NSW DEPARTMENT OF
PRIMARY INDUSTRIES

## Readers' Note

# Plague thrips and western flower thrips

***Thrips imaginis* and *Frankliniella occidentalis***

## IPDM quick facts

***Plague thrips***

**Sample unit:** *Buds and flowers*

**When to monitor:** *Budswell to shuckfall*

**How often:** *Fortnightly*

**Action level:** *If present*

***Western flower thrips***

**Sample unit:** *Sticky traps*

**When to monitor:** *Budburst to harvest*

**How often:** *Fortnightly*

**Action level:** *If present*

### The pests and their damage

Plague thrips (*Thrips imaginis*) is an Australian native species that feeds on a wide variety of plant hosts. Female plague thrips are 1.1 to 1.3 mm long, whereas males are smaller (0.8 to 1.0 mm). Western flower thrips (WFT) are larger than plague thrips. Female WFT are 1.4 to 1.8 mm long and males 0.9 to 1.1 mm. Plague thrips are almost always female, particularly early in the season. WFT at low population densities are predominantly male, but the sex ratio switches as populations become larger.

Adult thrips have two pairs of fringed wings. Larvae are white or yellow, wingless, with few distinguishing characteristics.

#### *Damage at flowering to fruit set*

Damage at this time is largely a result of larvae feeding on the developing fruit surface, causing tissue scarring and russetting, which expands and turns brown as the fruit grows. WFT rarely causes this type of damage in Australia. For example, there have been no confirmed reports of WFT causing damage of this type in NSW. Damage at this time is likely to be caused by plague thrips.

Early season feeding by adult and larval thrips can also result in bronzing of petals and sepals and occasionally fruitlet abortion if stamens and styles are severely damaged.

#### *Damage close to harvest*

WFT is more likely to be found during summer on ripening fruit. This damage is caused by adult and larval thrips feeding on the mature fruit surface. Damage can occur on the earliest maturing varieties through to those that are harvested last. This damage appears as either or both of:

- patches of silvering on the fruit surface, especially where it has been protected by leaves or where fruits touch
- white patches around the stem end of the fruit where it is protected by the tree branch.

Damage is more likely to be located on the protected parts of the fruit surface. This silvering damage is done in the final fruit-swell stage up to 21 days before harvest and occurs very quickly. Overseas, increased silvering damage has been associated with drought conditions, when alternative WFT habitats such as ground covers, weeds and native bush have browned off or died.

### Plague thrips: a serious regional issue during the last ten years in:

- Goulburn Valley
- Riverlands
- Alstonville
- Swan Hill
- SE Queensland
- Granite Belt
- Perth Hills

*Plague thrips*

*Western flower thrips*

**Western flower thrips: a serious regional issue during the last five years in:**

- Manjimup/Donnybrook
- Perth Hills
- NSW Central West
- Granite Belt
- Goulburn Valley
- Sydney Basin

Orchardists from all Australian summerfruit regions are concerned about the threat posed by WFT, even where its presence has not been confirmed. In many cases symptoms that may have been caused by WFT have been seen but WFT has not been confirmed as the cause of the problem. It is difficult to identify the particular species of thrips responsible for the damage. Orchardists who suspect that they may have WFT are encouraged to monitor (see below) and seek professional identification of their thrips by their State Government department of primary industries or agriculture.

Orchardists in the Forbes (NSW Central West) region observed WFT-like damage during the 2003–04 season. WFT has recently been confirmed as the cause of this damage.

## Prevention

Strategies for preventing WFT and plague thrips infestations are similar.

### *Orchard management*

Both thrips species are found on a wide range of broad-leaf weeds and flowering plants. Flowering plants are particularly attractive to WFT, with clover (especially white clover) and lucerne having the highest thrips densities. WFT feeds on the pollen of these plants; therefore, preventing flowering can be an effective strategy. Total removal of clovers and other broad-leaved weeds is one option, but if this is not possible then keep them mown short throughout the year to prevent flowering.

Managing your ground cover and weeds is critical to reducing thrips populations and preventing population carryover. As WFT does not feed on grasses, replace broad-leaved ground cover with grasses.

If ground covers/weeds have been left unmown, it is important **not** to mow them just before or during flowering of summerfruit, as this will send the thrips (if present) up into the flowers on the trees. Wait until shuckfall is complete and then mow. Keep ground covers/weeds mown throughout the fruit development stages and especially close to harvest.

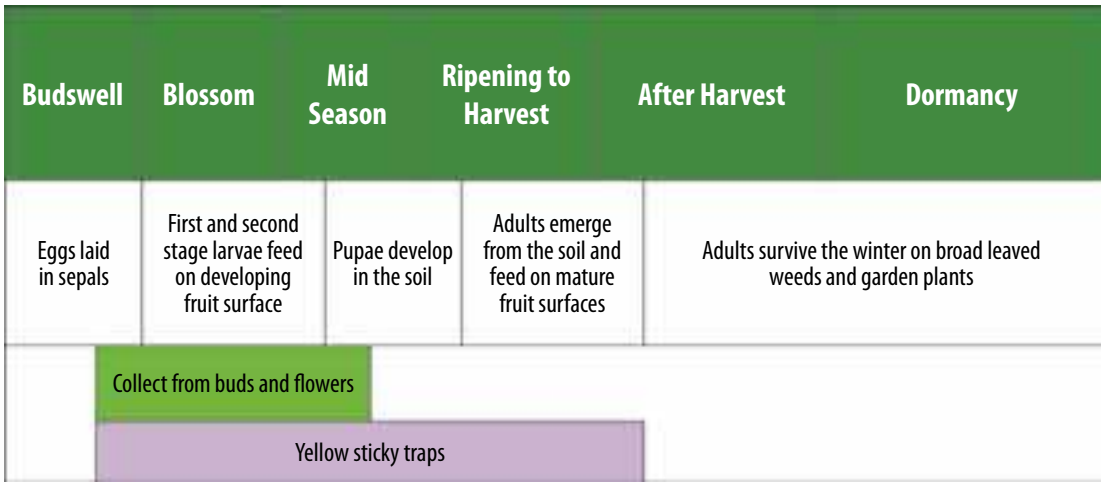
If thrips have been a problem in previous seasons and a decision is made to control weeds using a herbicide, it is advisable to treat for thrips at the same time. If thrips are not treated they will move to trees as the weeds die.

### *Choosing species and varieties*

All species of summerfruit are susceptible to WFT damage. Highly coloured nectarines are favoured by WFT. If damage has occurred during previous seasons, avoid planting these varieties.

### *Movement*

Plague thrips can be carried into the orchard from considerable distances on the wind. There are very few practical measures that can be taken to restrict this movement. However, WFT spend winters on broadleaved weeds or garden plants. Therefore, avoid moving from blocks that have been infested with WFT in previous seasons into 'clean' blocks. Plan your movements around the orchard so that blocks previously infested with WFT are the last to be visited.




***Sticky trap in a tree***

***Sticky trap above the ground cover***

WFT can be moved around the orchard on tools and clothes. Avoid wearing yellow, white or blue clothing, as these are attractive to WFT.

Be careful when purchasing new trees from a nursery in an area that has recorded WFT infestations. Check with the supplier to ensure that they monitor for WFT and that the plants are free of the pest.

## Monitoring

### *When to look*

(See chart on previous page).

Aim to monitor throughout the season (from bud burst to harvest). The developmental stages of thrips are closely tied to the weather, and particularly temperature. The timings may have to be modified to suit your orchard.

### *What to look for*

There are two methods of monitoring thrips.

