Provision of western flower thrips technology transfer services in Bundaberg and Bowen

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Iain Kay *et al.*

Queensland Department of Primary Industries and Fisheries

Project Number VG03099

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Media Summary

A project to transfer Western Flower Thrips (WFT) information and technology from southern Australia to Queensland vegetable growers has had major benefits for industry. An independent evaluation reported a high level of awareness of the project with significant impact on practice change.

The first step was to find out what growers and agribusinesses needed to improve WFT management and to then adapt information and technology to suit. This involved extensive trial work in the field leading to:

- Insecticide efficacy data to help expand the current control options for WFT
- Insecticide resistance information for WFT in Queensland
- A better understanding of peaks in WFT activity and major weed hosts.

WFT is an important pest of vegetables particularly capsicum, tomato, lettuce and eggplant, causing damage by feeding and by transmitting the disease Tomato spotted wilt virus (TSWV). WFT spread to major vegetable production districts in the late 1990s and caused major crop losses in North Queensland in 2002.

The project targeted the production districts of Bundaberg-Gin Gin-Childers in the sub-tropics and the Bowen-Gumlu-Burdekin region in tropical North Queensland. The main messages were:

- "Get mean, keep clean" to encourage growers to implement good farm hygiene practices by controlling weeds and removing old crops promptly
- Monitoring for thrips and other pests on a regular basis
- Implementing a 3-spray strategy when WFT were detected
- Balance – preserving natural enemies by using selective insecticides to manage pest problems

The project team included researchers from the Queensland Department of Primary Industries and Fisheries and two horticultural consultancies, Bowen Crop Monitoring Services and T-Systems Australia. Four interrelated strategies provided information and promoted improved practices to growers and their service providers:

- Seminars, workshops and field walks on WFT and a variety of other pest and disease management issues relevant to the districts
- Communication via post and email including eight issues of the project newsletter "WFT Queensland Update" and a thrips and tospoviruses booklet
- Working with growers via consultants and other service providers to cater for grower preference to obtain information through one-on-one contact
- Commercialising project outcomes by developing consultants' skills and by developing the skills and technical capacity of other agricultural service providers in both districts.

Developing, adapting and adopting pest management practices for WFT, or any pest problem, is a dynamic process. Future extension efforts to improve pest management need to be directed at influential service providers as well as growers to maximise impact.

Introduction

Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), is a major pest of agricultural and horticultural cropping systems around the world. Kirk (2002) reviewed its spread from the western states of the United States of America throughout the world and its evolution from a minor to a major economic pest.

WFT was first recorded in Australia in 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).

In Queensland WFT was first recorded in the Redland Bay district in 1994 (Baker *et al.* 2004). It was found on a flower farm at Bundaberg in early 1996 but was not noticed again until it was found commonly around the district in 2001. In 2002 WFT caused severe damage to capsicum crops in the Gumlu district in north Queensland.

WFT has a wide host range. It damages vegetables through its feeding, by ovipositing in plant tissue and by transmitting a tospovirus, tomato spotted wilt virus (TSWV). WFT feed by puncturing plant cells and sucking the contents. This feeding can result in distortion, scarring or silvering of the affected plant parts. As WFT are mainly found in the flowers it is usually the fruit that are affected. WFT is an important vector of TSWV, which can cause a range of symptoms such as ring-spots, mottling, chlorotic blotches and distortion, and there can be severe loss of yield in affected plants. The major commercial host crops of TSWV are capsicums, lettuce, tomato, potato and peanuts, and it has a wide host range among weeds and ornamental plants.

The detection of WFT in Australia prompted a major research effort into ways to manage the pest, conducted under the auspices of the National Strategy for the Management of Western Flower Thrips and Tomato Spotted Wilt Virus and funded through the Horticultural Research and Development Council and then Horticulture Australia Limited (HAL). The National Strategy and the research and development projects it supported started in June 1993 and concluded at the end of June 2003. Activities and projects to develop management technology for WFT and TSWV conducted under the National Strategy were reported in 30 issues of Western Flower Thrips Newsletter from November 1994 to June 2003.

The project "Western flower thrips management strategy – Information delivery pilot project" (VG00085) started in 2000 to transfer information produced in projects conducted in Western Australia and New South Wales to growers in South Australia (Baker *et al.* 2004). The project adopted an action learning approach between growers, technical experts and other industry stakeholders to achieve adoption of basic integrated pest management (IPM) for WFT. The project recommended that other horticultural regions affected by WFT be supported to achieve transfer of this management technology to their growers (Baker *et al.* 2004). In response, a follow-up project, VG02040 "Facilitating IPM Adoption in Vegetable Crops Through Regional Extension Programs", extended these efforts in South Australia (Burfield 2005) and in 2003 HAL decided to focus future efforts on the extension of existing research to growers.

In mid 2003 HAL called for expressions of interest (EOI) to deliver WFT and TSWV technology transfer services to the Bundaberg and Bowen regions, and to the Perth North and Greater Sydney regions. Following a successful EOI submission, a full project application resulted in VG03099 "Provision of western flower thrips technology transfer services in Bundaberg and Bowen". This project effectively started in June 2004 with a project team that included DPI&F entomologists, virologists and extension specialists and members of the major commercial horticultural consulting firms in each district, Crop Tech (now T-Systems and referred to as T-Systems in this report) in the Bundaberg area and Bowen Crop Monitoring Services (BCMS) in North Queensland. Similar projects were developed in NSW: VG03098 "Regional extension strategy for managing western flower thrips and tomato spotted wilt virus in the Sydney region"; and in Western Australia: VG06037 "Increasing adoption of IPM by WA vegetable growers and development of an ongoing technical support service".

The Queensland project was designed to modify and adapt technology and information from previous projects to the Queensland situation, and to promote adoption of modified technology and information in the Bowen and Bundaberg districts and to support commercialisation to ensure continued use of project outputs beyond the life of the project.

This Final Report reports on the activities undertaken to achieve these outcomes and on the evaluation of the impact and effectiveness of the project in achieving its aims. It is supported by the evaluation report submitted with it:

- The report of the external project evaluation (Summary of survey of Agribusiness and Vegetable Growers for "Provision of western flower thrips technology transfer services in Bundaberg and Bowen" (VG03099). Kerry Bell, Amy Samson and Jeff Coutts, September 2008, Coutts J&R.)

(NB. In this report the term "Bundaberg" refer to the broad horticultural region around the city of Bundaberg that includes the Childers and Gin Gin areas. The term "North Queensland" refers to the extensive horticultural areas around Bowen, Gumlu and the lower Burdekin based on the towns of Ayr and Home Hill through to Giru and Townsville.)

Technology transfer strategy and methodology/activities

Introduction

The technology transfer strategy and the methodology and activities employed in this project were designed to achieve the following outcomes.

- Modification of technology and information from the existing pool of knowledge to the Queensland situation.
- Adoption of modified technology and information in the Bowen and Bundaberg districts.
- Commercialisation of services to ensure continued use of technology and information generated in WFT research, development and extension projects funded by HAL beyond the life of the project.

Much of the available WFT technology and information was developed in southern Australia and in protected cropping systems. The Bundaberg and North Queensland districts are in the sub-tropics and tropics respectively, with climate and weather patterns quite different from those in the southern areas. The majority of crops in the Bundaberg and North Queensland districts are grown in the field although there is some protected cropping of cucumbers and eggplant at Bundaberg. These differences in climate and farming systems between the source areas of WFT research and development and the target areas for technology transfer meant that some modification of the technology was necessary.

The methodology and activities conducted to encourage adoption of WFT/TSWV management technology needed to be designed for the characteristics of the target audience in the Bundaberg and North Queensland districts. These characteristics were quite different from those of the target audience for VG00085 and VG02040. Most of the growers in the Bundaberg and Bowen districts were experienced, independent and had been exposed to the concept of IPM, but had little experience with managing WFT in their crops. Most growers in the Queensland target districts were either from an English speaking background or were second to fourth generation Australians so non-English speaking issues of culture and language were not a key concern.

The presence of well established commercial agricultural consulting firms in both districts provided an accelerated start to the commercialisation process. The inclusion of these firms in the project team strengthened the team's capabilities and their technical expertise.

Needs Analysis

An industry needs analysis to fine-tune strategies and methodologies used in the project was the first step in achieving the project's aims. The survey, based on a series of face-to-face interviews with growers and their service providers, was conducted by project staff early in the life of the project from late July 2004 to mid February 2005.

The survey was limited to the target regions of Bundaberg and North Queensland. Broad topics for data collection were:

- Issues and needs of growers and agribusiness to improve WFT management within and IPM context
- Identifying and confirming target groups for the project
- Current pest management practices

An additional aim of the survey was to promote the project and its team members amongst the farming community by visiting growers and industry personnel at the start of the project.

The following provides a summary of the processes used and results and recommendations arising from the industry survey described in more detail in Heisswolf and Kay (2007).

Eighty-nine people took part in interviews, comprising owners of 50 vegetable growing enterprises, four in-house agronomists/managers and personnel from three independent consultancy firms, staff of nine agrichemical distributors (commonly known as resellers) and two seed companies as well as owners and staff of six seedling nurseries. A standardised questionnaire consisting of a mixture of closed and open questions was used to collect quantitative and qualitative data to answer the following key questions:

- Who are the target groups and which are the target crops?
- What pests cause the most problems?
- What are people doing now to manage these pests?
- What would help people improve their pest management, particularly for WFT and associated viral diseases?
- How would people most like to receive information about the project?

Respondents were selected from an updated list of existing contacts. The aim was to interview a representative mix of large and small growers across the range of target crops including growers who use consultants as well as staff from agribusinesses likely to have an impact on pest management issues and decision-making on farm. We did not interview chemical company staff.

Quantitative data was not statistically analysed. Qualitative data were interpreted using a theme analysis approach. Where strong trends in themes emerged, quantification of results against themes was attempted.

Results

The survey indicated that the main target crops affected by thrips in both regions were capsicum, chillies and eggplant. While WFT had caused extensive damage at Gumlu (North Queensland) in capsicum over winter/spring 2002, it was less of a problem in 2003. Generally, for growers and industry WFT were not seen as a major issue in the target regions providing fipronil and spinosad were available for control. Most felt that they were managing thrips with monitoring and insecticide applications but there were concerns about reinfestation and insecticide resistance developing. Silverleaf whitefly, *Bemisia tabaci* Gennadius biotype B, and heliothis, *Helicoverpa* spp., were considered more important pests for vegetable crops in both regions.

Growers used a range of strategies to manage pests but relied heavily on insecticides particularly in North Queensland. Non-chemical control methods used included good farm hygiene practices, controlling weeds, regular monitoring/checking of crops and farm layout. Natural enemies were mentioned infrequently. Thirty-five percent of North Queensland growers interviewed employed a crop consultant. There appeared to be two main strategies for managing pests, the "soft option and reduce spraying" approach used by a small number of growers (IPM) and the "keep on top of pests by spraying regularly" approach employed by the majority of growers interviewed (chemical based IPM).

Growers nominated consultants, their own experience, other growers, state government staff, printed and electronic information and agricultural chemical company staff and their distributors as their main sources of pest management information. The importance of each of these sources of information varied between growing districts probably in response to the profile and availability of individual staff within these different sectors of service providers. Agribusiness considered their peers, their own research and experience, state government staff, printed media, compact discs and the internet as important although a wide range of other sources were also mentioned.

Both growers and agribusiness did not rate meetings or courses as important sources of information for managing pests. This was in contrast to a question to gauge interest in attending project field days, workshops and seminars where the majority answered in the affirmative. Some growers said that they expected their consultant to attend these activities on their behalf. Respondents were also very clear about extension activities (including printed material) needing to be short, topical and relevant to their business. Agribusiness saw mail and email as the best methods for being kept informed about project progress while growers preferred fax and mail, including growers who are comfortable using email and the internet.

