

	CONTROLLING KEY PESTS IN VIRGINIA GREENHOUSES	
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**HOW TO IMPROVE PEST CONTROL
IN GREENHOUSE CROPS**

And save a lot of money and time !

This booklet covers the following topics to explain why this is needed and how it can be done:

1. Background to the problem

- ❖ A change is needed
- ❖ Insecticide resistance is a big problem
- ❖ Managed Change is Effective

2. Steps for improving your pest control program

- ❖ Following a management cycle
- ❖ Check and correct weaknesses in your insecticide use
- ❖ Improve farm hygiene
- ❖ Use regular crop monitoring
- ❖ Pay attention to greenhouse design
- ❖ Consider the role of beneficial insects

3. How to get more information on pests and effective chemical use

A CHANGE IS NEEDED

The Northern Adelaide Plains is a economically significant, horticultural region, that has a concentration of major pest problems affecting most growers. This can be a costly situation because of high pest control expenses and frequent reductions in marketable harvest due to insect pest and disease damage. In fact a modest estimate for costs and losses to the industry each year is about \$25m and up to \$80m in a severe season.

The problems at Virginia are due to a combination of factors:

- high pest pressure emerging from poorly managed weeds and old crops
- failure to control all these pests because of pesticide resistance and a lack of knowledge about the most effective ways to use pesticides
- poor timing, assessment and improvement of pest management decisions because very few growers are regularly monitoring pest and disease levels in their crops
- too few growers have realised the benefit of a range of non-chemical strategies to reduce pest pressure and control pests, or lack the support to implement them

INSECTICIDE RESISTANCE IS A VERY BIG ISSUE

Most growers at Virginia are familiar with the problem of pests becoming 'immune' to insecticides. This is called insecticide resistance. There is a long history of insecticide resistance issues with pests such as Western Flower Thrips (which spreads Tomato spotted wilt virus) and Greenhouse whitefly. Two Spotted Mites (or 'spider mites') have now also become resistant to Vertimec on many farms. Other potential resistance problems are lurking on the horizon with pests like Bronze Mites that can cause problems in tomatoes and Broad Mites in capsicums. There is a new disease affecting many tomato crops interstate called Yellow Leaf Tomato Virus that is spread by whitefly. Green peach aphids can be an issue for capsicum growers under some circumstances.

If an insecticide (or fungicide) is not rotated properly with other insecticides from a different chemical group, or is otherwise not used according to the label rates and conditions, high levels of resistant insects are likely to develop. Once resistant insects breed and reach a critical level they will become uncontrollable when weather conditions are suitable – which can be year round in a greenhouse !

Once pests are resistant to an insecticide it is usually not possible to use that insecticide again as a reliable control measure. It becomes a lost weapon in the fight against pests. There are some exceptions:

1) Where a farm is far enough away from other farms with resistant pests a grower may manage to prevent the onset of critical levels of resistance in their pest populations if they have a very well run pest control program with effective chemical rotations.

2) Sometimes when the insecticide has not been used for a lengthy period of time the resistance levels drop enough to start using the chemical again on a less frequent basis and rotated with insecticides from a different group. This strategy may be possible in the case of Vertimec resistance in Two Spotted Mites. However resistance will return very rapidly if the chemical is overused or otherwise abused again.

Resistance is not however the only cause of pest control failure and may not even be the most common. This booklet looks at all of the likely causes and shows how to identify and deal with them.

Without major change the current situation will ensure that a large number of growers remain trapped on an expensive, and often ineffective, insecticide treadmill as they battle to protect their crops. In fact resistance problems are likely to increase.

MANAGED CHANGE IS EFFECTIVE CHANGE		
	<p>These improved pest management practices may create some extra cost at first, but the gains more than outweigh the losses very quickly. This is not hard to see when we know that between \$25m and \$80m is going down the drain every year. Quite a few growers have already proved this for themselves and highly recommend these practices to other farmers as the following quotes demonstrate:</p>	

Quotes etc. re what has been changed

- ❖ *Emmanual*
- ❖ *Others*

These improved pest management practices have been vital for these growers to maintain the high standards of produce that Virginia growers aim to meet market demand. Information in this booklet describes how growers can deal with these issues and includes useful information about key greenhouse pests.