### *Collect from buds or flowers*

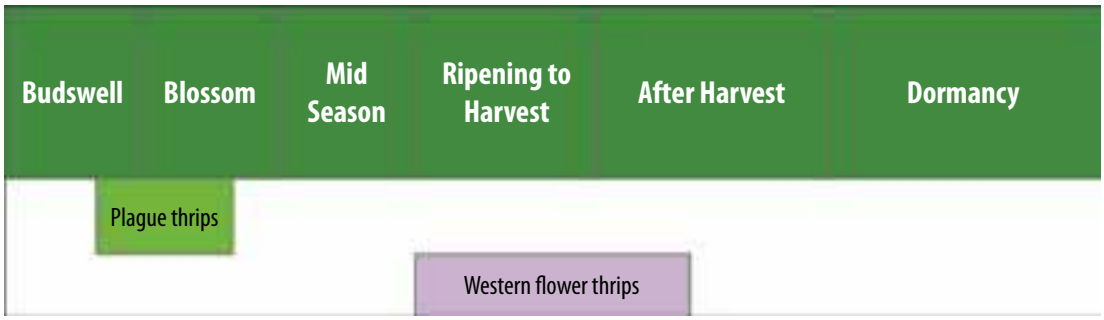
Thrips can be collected from buds or flowers. Collect 20 or 30 from each area and place them in labelled zip-lock bags. Transfer thrips to 70% alcohol to preserve for identification.

For WFT, pay particular attention at full pink and bloom stages. Larval development appears to be well synchronised with bud development.

### *Yellow sticky traps*

Monitoring with yellow sticky traps is useful for determining the presence or absence of WFT within an orchard.

- Varieties in which WFT is detected can be sprayed, minimising damage.
- Varieties that mature subsequently can be monitored more carefully following detection on early varieties.
- The number of beneficial organisms can be assessed.
- The information will help in management decisions the following season.




Locate the traps as follows:

- **Hang some in the trees for the entire season.** As a rough guide, use two traps in a block or 5 traps/hectare. Hang them in the lower third of the tree.
- **Place extra traps in the ground cover from bud burst to fruit set.** Place the traps on a stake at a height of 0.25 to 0.5 m in the inter-row sod.

Replace the traps at intervals of 1 or 2 weeks, especially at peak times of likely activity. The yellow sticky traps in the trees are important in the pre-harvest period. Monitor very carefully in the period 1 month before harvest.

Watch for symptoms of fruit damage in the critical 21 days before expected harvest. If observed, treat the affected variety and prepare to also treat those that ripen subsequently.

Identification can be done by your State Government agricultural authority. Most agencies now charge fees for this service. Check with your local authority to determine what charges apply. By the time thrips are detected through monitoring it is often too late to eliminate their damage. Immediate appropriate action can reduce the severity of the damage and gives an early indication that action will need to be taken late in the season and early next season.

## Appropriate action

### *Action level for plague thrips*

If present.

### *Action level for WFT*

If present (see chart above).

Very few thrips are required to cause economically significant damage.

### *Plague thrips*

Apply tau-fluvalinate to nectarines once only between mid-pink and petal fall if monitoring indicates that plague thrips have exceeded the action level. Tau-fluvalinate will affect predatory mites if present, and this could result in a two-spotted mite problem.

### *Western flower thrips*

Chemical control is difficult for WFT early in the season, because the shuck protects the larvae.

If you suspect or confirm the presence of WFT, start chemical control. WFT has developed resistance to chemicals used to control other thrips, including tau-fluvalinate. If you have used tau-fluvalinate to control plague thrips and still have a thrips problem, suspect WFT. Use monitoring and professional identification to confirm these suspicions (note earlier comments on fees for this service). Good control of WFT has been achieved with one application of spinosad Success™ Naturalyte® if it is applied at the right time (2 or 3 weeks before harvest) and the correct rate (80 mL/100 L).

## More information

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Herron G (2005) *Western Flower Thrips (WFT) Insecticide Management Plan—Stone Fruit.* Available through the NSW DPI website, www.agric.nsw.gov.au

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Swanson B (1997) *Western Flower Thrips in Victoria.* State of Victoria, Department of Primary Industries. Available through DPIV website, www.dpi.vic.gov.au/dpi/index.htm

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# Rust

*Tranzschelia discolor*

## IPDM quick facts

**Sample unit:** *Leaves—temperature and leaf wetness*

**When to monitor:** *Mid-season to after harvest*

**How often:** *Weekly*

**Action level:** *If all three of the following occur simultaneously:*

- *rust present in recent seasons*
- *leaves wet for more than 4 hours*
- *temperature between 13 and 25 °C*

*and/or*

- *you observe rust symptoms.*

### Causes and consequences

Rust is caused by the pathogenic fungus *Tranzschelia discolor*. If it is not controlled, a severe infection can cause premature leaf-fall. Yield from trees infected with rust is considerably reduced. The fruit on trees defoliated before harvest does not mature satisfactorily, with sugar levels remaining low.

The effects of premature loss of leaf may be greater than the loss of the immediate crop. The leafless trees must live on stored food reserves for the rest of the season, depleting food reserves for winter requirements and next season's bud development. This can cause weak bud development and below-normal crop yield in the following season.

Defoliated trees often shoot and flower in autumn, reducing the size of the crop the following season because many flower buds are wasted by premature blossoming. In mid- to late summer, defoliated limbs are exposed to direct radiation from the sun for long periods and are in danger of being sun-scalded and then invaded by wood-rotting fungi. Limbs affected in this way are weakened, less productive, and prone to breaking under the weight of a crop. When rust infection has occurred in several seasons, tree life may be shortened.

*Rust lesions on prune*

Fruit infected with rust is unsaleable. The infections penetrate several millimetres into the flesh.

### Symptoms

#### *Leaves*

The upper surface of an infected leaf becomes speckled with small yellow patches that often run together. The underside develops corresponding rusty brown spots. These are powdery masses of fungal spores that are sometimes so numerous that the undersurface of the leaf seems coated by brown dust. As autumn approaches, the spots on the undersides of the leaf often turn black.

#### *Shoots*

Shoots may also be attacked, resulting in small dead patches where the bark splits on 1- and 2-year-old shoots.

#### *Fruit*

Rust infection occurs on peaches, nectarines and apricots. Symptoms are small, depressed spots with dark, reddish centres and often with pale green borders.

**A serious regional issue during the last 10 years in:**

- NSW southwest slopes
- Goulburn Valley
- SE Queensland

## Prevention

### *Choosing species and varieties*

All species and varieties of summer fruit can be infected by rust, but some are more susceptible than others. In coastal districts, severe rust infection often develops on early-maturing dessert peach varieties. In inland districts, rust is more likely to develop on some canning varieties and sugar plums (French prunes). In cooler regions, mid- to late season peaches usually show severe infection only in autumn. Rust is not usually seen on apricots until autumn.

### *Orchard design*

This disease is very responsive to weather. Setting up and managing an orchard to minimise weather favouring disease development is a very effective management strategy.

Where possible, avoid planting in valleys. Humid air favours the disease and tends to pool in these areas. Rain and heavy dews during warm weather also favour disease development, and orchards should be set up so as to allow rapid drying of the leaves. Younger trees are more resistant to the disease. If rust is a serious problem in older orchards, replace the trees.

### *Pruning and shaping trees*

Large bushy trees tend to trap air within their canopies and create a humid microclimate. Thorough pruning allows better airflow through the trees and ensures more thorough penetration of sprays if the disease is severe enough to warrant them.

Infections often occur in mid- to late summer but can occur at any time during the growing season. Therefore, careful monitoring throughout the season is advised.

