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Management of thrips and tomato spotted wilt virus

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Thrips are small (1-2 mm), slender insects, just visible to the naked eye. Thrips can be an economic problem in a wide range of crops including ornamentals, vegetables, strawberries, grapes, pome fruit, and stone fruit. There are six economically important thrips species found in Western Australia:

- western flower thrips (*Frankliniella occidentalis*)
- tomato thrips (*Frankliniella schultzei*)
- onion thrips (*Thrips tabaci*)
- greenhouse thrips (*Heliothrips haemmorhoidalis*)
- plague thrips (*Thrips imaginis*)
- melon thrips (*Thrips palmi*)

With the exception of melon thrips (currently found only in Kununurra and parts of the Northern Territory and Queensland), most species are found throughout Australia. Western flower thrips (WFT) is the most damaging of all thrips species and was first detected in Australia in Perth in 1993. The source of infection was thought to be imported cut flowers.

Direct damage – feeding, egg laying

Thrips pierce plant cells with their mouthparts and feed on the plant juices. The collapse of plant cells can result in the formation of deformed flowers, leaves, stems, shoots, and fruit (Figure 1). Silvery flecked scars or small black faecal spots may also be seen on the leaves and fruit. Thrips can also damage buds and flowers through their egg laying. This can cause deformed fruit to develop.

Figure 1. Adult WFT feeding on bean leaves have caused the mottled effect.

Indirect damage – plant viruses

Thrips also spread plant viruses. WFT, onion thrips, and tomato thrips spread the tomato spotted wilt virus (TSWV). TSWV was first found in Western Australia in the 1920s, causing sporadic epidemics in vegetable and ornamental crops. The efficiency with which the virus is transmitted differs between species: WFT is the most efficient vector of TSWV. Since WFT was found in Western Australia the frequency of TSWV epidemics has increased.

TSWV is mainly of concern in tomatoes, capsicum, and lettuce where it can cause up to 100 per cent crop loss. Plants such as grapes, stone, pome fruit, strawberry, brassica, and cucumber are not affected by the virus.

Figure 2. Crop loss from TSWV estimated at 30 per cent to field grown lettuce in Carabooda, Western Australia. Inset: TSWV symptoms on butter crunch lettuce.

Figure 3. Capsicum plant affected by TSWV. Inset: brown lesions caused by TSWV on fruit.

TSWV symptoms

Plants infected with TSWV show one or more of the following symptoms:

- irregular necrotic (dead) spots on leaves (Figure 3)
- black or purple stem streaks (Figure 4)
- chlorosis (yellowing), chlorotic blotching, chlorotic or necrotic ring spots and line patterns on leaves and fruit (Figures 2 and 3)
- leaf distortion and deformation (Figures 3 and 4)
- dropping of leaves or shedding of buds
- dieback and leaf collapse
- stripes on petals
- plant death caused by wilting (Figure 2).

Figure 4. A TSWV-infected tomato plant (left) showing purpling and mottling symptoms. A healthy plant is on the right.

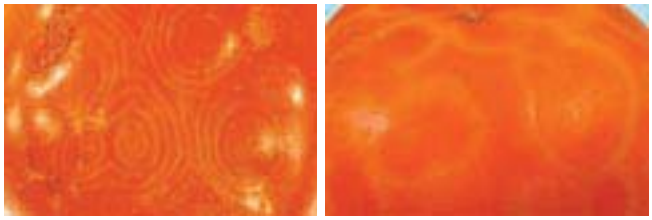

Figure 5. Like the common cold, there are different strains of TSWV and differences in the severity of symptoms. At left is a tomato with the classic 'thumb-print'; at right is a fruit showing faint haloes.

How thrips acquire and spread TSWV

- TSWV can only be acquired by newly hatched thrips (first instar nymphs) feeding on a plant infected with TSWV: older nymphs and adults cannot acquire the virus.
- If no source of infection is present, thrips cannot acquire or transmit the virus.
- Over 900 species of cultivated crops and weeds are known to harbour TSWV.
- Nymphs can acquire the virus in as little as 15 minutes. The virus moves through the gut and into the salivary glands from where it is injected directly into healthy plants (Figure 6).
- Approximately five days of incubation are required before the thrips can transmit the virus. Once infected with the virus, the thrips is infected for life (Figure 6).
- Male and female thrips can acquire TSWV: infected adults cannot transmit the virus to their offspring.

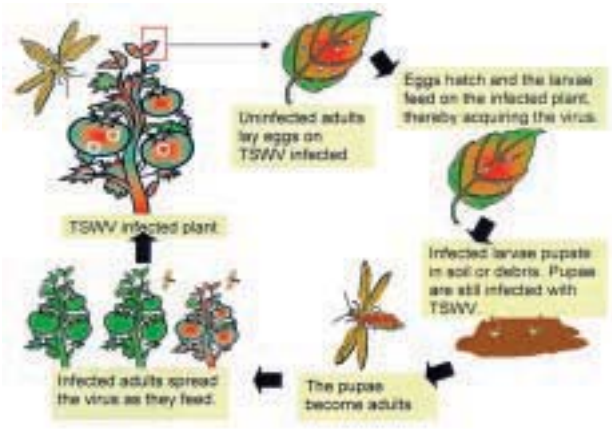

Figure 6. Transmission of tomato spotted wilt virus by thrips.

