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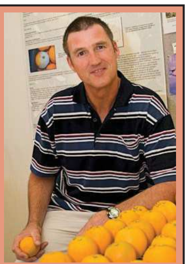

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DEGREENING PRACTICES

I publish an article on degreening around this time because there are usually enquiries about degreening. Frankly, the details don't change much. This is a slightly updated version of previous years' articles. Detailed instructions for Australian conditions can be found in the Citrus Handling Guide (Tugwell 1999).

It may sound odd, but the degreening process starts with proper harvesting. A summary of the important harvesting considerations is;

- Early season fruit must show some natural colour development prior to degreening
- Fruit intended for degreening should be harvested with special care to minimize injury and wastage due to higher risk of mould development.
- Wet, turgid fruit should not be picked because this fruit is likely to incur rind cell disruption (Oleocellosis). Oleocellosis spots remain an obvious dark green after the degreening process.
- Full colour will not develop during degreening if oil sprays have been applied shortly before harvest.

BIN DRENCHING

Fungicide application prior to degreening is important because degreening provides ideal conditions for mould development.

Tugwell (1999) suggested that dipping in fungicide is also useful because evaporation from wet fruit raises the humidity within the degreening room. However, wet fruit is a potential problem when 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 can vary with cultivar, with best results obtained on lemons (Tugwell 1999). The optimum rates of 2,4-D ester vary but lower rates are often cited for use on easy peel cultivars. In Spain, 5 or 10ppm 2,4-D ester has been used on mandarins. The 2,4-D can delay colouring, but fruit usually reaches acceptable colour by 7 days at 85%RH.

SORTING

A recent paper by Moscoso-Ramirez and

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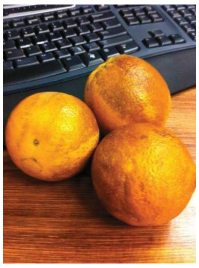
INSIDE THIS ISSUE

Read the Packer Newsletter and stop the rot.



TIPS FOR THE CONTROL OF ANTHRACNOSE

The best control of anthracnose can be achieved by a combination of in-field and postharvest treatments.

✓The fungus responsible for anthracnose harbours in deadwood. Good cultural practices to reduce deadwood should be encouraged.

✓Field sprays of copper-based fungicides or Mancozeb® may inhibit spore germination. Heavy rain may wash off a copper application and allow infection. There is also an emergency permit use for iprodione and azoxystrobin in Queensland.

✓Ethylene stimulates anthracnose development. Delayed harvesting or selective picking for better colour will minimise the amount of time in degreening. Ethylene degreening should not be above optimal concentrations (5ppm or less -trickle method).

✓Harvested fruit should be washed on revolving brushes to remove appressoria &/or dipped in a thiabendazole fungicide before degreening. *NB. Dipping in guazatine alone will not control anthracnose. Fruit treated with guazatine and a benzimidazole will control moulds, sour rot and anthracnose.*

✓If disease pressure is high, a combination of two different fungicides with activity against anthracnose, i.e., thiabendazole, Tecto®, and fludioxonil, Scholar®), should provide superior protection.

NB. Dipping in thiabendazole and fludioxonil will not control sour rot. Check before using for Japan because some importers are reticent to allow fludioxonil use.

✓Immediate cold storage of fruit after packing may assist in reducing the expression of anthracnose.

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Palou (2014) shows that susceptibility to disease after degreening is dependant on the peel colour, with less green (more mature) fruit being more susceptible to disease. Cultivars varied in their response, with 'Navelina' oranges and 'Clemenules' mandarins more susceptible. They suggest that colour index thresholds should be set for these varieties. Alternatively, sorting of fruit into same colour groups prior to degreening allows each colour group to be degreened for the optimum period. Wardowski *et. al.* (2006) found that colour sorting actually increases the efficiency of degreening and reduces decay.

DEGREENING PROCESS

Sometimes external appearances early in the season can be deceiving ; fruit can be green but internally mature. Under ideal conditions, as fruit matures it produces sufficient ethylene to colour naturally (Wardowski, Miller and Grierson 2006). When this does not occur, ethylene gas can be applied to hasten colouring. Ethylene does not ripen citrus fruits. However, ethylene does destroy chlorophyll, and promote the development of yellow and orange carotenoids in the flavedo (Stewart and Wheaton 1972).