## Monitoring

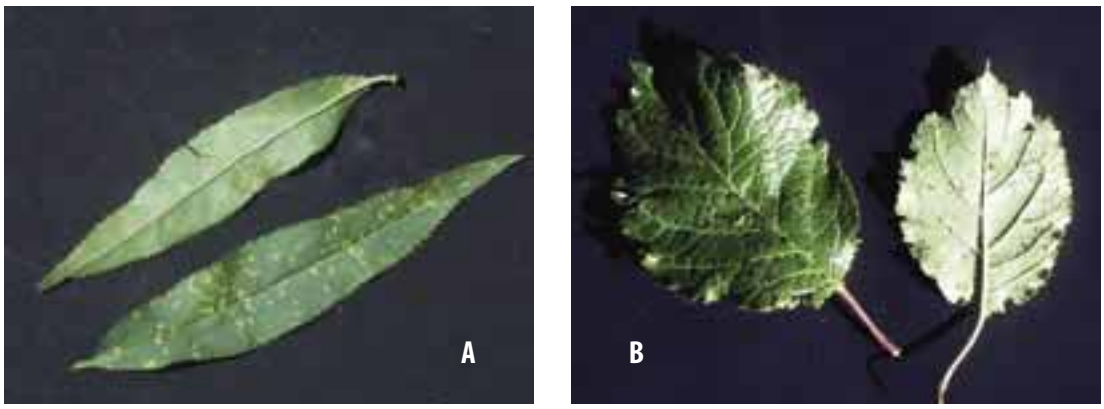
### *When to look*

This disease is spread readily by the wind and can be splashed about by rain. For these reasons, it can appear suddenly in orchards with no previous history of rust infection. Monitoring of the weather from mid-season to leaf fall is recommended in regions prone to rust infection. Infections occur in a predictable way in response to the weather. Because of the potential for rapid spread it is far more effective to monitor for favourable weather rather than symptoms. If the disease has been a problem in previous seasons, it is likely to recur and a protective spray schedule should be used.

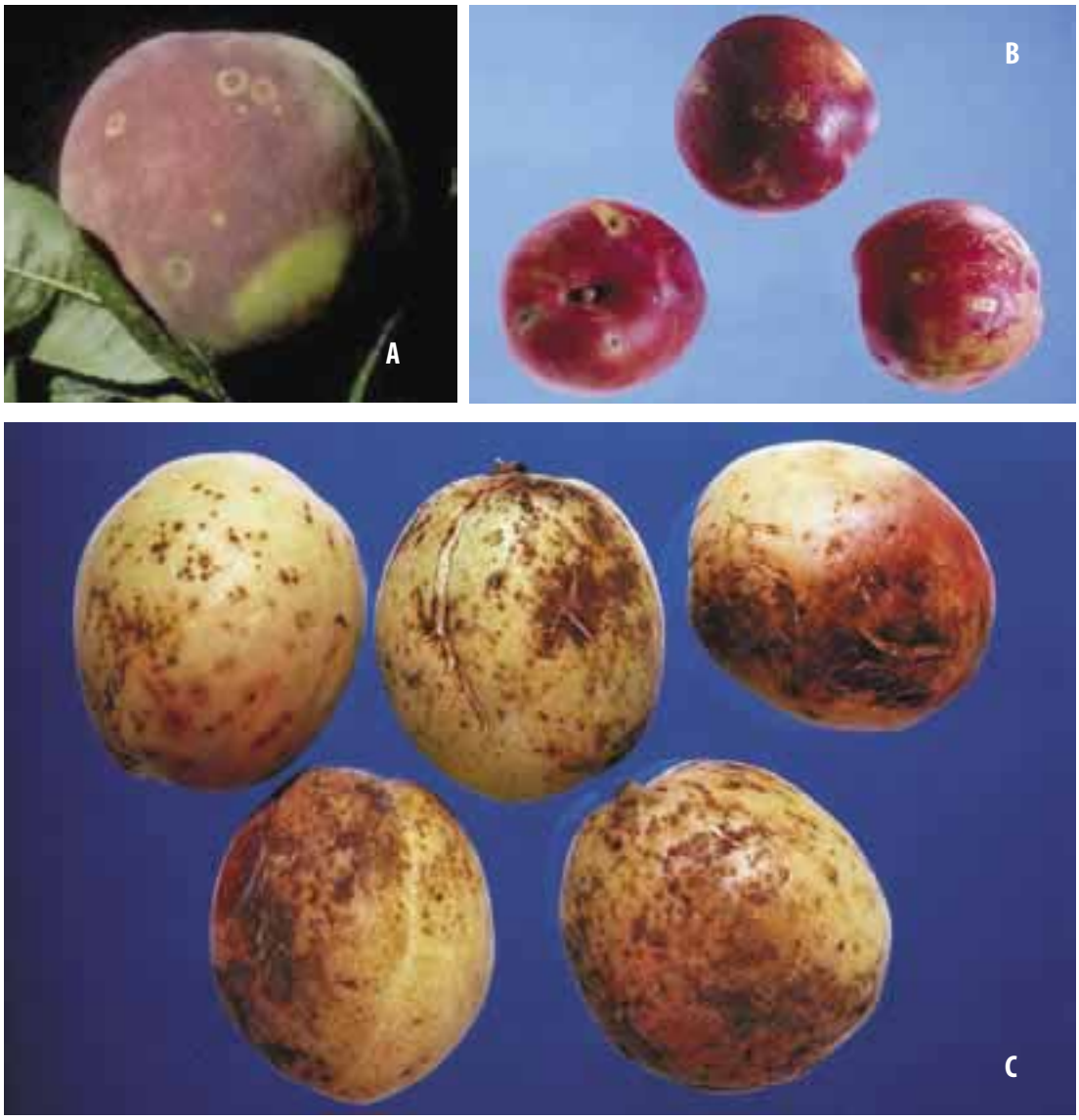
### *What to look for*

Carefully monitor the weather and treat your orchard in response to the periods that favour disease development in your region. In plums, for infection to occur, leaves must remain continually wet for at least 4 hours at temperatures between 13 and 25 °C. If leaves are continuously wet for longer, infection becomes more severe. At temperatures below 13 °C and above 25 °C, infection takes longer to occur. No infection occurs at or above 30 °C.

Monitoring for symptoms is also recommended. Examine the leaves on four lateral branches of each of your monitoring trees at weekly intervals from mid-season to after harvest.




*Rust infections on the upper and lower surfaces of (A) peach and (B) plum*




***Peach (A), nectarine (B) and apricot (C) fruit with rust infections***

## Appropriate action

### *Action threshold*

(See chart on next page)

If all of the following occur simultaneously:

- rust has been a problem in recent seasons
- leaves have been wet for more than 4 hours
- temperatures are between 13 and 25 °C and/or
- rust is seen on the leaves.

Sanitation measures are designed to break the disease cycle in single orchards. They can also reduce the severity of rust by delaying epidemics. If an orchard is free of the disease at the beginning of a new season, it will take rust much longer to invade from distant orchards or other sources.

### *Remove all diseased wood and leaves during pruning*

When pruning peach trees, remove all diseased wood and where possible burn the prunings and any diseased leaves.

### *Remove all fallen leaves from branches, crotches etc.*

During winter, remove and destroy all dead leaves from within the framework of orchard trees. Leaves commonly lodge in the tree crotch where the main branches divide from the trunk, so look for leaves in these areas while pruning. Removing and destroying dead, infected leaves is preferable to dropping them on the orchard floor: rust spores can survive just as well on dead, infected leaves on the ground as they can within the tree framework.

***Remove any green leaves retained by the tree***

Some summerfruit species and some varieties within species tend to retain some living leaves through the winter. Remove these leaves if possible, as they may be a source of rust infection in the new season.

***Protective spray program***

Where rust has been a problem in previous seasons and the crop is being grown in conditions conducive to disease infection, you should undertake a full fungicide spray program to control this disease. A complete program for the control of rust is provided in this manual (page 137).