Implementing these practices will benefit each grower and add to an overall regional reduction of pest pressure. If all of the region's farms implement an appropriate pest management program pest levels will probably reduce by at least half in the first year and continue to drop steadily each year after that for some time. Disease levels, especially tomato spotted wilt virus and any other diseases spread by insects, would reduce to the same degree. It is obviously worthwhile co-operating to achieve this goal as soon as possible.

So to find out how to save a lot of money and time you may be spending on pests and diseases take a close look at the information that follows. If the information is unclear or incomplete for your needs seek expert advice from an agronomist or other expert advisor.

	KEY PEST CONTROL STRATEGIES	
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STRATEGIES TO MANAGE INSECT PESTS EFFECTIVELY

If you would like to improve pest management results and cut costs it is important to identify areas where effective changes and improvements can be made to your pest control program.

This section contains some information that can be used to help you go through this process and come out with some clear decisions about what needs changing.

A good Pest Management program includes a range of management areas working together as follows:

- farm hygiene, crop planning and greenhouse design features are used to reduce pest pressure and the need for insecticides wherever possible
- a top notch spray program ensures that when insecticides are called for they are effective, at minimum cost and are used in a way that prevents insecticide resistance and unnecessary loss of beneficial insects from the farming system
- routine pest monitoring improves decision making about when to take (or withhold) action with insecticides, and measures the effectiveness of any action taken
- a good understanding of the presence and effect of beneficial insects and the impact of chemicals on them enables growers to conserve the natural enemies of their pests

Integrating these practices enables more reliable pest control with minimum reliance on chemicals ! When they were implemented in the Virginia farm trials pest control was improved to very acceptable standards in commercial crops on a range of vegetable and herb farms. These growers reduced their chemical use by up to 75%, and achieved better crop protection at the same time. It was often found that spray programs had typical weaknesses that had to be addressed before sustained control of key pests like WFT could be achieved ,such as, resistant chemicals, chemicals not compatible and spray coverage. Now these growers are in a much better position to conduct well-managed trials of biological control agents for WFT whitefly, mites and other pests.

STEPS IN IMPLEMENTING A PEST MANAGEMENT CYCLE FOR YOUR CROP

- ❖ Get hold of diagnostic information about your key pests and diseases
- ❖ Take action to reduce unnecessary pest and disease pressure
- ❖ Develop and implement a crop monitoring program
- ❖ Make sure you know enough about the effective use of pesticides
- ❖ Consider supporting biological control agents in your crop

An example based on managing western flower thrips is provided below



1. GET INFORMATION ON KEY PESTS AND DISEASES:

PEST FACT SHEETS

Below is a list the key pests in Virginia greenhouses. For more information about controlling these contact Stacey Brouwers at the VHC, or your preferred retailer for:

- ❖ chemicals to control and rotate to reduce resistance, that have permits and exemptions
- ❖ a detailed information package on effective chemical use
- ❖ more information about these pests and major diseases such as powdery mildew and botrytis

1. Western Flower thrips

2. Greenhouse whitefly

3. Two Spotted Mites

4. Broad Mite

5. Bronze mite

6. Green peach aphid

2. PROTECT YOUR CROP FROM ATTACK

3. MAINTAIN CROP HYGIENE:

Many things are very effective in reducing the threat from pests and diseases:

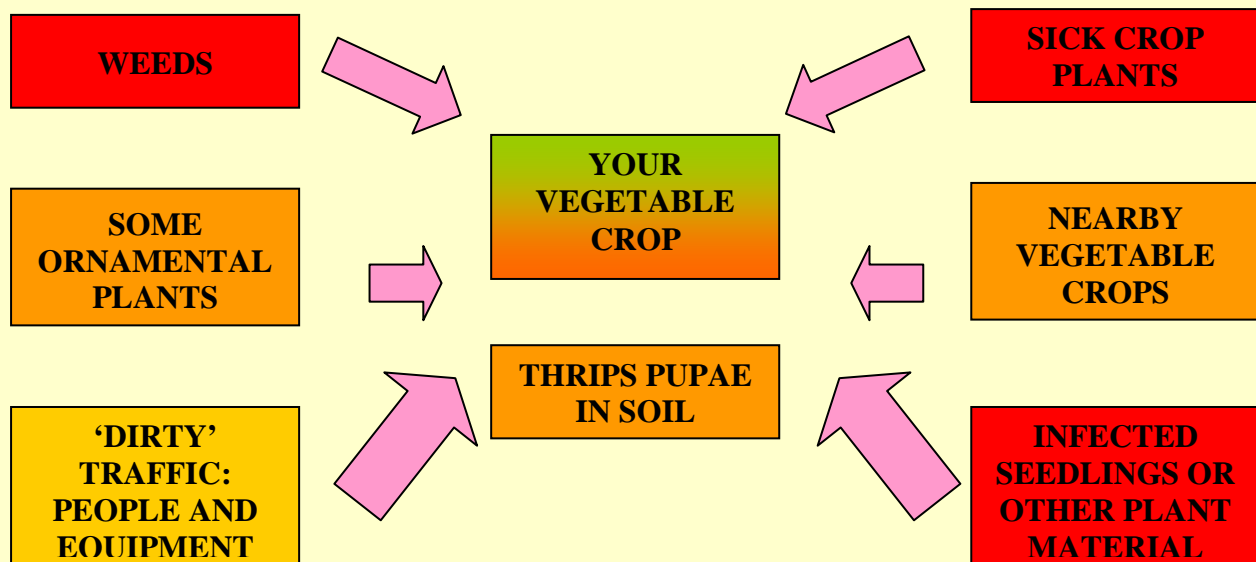
- ❖ Weed control
- ❖ Removing sick plants in the crop
- ❖ Removing old crops promptly
- ❖ Following greenhouse design and procedures to reduce pest entry
- ❖ Selecting plant varieties for resistance/tolerance to damage where possible
- ❖ Timing and placing crop plantings to reduce exposure to threats
- ❖ Cleaning up the region farm by farm

Farm Hygiene Map

GUIDELINES FOR GOOD CROP HYGIENE

TSWV = Tomato Spotted Wilt Virus
WFT = Western Flower Thrips

PROTECT YOUR CROPS FROM THESE THRIPS AND VIRUS THREATS:



MANAGEMENT STRATEGIES FOR REDUCING MAJOR THREATS

- *Clean up weeds regularly, especially before flowering. If already flowering in spring, summer or autumn you should use pesticide with weed control or pests will move to crops*
- *Do not leave old crops standing or dump crop waste near to new crops.*
- *Check regularly for TSWV infected plants and remove them, preferable by placing a bag over them before pulling them out. Dispose of well away from the crop.*
- *Do not move people and plants from thrips and virus infested crop areas to clean areas*

OTHER FACTORS TO CONSIDER

- *Restrict vehicle access to cropping areas*
- *Be aware that bright yellow, white, bright blue and purple colours attract thrips*
- *Share your management concerns and strategies with your neighbour and friends*
- *Support by example a clean-up policy for the Northern Adelaide Plains*

BROADLEAF WEEDS MEAN TROUBLE

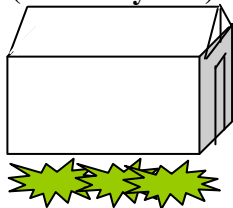
Weeds create harm for your crops by breeding western flower thrips and other pests. They also host tomato spotted wilt virus that thrips will carry into your crop !

