IPDM[i] FOR LOW CHILL STONEFRUIT

Dr Shane Hetherington
NSW Department of Primary Industries, Orange Agricultural Institute, Forest Road, Orange 2800[ii]

Abstract

Managing pests and diseases is difficult at the best of times, but add the complexity of ICA requirements and pests such as Queensland fruit fly and White Peach scale and the job becomes even more difficult. So where does a 'soft' strategy like Integrated Pest and Disease Management (IPDM) fit into the low-chill picture?

We recently asked growers to tell us which pests and diseases were causing them the most worry and how they were dealing with them. Fruit fly tops the list for low-chill orchardists with other problems including thrips, mites, Orange fruit moth and brown rot.
Fruit fly control (including mandatory control under ICA-21) requires frequent applications of Fenthion (Lebaycid). Fenthion is hard on beneficials such as predatory mites like *Phytoseiulus persimilis* which control two-spotted mite outbreaks under IPDM. This means that IPDM in low chill orchards is often a compromise between sound ecological management and what has to be done by law to get fruit to market.

Low chill orchardists have to deal with different pests and management options to their high chill cousins. This paper looks at the benefits and limitations of using IPDM in Australian low-chill production.

Background

Australians grow stone fruit in a diverse range of places and orchardists face a similarly diverse set of pests and diseases. As part of HAL project SF03001 we were asked to establish a national IPDM strategy. Our first step was to ask orchardists which issues they felt caused them the greatest problems. During the 2003 fruit season we interviewed growers from northern NSW and southeast Queensland.

All of the data presented in this paper was gathered from Australian orchardists. It represents the actual pest and disease management strategies of 66 Peach and 65 nectarine orchardists. Orchardists were asked to tell us what they were doing to control pests and diseases and we thank them for their honesty. In particular note that the graphs showing pesticide use (Figures 1-5) contain unregistered uses. These should not be considered recommendations. Orchardists should only use pesticides in a way that reflects their legal, registered use as prescribed on the product label. Inclusion of this data here is designed to allow low chill stone fruit orchardists to compare their pesticide use with the pesticide use patterns of other sectors of the industry.

Low chill stone stone fruit and its 'necessary evils'

Growing subtropical stonefruit is very different to growing more 'conventional' high chill varieties. There are different pests and diseases, requiring different management and the regulatory problems associated with interstate and export markets. Orchardists told us that the principal villain in the piece is Queensland fruit fly. There are a range of other problems including thrips, scales, monolepta and brown rot, but the starting point for managing pests and diseases is to get your fruit fly schedule right. In many cases this involved frequent applications of Fenthion (Lebaycid). The label recommendation for control of Queensland fruit fly in stone fruit is to apply Fenthion 6, 4, 3, 2, and 1 week before harvest. For interstate markets this is required (ICA-21).

Fenthion is a broad-spectrum insecticide and in addition to controlling fruit fly it kills a range of other arthropods. This includes predatory mites such as *Phytoseiulus persimilis* which can provide control over pest mites like two-spotted mite.

So, the starting point for bringing IPDM into low chill enterprises is that fruit fly control is paramount and the use of some of the 'traditional' aspects of IPDM such as predators is limited.

Many low chill growers also need to grow under nets to prevent bat and bird damage. This increases humidity in the orchard and promotes pests and diseases like white peach scale and brown rot.

This means that low chill growers operate under a handicap with respect to IPDM. Because low chill fruit faces threats not encountered by other growers IPDM is more difficult. But, IPDM can still save you money and its also worthwhile taking a moment to reflect on what IPDM really is.

A word on IPDM

IPM[iii], and now IPDM, has become jargon and a lot of people have only got a vague idea of what the acronyms mean. Almost everyone is aware of predacious mites and natural biological control agents which help to reduce the amount of pest-related damage in orchards and the number of spray applications needed. But how does all this fit into a system?

A practical definition of IPDM is that it involves any pest and disease management which increases the long-term health of your orchard and the people who work in it. IPDM encourages the use of 'soft' chemicals because they have a low impact on non-target insects, micro-organisms and human health. But, IPDM doesn't exclude the use of hard chemicals. Sometimes their use is unavoidable and fruit fly in low-chill orchards is a good example.

IPDM is a system involving preventing pests, monitoring for their arrival and taking appropriate action when they arrive.

Fruit fly

Queensland fruit fly (*Bactrocera tryoni*) infestation remains one of the most serious problems facing the low chill stone fruit industry. While bait sprays usually provide good early season protection most orchardists find it necessary to switch to cover sprays as fruit matures.

Prevention

Because of the relatively small size of most low chill blocks prevention is often difficult. Fruit fly migrates from other fruit crops which are grown in close proximity to stone fruit blocks. In our region the notable exception to this is the Kumbia region which has large blocks which are relatively isolated from other host crops. In both cases, following a few simple preventative strategies will reduce the problem.

Remove unwanted fruit trees from around sheds and houses and along boundary fences and irrigation channels. Practise good packing shed hygiene, with thorough inspection to remove any infested fruit. Properly dispose of reject fruit by burning, boiling or soaking with water with a surface layer of kerosene for 3 days.

Do not bury fruit, as fruit flies have a soil-inhabiting phase in their life cycle and burial will help them to survive. Remove all late-hanging and fallen fruit missed during harvest. Prune to keep the orchard canopy open for better spray penetration.

