Packer Newsletter

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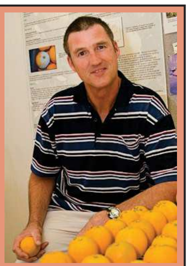

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Coolroom disinfection (the IPhM way)

Imagine this situation! A busy export navel orange season nearly finished. Hygiene has dropped off as other more pressing demands have required your attention. Packed fruit has been on the premises much longer than you expected. And, the latest survey shows TBZ resistant green mould spores throughout the cool room. How do you to clean up?

It is very difficult to thoroughly clean and decontaminate a cool room. Formaldehyde has been used in the past for cleaning cool storage areas because it has a fumigant action. However, it is toxic, an irritant, and the US Environmental Protection Agency (EPA) website describes formaldehyde as a probable human carcinogen (Group B1) (see link; http://www.epa.gov/ttnatw01/hlthef/formalde.html).

In 2007, I wrote an article about safer alternatives for cool room decontamination (Packer Newsletter 89). In large part, these alternatives have not be adopted by citrus packers in Australia. I'm not surprised. Fungicides have been a reliable 'silver bullet'. However, the strength of fungicide control is also its weakness. We are too reliant on fungicides and cracks are appearing. Surveys show resistant spores can quickly build up in cool rooms. In addition, markets are becoming less accepting of chemical residues; MRLs are being lowered. Clearly, we need more than one approach to satisfy the chemical residue concerns of consumers and still preserve our fungicides.

So, there are now two questions: How do you clean up? And, can you also reduce your reliance of fungicides?

In this issue, I will explore both questions. Firstly, I review some methods to disinfect and maintain low spore levels that are used successfully in other food industries. Safer, non-residual alternatives are preferred because the rooms you need to disinfect often still contain fruit.

The secondary aim is to reduce reliance on fungicides. Safer alternatives can be used more frequently (up to 24/7) to create optimum conditions in storage, thereby, lessening the need for fungicide residues on fruit. This heralds an incremental IPhM approach (in the future) by substituting fungicides with safer &/or lower chemical residues in the line, then storing in optimal conditions.

This is a issue to make you think; to solve a current dilemma and consider investing in the future, at the same time.

Peter Taverner

Inside This Issue

Read the Packer Newsletter and stop the rot.

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

SOUTH AUSTRALIA

Government of South Australia Primary Industries and Regions SA

UV light disinfection units installed in cool rooms reduce spoilage on meat surfaces *(image source: UV Light Technology Limited, UK Website)*

UV LIGHT AND OZONE COOL-ROOM DISINFECTION

The technique of using UV-C light to disinfect water, air and surfaces is well established. Early UV-C treatments used low-pressure mercury lamps designed to produce a continuous wave (CW) of energy at 254 nm (monochromatic light). Later, medium-pressure UV lamps emitted a polychromatic output, including the germicidal wavelengths from 200 to 300 nm. UV pulsed light (PL) uses short time pulses of intense broad spectrum, rich in UV-C light. PL is considered faster acting than CW and may penetrate deeper into surfaces. Regardless, UV light disinfection is typically superficial. UV light seems well suited to disinfect the smooth walls of citrus cool rooms. And, with the fruit safely present in the room. However, there may be reduce disinfection due to the shielding effects of very dirty surfaces. The advantages of UV light are the lack of any residual chemical after treatment. UV light is considered safe on food; it is used to pasteurise fruit juices, and disinfect meat, dairy and bakery items. Some precautions must be taken to avoid exposure of cool-room workers to light and to evacuate the ozone generated by shorter wavelengths. Alternatively, there is potential to use ozone to scrub ethylene. Sealed UV light and ozone air purifiers can filter air to maintain consistently low microbial and ethylene levels. This would provide a safe, 24/7 clean cool-room environment. Finally, the use of these technologies should not be limited to air and cool room decontamination. They can contribute to enhanced shelf life and may provide in-line fruit disinfection. In-line UV-C prototypes are being evaluated in Spain for citrus (Go for it!, Luis) .

Peter Taverner

FOGGING DISINFECTANTS INTO DEGREENING ROOMS.

