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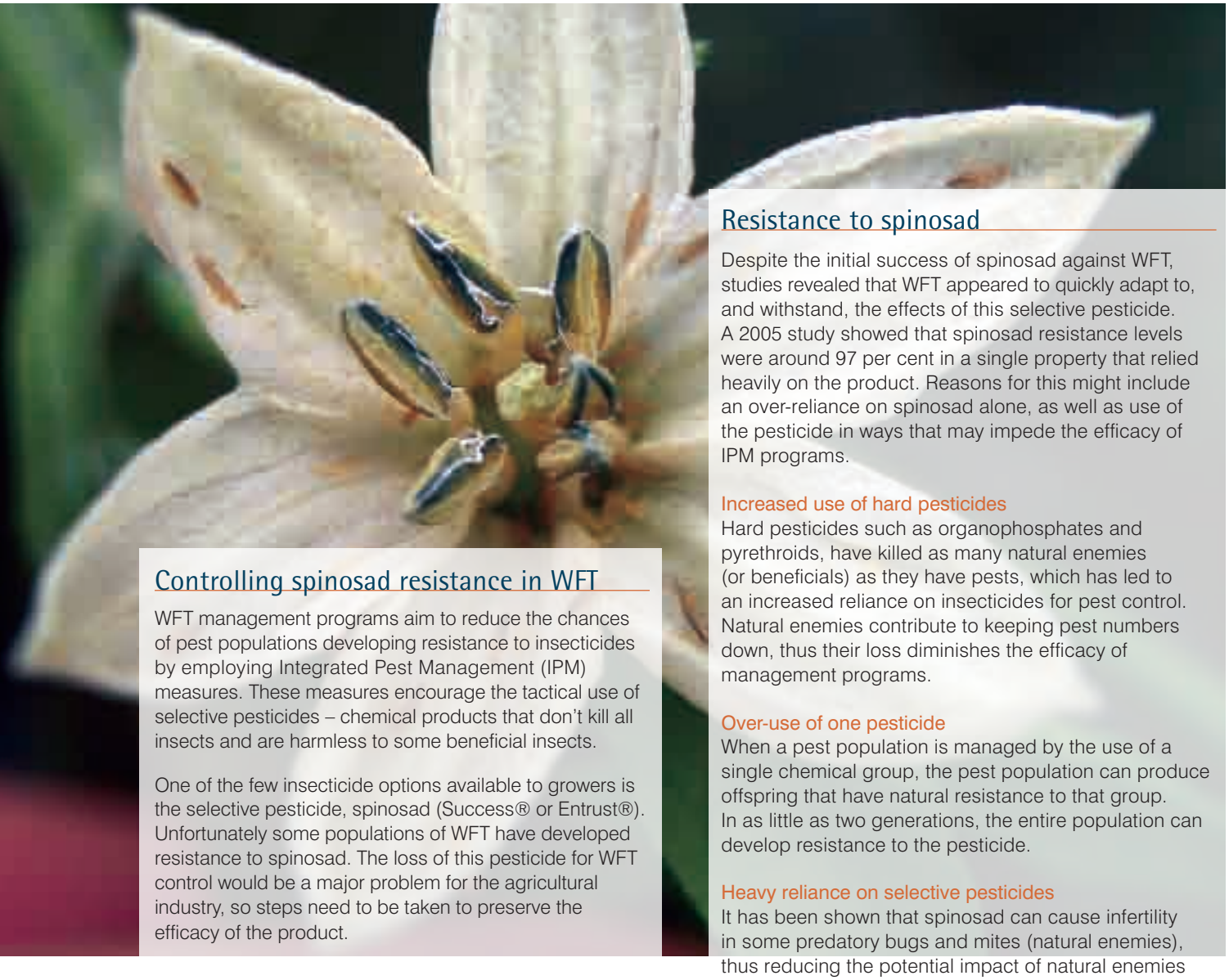
Controlling Spinosad Resistance with WFT

Western Flower thrips (WFT), *Frankliniella occidentalis*, is a devastating and hard pest to manage in crops in many countries around the world. It can carry and transmit the destructive Tomato Spotted Wilt Virus (TSWV) between host plants, and also cause direct feeding damage in some crops including cucumber, lettuce and capsicum. WFT is considered to be threatening as it has developed resistance to an array of insecticides and is known to build up resistance rapidly.