Respondents provided an abundant description of the types of skills and information they needed to better manage pests including thrips. This included thrips identification, life cycle, biology and ecology, symptoms and damage, insecticides and resistance, natural enemies, viral diseases and thrips activity throughout the district. Growers and agribusiness wanted better knowledge of pests, diseases and disorders in general with leaflets and booklets mentioned as ID tools. Many said that it was difficult to keep up to date with chemical registrations and any current information on all aspects of chemical use was seen as helpful. There was some interest in alternative strategies including biological controls, better understanding of alternative weed hosts and area-wide management including early warning systems, coordinating planting dates, insecticide resistance management and cleaning up dirty farms.

Conclusions and recommendations

The needs analysis firmed up target groups and target crops and highlighted that the commercialisation strategy had to include all sectors of the industry with an influence on pest management decision-making. It generated some useful information on current pest management practices for project evaluation purposes.

The results confirm that in the absence of a WFT management crisis, it would be a challenge to match grower needs with project needs without making major changes to our approach. Some general conclusions are:

- WFT management is unlikely to engage grower interest unless it becomes difficult to manage, however SLW and heliothis management might.
- It is unrealistic to expect a large proportion of growers to attend seminars and workshops in the absence of a crisis.
- Keeping growers informed on chemical issues will help build goodwill and credibility.
- There are opportunities for building skills and capacity by developing activities that target specific grower and agribusiness interests.
- We need to target agrichemical distributors with training and support consultants with service development since both are important sources of information for growers.

The results also confirm that several interlinked strategies that are flexible and responsive to changing grower and industry needs are likely to be the most effective extension approach. After discussion with project team members and project funders, the project brief was broadened to take a more integrated multi-pest approach, particularly by building strong links with HAL project VG05050 "Development and promotion of IPM strategies for silverleaf whitefly in vegetable crops". Four core, interrelated extension strategies were developed:

- Workshops, seminars and farm walks to provide opportunities for discussion, skills development and information sharing amongst the project team, interested growers and agribusiness personnel.
- Communication based on newsletters and information leaflets to keep in touch and keep target groups informed about project progress.
- Working with growers via consultants and other service providers to cater for grower preference to obtain information through one-on-one contact.
- Commercialisation of services via two major consultancy firms collaborating in the project but also other service providers especially agrichemical distributors.

These four strategies are described in more detail in the sections on adoption of modified technology and information and commercialisation of services.

Modification of technology and information

While considerable research and development had been undertaken on WFT in other states through the National Strategy (see Western Flower Thrips Newsletters), there was very little information about the insect specifically for Queensland. It was necessary, therefore, to conduct some research and development activities in the Bundaberg and Bowen districts to fill these gaps in our knowledge to ensure that the management technology being transferred was appropriate for each district, and where necessary was adapted to suit the Queensland situation. Studies on the efficacy of insecticides against WFT, the resistance status of WFT, its seasonal occurrence and the importance of weeds and other crops as alternative hosts were undertaken to achieve this.

1) Testing insecticides

A series of full insecticide trials was conducted at Bundaberg, supplemented by several smaller trials in the Bowen district.

Bundaberg trials

Introduction

Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae), western flower thrips (WFT), is a major pest world wide (Kirk 2002). It damages plants in its large host range by its feeding, causing scarring and other blemishes, by ovipositing in plant tissue and by transmitting the tospovirus tomato spotted wilt virus.

WFT was first recorded in Australia in Western Australia in 1993 (Malipatil *et al.* 1993) and was recorded in Queensland at Redland Bay in the same year. It was first recorded at Bundaberg in 1996 and was common in the district by 2001. WFT was noticed causing damage to capsicums in the Bowen – Burdekin district in 2002. It continues to occur and cause crop damage in the Bundaberg and Bowen – Burdekin districts, with capsicums and chillies (i.e. peppers) the main crops affected.

Growers rely heavily on insecticides to control WFT. Recommendations for insecticidal control of WFT are based on a resistance management strategy that recommends three consecutive sprays of the same insecticide 3-6 days apart followed if necessary at least two weeks later by a further series of three sprays with a chemical from a different insecticide group (Herron and Cook 2002; Herron *et al.* 2007). Few insecticides apart from spinosad have been registered for use against WFT in Australia but a number of insecticides including abamectin, alpha-cypermethrin, acephate, chlorfenapyr, chlorpyrifos, endosulfan, fipronil, malathion, methamidophos, methidathion, methiocarb and methomyl have been available for use on various crops under permits issued by the Australian Pesticides and Veterinary Medicines Authority (formerly the National Registration Authority).

Seaton *et al.* (1997) tested 10 insecticides against WFT in trials in Western Australia and reported that methamidophos was the most effective. Laboratory testing of insecticides for efficacy against WFT and to detect resistance has been conducted in NSW since the insect was first recorded (e.g. Herron *et al.* 1996; Herron and Gullick 2001; Herron and James 2005), while Broughton and Herron (2007) conducted field trials in strawberries and lettuce to test the efficacy of laboratory based permit application rates of abamectin, acephate, endosulfan, methidathion, spinosad and methamidophos.

The four trials reported here were done to test a number of insecticides for their efficacy against WFT in the Bundaberg district. Most insecticides were tested initially in Trials 1-3 and those showing the most promise or reportedly having activity against thrips were re-tested in Trial 4.

Materials and Methods

Four trials were conducted to determine the effectiveness of insecticides in controlling WFT on chillies and capsicums at Bundaberg. The insecticides trialled are listed in Table 1.

Trial 1 was conducted in a commercial crop of cayenne chillies in August 2005. Plots were four rows by 5 m, with rows spaced 0.8 m apart and the treatments were arranged in a randomised complete block design with four replicates. There was a 1m guard area between plots along each row. Treatments were applied twice, on day 0 and on day 3. The numbers of thrips were assessed on day -1, day 2, day 6 and day 9 by collecting 15 flowers from the central two rows of each plot into paper bags, which were returned to the laboratory. In the laboratory, thrips were extracted from the flowers on a white tray and the numbers of adults and larvae counted.

Trials 2 and 3 were conducted in October and November 2005 in a crop of capsicums (var Raptor) grown on plastic mulch with trickle irrigation and using standard agronomic practices at Bundaberg Research Station. Plants were 25 cm apart in rows separated by 1.5 m. Plots were three rows by 5 m, with 1m of guard between plots along each row, and the treatments were arranged in a randomised complete block design with four replicates. Treatments were applied on day 0 and day 3. Thrips numbers were assessed pre-treatment (on day -1 in Trial 1 and on day -2 in Trial 3), on day 3 (before spraying), on day 6 and on day 10 by collecting 10 flowers from the centre row of each plot into a vial of 70% alcohol. The vials were returned to the laboratory and the numbers of adult and larval WFT counted under a stereo-microscope.

Trial 4 was conducted in November 2006 at Bundaberg Research Station in a crop of capsicums, var Raptor. The agronomic practices, plot size, trial design and method of assessing thrips numbers were the same as those for Trials 2 and 3. Treatments were applied on day 0, day 3 and day 6 according to the requirements of the National Strategy for WFT Resistance management (Herron and Cook 2002; Herron *et al.* 2007). WFT numbers were assessed on day -1, day 2, day 5, day 9 and day 13.

All insecticide treatments, with the exception of imidacloprid in Trial 2, were applied using a motorised Echo knapsack sprayer fitted with a boom and four Albuz brown hollow cone nozzles operated at 690 kPa. Treatments were applied in the equivalent of 500 L/ha of water in Trial 1 and in the equivalent of 1000 L/ha of water in Trials 2, 3 and 4. In Trial 2 the imidacloprid treatment was applied as a drench to each plant on day -23 when approximately 50% of the plants were flowering. The imidacloprid was applied at 0.04 g a.i./plant in 80 mL/plant of water to the soil at the base of each plant.

Data on numbers of WFT adults and larvae were analysed using GenStat Release 9.2 in each trial. Data were normalised using $\log_{10}(x + 1)$ transformation before analyses of variance were conducted. Means were separated using a protected least significance difference test. There were significant differences between means in the pre-treatment counts of both adults in Trial 2, so the pre-treatment counts were used as covariates in analyses of the post-treatment counts. The covariates were not significant so the results of these covariance analyses were not used.

Results

WFT was the predominant species in each trial. The percentages of WFT in the pre-treatment adult counts were 97.6%, 98.3%, 98.1% and 99.2% in Trials 1, 2, 3 and 4 respectively. Although the larvae could not be identified to species it is reasonable to assume that they also were predominantly WFT.

In Trial 1 (Table 2) spinosad was the only treatment that significantly ($P<0.05$) reduced numbers of adults compared to the untreated control. Spinosad and methidathion had significantly fewer ($P<0.05$) larvae than the untreated control after one application (i.e. on day 2). These two treatments and bifenthrin and methomyl had significantly fewer ($P<0.05$) larvae than the untreated control on day 6 and day 9, after the second application, with significantly fewer ($P<0.05$) larvae in the spinosad than in the bifenthrin, methomyl and methidathion treatments.

None of the insecticidal treatments in Trial 2 (Table 3) significantly reduced ($P>0.05$) the number of WFT adults compared to the untreated control. There were significantly fewer ($P<0.05$) larvae in the methamidophos treatment than in all the other treatments at day 3 after one application and at day 6 after two applications. At day 10, seven days after the second application, there were significantly fewer ($P<0.05$) larvae in the spirotetramat treatment than in all the other treatments, and fewer ($P<0.05$) in the methamidophos treatment than in the untreated control.

In Trial 3 (Table 4) only fipronil had significantly fewer ($P<0.05$) adults and larval thrips than the untreated control in post-treatment counts.

In Trial 4 (Table 5) on day 2, after the first application, there were significantly fewer ($P<0.05$) adults in the spinosad and methamidophos treatments and significantly fewer ($P<0.05$) larvae in the spinosad, methamidophos, pyridalyl and fipronil treatments than in the untreated control. On day 5, after the second application, there were significantly fewer ($P<0.05$) adults in the spinosad, spirotetramat, methamidophos and fipronil treatments and fewer ($P<0.05$) larvae in these and the pyridalyl treatments than in the untreated control. On day 9, after the third application, there were significantly lower ($P<0.05$) numbers of adults in the spinosad, methamidophos and fipronil treatments and fewer ($P<0.05$) larvae in the spinosad, spirotetramat, pyridalyl and fipronil treatments than in the untreated control. On day 13 there were significantly fewer ($P<0.05$) larvae in the spirotetramat treatment than in any other treatment, while larval numbers in spinosad treatment also were significantly lower ($P<0.05$) than the untreated control. Numbers of adults and larvae in the bifenthrin treatment were significantly higher ($P<0.05$) than those in the untreated control from day 5 onwards.

Discussion

These trials identified several insecticides that were effective against WFT. The small plot design of the trials probably allowed reinfestation of effectively treated plots by thrips from guard areas and from ineffective treatment plots, which may have confounded results as the time from the application dates increased. Trial 1 covered a small area in a large expanse of commercial crop that was heavily infested with WFT, so it was particularly affected. Hence it would be expected that insecticides shown to be reasonably effective in these small plot trials would be effective when applied over large areas of crop where the reinfestation factor would not apply.

Spinosad was effective against adult and larval WFT in Trials 1 and 4. It is registered for use against WFT and is widely used, which means that there is a significant risk of resistance development. Resistance to spinosad in WFT has been reported already n some areas (Herron and James 2005).

Fipronil was effective in Trials 3 and 4 and it was effective in an earlier trial (Walsh *et al.* 2004). Permits for its use against were available, but were not renewed after Permit 4415 expired in March 2005. Its continued availability would have allowed rotation of insecticide groups and so reduced the selection pressure on spinosad.

Methamidophos was effective in Trials 2 and 4 and it was effective in the earlier trial (Walsh *et al.* 2004). Broughton and Herron (2007) also reported that methamidophos was effective against WFT. It is permitted for use against WFT in lettuce (Permit 10416) and is registered against heliothis (*Helicoverpa* spp.) on capsicums, so it could be useful in an insecticide rotation system. However its broad spectrum of activity and non-selectivity make it incompatible with IPM systems. It is believed that melon thrips (*Thrips palmi*) are resistant to organophosphate insecticides such as methamidophos, and up to 30% of adult thrips in post-treatment counts in methamidophos plots in Trial 4 were melon thrips, compared to very low percentages in other treatments and in the pre-treatment counts (<1%). It is probable, therefore, that many of the larvae in the Trial 4 Day 9 methamidophos plots also were melon thrips. Methamidophos should not be used if there is a significant proportion of melon thrips in the thrips population.

