Know-how for Horticulture™

Management options for controlling melon thrips in vegetable crops

Bronwyn Walsh
QLD Department of Primary Industries and Fisheries

Project Number: VX01018

VX01018

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the vegetable industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of QFVG, Sumitomo Agricultural Producers Commission, the potato unprocessed and value added and vegetable industry.

ISBN 0 7341 0912 1

Published and distributed by:
Horticultural Australia Ltd
Level 1
50 Carrington Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399
E-Mail: horticulture@horticulture.com.au

Know-how for Horticulture™

Queensland **the Smart State**

Final report

Horticulture Australia Project VX 01018

Managing melon thrips in vegetable crops.

Bronwyn Walsh
Queensland Department of Primary Industries and Fisheries

Queensland Government
Department of Primary Industries

Horticulture Australia Project Number VX 01018
March 2004

Project Leader: Bronwyn Walsh

Contact details: Postal: Locked Bag 7
MS 437
Gatton QLD 4343
Ph: (07) 5466 2222
Fax: (07) 5462 3223
e-mail: Bronwyn.Walsh@dpi.qld.gov.au

Key personnel

Mr John Maltby
Mr Brendan Nolan
Mr Iain Kay
Mr Larry Cooper
Mr John Donaldson

This document reports on research activities undertaken during the Horticulture Australia project VX 01018, from November 2001 until March 2004.

Acknowledge funding contribution of Horticulture Australia, Heavy Produce Committee of Queensland Fruit and Vegetable Growers, Sumitomo Chemicals and Queensland Department of Primary Industries and Fisheries.

Contents

Media summary

Melon thrips, *Thrips palmi*, took their toll on vegetable crops in the Lockyer Valley, Queensland, over several seasons in the late 1990s and into the new millennium. Potato and cucurbit crops in particular suffered severe damage. During the same period, melon thrips were detected in northern horticultural regions of Queensland. In addition the potential exists for this pest to spread further to temperate regions, especially to glasshouses. The establishment and spread of melon thrips threatens horticultural crops by affecting the quality and quantity of supplies and market accessibility. At a meeting with stakeholders in October, 2000 it was agreed that immediate action was necessary to address the rising threat of melon thrips.

Melon thrips is a relatively new pest to establish itself in horticultural crops in Queensland. Worldwide there have been 50-90% losses of a variety of crops, including potatoes, capsicum, eggplant, cucurbits and beans. Not only can melon thrips damage crops but they also pose a market access problem as several states and overseas countries have imposed quarantine restrictions on the movement of host plant material.

Researchers from the Queensland Department of Primary Industries and Fisheries (DPI&F) investigated the seasonal abundance of thrips and damage in potato and capsicum crops and conducted insecticide efficacy trials to investigate short term management options for this pest. The project also provided support to research into viruses that are spread by thrips.

The Lockyer Valley and Bundaberg regions were targeted for the thrips surveys as melon thrips infestations are already present in these areas and they are major regions for potato and capsicum production in Queensland.

Potato crops in the Lockyer Valley were monitored for melon thrips in autumn and spring 2002. A 30% loss in premium grade yield was recorded in autumn Sebago crop. An analysis of the costs showed that for an investment of $300/ha towards monitoring and an effective pesticide, a loss of $2400/ha in yield and ineffective management practice would be avoided.

Another consideration for effective management is the thrips species present. Thrips identifications have shown that the load of different thrips species varies throughout the year. It is important to correctly identify thrips in order to choose appropriate pesticides.

Capsicum crops in the Bundaberg and Lockyer Valley region were monitored for thrips in autumn and summer crops. Flowers were used for monitoring the capsicum and to investigate the thrips species complex in capsicum crops. Western flower thrips (WFT), *Frankliniella occidentalis*, tended to be the dominant species in spring and summer capsicum crops while melon thrips was present in the autumn crops. In most autumn crops there was less than 1.4 thrips per flower and in summer crops up to 8 thrips per flower, with no damage evident. Silvering on maturing capsicum fruit was recorded around the State during 2002. It was suggested that it was due to thrips feeding on developed fruit rather than the traditional means of damage, done early in the flower as the young fruit develops. A damage assessment as well as monitoring the level of thrips was conducted in the second year of the project to clarify causal agents for the damage seen on capsicum fruit.

There is some confusion over the damage caused by thrips in capsicum; in part due to the silvering damage recorded this year. In response to this confusion we will conduct a more detailed threshold trial to establish levels of thrips that cause damage to capsicum fruit. Seasonal abundance in capsicums in the different growing regions will continue to consolidate and add to data gathered this year.

Two insecticide trials were conducted towards getting minor use permits for managing melon thrips in potatoes and capsicums. Trials were frustrated by very low numbers of melon thrips. An efficacy trial in a capsicum crop indicated some effective pesticides for use against thrips.

Evidence from the seasonal abundance trial in potatoes suggests that imidacloprid is effective against melon thrips. This product was included in the insecticide trials.

Two DPInotes outlining biology, seasonal abundance and management options for melon thrips in potatoes and thrips in capsicums have been produced. Both are 3-4 page factsheets with images, diagrams and information on the thrips in the relevant crops. The DPInotes will be available via the Internet at www.dpi.gov.qld.au. The DPInote also directs the reader to information on other pests and their management in potato and capsicum crops.

Valuable experience has been gained from the research and extension activities in this project and it will be useful for future sites of infestation around Australia. The project's activities have provided information towards understanding the biology of the pest, pesticide efficacy, training and information. These are the first steps in overcoming the sole reliance on pesticides for thrips management, effective and legitimate use of new control strategies, improved market access of produce, integration of melon thrips control into existing pest management in host crops, reduction in pest status of thrips and the maintenance of supply of safe, environmentally responsible produce.

Management tactics for other thrips such as WFT, developed in previous and current projects, provide complementary information that growers can use for integrating the wider thrips management issues. Managing thrips has become particularly important to integrated pest management (IPM) growers lately. These growers have switched to biological pesticides to manage caterpillar pests, consequently they are becoming more aware of other pest species present in the crop. The information on identification, thresholds and access to control options - 'soft' and 'hard' are important to these growers to avoid interrupting their IPM systems.

For effective thrips management in potato and capsicum crops stakeholders should:

- Monitor crops and get thrips species identified
- Choose a management method relevant to the thrips species found
- Be aware that other agents could be causing damage sometimes attributed to thrips
- Be aware of all pests and natural enemies present when making management choices

This project has provided the first opportunity to study melon thrips in Queensland. It has meant that the seasonal abundance and potential thresholds for implementing management practices against melon thrips in potatoes and thrips in capsicums could be investigated

It has highlighted some of the difficulties in working with melon thrips

In capsicum crops it has provided evidence of efficacy of current pesticide registered for WFT and seasonal abundance in the Bundaberg region

Future research and extension activities should be aimed at five areas. The first to investigate options other than pesticides for managing melon thrips, as well as other pests in potato and capsicum crops. This is important considering both crops have several major pests that develop tolerance to pesticides. Interstate and international research indicates that melon thrips does not remain a serious pest if several management options are used instead of sole reliance on pesticides. Alternative options have included growing different varieties, using irrigation and natural enemies. For any of the management practices developed, activities should include the developing or validating thresholds.

The second is the efficacy of other pesticides remains to be investigated, and is important for providing pesticide groups for rotation to avoid the development of tolerance to pesticides in thrips populations. New chemistries can also provide choices that are ‘softer’ on natural enemies. Alternative application than foliar application can also provide some protection to natural enemies and has proved effective

Thirdly the biology of melon thrips could be investigated to discover the reason for it becoming a pest, whether due to the absence of natural enemies or a biological mechanism triggered by the application of pesticides. Understanding this will help to implement the most effective management practices.

Fourthly, other pests playing a role in the system, for example broad mite, silverleaf whitefly and aphids have all been identified as potentially influencing the level of melon thrips present or being responsible for damage attributed to melon thrips. Any of these pests could be investigated further.

And lastly, other solanaceae crops such as eggplant and chillies were reported to be suffering damage to different extents during the life of the project. Evidence of scarring damage was seen in eggplants and some chilli varieties in Bundaberg and the Granite Belt regions. Similar results have been seen overseas in Thailand, South America and India. These crops would benefit from research specific to their needs.

Technical summary

Melon thrips, *Thrips palmi*, took their toll on vegetable crops in the Lockyer Valley, Queensland, over several seasons in the late 1990s and into the new millennium. Potato and cucurbit crops in particular suffered severe damage. During the same period, melon thrips were detected in northern horticultural regions of Queensland. In addition the potential exists for this pest to spread further to temperate regions, especially to glasshouses. The establishment and spread of melon thrips threatens horticultural crops by affecting the quality and quantity of supplies and market accessibility. At a meeting with stakeholders in October, 2000 it was agreed that immediate action was necessary to address the rising threat of melon thrips.

Melon thrips is a relatively new pest to establish itself in horticultural crops in Queensland. Worldwide there have been 50-90% losses of a variety of crops, including potatoes, capsicum, eggplant, cucurbits and beans. Not only can melon thrips damage crops but they also pose a market access problem as several states and overseas countries have imposed quarantine restrictions on the movement of host plant material.

Researchers from the Queensland Department of Primary Industries and Fisheries (DPI&F) investigated the seasonal abundance of thrips and damage in potato and capsicum crops and conducted insecticide efficacy trials to investigate short term management options for this pest. The project also provided support to research into viruses that are spread by thrips.

The Lockyer Valley and Bundaberg regions were targeted for the thrips surveys as melon thrips infestations are already present in these areas and they are major regions for potato and capsicum production in Queensland.

Potato crops in the Lockyer Valley were monitored for melon thrips in autumn and spring 2002. A 30% loss in premium grade yield was recorded in autumn Sebago crop. An analysis of the costs showed that for an investment of $300/ha towards monitoring and an effective pesticide, a loss of $2400/ha in yield and ineffective management practice would be avoided.

Another consideration for effective management is the thrips species present. Thrips identifications have shown that the load of different thrips species varies throughout the year. It is important to correctly identify thrips in order to choose appropriate pesticides.

Capsicum crops in the Bundaberg and Lockyer Valley region were monitored for thrips in autumn and summer crops. Flowers were used for monitoring the capsicum and to investigate the thrips species complex in capsicum crops. Western flower thrips (WFT), *Frankliniella occidentalis*, tended to be the dominant species in spring and summer capsicum crops while melon thrips was present in the autumn crops. In most autumn crops there was less than 1.4 thrips per flower and in summer crops up to 8 thrips per flower, with no damage evident. Silvering on maturing capsicum fruit was recorded around the State during 2002. It was suggested that it was due to thrips feeding on developed fruit rather than the traditional means of damage, done early in the flower as the young fruit develops. A damage assessment as well as monitoring the level of thrips was conducted in the second year of the project to clarify causal agents for the damage seen on capsicum fruit.

There is some confusion over the damage caused by thrips in capsicum; in part due to the silvering damage recorded this year. In response to this confusion we will conduct a more detailed threshold trial to establish levels of thrips that cause damage to capsicum fruit. Seasonal abundance in capsicums in the different growing regions will continue to consolidate and add to data gathered this year.

Two insecticide trials were conducted towards getting minor use permits for managing melon thrips in potatoes and capsicums. Trials were frustrated by very low numbers of melon thrips. An efficacy trial in a capsicum crop indicated some effective pesticides for use against thrips. Effective pesticides for managing western flower thrips (WFT), *Frankliniella occidentalis*, in capsicum crops are spinosad, methidathion, fipronil and abamectin for nymphs

Evidence from the seasonal abundance trial in potatoes suggests that imidacloprid is effective against melon thrips. This product was included in the insecticide trials.

Two DPInotes outlining biology, seasonal abundance and management options for melon thrips in potatoes and thrips in capsicums have been produced. Both are 3-4 page factsheets with images, diagrams and information on the thrips in the relevant crops. The DPInotes will be available via the Internet at www.dpi.gov.qld.au. The DPInote also directs the reader to information on other pests and their management in potato and capsicum crops.