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'. Ethylene also plays a role in the induction of anthracnose decay. The level of ethylene used in degreening is important.

DEGREENING PRACTICES

The 'trickle' method is a common method to apply 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) and, perhaps, becoming more practical to achieve.

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°C and 25°C for oranges and up to 30°C 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. A Spanish study found that maintaining 95%RH by automatic controllers (rather than 85% RH) resulted in 2% more saleable fruit (less shrinkage).

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Peter Taverner

CALTEX PROSPECT®—POSTHARVEST FRUIT TREATMENT FOR CONTROL OF SURFACE PESTS

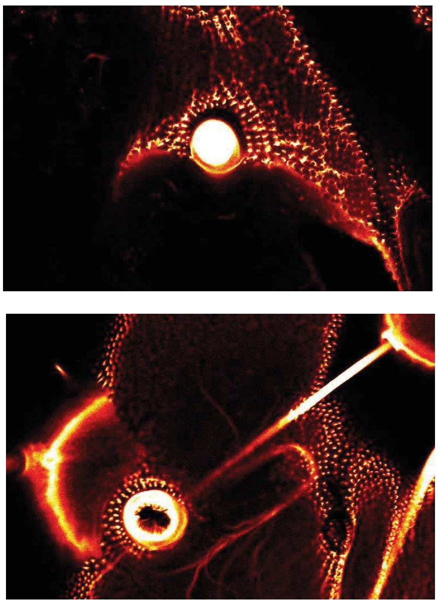
The Caltex website describes Prospect as 'a unique, emulsifiable, low viscosity, food-grade, paraffinic oil for use in a dip or in-line in a post-harvest packing operation'. What a mouthful! But, it is unique and requires a new understanding and approach. Maybe, this is why it has slipped under the radar.

Before I start, I must declare my interest in this product. I was involved in its development around 20 years ago. South Australia was desperate to send oranges into the new USA market but were hampered by the presence of lightbrown apple moth. We tried all sorts of chemicals, soaps and potions but nothing came close to this seemingly unremarkable clear fluid. It was used and the problem disappeared. Other pests have occur over the years generating equally sporadic use.

An interesting example was with Queensland rambutan growers. They were air-freighting rambutans in Japan only to see fruit rejected for mealybug and left on the tarmac. They were desperate and tried CPD (a precursor to Prospect) at very high rates. The mealybug died, the fruit looked great and the market opened up.

Prospect can be quickly added to existing processes with reasonable results and is generally used as a 'pinch hitter' (to use a baseball analogy). However, there is a small group of citrus packers that use the product regularly and have developed very efficient systems for application. Thankfully, Caltex maintains the product despite the small volumes used. We need more use to maintain it and more development to unlock its potential. Let me explain!

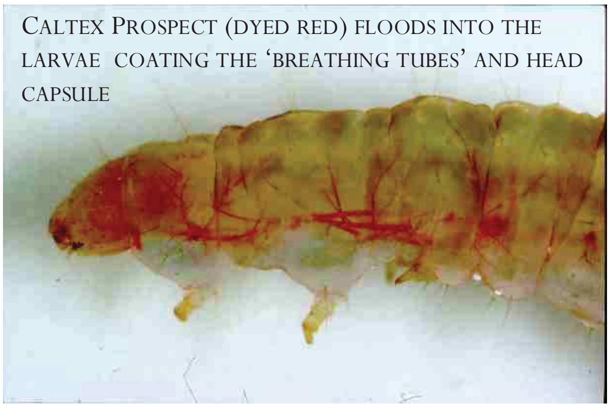
We initially referred to it as 'postharvest oil', which was inappropriate and a mistake. Packers and growers thought of spray oils and were immediately skeptical. This fluid is no 'oil'; it was orders of magnitude more potent than spray oils.



ENHANCED MICROSCOPE IMAGES OF LARVAL SURFACES:

Dipped in spray oil. A small amount of oil blocks a 'breathing tube' opening (top).

Dipped in Caltex Prospect. The fluid flows and coats the breathing tubes throughout the insect (bottom).



CALTEX PROSPECT (DYED RED) FLOODS INTO THE LARVAE COATING THE 'BREATHING TUBES' AND HEAD CAPSULE

It was so different that I devoted my PhD studies to comparing it's action to spray oils and discovering how it works. It was a revelation!