Protect your crops by clearing weeds to:

- *reduce thrips*
- *reduce virus*
- *reduce other pests and diseases like white fly*

WHEN CLEARING WEEDS WATCH OUT FOR:

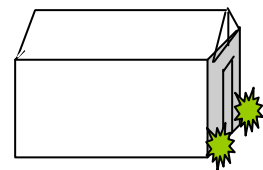
1. Weeds too close
(10m away best)



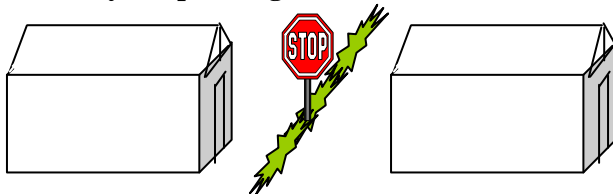
2. Thin rows of weeds up
against greenhouse



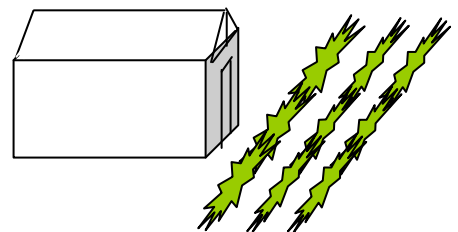
3. Weeds at doorway



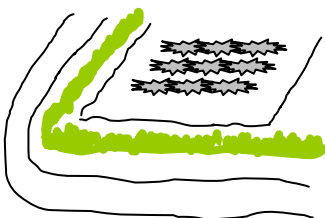
4. Weed banks which staff could walk through
and carry thrips into green house on clothes



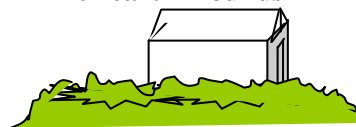
5. Weeds in vehicle tracks



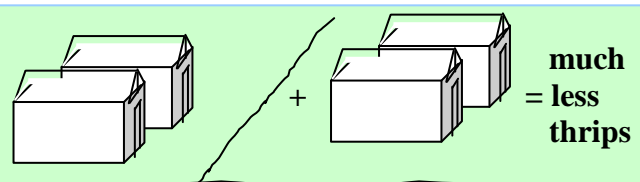
6. Weed rows along road verges



7. Weeds in difficult areas to clear
like earth mounds



WORK TOGETHER WITH YOUR NEIGHBOURS !



MAKE LIFE HARD FOR WESTERN FLOWER THRIPS

Clear Those Weeds before They Seed !

- ◆ Clear flowering weeds **NOW** while it's easier
- ◆ Once they flower they become a thrips plague factory
- ◆ No weeds means less thrips in spring & less weeds to clean up next year

- ◆ Clear At least 10m around every glasshouse or crop – the whole farm is even better !
- ◆ Flowering weeds on or near to your farm are where Western Flower Thrips breed up in spring
- ◆ Many flowering weeds also hold Tomato Spotted Wilt Virus for the thrips to carry onto your crops
- ◆ Many weeds have very small flowers, but still contain thrips, including ground covering weeds
- ◆ Generally grasses are fairly safe, but can provide thrips with temporary homes

When growing greenhouse crops then greenhouse design is very important

BETTER GREENHOUSE DESIGN

can give you

Greatly Improved Control of Thrips, Virus and Whitefly

Farm trials at Virginia have demonstrated that improved greenhouse design can lead to much better control of thrips, virus and whitefly using almost no chemicals.

To get real benefits from your investment it is important to consider the following things before improving an existing greenhouse or designing a new one:

- Use the fine 'anti-virus mesh' which is now much cheaper. This can cause an increase in humidity and more plant disease so you may need to improve greenhouse ventilation
- You should build a double entry door to reduce the entry of thrips and whitefly
- You should include an easy system for raising and lowering plastic sheets over the mesh
- If fine mesh is added to old greenhouses they may still have cracks and holes, e.g. along the edges of corrugated fibreglass sheets, where thrips will still get in and then build up

EVEN WITH AN IMPROVED GREENHOUSE YOU WILL STILL HAVE TO MONITOR AND CONTROL PESTS SO THAT THEY CANNOT BUILD UP AND CAUSE DAMAGE.

