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100th Edition of the Packer Newsletter

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When I wrote my first Packingshed Newsletter (as it was called then) back in 1997, I never expected that I would still be writing them now. The first 50 editions were edited by Kevin Gillespe and later Jim Hill, with Barry Tugwell supplying technical articles through the entire period (1979-93). It was a great practical resource, which was modeled on the even greater Florida Packinghouse newsletter. Barry Tugwell coaxed me into starting the newsletter again in 1997. I expected to drop it after a few years as interest waned. Amazingly, we are still here 50 editions later to reach the 100 milestone.

This edition focuses on degreening, which is perennial favorite topic at this time of the year. I have updated the degreening article and tried to add something new on mandarins. I hope you enjoy the 100th edition.

INSIDE THIS ISSUE

Early season degreening and associated practices.

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Citrus are non-climacteric fruit, which means that they do not undergo a defined ripening process, i.e., changes are relatively slow. This allows us to harvest and store fruit for reasonably long periods without significant change to internal quality, but it can make the decision when to commence harvest difficult and arbitrary. Many countries have maturity standards that relate to internal taste characteristics, such as sugar (TSS) and acid ratios. As such, the decision to harvest is based on internal 'taste' and external appearances early in the season can be deceiving.

Although immature citrus fruits are green, and the majority of citrus fruit are coloured at marketing, the internal maturity of citrus fruits cannot be judged by the external appearance. Citrus fruit grown in hot humid and warms subtropics are green when mature. The development of colour is promoted by the mild stress of cold night temperatures (<12^{0}C), such as in Mediterranean-type climates. Under these conditions,

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the fruit produces sufficient ethylene to colour citrus fruit (Wardowski, Miller and Grierson 2006). Ethylene gas can be applied to hasten colouring where 'natural' colouring has not coincided with internal maturity. This process is commonly referred to as 'degreening'.

There are a number of important considerations to consider in handling early season fruit destined for degreening. They can vary depending on your geographical and climatic conditions, but detailed instructions for harvesting and handling under Australian conditions can be found in the Citrus Handling Guide (Tugwell 1999).

A summary of the important harvesting considerations is;

- Early season Navel oranges must show some natural colour development prior to degreening
- Fruit picked when trees are suffering water stress tend to wilt and lose their calyx during degreening.
- Hot fruit should be allowed to cool to below 27^{O}C before degreening commences
- Fruit intended for degreening should be harvested with special care to minimize injury and wastage due to later mould development.
- Wet, turgid fruit should not be picked because this fruit is likely to incur rind cell disruption (Oleocellosis). Oleocellosis spots remain a very obvious dark green after the degreening process.
- Full colour will not develop during degreening if oil sprays have been recently applied to the trees prior to harvest.

Bin Drenching

The first fungicide application should be applied to fruit as soon as possible after harvest, and preferably as a bulk dip or high volume drench in the orchard or on arrival at the packing facility. Dipping or drenching bins of citrus with fungicides is undertaken because most injury and, subsequent inoculation of fruit, occurs during harvest. The general rule is that fungicide treatment should not exceed 24 hours after harvest or mould development can occur beyond the point of control (Tugwell 1999). However, this recommendation is not adequate for all temperatures and fungicide groups (Wild and Spohr 1989).

Currently, Australian packers use guazatine (for domestic) and thiabendazole (for export) in postharvest dips. Guazatine has the advantage of controlling moulds and sour rot. Thiabendazole (TBZ) doesn't control sour rot, but is mixed with sanitisers to control sour rot spores in solution. Smilinick and coworkers showed combinations of sodium bicarbonate and TBZ were more effective in controlling mould and also did not effect the degreening of oranges (but there was a slight colour delay in lemons). Our work suggests that combinations of sodium bicarbonate and TBZ are also quite effective against sour rot. The rate of sodium bicarbonate with TBZ often 2-3%, but during degreening is usually lower (at 1%) to reduce the risk of increased weight loss. Packers should also add a sanitiser to this combination, but remember to take into account the pH shift due to the sodium bicarbonate in solution. The rate may need to be increased to compensate or consider using a sanitiser less sensitive to pH.