## More information

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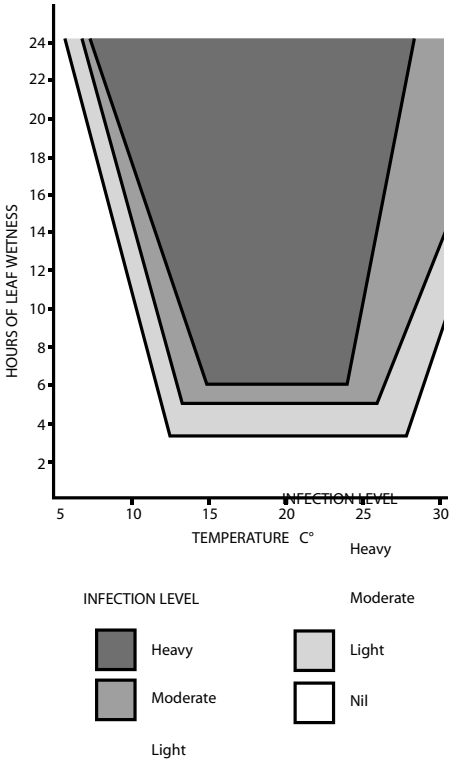
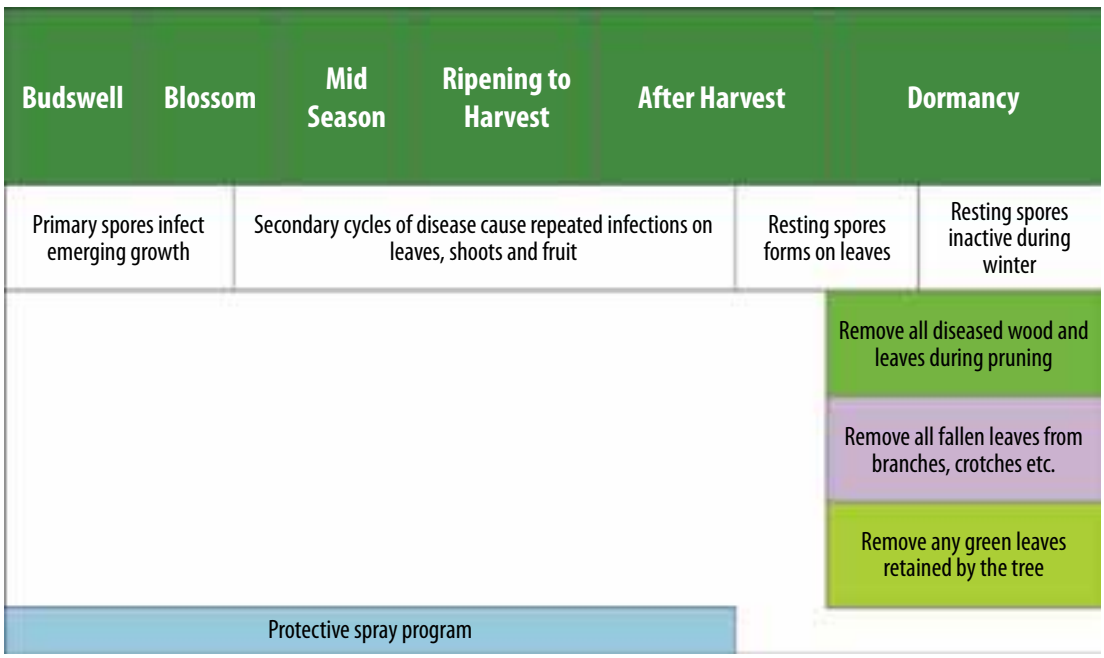
Strand LL (1999). Rust. In: *Integrated Pest Management for Stone Fruits*. Statewide Integrated Pest Management Project. University of California Division of Agriculture and Natural Resources, Oakland California, pp 130-32 †




***Relationship between temperature and leaf wetness period and the severity of rust infection in sugar plum (reproduced from Prune Rust Infection Prediction Service: Operator's Manual, Biological and Chemical Research Institute, NSW Agriculture and Fisheries)***



# San José scale

***Diaspidiotus (Quadraspidiotus) perniciosus***

## IPDM quick facts

**Sample unit:** *Tree butt and branches*

**When to monitor:** *Late blossom to dormancy*

**How often:** *Fortnightly*

**Action level:**

- *if scale damage has been seen in the previous season*
- *if scale infestation is heavy during the current season*

*Take extra care when monitoring:*

- *during warm dry weather*
- *when there is dust on trees.*

### The pest and its damage

San José scale is a major pest of fruit trees but can be quite inconspicuous until numbers build up. In winter immature nymphs survive on limbs and trunks. In spring these nymphs develop into winged male and stationary female insects. Adult female San José scale insects have a grey circular covering. If the covering is removed, the yellowish scale body can be seen underneath.

They lay eggs that immediately hatch and emerge from under the scale as crawlers. There can be up to four generations of crawlers per season.

*San José scale infestation*

San José scale damages the tree by feeding on twigs, branches and fruit. A heavy infestation will be obvious on the trunk and branches as a grey, scurfy layer.

When rubbed with the hand, dead scale covers will flake off. If the scale is alive, rubbing will leave the hand with a yellow to reddish deposit. Often the tree will react by producing gum at the site of a San José scale infestation.

In extreme cases entire trees can be killed.

During the growing season, scale crawlers (see description of the pest's life cycle in 'Monitoring') will move to the new lateral growth and onto the fruit. Once the pest has settled and the mouth parts have been inserted into the fruit, individual scales will often be highlighted by a red ring.

### A serious regional issue during the last 10 years in:

- Alstonville
- Perth Hills
- NSW central west
- Swan Hill
- Southeast Queensland

### Prevention

#### *Pruning*

Prune out infested branches and burn. This will also improve spray penetration.

#### *Neglected trees and other hosts*

Scale can build up heavily on neglected fruit tree seedlings around orchard areas, on many ornamental trees and shrubs related to summerfruit, and on several unrelated hosts, for

*Yellowish body of an adult female San José scale*

*A heavy infestation of San José scale*

example, tree lucerne, osage orange and willow. It can be spread from these to summerfruit by wind or birds. Don't overlook such sources of infestation in areas where scale is a problem. Spray infested deciduous ornamentals with oil. Neglected pome fruit trees, summerfruit trees and other hosts should be cut down and burned.

## Monitoring

### *When to look*

Look at the butt and branches of the marked monitoring trees from late blossom to dormancy at fortnightly intervals. San José scale numbers can build up very quickly, so monitor thoroughly (see chart below).

San José scale has quite a complex life cycle that is tied closely to temperature.

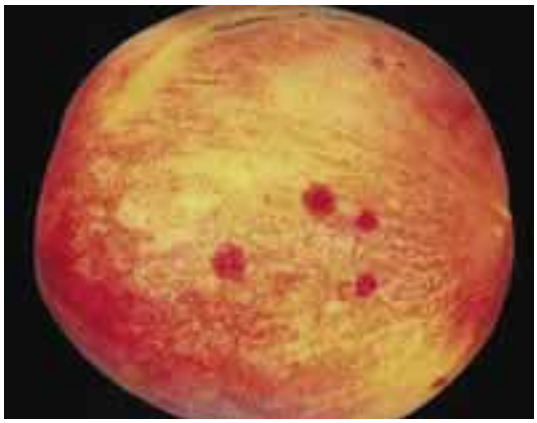
In cooler regions San José scale survives the winter under a black waxy cap. This is the 'black cap stage'. In spring the female lays eggs under the scale; these immediately hatch as 'crawlers'. Crawlers are tiny yellow insects that move about until they find a suitable feeding site. They then settle down and secrete a white waxy covering. After a period of time, the scales turn dark grey. Male scales are more elongated than those of females.

In warmer regions it is possible that all stages of the San José scale life cycle are present throughout the year. The life cycle will vary considerably from region to region, largely corresponding to variations in temperatures.

Because the development of scale is closely associated with temperature, management models have been developed. These allow orchardists to monitor temperature and apply management at a time when scale is most likely to be controlled. These models are currently available only to overseas orchardists but are now being developed for Australia.