Monitoring

Monitoring in your orchard will allow you to detect fruit flies early and take appropriate action before too much damage is done. There are two types of monitoring

Fruit fly traps. The most common type of trap used in Australian orchards is the Lynfield lure trap. Traps are commercially available from rural suppliers in fruit fly- prone areas.

Traps attract only the male fly and therefore do not give an accurate indication of female fly activity. This is a major limitation of this monitoring technique, as females are responsible for fruit damage through egg laying and subsequent maggot infestation.

Traps for Queensland fruit fly use a synthetic lure called cuelure. It is important when using these lures not to allow this chemical to come in contact with your hands. The odours given off by your body can significantly alter the effectiveness of the cuelure. This can lead to non-target fruit flies being caught making identification difficult.

Hang fruit fly traps at around late blossom. Hang one trap in the centre of each large block. Check traps every 3 or 4 days as the fruit softens and count the male fruit flies. Empty the traps after counting. The Queensland Department of Primary Industries & Fisheries recommends that appropriate action to control fruit flies be taken when 20 flies are caught per trap[iv].

Check fruit for stings. Fruit fly can lay eggs in fruit up to 8 weeks before fruit is mature. The sting sites on fruit show as discoloured (sometimes prematurely coloured), often blackish spots that may exude filaments or blobs of clear gum. If you are unsure, cut through the tentative sting with a very sharp knife or razor blade and inspect it with a hand lens. You should be able to see fly eggs. The Queensland Department of Primary Industries & Fisheries recommends that appropriate action to control fruit flies be taken as soon as stings are visible or adult flies are seen on fruit or foliage.

Appropriate action

Bait sprays. Bait spraying is a good alternative to orchard cover sprays in areas where fruit fly pressure is low. It can also be used when fruit fly is first expected to enter the orchard and can effectively reduce the number of cover sprays needed. Details of bait sprays their formulation and application can be found in various places[v]. Another effective strategy for using bait sprays is to place them in windbreak (or other) trees around the perimeter of the orchard (Bob Nissen pers comm). Fruit flies are then drawn away from the orchard.

Cover sprays. Fruit subject to ICA-21 are treated with cover sprays. In low chill regions all fruit is likely to need at least some cover sprays. Where possible these should be minimised because of the impact of cover sprays on beneficial organisms (see next section).

Fruit fly & the off-target impact of pesticides

The three most commonly used insecticides for fruit fly control are Fenthion (Lebaycid), Dimethoate (Rogor etc.) and trichlorfon (Lepidex, Dipterex). All three of these insecticides are harmful to beneficial insects

Table 1. The effect on beneficial insects of the insecticides used most commonly for fruit fly control in low chill stonefruit orchards. ☠ = a high proportion of beneficials killed ; ✓ no beneficials killed or only a small percentage; ? no information on this interaction available.[vi]

Chemical name	Predatory mites									Parasitoids				Predator
	Phytoseiulus persimilis			*Typhlodromus occidentalis*			*Amblyseius* spp.			*Aphidius colemani*		*Trichogramma* wasps		Green lacewings
	egg	nymph	adult	egg	nymph	adult	egg	nymph	adult	mummy	adult	pupa	adult	
Fenthion	☠	☠	☠	☠	☠	☠	?			?		☠	☠	☠
Dimethoate	☠	☠	☠	☠	☠	☠	☠	☠	☠	☠	☠	☠	☠	☠
Trichlorfon	☠	☠	☠	?			☠	☠	☠	?	☠	✓	☠	?

Some growers on the NSW north Coast and SE Queensland reduce the harmful impact of these sprays by monitoring and only spraying when fruit fly is seen and/or using bait sprays during and after harvest. Others use tree phenology and take stone hardening as their cue to start spraying. The weather is also a useful cue with rain and warm weather leading to greater number of flies.

Unfortunately given the high probability of infestation and the legislative requirement for cover sprays for interstate trade (ICA-21), the starting point for controlling all of the other pests and diseases is that populations of beneficials are likely to have been decimated by hard pesticides.

Mites

As with all other fruit production regions, two-spotted mites (*Tetranychus urticae*) tend to be the most problematic mite species in low-chill production regions although European red mite can also cause problems in cooler inland area like Kumbia[vii]

Prevention

Most orchardists have trouble in maintaining effective populations of predatory mites in their crops because of necessary sprays for fruit fly. Some release *Phytoseiulus persimilis* early in the season every year and a small number of growers have established permanent populations of predatory mites. Populations of *Chilicorus* ladybird larva can be transferred from crops like strawberries to stone fruit. Certain weeds can be encouraged (eg. blue billy goat weed) as these provide overwintering sites for predators. But orchardists should be aware that this may not be advisable if western flower thrips is a problem.

Mite infestations are often associated with fresh green growth and excessive use of nitrogen fertilisers can lead to trouble. For the same reason regrowth at the base of the tree should be removed. However, infestations are also favoured by hot dry weather and irrigation should be maintained. Dust should be minimised and when its dry and the alternative exists vehicles should drive on the leeward side of orchards.