The bottom line

- Over-use of pesticides, for controlling WFT in crops like capsicum, cucumber, herbs and lettuce can ultimately lead to resistance to the pesticide spinosad. One of the few chemicals compatible with integrated pest management (IPM).
- To prevent WFT becoming resistant to spinosad, growers need to implement certain spraying techniques, such as the three-spray strategy and closely monitor their crops for signs of spinosad resistance.
- Research has shown that with the use of other IPM practices and techniques, WFT and resistance management can be reduced and managed effectively.



Controlling spinosad resistance in WFT

WFT management programs aim to reduce the chances of pest populations developing resistance to insecticides by employing Integrated Pest Management (IPM) measures. These measures encourage the tactical use of selective pesticides – chemical products that don't kill all insects and are harmless to some beneficial insects.

One of the few insecticide options available to growers is the selective pesticide, spinosad (Success® or Entrust®). Unfortunately some populations of WFT have developed resistance to spinosad. The loss of this pesticide for WFT control would be a major problem for the agricultural industry, so steps need to be taken to preserve the efficacy of the product.

What is spinosad?

Spinosad is a pesticide that is derived from fermented material of the natural soil micro organism *Saccharopolyspora spinosa*.

Research has shown that spinosad is capable of killing more pests than it does natural enemies, which means there is reduced disruption to the biological control mechanism provided when natural enemies kill the pest. For instance, spinosad kills caterpillars and thrips, but not some of the key beneficial insects such as nabids and ladybeetles, which makes the pesticide especially useful in an IPM program.

Spinosad does kill wasps, so it needs to be used with care in cropping systems where these parasitoids are just as important as natural enemies. Growers who practise IPM for processing tomatoes in the Riverina area of NSW often control Helicoverpa caterpillars via *Trichogramma* wasps that parasitise the *Helicoverpa eggs*. Growers should consider the impact of spinosad killing the egg parasitoids, before using spinosad.

Resistance to spinosad

Despite the initial success of spinosad against WFT, studies revealed that WFT appeared to quickly adapt to, and withstand, the effects of this selective pesticide. A 2005 study showed that spinosad resistance levels were around 97 per cent in a single property that relied heavily on the product. Reasons for this might include an over-reliance on spinosad alone, as well as use of the pesticide in ways that may impede the efficacy of IPM programs.

Increased use of hard pesticides

Hard pesticides such as organophosphates and pyrethroids, have killed as many natural enemies (or beneficials) as they have pests, which has led to an increased reliance on insecticides for pest control. Natural enemies contribute to keeping pest numbers down, thus their loss diminishes the efficacy of management programs.

Over-use of one pesticide

When a pest population is managed by the use of a single chemical group, the pest population can produce offspring that have natural resistance to that group. In as little as two generations, the entire population can develop resistance to the pesticide.

Heavy reliance on selective pesticides

It has been shown that spinosad can cause infertility in some predatory bugs and mites (natural enemies), thus reducing the potential impact of natural enemies feeding on WFT.

Therefore, it is essential that spinosad is used in moderation, as part of an overarching IPM program. The use of selective pesticides as part of an IPM strategy increases the efficacy of pest control by also allowing natural enemies to help reduce pest numbers.

Integrated pest management (IPM)

IPM is crucial for mitigating the impact of pesticides on the environment and the health and safety of humans, as well as the unwanted effects that broad spectrum insecticides have on natural enemies.

Strategies may be biological, cultural, physical and chemical. The benefits of these multiple approaches are: a more hardy system of crop protection against pests; additional ways of mitigating environmental damage; encouragement of beneficials; encouragement of the tactical use of pesticides; and the encouragement of crop monitoring so that potential problems are either noticed early or avoided completely.

