Rearing Orius for vegetable industry

Lachlan Chilman
Manchil IPM Services

Project Number: VG08186

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Investigations for mass rearing of *Orius armatus* for controlling Western Flower Thrips in the Australian Vegetable Industry

Project Number VG08186

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Lachlan Chilman

Manchil IPM Services Pty Ltd

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The main purpose of the project was to develop a mass rearing system for *Orius armatus* so that it could be used by the vegetable industry. Additionally, the project aimed to determine if *Orius armatus* will survive and breed in capsicum crops and to trial a pilot IPM program for commercial capsicum growers around Australia that will succeed in controlling all pest insects and mites.

This publication is the Final Report for HAL Project Number VG08186, Rearing *Orius* for the Australian Vegetable Industry.

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Contents

Media Summary

Integrated Pest Management (IPM) is a strategy used to control pests. It is usually adopted when the conventional approach of applying pesticides has failed. This project was initiated because of the commercial failure of a pesticide –based strategy. We proposed using an IPM approach which involved a primary control based on biological control agents (Orius) with support from cultural (management) techniques and only strategic support from pesticides.

The term IPM (Integrated Pest Management) has been much abused over recent years, and has been given to a range of tactics such as monitoring of pests before spraying, or combined with rotation of pesticides but with no care for the biological control agents present in the crop. IPM is primarily based on a non-chemical preventative approach, focusing on naturally occurring beneficial insects and mites, with the release of mass produced beneficial insects and mites when required, and the use of strategic chemical products only when necessary as stated by Australia's only IPM logo accreditation scheme for growers. In some areas, Australia is lagging behind other western countries in the establishment of biologically based IPM. For example, Israel has over 2000 Ha of capsicums under IPM, compared to Australia's 10 Ha. In other areas, such as potato production, Australia leads the world in IPM.

Western Flower Thrips, *Frankliniella occidentalis*, (WFT) is one of the greatest pest threats to vegetable and flower production in Australia. The challenge for growers is how to effectively manage WFT, given that it has rapidly developed insecticide resistance so that now, Australian populations are resistant to all major classes of insecticides, including newer chemistries released only a few years ago. Controlling WFT with insecticides is not sustainable. WFT is currently able to survive all insecticide sprays that are currently legally available to growers in the crops studied in this project.

Extensive testing of the effects of a range of insecticides on *O. armatus* was undertaken in this project. The results showed that the neonicitinoid group of chemicals are the most toxic products. In particular imidacloprid remained in the soil residually and completely killed all *O. armatus* for several years after application. This has been observed by Manchil IPM Services in Virginia South Australia, Baldivis Western Australia and also in Israel.

Extensive commercial field trials were undertaken across Western Australia, Victoria, South Australia and Tasmania. All commercial trials had good results as measured by control of WFT, with some spectacular results. For example, some growers in WA went from 2 sprays a week to no sprays for the entire season for WFT and Two-spotted mites. Understanding the impact of a range of insecticides on the survival and breeding of *O. armatus* survival, as well as the environmental conditions across Australia, are critical in being able to use this biological control agent in an effective way.

At the start of the project Manchil IPM Services was producing 1000 *O.armatus* a week which could cover 500m^2 at 2 *O. armatus*/m$^{2.}$ The mass rearing of *O. armatus* was successfully achieved and weekly production increased to 400, 000 *O.armatus.* If released at 2 *O. armatus*/m^2 this would be enough to cover 20ha/week

Technical Summary

Chemical control of *Frankliniella occidentalis,* Western Flower Thrips (WFT) is difficult because it has developed resistance to all major classes of insecticides used for its control. IPM has not been undertaken in a major way in certain hydroponic crops in Australia due to the lack of key biological insects like Orius that have not been available until this time also there is currently a lack of pesticide residue testing on produce, and this allows growers to apply unregistered pesticides which would be detected earlier in overseas countries like Israel and Holland. The lack of IPM consultants in the field and the lack of IPM training undertaken by chemical resellers have reduced the adoption of IPM in Australia till this point and allowed calendar spraying as the main pest management tactic.

Most commercially produced beneficial insects and mites in the world are reared by private companies, and very little information is in the public domain. The aim of this project was to rear *O. armatus* in commercial quantities. This was undertaken investigating the preferred egg laying material for the insect, in this instance pole bean pods. This bean had to be grown by the insectary due to lack of supply of this variety domestically and the risk of insecticide residue on the beans causing contamination. Other parameters investigated were rearing densities, food sources, temperature, humidity and lifecycle. At the start of the project Manchil IPM Services was producing 1000 *O.armatus* a week which could cover 500m^2 at 2 *O. armatus*/m$^{2.}$ The mass rearing of *O. armatus* was successfully achieved and weekly production increased to 400, 000 *O.armatus.* If released at 2 *O. armatus*/m^2 this would be enough to cover 20ha/week. Difficulties in temperature, humidity, food source, egg laying material, and rearing cages were all overcome with trials conducted during this project.

Extensive testing of *O. armatus* to a range of insecticides was undertaken in the laboratory and in greenhouse grown crops. The results suggest that imidacloprid and thiamethoxam applied as soil drenches are highly toxic to beneficial insects. This has been reported from Australia by Cole and Horne, and Stuffkins (NZ). Other pesticides that are incompatible with a biologically based IPM in capsicums are fipronil, bifenthrin, dimethoate, methamidophos and spinosad. It is important to note that biological control alone performed better in controlling WFT in glasshouse trials than a combination of *O. armatus* released and fortnightly sprays with spirotetramat as can be seen from our trial work in the glasshouse. Biological control also outperformed thiamethoxam and imidacloprid applied as soil drenches. Azadirachtin and Eco oil had few adverse effects on beneficial insects, but gave little control of WFT.

Selected growers from Western Australia, South Australia, Victoria and Tasmania took part in commercial trials. In greenhouses; *Orius armatus*, *Aphidius colemani*, *Encarsia formosa*, *Phytoseiulus persimilis* and *Neosiulus cucumeris* were released throughout the capsicum crops.

O. armatus works well in controlling WFT in the summer months in Australia. However, it is limited in its application as it enters diapause between March and July (we would like to carry out more studies to determine which life stages it affects), is very sensitive to chemical applications, and is expensive to rear. The continued search for predatory species that do not enter diapause needs to continue all over Australia. *O. armatus* was found during routine monitoring of crops, so we are ever hopeful of finding more species. Feeding costs for *O. armatus* are high and make up more than 60% of the cost of production. Improved rearing containers that reduce labour are important to reduce costs, and alternate foods will continue to be investigated. Until we find and rear a more effective species, *O. armatus* will provide an important element in IPM programs in capsicums as capsicums are a major host of WFT and *O. armatus* survives in this crop due to its pollen source. Testing of soil or leaf samples for insecticide residue prior to releasing biological controls should help reduce potential establishment failures. For the long term viability of *O. armatus* Manchil IPM Services will need to target low tech capsicum growing regions like Bundaberg/Bowen in Qld, the Adelaide Plains area in SA, and Carnarvon in WA where there are significant plantings of Capsicums of both protected and unprotected cropping systems. Overall a larger market is required for the rearing of *O. armatus* to be economical. *O. armatus* information can be found on our website at www.manchilipmservices.com.au.

Introduction

Western Flower Thrips, *Frankliniella occidentalis*, (WFT) was first recorded in Australia in commercial flowers in Western Australia in 1993 (Malipatil *et al.* 1993) and was subsequently recorded in Queensland and New South Wales in 1994, South Australia and Tasmania in 1995 and in Victoria in 1996 (Baker *et al.* 2004).

WFT is a major pest of vegetables, damaging crops by feeding on leaves, flowers and fruit (Fig. 1) and by transmitting plant viruses, particularly tomato spotted wilt virus (TSWV). To control WFT, many growers rely on pesticides. However, chemical control of WFT is difficult because it has developed resistance to all major classes of insecticides used for its control in Australia, and in other parts of the world. Resistance to the newer chemistry insecticides such as spinosad is particularly worrying, since it is currently the only insecticide, for control of thrips that is compatible with IPM programs and is highly efficacious against WFT as resistance is going to be an issue if any mode of action is continually used without rotation. In crops such as greenhouse capsicum, where growers release biological control agents to control pests such as aphids (e.g. green peach aphid, *Myzus persicae*) and two spotted mite (*Tetranychus urticae*), WFT populations resistant to spinosad are widespread and are threatening the continued use of IPM compared with the other option of calendar spraying with toxic unfriendly IPM chemistries.

Figure 1

Western Flower Thrips feeding damage to the top of a red capsicum.