Spirotetramat, a new chemical, was very effective against larval WFT, but not adults, in Trials 2 and 4, although its effectiveness took some time to become apparent. It will be a very useful insecticide against WFT particularly in situations where there is not continual re-invasion by adults.

Pyridalyl also showed some effectiveness against larvae in Trial 4 and Isayama *et al.* (2005) reported that it showed high toxicity against both adult and larval WFT. Methidathion had some effect in Trial 1 and there have been and are permits for its use against WFT (Permit 10265) but it is a broad spectrum organophosphate insecticide, incompatible with IPM programs.

The other insecticidal products tested were not effective. Imidacloprid as a plant drench was not effective in Trial 2, while Walsh *et al.* (2004) showed it was not effective as a foliar spray. It is believed to be effective against melon thrips (Walsh *et al.* 2004). There are permits (Permit 10670) for the use of abamectin against WFT but Herron and Gullick (1998) and Broughton and Herron (2005) suggested that higher than permit rates are needed for abamectin to be effective. There are a number of permits for the use of methomyl against WFT (Permits 6914, 7588, 9932,) but methomyl was not effective in Trial 1. Methomyl is widely and regularly used against heliothis, *Helicoverpa* spp., in crops that still are heavily infested by WFT, further evidence that it is ineffective. Bifenthrin was ineffective in Trial 1 but was re-tested in Trial 4, despite known resistance to synthetic pyrethroids in WFT (Herron and Gullick 2001) as it has a variety of uses in WFT host crops. In Trial 4 its use resulted in large increases in WFT numbers. It is not suitable for use in WFT infested crops. As well, both methomyl and bifenthrin are broad-spectrum insecticides, unsuitable for use in IPM programs. Emamectin benzoate was not effective in Trials 3 and 4, although it has been reported a potent compound for controlling WFT in both laboratory and field conditions (Ishaaya *et al.* 2002).

This series of trials has identified which insecticides are effective against WFT in the Bundaberg district and which are not. Similar results have been obtained in small

trials and through grower experience in the North Queensland region. Unfortunately there is only one effective chemical, spinosad, registered or permitted for use against WFT on capsicums and chillies, the main WFT host crops in these districts. This makes it impossible to recommend an insecticide rotation within the WFT 3-spray resistance management strategy and increase the risk of resistance developing to spinosad. It is critical that more, effective insecticides are available and the results of these trials have been supplied to the relevant chemical companies to facilitate registration of those shown to be effective.

Bowen trials

Three trials were conducted in 2005 by BCMS in capsicum crops at Gumlu, 60 km north of Bowen.

Trial#0105 screened eight insecticide treatments (with an unsprayed control) with a single application, using one replicate. Thrips were counted in 24 flowers per plot two days after treatment. The results indicated that spinosad, methamidophos, bifenthrin, bifenthrin + piperonyl butoxide and fipronil were the most effective treatments. Emamectin, abamectin and piperonyl butoxide were much less effective.

In Trial#0405 nine insecticides (and an untreated control) were screened for efficacy. Spray treatments were applied in three applications a week apart, with a single application of a drench treatment. There were two replicates. Assessments (thrips per plant on 10 plants per plot) were conducted two and seven days after application. The results indicated that spinosad, spinosad + paraffinic oil, methamidophos and dimethoate were effective in controlling thrips. Thiamethoxam as a foliar spray and as a plant hole drench, chlorfenapyr and pyriproxyfen + pyridalyl were less effective and comparable to the untreated control.

Trial#0305, with one replicate, aimed to compare the 3 spray strategy (using spinosad) recommended by the National Strategy with a rotation of three insecticides (spinosad, methamidophos and bifenthrin, weekly applications of amorphous silica and the grower's commercial spray program (primarily a rotation of methamidophos, spinosad and bifenthrin, some of which were applied against other pests in the crop). Five weekly applications were made. Thrips numbers in all flowers on 20 plants per plot were counted seven days after each application. The results indicate that the 3 spray strategy, the rotation of three chemicals and the commercial program all resulted in a low number of thrips (although counts in the commercial program were high after the third spray). It is most important to remember that the 3 spray strategy is designed to minimise the risk of resistance developing in WFT by controlling all stages of one generation of the thrips before using a news insecticide on the next generation. The amorphous silica treatment was not effective.

The results of these trials showed several differences from those at Bundaberg. Bifenthrin appeared to be effective at Gumlu while it most definitely was not at Bundaberg. Similarly dimethoate was ineffective at Bundaberg but showed some promise at Gumlu.

The important outcome form these trials in both districts is that chemical recommendations for WFT management can be made with sound knowledge of which insecticides are effective against WFT.

Table 1
Insecticides used in the Bundaberg trials.

Active ingredient	Formulation	Trade name
Abamectin	18 g/L emulsifiable concentrate	Vertimec
Amorphous silica	500 g/L suspension concentrate	Abrade
Bifenthrin	100 g/L emulsifiable concentrate	Talstar
Chlorpyrifos	500 g/L emulsifiable concentrate	Lorsban
Dimethoate	400 g/L emulsifiable concentrate	Rogor
Emamectin benzoate	44 g/kg water dispersible granules	Proclaim
Endosulfan	350 g/L emulsifiable concentrate	Endosulfan
Fipronil	200 g/L suspension concentrate	Regent 200 SC
Imidacloprid	200 g/L suspension concentrate	Confidor 200 SC
Methamidophos	580 g/L emulsifiable concentrate	Nitofol
Methidathion	400 g/L emulsifiable concentrate	Supracide
Methomyl	225 g/L emulsifiable concentrate	Lannate L
Potassium salts of fatty acids	285 g/L insecticidal soap	Natrasoap
Pyridalyl	100 g/L suspension concentrate	Alegro
Spinosad	120 g/L suspension concentrate	Success
Spirotetramat	240 g/L suspension concentrate	Movento

Table 2
Mean numbers of western flower thrips adults and larvae in Trial 1.

Treatment	Mean numbers* of WFT adults and larvae on each sampling date. Treatments were applied on Day 0 and Day 3							
	Day -1		Day 2		Day 6		Day 9	
	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
Untreated control (-)	32.6 a	81.4 a	37.8 a	93.4 a	69.5 ab	173.2 a	74.0 ab	168.0 a
Spinosad (96 g a.i./ha)	32.4 a	60.9 a	11.3 b	19.0 c	33.8 c	11.8 c	41.8 c	5.8 c
Bifenthrin (60 g a.i./ha)	26.5 a	71.1 a	36.5 a	55.8 ab	79.4 a	79.0 b	93.6 a	98.5 b
Methomyl (450 g a.i./ha)	31.2 a	58.0 a	42.4 a	56.4 ab	80.9 a	72.0 b	92.1 a	105.7 b
Methidathion (560 g a.i./ha)	35.6 a	77.3 a	31.7 a	43.2 b	51.0 b	67.9 b	80.1 a	100.9 b
Insecticidal soap (4275 g a.i./ha)	26.2 a	58.0 a	39.0 a	75.0 a	54.5 ab	174.4 a	59.7 b	150.0 a

* Back-transformed means following $\log_{10}(x + 1)$ transformation before analysis.
In each column means followed by the same letter are not significantly different (P>0.05).

Table 3
Mean numbers of western flower thrips adults and larvae in Trial 2.

Treatment	Mean numbers* of WFT adults and larvae on each sampling date. Treatments were applied on Day 0 and Day 3							
	Day -1		Day 3		Day 6		Day 10	
	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
Untreated control (-)	23.1 bc	68.8 a	67.9 a	60.8 a	44.9 a	58.7 a	177.7 a	118.4 a
Imidacloprid (0.04 g a.i./plant)	39.7 a	142.9 a	88.7 a	69.2 a	68.5 a	48.7 a	228.1 a	124.9 a
Methamidophos (1218 g a.i./ha)	19.5 c	64.6 a	48.2 a	29.3 b	23.9 a	15.4 b	202.2 a	55.8 b
Spirotetramat# (144 g a.i./ha)	34.7 ab	82.0 a	76.1 a	78.8 a	40.7 a	33.4 a	235.1 a	13.7 c
Endosulfan (665 g a.i./ha)	25.1 abc	71.4 a	61.4 a	54.3 a	41.7 a	59.0 a	122.9 a	98.5 ab
Abamectin (8.1 g a.i./ha)	19.8 c	60.1 a	87.9 a	44.1 ab	48.8 a	37.8 a	160.8 a	127.2 a

* Back-transformed means following $\log_{10}(x + 1)$ transformation before analysis.
# A spray adjuvant (Hasten™) was added to the spirotetramat sprays at 0.1%.
In each column means followed by the same letter are not significantly different (P>0.05).

Table 4
Mean numbers of western flower thrips adults and larvae in Trial 3.

Treatment	Mean numbers* of WFT adults and larvae on each sampling date. Treatments were applied on Day 0 and Day 3							
	Day -2		Day 3		Day 6		Day 10	
	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
Untreated control (-)	71.3 a	78.6 a	105.4 a	282.8 a	103.7 a	186.9 a	266.3 a	364.6 a
Fipronil (50 g a.i./ha)	66.0 a	91.9 a	123.7 a	84.1 b	48.9 b	50.4 b	289.4 a	124.6 b
Dimethoate (300 g a.i./ha)	53.2 a	88.5 a	113.0 a	231.8 a	114.9 a	221.8 a	247.3 a	412.1 a
Chlorpyrifos (350 g a.i./ha)	65.8 a	78.3 a	157.1 a	341.0 a	97.4 a	265.7 a	230.2 a	477.6 a
Emamectin benzoate (11 g a.i./ha)	63.6 a	64.5 a	105.7 a	322.6 a	93.6 a	193.1 a	237.8 a	360.4 a
Amorphous silica (2500 g a.i./ha)	43.9 a	71.3 a	93.8 a	220.8 a	91.0 a	176.4 a	286.1 a	319.6 a

* Back-transformed means following $\log_{10}(x + 1)$ transformation before analysis.
In each column means followed by the same letter are not significantly different (P>0.05).

Table 5
Mean numbers of western flower thrips adults and larvae in Trial 4.

Treatment	Mean numbers* of WFT adults and larvae on each sampling date. Treatments were applied on Day 0, Day 3 and Day 6.									
	Day -1		Day 2		Day 5		Day 9		Day 13	
	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
Untreated control (-)	68.0 a	97.4 a	98.1 ab	127.2 a	140.6 ab	163.1 bc	93.4 bc	216.3 bc	74.2 de	82.4 bc
Spinosad (96 g a.i./ha)	57.8 a	81.0 a	27.6 d	11.9 c	21.5 e	5.5 g	34.2 e	3.7 f	91.0 cde	17.4 d
Bifenthrin (60 g a.i./ha)	62.8 a	94.3 a	133.0 a	140.3 a	204.2 a	287.4 a	214.3 a	583.8 a	164.6 a	315.2 a
Spirotetramat# (144 g a.i./ha)	59.5 a	91.7 a	86.7 abc	132.1 a	89.2 c	84.7 d	111.7 b	12.0 e	131.4 abc	7.2 e
Methamidophos (1218 g a.i./ha)	73.6 a	111.7 a	62.5 c	65.7 b	55.0 d	30.0 e	55.9 d	105.4 cd	70.6 e	121.5 b
Pyridalyl (200 g a.i./ha)	40.8 a	64.5 a	78.8 bc	57.8 b	108.7 bc	27.4 e	93.2 bc	60.5 d	114.4 abc	107.1 bc
Fipronil (50 g a.i./ha)	44.0 a	58.2 a	76.5 bc	43.0 b	57.3 d	14.8 f	59.0 d	23.1 e	134.8 ab	51.1 c
Emamectin benzoate (11 g a.i./ha)	65.1 a	74.5 a	104.2 ab	110.4 a	158.6 ab	122.0 cd	115.7 b	274.4 ab	119.2 abc	150.4 ab
Insecticidal soap (8550 g a.i./ha)	52.7 a	84.7 a	99.9 ab	154.6 a	126.1 bc	212.8 ab	75.6 cd	390.7 ab	107.6 bcd	157.1 ab

* Back-transformed means following $\log_{10}(x + 1)$ transformation before analysis.
# A spray adjuvant (Hasten™) was added to the spirotetramat sprays at 0.1%.
In each column means followed by the same letter are not significantly different (P>0.05).