The recommended IPM strategy for WFT focuses largely on cultural methods. Growers can take the following steps as part of an IPM strategy targeting WFT:

- Ensure only seeds and plants that are pest and disease-free are brought on to the production site
- Clear weeds or unnecessary crops before planting new crops to prevent WFT populations from breeding on the weeds and then moving into the crop
- Manage on-farm hygiene which includes the removal of flowering weeds that can act as habitats for WFT
- Use fine thrips-grade mesh covers and install double doors in greenhouses to prevent entry of WFT

Other IPM strategies for WFT control encourage growers to:

- Harness natural predators to feed on the pest
- Cultivate crops such as oats, as there is some evidence that this may provide a natural habitat for predators
- Grow TSWV-resistant varieties of vegetables, where available

All pest control programs begin with identifying the nature and extent of the problem by monitoring the crop. Growers need to have a thorough knowledge of the pest to adopt a detection program to prevent or combat an infestation. In the case of WFT, growers need to be able to identify the insect, and also recognise the symptoms of TSWV in their crops.

WFT lifecycle

WFT can produce several generations a year. In greenhouse crops, WFT can reproduce up to 15 generations in one year. The insect has a four-stage lifecycle, which can take between 15 and 44 days to complete, depending on the temperature.

Stage 1 **Egg** → Around 20 to 40 eggs are laid, generally distributed under the surface of plant material. Occasionally eggs may be laid within closed flower buds.

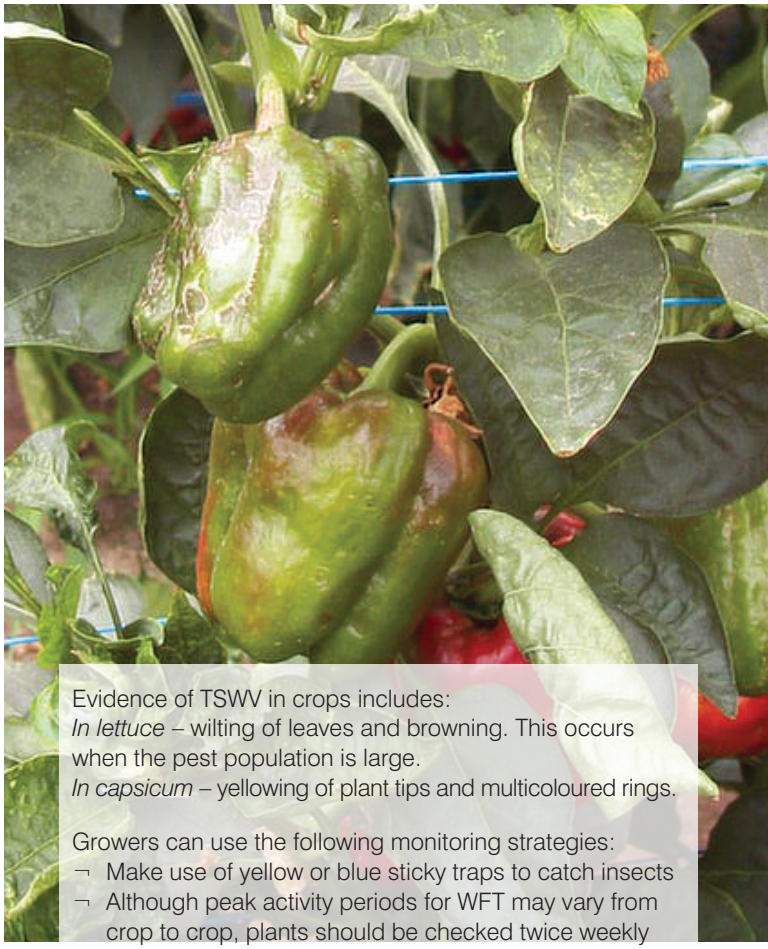
Stage 2 **Larvae** → The eggs hatch into wingless larvae, then form into pupae.

Stage 3 **Pupae** → Pupae can be found in the soil and on the plant throughout the WFT life cycle.

Stage 4 **Adults** → The adults hatch from the pupae and feed on leaves, flowers or stems. Adults are flat and narrow and about 2 millimetres in length. Males are pale yellow while the females are yellow to pale brown with a light edging on their abdomens. There are usually more females than males, and the females do not need to mate to produce eggs.