Valuable experience has been gained from the research and extension activities in this project and it will be useful for future sites of infestation around Australia. The project's activities have provided information towards understanding the biology of the pest, pesticide efficacy, training and information. These are the first steps in overcoming the sole reliance on pesticides for thrips management, effective and legitimate use of new control strategies, improved market access of produce, integration of melon thrips control into existing pest management in host crops, reduction in pest status of thrips and the maintenance of supply of safe, environmentally responsible produce.

Management tactics for other thrips such as WFT, developed in previous and current projects, provide complementary information that growers can use for integrating the wider thrips management issues. Managing thrips has become particularly important to integrated pest management (IPM) growers lately. These growers have switched to biological pesticides to manage caterpillar pests, consequently they are becoming more aware of other pest species present in the crop. The information on identification, thresholds and access to control options - 'soft' and 'hard' are important to these growers to avoid interrupting their IPM systems.

For effective thrips management in potato and capsicum crops stakeholders should:

- Monitor crops and get thrips species identified
- Choose a management method relevant to the thrips species found
- Be aware that other agents could be causing damage sometimes attributed to thrips
- Be aware of all pests and natural enemies present when making management choices

This project has provided the first opportunity to study melon thrips in Queensland. It has meant that the seasonal abundance and potential thresholds for implementing management practices against melon thrips in potatoes and thrips in capsicums could be investigated

It has highlighted some of the difficulties in working with melon thrips

In capsicum crops it has provided evidence of efficacy of current pesticide registered for WFT and seasonal abundance in the Bundaberg region

Future research and extension activities should be aimed at five areas. The first to investigate options further options for managing melon thrips, as well as other pests in potato and capsicum crops. This is important considering both crops have several major pests that develop tolerance to pesticides. Interstate and international research indicates that melon thrips does not remain a serious pest if several management options are used instead of sole reliance on pesticides (Kawai & Kitamura, 1987; Kawai, 1990; Cermeli & Godoy, 1993; Young & Zhang, 1998). Alternative options have included growing different varieties, using irrigation and natural enemies. For any of the management practices developed, activities should include the developing or validating thresholds.

The second is the efficacy of other pesticides remains to be investigated, and is important for providing pesticide groups for rotation to avoid the development of tolerance to pesticides in thrips populations. Other pesticides for investigation could include such as Natrasoap®, methidathion and imidacloprid. These represent pesticides that are already registered for use in potatoes and therefore Maximum Residue Levels already exist for potatoes. They are also reported to be effective against melon thrips (Hargreaves, unpublished data; Young & Chang, 1998). Spinosyn is also reported to be effective against melon thrips and is due to be released for use in potatoes in the near future (Doweagrosciences, pers. comm. 2002). New chemistries can also provide choices that are ‘softer’ on natural enemies. Alternative application than foliar application can also provide some protection to natural enemies and has proved effective. Cost effectiveness should also be included as part of the assessment for choosing management options for investigation.

Thirdly the biology of melon thrips could be investigated to discover the reason for it becoming a pest, whether due to the absence of natural enemies or a biological mechanism triggered by the application of pesticides. Understanding this will help to implement the most effective management practices.

Fourthly, other pests playing a role in the system, for example broad mite, silverleaf whitefly and aphids have all been identified as potentially influencing the level of melon thrips present or being responsible for damage attributed to melon thrips. Any of these pests could be investigated further.

And lastly, other solanaceae crops such as eggplant and chillies were reported to be suffering damage to different extents during the life of the project. Evidence of scarring damage was seen in eggplants and some chilli varieties in Bundaberg and the Granite Belt regions. Similar results have been seen overseas in Thailand, South America and India. These crops would benefit from research specific to their needs.

Research report: Introduction

Melon thrips, *Thrips palmi*, took their toll on vegetable crops in the Lockyer Valley, Queensland, over several seasons in the late 1990s and into the new millennium. Potato and cucurbit crops in particular suffered severe damage. During the same period, melon thrips were detected in northern horticultural regions of Queensland. In addition the potential exists for this pest to spread further to temperate regions, especially to glasshouses. The establishment and spread of melon thrips threatens horticultural crops by affecting the quality and quantity of supplies and market accessibility. At a meeting with stakeholders in October, 2000 it was agreed that immediate action was necessary to address the rising threat of melon thrips.

Melon thrips is a relatively new pest to establish itself in horticultural crops in Queensland. Worldwide there have been 50-90% losses of a variety of crops, including potatoes, capsicum, eggplant, cucurbits and beans. Not only can melon thrips damage crops but they also pose a market access problem as several states and overseas countries have imposed quarantine restrictions on the movement of host plant material.

In the Northern Territory, the first point of infestation in Australia, the pest is managed by implementing integrated pest management (IPM). Understanding the biology of the pest, pesticide efficacy, training, information and integrated control options are all included in this project as first steps toward implementing IPM strategies in potato and capsicum crops for managing this pest. The project aims to intervene between the reactive response of seeing thrips and spraying pesticides. Such dependency on the one tool only leads to tolerance of pesticides in the pest population.

Managing thrips has become particularly important to IPM growers lately. These growers have switched to biological pesticides or narrow spectrum pesticides to manage caterpillar pests, consequently they are becoming more aware of other pest species present in the crop. The information on identification, thresholds and access to control options - 'soft' and 'hard' are important to these growers to avoid interrupting their IPM systems.

One of the cornerstones to IPM is monitoring the crop. Project activities investigate the seasonal abundance of thrips in these crops. One of the management tools are effective pesticides, preferably with different modes of action. Only 3 of the 43 pesticides registered for thrips control are reported to be effective against this species. Therefore efficacy trials were conducted.

The project builds on research from overseas that confirm the potential losses in potato crops from melon thrips and have investigated thresholds and management options in potatoes and capsicums. Australian research into thrips such as western flower thrips has also been used in the project.

Initial steps can lead to longer term outcomes such as overcoming the sole reliance on a few pesticides for thrips management, effective and legitimate use of new control strategies, improved market access of produce, integration of melon thrips control into existing pest management in host crops, reduction in pest status of thrips and the maintenance of supply of safe, environmentally responsible produce.

The trials used to address these objectives are described in the following sections with methods, results, discussion, recommendations and the related technology transfer outlined for each.

Determining a threshold in potato crops

Bronwyn Walsh and Brendan Nolan

Introduction

In the late 1990s and the early new millennium, potato growers reported reduced yield, delayed harvest and damage in their autumn crop, particularly the Sebago variety. Inspection of the crop and the thrips present identified melon thrips on the underside of leaves where significant browning was evident. Similar damage had been reported overseas where losses between 30 and 90% have been reported in Phillipines (SEAMEO, 1991), South America (Cermeli & Motagne, 1993), Indonesia (Supartha *et al*., 2000) and Korea (Cho *et al*., 1999;2000).

This trial aimed to establish the seasonal abundance of thrips, particularly melon thrips in the autumn potato crop, in order to develop a potential threshold for managing the pest.

Method

Two commercial autumn plantings of Sebago potatoes were selected for this trial. They were established in late February, 2002 and were properties where melon thrips had been previously identified. Property 1 reported a lower level of thrips since they had decreased the number of pesticide applications while the second property sprayed pesticides more often, including melon thrips as a target.

Within each commercial planting an area of 0.4ha was selected for monitoring the level of thrips. The same area was used to investigate a threshold for managing melon thrips. A complete randomised block design was used with three replicates. Plots were 17m x 18rows wide. Three treatments were applied:

A high threshold of 20 thrips/leaflet
A medium threshold of 3 thrips/leaflet
And a low threshold of 1 thrips/leaflet

Based on the level of thrips present the plots were sprayed with Confidor® (imidacloprid) to keep the level of thrips below the assigned threshold.

Weekly monitoring involved inspecting one lower leaflet per plant from 20 plants per plot for thrips. The number of adults and nymphs present was recorded. Adult thrips were collected at irregular intervals to confirm their identification. Rogor® (dimethoate) and /or Nitofol® (methamidophos) were used to manage aphids and heliothis on Property 2. Fungicides were applied to both plantings as required.

At harvest, May 2002, potatoes were graded and weighed according to the commercial standard.

Analyses of variance were used to compare the treatments.

Results and Discussion

On Property 1 there was no significant difference in the yield of plants from the different thresholds (Figure 1).

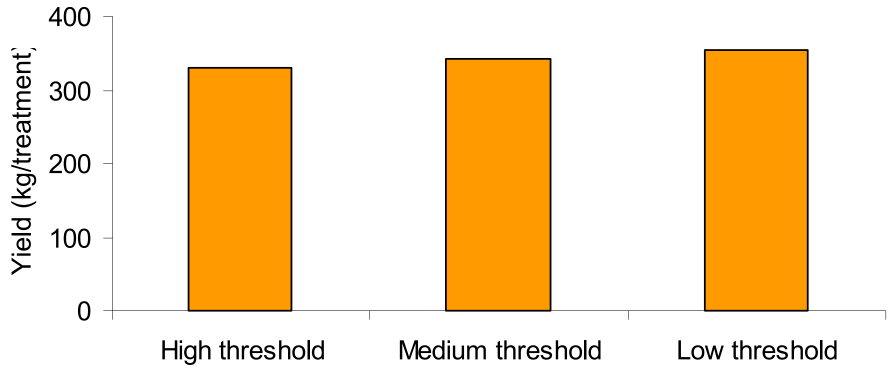


Figure 1. The effect of melon thrips on the potato yield at three different thresholds on Property 1, 2002

The level of thrips on this property was low, at less than 1 thrips per leaflet for all treatments, until May, when it went up to 3-4 thrips per leaflet (Figure 2). After this brief increase, the level of thrips fell back to equal or less than 1 thrips per leaflet in all treatments

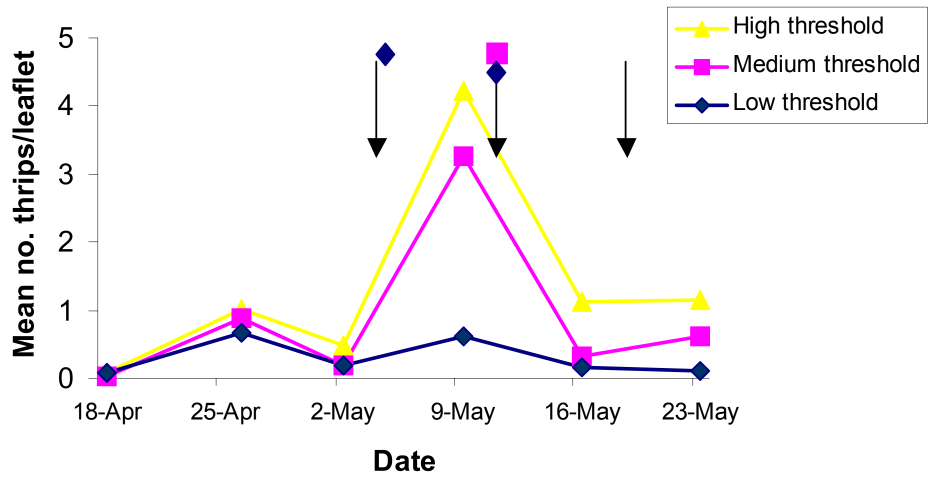


Figure 2. The abundance of melon thrips in three thresholds in a potato crop on Property 1, Lockyer Valley, Queensland, 2002. Arrows indicate the time of a pesticide application. The diamond represents an application to the low threshold and the square represents an application to the medium threshold.

The results from Property 1 indicate that an autumn Sebago crop can tolerate under 1 thrips per leaflet without yield loss and up to 4 thrips per leaflet can be tolerated for a short period, such as two weeks.

On Property 2, there was a significant loss of up to 30% yield due to melon (Figure 3).