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Reducing Grower Reliance on Pesticides

Since WFT develops resistance to pesticides, chemical control is not a long term option. Arthropod predators of thrips belong to several families in the orders Heteroptera, Diptera, Neuroptera, Coleoptera, Araneida, and some species of Thysanoptera (Lewis 1973). The most widely employed predators are anthocorid bugs of the genus, *Orius* (Anthocoridae) and phytoseiid mites (Acari) (Sabelis and Van Rijn 1997). *Orius*, also known as pirate bugs, are generalist predators reared commercially for the suppression of thrips and feeds on other insects such as spider mites, predatory mites, aphids and whiteflies (REF). Whilst several species of *Orius* are used for thrips control in greenhouses in Asia, Canada, Europe and the USA, *Orius* has not been used in Australia due to quarantine restrictions that prohibit its importation. In 1995, a native species of *Orius*, *O. armatus*, was found in Western Australia (Cook et al 1993). Preliminary field trials in carnations indicated that it was able to suppress WFT populations, but attempts to rear it by DAFWA (Cook) and NSW DPI (Steiner & Goodwin) were unsuccessful. In 2007, *O. armatus* was rediscovered and reared in small quantities in WA by Manchil IPM Services (Fig. 2).

To further develop *O. armatus* for the Australian vegetable industry, mass-rearing techniques need to be developed to enable commercial production. However, no technicians are present in Australia that have reared *Orius,* and overseas producers of *Orius* do not disclose their rearing techniques due to the commercial sensitivity of the information. Literature searches for published material on rearing *Orius* were based on production of *Orius* for small-scale experiments; not for production of commercial quantities. Rearing techniques thus required development, with initial information obtained from published papers.

A second aim of this project was to assess the efficacy of *O. armatus* against WFT. Capsicum was chosen as the initial trial crop because overseas research indicates that pollen is important for *Orius* establishment. Other crops with high pollen loads include tomato, strawberries and ornamentals, which may be considered at a later stage.

Figure 2

Adult *O. Armatus* on left and Juvenile *O. Armatus* on right

Materials and Methods

Rearing Orius armatus

Effect of pesticides on *Orius armatus*

To establish the effects that some pesticides commonly used by vegetable growers has on *O. armatus*, laboratory bioassays and a greenhouse trial at the Muchea insectary were carried out.

Laboratory bioassays

Bioassays were carried out by IPM Technologies and DAFWA. IPM Technologies exposed *Orius armatus* to dried residues of the insecticides pymetrozine (Chess) and chlorantraniliprole (Coragen) and the fungicide chlorothalonil (Barrack).

Department of Agriculture W.A has been evaluating the effect of different insecticides on *O. armatus* focussing on systemic insecticides and how it affects *O. armatus* and their egg lay on treated beans. Detailed methods and materials are provided in Broughton and Chilman (2011) Project number VG06019.

Briefly, the effect of systemic insecticides on survival, mortality and fecundity were examined by exposing adults to beans that had been treated with a systemic insecticide. Pole beans (*Phaseolus vulgaris*) were obtained from Manchil IPM Services and re-potted into pots (32.5w x 40.5h cm) containing potting mix in glasshouses at DAFWA. Once plants had begun to produce beans, they were treated with insecticide. After three weeks, when the insecticide is regarded to have been incorporated into the plant, beans were harvested for use in bioassays.

In the laboratory, beans were cut into 6cm lengths with a scalpel blade. Separate scalpels and paintbrushes were used for each treatment to avoid cross-contamination. Ten adult male and female *O. armatus* were added to each cage and provided with food (moth eggs, pollen) and water, then placed in a constant temperature cabinet (25^{o}C+- 1^{o}C photoperiod 16L:8D). There were six replicates per treatment and trials were repeated three times.

O. armatus were classified as dead if individuals did not respond when prodded with a fine paintbrush. Separate paintbrushes were used for each treatment to avoid cross-contamination. The sex of the dead adult was recorded. The number of eggs laid in the beans over the previous 24 hour period was counted. The bean was then placed in a plastic petri dish and returned to the constant temperature cabinet, and a new bean was added to the cage. Beans were replaced every 24 hours for a total of 72 hours.

After three to four days (the time taken for *O. armatus* eggs to hatch), the numbers of hatched eggs were recorded and any nymphs removed to avoid cannibalism of unhatched eggs. Beans were examined every 24 hours for a further 48 hours for egg hatch before being discarded.

The number of eggs produced per female was estimated by dividing the total number of eggs by the number of surviving females in each replicate. Fecundity was similarly determined. *O. armatus* were removed with a fine paintbrush and placed individually into cages. Individuals were supplied with *Sitotroga cerealella* eggs and a cotton dental wick soaked in water was placed through a hole in the top of a cage. In addition, adults were given a small rectangle of cardboard (approx. 2mm x 4mm) for shelter. Cages were placed in a constant temperature cabinet (25^{o}C+- 1^{o}C photoperiod 16L: 8D). There were 3-4 replications per treatment, and 10-12 individuals per replicate.

Mortality was checked at 24, 48, 72 and 96 hours. Mortality data were expressed as a percentage and corrected using Abbotts Formula (Abbott 1925).

Insecticides were classified using International Organization of Biological Control (IOBC) guidelines:

1= Harmless (<25% mortality),

2=Slightly Harmful (25-50% mortality),

3=Moderately Harmful (51-75% mortality) and

4=Harmful (>75% mortality) (Sterk et al. 1999).

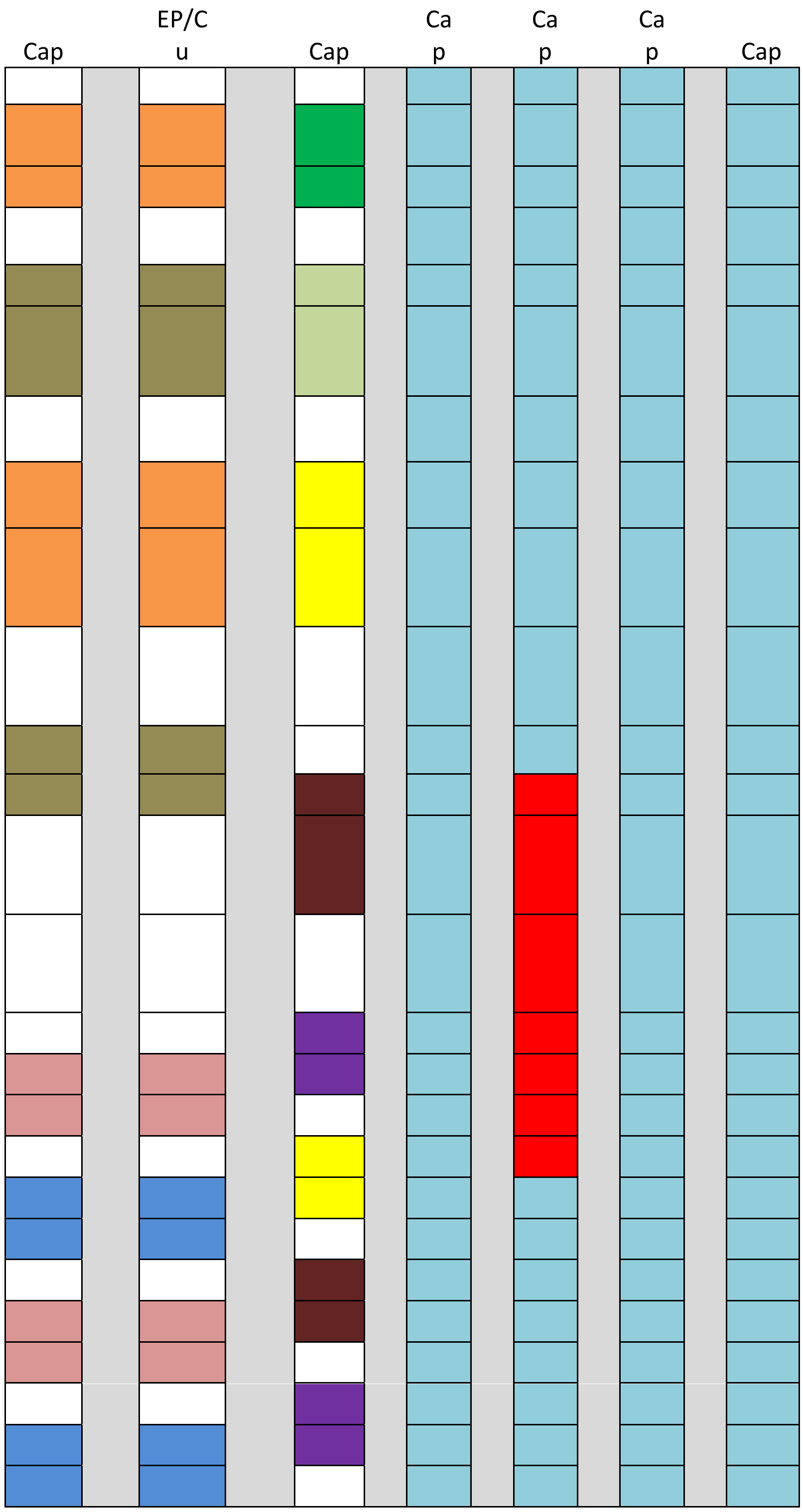
Greenhouse bioassays

Further testing was carried out in a greenhouse at Muchea to assess the effect of systemic insecticides on pests, *O. armatus* and other beneficial insects. Crops included roses received from a nursery, and capsicum, eggplant and cucumber. The trial lay out is shown in Figure 3. The capsicum and eggplant seeds were planted on 13/06/2011 and the cucumber seeds planted 27/06/2011. Seedlings were transplanted into bags of cocopoeat in the greenhouse over the period 01/08/2011 to 03/08/2011. Plants were irrigated daily. Pests were introduced and included Two Spotted Mite (TSM, Tetranychus urticae), Western Flower Thrips (WFT), Aphids (*Myzus persicae*) and Whitefly (*Trialeurodes vaporariorum*). The beneficial insects that were introduced included the predatory mite *Phytoseiulus persimilis* (for control of TSM), *Orius armatus* and the mite *Neoseiulus cucumeris* (both for the control of WFT) and the wasps *Aphidius colemani* (aphid parasite) and *Encarsia formosa* (whitefly parasite). Except for *A. colemani* and *E. formosa* supplied by Biological Services, all were reared by Manchil IPM Services.