At present, in Australia the most effective controls are applied during the dormant period. They are applied in response to damage observed during the previous season(s). Therefore, the most appropriate period for monitoring is during the production season. Be especially vigilant in years of crop failure, when sprays are likely to be reduced. These are the years in which populations will increase to levels that are difficult to control.

| Budswell | Blossom | Mid Season | Ripening to Harvest | After Harvest | Dormancy |
|---|---|---|---|---|---|
| First-generation crawlers infest trees | | Four or five overlapping generations of scale during a growing season | | | Scale overwinters as black cap stage |
| | | MONITOR | | | |



***Fruit damage caused by San José scale***

#### *What to look for*

Look for any sign of damage due to San José scale or the scale themselves. It is important to look very thoroughly, as numbers can build up quickly.

### Appropriate action

(See chart below).

#### *Action threshold*

- if scale or scale damage has been seen during the previous season
- if scale infestation is heavy during the current season

#### *Apply dormant oil*

This pest is best controlled in winter. Treat summerfruit trees with dormant oil in winter. Thorough application (drenching) is important to achieve good control. Most dormant oil formulations are registered for use at 3 L per 100 L (3%) for the winter application. If cost is an issue, it is acceptable to use 2 L per 100 L (2%) at the dilute spraying volume as specified on the label. Drive slowly to achieve a drenching cover and obtain good control. If this treatment is applied properly, chances are you will not need any other control for San José scale during the season.

#### *Insecticide application*

If dormant oil has not provided sufficient control or infestations are very heavy, consider applying an insecticide. A recommended schedule is provided on page 137. Note the warning provided about fruit marking.

### More information

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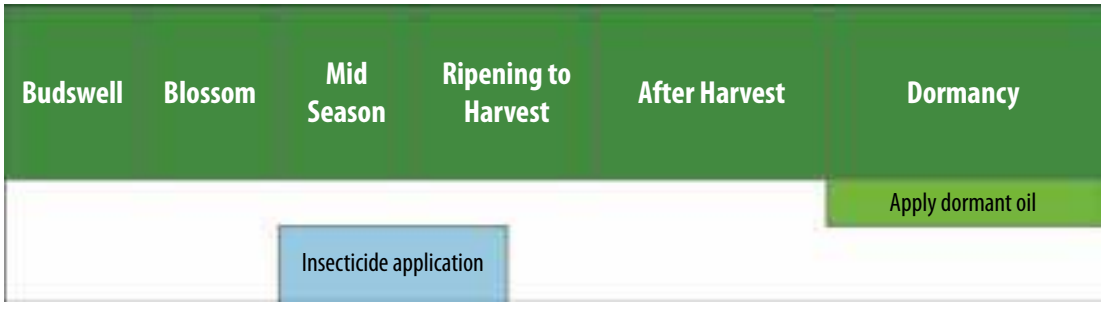


# Shot-hole

***Wilsonomyces carpophilus***

## IPDM quick facts

**Sample unit:** *Leaves*

**When to monitor:** *Shuckfall to harvest*

**How often:** *Fortnightly*

**Action threshold:** *When 5% of leaves have spore-forming lesions and rain is expected within a week.*

***Take extra care when monitoring:***

- *when it has been wet in late winter and early spring*
- *leaves have been wet for at least 24 hours*
- *fruit infection is favoured by wet spring weather.*

### Causes and consequences

Shot-hole occurs on all types of summerfruit but is less severe on plum. It is caused by the fungus *Wilsonomyces carpophilus* and affects leaves, fruit and buds. The disease decreases the efficiency of the tree by decreasing its photosynthetic capacity. If leaf infection is severe, premature leaf fall can occur. Fruit infections are superficial but disfigure the fruit, making it unmarketable.

### Symptoms

#### *Leaves*

Leaf lesions start as reddish specks that enlarge and develop tan centres with purplish margins. Often leaf lesions will be surrounded by a light green or yellow halo.

The brown tissue in the centre of leaf lesions usually falls out, leaving a typical 'shot-hole' appearance. Many other diseases can cause similar symptoms. A diagnostic feature of this disease is the presence of tiny, black, spore-forming structures in the centre of the tan lesions. These can be seen with a hand lens.

#### *Twigs and buds*

Lesions on twigs look similar to those on leaves. They are initially red and then turn tan with a purplish margin as they enlarge. Again, black spore-forming structures can be seen in the centres of these lesions.

Infected buds turn black, and often—but not always—gum is exuded. When the bark is cut away from beneath the diseased bud, brown water-conducting tissue can be seen.

#### *Fruit*

Fruit lesions are similar in appearance to those on leaves and twigs. Older lesions have a brownish-purple border and a tan centre. Unlike leaf and twig infections, no spore-forming bodies form on fruit lesions.

*Shot-hole on apricots*

*Early symptoms of shot hole on apricot leaves*

*Bud killed by shot hole. Note the darkening of internal tissue under the bud.*

*Fruit infected by the shot-hole pathogen*

**A serious regional issue during the last 10 years in:**

- NSW southwest slopes
- Tasmania
- Manjimup/Donnybrook
- NSW central west

## Prevention

### *Pruning out infected wood*

Prune out as much infected wood as possible during dormancy and burn prunings. A protective spray schedule will still be required in affected orchards, but pruning will improve the efficacy of sprays.

### *Irrigation*

Be careful that irrigation does not wet the leaves. Shot-hole, and many other diseases, will become established only after the leaves, fruit or twigs are wet for prolonged periods.

### *Hasten leaf fall*

Orchardists who hasten leaf fall as part of their management strategy will find that this will also have benefits for shot-hole. It prevents levels of inoculum from building up in late autumn.

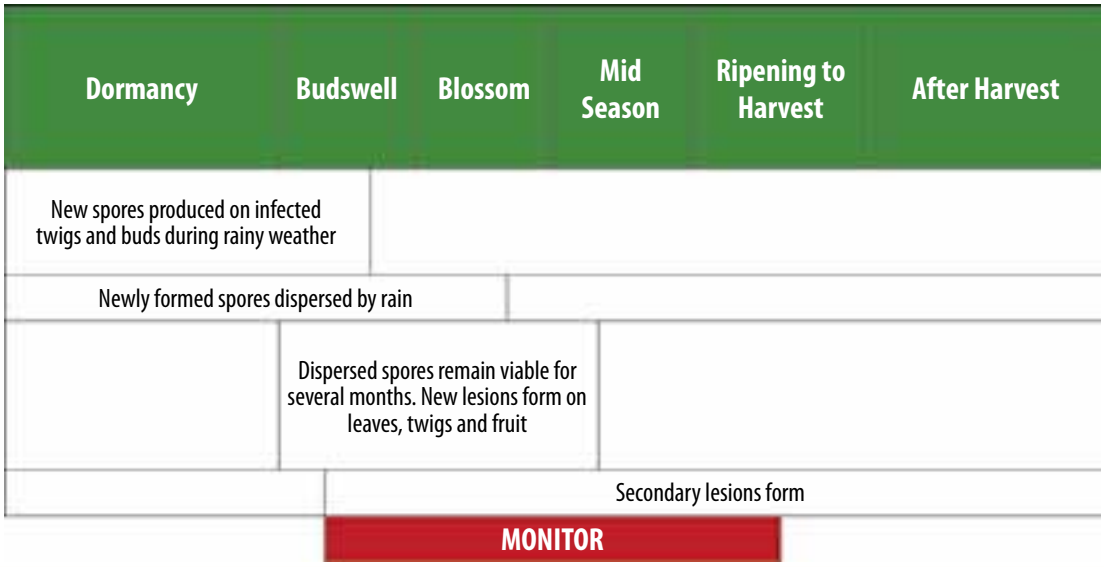
## Monitoring

### *When to look*

(See chart below).

Carefully examine leaves on four limbs of each marked monitoring tree at fortnightly intervals until mid-harvest.