Before you spend your money consider getting the most from your improvement \$\$'s by investing in other changes like:

- Better climate control from increased ceiling height, circulation fans. overhead misting and heating
- Selecting a different trussing system to harvest more efficiently with extended crop life
- Changing plant/row spacing to increase productivity and ease crop care and harvest labour
- Putting in a hydroponic system

For expert advice on greenhouse design contact

- Your local consultants, retailers of greenhouse materials and greenhouse specialist companies
- The Australian Hydroponic Greenhouse Association produce an industry publication ('Soilless Australia') specialising in greenhouse technology.
Contact Saskia Blanch on 02 9939 5992
- Internet sites for greenhouse technology (eg NSW at: www.agric.nsw.gov.au/reader/15441)

4. PLAN AND IMPLEMENT A MONITORING PROGRAM:

Monitoring needs to be based on a realistic, but effective system suited to your farm needs.

Firstly you must be clear about:

- ❖ What pests (and diseases) you are monitoring for
- ❖ The decisions you want to be able to make using the monitoring results
- ❖ The information you need to collect to make these decisions

Then you need a system that enables you to:

- ❖ Collect the information easily that you need
- ❖ Use it to make decisions

You must also decide if:

- ❖ You will manage all of this yourself, include staff, or use a consultant

Pest Monitoring Will Save You Money

Routine spraying without checking pest levels or spray effectiveness is very hit and miss and is likely to result in increased levels of resistance where WFT and whitefly are a problem. Routine spraying is also likely to take more time and money than necessary and give poor results a lot of the time.

Effective pest management depends on identifying changes in pest (and beneficial) insect activity in and around the crop in time to keep damage levels low. Crop monitoring is the only way to gather information and determine the best response to changes in insect levels, including the option of NOT spraying. It is the backbone of reliable crop protection whether using chemical or non-chemical strategies.

Setting up a suitable monitoring program is probably the most complex and time-intensive component of an IPM program, but it is an essential risk management tool for protecting all other investments made in the business. If the initial set-up is done well and then fine-tuned and maintained it quickly becomes highly effective and easier to run.

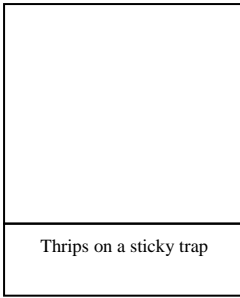
Simply introducing a good monitoring program will cut crop losses and unnecessary chemical costs and identify hidden weaknesses in the pest control program. Good crop monitoring is absolutely essential if you want to also incorporate beneficial insects into your pest control program.

The notes that follow describe some of the common methods (yellow sticky cards and plant checks) that can be used in a monitoring system and how the information gathered can be used to make decisions, especially for Western Flower Thrips.

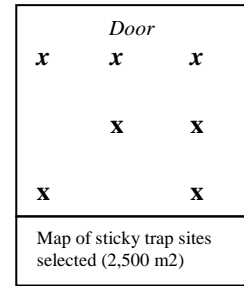
Quotes from case histories:

- ❖ Emmanuel
- ❖ Jeff/others

YELLOW STICKY TRAPS OR CARDS



Sticky traps are useful as a way of keeping an eye on flying pests like thrips, whitefly and aphids. They attract these insects because of their colour in the same way that white and yellow flowers do. Thrips are attracted to yellow, blue, and even white. Yellow traps attract thrips, whitefly and aphids. They are very useful for detecting the arrival of these flying insects in the cropping area and can also help to keep an eye on pest levels in the crop. They are also a useful way of



sending samples away for identification of thrips species etc. However they do not give a complete picture of pest dynamics in the crop. Adult insects may settle into the crop after flying in and juvenile non-flying stages (eggs, pupae and possibly larvae if coverage is not good) may survive spray applications but will not show up on the traps.

How to use Sticky traps

Sticky traps should be changed or checked at least weekly. They need to be placed just above the growing tips of the plants to catch insects hovering above them and to avoid getting stuck and lost in the crop

Sticky trap in cucumber crop just above growing tips (15cm)



Sticky Trap over seedlings (5cm above)