A. colemani and *E. formosa* were released weekly, *P. persimilis* was released 8 weeks after planting, *O. armatus* was released 6, 8 and 10 weeks after planting and *N. cucumeris* released 5 and 7 weeks after planting.

Figure 3

Chemical Treatment Plan for Tunnel 5 Manchil IPM Services.



Monitoring to be carried out once a week. Check 2 plants in each bag. Each plant, monitor bottom and top leaf for Pest and Biological controls
Check 2 flowers, 2 fruit and under calyx of fruit for pests and beneficials.

Key

	AzaMax, every fortnight starting at 3 weeks 2.5mls + 2mls of Eco Oil/1L
	Eco Oil every fortnight starting at 3 weeks @ 5ml/1L
	AzaMax and Eco Oil every fortnight starting at 3 weeks @ 5mls Eco Oils and 1ml Azamax/lt
	Durivo drench prior to planting at label rate
	Confidor Guard drench prior to planting at label rate
	Movento at 40ml/100L + Hasten at 50ml/100L 3 & 5 Weeks
	Movento at 40ml/100L + Hasten at 50ml/100L every fortnight starting at 3 weeks
	Roses IPM
	Capsicums IPM
	Success Neo every fortnight starting at 3 weeks at 40ml/100L
	Success 2 every fortnight starting at 3 weeks at 40ml/100L

Cap - Capsicums

EP – Egg Plant

Cu - Cucumber

***** Notes *****

Rose plants arrive 14/07/2011.
Plant Capsicum and egg plant seeds 13/06/2011.
Plant cucumber seed 27/06/2011.
Plant out all seedlings 01/08/2011 - 03/08/2011.
Start Confidor guard and Durivo treatment 01/08/2011.
Start Movento treatment 29/08/2011.

Bag is 1.1m.

Space bags 1.2m apart.

The experiment was laid out as seen in Figure 3, with capsicums the main crop, followed by eggplant, cucumbers and roses. Half of the plants were treated with pesticides whilst the other half was controls (biologically based IPM). The pesticides used in this trial are listed in Table 1.

Table 1: Pesticides applied

Pesticide	**Mode of action**	**Manufacturer**
Azadirachtin (AzaMax™) 2.5 mL + Eco Oil	Antifeedant and insect growth regulator	Organic Crop Protectants
Azadirachtin (AzaMax™) 1 mL + Eco Oil	Antifeedant and insect growth regulator	Organic Crop Protectants
Imidacloprid (Confidor®)	Systemic	Bayer CropScience
Chlorantraniliprole and thiamethoxam (Durivo®)	Broad-spectrum systemic	Syngenta
Spinosad (Success™)	Stomach/contact insecticide	Dow AgroSciences
Spinetoram (Success™ Neo)	Stomach/contact insecticide	Dow AgroSciences
Spirotetramat (Movento®)	Systemic	Bayer CropScience

Confidor and Durivo were applied by drenching the seedlings prior to transplant at the recommended rate by the chemical manufactures.

The AzaMax 2.5ml and Eco Oil, AzaMax 1ml and Eco Oil, Eco oil, Success and Success Neo trials commenced 5 weeks after planting. These insecticides were applied at the recommended rate with a hand sprayer till the point of run off every fortnight.

Movento® was trialled using two different application time intervals: applied on week 3 and week 5 of the trial, and on a fortnightly basis starting at week 3. Movento® was applied at the recommended rate as above.

Plants were monitored once a week. Four leaves, two flowers and two fruits were checked on each plant to establish the numbers of both pests and beneficial insects alike. These results were then recorded and evaluated.

Extension

In addition to WFT, other pests are found in capsicum including aphids (*Myzus persicae*, *Macrosiphum euphorbiae*) and greenhouse whitefly (*Trialeurodes vaporariorum*): both are sap-sucking insects. Their feeding results in the formation of honey dew and sooty mould on leaves and fruits, reducing plant vigour and pack out. Feeding on the underside of leaves by two-spotted mite (TSM, *Tetranychus urticae*) produces yellow feeding marks and in severe infestations, whole leaves can turn yellow and webbing can cover the entire plant. Fungus gnat (family Sciaridae) larvae live in the rearing media and can trip plant roots, resulting in loss of plant vigour and yellowing and wilting of the leaves. All of these pests may be successfully controlled by releasing natural enemies (Table 2).

Weekly monitoring of capsicums was carried out by sampling the leaves, flowers and fruit, and levels of recording pests and predators. In field monitoring was undertaken using a 10 times hand lens.

Table 2: Biological control agents (BCA) used in capsicum IPM program and standard release rates

BCA name	Supplier*	Target pest	Standard release rate
Hypoaspis Stratiolaelaps spp. (predatory mite)	BS	Fungus gnats, WFT pupae	15,000/250-400m^2
Aphidius colemani (parasitic wasp)	BS	Aphids (small species such as *Myzus persicae*, green peach aphid)	2000/ha every 2 weeks, 2 weeks after planting. Hot spots treated at 1/m^2
Aphelinus abdominalis (parasitic wasp)	BS	Aphids (larger species such as *Macrosiphum euphorbiae*, potato aphid)	Experimental
Orius armatus	M	Thrips, all stages	3-4 releases, 1st at early flowering: 4-8/m^2, then at weekly intervals, 2nd: 2-8/m$^{2;}$ 3rd: 2-8/m$^{2;}$ 4th: 0-8/m^2. Total release: 32/m^2 for high thrips, 16-24/m^2 for moderate thrips and 8/m^2 for low thrips populations.
Phytoseiulus persimilis	M	Spider mite including TSM (*T. urticae*), and *T. ludeni*, bean spider mite	10,000/1000m^2 2 releases
Neoseiulus cucumeris (predatory mite)	BS	Thrips – 1st instar, broad mite.	Release 1L/150m^2 onto seedlings 1 week before planting. Main crop, two releases commencing at first flowering at 1lt/500m^2 two weeks apart. Early establishment important to manage thrips population before *Orius* introduced.
Encarsia formosa (parasitic wasp)	BS	Greenhouse whitefly – 3rd and 4th instars	As needed

*BS = Biological Services; M = Manchil IPM Services

Table 3: Thrips pressure rating and growers cooperating in the capsicum IPM program

WFT pressure rating	Description	Grower	Climatic zone
Extreme	Large thrips population, heavy damage, >20% crop loss to TSWV	Cafcakis, Virginia, Northern Adelaide Plains, South Australia Zalsman, Baldivis, Western Australia	Mediterranean Mediterranean
Moderate	Moderate thrips damage to fruit or 5-20% loss to TSWV	Coulthard, Baldivis, Western Australia Spurling, Coldstream, Victoria	Mediterranean Temperate, cool winters, but hot summers
Low	Very low thrips numbers, no damage problems, no loss to TSWV	Henderson, Kindred, NW Tasmania New Life Industries, Lillico, NW Tasmania Wallace, Keilor, Melbourne, Victoria	Temperate, cold winters, mild summers Temperate, cold winters, mild summers Temperate, cool winters, but hot summers

Figure 4

Grower Terry Coulthard on left and Lachlan Chilman on right inspecting Terry's

IPM capsicum crop.

South Australia

Bill and Emmanuel Cafcakis, Virginia, South Australia

Virginia has extreme pest pressure, mainly due to a high level of cropping, high weed levels, old abandoned crops and a warm climate. Capsicums are planted in July and are grown in Grodan™ rockwool blocks and bags over 50-51 weeks. Bill and Emmanuel's *O. armatus* trial was carried out in a 6000m^2 Faber polyhouse and a 3000m^2 Faber glasshouse, the two structures forming a continuous growing area. The structure had an AIS fogging system. This is a very hot region and when temperatures reach 45^{0}C outside the fogging system can maintain the inside temperature at a tolerable 30^{o}C. The ability to control temperature and humidity is very important for biological control. The Cafcakis brothers also had two soil grown crops that became part of the trial, one soil crop on new ground and a 2nd on old ground. The release program for beneficials was the same as table 2, but their situation was extreme.