Keep accurate records of shot-hole severity in your orchard. Where shot-hole has been present in the orchard in previous seasons it is advisable to use a protective spray schedule before symptoms appear and apply fungicides at regular intervals until shuckfall (see page 137).




Monitoring can reduce the number of sprays required for shot-hole after shuckfall. With a hand lens, carefully inspect lesions that form on leaves in spring.

***What to look for***

If black spore-forming bodies are present and rain is likely within the next week, apply a fungicide. If either of these conditions is not met it is not necessary to apply a protective fungicide.

## Appropriate action

***Action threshold***

- 5% of lesions seen in spring have spore-forming bodies
- rain is expected within a week.

***Protective spray program***

In most cases early season application of protective fungicides for diseases such as brown rot and leaf curl will be sufficient to control shot-hole (see chart above). In these cases no specific additional fungicide applications are required.

If shot-hole was present in the orchard in the previous season, and particularly if spore-forming bodies were seen on leaves in autumn, the young buds must be protected up until shuckfall. Do not wait to see symptoms at this stage of the year.

It may be possible to reduce the number of fungicide applications necessary after shuckfall by carefully monitoring the young leaves at this point.

***Lime sulfur***

Where shot-hole has been a serious problem, an application of lime sulfur during dormancy will reduce the number of spores carried over from the previous crop. In most cases this application should not be necessary.

## More information

*Some of the information provided in these references comes from other countries (marked †). Always remember that the biology of pests and diseases and the tactics used to control them vary subtly from country to country and will change with time. Be particularly cautious with pesticide recommendations. If a pesticide is not recommended in this manual (page 137) you must check that it has current registration in your State and abide by the conditions of that registration, as specified on the pesticide's label. ALWAYS READ THE LABEL.*

Strand LL (1999) Shot-hole. In: *Integrated Pest Management for Stone Fruits. Statewide Integrated Pest Management Project*. University of California Division of Agriculture andNatural Resources, Oakland California pp. 125-127 †

# Silver leaf

***Chondrostereum purpureum***

## IPDM quick facts

**Sample unit:** *Leaves*
**When to monitor:** *Mid-season to leaf fall*
**How often:** *Fortnightly*
**Action threshold:** *If silver leaf is seen*

***Silver leaf on peach***

### Causes and consequences

Silver leaf is caused by the fungal pathogen *Chondrostereum purpureum.* This fungus attacks a wide range of temperate trees and shrubs, including all types of summerfruit, pome fruit, willows, eucalypts and roses. Although the fungus causes symptoms on leaves, it primarily causes an aggressive wood-rotting disease. At worst it can cause tree death, but less severe consequences of the disease include a reduction in fruit size and number, poor colour and reduced storage life.

### Symptoms

#### *Leaves*

The disease is called silver leaf because of the silvery sheen it causes on the foliage. This sheen is caused by a toxin that is produced by the fungus and is carried through the water-conducting tissue. The toxin causes the leaves to turn silver-grey. They may also curl and turn brown at the edges.

Leaves may turn silver on single branches or the whole tree. The extent of silvering is generally related to the size of the wound that the pathogen has colonised on the limbs or trunk.

These symptoms are easily confused with the damage caused by peach silver mite (page 95). In the case of silver leaf, symptoms on leaves are always associated with nearby limb and trunk infections. Look for these to differentiate between peach silver mite and silver leaf.

#### *Trunks and limbs*

The fungus enters the tree through wounds. Unprotected pruning wounds are a prime site of entry. Upon entry it begins to produce toxins, which kill the trunk or branches. The toxin also spreads to the leaves, causing the characteristic silver foliage associated with this disease (see above for more details). Infection can be detected by a dark brown discolouration of the heartwood on dying limbs. The fungus remains confined to the tree's water-conducting vessels until the limb or trunk is dead. When the limb is dead the fungus moves out of the water-conducting tissue and produces its characteristic fruiting body. These are small leathery structures with a greyish white upper surface and purplish lower surface.

### A serious regional issue during the last 10 years in:

- Adelaide Hills
- Goulburn Valley

### Prevention

If silver leaf has been a problem in the orchard during the last 4 years, you will need to take rigorous preventive action.

#### *Varieties*

No varieties are immune to silver leaf, but some are less susceptible. If silver leaf has been a problem in your orchard, ask your supplier about the susceptibility of trees for new plantings.

#### *Pruning*

The most common point at which the pathogen enters trees is through pruning wounds. Correct pruning is therefore critical in preventing and controlling silver leaf in disease-prone orchards.

Avoid winter pruning, particularly on calm, damp, overcast days, as these are the days when most fungal spores will be present in the orchard. Aim to produce a pruning wound that will heal quickly to produce a doughnut-shaped callus. Good technique and tools are important. Use good quality sharp pruning tools. Ragged wounds help the pathogen to colonise.

The disease is not easily transmitted on pruning tools, and you don't need to sterilise your tools between cuts.

All prunings must be buried or burnt.

Also note that other forms of wounding may create infection sites for this disease; see information on controlling 'four-legged pests' (page 17).

### *Wound dressings*

Apply wound dressings as soon as possible after pruning; certainly on the same day. The fungus produces more spores in the dark, and leaving wounds unprotected overnight is a recipe for disaster. If for some reason wound dressings aren't applied quickly, it is often best to leave wounds unprotected. Infection is likely to have already occurred. The pathogen is likely to have penetrated some depth into the tree and a surface dressing merely traps the fungus in the tree. Applying a late wound dressing is also likely to kill beneficial organisms that may otherwise kill the fungus.

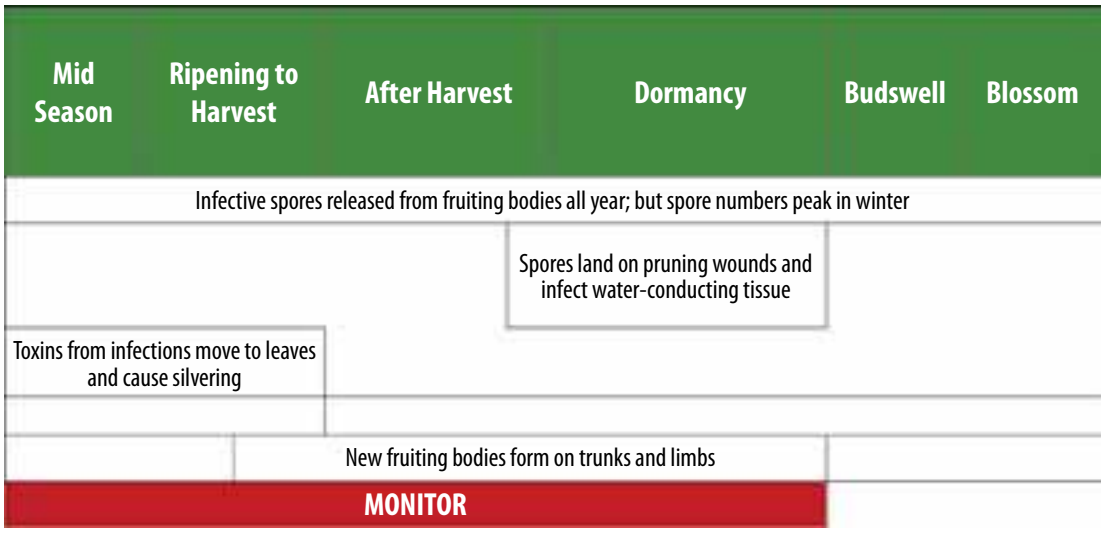
Acrylic paints often form a physical barrier sufficient to stop the pathogen penetrating through wounds. Do not water the paints down; this reduces their effectiveness significantly and is false economy. Where wounds are particularly large, a second coat of paint may be required.