Where populations of predatory mites have been established orchardists need to be aware of the effects of their insecticide applications. In addition to fruit fly sprays other insects can have an extremely detrimental effect on predators. For example Bifenthrin applications for

carpophilus beetles are extremely damaging and often result in two-spotted mite infestations post harvest. These sprays should be delayed for as long as possible.

Monitoring

Consultants for two-spotted mite monitoring aren't often available in low-chill regions; orchardists should learn to do this job themselves.

A simple, quick and effective scheme involves monitoring visible damage on trees. Rate the trees with the worst infestations according to Table 2.

Table 2. Categories which can be applied to rate the level of damage caused by two-spotted mite on stone fruit.

Rating code	Desription	Visible damage[viii]
0	Nil	No damage
1	Trace	Detectable by close inspection
2	Slight	Some bronzing in inner, lower areas of tree
3	Moderate	Obvious bronzing confined to lower quarter of tree
4	Severe	Bronzing extending to halfway along limbs
5	Extreme	More extensive bronzing and defliation

If there are two or three patches of trees with a rating of three in a block where most trees do not exceed a rating of 1, the block would receive a rating of 3.

Appropriate action

If the visual damage assessment gives a rating of 3 or more, a spray should beapplied, unless it's clear that most of the block is under biological control. In the latter case, it may be worthwhile applying a spot spray in sections where predators are lagging. A spray should also be considered where most sprays have been rated at 2, as it will not be long before many will reach a rating of 3, if predators are lagging.

When monitoring indicates that a problem requires action orchardists are faced with a variety of choices. What miticides are low chill orchardists currently using, how does this effect beneficial insects and how does this compare to what is being used nationally (Figure 1).

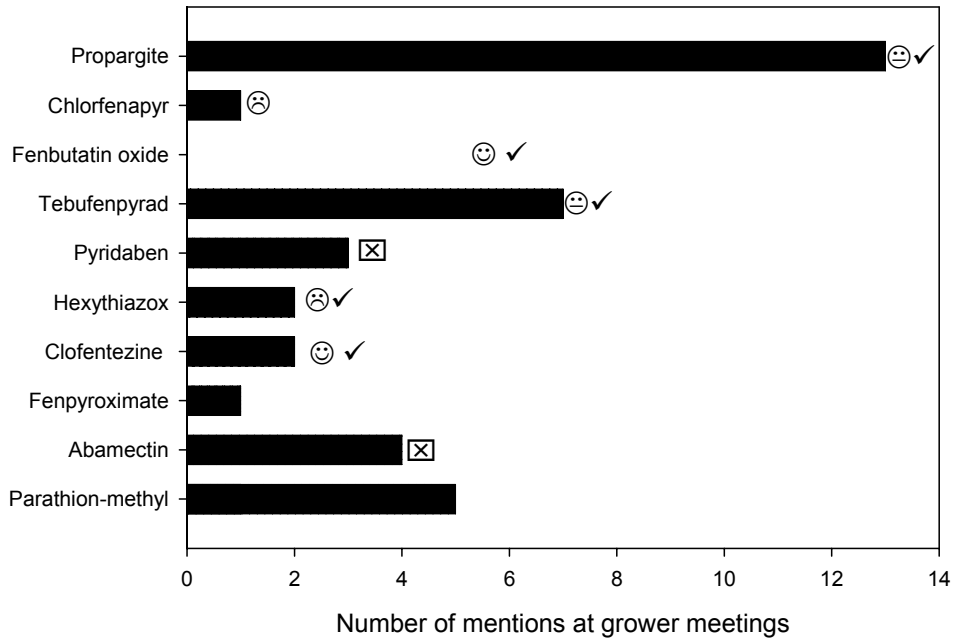

Figure 1. Insecticides and miticides for the control of two-spotted mite mentioned by orchardists at IPM meetings during the 2003/04 season. ✓ = mentioned by low-chill orchardists; ☺ = Low toxicity; nil or low impact on beneficials; 😐 Moderate toxicity; moderate impact on beneficials; ☹ = a high proportion of beneficials killed[ix]; ☒ not registered for this use.

Low chill orchardists use a similar group of chemicals for two-spotted mite control to all other Australian orchardists. Orchardists from Kumbia felt that Chlorfenapyr (Secure) and Tebufenpyrad (Pyranica) weren't working effectively while Clofentezine (Apollo) and Omite (Propargite) were expensive.

Fenbutatin oxide (Torque) is a good option as it has low toxicity to predatory mites. Its label also contains specific instructions on spraying when orchards are using biological control. However, it is important not to rely on one chemical group. Rotate between groups to prevent resistance developing.

Thrips

Plague thrips (*Thrips imaginis*) are a problem in all Australian low-chill production regions. Western flower thrips (*Frankliniella occidentalis*) are a problem in Queensland and while they haven't been found in northern NSW grower are aware of the threat they pose. In Australia russetting and scarring is usually caused by plague thrips feeding. Western flower thrips usually cause late season damage by attacking fruit in the final stages of fruit swelling (up to 21 days before harvest). This late season damage results in patches of silvering on the fruit surface and / or white patches around the stem end of the fruit[v].

Prevention

Controlling broad-leaved weeds is one of the most effective ways of limiting thrips damage. Western flower thrips particularly like white clover and this should be managed carefully. Slash or use a selective herbicide to remove flowering weeds before orchard blossom. If for some reason you are delayed do not slash during flowering as this will drive thrips into the

trees. Wait until shuckfall and then mow. Control of wild radish and wild turnip is also critical.