- Plants can take 14 to 21 days to show symptoms of infection.
- Plant seeds are not known to harbour TSWV.

How thrips move

- Thrips are poor fliers and their main methods of dispersal are by wind, on plants, people, or on equipment.
- To some extent, thrips can control where they will land and artificial or natural windbreaks can provide some protection from wind-borne thrips.
- Thrips respond to colour, UV reflectance, and scent.
- Be careful what colours you wear when working in your crop. WFT are particularly attracted to yellow, white, and blue.

Strategies to control thrips and spread of TSWV

Weed control

- Weeds act as reservoirs for TSWV and thrips. Thrips are particularly attracted to flowering weeds as they feed on the pollen.
- Thrips feed on and reproduce in weeds, particularly if there are no cultivated crops being grown. When a new crop is planted the thrips move off the weeds and onto the new crop. Try to keep a weed-free area of at least 10 m around the crop. This can be bare ground, closely mown grass, concrete, stones, or some other hard surface.
- Be careful if you spray weeds with herbicide. As the weeds die off, thrips can move off the weeds onto your crop. You may want to treat weeds with insecticide at the same time.

Crop hygiene

- Plants infected with TSWV should be removed when the first symptoms of the disease are seen.
- Dispose of plants by burning or burying. You may want to spray the plant with insecticide first, to ensure that any thrips infected with TSWV are killed.

Seedlings

- If you grow your own plants, grow them from seeds where possible. Seeds are not known to harbour TSWV.

- If buying seedlings, check with suppliers that they monitor for WFT and TSWV and that the plants are free of WFT when sold.

Indicator plants

- Indicator plants can be used to determine if thrips are carrying TSWV (Figure 7).
- Certain varieties of petunia and faba bean are highly attractive to thrips. Remove the flowers so that the thrips feed upon the leaves. A lesion may be seen if the feeding thrips are carrying the virus.
- Since the virus infection is localised in petunias, the indicator plants do not serve as a source of TSWV. Simply remove the infected petunia leaves and continue to use.
- Faba bean indicator plants should be removed to avoid the possibility of a systemic infection.

Quarantine new plants

- The spread of WFT and TSWV has mostly been through the movement of plant material. For this reason, always inspect incoming plant material thoroughly for thrips.
- Hold plants in a monitored quarantine area if possible for up to two weeks. This will allow enough time for all eggs and pupae to hatch. By quarantining plants you will also ensure that they are not infected with TSWV.
- A quarantine area may be a glasshouse used specifically for that purpose, or a sectioned-off holding area. This can be made using a double thickness of shadecloth treated with permethrin.

Crop rotation and spacing

- Leave a fallow break between successive plantings; this will act as a virus break.
- Avoid planting overlapping sowings close together, and sequential plantings side by side. This will help to prevent TSWV moving from one crop to the next.
- Grow high-density crops to act as a diluter of the virus.

Thrips proof mesh

- Barriers of fine mesh can help to prevent thrips' movement into glasshouses. However, this mesh is expensive and since you need to cover all vents and doorways, air circulation is reduced and extra venting may be required.
- Trials have indicated that the maximum hole size for the exclusion of WFT is 0.192 mm.

Sterilise greenhouses between crop plantings

- Greenhouses should be sterilised between crop plantings. Sterilise or steam the soil to kill pupae and fumigate the greenhouse to kill adults.
- Alternatively, keep the greenhouse hot, dry, and empty for at least one week, or longer in cold weather. Any thrips in egg or pupal stages will hatch and subsequently die.
- Sticky traps should be placed in the empty greenhouse to attract many of the remaining adult thrips. It is important that the greenhouse contains no plant material for this strategy to work.

Figure 7. Indicator plants such as some petunia varieties can be used to monitor for thrips carrying TSWV. When thrips carrying the virus feed on the leaves, a lesion develops.

Figure 8. Predatory bugs such as Orius *are effective biocontrol agents. Native species of* Orius *do occasionally occur in crops.*

Figure 9. Predatory insects such as this lacewing larva will feed on thrips nymphs and other crop pests such as aphids.

Biological control

- Few biological control agents are available for thrips control in Australia. Due to strict quarantine restrictions, it is unlikely that agents that are effective overseas will ever be available here.
- A predatory mite from Queensland, *Typhlodromips montdorensis*, is being trialed in greenhouses and is expected to be commercially available in the future.
- Lacewings (such as *Mallada* spp) are commercially available and can provide some control. Lacewings are voracious predators that will also eat other pests such as aphids (Figure 9).