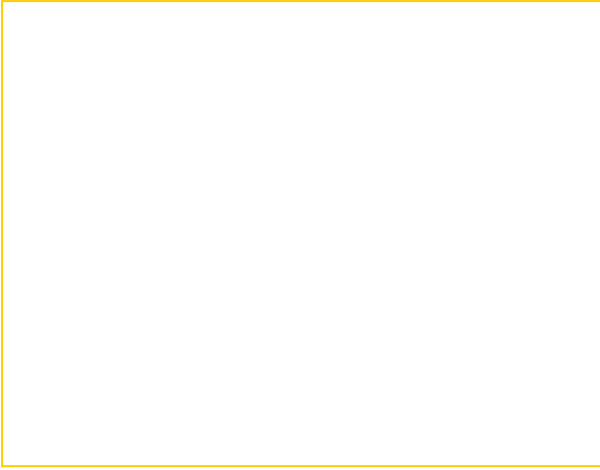


How do you check the insects on the cards ?

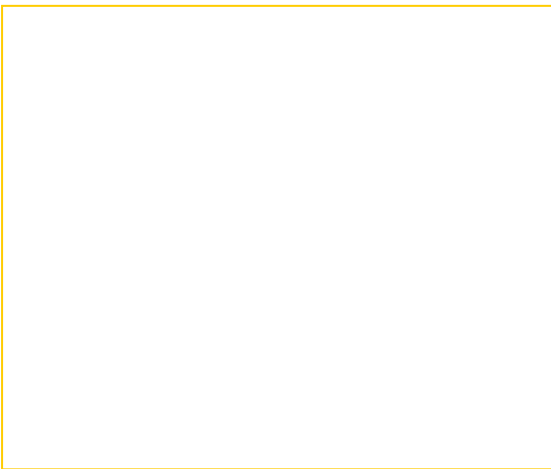
Sticky traps can be inspected with the naked eye (to get a rough count of the number of different pests), with a hand lens (to be certain how many thrips, whitefly etc), with a microscope (to see what species of thrips or other pests are present). It is important to note and record changes and, if concerned, send traps away for insect identification for Western Flower Thrips.

Changes in pest numbers for different species can be estimated providing important information about the level of threat to your crop and whether or not action is required.

Whitefly on a sticky trap



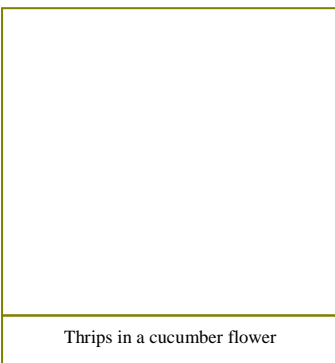
Thrips on a sticky trap



WALKING THROUGH AND CHECKING CROP PLANTS AND WEEDS

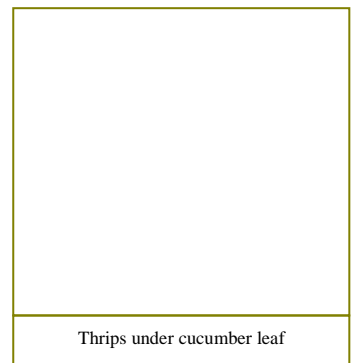
Sampling flowers and leaves in the crop can tell you much more than a sticky trap including:

1. The presence or absence and levels of non-flying juvenile stages (eggs, larvae, pupae)
2. The presence/absence and levels of non-flying adult insects (mites snails etc.)
3. The early stages and extent of pest damage



Thrips in a cucumber flower

This information is much more powerful for assessing pest levels, accurately predicting trends and checking the effectiveness of control measures. It is essential for making decisions and following up on the results. It will also reveal a lot about the behaviour of pests and beneficial insects that will help you to manage problem pests. Depending on the pest, where it feeds, hides and breeds