The brothers were struggling to control WFT spraying every 2-3 days yet still finding 80% of plants infected with TSWV. In one season, up to 10,000 plants were lost to TSWV, resulting in the crop being removed four months early.

Figure 5

Bill and Emmanuel Cafcakis capsicum hydroponic crop

Western Australia

Zaldeesh, Baldivis, Western Australia

David Zalsman has struggled to grow capsicums under extreme thrips and virus pressure. The climatic region is similar to that of the Cafcakis brothers in South Australia. At 2.4ha, Zalsman is the second largest greenhouse capsicum producer in Australia. He propagates his own seedlings and plants in July and has undertaken full biological control over the past two seasons.

Previously, he was spraying for two-spotted mite and WFT every 3-4 days. However, he was unable to control TSM and WFT, and both pests became resistant to every insecticide in use. For example, TSM had high level resistance to bifenazate (Acramite™), abamectin (Vertimec™), milbemectin (Milbeknock™) and etoaxole (Paramite™) was confirmed.

Thrips developed resistance to spinosad (Success™) in 2009. Dichlorvos had been applied as a fumigant to control thrips adults prior to replanting with only partial control; Grant Herron from New South Wales Department of Agriculture had confirmed resistance to DDVP. Though Zalsman had been using TSWV resistant capsicum cultivars for 4-5 years, resistance had broken down, losing the crops to virus in two of his greenhouses.

Overlapping crops meant that TSM and WFT were always present to reinfest new plantings, producing constant pressure on insecticides. The release program for beneficials was the same as table 2, but his situation was classified as ‘Extreme’.

Plenty Grow Hydroponics, Baldivis, Western Australia

Terry Coultard has a 2000 m^2 greenhouse, and is relatively isolated from other growers. In 2007, weekly spraying for WFT resulted in the development of resistance. While major thrips feeding damage to fruit occurred, he was fortunate to get away with only slight loss to virus, probably due to his relative isolation.

During a 4-5 week break between crops, the greenhouse is cleared of the previous crop, solarised and monitored for thrips emergence with sticky traps. Coultard plants into cocopeat in April, earlier than other growers and now grows his own seedlings. The release program for beneficials was the same as table 2, but his situation was classified as ‘Moderate’.

Victoria

Gateway Hydroponics, Coldstream, Victoria

Tony Spurling has a 5000m^2 temperature controlled greenhouse, and moderate thrips pressure. He grows capsicum in cocopeat and plants in late July. Early in the crop of 2009/10, Spurling preferred to use chemical sprays. Though he applied spinosad, abamectin and imidacloprid from July to September, a 10-15% loss to virus was recorded. An enquiry about using *O. armatus* was deferred until December to give imidacloprid residues time to reduce, but *O. armatus* were unable to establish due to the imidacloprid residues. By the end of the crop, 30-40% of the plants had perished to TSWV.

While Spurling was producing his own seedlings, it was in an area shared with WFT infested herbs. He was advised to make sure the propagation greenhouse was cleared of other plants before commencing to grow capsicum seedlings. He was also advised to ensure the production greenhouse was cleared and cleaned out between crops and free of WFT, something that hadn’t been happening. He was also advised to use dichlorvos for the first few weeks to reduce thrips numbers before it was climatically suitable for *O. armatus* to establish. The release program for beneficials was the same as table 2, and his situation was classified as ‘Moderate’.

Wallace Vegetable Farms, Keilor, Victoria

David Wallace grows capsicum in new cocopeat and plants in August. His previous experiences with IPM over several years have been quite successful using minimal sprays, but thrips control could still be improved. In 2010/11 Wallace was contacted in July before planting to discuss his IPM program. David produces his own seedlings and the greenhouse is emptied between crops. It is too cold at that time of the year to consider solarisation. Unfortunately the grower drenched his seedlings with imidacloprid for aphids in the mistaken belief that it wouldn't harm his subsequent biological control agents. The release program for beneficials was the same as table 2. His situation was classified as 'low'.

Tasmania

Henderson Hydroponics, Kindred, Tasmania

Robert Henderson also grows in cocopeat and plants in August. Henderson started using biologically-based IPM in 2009. Henderson starts his beneficial release in early October when it is warmer. He did not spray between planting and recorded no WFT, TSWV or TSM. The grower believes that *N. cucumeris* remains in the greenhouse between crops, which is unlikely, but it affects his decision on when to release *N. cucumeris* into the new crop. Other than that his release program for other biological control agents is fairly standard. Prior to using *O. armatus*, IPM consultant Dr Paul Horne of IPM Technologies met with him in 2008 and discussed the use of *N. cucumeris*. Initial scepticism with biological control turned to conversion as he saw his virus problem reduced from 75% in 2007/08 to 2% in 2008/09. Henderson has also had good success with other beneficials. The release program for beneficials was the same as table 2, and his thrips pressure was classified as 'low'.

Carnarvon, Western Australia

Figure 6
Growing Capsicums in Carnarvon, this crop was under IPM.

O. armatus have been trialled by three growers in the Carnarvon area. The trials began in late March 2010 and finished in September 2010. Capsicums grown in Carnarvon are shaded by netting and are planted in the ground. Growers released *O. armatus, P. persimilis, A. colemani* and *N. cucumeris*. Cucumber mosaic virus is a major problem in this district which is transmitted by aphids. Carnarvon is a district that relies on insecticides, with little to no IPM practised in the area.

Results

Rearing Orius armatus

Effect of pesticides on *Orius* armatus

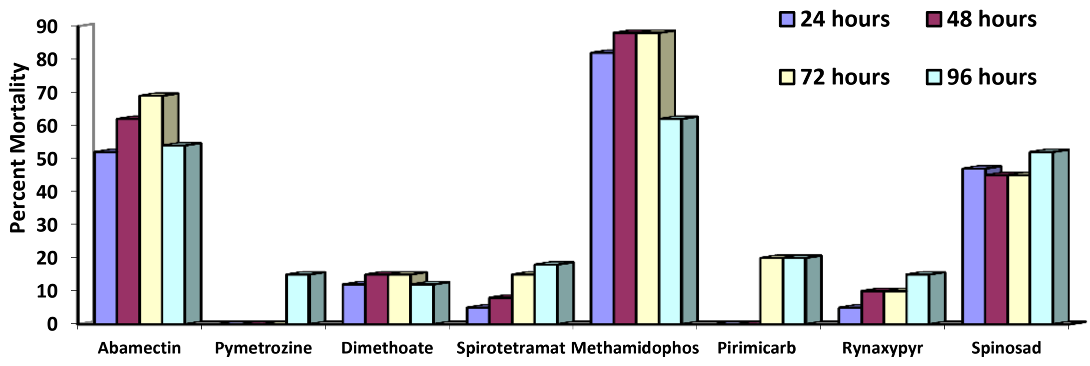
Laboratory Bioassays

The data from all the bioassays are summarised in Table 4 and Figures 10 and 11 for nymphs and adults respectively. The protocol used followed the Guidelines set by the IOBC International Organization of Biological Control.

Table 4: IOBC Classification based on bioassay results (Broughton, 2009)

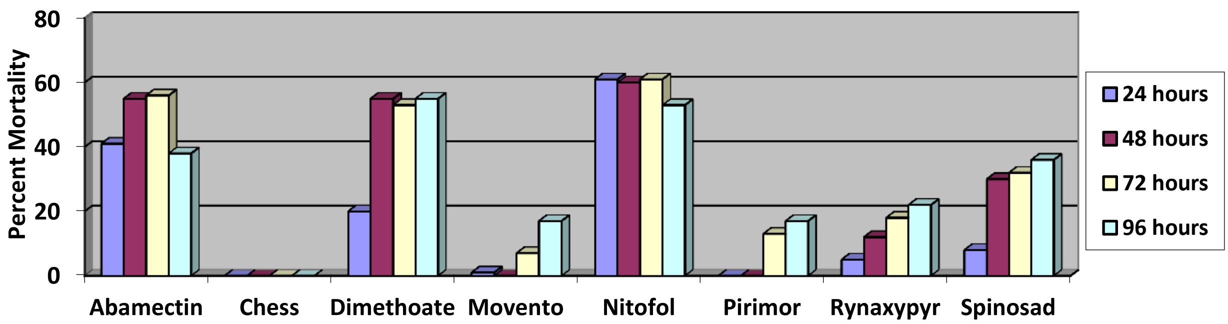
Insecticide and trade name	**Nymphs**	**Adults**
Pymetrozine (Chess®)	1	1
Abamectin	3	3
Dimethoate	1	2
Spirotetramat (Movento®)	1	1
Methamidophos (Nitofol)	4	4
Pirimicarb (Pirimor)	1	1
Rynaxypyr™	1	1
Spinosad (Success™)	3	3

