms are increased with lower storage temperatures for longer treatment times. Some symptoms of chilling injury can occur while the fruit is at low temperature but these symptoms increase when the fruit is removed from the chilling temperature to room temperature.

The major challenge with chilling injury is that the biochemical and physiological basis for its development is not known. While the biochemical and molecular mechanisms involved in chilling tolerance in different citrus types have been extensively studied there seems to be a complex interplay of different metabolic pathways which operate in the induction of cold tolerance (lipid metabolism, oxidative stress, dehydrins, osmoprotectants, metallothioneins, defence responses etc.).

Predicting the onset and severity of chilling injury is also difficult, due to the unpredictable nature of the time by temperature combinations required to produce the onset of symptoms. A short cold treatment time may not develop any symptoms, but longer cold storage times may express the disorder. The easiest way to avoid chilling injury is to avoid storing citrus at < 5°C, however many of the phytosanitary cold treatment against fruit flies requires cold treatment (1°C) for up to three weeks treatment.

Although the mechanisms of chilling injury are not fully understood, there are a number of pre- and postharvest factors which interact to affect the development of chilling injury symptoms.



Preharvest factors affecting chilling injury

Preharvest factors contributing to the development of chilling injury include citrus type and cultivar, preharvest orchard temperatures, harvest times, growing locations etc. The susceptibility to chilling injury differs among species and different citrus types. For example limes and lemons are generally more susceptible to chilling injury than oranges and mandarins. But even within a citrus type, there are differences in susceptibility to chilling injury. For example comparing the susceptibility of different Navel oranges; 'Navelina' fruit have stronger tolerance to chilling temperatures while 'Thomson' are moderately sensitive and 'Navelate' and 'Roberts' fruit are highly sensitive to chilling temperatures (Lindhout, 2007). Grapefruit are one of the citrus types most susceptible to chilling but there are significant differences in susceptibility between red and regular grapefruit types. Lado et al. (2015) showed there is a positive relationship between carotenes content, mainly lycopene, and chilling tolerance during storage of grapefruit at low temperature (Figure 2). The potential protective role of lycopene in chilling injury has been shown to be related to the antioxidant properties of lycopene (Lado et al., 2015).

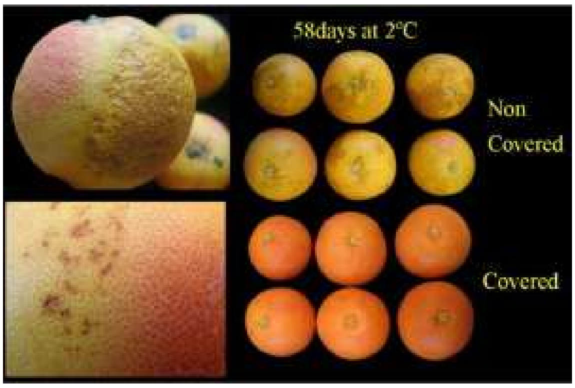


Figure 2. Chilling injury symptoms present in yellow chilling injury -sensitive rind zones/fruit and completely absent in lycopene-containing chilling injury-tolerant rind zones/fruit. *From Lado et al. (2015)*.

The incidence of chilling injury also depends on pre-harvest factors, including fruit maturation stage and environmental conditions during fruit growth such as field temperatures prior to cold storage. For example in some situations, fruit harvested earlier and later in the season are more susceptible to chilling injury than mid-season fruit, but this does not always hold in different seasons and growing conditions.

Postharvest management to reduce chilling injury symptoms

Temperature treatments. Short term high temperature treatments in the form of hot water dips, hot water brushing, curing or conditioning with hot humid air have been shown to reduce the incidence of chilling injury in citrus. It is considered that these heat treatments are a form of stress which helps protect the fruit from another stress, i.e. cold stress and chilling injury. The protective nature of heat treatments have been shown to occur through various physiological mechanisms such as the development of heat shock proteins and induction of other defence mechanisms in the citrus albedo. A range of curing and heat treatment conditions have been tested and show a range of results depending on the fruit type and treatment.

Conditioning citrus fruits with hot air for three days at 37°C has been consistently found to be effective in increasing chilling tolerance without inducing heat damage. This has been demonstrated for different citrus seasons and in fruits harvested at all maturity stages, despite the variable susceptibility of fruit throughout the season. In addition hot water dip treatments, intermittent warming, and rinsing and brushing at temperatures of 60°C for a few seconds have been also reported to be effective at reducing the symptoms of chilling injury.

Plant growth regulators. A range of different plant growth regulators such as jasmonic acid and salicylic acid have been implicated in the development of chilling injury. Jasmonic acid and its various metabolites have been shown to regulate plant responses to abiotic and biotic stresses including chilling injury in a range of crops, including citrus. Jasmonic acid and salicylic acid have been shown to reduce the incidence of chilling injury in citrus possibly through enhanced antioxidant activities, increased production of total phenolics and /or suppressed membrane lipid peroxidation and reactive oxygen species production.

Fungicides. Common postharvest fungicides such as thiabendazole are applied to control postharvest decay such as green mould but it has also been shown to reduce the incidence of chilling injury. Furthermore the application of thiabendazole as a warm dip (40°C) has been shown to further decrease the expression of chilling symptoms. It is thought that the increased temperature results in higher deposition of the chemical into the fruit, but it is not known how thiabendazole confers increased chilling tolerance.

Waxes. The application of waxes are commonly used to replace the natural waxes / cuticle which are removed with postharvest brushing, handling and packing. Waxes reduce water loss from the fruit and have also been shown to reduce the incidence of chilling injury but with different outcomes with different wax and fruit types.

Modified atmospheres. The use of modified atmosphere packaging is not widely commercially used, but it has been shown to reduce chilling injury. It is thought that the high relative humidity within the storage carton reduces water loss and chilling injury.

References

Lado, J., Rodrigo, M.J., Cronje, P. and Zacarías, L. (2015), Involvement of lycopene in the induction of tolerance to chilling injury in grapefruit. *Postharvest Biology and Technology.* 100, 176-186.

Lindhout, K. (2007) Physiology of chilling-related postharvest rind breakdown of navel oranges (*Citrus Sinensis* (L.) Osbeck).PhD thesis. La Trobe University. Australia.

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