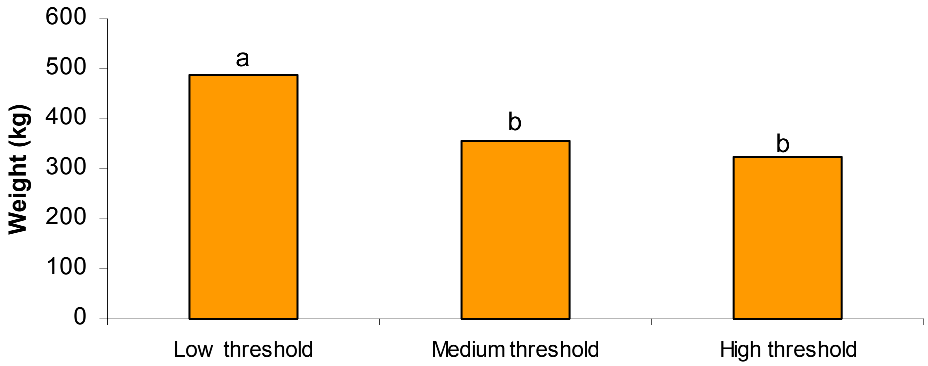


Figure 3. The effect of melon thrips on potato yield at three thresholds on Property 2, 2002. l.s.d.= 22.03

At this property, the level of melon thrips reached over 12 thrips per leaflet and thrips were present at higher numbers throughout the season than on Property 1 (Figure 4). There was also a higher level of thrips from earlier on than on Property 1.

Another observation of note was that despite the medium and low threshold treatments having a similar level of thrips/sampling date overall, at only 2 thrips per leaflet difference most of the time, there was a significant difference in the yield between these two treatments.

The results from this property suggest that the critical time for managing the pest is early in the life of the crop, when the level of thrips in the medium and high thresholds were similar, over 8 thrips/leaflet or that the cumulative effect of the thrips over the crop's life is affecting the yield.

The relatively higher level of melon thrips present on Property 2 may be a result of management practices, such as pesticide application, used against other pests in the crop that either kill the natural enemies of melon thrips or induce a population increase through resistance or other mechanisms.

Using the measured loss of yield of 30%, and the price of an effective pesticide, sprayed 3 times 5-7 days apart, an effective management strategy was considered to be attainable at a cost of $300/ha. While in the absence of an effective management strategy, the value of the yield lost and the cost of the ineffective management choice could cost $2400/ha.

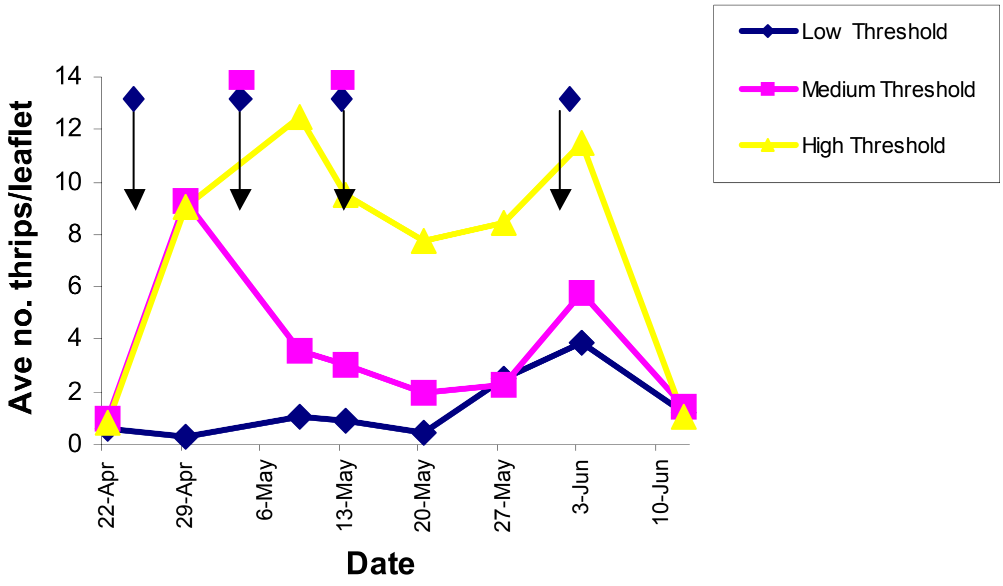


Figure 4. The level of thrips in a Sebago potato crop at three thresholds on Property 2, Lockyer Valley, Queensland, 2002. Black arrows indicate the timing of pesticide applications. A diamond next to the arrow represents an application to the low threshold treatment and a square next to the arrow represents an application to the medium threshold treatment.

Recommendations

Melon thrips can be managed. Yield losses can be avoided with an investment in crop monitoring and effective melon thrips management of about $300/ha versus a loss of $2400/ha.

Effective strategies include:

- monitor the underside of leaves for thrips, particularly nymphs, from the time of crop emergence
- if there are more than four thrips per leaflet at tuber initiation, action may be required
- minimise the application of chemicals for other pests by monitoring and targeting sprays.

Further research in two areas could be considered. The first should test the proposed thresholds, for example to manage melon thrips early in the season if the level is over 4 thrips per leaflet and to develop a cost effective monitoring protocol.

The second area is biology, to investigate the increase in population that may be caused by spraying certain pesticides and lastly management options, to investigate a wider choice of pesticides, to include IPM compatible products. Some options could include Natrasoap®, methidathion and imidacloprid. These represent pesticides that are already registered for use in potatoes and therefore Maximum Residue Levels already exist for potatoes. They are also reported to be effective against melon thrips (Hargreaves, unpublished data; Young & Chang, 1998;). Spinosyn is also reported to be effective against melon thrips and is due to be released for use in potatoes in the near future (Doweagrosciences, pers. Comm. 2002). New pesticides could also be investigated.

Other observations regarding thrips in potatoes

Irregular monitoring in spring potato crops in the Lockyer Valley and interviewing growers revealed that onion thrips, *Thrips tabaci*, were present on leaves in the spring (Cantrell *et a*l., 1983; Horne *et al*., 2002) and there was no apparent loss in yield. This has also been found in Victoria. Other thrips species such as WFT, *Frankliniella occidentalis,* were found in the flowers of potatoes throughout the year but not on the leaves.

Growers also reported no significant loss in yield from Atlantic potatoes grown in the autumn. Growers attributed this to the stronger vigour of Atlantic compared to Sebago potatoes.

Technology Transfer

Results from this trial were presented at a Potato field day, March, 2003. Articles also appeared in March, 2003 in the Gatton Star, QFVG News and Eyes on Potatoes and in September 2003 in Potatoes Australia.

Further, the trial results were incorporated into a DPInote on "Melon thrips in potatoes" that has been produced for potato growers and industry stakeholders. The DPInote is a 3-page factsheet that includes information on the pest's biology, symptoms of damage in potatoes, monitoring techniques and management guidelines. The DPInote also directs the reader to information on other potato pests and their management.

Acknowledgements

The assistance of Carolyn Lee and the cooperation of owners of the two commercial properties were invaluable.

Efficacy of insecticides against thrips in potato crops I

Bronwyn Walsh and Brendan Nolan

Introduction

Various field studies have investigated the efficacy of pesticides against melon thrips (Kawai, 1990; Seal, 1994; Young & Zhang, 1998). Those that are already registered for use in potatoes and some potential pesticides were included in this trial investigating the efficacy of insecticides against melon thrips in autumn potatoes.

Method

Sebago potatoes were planted at the DPI&F Gatton Research Station in late February, 2002. There were eight insecticide treatments and each treatment was replicated three times. A randomised block design was used to allocate treatments within the planting.

Unsprayed
Rogor, dimethoate
Confidor, imidacloprid
Success, spinosad
Supracide, methidathion
Vertimec, abamectin
Product in development, MTI446
Product in development, S1812

Treatments were applied at the recommended rate using a backpack sprayer at a volume of 450L/ha. The plots were sprayed twice, 5 days apart.

In a trial area of 450m^2, plots were 5m long and 5 rows wide. Monitoring was conducted weekly by selecting 5 plants per row and counting the number of nymphal and adult thrips on the underside of one leaflet per plant. This gave an indication of the level of thrips present in order to indicate when to start the trial. Once sufficient thrips were present, one leaflet from 10 plants was monitored pre-spray and 1 day after each spray. Adult thrips were identified to confirm they were melon thrips.

The planting was not sprayed with insecticides except for the treatment applications. Fungicides were applied as required to ensure the health of crop.

At harvest, May 2002, potatoes were graded and weighed according to the commercial standard.

Analyses of variance were used to compare differences between the harvest and level of thrips in treatments. A log transformation was applied to the thrips data.

Results and Discussion

There was no significant difference in the harvest results between treatments.

The level of melon thrips present in the trial was very low making it difficult to draw any strong conclusions from the data. Analysis showed there was no significant difference between treatments for adults or nymphs. The low number was attributed to a large aphid infestation that developed while we were waiting for the melon thrips population to build up. There was potentially competition between the two pests for the same feeding sites. It was difficult to manage the aphid population since many aphicides were reported to be effective against melon thrips and would therefore potentially jeopardise the melon thrips population we were trying to encourage within the crop. Alternative sites were considered and prepared however the unregistered nature of the products resulted in a withdrawal of cooperation for this trial.

Other observations

On the property used for the threshold research, conducted at the same time as this trial, dimethoate was used on some of the treatments and did not seem to affect the development of the melon thrips population. It may have increased the population.

The successful use of imidacloprid to moderate the level of melon thrips in the threshold treatments seems to indicate that it is effective against melon thrips.

Recommendations

The difficulties experienced in this trial suggested that it be repeated and to take steps to control aphids and to introduce melon thrips artificially.

Technology transfer

Due to the inconclusive results from this trial no technology transfer activity occurred except to discuss trial improvements with chemical companies and other entomologists.

Acknowledgements

Many thanks to Carolyn Lee, Sandra Dennien, David Schofield and DPI&F farm staff for their assistance with this trial.

Efficacy of insecticides against thrips in potato crops II

Bronwyn Walsh and Brendan Nolan

Introduction

This trial aimed to repeat the efficacy trial attempted in the previous season, and to investigate the best management option for managing melon thrips in autumn potatoes.

The trial was established however preliminary monitoring revealed there were insufficient thrips to conduct an efficacy trial. Seeding the crop with melon thrips did not increase the level of thrips and silverleaf whitefly, *Bemesia tabaci Biotype B* became established early in the crop.

Method

A planting of Sebago potatoes, 96m^2, was planted at DPI&F Gatton Research Station on March 5th, 2003. It was treated with dimethoate for aphids since the previous season's trial had a problem with aphids. The eight treatments planned for the trial included insecticides for testing their efficacy and two treatments for investigating the timing of pesticides applications. Each treatment was replicated three times.

Unsprayed
Success, spinosad
Admiral, pyriproxyfen
Product under development, S1812
Product under development, MTI446
Confidor, imidacloprid
Early season threshold
Later season threshold

Treatments were applied at the recommended rate using a backpack sprayer at a volume of 450L/ha. A randomised block design was used to allocate treatments to the planting. Plots were 8m long and 6 rows wide. An inner area of 4 rows x 5m was used to select plants for monitoring. Monitoring was conducted weekly by selecting 5 plants per row and counting the number of nymphal and adult thrips on the underside of one leaflet per plant. This gave an indication to assess the level of thrips present in order to decide when to start the trial.

Melon thrips were reared in the laboratory and released weekly into the potato planting to encourage the establishment of a population in the crop.

Results

Results of the preliminary monitoring are shown in Figure 1.