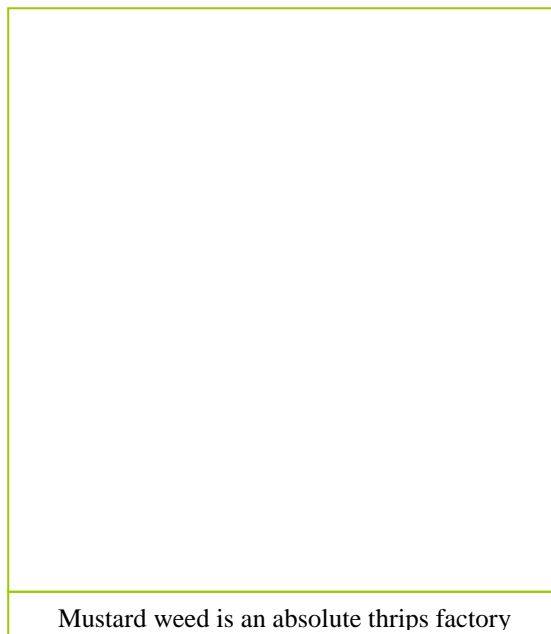
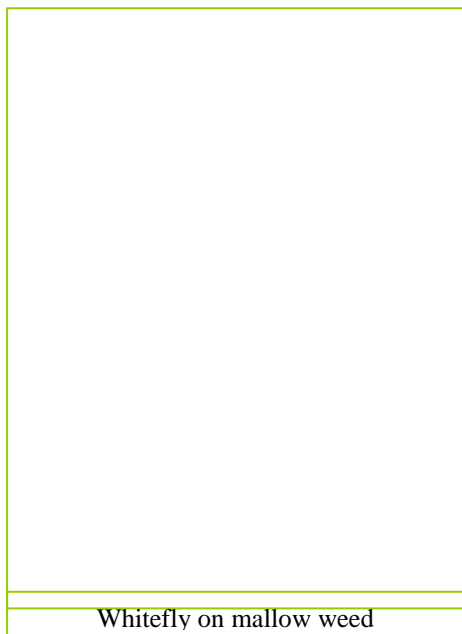


Thrips under cucumber leaf

you will need to check flowers, leaves, fruit etc. The pattern, frequency and level of sampling depends on the crop, pests of concern and beneficial insects of interest and the time of year.

Checking weeds close to the crop for pest and disease levels

Weeds near to your farm/crop will build up large numbers of pests in spring. Inspecting the weeds can keep you in touch with how the local pest pressure is building up. Better still remove the weeds before the pests build up on them !



5. MAKE SPRAY PROGRAM IMPROVEMENTS

The effective use of insecticides is essential for sustainable pest control so you must ensure that the following things are done correctly:

- ❖ Appropriate selection of the legal chemicals for the job
 - ❖ Follow all requirements of effective insecticide application, taking careful note of the different application requirements of some chemicals
 - ❖ Manage the threat of resistance by proper rotation of chemical groups
 - ❖ Check pest control results as soon as safely possible after application
- ❖ **Appropriate selection of the legal chemicals for the job**

Suitable chemicals

When choosing a chemical several factors are important – not just price alone. Is it effective against that pest ? Will the with-holding period or other safety issues fit with your harvesting schedule ? Can it cause any damage to the crop ? Will it kill beneficial insects you are trying to protect ? Do you know how to use the chemical to its full effectiveness ? Do you have the right equipment and application methods for that chemical ? Is it legal to use it on your crop ?

Legal chemicals

There are different legal forms of permission to use an insecticide. Here are some definitions to clarify their meaning.

1. Registered Chemicals:

Before they can be supplied distributed or sold anywhere in Australia an agricultural or veterinary chemical product must be registered for use by the APVMA by way of a product label. Variations to the formulation of a currently registered product must also be approved, as must proposed new patterns of use and new labels. This includes changes to the current use pattern or the products claims. All agvet products can only be used as per label instructions. Find registered products at: <http://services.apvma.gov.au/PubcrisWebClient>

2. Off Label Permits:

Chemicals shall be used in accordance with relevant State Legislation for off label use. Once the APVMA has registered a product for use, the states and territories are responsible for control of its use. Due to differences between states in their regulatory requirements not all uses are bound by permits to use chemicals off label but all uses must comply with the Food Standards Code and abide by a maximum residue limit(MRL) for the chemical in the code. This allows growers in to use products in compliance with food standards and quality assurance(QA) systems required by their markets.

In general an “Off-Label” permit allows a person or an organisation to use registered Agvet products in situations that would otherwise be an offence either against certain provisions of the federal legislation (Agvet Code) or of appropriate State control of use legislation. Permits can only be issued, in response to an application for:

- a minor use
- an emergency use
- research purposes.

