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Scholar – a new fungicide for postharvest use on citrus in Australia

Peter Taverner

SARDI

In May this year, the APVMA granted registration of Scholar Fungicide (Syngenta Crop Protection Pty Ltd) for post harvest treatment of citrus. This was a significant event for two reasons: Firstly, it is the first new active (fludioxonil) to be registered for postharvest use on citrus since imazalil (that was well before my time), and secondly, it is the first 'reduce risk' fungicide for postharvest use on citrus in Australia.

In regard to the first point, citrus exporters have had only two actives, thiabendazole and imazalil, available for most markets this season. Many packers use the same few actives all year, for season after season. The continuous use of the same actives coupled with a trend to hold packed fruit on the premises for longer is a potent recipe for developing resistance problems. We haven't seen widespread problems in Australia yet, but isolated resistance to thiabendazole has been detected in some packingsheds. In theory, the introduction of a new active, such as fludioxonil, offers the opportunity to develop improved resistance management programs by allowing the rotation of fungicide groups.

In regard to the second point, there is, and will continue to be, increasing scrutiny by various government regulators on the risk to human health and the environment posed by 'old' pesticides, including postharvest fungicides. The list of postharvest fungicides has been dwindling, without any additions for many years. Replacements are needed, but they also need to be safer.

Reduced risk fungicides

The US EPA has a program that expedites the review and regulatory decision-making process of conventional pesticides if they pose less risk to human health and the environment than existing alternatives. The US EPA classifies compounds 'reduced risk' for a particular use. The goal is for reduced risk compounds to be registered more quickly and available to end-users as soon as possible. This program expedited the registration of fludioxonil on citrus in the USA.

Other countries, including Australia, have

Continued on page 2

INSIDE THIS ISSUE

Continued from page 1

independent review and regulatory decision-making processes for agricultural chemicals. However, the US EPA classifying a compound as reduced risk is probably a good indicator of its likely acceptance in other countries. A trend towards reduced risk compounds being more readily registered and commercially available is encouraging. It is particularly relevant for postharvest use on fruit, where there may be a short period from treatment to consumption.

Fludioxonil and MRLs

The first thing to consider before using Scholar is the fruit's destination. If you only pack domestically, there should be no MRL problems when you use good practices. However, the MRLs for various overseas markets need to be considered before use. The MRL for fludioxonil in Australia, USA and Canada is 10 ppm. Many countries defer to Codex, which is 7 ppm for citrus fruit. A notable exception is Japan, where lemons and grapefruit are 10 ppm, but other citrus (including oranges and mandarins) are limited to 1 ppm only. Unfortunately, this will limit the use of fludioxonil as Japan is an important market for all citrus most of the year.

Schirra and co-workers (2005) suggest that ~1 ppm FLU is the minimum fruit residues (whole fruit) required for reasonable control of postharvest disease on non-wounded oranges. More packers are heating solutions and this can affect residues depending on the product. They found that fludioxonil responded to heat, with residue concentrations from 2.6 to 4 times higher in fruit treated at 50^{0}C compared to 20^{0}C.

They also stored fruit and recorded the change in fludioxonil residues over time. Interestingly, the dissipation rate of residues was lower in fruit treated at the higher temperature, with between 45-56% losses for 20^{0}C treated fruit compared to 32-37% loss in fruit treated at 50^{0}C and stored for the same period.

A number of packers have expressed an interest in knowing the degradation profile of fungicide residues during transit. However, care must be taken in extrapolating these losses to other storage situations. The overall losses will vary with products, mixtures used and storage conditions. The storage regime in this case was 3wks at 1^{0}C, then 6 wks at 8^{0}C, followed by 2 wks at 20^{0}C.

Fludioxonil efficacy and mixtures

Australian packers will develop confidence in fludioxonil through their own experiences. However, they should appreciate that this product is already being used successfully overseas. Scientific studies may also provide further insights on the best use of fludioxonil on citrus in Australia.

Zhang (2007) assessed the efficacy of fludioxonil (FLU) on diplodia stem-end rot and green mould on Florida citrus. He conducted some good work by simulating commercial applications used in Florida.

For stem-end rot tests, fruit were drenched for 3 min with high volume solutions, followed by 4 min draining, degreening over 3 days and 4 weeks at 21^{0}C. He found that:

- 500-1200ppm FLU similar efficacy to 1000ppm TBZ or IMZ.
- FLU was also compatible with chlorine

For green mould tests, fruit received a non-recovery spray at a rate of ~50 ml per 60 fruit. He found that:

- 500-2000ppm FLU was similar to 1000ppm IMZ and TBZ. However, the natural infection rate was only 15%, and the rate in FLU treated fruit was 4-5%. A significant reduction, but would it be commercially acceptable?
- 1000 ppm FLU controlled a TBZ-resistant strain of green mould.

Zhang also conducted some sporulation tests, where fruit was dipped for 1 min in 1000 ppm FLU, but it resulted in inferior control when compared to similar rates of IMZ.