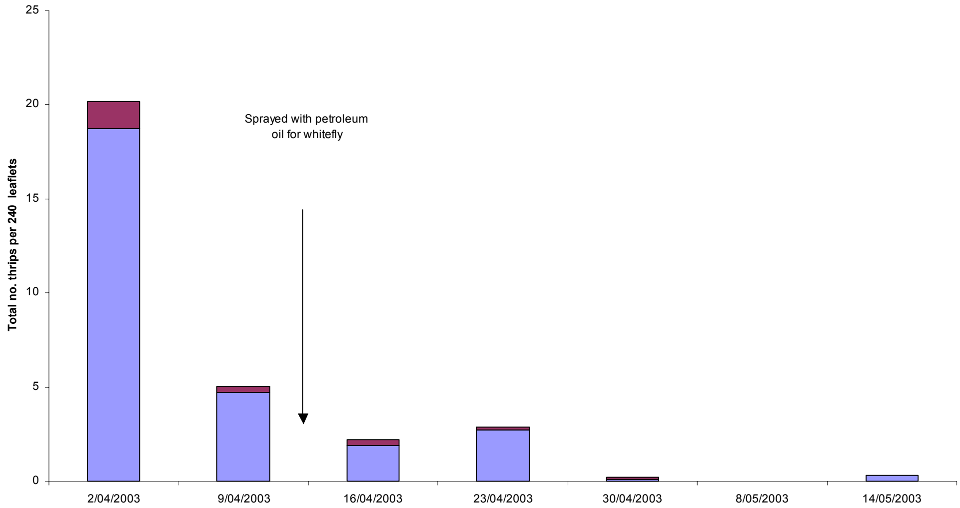


Figure 1. The number of adult and nymphal thrips per sample

This season aphids were not a problem however silverleaf whitefly became established in the trial area. Management options for this pest were limited as effective pesticides can potentially impact on melon thrips and therefore hinder the establishment of a melon thrips population. An application of petroleum oil was made on 9th April. It was hoped the oil would have minimum impact on the melon thrips..

Other observations

The use of petroleum oil may have reduced melon thrips (Figure 1), although a drop in the number of thrips was seen in the previous year's trial as well.

Recommendations

Laboratory trials seem to be the best method for investigating efficacy of pesticides against melon thrips, particularly if new or unregistered pesticides are included.

Collecting data on alternative pesticides from different insecticide groups and that have a low impact on natural enemies should be targeted for future efficacy trials.

Technology transfer

No technology transfer occurred for this activity.

Acknowledgements

Many thanks to Karen Kruger, Sandra Dennien, David Schofield and DPI&F farm staff for their assistance with this trial.

Seasonal abundance of thrips in capsicum crops

Bronwyn Walsh, John Maltby, Brendan Nolan and Iain Kay

Introduction

Thrips damage to capsicums from field or protected crops has been reported around the world (Kumar, 1995; Lacasa *et al*., 1995; Morishita & Azuma, 1998). Thrips feed in the flowers leading to poor seed set and fruit distortion. Damage to the fruit has also been described as curling and scarring of calyx and areas of bronzing and silvering on the surface. Feeding on young expanding fruit results in suture-like scars. It is often worse where fruit has remained in contact with other plant parts (Frantz *et al*., 1995). Melon thrips also feed on the foliage and cause leaf distortion and shortened internodes.

In Queensland, melon thrips have been identified in Bundaberg and Lockyer Valley capsicum crops. Capsicums are also grown in the Granite Belt region where melon thrips have not been reported. Similar to overseas studies (Kawai, 1990; Lacasa *et al*., 1995; Frantz *et al*., 1995; Shipp *et al*., 1996; Morishita & Azuma, 1998), the seasonal abundance and thresholds of thrips in capsicum crops was investigated as a starting point to developing management practices to prevent losses caused by thrips.

Method

Fifty flowers were taken weekly from commercial capsicum properties around Bundaberg, Queensland intermittently between July 2002 and July 2003. Thrips were collected from the flowers, counted and adults were mounted on microscope slides for species identification.

Due to the time involved in processing thrips for identification, a full survey was not conducted in the Lockyer Valley and Granite Belt regions of Queensland.

Harvest assessment quantified the types of damage occurring and being reported as thrips damage.

Results and Discussion

Species distribution

Analysis of the thrips species composition in capsicum flowers from Bundaberg showed there is a difference in the species composition according to the time of the season. Western flower thrips tended to dominate in the spring while melon thrips was present in the autumn (Figure 1). *Pseudanaphothrips achaetus* was the next most abundant species present in the capsicum crops monitored (Figure 1). Onion thrips, tomato thrips, *Frankliniella schultzei*, and other thrips species represented less than 5% of the thrips population in the flowers throughout the year. Given the different efficacy of pesticides against thrips species, this information highlights the importance of correct thrips identification when choosing pesticides for managing thrips.

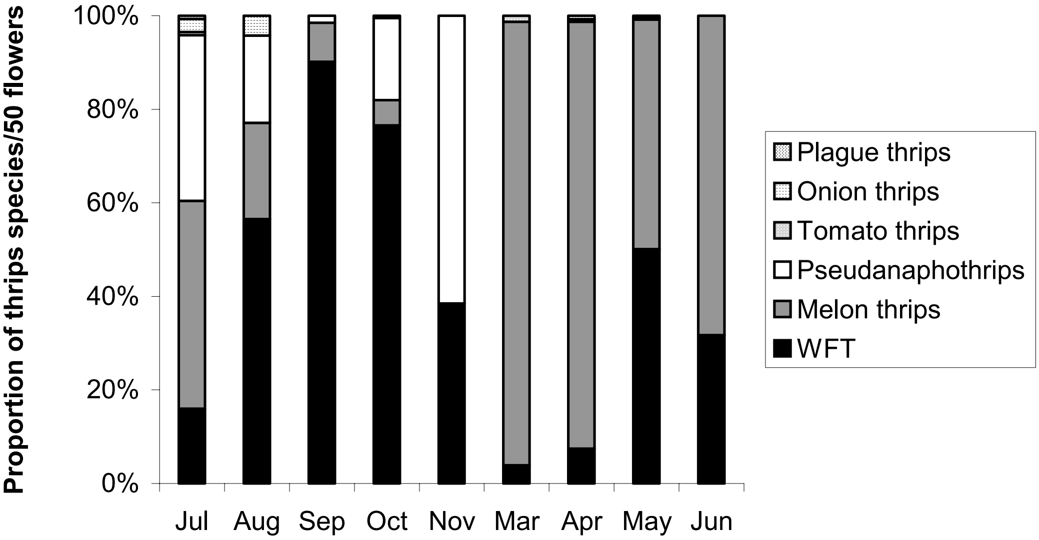


Figure 1. The average proportion of thrips in 50 capsicum flowers from commercial crops in the Bundaberg region, 2002-2003.

The proportion of thrips species present was different between sites. Site 3 had 80% western flower thrips in May-June, while on Site 6 there was an average of 30% WFT at the same time of year (Figure 2). All of the sites that were monitored, in September the highest proportion of WFT was recorded, from 40-90%, and the lowest was in July when there was less than 20% WFT. The greatest range of proportion of WFT present between sites was in May and June where it ranged from 0-80%. The proportion of melon thrips present in June or July was 0-85%. The proportion of melon thrips present on sites complemented the presence of WFT, except at sites 4,5 and 6 where there were *P. achaetus*, at 15-85% of total thrips species. Site 4 had the highest diversity in thrips species.

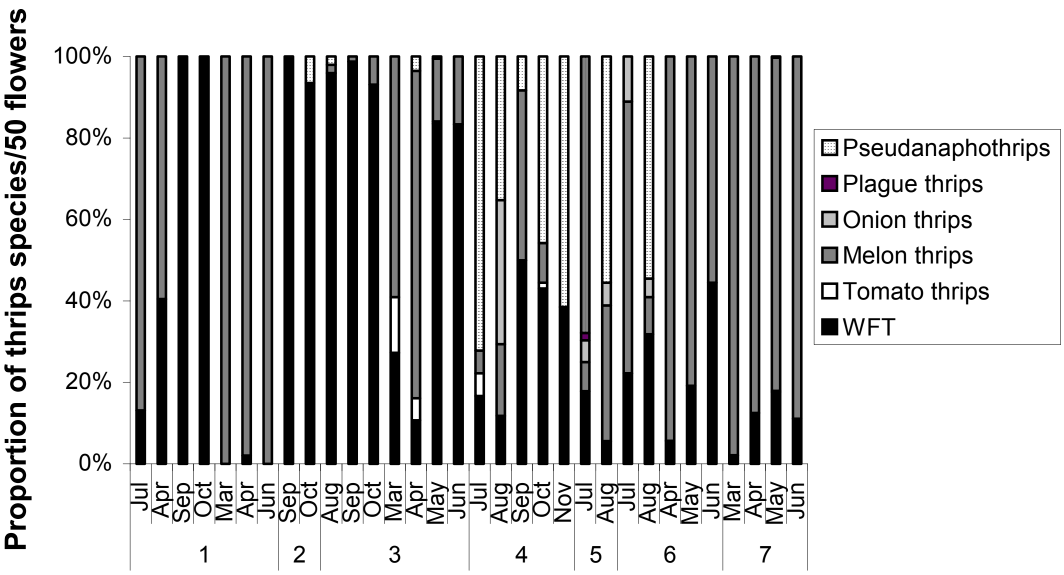


Figure 2. The average proportion of thrips species per 50 capsicum flowers from 6 commercial plantings in the Bundaberg region from Jul 2002 to June 2003

Plague thrips, onion thrips and tomato thrips were present at levels less than 5% of the total thrips population throughout the year.

In the Lockyer Valley in summer WFT was also the dominant species in a sample of capsicum flowers from an unsprayed planting, at 65% of the total population (Figure 2). Melon thrips were only represented by 5% of the thrips population and other thrips species made up more than 20% (Figure 2). The other thrips species included plague thrips and Tubuliferans. The higher diversity in species is indicative of the usnprayed nature of the planting.

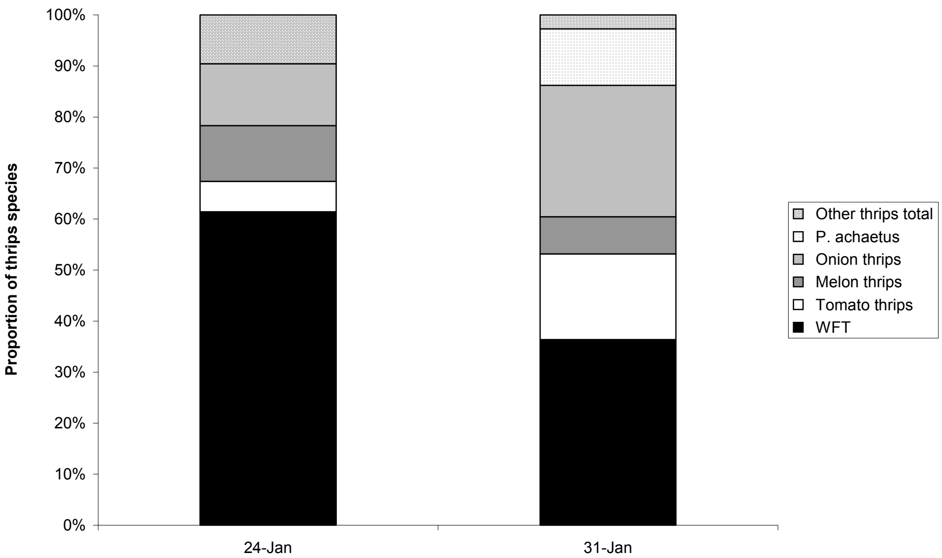


Figure 2. The proportion of thrips species found in flowers from an unsprayed capsicum planting in the Lockyer Valley, Jan 2002

No melon thrips were found in capsicum flowers from the Granite Belt region (Figure 3). Again the dominant species was western flower thrips from February to March. Other thrips species such as plague thrips, tomato thrips and *P. achaetus* were also present.