A number of other measures can help. Nectarines with showy flowers are particularly attractive to thrips and if thrips have been a problem in previous seasons these varieties should be avoided. When moving around the orchard always visit thrips infested blocks last and avoid wearing yellow, white or blue clothing as these are attractive to Western flower thrips.

Monitoring

A full monitoring schedule is available in the manual 'Integrated Pest and Disease Management for Australian Summerfruit. There are a number of key points which should be remembered.

- Monitor throughout the season
- Damage at flowering to fruit set is usually caused by plague thrips
- Late season damage is usually caused by western flower thrips
- There are two types of monitoring; collection from buds / flowers and yellow sticky traps.
- Damage occurs very quickly and, in reality, monitoring provides an indication of when preventative action should occur next season.
- Because there is only one registered chemical for each of type of thrips, and because they are so difficult to tell apart, it is important that thrips caught in the orchard should be sent to state government agencies for identification.
- Appropriate action is necessary as soon as either plague thrips or western flower thrips are detected in the orchard.

Appropriate action

Tau –fluvalinate (Klartan, Mavrik) is registered for use against plague thrips. Spinosad (Entrust Naturalyte) is registered for use against western flower thrips. When either thrips type is detected they should be treated with the appropriate pesticide. Some orchardists have used Tau-fluvalinate against western flower thrips (Figure 2). This is not advisable as many western flower thrips populations have developed resistance to this chemical.

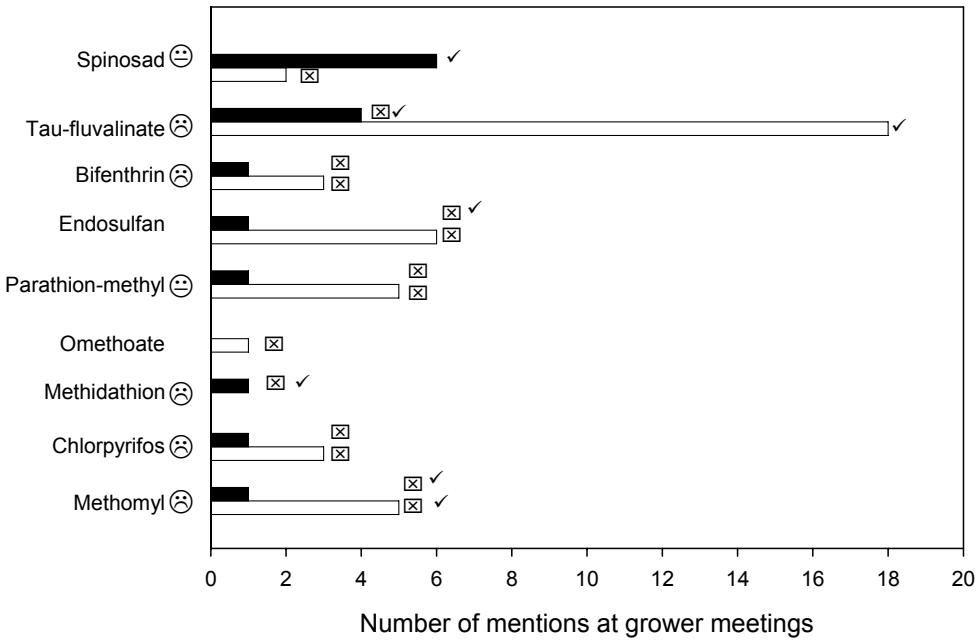

Figure 2. Insecticides and miticides for the control of thrips mentioned by orchardists at IPM meetings during the 2003/04 season. ✓ = mentioned by low-chill orchardists; ☺ = Low toxicity; nil or low impact on beneficials; 😐 Moderate toxicity; moderate impact on beneficials; ☹ = a high proportion of beneficials killed[x]; ☒ not registered for this use.

■ Western flower thrips, □ Plague thrips

Scales

Many low chill growers feel that scale has become a more serious problem with increasing numbers of sprays associated with ICA-21. In particular white peach scale (*Pseudaulacaspis pentagona*) has emerged as a particularly difficult pest to control. In low chill areas netting also seems to favour the development of white peach scale.

Prevention

White peach scale is most severe when humidity is high. Anything you can do in the orchard to reduce humidity will discourage white peach scale. Particular attention should be paid to pruning to keep the canopy open; this will also help to get better spray coverage which is crucial for scale control. Infested prunings should be removed from the orchard and burnt.

Over-watering will also increase humidity in the orchard and is likely to increase scale problems. Carefully monitor and optimise watering.

White peach scale can also build up on neglected trees near the orchard. While old stone fruit should be removed scale can also infect a wide range of other trees including mulberries and persimmons. If they're not wanted get rid of them.

Monitoring

While the life cycle of San José scale is widely known, virtually nothing is known about the life cycle of white peach scale in Australia. Monitoring recommendations therefore assume that the lifecycle of these two pests is similar and recommendations for white peach scale also rely on information from southern USA.

Control during the season is difficult. It is therefore recommended that the orchard be thoroughly examined after harvest. Encrustations of male white peach scale will give trees a fluffy or white-washed appearance at this time.