Nancy (Cunningham) conducted some work on fludioxonil in 2007. She inoculated wounded fruit and treated by dipping fruit for 30 sec, then placed in plastic bags to induce high humidity. The treated fruit were held at 20^{0}C for 7 days. Infection rates were assessed at 3 and 7 days. This strong challenge found that:

- At 3 days, FLU (600 ppm) was comparable to IMZ (500 ppm) and TBZ (1000 ppm) for all citrus evaluated.
- At 7 days, FLU (600ppm) was comparable to IMZ (500 ppm) and TBZ (1000 ppm) for lemons only. FLU did not perform as well as IMZ and TBZ on oranges and

Continued on page 3

Continued from page 2

mandarins.

- No phytotoxic response recorded on any citrus fruit (up to 1500 ppm FLU).

Other work conducted in Jim Adaskaveg's laboratories looked at various mixtures with fludioxonil (Kanetis et al., 2008). They found that mixtures of sodium bicarbonate, sodium hypochlorite and fludioxonil were compatible. Indeed, adding sodium bicarbonate alone or with chlorine improved the efficacy of fludioxonil. Fludioxonil was also stable when mixed with a hydrogen peroxide/peroxyacetic acid solution.

The bottom line…

It's great to have a new fungicide in the arsenal, but the current MRL restriction for Japan will limit its usefulness on citrus in Australia.

It's great to have a new fungicide in the arsenal, but the current 1 ppm MRL for Japan will limit fludioxonil's usefulness for our orange and mandarin export packers.

It has great potential in mixtures and responds well to heating. Initially, a niche use, but, more regular use as it's 'reduce risk' status becomes more widely accepted.

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Using carbonate salts in Packingsheds – practical applications

Nancy Cunningham

SARDI

The SARDI citrus postharvest team, in an effort to provide solutions for on-going decay control issues facing the citrus industry, have recently focused on evaluating the effect of carbonate salts with fungicide solutions currently being used by citrus packingsheds.

Carbonate salts have seen resurgence in use in citrus packingsheds around the world as they are readily available, inexpensive and easy to use. Research, both here and overseas has shown that carbonate salts (as sodium bicarbonate or sodium carbonate) can significantly reduce Penicillium moulds on citrus. They have also shown some efficacy against *Geotrichum citri-aurantii* the pathogen responsible for sour rot.

The issue with sour rot has been particularly problematic and a perennial issue for Australian citrus packers. Incidence of the disease may cause havoc in exports one year only for the issue to completely disappear the next. Good shed hygiene practices may have some influence over this but whether the disease reoccurs because a lapse in sanitation or because of virulent strains of the disease is unclear.

Laboratory results using carbonate salts in combination with conventional fungicides on Australian citrus fruits have been encouraging. As a consequence we have evaluated the use of sodium bicarbonate in several citrus packingsheds in the Riverland region of South Australia. The idea was to compare packingshed solutions of fungicide/bicarb with lab preparations of the same concentration/fungicide combinations.

The three packingsheds evaluated each used different concentrations of bicarb, different fungicides and treatments were in different parts of the packingline.

Samples were taken from the line and bought back to the lab and compared with lab solutions against a virulent strain of sour rot.

Shed treatments

- Shed 1 – bicarb/imazalil, inline,0.5%, 500ppm
- Shed 2 – bicarb/thiabendazole, bulk dip tank, 1%, 1000ppm

Continued on page 4

Continued from page 3

- Shed 3 – bicarb/thiabendazole, bulk dip tanks and inline, 3%, 1000ppm

Lab treatments

- 1% bicarb + 1000ppm thiabendazole
- 3% bicarb + 1000ppm thiabendazole
- 0.5% bicarb + 500ppm Imazalil
- 0.5% bicarb + 500ppm Imazalil + Tsunami sanitiser

Results

Shed 1 – in line fungicide/bicarb (see right)

Results showed that the shed solution was more effective at reducing sour rot than the 0.5% laboratory mixes of bicarb and imazalil. Some rot did start to initiate, but was arrested before the day 7 assessment.

Shed 2 – bulk dip fungicide/bicarb (see right)

Results showed that the shed solution was as effective as lab solutions of the same mixture. However, the shed solution was not as effective as the 3% sodium bicarbonate lab solution (results not presented).

Shed 3 – bicarb/thiabendazole (see right)

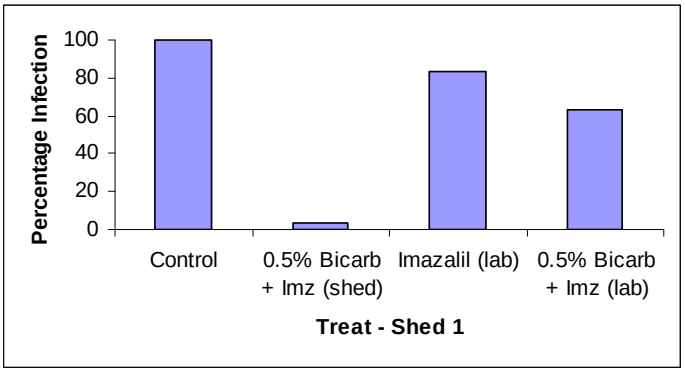
Results showed that shed solutions of sodium bicarbonate/thiabendazole were more effective than lab solutions of the same mixture.