Many fungicides are toxic to trees when applied at the wrong rates and can seriously harm trees. Therefore, avoid home-made mixtures of paint and fungicides. Use of copper-based products is especially dangerous, as they increase the tree's susceptibility to silver leaf. A commercial wound dressing formulation is available that contains the fungicides cyproconazole and iodocarb. Use this formulation if silver leaf has been a serious problem.

### *Remove alternative hosts*

The silver leaf pathogen infects a wide range of trees and shrubs. Some trees should be removed from around orchards, because they pose a particular risk. Willows and poplars are particularly susceptible to the disease, and those close to the orchard should be cut down and burned. Be careful when your orchard is near a watercourse.

***Leaves have a silvery grey sheen after infection***




## Monitoring

### *When to look*

(See chart above).

Silver leaf needs to be included in your monitoring schedule if it has been observed in your orchard at any time during the last 4 years.

Carefully observe four lateral branches on the marked monitoring trees for silvering of the leaves from mid-season to leaf fall. You should also observe the other trees in the orchard as you walk between the trees. Closely investigate any signs of silvering.

Monitoring for new fruiting bodies should concentrate on the period immediately after leaf fall. The fruiting bodies are easier to see at this time.

***Spore-producing body of Chondrostereum purpureum, the silver leaf fungus***

### *What to look for*

Silvering is the most obvious early indicator of silver leaf infection. Observe monitoring trees for the presence of new fruiting bodies. These may form without any obvious leaf silvering symptoms.

## Appropriate action

### *Action threshold*

If silver leaf is seen (see chart on next page).

### *Prune out infected limbs and burn or bury prunings*

Individual fruiting bodies are capable of producing spores for 2 years. Aim to prune out spore forming bodies when you see them, except during cold, wet and still weather. Pruning in early or late winter should help. This pruning should be done in conjunction with careful monitoring. Where leaf silvering and /or fruiting bodies haven't been observed in the orchard for 4 years, a more normal mid-winter pruning schedule can resume.

As spore numbers are highest during cold, wet and still days, new fruiting bodies should be pruned out very early in winter, when these conditions are less frequent.


## More information

*Some of the information provided in these references comes from other countries (marked †). Always remember that the biology of pests and diseases and the tactics used to control them vary subtly from country to country and will change with time. Be particularly cautious with pesticide recommendations. If a pesticide is not recommended in this manual (page 137) you must check that it has current registration in your State and abide by the conditions of that registration, as specified on the pesticide's label. ALWAYS READ THE LABEL.*

Strand LL (1999) Silver leaf. In: *Integrated Pest Management for Stone Fruits. Statewide Integrated Pest Management Project.* University of California Division of Agriculture and Natural Resources, Oakland, California pp. 145–146. †

# Two-spotted mite

***Tetranychus urticae***

## IPDM quick facts

**Sample unit:** *Two leaves per sample tree*

**When to monitor:** *Summer, particularly in hot weather*

**How often:** *Fortnightly*

**Action level:** *65% to 80% of leaves infested*

- *Use visual orchard damage assessment when infestations are patchy.*
- *Increase monitoring frequency in hot weather.*

### The pest and its damage

Two-spotted mite is a distinctive, common species, easily recognised by the two dark spots on either side of its body. These spots may not always be prominent, and sometimes they almost join into a large dark area at the front of the abdomen. Male two-spotted mites are distinguished from predatory mites by their pointed abdomen, two dark spots and small red 'eye spots' towards the front of the body. The 'eye spots' also occur on female two-spotted mites.

Adult females are about 0.6 mm long, oval and pale green or yellowish green, with a dark green spot on each side of the body. In late autumn in cold climates the females change colour to orange as their development becomes suspended for that season.

Adult males are a little smaller and less abundant than females. They have a triangular, pointed abdomen.

The immature stages resemble the adult females in general appearance, but are smaller and usually pale greenish white. The eggs are minute (0.1 mm diameter), spherical, and clear or pale yellow. They are usually laid on the undersides of leaves, or on fine webbing spun by the females.

Two-spotted mites suck the juice from individual leaf cells, making the leaves turn brown and fall.

*Two-spotted mite*

In extreme cases almost complete defoliation can occur. If defoliation occurs before harvest, the reduced photosynthesis may reduce the size of the fruit and adversely affect fruit colour. Severe infestations may also reduce fruit bud set and yield for the following year because of a reduction in the amount of reserves going into the tree before dormancy.

### Prevention

#### *Reducing dust*

Two-spotted mites become more of a problem on trees in dusty blocks. Any measure that will reduce the amount of dust blowing onto trees will minimise mite problems. Wet down dusty tracks, or drive on the leeward side of the orchard during hot dry weather.

#### *Delay spraying*

If two-spotted mites have been a problem in the past, it is a good idea to delay spraying other insect pests and diseases for as long as possible. Many insecticides (e.g. bifenthrin) and even fungicides reduce populations of the natural enemies of two-spotted mite (and other mites). These reductions can lead to mite outbreaks.

#### *Irrigation*

If the weather is hot and dry there is greater risk of rapid increases in pest mite numbers and greater stress on the trees from mite damage. This stress will be lessened if the block has adequate irrigation.

#### *Biological control*

Biological control agents that are effective against two-spotted mite are available from a number of commercial outlets in Australia (page 119). The predatory mites *Phytoseiulus persimilis* and *Typhlodromus occidentalis* will reduce two-spotted mite populations. Predatory mites must

be introduced early, before pest mite numbers build up. The toxicity to predatory mites of the chemicals that have been used or are intended for use in the orchard must be checked (see page 112). Some chemicals have a long-lasting residual effect that will lower the effectiveness of biological control. There is often a need to re-apply biological control agents during the season in response to two-spotted mite build-up. Biological control agents usually need to be re-introduced in subsequent seasons, as they are unlikely to be present in the orchard year after year.

## Monitoring

In many cases orchardists employ consultants to monitor their crops for mites. A trained consultant should be able to identify both pest mites and their natural enemies and take account of these in advising action thresholds. Although this is the most accurate method of monitoring, orchardists themselves can also monitor their crops by using visual assessment. Two-spotted mite infestations usually start in the lower part of the tree, in the crotch. This is where the early phase of monitoring should be concentrated. Both monitoring techniques are outlined here (see chart below).

### *Monitoring by consultants*

Professional consultants should use this technique to monitor both mite and predator populations where populations are relatively uniform. In the case of patchy infestations visual assessment (see below) is more effective and should be used by consultants as well.

At fortnightly intervals two leaves are taken from each of the sample trees in the block. Leaves should be dry and mature and come from the lower part of the tree, below head height. One leaf should be taken from the inner part of each tree and one from outer areas. The inner leaf

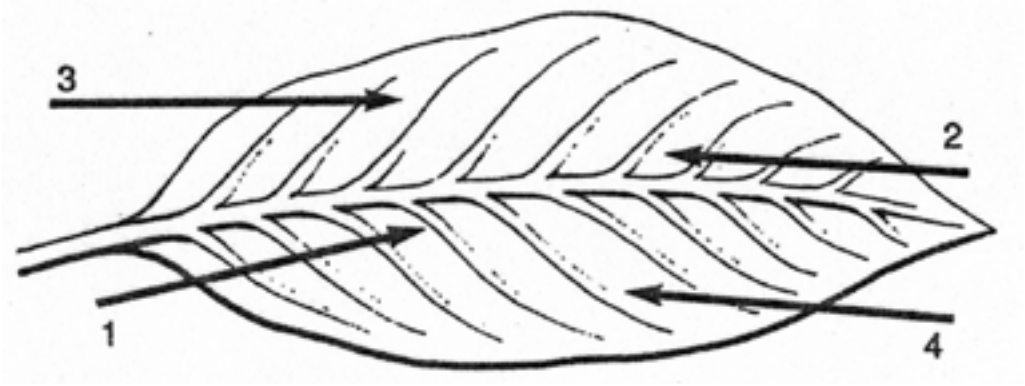
***Overwintering female two-spotted mites. Note the orange colour.***

will allow detection of the early stages of two-spotted mite infestation. Pick leaves at random; don't deliberately select heavily infested ones or avoid uninfested ones. Put them in a plastic or paper bag and transport them in a cool esky or portable refrigerator. It is essential to keep the sample cool; don't leave it in the sun or in the car. Prolonged exposure to the sun causes the leaves to turn brown and may kill mites, making counting very difficult. Label the sample bag with the orchard name, block number and sample date.