Markets pay a premium for early season fruit but they will not accept immature looking 'green' rind. Degreening using ethylene is a legitimate treatment to colour the rind of fruit that is internally mature.

In Australia, early season citrus is treated with ethylene in humidified degreening rooms at around 20°C. Unfortunately, these conditions are also optimal for our major postharvest diseases and, despite fungicide drenching, decay is common during extend periods of degreening. Decay on premises can lead to severe spore contamination during the early stages of a packing program; at a time when there is limited opportunity to stop, clean and decontaminate rooms. If treatment is possible, formaldehyde has been used because it has a fumigant action. However, its use is problematic and safer alternatives are required.

Joe Smilanick and coworkers (2014) fogged disinfectants into citrus degreening rooms and evaluated efficacy on green mould spores. They selected products approved by food industries and used rates according to safety, cost and prior registrations. Although the rates were selected for treating empty degreening rooms, they did recognize the advantage of a treating when fruit was still in the room.

Disinfectants

A range of sanitisers and generally regarded as safe (GRAS) compounds are likely candidates as replacements for formaldehyde.

Smilanick and coworkers (2014) found a few products that were efficacious in fogging trials. I will discuss two of the active compounds; hydrogen peroxide and acetic acid.

In their study, fogging at 1-2% hydrogen peroxide in water applied at >4.4g per m^3 provided comparable spore kill to formaldehyde. Hydrogen peroxide is a strong oxidizer, which decomposes into oxygen and water. Low concentrations are still antimicrobial and classified as GRAS. Prior work, dipping lemons in up to 15% hydrogen peroxide for 15 to 30 seconds caused no injury. However, longer dips can cause injury and the risk of fruit phytotoxicity has not been established for a fogging application. There are also safety concerns for workers. Hydrogen peroxide vapours are irritant and chronic exposure to low concentrations can result in lung damage.

Glacial acetic acid applied at 5-10 g per $m^3$was successfully used but vinegar would be safer to handle. Acetic acid residues are considered GRAS for many food applications. Acetic acid has a mildly fumigant action that inactivates many spores, including green mould. There are safety considerations as vapors are pungent and cause irritation to eyes and skin. The study did not evaluated phytotoxicity to citrus fruit.

Fogging application

Smilanick and coworkers were surprised that many sanitisers effective in water, such a chlorine and chlorine dioxide, did not perform well in degreening rooms.

But fogging application may play a role: A fogger that produced droplets ~15 µm in diameter was considered suitable by Smilanick and coworkers because of the relatively long settling time (45-60 mins). However, they did concede that a more sophisticated system may improve efficacy.

Other studies, reported good control on stored figs with low volumes (1.5L) of chlorine dioxide (up to 1,000ppm) in 16 m^3 cool rooms (Karabulut et. al. 2009). In their study, they used an ultrasonic aerosol generator producing droplets 1.2 µm in diameter.

There are undoubtedly other factors such as air circulation (see Fogging fungicides, Pg 3) and temperature (lower temperatures in cool rooms), that may impact on overall efficacy.

This is an interesting and worthy area for further practical research.

Key reference

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Peter Taverner

FOGGING FUNGICIDES

As you are aware, I am a great advocate for treating fruit with fungicide within 24 hours from harvest. During degreening, it is common to apply fungicides to field bins full of fruit by drenching or dipping. However, many packers find this method challenging. Yes! There is potential for spores to accumulate in the solution, and dirt reduces effectiveness over time. However, this can be overcome with good practices. There is capital expense in designing a good drench/dip system and there are the issues with disposal of large volumes of spent fungicide. If you are looking for an alternative; there may be one being developed. Fogging fungicides in cool rooms occurs for the control of mould during long-term storage of pome fruit. And, similar systems may be applicable for fogging citrus in degreening rooms. The key would be providing adequate fungicide deposit of fruit and uniformity on all fruit. This is likely to be challenging because air flow in a cool room stacked with fruit leads to notoriously uneven cooling. Delele et.al. (2012) assessed thermal fogging systems in cool rooms loaded with different configurations of apple bins. Pyrimethanil was used; the total fogging time was 10-11 mins, with a 2 hour settling period. They found that a fully stacked room (4 bins high) increased penetration into the stack compared to uneven layers. They assumed this was due to less free space over the stack. A full load and uniform stacking improved uniformity of fungicide deposition. They also found that fogging while the air circulation was off gave the highest deposition. High air circulation during fogging (max. 6800 $m^3 h^{-1}$ or ~ 85 room volumes h^{-1}) resulted in fungicide being deposited in the cooler assembly, rather than on bins. I think fogging rooms (with fungicides &/or sanitisers) has promise and I look forward to seeing more data on the deposit characteristics in citrus degreening rooms.