Fungicide application prior to degreening is important because degreening provides ideal conditions for mould development (see 'ethylene effects of decay'). Tugwell (1999) suggest that dipping in fungicide is also useful because evaporation from wet fruit raises the humidity within the degreening room. Many packers are concerned about placing wet fruit into degreening rooms. There is a risk that free water on the surface of the fruit will interfere with the ethylene colouring process. As such, placing wet fruit in the rooms is a potential problem where humidity is already very high and there is insufficient airflow to evaporate free water from the fruit's surface. If your degreening rooms are already at optimum humidity &/or you have automated humidity control, you may be better to leave dipped fruit for 2-3 hours to dry before placing in the room. What you do depends on your situation, and requires effective monitoring of the conditions in your degreening rooms.

The calyx can be kept green by dipping in a solution containing 2,4-D before degreening. The effect of 2,4-D can vary with cultivar, from useful extension of button life in navel orange to almost no effect in degreened Valencia oranges. The best results are obtained with lemons (Tugwell 1999). The label for postharvest use on citrus in Australia is 500ppm, but high rates of 2,4-D ester can inhibit colouring in

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sensitive cultivars, such as tangelos. In some countries, much lower rates are used on easy peel cultivars prior to degreening (see article below on degreening mandarins).

Sorting

The sorting of fruit into colour groups prior to degreening is highly desirable since each colour group can be degreened for the optimum period. Wardowski *et. al.* (2006) found that colour sorting actually increases the efficiency of degreening and reduces decay. This is because more fruit can be degreened in the same facility by removing well-coloured fruit and shortening the degreening time for lots with greater colour break. The advancement of automated colour sorting equipment and computer monitoring of degreening rooms allows this approach to be cost-effective.

Degreening process

Many citrus cultivars can be quite palatable while their peel colour is still green. The consumer associate green with immaturity and the use of ethylene to 'degreen' is a legitimate method to improve the visual quality of, otherwise, mature fruit.

Ethylene effects on citrus colouring

Ethylene is a natural growth regulator produced by most fruits as a response to stress or during the natural ripening process. Ethylene does not ripen citrus fruits. As such, the acid, sugars and flavour of the juice are unaffected by ethylene exposure. However, ethylene does destroy chlorophyll, and promote the development of yellow and orange carotenoids in the flavedo (Stewart and Wheaton 1972). Under conditions of mild stress, such as cold nights, citrus degreen naturally. The postharvest use of ethylene seeks to chemically hasten the degreening process.

Ethylene effects on decay

Ethylene promotes senescence (aging), which increases the susceptibility of citrus to decay. The temperature (typically, 22^0 to 24^0 C) and high humidity (ideally, 95% RH) required for ethylene degreening also provides ideal conditions for the development of postharvest disease. Ethylene accelerates senescence of the fruit calyx, which favours 'stem-end rots' (eg. *Diplodia natalensis, Phomopsis citri* and *Alternaria citri*). Ethylene also plays a role in the induction of anthracnose decay (*Colletotrichum gloeosporiodes*). The level of ethylene used in degreening is considered important. Ethylene levels above 5 ppm do not hasten degreening or improve colour, but may cause serious loses from anthracnose disease. Exogenous ethylene causes germination of the appresorria to begin the infection process, but ethylene can also induce physiological changes required for the development of fruit resistance. The role of ethylene in anthracnose development is complex, and well described by Timmer and Brown (2000).

Degreening practices

Citrus fruit require some colour break prior to harvest for effective degreening. The harvested fruit are usually treated with a fungicide prior to placing in degreening rooms or under plastic tents. The 'trickle' method is a common method to apply ethylene. This involves continually replacing the air in the degreening area with a low concentration of ethylene. Traditionally, the concentration of ethylene is usually around 5ppm, and should seldom exceed 10ppm. However, it has long been recognised that 1ppm is adequate (Grierson 2004). The development of sophisticated monitoring systems means we can deliver a consistent lower dose, with rates of >1.5ppm used successfully in commercial citrus degreening rooms.