Generally, permits to allow off-label and emergency uses can be viewed as additional or an addendum to the use pattern or instructions on an approved label Find current permits at: <http://www.apvma.gov.au/permits/permits.shtml>

6. SPRAY IF PESTS TOO HIGH

❖ **If your crop monitoring tells you the pests have reached a level where spraying is required then follow all requirements of effective insecticide application**

Prepare correctly and thoroughly for spray application

- *Select an insecticide from the right chemical group according to your chemical rotation plan*
- *Note all important legal and safety requirements (e.g. protective gear, re-entry time and with-holding period from spray to next pick)*
- *Examine and closely follow all guidelines for effective use of the chemical (e.g. use of a wetting agent if required, avoidance of high temperatures etc.)*
- *Ensure you are mixing the correct rate and volume for the crop and pest*
- *Avoid using any other additives in the tank mix unless certain that it is a safe and effective combination*
- *Mix and apply the chemical promptly, at the best time of day for a good kill - usually morning or late afternoon*
- *Check pH of the mixture before adding the chemical to make sure it is between 6.0 and 8.0 (6.5 is best)*
- *Find out how long it should take the chemical to work (minutes or days)*

Apply the chemical to achieve good coverage by

- Making sure the spray equipment is calibrated to deliver the correct volume for the crop area and growth stage and that the jets and pressure setting are delivering the right droplet size and penetration to get good coverage
- Making sure that your movement of the spray nozzles is achieving good coverage from top to bottom, between plants and under leaves.
- Avoiding run off with most chemicals as this often leads to leaf burn and can actually leave less chemical on the leaf for insects !

❖ Manage the threat of insecticide resistance

By following these procedures you will help to reduce the risk of increasing the level of resistant insects in the pest populations through:

- Rotating the chemical according to your chemical group rotation plan
- Making sure that the chemical is correctly mixed and used under the right conditions (additives (+/-), temperature, pest threshold level etc.)
- Making sure that you get good coverage to get the maximum kill
- Not spraying more often than you need to

7. CHECK PLANTS AFTER SPRAYING

❖ Check effectiveness of the spray application

You must check the effectiveness of the spray application by comparing before and after spray pest numbers:

- Check fruit flowers for a comparison of pest numbers in 1-3 days depending on how long the chemical takes to work
- Check sticky traps twice over the next week for pest build up (at 2 and 5 days)

8. GET EXPERT ADVICE ON PERSISTENT PROBLEMS

Advice on chemical permits and chemical use: <ul style="list-style-type: none">❖ VHC 8282 9200 (Stacee Brouwers)❖ Your preferred reseller❖ APVMA: http://www.apvma.gov.au/pubcris/subpage_pubcris.shtml	Advice on using beneficial insects <ul style="list-style-type: none">❖ Biological services 8584 6977❖ Commercial consultants❖ SARDI Tony Burfield (0401 120 857)
Advice on spray coverage <ul style="list-style-type: none">❖ Your preferred reseller❖ Commercial consultants❖ ChemCert course – via VHC 8282 9200	General agronomy <ul style="list-style-type: none">❖ VHC 8282 9200 (Stacee Brouwers)❖ Your preferred reseller❖ Commercial consultants
Insect and disease diagnostics: <ul style="list-style-type: none">❖ Your preferred reseller❖ Commercial consultants❖ SARDI (Insect Tony Burfield 0401 120 857, Disease BarbaraHall ??)	Resistance testing <ul style="list-style-type: none">❖ SARDI Tony Burfield (0401 120 857)

9. INTEGRATE BIOLOGICAL CONTROLS INTO YOUR PEST MANAGEMENT STRATEGY

- ❖ Learn about wild and commercially available beneficial insects that will eat your pests
- ❖ Improve your monitoring program to include beneficial insect counts vs pests
- ❖ Modify your use of chemicals to protect beneficial insects
- ❖ Look at other ways to encourage beneficial insects to stay on your farm, e.g. suitable host vegetation