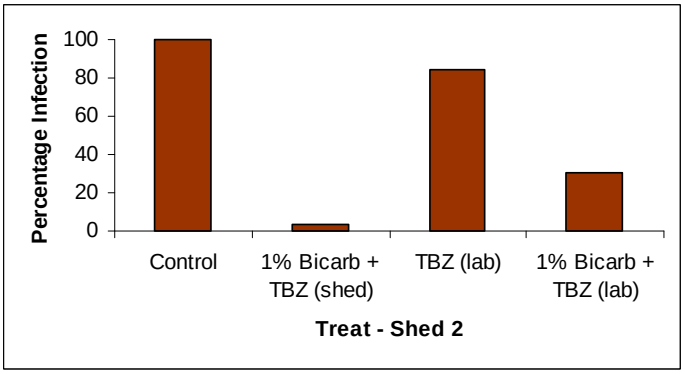
Discussion and recommendations

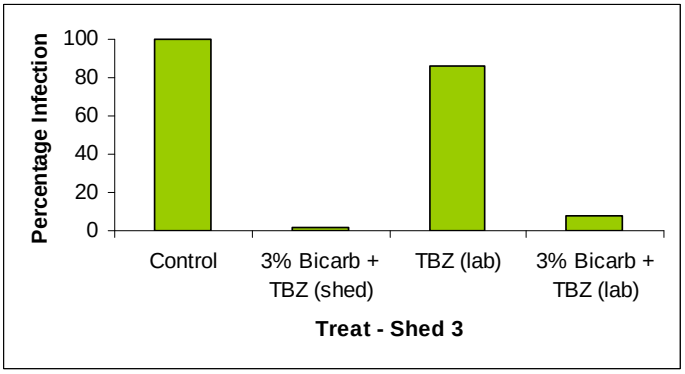
The results from shed solutions show that combinations of fungicides with sodium bicarbonate are effective against sour rot. We did not measure the sodium bicarbonate concentration directly, and the superior result for shed solution may be due to over-dosing. Regardless, this is a favourable result for those citrus packers using sodium bicarbonate as a means to combat the effects of sour rot.

However, there are a number of important recommendations that packers need to be aware of if they want to use sodium bicarbonate in their sheds.

- Treat fruit as quickly as possible on arrival (ie within 24hrs), reducing time between possible sour rot infection and treatment is important for reducing the effect of sour rot on export fruit.
- When combining with imazalil based fungicides carbonate salts will raise the pH of a solution, imazalil becomes less soluble in an alkaline environment, so adequately agitating tanks is needed.
- If sheds are concerned with bicarbonate residue, a lower than the 3% rate can be used effectively.
- Carbonate salts should be used along side or in combination with other fungicides for improved protection against major citrus pathogens. ❋







Continued on page 5

Continued from page 4

Research in Brief

[This is a new approach where we briefly list what's been happening in our labs recently. If you interested – just contact us for more information. Ed]

Differential sensitivity of Rhizopus, sour rot and green mould occurring on citrus to the fungicides Imazalil, TBZ, Fludioxonil and Pyrimethanil.

New fungicides and emerging diseases in citrus evaluated

The effect of Calcium Polysulfide on mould and sour rot occurring on early season navel oranges.

Calcium polysulfide (lime sulphur) was evaluated.

The influence of fruit temperature and application time on the efficacy of fungicides against green mould.

Ultimately this will help determine how long you can leave fruit before treating with fungicides.

Rhizopus control using fungicides Imazalil, TBZ, Fludioxonil and Pyrimethanil infused in Potato Dextrose Agar

Rhizopus is an emerging decay problem for soft citrus.

The effect of preharvest salts on the reduction of fungi occurring on citrus fruit surfaces.

Pilot field spray program using potassium bicarbonate to reduce postharvest decay problems.

Effect of postharvest oil on fungicide efficacy and residues.

Does postharvest inhibit or enhance fungicides and do they affect subsequent fungicide residue levels?

Effect of fludioxonil and carbonate salts on green mould occurring on fruit.

Can fludioxonil be improved with the addition of carbonated salts?

Work in progress

Packingshed Experiments – sodium bicarbonate + fungicides and their effect on a lab strain of sour rot.

See article in this newsletter (pg 3-4)

The effect of Potassium Sorbate and fludioxonil on mould and sour rot.

Building on from promising overseas work using potassium sorbate (Go Clara!)

The effect of lime sulphur as a mould antagonist in wax.

Can lime sulphur work in wax? Maybe not!

Effect of fludioxonil and carbonate salts on Rhizopus occurring on fruit

Plate studies showed promise. What about on fruit?

Other citrus related project work has involved further examination of the new postharvest oil.

Currently "Prospect" is registered for use on citrus to control lightbrown apple and investigations are underway to determine the best treatment for Citrophilous Mealybug.

We are still working through compatibility of oil with a range of sanitisers and fungicides.

For more information on current and ongoing work, please contact the SARDI postharvest citrus team.

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