Insecticide resistance

- WFT develop resistance to chemicals quickly and often the first sign that WFT are present in a crop is the failure of insecticide to control thrips.
- Some WFT are resistant to only one or two chemicals, some are resistant to many. Most thrips populations are resistant to a variety of chemicals.
- To reduce the incidence of resistance, spray three times with the same insecticide. After three sprays, stop and monitor for WFT. If WFT numbers are still high, choose another insecticide from a different chemical group. For example, rotate from spinosad (spinosyn group) for the first series of three sprays to methamidophos (organophosphate group). There must be at least a 3 week break (<20˚C) to 2 week break (>20˚C) before another series of sprays are applied.

Insecticides registered for control of WFT

- Insecticides registered for control of WFT are currently under temporary permit and vary with crop. For this reason, recommendations are not provided here. Fact sheets containing information on which insecticides are currently registered are available from the Department of Agriculture, or your chemical reseller.

- Not all chemicals registered or permitted for WFT will be effective at controlling WFT and they may interfere with IPM programs that have a biological control component.

How often to spray

- The WFT lifecycle is almost continuous, particularly in greenhouses. All life stages can be found year-round (Figure 10) and WFT populations tend to peak in spring (mid to late October) and autumn (March to May). A female WFT lives from 30 to 45 days and can produce 150 to 300 eggs in this time.
- Spray applications are only effective when WFT are actively feeding as larvae or adults (Figure 11). The application of a series of pesticide sprays increases the likelihood of larvae and adults coming into contact with the chemical.
- Like all insects, the rate that WFT go through their lifecycle depends on temperature (Figure 12). At higher temperatures thrips develop more quickly, requiring a shorter length of time between sprays (Table 1).

Table 1. Spray intervals and temperature

Daytime average temperature °C	Days between sprays	Length of life cycle – days
10-20°C	6	25-35
20-30°C	3-5	15-25

Figure 10. The life history stages of WFT. From the left: egg, first instar nymph and second instar nymph, propupa, pupa, adult male, and adult female.

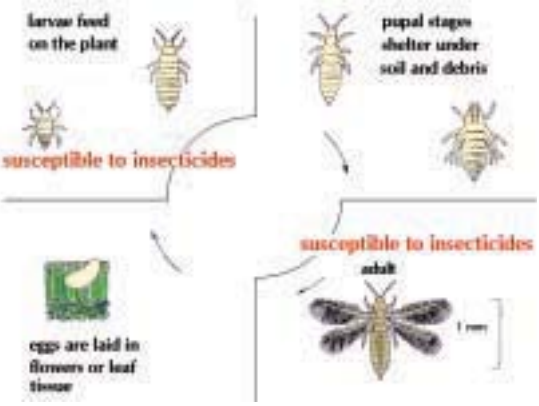

Figure 11. Thrips life cycle and timing of spray applications.

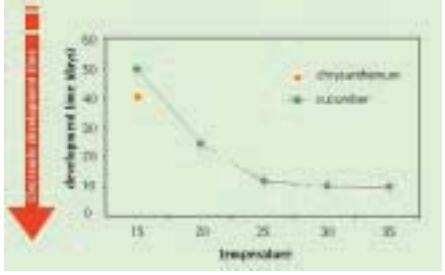

Figure 12. The effect of temperature on thrips' development.

Hints for successful thrips control with insecticides

- Take action before the thrips become established.
- Reserve the insecticides recommended for the control of WFT until WFT is found in your crop (monitor for thrips, Figure 13).
- Use small droplets (<100 microns) rather than large droplets, as they are more effective. Droplet size can be checked using water-sensitive paper.
- Spray in the early morning or mid to late afternoon. The leaves stay wet longer and prolong exposure of the thrips to the insecticide.
- **Do not mix insecticides!** The insecticides that you mix may not be compatible and could cause phytotoxic effects to the crop and be dangerous to your health.
- **Do not mix insecticides!** Mixing insecticides is likely to increase the levels of resistance in the thrips population, as you are exposing thrips to multiple insecticides, rather than just one.
- Control thrips before flowering where possible. When thrips enter the flowers they are difficult to reach with insecticides as they are hidden.
- Check the pH. pH affects the activity of insecticides. A neutral pH is best (pH 6.5 to 7.0).

Figure 13. Yellow sticky traps can be used to monitor for thrips in the greenhouse and in the field.

Further information

If you have difficulty controlling thrips or have an unusually high level of virus symptoms in field material, please contact Department of Agriculture on (08) 9368 3333.

Further reading

Farmnote No. 41/93 Tomato spotted wilt and impatiens necrotic spot – viruses spread by thrips.

Acknowledgements

The photograph of the WFT lifecycle (Figure 10) was taken by Jack Kelly Clark.

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