Figure 10: Effect on *O. armatus* nymphs (6 day old-3-5 instars)



(Broughton, 2009)

Figure 11: Effect on Adult Orius

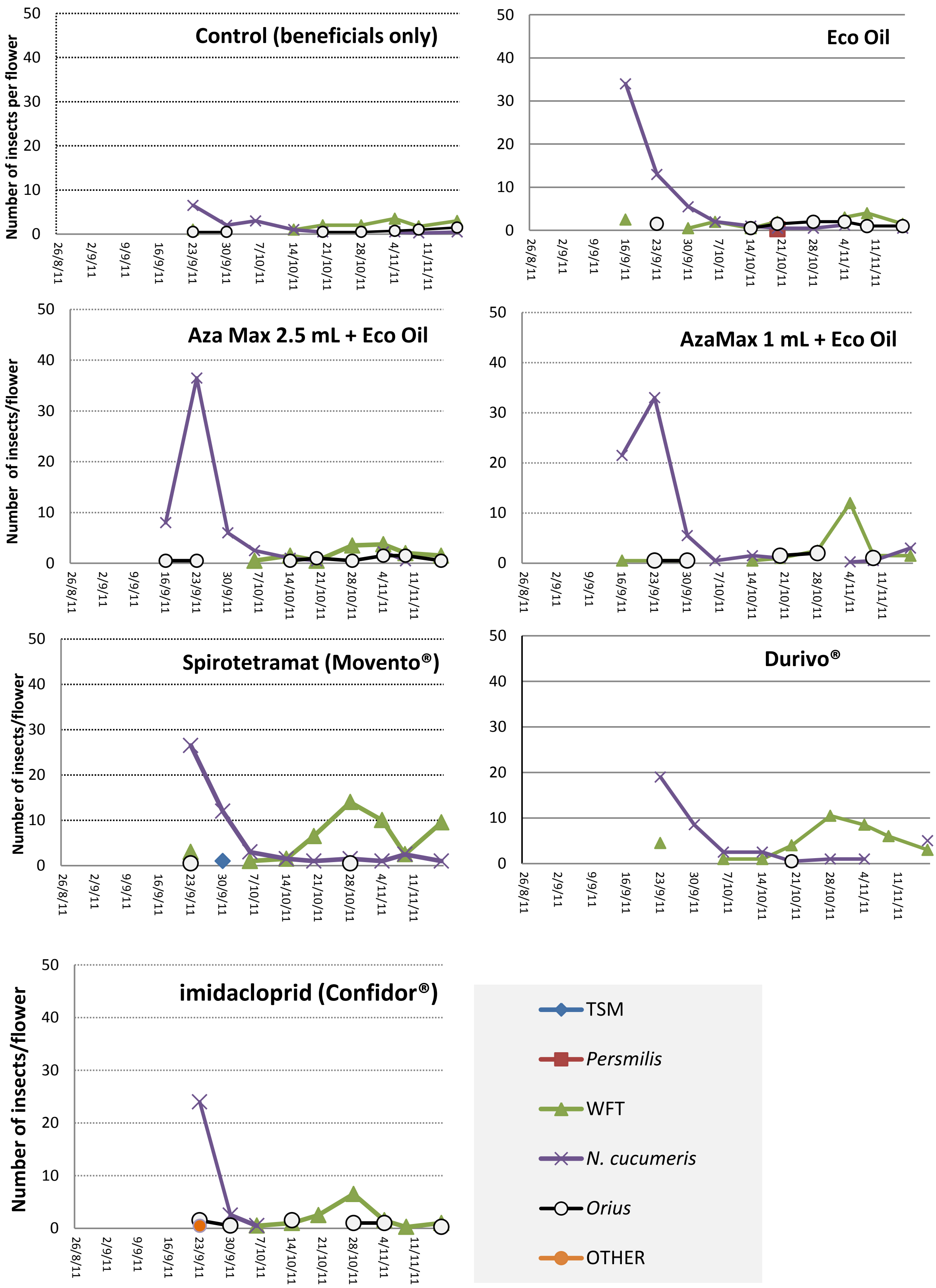


(Broughton, 2009)

Greenhouse bioassays

The effect of insecticides and IPM on the number of WFT and establishment of *O. armatus* are shown in Figure 12.

Figure 12: Effect of different pesticide treatments on the number of beneficials and WFT in capsicum flowers



Extension

Prior to this study, the only other analysis of the effect of *O. armatus* on WFT was by – Cook *et al* in 1993 in Western Australia. Cook *et al*. (1993) found that "There was a consistent, negative relationship between the numbers of adult *F. occidentalis* and *O. armatus* in successive rows of carnations. *F. occidentalis* larvae in particular, were significantly reduced by the presence of *O. armatus*. Although numbers of adult *F. occidentalis* did not decline at the monitoring site, on carnations nearby (50 m) that were sprayed weekly for thrips, *O. armatus* was rarely present and *F. occidentalis* were at least twice as abundant. The trial carried out by Cook *et al* was of natural *O. armatus* populations not as an introduced procedure.

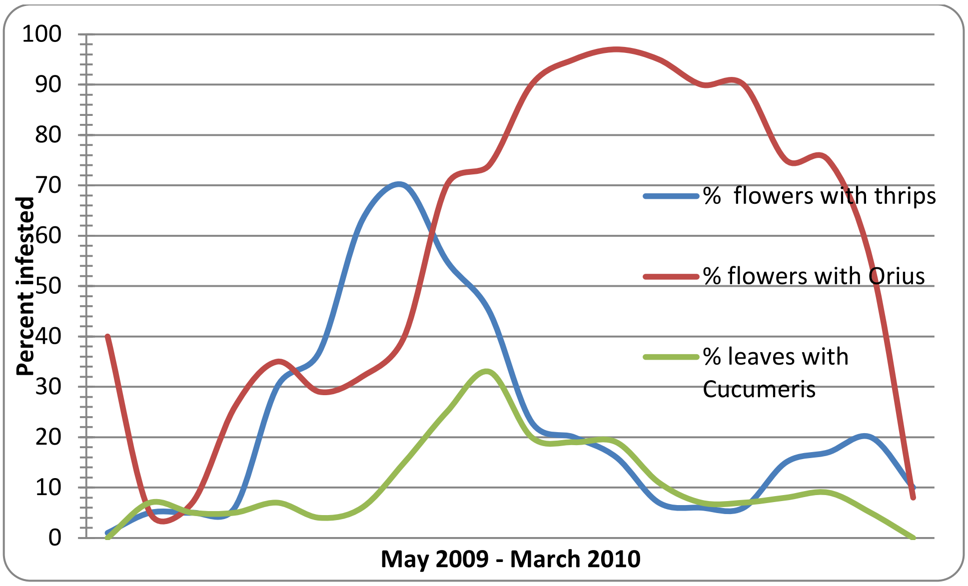


Figure 13: Effect of *Orius* and *N. cucumeris* on western flower thrips infestation, Plenty Grow Hydroponics greenhouse capsicums, 2009-10.

Table 5: An example of the monitoring table used in Carnarvon to record pest numbers and beneficial numbers.

LOCATION : Carnarvon

PEST MONITORING REPORT (Monitoring Service Provided by MANCHIL IPM SERVICES)

EMAIL: lachlanchilman@hotmail.com

Contact Lachlan Chilman 0403727252

web site: manchilipmservices.com.au

Capsicums

Week of	<20	20-100	>100	Mite(Persimils)	(Cucumeris)	Orius Predatory bug	thrips	Thrips in Flower 1	3	Thrips in Flower 3>	calyx	Aphids	Wasps)	Mealy Bug	Botrytis	Powdery Mildew	Heliothis	Trichogramma	Whitefly	Mirrids
29-Apr-10	2	3	0	0	9	15	30	20	30	20	8	4	0	0	0	6	21	7	3	0
24-May-10	12	6	1	4	30	35	50	25	15	10	14	4	0	0	0	8	2	35	3	35
16-Jun-10	10	7	1	13	30	21	60	20	15	5	8	4	0	0	0	7	2	15	3	23
12-Jul-10	1	0	0	8	35	1	70	20	5	5	5	10	1	0	0	7	1	21	1	3
10-Aug-10	2	0	0	4	19	0	71	15	8	6	7	2	2	0	0	6	4	6	0	0

Note: All numbers in boxes represent a percentage.

The costs of conventional chemical control versus using biologically-based IPM are summarised in Table 6. Whilst IPM was slightly more expensive ($430 per hectare), it is a sustainable strategy compared to chemically-based control.

Table 6: Cost: benefit comparison of spraying versus IPM in greenhouse capsicums in high tech production.