Caltex Prospect and previous formulations flow and spread to penetrate the smallest crevice. This was perfect for reaching small insects under the calyx of an orange. This property may also explained the rapid potency on insects. By using a microscope, we could see the the fluid penetrating throughout the 'breathing tubes' of lightbrown apple moth larvae. This caused rapid and irreversible damage. On the other hand, spray oils could not readily flow under the calyx. Exposed insects are coated and oil tends to plug the breathing tubes. Oil-soaked insects will eventually succumb if the oil plug remains.

CALTEX PROSPECT STRIPS THE WAXY COATING OFF MEALYBUG

Observations on treated mealybug shows another reason why Prospect is potent. The fluid dissolves the waxy coating exposing the insect to desiccation. Prospect is working on insects at several levels.

Prospect is potent but it is not a fumigant. It works best when integrated with other control methods. It's a numbers game. If you kill 99% in a consignment with a few insects—the risk is small. If you kill 99% of a highly infested consignment— the risk may still be too high. For instance, when

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Acknowledgements

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POSTHARVEST SNIPPETS!

QUIET BEFORE THE STORM

We are currently writing reports, waiting for funding outcomes and preparing for the new navel season .

Hopefully, it won't be long and we will be out and about again. We aim to conduct fungicide resistance surveys in early June. This will provide a benchmark for any changes as the season progresses.

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mealybug are in very high numbers the occasional rejection still occurs even after Prospect treatment. To the uninformed, Prospect failed and we should look for a different 'silver bullet'. To the more enlightened, Prospect is almost there. It can be the major player in a combination of treatments. A systems approach, involving orchard and packingline treatments. Something I have advocated for many years.

Mealybug is a good example. Our work showed that high pressure washers were removing up to 95% of mealybug. The Prospect treatment was providing 99% kill. Neither enough on their own. However, when they were combined; what happened? We found that the oil treatment loosened the mealybug and improved removal (up to 99%). In addition, between 98 to 100% of the 1% of mealybug remaining on fruit were dead (See Packer Newsletter Vol. 93 for more details). We had a workable solution for packers.

A similar approach has been applied to Fullers rose weevil (FRW). We are involved in a New Zealand Plant & Food Research program to evaluate advanced washing systems for removal of pests. The project was commissioned by Horticulture Australia in partnership with Citrus Australia.

Some time ago (2006), we evaluated a number of chemicals and high pressure washes to remove FRW egg masses. We determined that only ~10% of egg masses were removed by washers. Fortunately, high pressure washers have improved. Hence, the new program.

We also discovered that pre-treatment in Prospect improved the result, with ~60% of egg masses, rather than ~10%, removed after washing in the same system.

Currently, orchards are inspected to ensure freedom from FRW but we are always looking to improve our biosecurity measures. Orchard inspection, advancing washing systems, and possibly, Prospect to loosen the eggs, should provide a very robust system to ensure packers are not subject to costly rejections.

Approaches using sophisticated and multiple treatments are becoming accepted. At last, products, such as Prospect, may start to be recognized for the important contribution they can make to meeting quarantine restrictions.

Finally, a bit of navel gazing (pun intended). The use of pesticides, whether to control insects or disease, are being scrutinized. Researchers are turning to food preservatives and processing aids with a long history of safe use. Unfortunately, they do not have the potency of the synthetic chemicals currently used. There needs to be a way to enhance potency.

The use of oils as carriers and adjutants is well established. Knowing this, I was curious about some of the effects of CPD (a precursor to Prospect) after some incidental contamination with other chemicals. Many years ago, I conducted a small experiment with mixtures of CPD and ethanol or ascorbic acid (see table below). Killing an insect with Vitamin C demonstrates a principle.

Anything can be toxic at the right dose, and, I would add, if you can get the chemical to where it will work. We spend a lot if time on the first (dose) but not too much on the second (getting it there). Delivery to the site may be a key to enhancing some 'safe' alternatives. Prospect may not the answer by itself but it is a good starting point.

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chemical	rate	% mortality
CPD	0.1%	0
Ethanol	40%	0
Ascorbic acid	10%	0
CPD + ethanol	0.1% + 40%	50
CPD + ascorbic acid	0.1% + 10%	100

MORTALITY OF LIGHT-BROWN APPLE MOTH (5TH INSTAR) AFTER DIPPING IN CPD, ETHANOL OR ASCORBIC ACID ALONE, AND IN COMBINATION.