2) Resistance testing

WFT were collected from crops in the North Queensland and Bundaberg districts on a number of occasions and forwarded to Dr G Herron, NSW Department of Primary Industries, to be tested for resistance to a range of insecticides. Dr Herron conducted the tests as part of the projects HG03003 "Evaluation of insecticides for western flower thrips resistance" and VG06010 "The sustainable use of pesticides (especially spinosad) against WFT in vegetables". Thrips were tested with each insecticide by treating them with a discriminating dose, a rate of insecticide that will kill all susceptible WFT. This gives a simple indication of the level of resistance in the population as survivors are considered resistant.

The results are shown in Table 6 and Table 7. They show that there are no obvious resistance problems for acephate, dimethoate, endosulfan, methamidophos or methidathion in either district. In both districts, a small percentage of resistant WFT was recorded to dichlorvos, which may be used for thrips control in greenhouses and glasshouses. There were small percentages of WFT resistant to methomyl in both districts but not enough to explain why methomyl is ineffective in trials and in commercial applications on crops. The substantial percentage of WFT resistant to bifenthrin at Bundaberg accords with lack of effectiveness in trials. The percentages of WFT resistant to chlorfenapyr at Gumlu in late 2005 cannot be explained easily. Testing in both districts occasionally showed low percentages of WFT resistant to fipronil. Fipronil was permitted for use, and was used, against WFT on ornamentals and capsicums until the end of March 2005 (Permit 4415). The small percentages of WFT at Bundaberg resistant to spinosad in 2004 and 2005 were of concern considering its widespread use against both WFT and heliothis, but later testing has shown 100% mortality.

This testing has provided valuable information on the resistance status of WFT in the two districts. Such information is important background information for providing sensible and correct guidance on the use of insecticides for WFT management.

Table 6
The percentage mortality of WFT from North Queensland tested for resistance with a discriminating dose of insecticide.

Insecticide	Percentage mortality at discriminating dose						
	Gumlu Chilli 17/08/04	Gumlu Capsicum 07/09/04	Gumlu Capsicum 23/06/05	Gumlu Capsicum 23/11/05	Gumlu Chilli 23/11/05	Gumlu Chilli 24/10/06	Gumlu Melon 24/10/06
Abamectin	100						97
Acephate						100	
Chlorfenapyr				92	69		
Dichlorvos	95	98	97			100	96
Dimethoate	100			100	100		
Endosulfan				100	100	100	100
Fipronil	100	84	99	100	100	100	96
Methamidophos				100	100		
Methidathion		100	100			100	
Methomyl			98			97	93
Pyrazophos							96
Spinosad		100	100	100	100	100	100
Thiamethoxam				100	100		

Table 7
The percentage mortality of WFT from Bundaberg tested for resistance with a discriminating dose of insecticide.

Insecticide	Percentage mortality at discriminating dose							
	Bund. Chilli 30/11/04	Bund. Capsicum 30/11/04	Bund. Chilli 25/08/05	Bund. Capsicum 05/12/05	Bund. Chilli 12/09/06	Bund. Capsicum 23/10/06	Bund. Capsicum 04/12/06	Bund. Tomato 29/08/07
Abamectin				100				100
Acephate					100	100	100	100
Acetamiprid				100				
Bifenthrin							55	
Chlorfenapyr				100				
Dichlorvos	98	98	97		99	99	100	94
Dimethoate				100	100			
Endosulfan				100	100	100	100	100
Fipronil	100	92	100	100	100	99	100	93
Methamidophos				100			100	
Methidathion	100	100	100		99	100	100	100
Methomyl	91	98	100		88	98	100	100
Pyrazophos								100
Spinosad	100	94	98	100	100	100	100	100
Thiamethoxam				100				

3) Seasonal occurrence, refuge areas and alternative host surveys

It is important to have some understanding of the ecology of WFT in each district to be able to develop, adapt and promote effective management strategies for it and for TSWV. The occurrence of WFT during the year or growing season and its use of alternative hosts and refuges are important aspects of it ecology. Basic studies on these were conducted in both districts.

Walsh *et al.* (2004) had studied the seasonal abundance of thrips in commercial capsicum crops in the Bundaberg district from July 2002 to July 2003, with crops available for sampling from July to November and from March to July. They collected flowers from each crop and extracted, identified and counted the numbers of each species present. WFT were present in low numbers only and as small proportion of the thrips population in March – April. The proportion of WFT increased in May – July and WFT dominated the thrips population from August – November. Crop monitoring and thrips assessments by the consultants and other occasional sampling of thrips in crops conducted as part of this project confirmed that WFT were scarce in crops early in the year but numbers increased as the year progressed, with large numbers present in spring and early summer.

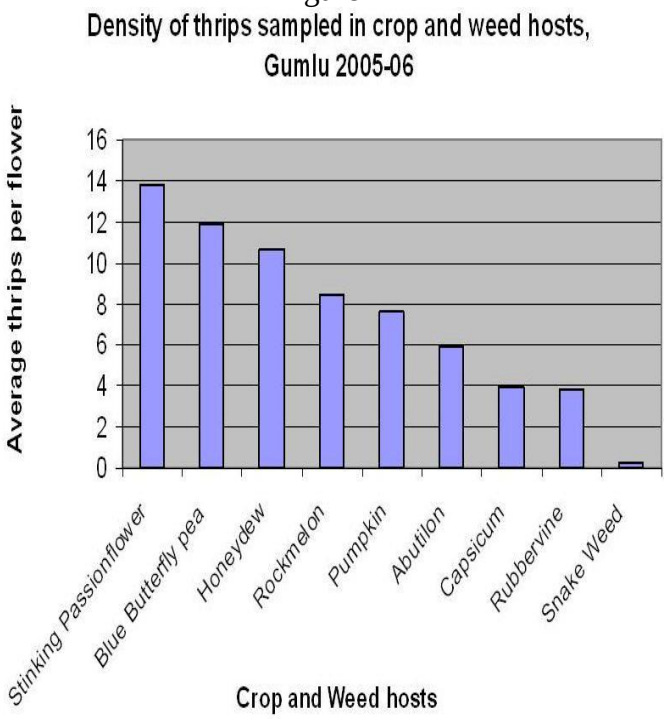
Surveys of common weeds and alternative crop hosts in the Bundaberg district were done in 2005 and 2006. WFT were recorded from wild radish, green amaranth, Shepherd's purse, common morning glory and common sensitive plant. Wild radish is a very common weed in the district, growing along the edges of sugarcane fields, on headlands and along roads and farm tracks. It is common in winter and early spring, so would be a source of WFT infestation into new spring crops. WFT were recorded from lucerne and peanut crops in March and April, a time when they are relatively uncommon in vegetable crops. Peanuts, grown during summer, may carry over WFT from year to year. WFT also were recorded in melon flowers. Crops of processing chillies, which carry large populations of WFT but suffer no damage so the thrips are not controlled, probably are a source of infestation for more susceptible crops. Few thrips were found along creek banks or gullies. Much of the Bundaberg area is intensively farmed for much of the year (as distinct from the more scattered cropping pattern at Gumlu where BCMS undertook weed/thrips studies), so perhaps these riparian areas are not as important as refuges. Neglected, weedy and old capsicum and chill crops, weeds on fallow land, on roadsides, and alternative crop hosts are important for WFT in the Bundaberg district.

In the North Queensland district, which has a vegetable growing season from February – March to October – November, sampling was conducted in the Gumlu area from March 2005 to March 2007. Farms were surveyed every 4 – 6 weeks, and thrips were collected and identified. In each year WFT numbers were low in March – April, with tomato thrips, *Frankliniella schultzei* (Trybom), the main species found. WFT were present by May – June, with moderate to high levels present from July to October.

Weeds, other crops on farms besides the main crops of interest, capsicums and chillies, old crop residues and volunteer crop plants were included in the regular sampling program at Gumlu. Weeds were sampled in and around crops and along creek and river banks adjacent to cropping areas. The average numbers of thrips in flowers of some of the weeds and crops sampled are shown in Figure 1. These results identified

stinking passionflower, blue butterfly pea, abutilon and rubber vine as important weed hosts and melon and pumpkin crops, residues and volunteers as important alternative crop hosts. The riparian zones, usually carrying the only green vegetation apart from irrigated crops in a dry landscape, were key refuge areas for WFT, as were old crop residues and volunteer cucurbit plants. Identification of these weed and crop hosts and refuge areas prompted a successful campaign under the banner "Get Mean, Keep Clean" to improve farm hygiene in the district.

Figure 1



Adoption of modified technology and information

As described earlier, the results of the needs analysis, together with the initial design of the project, shaped the extension approach used in the project. Four interrelated extension strategies were employed: workshops, seminars and field days; project newsletters and other publications; working with growers; and supporting commercialisation.

We felt it was important to make the project and its outputs clearly identifiable to growers, agribusiness, the research community and the general public. A unique logo (Figure 2) was designed to identify the project and was used on all communications arising from the project. The logo was designed by BCMS and depicts a grower halting thrips movement on his farm. The quirky logo attracted considerable interest and was a valuable tool in the extension process.

Figure 2
The project logo.

Workshops, seminars and field days

A series of workshops and seminars was held during the project. While the needs analysis suggested that workshops were not a primary source of information for busy vegetable growers, they were identified as important for disseminating information to growers, consultants and other agribusiness people provided certain criteria were met. Activities had to be timely, short, held at times convenient for the majority of the target audience (e.g. late afternoon/early evening in the mid week for growers), and to include only relevant and pertinent information. To add value to the workshops, presentations on other key pests and diseases were included in many of the workshops. In this way, information on WFT was transferred to a wider audience of growers and industry including those who may not have considered WFT a major concern to them but who would benefit from knowledge of it and its management.

Table 8 lists the workshops, seminars and field days and their topics held in North Queensland and Table 9 those in the Bundaberg district.

We held several spray application workshops in response to questions about poor spray application as a contributing factor in less than ideal spray results and insecticide resistance problems. Workshops were preceded by testing of growers' spray equipment, providing a practical illustration of where spray droplets are deposited on plants and showing how modification of settings altered spray efficiency. A spray application specialist with experience in vegetables was contracted to present up to date information on the theory and practice of good spray application. These workshops included a demonstration of spray deposition at different settings using fluorescent dyes. Spray testing kits containing water sensitive test papers, pens and instructions were distributed so that growers could test their own spray equipment.

Most seminars and workshops were well attended by growers, consultants and agricultural distributors. Some larger growers who did not attend were represented by their consultants or in-house agronomists. As the project evaluation indicated, seminars and workshops were generally well received. Formal presentations were supported by posters, displays (e.g. thrips under magnification) and printed hand-out material. We also encouraged questions and allowed time for informal discussions.

Table 8
Workshops in North Queensland districts.