Efficient airflow and ventilation facilitates uniform distribution of the ethylene and removes accumulated carbon dioxide. If you can measure CO_2 concentrations; the concentration should remain below 0.3%. If you can't measure CO_2, the common air ventilation recommendation of one room volume per hour is usually successful, but is related to good room design and automated humidity control (Wardowski *et. al.* 2006). The most undesirable effect of degreening under low humidity is fruit softening, and exacerbation of injuries and rind weaknesses.

Each growing region must determine its own optimum degreening conditions, especially temperature range. In Australia, a uniform temperature of between 20^oC and 25^oC for oranges and up to 30^oC lemons is considered ideal for colour development (Tugwell 1999). Humidity should be above 80% while heating fruit and above 90% when up to uniform temperature. Maintaining above 95% RH is difficult without automatic controls, but the 'up-front' cost may be well worth it.

Grierson (2004) described how degreening Temples (tangors) caused an ugly peel injury that disappeared when conditions remained above 85% RH. He also conducted a study on fruit shrinkage at 85% and 95% to demonstrate the value of automatic humidity

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control. 95% RH resulted in 2% more fruit to sell, which could pay for the instrumentation in one season.

Ethylene phytotoxicity

Excess rates of ethylene may produce rind damage or 'gas burn'. Some citrus cultivars are more sensitive to ethylene damage. To reduce the risk to sensitive varieties, such as 'Fallglo' tangerines, fruit can be allowed to 'degas' after ethylene treatment and prior to waxing. Alternatively, fruit can be exposed to ethylene for shorter periods (6-12 hours) before transferring into high humidity rooms (without ethylene) until acceptable colour development. (Petracek *et. al* 2006).

Ethylene can increase the susceptibility of fruit to anthracnose (caused by *Colletrichum gloesporioides*) and the symptoms of this disease can be misdiagnosed as ethylene damage unless carefully examined.

References

Grierson W. (2004) Early Degreening Research: Establishing Basic Principles. Proc. Fla. State Hort. Soc. ***117****, 348-350.*

Petricek P.D. Kelsey D.F. and Grierson W. (2006) Physiological peel disorders. pp. 374-419. In Fresh Citrus Fruits.Wardowski W. F., Miller W. M., Hall D. J. and Grierson W. (Editors) Florida Science Source, Florida, USA.

Smilanick JL. Mansour M.F. and Sorenson D. 2006 Pre- and Postharvest Treatments to Control Green Mould of Citrus Fruit During Ethylene Degreening. Plant Disease. ***90*** *(1): 89-96*

Stewart, I. And Wheaton, T.A. (1972) Carotenoids in citrus, their accumulation induced by ethylene. J. Agr. Food Chem. ***20****, 448-449.*

Timmer L. M. and Brown G E. (2000) Biology and control of anthracnose diseases in citrus, pp. 300-316. In Colletotrichum: host specificity, pathology and host-pathogen interaction, Pruski D., Freemen S. and Dickman M. B. (Eds) APS Press, St. Paul, Minnosota, USA.

Tugwell B. 1999. Citrus Handling Guide. South Australian Research and Development Institute, Adelaide, Australia. ISBN No. 0 7308 5245 8.

Wardowski W.F., Miller W.M. and Grierson W. (2006) Degreening pp. 227-298. In Fresh Citrus Fruits. Wardowski W. F., Miller W. M., Hall D. J. and Grierson W. (Editors) Florida Science Source, Florida, USA.

Wild B. L. and Spohr L. J. 1989. Influence of fruit temperature and application time on the effectiveness of fungicides in controlling citrus green mould, Penicillium digitatum. Aust. J. Exp. Agr. ***29****, 139-142.* ✯

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Degreening mandarins: some factors to consider

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During the last decade, there has been a continuous rise in the demand for, and consumption of, easy to peel mandarin varieties. For counties like Australia to benefit, this means shipping fresh fruit considerable distances to the more populous Northern hemisphere. Unfortunately, mandarins are more perishable than other citrus and the longer transport times pose increased challenges to maintaining fruit quality.

I have largely ignored this trend, but intend to 'get up with the times' and consider mandarins specifically. In regard to degreening mandarins, Australian packers have adapted information from overseas and learnt by trial and error. I don't have a lot of direct experience, but offer the following distillation of overseas information.