Program	Cost/ha $	Pros and cons
IPM – standard beneficial release program with average thrips pressure.	Beneficials 15,300 + soft chemicals Labour 800 Total 16,100	Pros: • No resistance • Cost competitive with chemicals • Sustainable year after year • Safe for workers • Much less time required, freeing up workers for other duties • Preserves useful chemicals for few times needed • Better crop health • Healthy produce • Higher yields Cons: Requires good monitoring, informed advice and preventive action (not necessarily a bad thing!)
Chemical (pre-IPM)-strong thrips pressure	Chemical 9,260 Labour 6,400 Total 15,660	Pros: Off the shelf, temporary control with new active ingredients Cons: • Unsustainable and mostly unreliable • Resistance can develop rapidly • Loss of yield – every 1% of plants lost, lose $9,120 • Crop damage – phytotoxicity, stunting • Worker OH&S issues (sprayers, pickers etc) • Residue contamination on produce • WHP[1]

[1] Not always adhered to

Discussion

Rearing Orius armatus

At the start of the project Manchil IPM Services was producing 1000 *O.armatus* a week which could cover $500m^2$ at 2 *O. armatus*/$m^{2.}$ The mass rearing of *O. armatus* was successfully achieved and weekly production increased to 400, 000 *O.armatus.* If released at 2 *O. armatus*/m^2 this would be enough to cover 20ha/week.

Effect of pesticides on Orius *armatus*

Laboratory Bioassays

Nymphs appear to be more susceptible to insecticides than adults, with the exception of dimethoate which was more toxic to adults (Figure 11, Broughton, 2009). For insecticides classified as IPM compatible (Pirimor, Rynaxypyr, Chess, Movento), mortality increases with time (Figs. 10 and 11).

These results suggest that methamidophos is toxic to *O. armatus* juvenile and adult stages. Abamectin has adverse effects on both stages of the *O. armatus*, while dimethoate seems to affect the adult stage more so than the juvenile stages. While the mortality rate in the laboratory tests on Movento was not too high, it is evident in the field tests done at the insectary in Muchea that Movento does have adverse effects on the *O. armatus*. This also proves that field tests as well as laboratory tests should be carried out on chemicals to establish the full scope of their effects on insect pest and beneficials. Chess, Pirimor and Rynaxypyr have little effect on the *O. armatus*.

Greenhouse bioassays

The numbers of WFT were lowest on the control (beneficials only), and organic options (Eco Oil, Aza Max). *O. armatus* were able to establish on flowers that had been treated with Eco oil, AzaMax 2.5ml/ Eco Oil and AzaMax 1ml/ Eco Oil, but were not able to establish on the flowers that had been treated with either Durivo® or imidacloprid (Confidor®). This suggests that these insecticides are more toxic and harmful to *O. armatus*. It also appears that Durivo® and Confidor® had reduced control of WFT, with a spike in WFT numbers on the 28th October for both treatments. *O. armatus* were able to establish on plants treated with spirotetramat (Movento®). Although there appeared to be some adverse effects of spirotetramat on *O. armatus*, it was not to the point of total loss.

Extension

South Australia

Bill and Emmanuel Cafcakis, Virginia, South Australia

The 2010/11 season has seen an amazing turnaround in fortunes, with only 100 virus-infected plants by the end of February. One critical lesson learned is that IPM starts prior to the crop going in. The previous crop had ended badly and this meant a potential carry-over of large numbers of virus-infected WFT in the greenhouse. To prepare for this, the brothers grew an interim crop of cucumber to reduce the virus load. Then they undertook a thorough clean out of the greenhouse, solarised it, fogged dichlorvos (DDVP™) to kill thrips and monitored thrips adult emergence with yellow sticky traps. Because of the previous high thrips population and despite the measures taken to rid the greenhouse of them, they withheld beneficials in the crop until flowers were present, preferring to fog with dichlorvos every four days for 2-3 weeks. By mid-September WFT numbers had declined to a tolerable one in every five flowers and a standard beneficial release program was undertaken. Together, *N. cucumeris* and *O. armatus* have provided exceptional control of thrips, while other biological control agents have greatly reduced the need for pesticides against other pests. Total parasitism of aphids was achieved with a mix of *Aphidius* and *Aphelinus,* and *P. persimilis* releases in November and December have avoided spider mite problems at the time of writing. Broad mite flared up in one area, but was controlled by extra releases of *N. cucumeris*. This may well have been due to an influx of whiteflies, which broad mites are known to migrate onto.

Another important lesson was that IPM must also be applied at the seedling stage. The Cafcakis brothers are now producing their own pesticide-free seedlings. Residues of bifenthrin (Talstar™) and imidacloprid (Confidor™) on purchased seedlings used in another older house made it impossible to establish biological control agents for the duration of the crop. It is difficult for commercial seedling propagators to separate small numbers of seedlings being grown for IPM clients away from their mainstream production and the influence of their over-bench sprayers, which regularly apply highly toxic and residual pesticides. Small wonder there is difficulty in establishing natural enemies.

In the 2011-2012 season two soil crops were grown, one on new ground and the second on old cropping land that had previous treatments of imidacloprid. The capsicum crop on new ground had good *O. armatus* establishment throughout but the crop on older ground had no *O. armatus* establishment, due to the imidacloprid staying in the ground for many years after its first soil drenching procedure. The capsicums grown in the soil in Virginia appear to be at a high risk of infestations of broad mites, this pest may need better biological controls to give 100% control.

The hydroponic, one hectare crop had all pests controlled successfully by the biological controls and a very small amount of plants were affected by TSWV.

Western Australia

Zaldeesh, Baldivis, Western Australia

An unexpected challenge to IPM came from another direction; gas heaters flued inside the greenhouse released exhaust gases toxic to *O armatus*, which are very sensitive to it. The flues were directed outside, but still too close to the greenhouse and small amounts of gas continued to disrupt attempts to establish *O. armatus*. Only when trialled without gas heaters was the solution demonstrated and the grower convinced.

In the 2010/11 season, further progress was made. WFT was first of all knocked down with a dichlorvos fog, because July is too cold in Western Australia for *O. armatus* to establish, and dichlorvos has very little residuality. The biological control program commenced with a standard release program for thrips, aphids and TSM similar to the Cafcakis crop in the Faber greenhouse. Reduction of the thrips population in the 2009/10 crop enabled the *O. armatus* to establish at a release rate of $12/m^2$. A spell of hot, dry weather favoured an outbreak of TSM, requiring an increased release rate of *P. persimilis* in September. The population of green peach aphid, *Myzus persicae,* exploded early in the crop, going from 5% to 70-80% infested plants in 7-8 days. Good *Aphidius* and *Aphelinus* parasitism occurred after a high release at 10,000/ha, but it was admitted that the initial incursion was not acted upon promptly enough. Biological control agents cannot respond that quickly to very high influxes of pests, which can and must be dealt with initially by prompt spot-sprays of a non-residual pesticide, followed by a series of biological control releases to mop up. In this way, Mealy bug was spot-sprayed with buprofezin (Applaud™).

To date there has been less than 1% of plants lost due to virus this season, so it is fair to predict that the crop will complete the season and the grower is on track to make a profit. This is not a bad turnaround from the previous disastrous situation.

Zalsman has not sprayed for either two-spotted mite (TSM, *Tetranychus urticae*) or WFT for three years. The 2011-2012 season has worked extremely well with no spray of WFT or Two-spotted mites carried out and no yield reduction at all from both of these pests. The 2011-2012 season, Zaldeesh recorded their highest yield ever from their greenhouses.

Plenty Grow Hydroponics, Baldivis, Western Australia

In 2009/10, Terry commenced with a standard beneficial release program. A mealy bug problem was effectively managed with a spot spray of Buprofezin after unsuccessfully trying the predatory beetle *Cryptolaemus*. An infestation of Looper Caterpillars was controlled with two sprays of *Bacillus thuringiensis* (Xentari™) in December and another in January against *Heliothis*. No broad mite was reported.

In the 2010/11 season, the biological control program has been much the same as for the previous crop. Due to success against WFT in 2009/10 (Fig. 13), thrips numbers were low at the start and the *O. armatus* release rate was able to be reduced to $9/m^2$ from $16/m^2$ in 2009/10. This chart is very similar for all trials that had no chemical contamination. This can result in substantial cost savings to growers and is more in line with rates used overseas. We learnt from last year that in Western Australia *O. armatus* does a lot better released in August and September due to improving light levels. It is also warmer, which *Orius* prefer. Despite growing susceptible cultivars, very low incidence of TSWV has been reported to date and there has been no fruit loss. Minor Aphid infestations have been spot-sprayed with Pirimicarb and there have been no Caterpillars recorded.