Key reference

Delele M.A. et.al. 2012. Investigating the performance of thermonebulisation fungicide fogging system for loaded fruit storage room using CFD model. J. Food Eng. 109: 87-97.

Peter Taverner

IMPROVE SHELF LIFE BY REDUCING ETHYLENE LEVELS

As citrus packers, you are aware of ethylene through the degreening process. But, you may not be aware of the role of ethylene in fruit senescence. This effect is most apparent in climacteric fruit, such as bananas, stone fruit, kiwi and apples, which soften and produce copious amounts of ethylene during the ripening process. Indeed, Smartfresh has been successful in prolonging storage of climacteric fruit, such as apples, because it blocks the effect of ethylene by using an ethylene action inhibitor (1-MCP).

Citrus fruit are non-climacteric and produce relatively low amounts of ethylene. As such, you could easily dismiss the role of ethylene in reducing shelf life; but this would be a mistake. If consumer trends are towards lower chemical residues on fruit and we need to reduce reliance on fungicides, then we need every 'trick in the book' to maintain quality. Ethylene blocking/removal is a non-residual method of maintaining optimal storage conditions; its not the whole answer but it may compliment other methods.

Ron Wills and others (see references) have provided ample evidence that very low levels of ethylene (5 parts per billion) affect the storage life of nonclimateric fruit, including citrus. Wills and coworkers (2000) measured ethylene levels in the atmosphere of Sydney wholesale markets, distribution center storerooms and supermarkets. They recorded levels they believed were sufficient to significantly reduce the shelf life of non-climacteric fruit (by 10-30%).

There are scant studies on ethylene and citrus storage life, apart from the degreening process. Studies that focused on postharvest application of 1-MCP discovered increased shelf life of citrus due to reductions in disorders, such as chilling injury, peel pitting and SERB (in Valencia orange). However, decay was often increased, depending on dose, storage conditions, cultivar and, probably, maturity. Generally, decay occurred at higher doses, and, fortunately, as doses were lowered the benefits of reduced chilling injury remained. To date, the use of 1-MCP on citrus is likely to be more value on specialty citrus, such as 'Shatangju' mandarin; to keep attached leaves fresh. More research on 1-MCP would be necessary to quantify benefits to citrus fruit. This may occur if marketing priories change (e.g. low residue citrus).

1-MCP inhibits the action of ethylene but ethylene removal is another option. As indicated, only small amounts are deleterious and ethylene from fruit can build up over time in storage areas. Cool rooms are seldom properly vented and nearby activity, trucks and propane-fuelled forklift trucks, increase ethylene levels in the ambient air. The easiest way to prevent the impact of ethylene is to remove it from the storage area.

Keller and coworkers (2013) give a detailed overview of ethylene, its impact, and existing methods of reducing ethylene from air. Some examples include;

Ventilation: The simplest and most effective means of reducing ethylene build up in storage areas is ventilation (e.g., one air volume per hour) with clean air. However, the substituted ambient air has be cooled and, often, dehumidified, which increases running costs.

Controlled atmosphere: A seemingly ambitious option for fresh citrus but it has been estimated that 20-30% of all cargo transported in refrigerated ships is carried under controlled atmosphere (ref from Keller et.al. 2013). Other perishable commodities are using it successfully! Optimal oxygen and carbon dioxide levels reduce respiration and ethylene production in fruit but care must be taken to avoid levels that would induce anaerobic conditions. Modified atmosphere packaging/fruit coatings can similarly modify oxygen and carbon dioxide levels to reduce ethylene production.