Appropriate action

No insecticides have Australian registration for the control of white peach scale. However insecticides applied for the control of San José scale are likely to also be effective against white peach scale and maintenance of a rigorous pray schedule for San José scale will help to control white peach scale.

These pests are best controlled when trees are dormant. Stonefruit trees should be treated with dormant oil at this time. Thorough application (drenching) is important to achieve good control. Most dormant oil formulations are registered for use at 3 L per 100 L (3%). If cost is an issue, it is acceptable to use 2 L per 100 L at the high volume. Drive slowly to achieve a drenching cover – and good control. Applied properly, chances are no other control for scales will be necessary during the season.

Where infestations do occur during the season, insecticide applications will be necessary. Australian orchardists use a range of insecticides for this purpose.

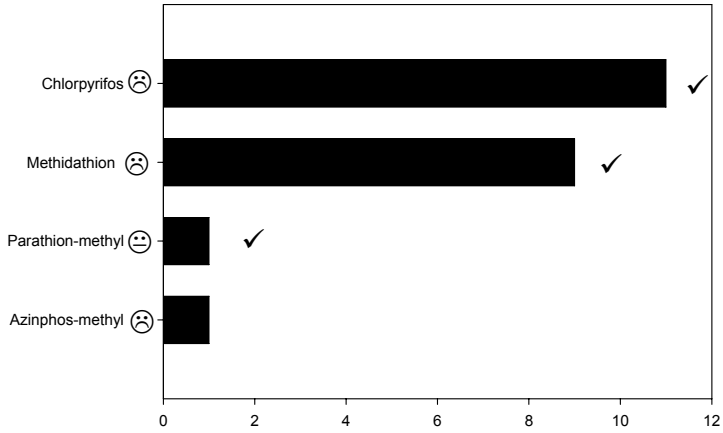

Figure 3. Insecticides for the control of scale mentioned by orchardists at IPM meetings during the 2003/04 season. ✓ = mentioned by low-chill orchardists; ☺ = Low toxicity; nil or low impact on beneficials; 😐 Moderate toxicity; moderate impact on beneficials; ☹ = a high proportion of beneficials killed[xi].

Carpophilus beetles

The low chill stone fruit industry based around northern NSW and southern Queensland rarely experiences any problems associated with Carpophilus beetle infestations. This is largely due to the short fruit development period in this region. Nevertheless some orchardists did indicate that they had experienced problems particularly with respect to Carpophilus beetle's role in moving brown rot spores around orchards.
Other orchardists actively encourage Carpophilus beetles which act as pollinators in custard fruit orchards.

Prevention

Where Carpophilus beetles have been a problem, future infestations can be prevented through orchard hygiene. Rejected fruit should be removed from the orchard as this fruit serves as a feeding and breeding site for Carpophilus beetles. Fruit fly control is especially important as rotting fruit following fruit fly infestation can also harbour populations of Carpophilus beetles.

Monitoring

Under normal circumstances structured monitoring for Carpophilus beetles is not warranted in low chill stone fruit. Orchardists should remain vigilant in the period from stone hardening and harvest. Where infestations have occurred Carpophilus numbers also need to be watched after harvest as this will give some indication of how big the problems will be next season. If orchardists do want to undertake structured monitoring, they should consult relevant references[xii]

Appropriate action

Low chill stone fruit orchardists rarely need to control infestations of Carpophilus beetles. Control for other Australian orchardists currently requires the use of Bifenthrin, the only registered product for this purpose (Figure 4). As Bifenthrin is harmful to beneficial organisms in the orchard, application of pesticides is discouraged unless absolutely necessary.

A lure and kill trapping system is in the final stages of development by DPI Victoria and should be available to Australian orchardists in the very near future.