Store leaf samples in a refrigerator or cool room at 4 °C before examination. If the leaf samples are in paper bags, place these in a larger plastic bag before storage to prevent the leaves from drying out. Samples should be assessed within 2 days of collection so that populations don't have time to change before the management strategy is applied.

Only the underside of each leaf is examined, individually, using a binocular microscope at 8 to 10 × magnification.

| Budswell | Blossom | Mid Season | Ripening to Harvest | After Harvest | Dormancy |
|---|---|---|---|---|---|
| Diapause | Females lay up to 200 eggs each.<br>Many overlapping generations of mites per season | | | | Diapause in cooler regions. Feeding and reproduction continues elsewhere |
| | MONITOR | | | | |




*Method of examining leaves for mites. Numbered arrows indicate the timing and direction of observations under the microscope.*

Scan each leaf systematically; pay particular attention to the area next to and below the midrib, where predators may be sheltering. Hold the leaf between the thumb and forefinger of each hand and pass it to and fro across the field of view. Adjust the microscope to focus on a plane 1 or 2 cm above the base plate, and keep the field of view in focus by raising or lowering the leaf by hand as you pass it underneath. Examine the leaf in four sweeps.

For speedy assessment place each leaf in one of four piles next to the microscope after examination. The four piles correspond to the four categories of leaves in columns A, B, C and D on the record card shown.

After you have examined all of the leaves, count the number in each category and enter the results on the card. The leaves can then be discarded and the percentages with pest mites or predators calculated.

The data obtained from a 50-leaf sample can be used to decide on the need for spraying. The percentage of leaves occupied by pest mites

**Australian Summerfruit IPDM Record Card**

ORCHARDIST: John Smith

| Sample date | Observer | A Zero mites/predators | B Two-spotted mites only | C Both mites and predators | D Predators only | E Total leaves | Percentage mites | Percentage predators |
|---|---|---|---|---|---|---|---|---|
| 4-12 | IL | 32 | 12 | 4 | 2 | 50 | 32 | 12 |
| | | | | | | | | |

**% mites = ([B + C] × 100)/E**
**= ([12 + 4] × 100) / 50**
**= 32% a**

**% predators = ([D + C] × 100)/E**
**= ([2 + 4] × 100)/50**
**= 12%**

indicates the likelihood of economic damage occurring. The ratio of pest mites to predators determines the probability of biological control succeeding before economic damage occurs. Knowledge of these relationships allows action thresholds to be set and appropriate spray decisions made.

### *Monitoring by orchardists: visual damage assessment*

Go for a walk through your orchard and identify any hotspots of mite activity. Rate the trees with the worst infestations according to Table 3.

*Table 3. Visual damage assessment by consultants: two-spotted mite*

| Rating code | Description | Visible damage |
|---|---|---|
| 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 defoliation |

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.

*Table 4. Actions to be taken depending on pest and predator numbers*

| **Percentage of leaves occupied** | | |
|---|---|---|
| **Pest** | **Predator** | **Action** |
| **0–49**<br>Very low chance of economic damage | | Check again in 2 weeks. |
| **50–64**<br>Low chance of economic damage | 0–5 | Effective biological control unlikely. Apply a selective miticide at the non-IMC† rate. |
| | 5–20 | Biological control may succeed. Check again in 1 week. |
| | > 40 | Effective biological control imminent or is occurring. Check again in 1 week. |
| **65–79**<br>Moderate chance of economic damage. Damage imminent. | 0–5 | Effective biological control unlikely. Apply a selective miticide at the non-IMC rate, if applicable. |
| | 5–40 | Biological control unlikely to succeed before damage occurs. Apply a selective miticide at the IMC rate, if applicable. |
| | > 40 | Effective biological control imminent or is occurring. Check again in 1 week. |
| **80–94**<br>High chance of economic damage. | 0–10 | Apply a selective miticide at non-IMC rate. |
| | 10–50 | Apply a selective miticide at IMC rate, if applicable. |
| | > 50 | Effective biological control imminent or is occurring. Check again in 1 week. |
| **95–100**<br>Very high chance of economic damage. | 0–10 | Apply a selective miticide at the non-IMC rate. |
| | > 10 | Apply a selective miticide at the IMC rate. Biological control is unlikely to occur quickly enough to prevent excessive damage, which may already be occurring. |

†IMC = Integrated mite control. IMC rates are specified on labels.

## Appropriate action

### *For professional consultants counting pest mites and natural enemies*

Essentially, unless there is extreme patchiness in the block sampled, the maximum tolerable level of mites is set at 80% of leaves occupied by pest mites. Sprays should be applied **before** the 80% level is reached, not after, to prevent excessive damage to trees. A spray is not usually needed for infestations occupying less than 50% of the leaves, so the decision needs to be made between population levels of 50% to 80% of leaves occupied.

For pest populations in the region of 50% to 65%, there should not be any significant damage occurring and it is advisable to wait a week and sample again, particularly if good numbers of predators are present. Delaying the spraying as long as possible gives predators the maximum opportunity to multiply, and gives the best chance of biological control being maintained after spraying.

For pest populations between 65% and 80% of leaves a spray should be applied, unless biological control is imminent.

Guidelines for the numbers of predators needed to achieve biological control of given pest populations are shown Table 4.

A closer watch is needed on mite populations in hot, dry weather, particularly as they approach critical levels. The decision to spray should allow for the potential for explosive increase in hot weather. A spray schedule for two-spotted mite is included in this manual (page 137).

It is important to remember that quite high numbers of predators are needed to control pest populations near the damage threshold. It is better to err on the side of caution and apply a spray than to wait too long and allow damage to occur.

If early-season monitoring indicates that two-spotted mites occur in some trees but not in

others (the infestation is patchy), then use visual damage assessment of the entire orchard (see below) to help you to decide if you have reached the action level. If the infestation is uniform, continue using the monitoring method above.

#### *For visual damage assessment by orchardists*

If the visual damage assessment gives a rating of 3 or more, a spray should be applied, 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 when most trees have been rated at 2, as it will not be long before many will reach a rating of 3, if predators are lagging. A spray schedule for two-spotted mite is included in this manual (page 137).

### More information

*Some of the information provided in these references comes from other countries (marked †). Always remember that the biology of pests and diseases and the tactics used to control them vary subtly from country to country and will change with time. Be particularly cautious with pesticide recommendations. If a pesticide is not recommended in this manual (page 136) you must check that it has current registration in your State and abide by the conditions of that registration, as specified on the pesticide's label. ALWAYS READ THE LABEL.*

*The Mite Management Manual* is described as a practical guide to integrated mite control. It contains colour photographs of mites and predators and details of how to control orchard mites with predators and miticides. Although this book is primarily intended for use by apple orchardists, many of the principles are useful in summerfruit orchards. It is available through NSW Department of Primary Industries Publications Sales, freecall 1800 028 374.

Barrass I (1995) *Predatory Mites to Control Two-spotted Mite in Orchards*. AGO215. Available through the Department of Agriculture Victoria at the DPIV website, www.dpi.vic.gov.au

Learmonth S (2005) *Using Miticides in Western Australian Deciduous Fruit Tree Crops 2004–05*. Department of Agriculture Western Australia. Available through the DAWA website, www.agric.wa.gov.au