Victoria
Gateway Hydroponics, Coldstream, Victoria

The light levels may not be suitable for *O. armatus* in Victoria until October. In the 2010-2011 season Dichlorvos was used right through to the end of August before WFT was low enough to commence using bio-control agents. A standard beneficial release program was undertaken with *O. armatus* releases totalling $20/m^2$. In late September there was good establishment of *O. armatus* and *N. cucumeris* was recorded at more than 10/leaf. WFT was quite low and there was no fresh TSWV found. In December a spot spray of pirimicarb was recommended for aphids. In late February the grower reported that he was happy with the outcome of the IPM program, with only 100 plants lost to virus. Not bad from a potentially ruinous 30-40% crop loss the previous season. A few farms in the Victorian area receive naturally occurring predatory mites called *Anystis sp,* that by January are in very high levels, these predators appear to be generalist feeders and we believe they may also feed on *O. armatus.* As long as the *O. armatus* are in good levels throughout spring and early summer and reduce the thrips levels to low levels the reduction caused by the *Anystis* is not a major problem. We would prefer the *Anystis* not to be present in the crop as they do not give as high WFT control as *O. armatus* but it appears it is only a problem in Victoria at the moment.

Carnarvon, Western Australia

The beneficials that were released into the crops in Carnarvon gave very good control of TSM and aphids. WFT was reduced to levels so that damage was not apparent, but due to a problem with *O. armatus* entering diapause during the peak growing season, the thrips were not completely suppressed. *N. cucumeris* also helped in the control of thrips. *N. cucumeris* was unable to completely control the broad mite that became a secondary problem once miticides were stopped. Cucumber mosaic virus is a major concern in the Carnarvon region and in recent years has caused 40-70% of plantings to be destroyed.

Table 5 from Carnarvon was different from other farms as it was a soil crop grown under shade. The table shows that WFT numbers started off at 70% of flowers, but as *O. armatus* increased in numbers from May-June, WFT reduced to 30% of flowers. *O. armatus* numbers also reduced over winter as *O. armatus* diapauses. Two spotted mites were controlled by *P. persimilis* by July. Aphids remained low in the crop. Mirids also followed the same trend as the *O. armatus*.

Carnarvon will not have a good IPM system until:

- A 4 week non-growing period in the middle of summer is implemented on virus susceptible crops. (The whole district)
- No weeds or old crops allowed in the district, government or grower association people would need to tour the district daily to check on these matters.
- No spraying of aphids, that are non-persistent. As it makes them infect more plants.
- All houses are netted with 50 micron shade mesh (Appears critical)
- All doors have a quarantine section.

Technology Transfer

Extension activities were a major focus of this project. An earlier HAL project (VG06037) worked with a few growers in the beginning of an IPM program in capsicums but this project was more extensive. Growers in Perth had monitoring visits every week for three years. While Carnarvon growers had monthly visits during the growing season, Manchil IPM Services also trained staff from Carnarvon Growers Association (CGA) on insect and mite identification, who in turn were able to provide feedback on some field trials. However due to the changing of staff at (CGA), it became difficult to train different people over this period.

Manchil IPM Services also visited Geraldton growers every month during the growing season to monitor crops and train growers and staff from Great Northern Rural on how to monitor for insects and mites.

Manchil IPM Services travelled to Victorian and South Australian growers 4-5 times a season over 3 years to monitor their crops and to train growers on how to monitor for insects and mites. In South Australia we worked closely with Tony Burfield in helping to monitor insects and mites in capsicums.

We attended the annual E.E. Muirs and Sons consultant meeting at which we presented the IPM program we have developed for capsicums to over 50 horticultural consultants.

Lachlan Chilman and James Altmann were guest speakers at the Bi Annual Australian Greenhouse conference in South Australia in 2011 presenting our IPM programs in Capsicums.

The South Australian Grower wrote an article on the *O. armatus* called "The potential biological weapon against Thrips" in Nov 2010.

Commercial trials with *O. armatus* were conducted in Western Australia, South Australia, Victoria and Tasmania. Trials were conducted in the 2009-2010, 2010-2011 and 2011-2012 growing seasons by Manchil IPM Service and Biological Services. Marilyn Steiner and Stephen Goodwin collected the extension information from both companies and have compiled reports.

Close to 90% of all growers that undertook the IPM programs continue to use Biocontrols as their main approach for controlling WFT. Some growers do not need to release *O. armatus* into each crop due to their low pressure situation and a few growers ended up using non-registered insecticides to control WFT. Growers can obtain information on Manchil IPM Services website http://manchilipmservices.com.au/ and email orders to info@manchilipmservices.com.au.

Recommendations

- Search for new *Orius* species that don't enter diapause will continue all over Australia by crop scouts and researchers *O. armatus* was found in the field during routine monitoring of crops so we are hopeful of finding more species that are yet to be identified or are hitch hiker insects, such as *Hippodamia* lady beetles.
- A key outcome from the project was that feeding costs for *O. armatus* are extremely high and make up more than 60% of the cost of production and an alternative feeding source that is cheaper to produce will be researched and developed in coming years.
- The problem of imidacloprid residue in field grown capsicums is a major concern and we are hopeful that Bayer CropScience will publish any existing research they have on this problem or carry out research immediately to determine how long imidacloprid remains in the soil.
- More chemical testing of pesticide residues on produce in Australia by retail food outlets should be done so that growers will not take a risk in using unregistered chemicals and will have to look at using more biological control agents as has happened in other developed countries, like Spain.
- A larger market is required for commercial rearing of *O. armatus* to be economically viable. We need to work with low tech capsicum growing regions like Bundaberg/Bowen in Qld, the Adelaide Plains area in SA, and Carnarvon in WA where there are significant plantings of Capsicums and develop IPM programs. This could be done by working with the crop monitoring businesses located in these regions like Bowen Crop Monitoring Service and T Systems in Bundaberg. In Virginia there is no crop monitoring services so growers will need to be approached regarding trials on their properties so other growers in the area can see the results.
- Continue to test new insecticides and fungicides for toxicity to *O. armatus*. By growing crops through a full crop cycle, it provides better information than a laboratory trial, especially with systemic chemicals.
- Educate the seedling producers around Australia that the insecticides that they apply will have an effect on biological control agents once the growers transplant them and to show them that they can spray insecticides but ones that are not detrimental to an IPM program.
- Before growers start releasing biological control agents, leaf and soil samples should be taken and tested for insecticide residue. By doing these tests you are able to assess if there are any harmful pesticide residues in the crop prior to releasing the biological control agents thus allowing for the successful establishment of the biological controls.
- Once a successful IPM system is established secondary pests like mirrids become established as previous calendar spraying would have controlled them so the impact of these pests needs to be determined. It is not known if they cause damage to the crop. If mirids do cause damage, at what infestation rate does damage begin?

Acknowledgements

Many people and groups helped with sections of the project and we are grateful for their assistance. In particular we thank the following:

James Altmann from Biological Services who we worked with in partnership, implementing biologically based IPM across Australia. James provided key beneficial insects and mites for trials and also gave a number of tips in the rearing of *O. armatus* that was critical.

Many growers across Australia, especially the growers that risked their crops to participate in the initial trials and were prepared to take on improvements each season to improve their IPM systems.

Bayer and Syngenta for providing and applying insecticides in the greenhouse grown insecticide trial.

Dr Sonya Broughton, David Cousins and Jessica Harrison for carrying out bioassay tests for *O. armatus*, and who gave assistance to writing various reports.

Tony Burfield, who has been pushing the IPM dream in South Australia for a number of years and has worked closely with the Cafcakis brothers.

Stephen Goodwin and Marilyn Steiner who have written extensive articles on the extension work carried out in this project, and their support in Biological based IPM is greatly appreciated.

Dr Paul Horne for assistance with writing and editing of the report.

The staff at MANCHIL IPM SERVICES who have aided in rearing of the *O. armatus*, and crop monitoring.

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Appendices

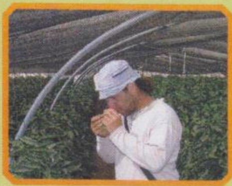
- Biological-Based IPM in protected sweet pepper in Israel 2011
- The South Australian Grower wrote an article on the Orius called the “Potential biological weapon against thrips in Nov 2010.”
- The South Australian Grower wrote an article on the Orius called the “Virginia wins battle to isolate thrips and virus in Nov 2010.”

Biologically-Based IPM in protected sweet pepper in Israel 2011

The package for IPM/Biocontrol in vegetables

Aphidius colemani
A parasitic wasp.
Controls the cotton aphid, the green peach aphid and the tobacco aphid.

Phytoseiulus persimilis
A predatory mite.
Controls the red spider mite and the two-spotted spider mite.

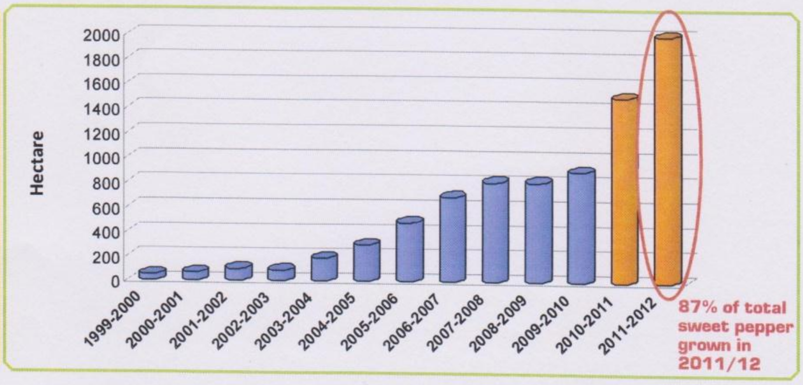


Intensive technical support from planting till crop termination (8 months).