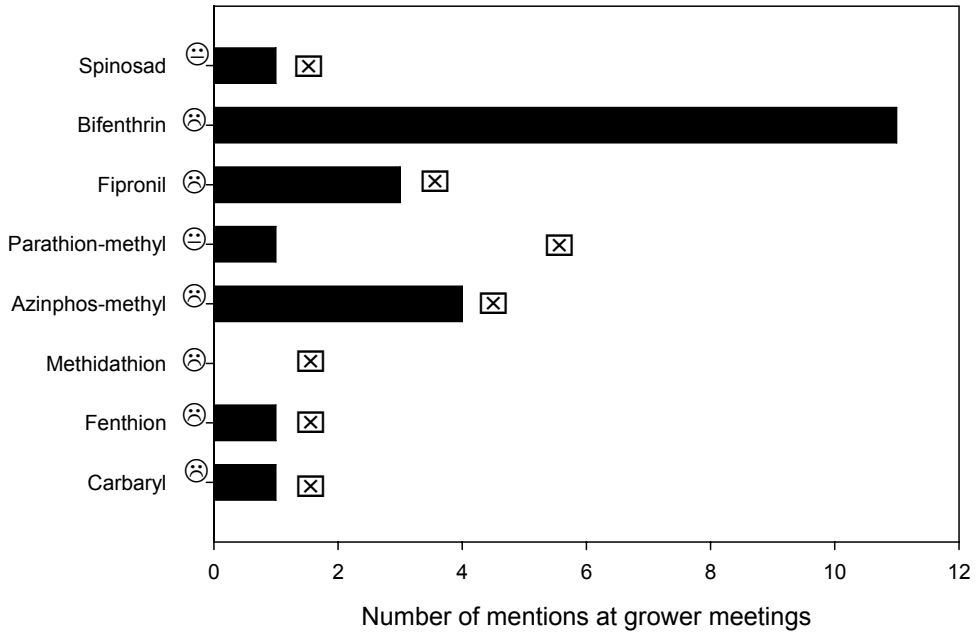

Figure 4. Insecticides for the control of Carpophilus beetles mentioned by orchardists at IPM meetings during the 2003/04 season. ✓ = mentioned by low-chill orchardists; ☺ = Low toxicity; nil or low impact on beneficials; 😐 Moderate toxicity; moderate impact on beneficials; ☹ = a high proportion of beneficials killed[xiii]; ☒ not registered for this use.

Monolepta

Monolepta or red-shouldered leaf beetle can be a serious problem in warmer coastal regions. The frequency of swarms in these regions varies from 'occasional years' to 2 or 3 infestations per season. Monolepta feed on developing fruitlets and can cause severe foliar damage, particularly in younger trees

Prevention

Very little can be done to prevent Monolepta incursions. Some orchardists feel that good weed management in the orchard and surrounds reduces the number and severity of swarms.

Monitoring

Monitoring is an important part of Monolepta control. Early detection is essential as beetle numbers can increase quickly. Infestations are more likely;

- stone fruit orchards are close to other subtropical tree crops such as avocadoes, custard apples and lychees and/or
- during stormy weather.

Monitoring of the orchard and surrounding wind breaks should be particularly stringent in both of these cases.

Appropriate action

Methomyl (Nudrin) is registered for the control of Monolepta in NSW but not in Queensland. Where application of this pesticide is allowed it should be used only in emergencies and only as a spot spray in response to swarms. Methomyl is extremely damaging to beneficial organisms and its use should be limited.

Orchardists noted that there was no registered control for this pest in Queensland, but noted that the problem is often less severe where fenthion (Lebaycid) has been used for Queensland Fruit Fly control. If the problem is severe registration should be pursued.

Fruit-damaging moths

Low chill stone fruit orchardists have problems with the following moths

- Light brown apple moth
- Orange fruit moth – problem knarling young trees
- Oriental fruit moth – mainly a problem with young stone fruit trees but control is needed because it's an issue for custard apples
- Painted apple moth – early season
- Heliothis – mid to late season

Prevention

Most problem moths live near orchards throughout the year and only infest fruit and foliage when they're available. This means that they need somewhere to survive when trees are dormant and/or the fruit isn't suitable for infestation. This means that the severity of infestations can be reduced by attacking the places in which moths take haven.

- Weeds – Removal of broad-leaved weeds such as capeweed, mallow and dock from the orchard and surrounding areas can be done using selective herbicides, mowing or grazing. Because broad-leaved weeds are preferred as overwintering sites, where moth damage has been a major issue, consider planting grasses in the inter-row.
- Unpicked fruit and prunings. Destroy any unpicked fruit and prunings before the start of the following season. This is particularly important for Oriental fruit moth. Infested prunings are often a source of new moths as the season starts. Make sure to burn any trees that have been bulldozed in the previous season.

- The neighbours – Most moths (eg. Oriental fruit moth) can fly 2-3 km and can move from infested neighbouring orchards. Know your district and where likely sources of infestation are. Encourage neighbours to clean up neglected orchards.
- Other crops nearby – Many of the fruit moths can feed on (and damage) a wide range of subtropical tree crops. In some cases low chill orchardists control oriental fruit moth specifically because of the damage it will cause in following custard apple crops. Be aware of the amount of moth activity occurring in surrounding fruit crops and if possible, control moths in crops which precede stone fruit.
- Fruit bins – never store other people's fruit bins on your property without thoroughly disinfecting them.

Orchard management can also have an impact on the likelihood of fruit moth infestation. Smooth-barked, calm, well-managed trees will have lower populations of moths than older, rougher, damaged or highly vigorous trees.

Also anything that can be done to increase the effectiveness of spraying will help in managing fruit moths. This includes pruning for better spray penetration and regular calibration of equipment.

Monitoring

Traps. Traps are available for monitoring of some moth types. Pheromone traps are available for Oriental fruit moths and other traps such as light traps and food lure traps can also be used for other moth types. Full details on traps and how they're used is available in 'Integrated pest and disease management for Australian summerfruit'. Monitoring is meant to give you an accurate indication of moth activity within you orchard. Because moths can move from orchard to orchard a number of points need to be remembered when monitoring with traps.

- Traps work best on larger blocks because you're not capturing moths from adjacent blocks or your neighbour's property.
- If you're using mating disruption to control oriental fruit moth you cannot use pheromone traps to monitor your orchard.

Inspect shoots and fruit for damage. Careful examination of fruit and foliage can often reveal the pest before it reaches numbers which would create a problem. Pay particular attention to the stem end of fruit, fruit in the centre of trees and fruit clusters.

Inspect broad-leaved weeds. Monitor broad-leaved weeds early in the season (budswell to shuckfall) for moth larvae. This can give some indication of how severe moth problems may become. Bear in mind though that moth development is closely linked to the weather. If the weather isn't conducive to moth development, the problem may not become as severe as numbers on weeds may indicate.