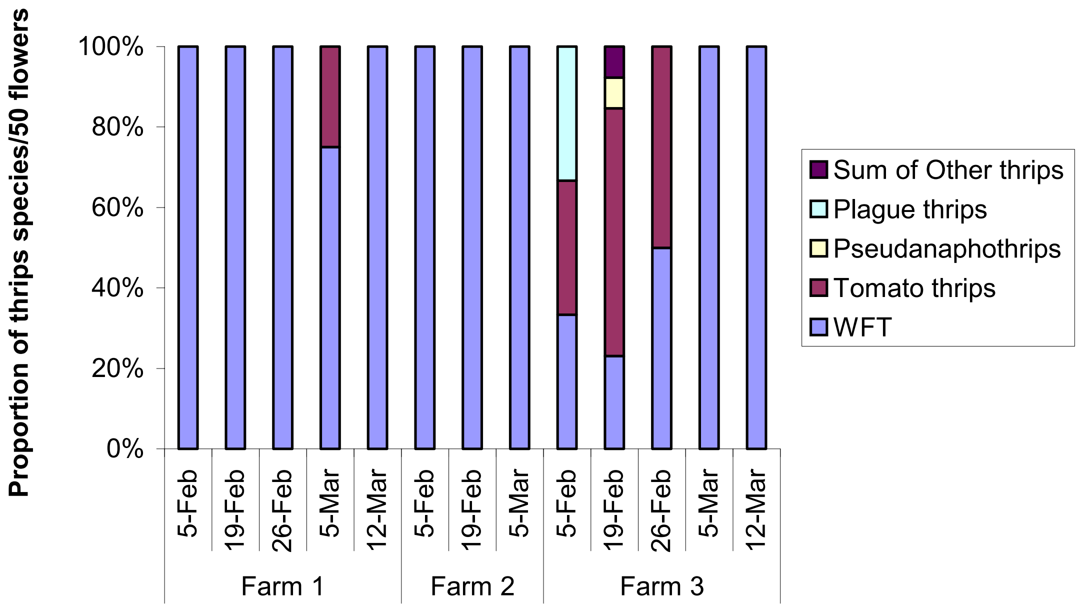


Figure 3 The thrips species in capsicum flowers from three commercial capsicum plantings in the Granite Belt region, Feb-Mar 2003

Abundance

The number of thrips present on properties were similar to the different proportion of thrips species found between properties, in that there was a different level of thrips present between properties at different times of the year in the Bundaberg region (Figure 4). On three properties monitored in the autumn period, melon thrips were present between 30-250 thrips per 50 flowers, equivalent to 0.6-5 thrips per flower between March and April. The number rapidly dropped on the three properties in June.

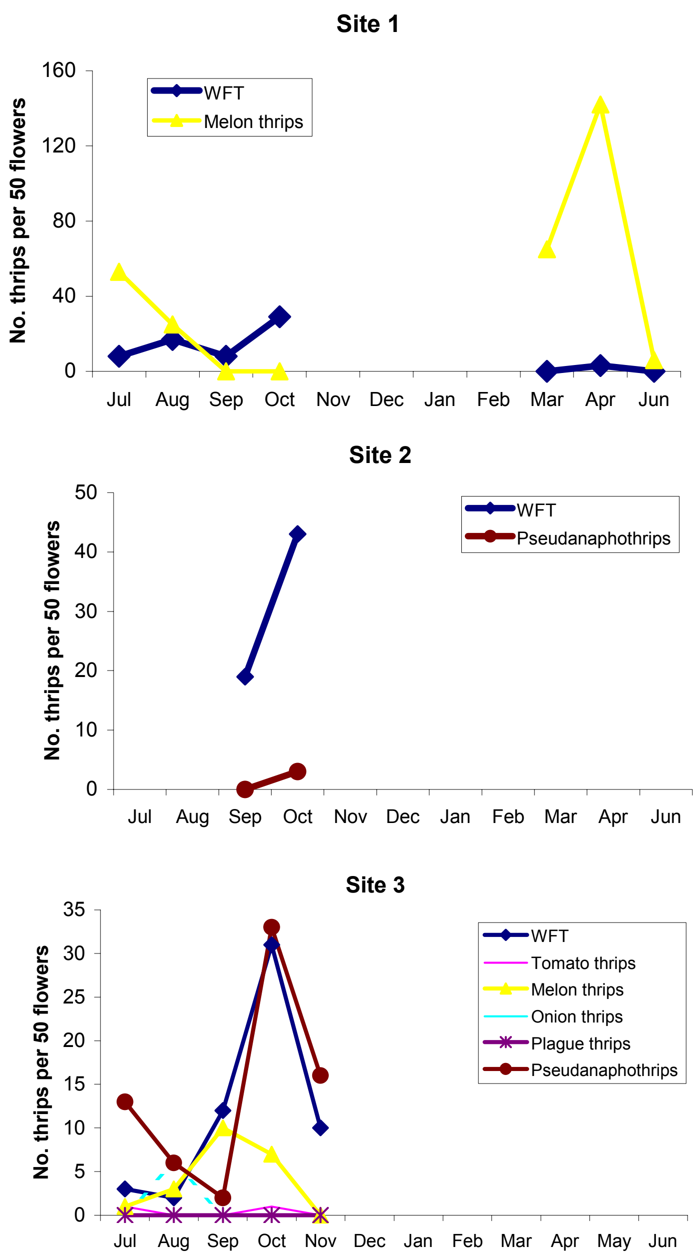


Figure 4a. The average number of thrips per sample from sites 1-3 of 6 commercial capsicum plantings in the Bundaberg region from July 2002 to June 2003

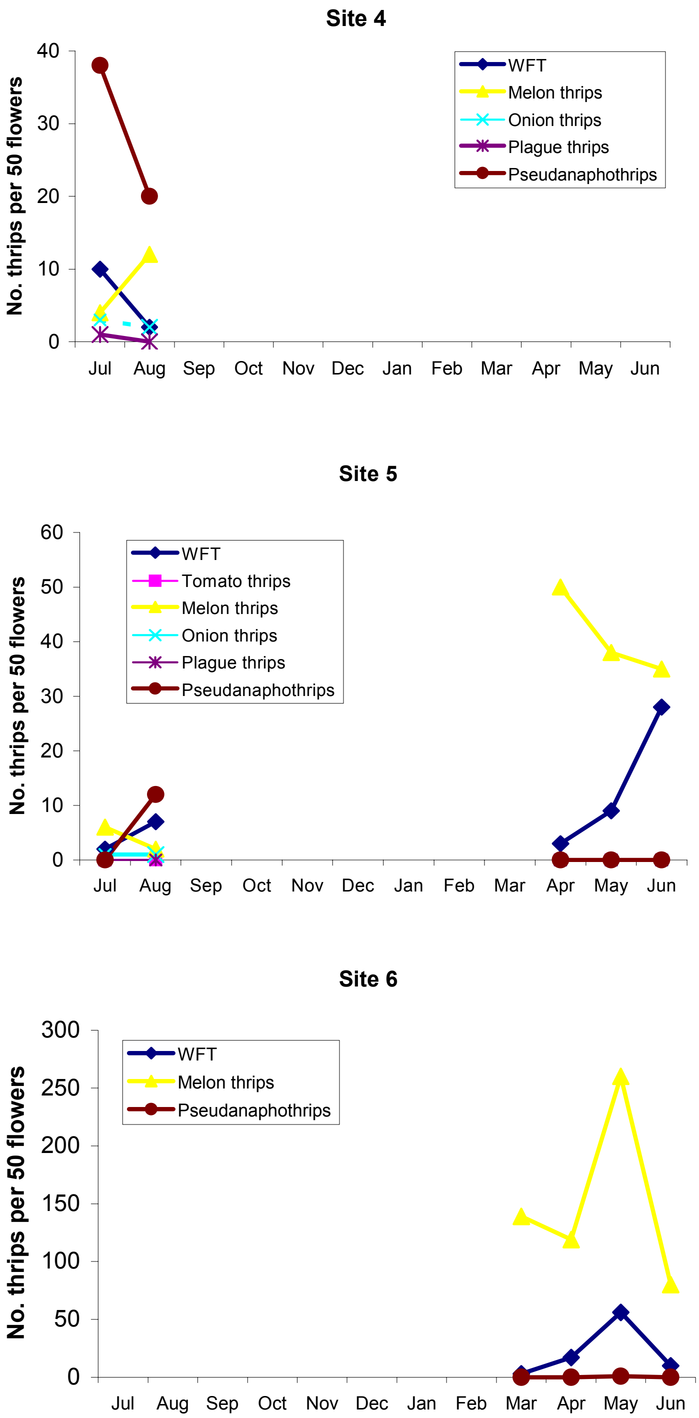


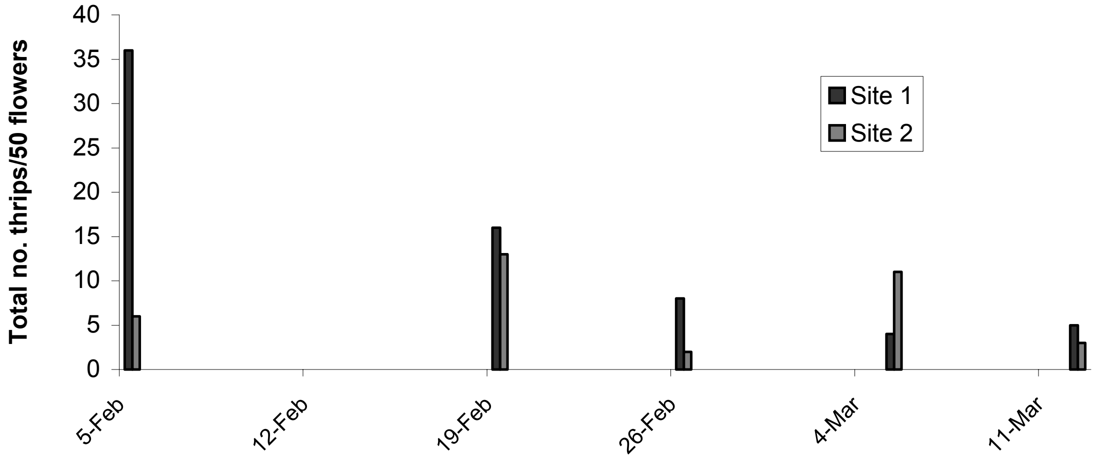
Figure 4b. The average number of thrips per sample from sites 4-6 of 6 commercial capsicum plantings in the Bundaberg region from July 2002 to June 2003

The level of western flower thrips per flower on any of the six sites did not reach the same level of infestation as melon thrips at any time (Figure 4). It remained at the equivalent to or less than 1 thrips per flower throughout the year. An exponential growth in the number can be seen from April-June on site 5, March to April on site 3 and July to October on site 4.
On site 4 and 5, *P. achaetus* were present at least in an equivalent or higher level than western flowers thrips from winter to spring (Figure 4). They were still present at less than 1 thrips per flower.

The other thrips species found were present at less than 0.1 thrips per flower. The level of thrips peaked at different times between sites.

In the Granite Belt region on Sites 1 and 2, there was less than one thrips per flower but on site 3 there were 1-4 thrips per flower (Figure 5).

Overseas much higher levels of thrips per flower have been recorded. Greenhouse capsicums in Spain reached 20 thrips per flower (Lacasa *et al*.,1995) and in southwest Florida (Frantz *et al*., 1995), although thrips population there were less than 2 thrips/flower in crops grown between winter and spring, they increased to 18 thrips per flower in the summer. This applied to melon thrips or western flower thrips. The exponential growth seen in the thrips population on some Queensland sites was also seen in the overseas populations.