Potassium permanganate: Ethylene scrubbing sachets are the most widely used technology. Potassium permanganate is combined with carriers (alumina beads) or ethylene absorbents (zeolites and clays) in sachets. Potassium permanganate oxidises ethylene into carbon dioxide and water, also forming manganese dioxide and KOH (which can be used as an organic fertilizer). The main disadvantage of sachets is the loss of activity over time as the potassium permanganate is 'used up'. There is also a side is-

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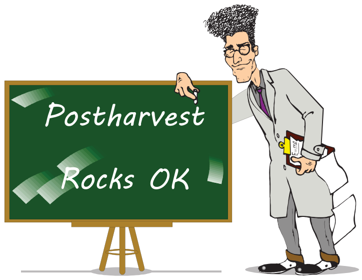
POSTHARVEST SNIPPETS!

CITRUS TECHNICAL 2015

You may have already receive notification from Citrus Australia regarding the Citrus Technical forum in March 2015. However, you may not be aware that they are planning a specific postharvest program to run concurrently with the normal grower sessions.

Citrus Australia have asked Nancy and myself to help coordinate the postharvest program. Citrus Australia will advertise the program when finalized. However, I will say that they are doing their very best to make it as interesting and valuable to packers as possible.

In the forum, I aim to provide you with a mix of information on the perennial postharvest issues and also get you thinking about approaches to meet future demands. The articles in this issue stem from some of my thoughts about where we are heading; our new challenges. Two days of postharvest knowledge. Wow! Just be there!



sue with loss of function due to adsorption of water in high humidity air. Widely used in storage of climacteric fruit; there is a lack of systemic studies on the ability of potassium permanganate to remove ethylene in citrus under commercial conditions.

Ozone: Ozone is a powerful oxidizer capable of removing ethylene from air. It also has potential benefits in the control of spores in air and sanitation of surfaces. Its use is limited due to its high toxicity to humans. To minimize safety issues, storage air may be circulated through sealed ozone reaction chambers or the system designed to work on day-night cycles when staff are absent. High concentrations may be suitable for commodity in sealed export containers. However, monitoring of ozone levels would be required to ensure worker safety and to minimize any fruit damage.

Photocatalytic oxidation: Photocatalytic oxidation is associated with remediation of polluted wastewater and industrial gasses. Its use in food has been advanced by spaceflight research, where reliable, low energy and low maintenance systems are required for extend spaceflight. Efficient plant growth in confined spaces requires pollutant removal (including ethylene). Compared to other methods, photocatalytic oxidation was considered highly promising. Theoretically, it can be applied on a small or large scale for effective removal of low and high ethylene concentrations. At this stage, studies on fruit are scarce and industrial scale examples do not exist. Keller et.al. (2013) describe a compelling case for further development of this technology for fruit storage applications. Laboratories studies using photocatalytic ethylene removal resulted in double the storage life of tomatoes, with no differences in nutritional value of ripe fruit. The process also inactivates microbes in air. Other studies have shown a reduction in the size of mould lesions on lemons coated with photocatalytic films.

Finally, there is a tantalizing suggestion that efficient ethylene removal may lessen the need to refrigerate, and therefore, save energy. Wills et.al. (2014) contend that it is feasible to transport bananas at 25°C using current technology and that the entire cool chain, including supermarkets, could make substantial refrigeration savings.

So! What does it all mean. Obviously, as packers, you are a long way from throwing out your fungicides and cool rooms; relying solely on these new technologies. Technologies, such as ozone and ethylene scrubbers, have been around for a while. In the past, you may have been put off by 'unsubstantiated' claims for citrus. However, these technologies continue to mature and evolve. We need to revisit them by comparing use in similar commodities and generating specific data for citrus as required. They may be worth investing in: If they can complement your existing practices. If they can provide additional benefits of sanitation and spore control. If they can provide a greater level of insurance during periods of high disease pressure. If they can provide the flexibility to try new approaches in the future, such a low residue packing or ambient storage.

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