Appropriate action

Biological control. Where lightbrown apple moth has been a regular problem orchardists are best to establish a biological control regime before seeing larvae or shortly after. DiPel is a commercial formulation of the bacteria *Bacillus thuringiensis.* It is registered for use against lightbrown apple moth but will also effect other moth larvae.

Mating disruption. Mating disruption for oriental fruit moth works best on larger blocks / orchards or where neighbouring orchardists collaborate to manage their orchards as a single unit. Mating disruption is suitable for orchards:

- that are isolated from other tree fruit crops which may act as reservoirs for oriental fruit moth.

- Where both external (moth migration) and internal sources (e.g. infested bins) can be successfully managed
- Where oriental fruit moth numbers are low but cause sufficient damage to warrant investment in mating disruption.

More comprehensive information on how to manage oriental fruit moth using mating disruption is available in 'Integrated pest and disease management for Australian Summerfruit'.

Insecticidal sprays, as indicated by monitoring. Pheromone traps and predictive models can be used to apply sprays at the most effective time.

Brown rot / Blossom blight

Blossom blight and brown rot of fruit are symptoms of the same disease caused by the fungal pathogens *Monilinia fructicola* or *Monilinia laxa*. Good early season control of blossom blights usually results in less brown rot.

Brown rot management forms the backbone of disease control programs across all Australian stone fruit growing regions. A carefully thought out brown rot schedule need only be supplemented by a few additional sprays to control other diseases such as rust, shot hole and leaf curl.

Prevention

Anything you can do in your orchard to reduce humidity and blossom or fruit drying times will reduce brown rot incidence. This includes orienting rows north-south or in a direction which will allow prevailing winds to travel down the rows. Remove any unnecessary windbreaks.

Trees should also be pruned to open the canopy allowing more air to enter. This also facilitates better spray penetration. Thin to singles. Bunched fruit results in areas of high humidity and allows infections to pass from fruit to fruit.

Remove all rejected fruit from the orchard and dispose of it. In low chill regions it is important that rejected fruit is NOT buried as fruit fly complete their life cycle underground. Importantly remove all hanging fruit after harvest. During dormancy be fastidious in removing all mummies left on branches, in trunk or branch crotches or on the ground.

Consider the flowering and fruit development stages of each block / variety in you orchard. Plant blocks in such a way that susceptible growth stages do not follow each other in neighbouring blocks.

Monitoring

There are two critical periods during which stone fruit is susceptible to brown rot and monitoring should be biased toward these periods.

1. Budswell to shuckfall – walk through the orchard carefully observing blossom at least weekly. If any blossom blight is observed take appropriate action.
2. Seed hardening to harvest - walk through the orchard carefully observing developing fruit at least weekly. If any blossom blight is observed take appropriate action.

Weather is also an important indicator of brown rot infection. If brown rot was a serious problem in the previous season and the following weather occurs take appropriate action without waiting for symptoms to occur.

1. Buds / blossoms are wet from rain or dew for 3-5 hours when the temperature is more than 20°C;
2. there has been hail;
3. the temperature has been 20-25°C with showery conditions and cool nights or;

4. There have been frequent rain periods and warm conditions near or at harvest

Appropriate Action

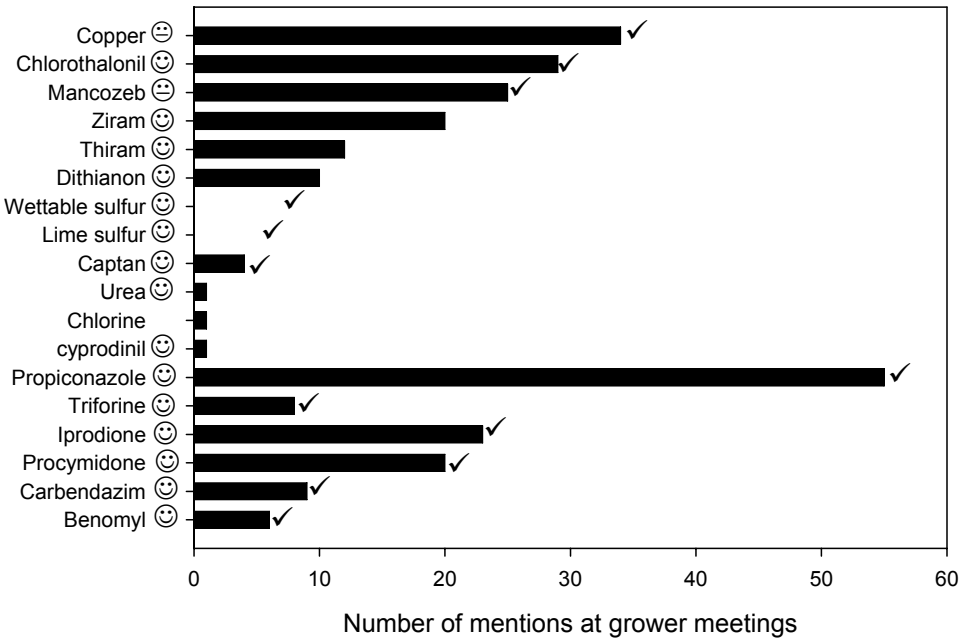

Figure 5. Fungicides for the control of brown rot and blossom blight mentioned by orchardists at IPM meetings during the 2003/04 season. ✓ = mentioned by low-chill orchardists; ☺ = Low toxicity; nil or low impact on beneficials; 😐 Moderate toxicity; moderate impact on beneficials; ☹ = a high proportion of beneficials killed[xiv]

Taking stock – the end of the season

In an orchard using IPDM management of one problem will often have an impact (good or bad) on another aspect of orchard management. This means that managing pests and diseases 'on-the-run' can become a complicated and frustrating pursuit. It is therefore important to sit down at the end of the season and try to make sense of it all.