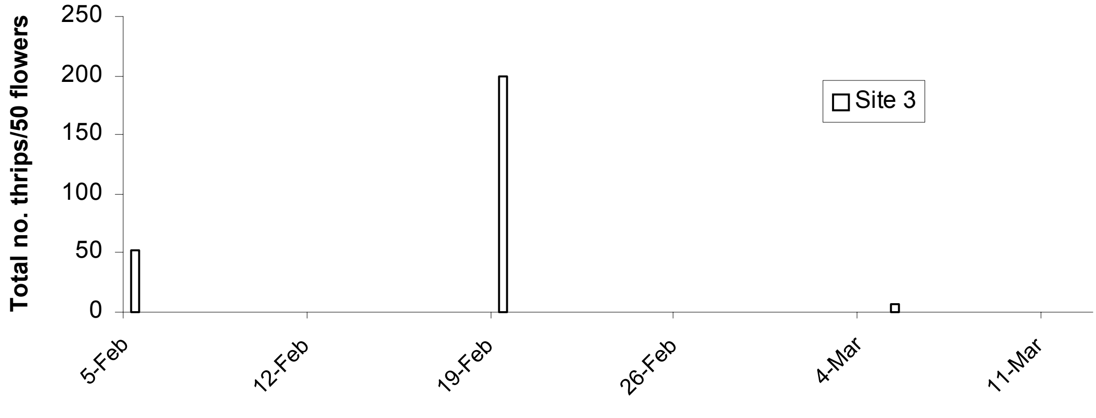


Figure 5 The level of thrips found in capsicum plantings from 3 properties in the Granite belt region, 2003

Damage

Some examples of the scarring attributed to thrips are in Figure 6a and b.

a)

b)

Figure 6 a) and b). Scarring under the calyx and a zipper scar on side of capsicum fruit.

Damage reported from the commercial properties in Bundaberg varied. On site 1 there was some marking and silvering. Site 4, where there was a similar level of western flower thrips to site 1, had no damage, and the high level of melon thrips that was seen on site 1 was not recorded.

The damage assessment done on the Granite Belt properties showed that site 3, where there had been the highest number of thrips, had the highest number of fruit with scars (Figure 7).

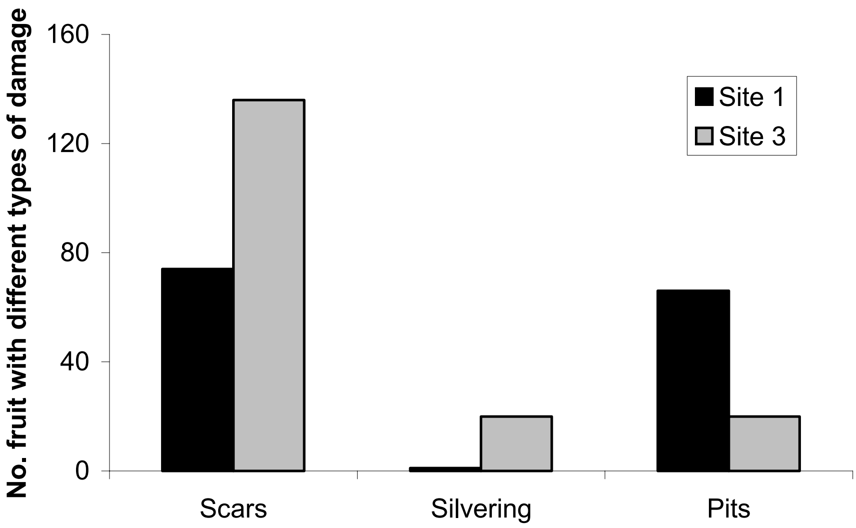


Figure 7 The number of damaged capsicums from site 1 in May and site 3 in April in the Granite Belt, 2003.

Overseas research into thresholds for managing thrips found where there was more than 2 melon thrips per flower, economic loss was observed (Frantz *et al*., 1995). By comparison in Japan in the glasshouse, Kawai (1990) estimated an economic injury level of loss of 5% at 0.08 female adults/flower. Using the first threshold, only site 1 would need to have managed the thrips population, on this site their was damage recorded so perhaps there is some validity in this threshold. For the Japanese threshold all sites would expect to get some damage that was not the case.

Recommendations

- Monitoring the crop is important as the number can increase rapidly
- Get thrips species identified, especially in the Bundaberg region
- Based on the thrips species identification choose the appropriate management option
- A potential threshold of 1-2 thrips per flower needs to be validated in the field.
- Investigate alternative management options

Technology transfer

Field days were held with capsicum growers in Bundaberg, Bowen, Ayr and Gumlu 2003. The field days also included presentations from other projects in capsicums and other pest projects, in particular heliothis and silverleaf whitefly.

A DPInote on thrips in capsicums has been drafted and includes information on seasonal abundance, management recommendations and types of damage. Results of the project have been incorporated where appropriate. Similar to the potato note, it is a 3-4 page factsheet with images, diagrams and information on the thrips in capsicums. The DPInote will be available via the Internet at www.dpi.gov.qld.au. The DPInote also directs the reader to information on other capsicum pests and their management.

Other information and observations

Viruses

Not only is the identification of the thrips species present important for choosing management tools it is also needed to understand potential virus incursions into the crops. This project linked with the research conducted by Dr Denis Persley and Murray Sharman, CRC Tropical Plant Pathology.

The tospovirus Capsicum chlorosis virus (CaCV) was first found in 1999 in capsicums at Bundaberg. The virus is now found in all capsicum producing areas in Queensland and is the dominant tospovirus in capsicums at Bundaberg and occurs frequently in crops in the dry tropics (Bowen/Gumlu/Ayr). Tomato spotted wilt virus also commonly occurs in all districts with the exception of Bundaberg.

In transmission tests done by Murray Sharman, melon thrips has been confirmed as a vector. The insects were raised on cucumber and insects from the healthy colony were allowed access to CaCV infected capsicums followed by inoculation access to healthy capsicum plants. Approximately 30% of these capsicum plants developed symptoms of CaCV infection. All transmission results were confirmed by testing the symptomatic plants by ELISA (Enzyme Linked Immunosorbent Assay). In parallel tests, melon thrips was also confirmed as a vector of TSWV.

Transmission tests with CaCV and WFT and tomato thrips have also been undertaken with final results to be confirmed.

Melon thrips was frequently found on sticky traps at Bundaberg and confirmation of its vector status for CaCV is critical in explaining both the detection of the virus at Bundaberg and its prevalence over the last four years. It is likely that the virus has been present in alternative hosts (unknown at present) and has been spread into capsicum crops by melon thrips once it arrived and became established. The virus is probably now able to survive at Bundaberg throughout the year on capsicums as some plants are present throughout the year in the district

TSWV has been successfully transmitted by with melon thrips, WFT and tomato thrips.

Thrips in chillies

Damage was reported and seen on chilli varieties in both Bundaberg and the Granite Belt (Figure 8).

Figure 8. Scarring on a chilli

A planting was monitored in the Bundaberg region with a high number of thrips per flower recorded however for this planting no damage was seen (Figure 9). The variety of chilli may play an important role in its susceptibility to thrips damage.

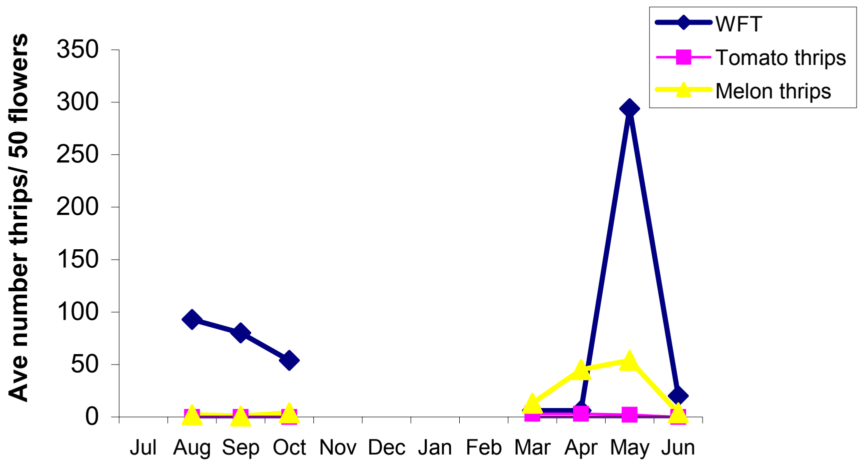


Figure 9. The number of thrips per 50 chilli flowers from a planting in Bundaberg

Acknowledgements

Thanks to Luke Jackson for processing thrips samples and Larry Cooper and John Donaldson for assistance with identification of thrips species.

Efficacy of insecticides against thrips in capsicum crops

Iain Kay, John Maltby, Bronwyn Walsh and Brendan Nolan

Introduction

The trial was undertaken to test the efficacy of a range of insecticides against thrips in capsicums. Melon thrips was the main thrips species of interest. Preliminary sampling indicated that a number of thrips species, and predominately western flower thrips (WFT) were present in the trial crop.

Materials and Methods

The trial was conducted at the DPI&F Bundaberg Research Station in late 2002. A crop of capsicums, variety Raptor, was grown on plastic mulch with trickle irrigation using standard fertiliser and irrigation practices. Row spacing was 1.5m and plant spacing was 0.25m. The crop was sprayed twice weekly with copper hydroxide (Kocide®) for disease control.

The trial was a randomised block design with three replicates and 10 treatments. Plots were three rows by 5 m, with 1 m of untreated guard along each row between plots and an untreated guard row lengthways between plots.

The treatments in the trial were:

- Water check: sprayed with water only
- S1812: a product under development (500 g ai/L EC) (Lot No. BK07L12) applied at 200 ml /ha (100 g ai/ha)
- MTI 446: a product under development (200 g ai/L SC) (Identification Code 0116252) applied at 500 g /ha (100 g ai/ha)
- Methomyl: Lannate® (225 g ai/L EC) applied at 2000 ml/ha (450 g ai/ha)
- Spinosad: Success Naturalyte® (120 g ai/L SC) applied at 800 ml/ha (96 g ai/ha)
- Abamectin: Vertimec® (18 g ai/L) applied at 450 ml/ha (8.1 g ai/ha)
- Imidacloprid: Confidor® (200 g ai/L SC) applied at 300 ml/ha (60 g ai/ha)
- Fipronil: Regent® (200 g ai/L SC) applied at 250 ml/ha (50 g ai/ha)
- Methamidophos: Nitofol® (580 g ai/L EC) applied at 2100 ml/ha (1218 g ai/ha)
- Natrasoap®: soap spray applied at 20 ml/L of water (10 L/ha)

The treatments were applied in the equivalent of 500 L of water per sprayed hectare using a motorised Echo sprayer fitted with a boom and Albuz brown APT hollow cone nozzles operated at 690 kPa. Treatments were applied on three occasions: 22nd November (day 1), 27th November (day 6) and 2nd December (day 11).

Thrips were sampled on 21st November (day 0), 26th November (day 5), 1st December (day 10), 6th December (day 15) and 9th December (day 18) (i.e. a pre-treatment sample, samples four days after each treatment application and a sample seven days after the third application.) On each sample date except day 18 five flowers were collected from each row of each plot (i.e 15 flowers per plot), taken to the laboratory and carefully examined for thrips under magnification using a Maggy lamp. All thrips were counted as adults or larvae and collected and placed into vials of AGA. Adults were mounted on slides and identified to species and counted. On day 18 flowers were sampled from the check, spinosad, fipronil and methamidophos plots only, and the thrips counted but not identified.

Analyses of variance were used to test for treatment differences. A square root (x + 0.5) transformation was used on all the thrips data on days 0, 5, 10 and 15. Pre-treatment (day 0) total counts were used as a covariate in the analyses of post-treatment total counts but the results of the covariate analyses were not used as the covariates were not significant. Day 18 data were not analysed.

Results

The numbers of all thrips (adults, larvae and total) counted before identification on each sample date are shown in Table 1.

There were no differences between plots allotted to treatments in the number of adult or larval thrips in the pre-treatment count but there were significant differences ($P<0.05$) in the total number of thrips. Obviously those differences were not due to the treatments as none had been applied but were due to fortuitous allocations of treatments to plots within blocks in a field in which thrips distribution was not uniform. Covariance analyses showed that using the pre-treatment total count as a covariate for post-treatment total counts were not significant ($P>0.05$). However the initial differences mean that care must be taken in interpreting the results of analyses of post-treatment total counts.