Temperature

The optimum temperature for degreening will depend on a number of factors, including the local climate and the initial color of the fruit. Florida has maintained a fairly high degreening temperature of 29^{o}C for citrus. Mediterranean-type climate countries have reduced temperatures, with temperatures of 20-25^{0}C commonly cited. However, a recent paper by Tietal and coworkers (2010) suggest that in the last few years it has become common in Spain to degreen Satsuma and other early mandarin varieties at 18-22^{0}C. A South African study (Terblanche 1999) comparing degreening of Satsumas at 18^{0}C and 24^{0}C gives some insights into the potential advantages and disadvantages of reducing temperature. He found an interesting effect; the higher temperature resulted in darker orange colour, but more fruit changed colour at the lower temperature. He suggested that fruit should have some colour break on tree before degreening, to colour sort before degreening and then manage the degreening process accordingly.

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Taste

Ethylene degreening may have an adverse effect of internal quality, resulting in off flavours. However, Tietel and coworkers found that degreening early season Satsuma mandarins (3-5 days; 4 ppm ethylene at 20°C) maintained quality. They also integrated a curing period into the degreening process (3-5 days; 4 ppm ethylene at 30°C). [Hang on! We have gone full circle back to Bill Grierson's original Florida recommendation?] Yes! This is reverting to earlier higher temperatures, but selectively. Early season fruit can be slow to reduce acid to palatable levels. Burdon and coworkers (2007) showed that short periods of conditioning at 30°C can reduce acid levels and, thereby, improve taste (e.g., TSS:Acid ratio from 6.7 to 9.4 after curing). However, it is only useful early in the season to reduce high acid to optimum maturity thresholds. Reducing acid in already internally mature fruit may make them taste insipid. Unfortunately, curing can also lead to higher weight loss and, subsequently, a shorter shelf life. As such, this is probably a strategy for early season domestic marketing and not for long overseas voyages.

Calyx Retention

The synthetic auxin 2,4-D has long been used as a postharvest treatment to delay calyx drying and browning that occurs as a consequence of degreening. The label rate in Australia remains high relative to rates used overseas, especially for mandarins. Carvalho and coworkers (2008) treated four Clementine varieties with either 5 or 10ppm 2,4-D ester before degreening and found low amounts of calyx browning at 10ppm and 5ppm for Clemenules and Clemenpons, respectively. The other 2 varieties, Marisol and Oronules, are both much more susceptible to browning and abscission. These rates were not sufficient to keep a high proportion of their calyces in acceptable condition. The 2,4-D used did delay colouring, but all fruit reached acceptable colour 7 days after degreening commenced. The fruit were under 2ppm ethylene, 95% RH and 21°C for either 3 days (for yellow-orange fruit) or 4 days (for green-yellow fruit). The overall message is that the success of treatments can vary depending on the cultivars and initial colour, but there still appears to be considerable scope to explore the use of lower 2,4-D rates for mandarins.

This work was instigated because the European Union has restricted the postharvest use of 2,4-D. It is still an acceptable treatment in a number of countries, including Australia. However, it seems appropriate to look at ways to lower rates and find replacement treatments.

References

Carvalho C.P. Salvador A. Navarro P. Monterde A. amd Martinez-Javega J.M. (2008) Effect of Auxin Treatments on Calyx Senescence in the Degreening of Four Mandarin Cultivars. HortScience. ***43*** *(3): 747-752.*

Grierson W. (2004) Early Degreening Research: Establishing Basic Principles. Proc. Fla. State Hort. Soc. ***117****, 348-350.*

Terblanche E. (1999) Effect of Temperature on the Colour of citrus during Degreening. ASAE meeting presentation paper no. 996120. Downloaded on 03/03/2011 at : http://www.docstoc.com/docs/20234974/EFFECT-OF-TEMPERATURE-ON-THE-COL

Petricek P.D. Kelsey D.F. and Grierson W. (2006) Physiological peel disorders. pp. 374-419. In Fresh Citrus Fruits.Wardowski W. F., Miller W. M., Hall D. J. and Grierson W. (Editors) Florida Science Source, Florida, USA.

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