Date	Workshop topics
28/07/2004 (Gumlu)	<u>WFT project – Information Forum</u> • The new Western Flower thrips project – what's it about and who is involved • Western Flower thrips survey and identification work planned for the Gumlu district • Research work planned for testing western Flower thrips control measures • What's needed and how big a problem is western flower thrips anyway?
15-17/03/2005 (Bowen, Gumlu, Ayr)	<u>Weeds are costing you $money$</u> • Bowen Crop Monitoring weed survey results • Permit updates for western flower thrips • The latest on managing Silverleaf whitefly and more
20-21/07/2005 (Bowen, Gumlu, Ayr)	<u>Are you hitting the target?</u> • Spray application seminar • Fluorescent dye farm walk
1-2/03/2006 (Bowen, Gumlu, Ayr)	<u>Pest Management Workshop</u> • Get mean and keep clean: Weeds, WFT and viral diseases • The latest on insecticide trial results & thrips survey work, Bowen • Update on insecticide trial results and thrips survey work, Bundaberg • Current information on TSWV and CaCV, • New silverleaf whitefly project & update on resistance management
27-29/03/2007 (Bowen, Gumlu, Ayr)	<u>Pest and Disease Management Seminar</u> • Capsicum powdery mildew project • Western flower thrips Results from insecticide trial work Update on thrips and weed survey work • TSWV and CaCV in capsicum & other crops • Eggplant caterpillar project results • Cucurbit powdery mildew project • Silverleaf whitefly project Natural enemy *Eretmocerus hayati* release program for Bowen & the Burdekin Spray programs & insecticide resistance management for selected crops • Tomato yellow leaf curl virus update
11-13/03/2008 (Bowen, Gumlu, Ayr)	<u>Pest and Disease Management Seminar</u> • Final WFT project update • The latest news on insecticide resistance levels in silverleaf whitefly • Managing virus diseases in cucurbits • Best strategies for powdery mildew control in cucurbits • High risk exotic vegetable pests: *Liriomyza* leafminers • Update on eggfruit caterpillar work & new Victorian entry conditions for eggfruit

Table 9
Workshops in the Bundaberg district.

Date	Workshop topics
17/11/2004	WFT project – Information Forum • The new Western Flower thrips project – What is it about? Who is involved? • The South Australian experience • Thrips surveys in the Bundaberg area • Results and ideas from grower interviews
9/04/2005	Gin Gin Growers Association Talk • Thrips morphology and biology • Western flower thrips • All about the project
24-25/05/2005	Thrips are costing you $money$ • Crop and weed survey results • Thrips lifecycles • Permit updates for western flower thrips • The latest on managing silverleaf whitefly
19-20/10/2005	Are you hitting the target? • Spray application seminar • Fluorescent dye farm walk
8/06/2005	Agribusiness Workshop • Thrips identification • Thrips biology •
14/03/2007	Pest and Disease Management Seminar • Silverleaf whitefly management • Insecticide resistance in silverleaf whitefly • The latest trial results of insecticides against western flower thrips • Current information on the viruses TSWV and CaCV and on breeding CaCV resistant capsicums • Eggfruit caterpillar and insecticides
27/05/2008	Pest and Disease Management Seminar • Final WFT project update • Managing virus diseases in cucurbits • Best strategies for powdery mildew control in cucurbits • High risk exotic vegetable pests: *Liriomyza* leafminers • Eggfruit caterpillar monitoring and insecticides
24/07/2008	Granite belt Young Growers Tour • Western flower thrips and its management • Eggfruit caterpillar and its management

Project Newsletters and other publications

WFT Update
Eight project newsletters, "Western Flower Thrips Queensland Update", were produced from February 2005 to January 2009. Each Update was emailed to approximately 150 recipients (mainly service providers) and posted to approximately 350 recipients (mainly growers) in the target districts.

There were two regular features in each Update: a Regional Round-up that summarised the WFT situation in each district; and a Chemical update that listed current insecticide permits. Each Updates include several short, informative articles on WFT and its management and on project activities, usually also reporting on key messages presented at seminars and workshops.

Examples of topics covered in Update articles are:

- "What thrips is that" – succinct information on each of the major pest thrips of vegetables.
- WFT lifecycle.
- Summaries of the information from the spray application workshops.
- Reports on insecticide screening trials.
- Description of how insecticide resistance develops and the results of resistance testing.
- The 3 spray strategy explained.
- Information on the major weed hosts of WFT in each district.
- "Get mean, keep clean" with recommendations for good farm hygiene.
- A summary of the project's evaluation report.

Two Information Leaflets containing lists of current APVMA permits for WFT control and on registrations and permits for other pests on selected vegetable crops were distributed in April 2005 and February 2006 to supplement the Updates.

The impact and value of the Update was monitored by survey in February 2006 after three issues of WFT Update had been distributed. The purpose was to determine if the aim of the newsletter was being met: "*"To keep in touch and keep our target groups, particularly those unlikely to participate in workshops and seminars, informed about the project progress and WFT"*. A small sample of seven vegetable growers, one in-house agronomist, five agrichemical distributors and a staff member of a seed company and one from a chemical company were interviewed using a series of open and closed questions by telephone on 21 February 2006 in our two target regions around North Queensland and Bundaberg.

The survey showed that agribusiness people found the newsletter valuable. It is read, displayed, distributed further (nationally and internationally) and kept for future reference. Many of the growers also were aware of the newsletter, although the negative responses may have depended on which family member was questioned. All respondents who could recall receiving the newsletter found the newsletters useful, at least sometimes. The full evaluation report is presented in Appendix 1.

Gumlu faxes
As part of the working with growers approach in the Gumlu area, a series of faxes were sent to 19 growers in that area during the project by BCMS. The faxes were designed to highlight key points for WFT management in the area. They contained a district survey map showing WFT incidence and distribution, crop management advice, IPM strategies, research and trial results, virus identification and incidence reports, and information on seasonally dominant weed species.

Thrips and Tospoviruses – a Management Guide
A booklet "Thrips and Tospovirus – a management guide", prepared by virologists within the Cooperative Research Centre for Tropical Pest Management with assistance from project team members, was published in late March 2007. The booklet was distributed widely to growers and service providers on the project's contact list, at seminars and workshops.

The booklet contains high quality colour photographs of virus symptoms on tomato, capsicum and other crop hosts. These include tomato spotted wilt virus and Capsicum chlorosis virus, both members of the tospovirus group of plant viruses. The booklet also lists important weed hosts of these viruses and the thrips that spread them. It explains the life cycle of thrips and how these small insects transmit viruses. The booklet summarises work done by DPI&F plant pathologists Denis Persley and Murray Sharman. Much of this work was completed under the umbrella of the Cooperative Research Centre for Tropical Plant Protection and supported through several HAL and AUSVEG funded projects.

(Persley, D., Sharman, M., Thomas, J., Kay, I., Heisswolf, S. and McMichael, L. (2007). Thrips and Tospovirus – a Management Guide. QDPI&F, Brisbane.)

Training and Information Pack
A CD containing copies of all issues the WFT Update, the Information Leaflets, the Gumlu faxes, seminar and workshop notices, seminar and workshop presentations, posters and various other project communications has been produced and distributed.

Other project publications and communication activities
A number of other publications were produced and communication activities undertaken to raise awareness of the project and its aims and achievements among the wider horticultural community, the general public and the scientific community. These included:

- Articles in local newspapers in both districts, in local grower association newsletters and in "Good Fruit and Vegetables".
- Interviews on local ABC Radio rural programs.
- A presentation on the needs analysis at the International Symposium on Cucurbits in Townsville in September 2005, which was published later as Heisswolf and Kay (2007).
- A poster "Extension Strategies for Improved Western Flower Thrips Management" displayed at the Vegetable Industry Conference in Sydney in May 2007.
- A presentation on the project's activities at the Northern Farming Systems IPM Researchers' Forum at Toowoomba in July 2007.

- A presentation at the Australian Entomological Society Conference in 2007. (Kay, I. and Heisswolf, S. (2007). Western flower thrips – transferring technology in Queensland. Australian Entomological Society's 38th AGM and Scientific Conference, Beechworth, 23-26 September 2007.)
- An abstract based on evaluation results for the project and project VG05050 has been submitted for presentation at the Australasia Pacific Extension 2009 International conference.

Working with growers

Working closely with growers was an important part of the technology transfer strategy. The needs analysis had shown that growers prefer one-on-one contact to access information on pest and disease management via several key service providers: consultant, agricultural distributor or a departmental staff member. This was probably influenced by the specific individuals available within a district, and the relationships formed to access timely information for day to day decision making.

As there are a large number of growers in each district, direct contact with all by project team members was not possible, hence our goal of involving service providers either directly, as was the case with the two consultancies collaborating in the project, or more indirectly by targeting the service provider networks with newsletters and seminars. The consultants in the project team worked closely with their clients to develop effective and efficient management of WFT using the available technology and IPM strategies. The consultants also worked with other growers (i.e. non clients) to develop the growers' thrips management skills.

T-Systems staff, as well as educating their growers, interacted with greenhouse (mainly producing continental cucumbers) and seedling nursery growers during surveys for thrips and viral diseases. They provided advice and guidance on thrips management and on weed control in and around these facilities. They worked closely with a number of growers to test spray equipment and to set up sprayers to provide the best coverage of target areas in thrips susceptible crops, in conjunction with the spray application workshop. Similar spray application advice was provided in North Queensland.

In North Queensland the Gumlu area was chosen to attempt an area wide approach to WFT/TSWV management through close interaction with all growers in the area. This district had suffered widespread WFT damage in capsicums in 2002. BCMS staff regularly surveyed the area for thrips and weed and crop hosts, visited and consulted with growers (clients and non clients) on thrips and disease management, and promoted good farm hygiene throughout the area. All growers received faxes several times each year with information on thrips levels in the district and management advice. A map showing thrips hotspots was included in these faxes to support and reinforce the need for good farm hygiene. Surveys indicated that farm hygiene improved and thrips numbers were reduced at the end of the program.

Supporting Commercialisation

The EOI for the project stated that developing a commercial service that can continue following completion of the program, while not interfering with existing local consultancy work and expanding the technical capacity of commercial services were among the primary aims of the project.

Existing agricultural consultancy firms were well established in both Bundaberg and Bowen. These firms, Crop Tech (now T-Systems) and Bowen Crop Monitoring Services, were invited to be part of the project team and readily joined. A full explanation of the business planning and justification for this approach can be found in Appendix 2.

The inclusion of the firms in the project team was mutually beneficial. The consultants contributed their skills in practical IPM and their knowledge of the districts and farming communities while their technical knowledge and expertise in thrips management was expanded and developed.

Two staff members from each firm attended an intensive three day thrips identification course in March 2005. They were trained to prepare and mount thrips for identification and to correctly identify thrips using a comprehensive key to families, genera and species. This specialist training provided them with the skills to correctly identify thrips species and developed and provided a source of these skills in each district. Since this course, staff turnover in both firms has meant that several of the trained staff no longer work for the firms, but in-house training has ensured that basic preparation and identification skills have been passed on to others in the firms. The capacity to mount and correctly identify at least the major pest species in vegetables has been retained.

The technical capacity of the firms was expanded in many other ways. They were provided with information on WFT biology and ecology, on tospoviruses, on virus transmission, on effective insecticides and on insecticide resistance, either directly or through participation in project activities. They participated in annual team project review and planning meetings and in teleconferences on specific subjects (e.g. explanation of and rationale behind the 3 spray strategy from Dr Herron). Both BCMS and T-Systems undertook surveys, trials and other field work with WFT and TSWV, which also increased their knowledge and understanding of the thrips and virus. They took an active part in seminars and workshops by presenting information on their work and taking part in discussions. They also made an important contribution to the newsletters by providing current information on thrips activity within their respective districts for the regional updates.

The commercialisation process was not limited to developing the skills and capacity of BCMS and T-Systems. As discussed earlier, growers rely on a range of service providers to provide information and timely advice for decision-making and the project attempted to transfer information and technology to the full range of this network. This includes other consultants, agronomists working for agrichemical distributors, chemical company representatives and in-house agronomists in large farming companies, seedling companies and spray operators. The project worked to develop and expand the technical capacity of these service providers through

involvement in workshops and seminars. Several workshops, on thrips identification and biology and on spray application, were held especially for them. The Update was distributed to them and project monitoring and evaluation activities showed that the information was valued and used. There also was a considerable amount of information flow between project team members and individual service providers throughout the life of the project.

Evaluation and measurement of outcomes – impact and adoption

From May July 2008, independent consultants Coutts J&R conducted a state-wide telephone survey relating to WFT with 30 agribusiness and 50 grower respondents taken from a stratified sample of growers and service providers across growing regions in Queensland. The purpose of the survey was to evaluate the effectiveness of the project against project aims and make recommendations for future work.