On day 5 the differences between treatments in numbers of adults, larvae and total thrips were complex, with few significant differences between insecticides and the water check. There were significantly more ($P<0.05$) adults in the MTI 446 treatment than in all the other treatments except methomyl and abamectin, and significantly more ($P<0.05$) larvae in the methomyl treatment than in all others except MTI 446.

On day 10 the treatment differences were clearer. There were significantly fewer ($P<0.05$) adults in the spinosad, fipronil and methamidophos treatments than in the check and other treatments except for Natrasoap®, and there were significantly fewer ($P<0.05$) larvae in the spinosad, abamectin, fipronil, methamidophos and Natrasoap® treatments than in the check. For total thrips, there were significantly fewer ($P<0.05$) in the spinosad, fipronil, methamidophos and Natrasoap treatments than in the check or any other treatment, and significantly more ($P<0.05$) thrips in the methomyl treatment than in the check.

On day 15 thrips numbers had increased greatly in all treatments. There were no significant differences ($P>0.05$) between treatments in numbers of adults, and only methomyl and imidacloprid with higher numbers differed significantly ($P<0.05$) from the check in numbers of larvae. The only treatments to differ significantly ($P<0.05$) from the check in total thrips were MTI 446 and methomyl, which had higher counts.

All adult thrips were identified to species, although a few were destroyed during the mounting process. The great majority, over 65%, were WFT, while tomato thrips, melon thrips, onion thrips and *P. achaetus* also were present in low numbers.

Table 1 Mean numbers of all thrips sampled pre- and post-treatment on days 0, 5,10, 15 and 18.

Treatment (g ai/ha)	Mean number of thrips on each sample date *				
	Day 0 #	Day 5 #	Day 10 #	Day 15 #	Day 18
Adults					
Water check	7.7 a	10.3 abcd	18.2 cd	112.9 a	131.3
S1812 (100)	6.5 a	8.0 abc	19.1 d	156.5 a	-
MTI 446 (100)	12.2 a	24.2 e	25.0 d	220.9 a	-
Methomyl (450)	3.7 a	14.6 cde	29.3 d	156.0 a	-
Spinosad (96)	6.6 a	7.7 abc	1.7 a	77.1 a	150.7
Abamectin (8.1)	9.2 a	17.6 de	26.0 d	189.4 a	-
Imidacloprid (60)	5.3 a	12.1 bcd	23.2 d	157.8 a	-
Fipronil (50)	7.6 a	6.0 ab	3.3 ab	146.4 a	320.3
Methamidophos (1218)	5.7 a	4.6 a	8.5 b	98.3 a	123.3
Natrasoap (10 L/ha)	12.9 a	9.2 abcd	8.8 bc	89.2 a	-
Larvae					
Water check	4.4 a	4.4 ab	14.1 def	40.3 abc	51.1
S1812 (100)	7.7 a	2.8 ab	5.6 bcd	25.1 ab	-
MTI 446 (100)	8.3 a	8.5 bc	9.9 cde	61.6 bcd	-
Methomyl (450)	4.2 a	15.4 c	23.4 f	97.2 d	-
Spinosad (96)	7.4 a	1.4 a	0.3 a	9.7 a	14.0
Abamectin (8.1)	4.7 a	5.6 ab	3.0 abc	57.4 bcd	-
Imidacloprid (60)	10.1 a	6.3 ab	16.5 ef	69.5 cd	-
Fipronil (50)	5.2 a	1.9 a	1.7 ab	11.6 a	20.0
Methamidophos (1218)	10.1 a	3.3 ab	2.5 ab	13.5 a	5.7
Natrasoap (10 L/ha)	9.9 a	6.2 ab	4.1 abc	34.8 abc	-

(Table 1 continued)

Total	Day 0 #	Day 5 #	Day 10 #	Day 15 #	Day 18
Water check	12.3 ab	14.7 ab	33.0 c	154.0 abc	182.3
S1812 (100)	14.7 bc	10.8 ab	26.0 c	182.3 abcd	-
MTI 446 (100)	20.9 cd	33.0 c	36.8 cd	284.4 d	-
Methomyl (450)	7.9 a	30.6 c	52.7 d	254.9 cd	-
Spinosad (96)	14.9 bcd	9.2 a	2.0 a	88.2 a	164.7
Abamectin (8.1)	14.2 abc	23.2 bc	29.2 c	246.6 cd	-
Imidacloprid (60)	16.6 bcd	18.4 abc	40.0 cd	226.6 bcd	-
Fipronil (50)	13.3 abc	8.1 a	5.4 ab	161.3 abcd	340.3
Methamidophos (1218)	15.8 bcd	7.9 a	11.3 b	116.4 ab	129.0
Natrasoap (10 L/ha)	23.3 d	15.9 ab	12.9 b	127.4 ab	-

* back-transformed means following square root (x + 0.5) transformation before analysis except for day 18 where untransformed means are shown.
# in each column for each thrips group means followed by the same letter are not significantly different at the 5% level.

Discussion

As most of the adult thrips were identified as WFT it is reasonable to consider that the results in Table 1 discussed here refer to WFT. The name "WFT" could be substituted for the term "thrips" used in the discussion without great risk of error. However the presence of the other species in the analyses is not ideal and may have affected some results as the susceptibility of the other species may have differed from that of WFT.

Spinosad, fipronil, methamidophos and Natrasoap® were the most effective insecticides in controlling thrips in this trial. They had little apparent effect on thrips numbers compared to the water check after one application but after two applications they had significantly fewer ($P<0.05$) thrips than the check. Spinosad appeared to be the most effective, reducing numbers to a level significantly lower ($P<0.05$) than did methamidophos and Natrasoap®.

The other insecticides tested were ineffective with the number of thrips increasing by day 10, and not differing significantly ($P>0.05$) from the check.

The number of thrips in all treatments increased greatly on day 15 after the third spray application. The reasons for the increases are not known but there are several possibilities. One is that thrips migrated into the trial crop from elsewhere. Movement of thrips around the crop was not monitored but there were no nearby crops that might have been a source for such a migration. Another possible explanation is that a generation of adults emerged from pupae in the guard areas and in the plots of ineffective treatments between day 10 and day 15 and re-distributed themselves throughout the trial area. Larvae may have emerged from eggs to account for the increase in numbers of larvae.

The last possibility is more likely, and it raises issues about the use of small plot trials in testing insecticides against thrips. It is very difficult to demonstrate effectiveness of an insecticide (or to control any insect) if there is continual reinfestation of the treated area. Thrips can be controlled if the whole area is treated so the whole population is reduced to a low level, but this is problematical when there are untreated guard areas and plots virtually untreated because the insecticides were ineffective. The adult and larval stages of thrips are susceptible to insecticides while the egg and pupal stages are not as they are in protected positions. The insecticide application strategy promoted by the National Strategy for the Management of Western Flower Thrips and Tomato Spotted Wilt Virus is to apply three spays of an insecticide separated by a number of days, with the interval lengths determined by the insect's developmental rate (i.e. by temperature), so that susceptible stages are treated as they develop from non-susceptible stages. After three applications all the thrips should have been treated at a susceptible stage. This strategy was used in this trial with sprays applied every five days. While it is obvious that some insecticides were effective the thrips population over the whole trial area was not reduced and the benefits of the three-spray strategy were not realised. However small plot trials are useful for identifying effective insecticides despite these problems.

Abamectin, acephate, chlorpyrifos, dichlorvos, endosulfan, fipronil, maldison, methamidophos, methidathion, methomyl and spinosad are registered or permitted for use against *F. occidentalis* on various crops and plants. Not all of these insecticides were tested in this trial. Of those that were spinosad, fipronil and methamidophos were shown to be effective, abamectin had some effect against larvae, while methomyl was completely ineffective.

Methomyl, methidathion, spinosad, fipronil, methamidophos and chlorpyrifos are registered or permitted for use against WFT on capsicums. This group includes at least three insecticides (spinosad, fipronil and methamidophos) that are effective, which allows for rotation of insecticides for resistance management purposes.

The pre-treatment counts showed that the initial thrips population was not uniform across the whole trial area, and blocking did not compensate for this. Thrips counts were variable. Extra replication may have helped, and it is suggested that future trials are designed with more than three replicates.

Very few melon thrips were collected during this trial so no useful information on the effect of the insecticides against melon thrips was obtained.

Technology Transfer

Field days were held with capsicum growers in Bundaberg, Bowen, Ayr and Gumlu 2003. The field days also included presentations from other projects in capsicums and other pest projects, in particular heliothis and silverleaf whitefly.

Press releases and a fax-out to industry have further informed the industry of management options for melon thrips.

A DPInote on thrips in capsicums has been drafted and includes information on seasonal abundance, management recommendations and types of damage. Results of the project have been incorporated where appropriate. Similar to the potato note, it is a 3-4 page factsheet with images, diagrams and information on the thrips in capsicums. The DPInote will be available via the Internet at www.dpi.gov.qld.au. The DPInote also directs the reader to information on other capsicum pests and their management.

Recommendations

Spinosad, fipronil and methidathion are effective against WFT. Abamectin has some effect against larvae and methomyl is not effective.

Efficacy against melon thrips still needs to be established

Acknowledgements

Thanks to Luke Jackson for processing thrips samples and Larry Cooper and John Donaldson for assistance with identification of thrips species.

Evaluating a best management option for thrips in capsicum crops

John Maltby and Iain Kay

Introduction

A field evaluation of three thrips management options against melon thrips and western flower thrips was established in November 2003. The management options to be tested were no spray, continuous spray and a managed spray program.

Materials and Methods

The trial was conducted at DPI &F Bundaberg Research Station. A capsicum crop, variety Warlock, was grown on plastic mulch with trickle irrigation using standard fertiliser and irrigation practices. Three blocks (Figure 1) of capsicums were grown: Blocks 1 and 2 were separated by a block of sweet corn while capsicum block 3 was a separate block some 70m away (with a tree line separating) from blocks 1 and 2. All blocks were of the same dimensions: 30m long, with 9 plant rows at a row spacing of 1.5m and plant spacing 0.25m.

All blocks were sprayed with copper (Kocide®) for bacterial spot control and Dipel Forte® (*Bacillus thuringiensis*) for heliothis control. Ten flowers from each block were taken weekly and examined for thrips under a Maggy lamp in the laboratory. All thrips were counted as adults or larvae and collected and placed into vials of AGA.

Trial treatments were:

Treatment 1 (Managed spray program). Once the level of thrips reached 4 thrips per flower then Success Naturalyte®: spinosad (120 g ai/L SC) was applied. The insecticide application strategy promoted by the National Strategy for the Management of Western Flower Thrips and Tomato Spotted Wilt Virus is to apply three spays of an insecticide separated by a number of days, with the interval lengths determined by the insect's developmental rate (i.e. by temperature). Three sprays of Success were to be applied separated by 5 to 7 days. If thrips numbers built up again then three consecutive sprays of Regent®: Fipronil (200 g ai/L SC) were to be used.

Treatment 2 (Continuous Spray). Spray Methomyl: Lannate® (225 g ai/L EC) on a weekly basis from first flower.

Treatment 3 (No Spray). No insecticide sprays (apart from Dipel Forte®) applied.

Sprays were applied using a commercial boom spray at a water application rate of 500 L/ha.

Broad mite (*Polyphagotarsonemus latus*) were identified in all blocks on 29/10/03 (seven days after capsicums were at 100% first flower) and immediately sprayed with Kelthane® (Dicofol 480g ai/L).

Weekly spraying with Lannate® (Treatment 2) began on 28th October. At no time during the course of the trial did thrips numbers reach four thrips per flower and so the "trigger" for treatment 1 was never reached. Thrips numbers were low in the whole Bundaberg district (Crop Tech pers. com.) during October to December 2003. This was particularly evident at Bundaberg Research Station where in the same period in 2002 thrips numbers greater than 10 per flower were counted in capsicums.