- What worked? What didn't?
- What saved you money? What cost you money? Remember here that perfect fruit isn't worth producing if you need to spend a fortune to get it that way. Do the sums and remember to include the cost of labour, machinery running and maintenance costs etc.
- If it worked plan to repeat it next year.
- Also take note of when a particular pest or disease became a problem. What was the weather doing when the pest or disease arrived? Was the pest or disease associated with any other organisms eg. beneficials, vectors, weed flowering.
- Were some varieties affected more or less than others? Why?

Importantly – WRITE IT ALL DOWN! Nobody has a perfect memory and the more information you can gather, the better your decisions will be in the future.

Suggested Reading

Strand LL 1999. Integrated pest management for stone fruits. Statewide integrated pest management project. University of California Division of Agriculture and Natural Resources. Publication 3389. 264pp

Hetherington S. (2005). Integrated Pest and Disease Management for Australian Summerfruit. NSW Department of Primary Industries and Summerfruit Australia Limited Inc. 171pp.

List of pesticides mentioned and their trade names

Insecticides		***Fungicides***		***Miticides***	
Common name	**Trade name**	**Common name**	**Trade name**	**Common name**	**Trade name**
Fenthion	Lebaycid	Chlorothalonil	various	Propargite	Omite
Dimethoate	Rogor Romethoate Saboteur Unidime	Mancozeb	various	Chlorfenapyr	Secure
Trichlorfon	Dipterex Lepidex	Ziram	Ziragranz	Fenbutatin oxide	Torque
Spinosad	Entrust naturalyte	Thiram	Thiragranz	Tebufenpyrad	Pyranica
Tau-fluvalinate	Mavrik	Dithianon	Delan Patrol	Pyridaben	Sanmite
Bifenthrin	Fenthrin, etc.	Captan	Orthocide Merpan	Hexythiazox	Calibre
Endosulfan	Endosan Thiodan	Cyprodinil	Chorus	Clofentezine	Apollo
Parathion-methyl	Folidol Penncap	Propiconazole	Tilt etc	Fenpyroximate	Acaban
Omethoate	?Omen Le-Mat	Triforine	Saprol	Abamectin	various
Methidathion	Supracide Suprathion	Iprodione	Civit Rovral Ippon		
Chlorpyrifos	various	Procymidone	Fortress		
Methomyl	Lannate Nudrin	Carbendazim	various		
Azinphos-methyl	Gusathion	Benomyl	Benlate		
Fipronil	Regent				
Carbaryl	Bugmaster				

Endnotes

[i] IPDM = Integrated Pest and Disease Management

[ii] shane.hetherington@dpi.nsw.gov.au phone: (02) 6391 3860

[iii] IPM = Integrated pest management

[iv] Vock N, Campbell J, George A, Slack J and Nissen R (1998). Low chill stonefruit information kit. Agrilink series QAL9705. Queensland Horticulture Institute. Department of Primary Industries, Queensland and New South Wales Agriculture.

[v] Integrated Pest and Disease Management for Australian summerfruit, Low chill stonefruit information kit Agrilink QAL9705, orchard Plant Protection Guide for deciduous fruits in NSW.

[vi] Information from the Good Bug Book, Koppert biological systems and Biobest Biological Systems.
[vii] Descriptions of these pests and their damage are included in the manual "Integrated Pest and Disease Management for Australian Summerfruit."
[viii] More information on monitoring including pictures of symptoms can be found in 'Integrated Pest and Disease management for Australian Summerfruit' pages 84-88
[ix] The pesticides mentioned in this figure represent feedback from orchardists. They are not necessarily registered for this use and this data is not a recommendation for use. Always read the label.
[x] The pesticides mentioned in this figure represent feedback from orchardists. They are not necessarily registered for this use and this data is not a recommendation for use. Always read the label.
[xi] The pesticides mentioned in this figure represent feedback from orchardists. They are not necessarily registered for this use and this data is not a recommendation for use. Always read the label.
[xii] Hetherington S (2006). Integrated Pest and Disease Management for Australian Summerfruit.
HAL project SF97003. Final report. Integrated management of Carpophilus beetles in stone fruit orchards.
HAL project FR99031. Final report. Developing integrated pest management strategies using pheromones for controlling oriental fruit moth and Carpophilus beetles in orchards.
[xiii] The pesticides mentioned in this figure represent feedback from orchardists. They are not necessarily registered for this use and this data is not a recommendation for use. Always read the label.
[xiv] The pesticides mentioned in this figure represent feedback from orchardists. They are not necessarily registered for this use and this data is not a recommendation for use. Always read the label.