An over-riding key question for the survey was "How successful has the commercialisation process been?" Specifics on practices, strategies and activities were explored to answer this question and provide guidance for future improvement. The full survey report is available via HAL:

Summary of survey of Agribusiness and Vegetable Growers for "Provision of western flower thrips technology transfer services in Bundaberg and Bowen" (VG03099). Kerry Bell, Amy Samson and Jeff Coutts, September 2008, Coutts J&R.

A summary of key evaluation findings are provided below.

During the life of the WFT project there has been a perceived decrease in the level of WFT damage across susceptible areas and crops across Queensland. Fruit scarring was the major damage reported. The WFT project and its key messages had a high level of awareness with DPI&F providing a critical role in information provision through newsletters and workshops. These have impacted positively on the commercialisation process.

DPI&F officers are seen as the major source of information on WFT by Agribusiness and are playing a critical role in the information system. Growers increasingly rely on crop consultants as their primary source of information. This highlights the impact of the commercialisation route.

- Almost 80% of respondents were aware of the WFT project. The WFT newsletter, the *"Western Flower Thrips Update*" had a high penetration level in the industry with 74% of people interviewed having seen the newsletter. It was rated as moderately useful and Agribusiness values and utilises the information in their commercial activities with growers.
- Agribusiness preferred to receive information via e-mail while growers generally preferred post.
- There was a high level of awareness of and participation in the pest and disease management seminars run by the DPI&F with just over 50% of people interviewed having attended at least one of these meetings. They were rated as moderately useful and clearly play an important role in information sharing and skill development.

There was a high level of awareness and understanding of the practices promoted by the project amongst growers and Agribusiness interviewed.

- Good farm hygiene was seen as important for keeping WFT at manageable levels by 96% of respondents.
- Monitoring/checking crops was seen as important by 92% of people.
- Spraying with insecticides was important for 66% of respondents with 57% of respondents aware of the 3-spray insecticide strategy.
- Just over 50% of respondents said they were aware of the broadleaf weeds that harbour WFT.

About 40% of agribusiness and grower respondents have changed the way they recommend or manage WFT.

- Thirty percent of enterprises interviewed now use a 3-spray strategy on detection of WFT.
- Forty percent now monitor for WFT.
- A quarter now rotate chemicals to reduce insecticide resistance problems.

Both agribusiness and grower respondents on average (out of 10) rated their own research/ information seeking/trials/experience (agribusiness 8.1, growers 8.3) as the top factors prompting change in practices for WFT.

- Agribusiness respondents next rated information about WFT that arrived on the farm from DPI&F (8.1) and discussions with crop consultants (7.9) as prompters of change.
- Growers next rated Pest and Disease seminars (7.8) and discussions with crop consultants (7.4) as prompters for change.

Recommendations made by the evaluators

1. The high level of awareness of the WFT project and its key messages with its impact on practice change is significant and should be acknowledged.
2. There is further work to be done to increase the uptake of the 3-spray strategy by Agribusiness and growers from the gains that have already been made.
3. The approach that DPI&F has taken to target Agribusiness and commercialisation as an industry adoption strategy is working and should be continued.
4. Newsletters are highly regarded and should be continued as an extension mechanism with agribusiness receiving them by e-mail and growers by post.
5. Pest and Disease workshops do play an important role and should be continued – with an emphasis on linking to local successful examples.
6. The high reliance on personal experience and observation by both consultants and growers highlight the importance of field demonstrations/trials and providing local case studies for growers to gain confidence in newer approaches.

Discussion

While WFT is an important pest in the Bundaberg and North Queensland districts and it has caused serious damage, particularly to capsicum crops in North Queensland in 2002, there has not been a crisis situation due to its presence. This is fortunate, but it has made the task of transferring technology for its management and effecting practice change more difficult in these districts. In a crisis an industry actively looks for a solution to the problem and changes to resolve the problem, so the technology transfer role, provided the solution is available, is relatively easier, with little need for hard sell or persuasion. In the absence of a crisis it is more difficult to engage the industry and the benefits of any change have to be clearly demonstrated.

The needs analysis conducted at the start of the project was very useful in a number of ways. It promoted and raised awareness of the project among those interviewed and to a wider audience as its results were discussed. It identified particular concerns held by growers and industry with thrips management generally and WFT management in particular, and the topics about which information was wanted and needed by growers and industry. It helped to identify some of the best ways to transfer information to growers and industry, even to the times most suitable for workshops and seminars, for example. (Growers preferred these mid-week in the late afternoon after the day's farm work was finished, while agrichemical distributors preferred them early in the morning before they opened the shop.) It was important that the project noted and catered for the needs and requirements of growers and industry identified in the needs analysis to maximise its chances of successfully transferring WFT management technology.

Some of the technology and much of the training materials produced in the South Australian projects (Baker *et al.* 2004; Burfield 2005) was not applicable or appropriate for use in Bundaberg or North Queensland. Much of it had been designed primarily for small scale greenhouse growers with basic farming skills and little knowledge of IPM. In contrast, the majority of growers at Bundaberg and in North Queensland were growing crops in the field in a dry tropical climate, many with large and sophisticated farming businesses. Many had experience with IPM, which they were already applying in the management of the complex of pests and diseases in their crops. Technology had to be adapted to suit the Bundaberg and North Queensland situations. For example, local hosts for WFT were identified and management strategies for them developed and promoted, and insecticides effective against WFT were identified. The dearth of effective registered/permitted insecticides and the ineffectiveness of several that were permitted for use and reputedly were effective elsewhere (e.g. methomyl) made promotion of the 3-spray strategy quite difficult. It is difficult to promote a strategy of rotating chemical groups when just one effective registered/permitted insecticide is available. The information and training materials produced and distributed in this project, such as the Updates and the Thrips and Tospovirus booklet, contained information for and were written in a style appropriate to the general skills level of the target audience.

It was important for the project to realise and to accommodate in its activities that WFT and TSWV were not the only concerns for the vegetable industry in the target districts. A range of other pests and diseases including heliothis, silverleaf whitefly, other thrips (e.g. melon thrips, onion thrips, tomato thrips), Capsicum chlorosis virus,

and bacterial and fungal diseases also have to be managed in crops. Promoting technology for managing WFT in isolation would have been pointless and counter productive. For this reason the workshops and seminars usually included presentations and discussions on a range of relevant pest and disease topics, realising the need to integrate management of problems in the crop and attracting a wider audience. Management strategies in the field for WFT had to be integrated with management strategies for the other pests, and doing this was one of the major efforts and achievements of the consultants in the project.

Including the two established agricultural consulting companies in the project team was worthwhile and beneficial for the project and for them. Their technical knowledge of thrips and their expertise in thrips management was developed, while they contributed greatly to the practical integration of WFT management in the field. The development of a commercial service that would continue following completion of the project, a primary aim of the project, was successfully achieved by including these firms in the project from the start. The chances were very low of successfully developing an on-going new commercial service in either district. A new service would have to provide more than just WFT/TSWV services, it would have had strong competition from the established firms, and there was a history of small, independent consulting businesses being unsuccessful. However, developing new consultancies to provide WFT management services may be necessary and successful in other areas.

Service providers, such as consultants, agrichemical distributors, in-house agronomists and chemical company representatives, are a very important part of the extension network. Growers nominated them as among their major sources of pest management information. Service providers often have frequent one-on-one interaction with growers, an important route for transferring information and technology, which has direct impact on growers' decision making. Hence providing information to the service providers and targeting them as a primary audience is extremely important. In the project they were a key audience for the seminars and workshops, which many of them regularly attended. They also were a key audience for the newsletters. The evaluation results indicate that both the seminar and newsletter strategies were successful.

While it is generally accepted that growers are not a homogenous group it is important for technology transfer projects to accept that service providers also are not all the same. Their philosophies and aims, and those of the companies they represent, may differ widely (e.g. an independent consultant with a passion for IPM who needs to sell a service compared to an agrichemical distributor with a passion for machinery but who needs to sell a chemical product). Technology transfer projects must identify the service providers impacting on pest management decision making, recognise what drives them, include them as a vital component of the target audience and tailor the project's activities to positively influence them.

The external evaluation was commissioned to explore and report on the effectiveness of the methods and strategies employed in the project to transfer WFT management technology. By doing this, the project team hoped to improve the quality and rigour of evaluation data obtained and to have a more objective measure of how to improve future IPM technology transfer project work. The evaluation showed that the interrelated set of extension strategies used to promote IPM was successful in

achieving practice change. By engaging an external evaluation team, some capacity to explore responses may have been lost. There was some risk that the evaluator may not have fully understood all the responses or the nuances within them, or been able to follow up lines of enquiry, as well as someone closely involved in the project, but this was offset by confidence in the data obtained. We consider that the external evaluation was very valuable and well worth doing.

The evaluation report produced a number of recommendations. Since this Queensland project has finished, options for taking these recommendations forward are somewhat limited. More pest and disease seminars are scheduled in the future as part of DPI&F's ongoing commitment to communicate R&D results to the vegetable industry. While the WFT Update will not continue, it is encouraging that newsletters are seen as a useful mechanism for distributing information to growers and agribusiness as there is a general trend for projects to include newsletters as part of their extension strategy.

As the evaluation points out, field demonstrations and on farm trials are the best method for testing new approaches as these provide a mechanism for adapting R&D to local conditions and experiences. As discussed earlier, it appears that growers continue to rely on one-on-one interaction with their service providers to obtain information for day to day decision making so targeting agribusiness in project work is essential for commercialising R&D outcomes. Achieving practice change is more than transferring technology and information but requires integration within existing experience to turn it into knowledge. We hope that recommendations from this project evaluation will be considered in future IPM technology transfer programs.

Recommendations

During the course of this project the importance of various matters became increasingly clear, as did deficiencies in other issues. Some of these issues are quite specific to WFT and its management whereas others are more broadly applicable. The following recommendations are derived from these experiences.

- The registration of new insecticides to control WFT should be encouraged and supported to overcome the current dearth of effective chemicals. Resistance management through the 3-spray strategy depends on the availability of effective insecticides in different chemical groups.

- Farm hygiene and district weed control are important factors in managing WFT and TSWV. Efforts to promote good farm hygiene and district weed control should be supported.

- Management methods for WFT and TSWV must be integrated with the management of other pests and diseases in target crops. The development of whole-of-crop IPM systems should be supported. These IPM systems must be practical and realistic for growers to implement. They must be adaptable and fit into the whole farm business.

- IPM technology transfer project teams should be encouraged to undertake a needs analysis at the start of the project to determine exactly who makes up the target audience, what the needs of the audience are, and how best to engage the audience.

- It is desirable to include field demonstrations/trials and local case studies in technology transfer projects to allow growers and service providers to gain confidence in new approaches through observation and integration with personal experience.

- Service providers need to be included as key members of the target audience in technology transfer projects. They have a large influence on growers.

- The importance of one-on-one interactions on information flow and decision making must be emphasised in technology transfer projects.

- IPM is a dynamic process. On-going RD&E for all pest and disease problems in vegetables should be supported.

- On-going support for the commercialisation process (i.e. for consultants and other service providers) is necessary and should be supported.

- External evaluation of all technology transfer projects should be encouraged.

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Dr G Herron (NSW DI) tested WFT collections from both regions for their resistance to insecticides.

Mr J Donaldson (QDPI&F, retired) presented the thrips identification training course for the consultants.

Mr G Geitz (Sprayrite) presented the spray application workshops.

Many QDPI&F officers presented talks and contributed to the Pest and Disease Management workshops and seminars.

Seedlings Australia, Gumlu, allowed the use of their facilities for the workshops at Gumlu.

Many growers in both regions participated in the project's activities and allowed access to their crops.

Many growers and service providers responded to the needs analysis and to the project evaluation.

Kerry Bell, Amy Samson and Jeff Coutts conducted the external evaluation.

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Appendix 1

A report on the evaluation of the Queensland WFT Update

Sue Heisswolf & Ross Wright, Dept Primary Industries and Fisheries, Bowen – March 2006

Using a two page questionnaire comprising a series of open and closed questions, we interviewed 7 vegetable growers, 1 in-house agronomist, 5 agricultural distributors, a seed company staff member and a chemical company staff member by telephone. Interviews were conducted on 21 February 2006 in our two target regions of North Queensland and Bundaberg (Figure 1).