Plants were first harvested on 26th November with all large fruit being taken, plants were stripped of all fruit at final harvest on 12th December. Fruit from each harvest was sorted into marketable and non marketable fruit. The non marketable fruit were further sorted into the defect that caused it to be non marketable (disease, insect damage, sunburn, blossom end rot, shape and size).

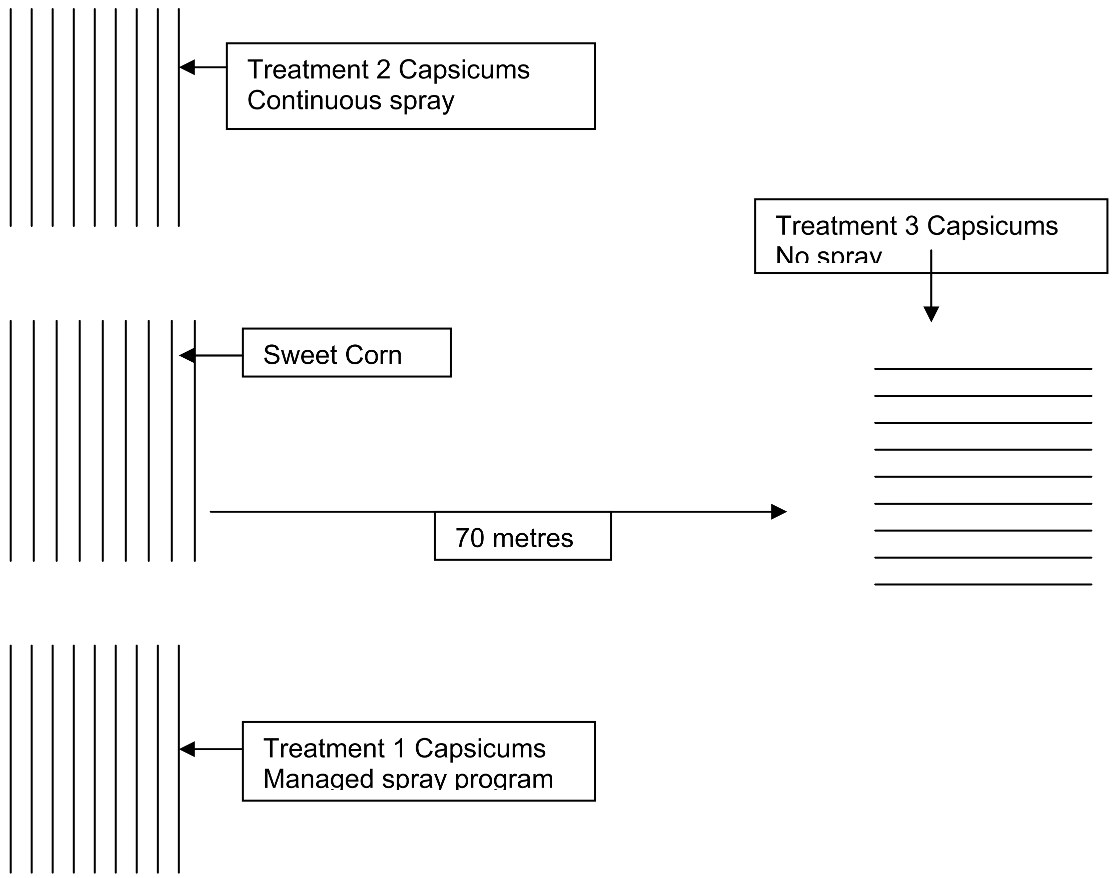


Figure 1 Trial plan

Results

The mean number of thrips (adults + larvae) per flower in the three treatment areas for each sampling event are shown in Table 1.

Table 1. The mean numbers of thrips per flower at each sampling event

Date	Mean Number of Thrips per flower		
	Treatment 1	Treatment 2	Treatment 3
15/10/03	0.4	0.7	0.4
23/10/03	0.5	0.4	0.6
31/10/03	0.6	0.6	1.4
07/11/03	1.3	1.1	1.6
14/11/03	1.1	1.6	0.6
21/11/03	1.0	1.8	1.3
28/11/03	0.7	0.6	0.1
08/12/03	1.8	2.0	1.1
12/12/03	2.5	2.1	1.8

Results show thrips numbers very low during the crops growth cycle and at no time reached the "trigger" for treatment 1 of four thrips per flower.

Harvest yield results are shown in Table 2. Results are reported as the percentage of fruit in each yield category at each harvest.

Table 2. The proportion of fruit in each yield category at each harvest

	Treatment 1 (%)		Treatment 2 (%)		Treatment 3 (%)	
Yield Category	H 1*	H 2*	H 1	H 2	H 1	H 2
Marketable – Grade 1	15	11	12	12	25	7
Marketable – Grade 2	16	17	14	29	26	23
Unmarketable - Broad mite damage	25	0	11	0	14	7
Unmarketable – Blossom end rot	33	11	34	14	27	9
Unmarketable - Sunburn	10	0	23	0	3	0
Unmarketable – Poor shape	1	4	6	2	5	14
Unmarketable – Thrips damage	0	0	0	0	0	0
Unmarketable – Small size	0	57	0	43	0	40
* H1: Harvest 1 * H2: Harvest 2						

Results show a high proportion of unmarketable fruit due to broad mite damage in harvest 1 c.f. harvest 2, similarly for blossom end rot and sunburn. No thrips damage was observed at either harvest. Predominate yield category in harvest 2 was unmarketable small size (range 40% to 57%).

Discussion

Unfortunately due to the very low thrips numbers the trial could not evaluate the three thrips management options: No spray, continuous spray and managed spray. One of the aims of the trial was to examine if continuous spraying was reducing natural enemies of thrips thereby leading to an increase in thrips numbers. There was no evidence of this in this trial however the fact thrips numbers were low in the entire Bundaberg district suggest environmental conditions may well have precluded any influence of natural enemies on thrips numbers.

The broad mite damage on capsicum is very similar to thrips feeding damage. In fact it was first thought to be thrips damage which at the time was very difficult to reconcile with the very low thrips levels in the trial and so other possible causes were explored. It is suggested that some damage being attributed to thrips in the district could in fact be caused by broad mite. The first many growers would see of broad mite infestation is distortion of the plants growing point. A spray would then be applied (in this trial Kelthane®) and the broad mites would be controlled however the damage to developing fruit is already done. The damage would not be noticed until harvest which may well coincide with high thrips numbers with thrips being given the blame by association. Minimal broad mite damage was found in the second harvest; believed due to the first harvest fruit being initiated when the broad mites were in the crop (one week after 100% first flower).

The high percentage of blossom end rot in the first harvest is indicative of the hot dry winds experienced in the early growth of the capsicums. This suggests soil calcium levels and irrigation schedule need to be investigated.

The high percentage of sunburnt fruit in the first harvest reflects the fact that first harvest fruit is normally very large and prone to sunburn. This is supported by the very high percentage of small fruit found in the second harvest (more than 40%).

Technology Transfer

A DPInote on thrips in capsicums has been drafted and includes information on seasonal abundance, management recommendations and types of damage. Results of the project have been incorporated where appropriate. Similar to the potato note, it is a 3-4 page factsheet with images, diagrams and information on the thrips in capsicums. The DPInote will be available via the Internet at www.dpi.gov.qld.au. The DPInote also directs the reader to information on other capsicum pests and their management.

Recommendations

Monitor crops for pests and natural enemies
Investigate alternative management options
Validate the 'best management option' used in this trial at higher level of thrips
Investigate in autumn and spring crops

Miscellaneous project activities

Project communication

A project review and planning meeting was held Dec 12th-13th, 2002. Dr Laurence Mound, CSIRO and Mr Graham Young, entomologist from the Northern Territory, both with experience with melon thrips were participants. Also present were IDO Julia Telford and Janine Clark, Queensland Fruit and Vegetable Growers Association. Temperate fruit entomologists working with WFT also joined team members to discuss the broader thrips management issues. Virologists from tomato spotted wilt virus and capsicum chlorosis virus projects did presentations to put into perspective thrips as vectors. The outcome of the meeting was a better understanding of thrips issues across crops, plans for the next year of the melon thrips project and a review of this year's results.

Results from trials were discussed with grower co-operators as the season progressed. Thrips identifications for crop consultants were also done to broaden the awareness of the thrips seasonal abundance and the importance of thrips identification for their management.

Thrips identification

Six DPI & F scientists were trained in thrips identification. This enabled them to identify thrips specimens that were brought in by the wider horticultural industry. Thanks to John Donaldson for providing the training.

Bibliography

Cantrell, B. K.; Donaldson, J.F.; Galloway, I.D.; Grimshaw, I.D. and K.J. Houston (1983). Survey of beneficial arthropods in potato crops in south-east Queensland. *Queensland Journal of Agricultural and Animal Science* 40(2):109-119.

Cermeli, M. and A. Montagne (1993). Present situation of *Thrips palmi* Karny in Venezuela. *Manejo Integrado de Plages* 29:22-23

Cermeli, M. and F. Godoy (1993). Preliminary results on the chemical control of *Thrips palmi* Karny on beans. *Boletin de Entomologie Venezolana*

Cho, K.J.; Kang, S.H. and K.B. Uhm (1999). Binomial sampling plan for classifying population density of *Thrips palmi* in potato. *Applied Entomology and Zoology* 34(4):537-546

Cho, K.J.; Kang, S.H. and G.S. Lee (2000). Spatial distribution and sampling plans for *Thrips palmi* infesting fall potato in Korea. *Journal of Economic Entomology* 93(2):503-510

Frantz,G.; Parks,F. and H.C. Mellinger (1995). Thrips population trends in peppers in southwest Florida. *Thrips Biology and Management*. B.L.Parker et al. Plenum Press New York p111-114

Horne, P. de Boer, R. and D. Crawford (2002). *Insects and Diseases of Australian potato crops*. Melbourne University Press.

Kawai, A. (1990). Control of *Thrips palmi* Karny in Japan. *Journal Agricultural Research Quarterly* 24(1)

Kawai, A. and C. Kitamura (1987). Studies on population ecology of *Thrips palmi* Karny XV Evaluation of effectiveness of control measures using a simulation model. *Applied Entomology and Zoology* 22(3):292-302

Kumar, N.K.K. (1995). Yield loss in chilli and sweet pepper due to *Scirtothrips dorsalis* Hood. *Pest Management in Horticultural Ecosystems*. 1(2):61-69

Lacasa, A.; Esteban, J.R.; Beitia, F.J. and J. Contreras (1995). Distribution of WFT in Spain. *Thrips biology and management. Proceedings of the 1993 International Conference on Thysanoptera*. P465-468

Lee, G.S. (1996). Seasonal occurrence of *Thrips palmi* Karny in Cheju Island. *MS thesis Seoul National University*, Suwon, Korea (in Korean with English summary)

Morishita, M. and K. Azuma (1998). Population fluctuation and economic injury level of *Thrips palmi* Karny on sweet pepper in vinyl-house cultivation. *Proceedings of the Kansai Plant Protection Society* 30:57-62.

Seal, D. (1994). Field studies in controlling melon thrips, *Thrips palmi* Karny on vegetable crops using insecticides. *Proceedings of the Florida State Horticultural Society* 107:159-162.

Shipp, J.L., Binns, M.R. and A.P. Papadopoulos (1996) Economic injury level and impact of western flower thrips on plant productivity of greenhouse sweet pepper. *Bulletin OILB/SROP* 19(1):151-154

Southeast Asian Ministers of Education Organisation (1991) Management of thrips and mites attacking potato in the lowland. *SEAMEO quarterly*14(4): 41-43

Supartha, I.W.; Susila, I.W.; Wijaya,I.N.;Sunari, A.A.A.A.S. and N. Darmiati (2000) *Study of habitat: attack and development of some important pest populations on potatoes in Bali*; 29p

Young, G. and L. Zhang (1998) Control of the melon thrips, *Thrips palmi*. *Northern Territory of Australia Agnote 753.* Agdex 230/612. 3p