How to identify WFT and TSWV

Discolouration of leaves and indentations where feeding has occurred is evidence of a WFT infestation in a crop. Also:
In cucumbers → curling of the cucumber, scarring on fruit and silvering on leaves.
In lettuce → scars on the leaves.
In capsicum → there might be a fleshy reaction in areas where eggs have been laid, including silvering on surface, and fruit scarring.



Evidence of TSWV in crops includes:
In lettuce – wilting of leaves and browning. This occurs when the pest population is large.
In capsicum – yellowing of plant tips and multicoloured rings.

Growers can use the following monitoring strategies:

- Make use of yellow or blue sticky traps to catch insects
- Although peak activity periods for WFT may vary from crop to crop, plants should be checked twice weekly during this time. In late spring, field crops should be inspected weekly, while in the winter period in temperate regions, fortnightly inspections will usually be adequate. Good records of scouting should be kept.
- Inspect the entire plant. WFT are adversely affected by temperature ranges beyond their degree of tolerance. For instance, in cold winters, adult insects may shelter in flowers and leaf buds.
- Keep an eye out for natural enemies of WFT, as they may indicate the presence of the pest. Natural predators include a native mite that has been beneficial for the control of WFT in greenhouse crops.
- WFT can be hard to distinguish from other thrips. To ensure you have correctly identified WFT, ask for assistance from your state department of agriculture or primary industries.

If WFT is detected and populations are increasing or TSWV symptoms are visible, strategic control including resistance management strategies are recommended.

Resistance management

Insecticide resistance management (IRM) is essential for IPM programs that draw on the use of selective pesticides. This involves using insecticides and pesticides in a way that discourages the development of resistance in pests. IRM comprises a multifaceted approach to controlling pest responses to chemicals, including reducing chemical use, not relying on a single pesticide and encouraging rotation of pesticide products.

Growers can ensure effective pesticide coverage, by adhering to the following spray application guidelines:

- ¬ Use well maintained, regularly calibrated sprayers. Sprayer coverage should be checked with water sensitive paper and then modified, if necessary, to maximise coverage of both upper and lower leaves
- ¬ Spray nozzles should produce droplets at around 100-135 microns (very fine to fine spray)
- ¬ Use clean water and ensure that the pH is 6.5-7.5
- ¬ Use the correct surfactant
- ¬ Ensure the application timing is correct and follow the 'three-spray strategy' (see Dr Grant Herron's recommendations below on the 'three-spray strategy')

Making the most of spinosad in WFT control

To effectively use spinosad pesticides, growers should adhere to the following program:

- ¬ Spray in the evening or early morning, as direct sunlight impedes the efficacy of the pesticide
- ¬ Don't irrigate immediately, and wait 24 hours after rain to commence spraying
- ¬ Avoid high temperatures and keep the product away from direct sunlight when being stored
- ¬ Observe and adhere to directions for use and withholding periods (WHP) as advised on the label of the product for the specific crop. For instance, when using Success in cucumber and lettuce crops, a rate of spray coverage is 400 mL/ha, along with a WHP of three days, is advised
- ¬ Rotate spinosad pesticides with other recommended pesticides from a different chemical group
- ¬ Target WFT at the right stages

Dr Grant Herron, NSW DPI, recommends a three-spray strategy for effective management. In this plan, three sprays of the same pesticide are applied consecutively, at 3-5 day intervals when temperatures are above 20 °C or at 6-12 day intervals when temperatures are less than 20 °C, to target all the insects within a single generation. The first spray is used to kill larvae and adult WFT present at the time. The second spray is applied to kill adults hatched from pupae and larvae hatched from eggs. Research has shown that a third spray is required to target any remaining larvae and adults

If further application is necessary, the pesticide needs to be rotated with other recommended and available pesticides from a different chemical group. Further information on rotation can be obtained from the NSW DPI website, <http://www.dpi.nsw.gov.au/agriculture/horticulture/pests-diseases-hort/multiple/thrips/wft-resistance>.

Further reading and acknowledgements

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Image: Thrips in uncontrolled crops.
Cover image, WFT in zucchini flower; p.2 Thrips in capsicum flower; p.3 TSWV damage.

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