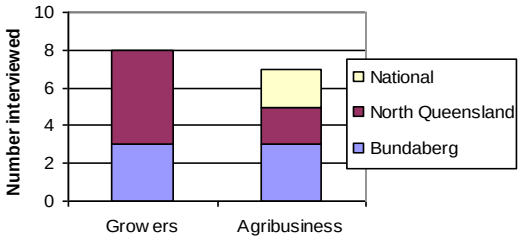

Figure 1: People interviewed for the evaluation

Crops grown or serviced by respondents included tomato (1), capsicum (4), chilli (2), pumpkin (3), melon (2) as well as vegetables in general and mango and other fruit crops.

The intent of this short evaluation was to determine if the aim of the newsletter was being met: *"To keep in touch and keep our target groups, particularly those unlikely to participate in workshops and seminars, informed about the project and WFT".*

We were also looking for ideas on how the newsletter could be improved.
To place the evaluation into context, three newsletters had been posted or emailed to growers and agribusiness contacts during 2005. The most recent edition of the newsletter was mailed/emailed to growers and industry in early December 2005.

Do you receive the WFT newsletter?

Figure 2 shows that all agribusiness staff and half of the growers interviewed were able to recall receiving the newsletter without prompting.

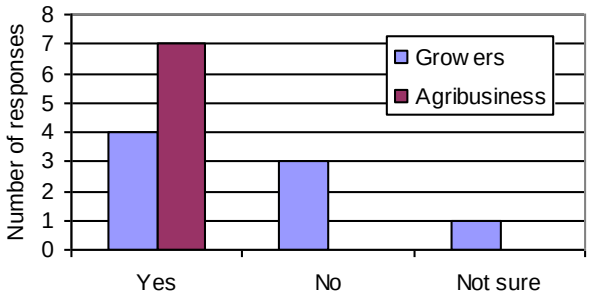

Figure 2: Response to the question "Do you receive the WFT newsletter?"

Those who could not recall getting the newsletter even after we prompted them with topics in the newsletters made remarks as follows:

- Doesn't sound familiar, keep getting stuff about different brews
- May get given to wife/husband but they have not mentioned it – will check with him/her
- Have been away and only just got back – my wife is the one that deals with this stuff
- If we get it, gets put on the table and I ask my wife to file it if important

This indicates that the person interviewed may not have been the person who reads or deals with the mail and information.

Do you read the newsletter?

All respondents who said they received the newsletter also said that they read it.

What happens to the newsletter once you have read it?

Responses included variations on the following:

- Keep it/ file it – in hard copy and electronic format
- Still have it somewhere
- File it so that other staff can use it as a reference tool
- Circulated to other staff/colleagues
- Goes onto display for staff and others to read
- Photocopied for others to use

There were comments made that indicate that the newsletter is not read from cover to cover but more like a newspaper. If a topic is relevant then it is read in detail before the newsletter is filed for future reference.

Email versions of the newsletter are also passed on nationally and internationally.

Do you find the newsletter useful?

As shown in Figure 3, we did not get a negative response to this question, although not everyone gave it a "yes".

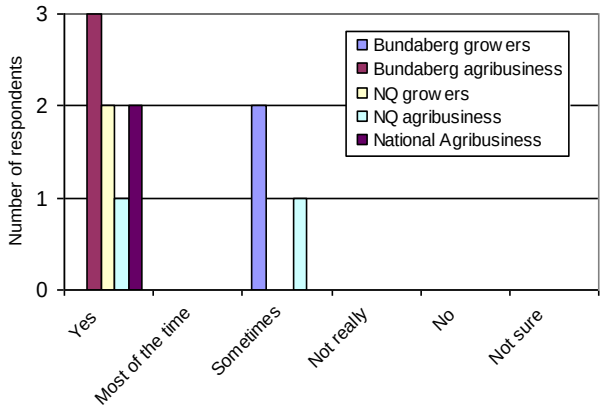

Figure 2: Response to the question "Do you find the newsletter useful?"

What do you like about the newsletter?

Responses included variations on the following themes:

- Overall content keeps us up to date with recent developments, good to find out what's happening in other areas – regional update and trial work
- Information on WFT & virus in relation to varieties – stay informed on what's happening in Queensland

- Highlights issues/ potential problems and control options
- Regularity of updates eg. thrips incidence and levels in my district
- Chemicals, rotating of different chemicals, different spray strategies, chemical updates, permit information
- If you think you are the only one with problems, lets you know that others are also having trouble
- Bit of revision – good to grab and have a bit of a look
- Growers raise topics from newsletters with us
- Short and punchy – don't like long newsletters, fairly brief, addresses the points and relevant – not into glossy stuff
- Good to have in both colour (hard copy) and email
- WFT is not a major problem in our district - would be good if newsletter was about more significant pests.

What improvements could be made to the newsletter?

In general, respondents were quite happy with the newsletter as it was but we did get some pointers for improvement including:

- Increasing the frequency of the newsletter
- Providing more information on effects of thrips/virus on specific varieties when there are outbreaks
- Providing information on how to stop resistance
- Not rehashing chemical information since there are not that many options available
- Using grower testimonials or case studies to illustrate what works and what's new

Summary and recommendations

After conducting this small survey, we are quite confident that agribusiness people find the newsletter of value and that it is an important tool for supporting the commercialisation process of the project. The newsletter is not only read by agribusiness staff, it is filed, photocopied, put on display and passed on to colleagues within a district, nationally and even internationally. The content and format in general is hitting the mark. It is important to keep topics relevant, to the point and easy to read.

To further improve the newsletter, it is worth including some grower case studies and testimonials on specific topics on a trial basis as suggested by some agribusiness staff.

The **direct** value of the newsletter to growers is less clear partly because the timing of the survey was not ideal. In north Queensland, many growers were still on holidays or had only just returned to their farms after their Christmas/New year break.

We would need to interview a larger sample of growers to make any definite statements. From our survey results there is an indication that perhaps 50% of growers read the newsletter and find it of some value. Other growers interviewed either do not remember reading the newsletter or do not receive it as someone else in the business/household deals with this type of information.

It would be worth interviewing an additional 6 or so growers a few weeks after the next newsletter (WFT Update 5) is distributed to decide if this is a real issue for the project and if it is, what could be done about it.

Each newsletter does take some effort to put together and costs perhaps 100 hours of project team members' time. Add to that DPI&F corporate staff time and printing costs plus around $500 per issue for distribution costs via post and email. This makes the newsletters one of the more resource intensive components of the project's extension effort. It is however an important communication tool for our project and results from this evaluation show that while there are some areas for improvement, it is well worth spending time and resources on the newsletter. It is an important component of the project's extension strategy, particularly as one of our key target groups – the agribusiness community – is finding the newsletter of value to their business.

Appendix 2

VG03099: The Provision of Western Flower Thrips Technology Transfer Services in Bundaberg and Bowen

Developing a Commercial Service

Introduction

The original call for Expressions of Interest (EOI) in Provision of Western Flower Thrips Technology Transfer Services stated that the aims of the program included:

- improving the ability of vegetable growers to implement integrated pest management (IPM) strategies, particularly for Western flower thrips (WFT) and tomato spotted wilt virus (TSWV);
- expanding the technical capacity for commercial services;
- developing a commercial service that can continue following completion of the program, while not interfering with existing local consultancy work;
- that after a two year period fees for provision of service be introduced and gradually increased to full cost recovery by the end of the project.

A business plan for the development of a commercial service was a specified output for the project.

The successful EOI submitted, which evolved into the project VG03099 "Provision of western flower thrips technology transfer services in Bundaberg and Bowen", included existing commercial consulting firms in both regions in the project team. The proposal stated "The presence of established consulting firms in Bowen and Bundaberg and inclusion of those firms in the project will enhance and simplify the commercialisation process".

The intent in the proposal was that these firms would be the commercial services that would continue to provide WFT/TSWV management and IPM services following the completion of the program. We considered that this approach was more likely to be successful than attempting to develop new commercial consultancies in each area, although a comprehensive business plan to justify the decision was not prepared at the time due to the extremely short time frame available.

The decision to include the two consultancy companies in the project team and to deem them as the commercial service obviously was acceptable to HAL as the EOI proposal and the subsequent project proposal were successful. Hence it would seem that a formal business plan for the development of a commercial service is unnecessary.

This document explains and justifies the decision to use the existing firms as the commercial service and explains how the project is enhancing and developing their capacity and skills in relation to WFT/TSWV. It is not a formal business plan although general business plan concepts are included.

Market Assessment

A. Potential market

The approximate numbers of vegetable growers in each district or sub-district are shown in Table 1. The Bundaberg (includes Childers and Gin Gin areas) numbers were supplied by the Bundaberg Fruit and Vegetable Growers' Association as vegetable growing members of that association, supplemented with a few non-member growers contacted through the project. The Bowen, Gumlu and Burdekin/Townsville numbers were collected by DPI&F extension officers and project team members. It is probable that both districts' numbers include some duplicates and that some grower have been missed, but the numbers are a reasonable approximation of the true figures.

Table 1
Number of vegetable growers

District	Number of growers
Bundaberg	167
Bowen	
Bowen	60
Gumlu	24
Burdekin/Townsville	75

These include small farming businesses (one or two persons), mid size and very large farming businesses, producing a wide variety of vegetable crops, not all of which are affected by WFT/TSWV.

These growers all could be potential customers for commercial IPM consulting services, but would not all be concerned about WFT/TSWV. Needs analyses in both districts recorded that a majority of growers use consultants for pest and disease monitoring and advice. There is considerable variation in how growers use consultants. Some use consultants' services regularly and constantly; others infrequently for general advice; some when an unusual or major problem occurs; and, of course, some not at all.

Growers expect consultants to provide advice on many crop production issues including insect pest and disease management, weed control, crop nutrient requirements, irrigation scheduling, spray application, etc. It is unlikely that a consultant relying solely on providing IPM services, let alone just WFT/TSWV advice, would be commercially viable.

B. Competition: The Existing Commercial Situation

In each district there is an established commercial agricultural consulting company that dominates the local market.

At Bundaberg, Crop Tech Pty Ltd has been in business for about 20 years and has grown over that time from a small business to one now employing 25-30 staff. The

company provides a wide range of agricultural services to vegetable, tomato, melon and tree crop growers, including IPM monitoring and advice. They service many of the district's growers, but the actual number is commercially sensitive information that we do not have access to.

Over the past 10 years there have been at least three small (one to two person) agricultural consulting businesses active in the Bundaberg district. Each has persevered for a few years before leaving the industry.

In the Bowen district, the agricultural consulting industry is dominated by Bowen Crop Monitoring Services (BCMS), which has been in the district for about 20 years and is particularly active in the Bowen, Gumlu and Burdekin areas. The company has two principals and four or five other staff. Again, we do not have access to their client list.

As in the Bundaberg area, over the past decade a number of other consultants have come and gone at Bowen. At present there are two other consultants working in the area. One is a retired DPI extension officer with a long history and strong personal following in the district. The other is an ex-employee of BCMS who now is associated with one of the national contract research firms as well as providing IPM consulting services.

In both districts staff of agricultural chemical resellers also provide advice to growers.

In both districts in recent years there has been a trend for the large farming companies (e.g. SP Exports, Barbera Family Farms, Auschilli, Mulgowie Farming Company, Rapisarda Farms) to employ their own agronomists and/or crop protection officers.

C. Assessment

The arguments for and against establishing a new IPM service (or services) to commercialise WFT/TSWV technology transfer in the Bundaberg and Bowen districts are summarised below.

For:

- There are many growers (i.e. potential customers) in both districts.
- There is general interest in IPM amongst most growers.
- There is a culture of using commercial consulting services in both districts.

Against:

- A consultant needs to provide more than pest monitoring and IPM services, and certainly more than just WFT/TSWV services, to be successful.
- In both districts the industry is dominated by large, established agricultural consulting companies providing pest monitoring and IPM advice services, which would be strong competition against a new service.
- Large farming companies are employing their own agronomists, so reducing the potential market.
- There is a history of small, independent consulting businesses being unsuccessful.