Orius laevigatus
Minute pirate bug.
Controls the Western flower thrips.

Amblyseius swirskii
A predatory mite.
Controls the sweet potato whitefly, the greenhouse whitefly, Western flower thrips and broad mites.

Evolution of IPM/Biocontrol in protected sweet pepper in Israel



IPM/Biocontrol & chemical residues
Results of residue tests in sweet pepper (Holland, 2009)

Country of production	% free of any residues	% under maximal residue limit	% over maximal residue limit
Spain	18	82	0
Holland	50	50	0
Israel	**71**	**29**	**0**

All three countries use biologically-based IPM as the primary method of pest control. In Israel, Biobee is responsible for implementing biologically-based IPM in 87% of the pepper production.

BioBee Sde Eliyahu LTD Beit Shean Valley 10810 Israel
Office:+972-4-6096907 Fax:+972-4-6096908
www.BioBee.com

Potential biological weapon against thrips

By TONY BURFIELD - SARDI

IMAGINE a little insect that loves living in capsicum flowers and eats Western Flower Thrips all day long.

Imagine that it can easily catch those jumpy adult thrips, especially when they visit a flower, which thrips also love to do.

Well I've seen them at work with my own eyes in a crop at Virginia, and believe me, they are quick and hungry and there were dead thrips all over the place that have had their guts sucked out by this wonderful bug.

From July to March last year we conducted our first trial in Virginia with this thrip predator, a small native insect called Orius.

Not everything went according to plan, because there were difficulties getting the Orius bugs established until very late in the crop.

In the end, however, when Orius bugs did establish and breed, they did an amazing job of cleaning up a very heavy infestation of thrips.

Other good bugs were released to control pests like red spider mite, broad mite and aphids, so the growers would not have to spray for them and risk harming the Orius.

Only a few applications of 'soft' insecticide were needed for aphids and red spider early in the crop.

It is suspected that one of these pesticides is the reason Orius did not establish at first.

Although the grower still lost quite a few plants this time because of the late establishment of the thrips bio-control agent, they were impressed enough to want to do a second trial.

ONE: Adult Orius attacking adult Western Flower Thrips

TWO: Aphid mummies that have been parasitized by tiny aphidius wasps (Aphidius colemanii)

The second trial is underway, and this time Orius bugs established without a hitch and are keeping the thrip numbers well down.

In eight weeks the growers have only had to pull out 18 plants with Tomato Spotted Wilt Virus from a crop of nearly 40,000 plants. By this time last year they had removed about 2000 plants. The bio-control strategy is working so well that it will be extended to a soil grown crop that has just been planted on that farm.

If successful in the soil, there will be new hope for controlling Western Flower Thrips on other farms.

The growers are also using bio-control successfully in their eggplant crop for a second successive season.

The first two Orius trials have been conducted in a hydroponic capsicum crop because the grower contributed funds for matching by Horticulture Australia (HAL), and because his house has heating and misting which we thought would make it easier for our first serious trial in a commercial crop.

The trial was supported by two commercial IPM experts, James Altmann from Biological Services at Loxton, and Lachlan Chilman from Western Australia.

James also put in money for matching by HAL, and Lachlan bred and supplied the Orius.

Tony Burfield and Gabriella Caon from SARDI helped to put the proposal together and visited the farm weekly to check the crop and talk with the growers and keep James and Lachlan informed. James and Lachlan made a number of specialist visits to the greenhouse to ensure the program was achieving its goals and to help answer any questions the growers and SARDI staff had.

We do need to finish the trials this year to be confident about what we recommend to growers, but are hopeful that those interested in switching to biological control of thrips and other pests can get the necessary advice in the foreseeable future.

It is expected that growers will need expert support in the first year or two to learn the ropes of running a biological control program which is quite different to a pesticide-based strategy. Early next year, depending on success in the trials and the level of interest in the area, we can look at creating a support program to assist growers wanting to go down this path.

We will also provide information about the costs and time commitments required to run a biological program in comparison with a pesticide program.

The greenhouse region in the south of Spain is a much bigger and more concentrated protected cropping area which began making the switch to bio-control a couple of years ago when the European Common Market banned the use of most pesticides on produce in their markets.

They have demonstrated that a major change of this nature is achievable.

Details: Tony Burfield – 0401 120 857 or James Altmann at Biological Services – 8584 6977. Lachlan Chilman can be reached on 0403 727 252.

THREE: The current crop

Virginia wins battle to isolate thrips and virus

By TONY BURFORD, Sunstainabe Farming Services

THE native Australian Orius bug has delivered fully on the promise made last season – after an encouraging trial – that it would beat western flower thrip.

In a high-tech hydroponic capsicum crop this year, planted in September, thrips and virus were controlled until early February.

Up to this point, less than 100 plants out of 40,000 had been lost to tomato spotted wilt virus in about six months.

After two disastrous years battling the pest, the grower is again making some real money.

Once again, other pests were very well controlled with the original releases of various natural enemies from commercial 'good' bug breeders – Biological Services at Loxton and Orius, from Manchil, in Western Australia.

A persistent outbreak of broad mite in one plant variety, near the greenhouse doorway, required additional releases of predatory mites.

There were also numerous 'free' natural enemies entering the crop again and helping with pest control.

One very important lesson with biological control is that growers need to ensure they do not allow pests to build up too much before introducing the natural enemies, making their job too hard. This may require initial and minimal use of compatible pesticides to hold down pest levels in the early stages.

This is not only true for thrips, but also whitefly, aphids and mites. Grubs can always be controlled with Bacillus Thuringiensis toxin and similar products that use a virus to attack the pest, without upsetting the natural enemies.

Spraying is not an answer to pest control problems, but can be a support when soft chemicals are required while the beneficials are getting established.

A typical example of this is using spot spraying with pirimicarb (eg, Pirimor) to control early aphid outbreaks until the parasitic wasps that control aphids can build up.

Biological control has its challenges that need to be managed at every stage of the crop.

This was demonstrated again this year when we attempted to implement biological control of thrips in a soil capsicum crop on the same farm.

Unfortunately, there was a gap in our planning. Instead of raising the seedlings on farm, they were purchased from a nursery without checking the nurseries pesticide program.

When natural enemies were introduced to the young plants, none of them established. We realised the seedlings might have a long-term systemic pesticide and this was indeed confirmed to be the case.

As with the hydroponic crop last year, biological control is worth another go in soil crops.

If any growers are interested in moving toward this option, two additional strategies would be helpful:

• Use plenty of compost to build up the organic carbon in the soil. This helps to support predatory mites and beneficial fungi that can attack the thrips pupae falling to the soil during part of their life-cycle, as well as making the plants generally stronger.

• Plant narrow strips of selected native vegetation in available space around the property as recommended by SARDI from the *Revegetation by Design* research program.

(I can supply a free booklet about these plants).

This can be used to suppress weeds that host thrips and virus and is also likely to support more natural enemies to attack pests.

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Tony Burfield says pests were very well controlled with the original releases of various natural enemies from commercial 'good' bug breeders.

Take full control of pests, disease

GROWERS at Virginia wishing to ensure pest and disease control should:

• Avoid the build up of weeds on their properties and do not leave old and dying crops unattended to spread pests and virus. It has become very clear during the past two years that without fumigation of the whole greenhouse – not just the dripper lines – the soil holds thrips pupae for many months, often resulting in severe damage to young plants in poly and glasshouses that have previously had a heavy thrip and virus infection. Now that qualified fumigation services are more difficult to obtain, growers need to be very aware of this threat.

• Remove all crop waste from properties as soon as it is pulled out, or at least put it in a bin or bury it. Unless the waste is disease-free, chopping in can have its own risks with some plant viruses and root diseases surviving in the old plant material in the soil.

But if the soil is reasonably moist and has good levels of organic carbon, breakdown of plant waste is much more efficient and may help to reduce disease levels. Crop rotation is also a very good strategy.

Growers and crop consultants who have visited the trial site recognise that what can be achieved in Virginia is a very significant demonstration of the power of biological control in such a close-packed farming area where pests are continually abundant.

We feel that it has been demonstrated that biological control is a viable, commercial option.

More information about these biological control trials will be delivered later this year at grower workshops and on a DVD.

Hopefully, by then a third set of trials will be under way involving hydroponic soil crops that demonstrate a truly effective biological pest control program in capsicums for adoption by the rest of protected cropping industry.

Details: 0401 120 875.