After considering these factors we concluded that the likelihood of the project successfully developing a new commercial service that can continue after the completion of the program was very low.

We concluded that the best way to successfully develop such a service was to do it through the existing major consulting firms and so they were included in the project team from the start. This also satisfies the requirement that the service should not interfere with existing local consultancy work.

Skills and Experience of the Businesses

Brief descriptions of the skills and experience of the two companies follows.

Crop Tech:
Crop tech is an agricultural consulting, laboratory and research business that has grown from a two person operation to a company with a staff of 25-30 over the last 20 years. (Recently Crop Tech has been bought by T-Systems (Australia) but is continuing business as before with the same management and staff.) Services provided to growers include nutrient and irrigation monitoring, pest and disease monitoring, crop mapping and environmental monitoring. The company also operates a plant and soil analysis laboratory.

The pest and disease monitoring activities, in which they monitor pest and beneficial insect activity and disease infestation levels regularly (or on-call) to make informed decisions on pest management using in-house thresholds and IPM principles, are of most relevance to this project. The staff members are agricultural university graduates and are experienced in monitoring and in providing IPM advice, so integrating WFT/TSWV issues into their program is relatively simple.

Bowen Crop Monitoring Services:
BCMS was started by the principals about 20 years ago as a one then two person business and has developed into a business employing four to five other staff, most of whom are university graduates. It currently services growers in the Bowen, Gumlu and Burdekin areas. It provides a similar range of consulting services as Crop Tech, with an emphasis on pest and disease monitoring and the provision of management advice based on the use of in-house thresholds and IPM principles. Again, integrating WFT/TSWV issues into their program is comparatively simple.

Developing the Commercial Service

The project aims to increase and develop the knowledge and skills with respect to WFT/TSWV of the two consulting companies through their involvement in the project. Their existing skills in pest and disease monitoring and management and their access to their clients are beneficial to the project.

Two staff members from each company were trained in thrips identification at an intensive workshop. This provided them with the skills to correctly identify thrips

species (particularly WFT) and developed and provided a source of these skills in each district.

Staff members from both companies have been provided with information on WFT biology and ecology (e.g. life cycle, hosts), on tospoviruses, on virus transmission, on effective insecticides, on spray strategies and on insecticide resistance. Some of this has been provided directly through project team discussions while some has been provided in meetings and workshops conducted primarily for growers.

Both companies have been undertaking studies to increase our knowledge and understanding of WFT in Queensland areas:

- surveys of thrips on weeds and other alternative hosts;
- collections of thrips for resistance testing;
- surveys on and around different farm types (e.g. protected cropping structures at Bundaberg);
- spray application work;
- and BCMS have done insecticide trials and WFT management trials.

These studies have had the dual effect of increasing our knowledge of WFT in the Bundaberg and Bowen districts and of transferring technology to the consultants using participative learning activities.

Financial Arrangements

The terms of the HAL WFT technology transfer program included "that after a two year period fees for provision of service be introduced and gradually increased to full cost recovery by the end of the project". The project's funding arrangements are structured to achieve this.

The two companies are being provided with funds from the project to participate in project activities (e.g. attend team meetings, participate in workshops, R&D activities as described above) and to provide WFT/TSWV monitoring and information services to all and any vegetable growers within their districts (i.e. services they were not being reimbursed for by their clients). These services may be by direct contact or by newsletter or fax (e.g. the faxed survey and information sheets used by BCMS at Gumlu).

The funds provided to the companies are small in Year 1 (the project was active for only part of the year), substantial in Years 2 and 3, small in Year 4 and none in Year 5. This arrangement simulates the fees for provision of service scenario required for the project. It is assumed that in Years 4 and 5 and on into the future that the companies will be charging their clients/growers for providing WFT management advice as part of their pest and disease management services.

It is assumed that the companies will maintain their existing clients (given a normal business environment) and it is expected that they should acquire more clients through their involvement in the project. Their involvement is promoted through project activities (e.g. workshops, WFT Update) and through their extra involvement with growers (e.g. through providing information and advice, Gumlu faxes).

N.B. The project is not ignoring other commercial interests. The project actively provides its information to the resellers, to agronomists working for large farming companies and to other consultants so that the technology is transferred to them and on to their grower clients.

The Future

It is probable that both Crop Tech and BCMS will continue in business for the foreseeable future. Individual staff may come and go but the businesses should endure and their IPM programs and procedures should continue. The longer term future of BCMS is dependent on the two principals of the company. This factor is no longer relevant to Crop Tech following its sale to T-Systems (Aust) but now it is subject to business decisions made by the parent company.

In summary, the inclusion of the commercial consulting firms in the project team and the expanding of their technical capacity with respect to WFT/TSWV through training and involvement in project activities should ensure a commercial service that will continue following completion of the program.

Report

Summary of survey of Agribusiness and Vegetable Growers for "Provision of western flower thrips technology transfer services in Bundaberg and Bowen" (VG03099)

September 2008

PREPARED BY

Kerry Bell
Amy Samson
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COUTTS J&R
MANAGING AND EVALUATING CHANGE

Acknowledgements

The survey questionnaire was designed with diligent feedback from the Western Flower Thrips and Silverleaf Whitefly project officers Sue Heisswolf, Siva Subramaniam and Iain Kay.

The contact list was compiled by Sue Heisswolf and her team, with numerous follow up input on determining categories for sampling and obtaining contact details.

Barbara Simes' effort is appreciated in contacting the individuals for sampling and completing the questionnaires with eligible respondents.

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September 2008

Disclaimer

Contents

Summary

During the life of the WFT project, there has been a perceived decrease in the amount of damage caused by WFT across susceptible areas and crops in Queensland. The WFT project and its key messages have a high level of awareness with around 30% of growers using the 3-spray strategy as needed. DPI&F have provided a critical role in information provision through its newsletter and workshops and have impacted positively on the commercialisation process.

Key messages

- *Overall 78.3% of the respondents were aware of the WFT project.*
- *Although there is no direct benchmark to measure changes in the level of damage, survey respondents considered retrospectively that damage by Western Flower Thrips had decreased over recent years. Scarring was the major damage reported.*
- *DPI&F Officers are seen as the major source of information on WFT by Agribusiness and are playing a critical role in the information system. Growers are relying more on the crop consultants as their primary information source. This highlights the impact of the commercialisation route.*
- *The Western Flower Thrips Updates newsletter had a high penetration level in the industry and was rated as moderately useful. Agribusiness continued (from 2006) to value and utilise the information from the newsletter in their commercial activities with growers. Agribusiness prefers e-mail as an information distribution mechanism and growers generally preferred post.*
- *There was a high level of awareness and participation of the pest and disease management seminars by growers affected by WFT with a little over half of respondents having attended one or more meeting. They clearly play an important role in information sharing and skill development.*
- *There was a high level of awareness and understanding of the 3-spray strategy amongst growers and Agribusiness. Good farm hygiene and crop monitoring were seen by almost all respondents as most important in controlling WFT. Just over half of respondents were aware of the broadleaf weeds that harboured WFT.*
- *Thirty percent of enterprises now use a 3-spray strategy on detection of WFT with 40% now monitoring for WFT and a quarter rotating chemicals to reduce resistance. 60% have not made a change in the way they recommend or manage WFT in the last few years.*
- *It is clear that personal experience and observation are major factors in prompting change by both Agribusiness and growers. DPI&F provide a major stimulation via their information provision to Agribusiness and through the pest and disease seminars for growers.*

Recommendations

1. The high level of awareness of the WFT project and its key messages with its impact on practice change is significant and should be acknowledged.
2. There is further work to be done to increase the uptake of the 3-spray strategy by Agribusiness and growers from the gains that have already been made.
3. The approach that DPI&F has taken to target Agribusiness and commercialization as an industry adoption strategy is working and should be continued.
4. Newsletters are highly regarded and should be continued as an extension mechanism with agribusiness receiving them by e-mail and growers by post.
5. Pest and Disease workshops do play an important role and should be continued – with an emphasis on linking to local successful examples.

6. The high reliance on personal experience and observation by both consultants and growers highlight the importance of field demonstrations/trials and providing local case studies for growers to gain confidence in the newer approaches.

Purpose

This survey report is part of the summative evaluation of the project: Provision of western flower thrips technology transfer services in Bundaberg and Bowen" (HAL project number - VG03099) referred to in the report as the WFT project.

Method

A telephone survey (from 234 contact names randomly stratified across regions in Queensland) was undertaken with 30 agribusiness and 50 grower respondents relating to questions on WFT.

Background of survey respondents

- Of the 80 respondents (30 agribusiness and 50 growers) from this survey the largest percentage were from North Queensland (41.3%).
- Approximately half (52.5%) of the grower and agribusiness respondents said that western flower thrips was an issue for the crops they grow or deal with in their work.
- 80.5% of the grower and agribusiness respondents (relevant to the WFT project) said that silverleaf whitefly was also an issue for the crops they grow or deal with in their work.
- The Lockyer Valley (100.0%) had a significantly higher percentage of SLW as a crop issue than other areas in Queensland and interstate (excluding the Bundaberg area and North Queensland).

Findings

Overall 78.3% of the respondents were aware of the WFT project.

Information sources

- Agribusiness respondents rated (out of 10) the following sources of information about managing pest and diseases as the top four most useful; their own experience (8.4), grower/peers (7.7), DPI&F officers (7.5) and Bowen Crop Monitoring Services (7.5). Growers found crop consultants (8.8), Bowen Crop Monitoring Services (8.2) and their own experience (8.2) as the three most useful sources of information.

- *Newsletter and leaflets:* Agribusiness respondents preferred to receive the colour newsletters and leaflet (56.7%) via emails as well as notifications about seminars and workshops (76.7%). Growers however preferred post for both these sources of information (68.0% colour newsletter and leaflet, 42.0% notification of seminars and workshops).

- *Pest and disease management seminars and meetings:* Over three-quarters (78.8%) of the respondents (relevant of WFT project) were aware of the pest and disease management seminars and meetings run by DPI&F. Of these, nearly three-quarters (74.6%) had attended at least one of the seminars and meetings and overall rated them as moderately useful with an average rating of 6.2 out of 10.

Awareness and use of management strategies

- *Newsletter:* A high percentage of respondents (73.9%) had seen the newsletter '*Western Flower Thrips Updates*', and gave an overall usefulness rating of 5.9 out of 10. After the agribusiness respondents have read the *WFT Updates* – most (89.5%) filed them away, just under half (47.4%) referred to them regularly, 21.1% took them out to growers to use as a business tool and a small number (5.3%) sent them on to colleagues.

- *3-spray insecticide strategy:* Overall 57% of the agribusiness and grower respondents said that they were aware of the 3-spray insecticide strategy for western flower thrips. The top three descriptions given by respondents for what they saw as most important for keeping western flower thrips at low levels were:
    - 'Good farm hygiene' (96.3%);
    - 'Monitor/check crops on a regular basis' (92.6%);
    - 'Spray with insecticide' (66.7%);

- *Broadleaf weeds:* Just over 56.5% of agribusiness respondents that said they were aware of the broadleaf weeds that harbour western flower thrips.

Practice change

- *Practice change:* Approximately forty percent (40.7%) of agribusiness and grower respondents have changed the way they recommend or manage western flower thrips, with 40.7% said that they monitor crops for WFT levels, 29.6% use a 3-spray strategy on detection of WFT and one quarter (25.9%) of respondents reduce insecticide resistance by rotating insecticides.

- Both agribusiness and grower respondents on average rated (out of 10) their own research / information seeking / trials (agribusiness 8.1, growers 8.3) and experience (agribusiness 8.1, growers 8.3) as the top two factors prompting change in practices for WFT. Agribusiness respondents next rated information about WFT that arrived on the farm from DPI&F (8.1) and discussions with crop consultants (7.9) and growers next rated Pest and Disease Seminars (7.8) and discussions with crop consultants (7.4) as prompters of change.

Crop damage

Crop damage: On average grower and agribusiness respondents rated the damage done to crops by western flower thrips (compared to several years ago) as having decreased - 6.6 out of 10 (0=much more damage, 5=same amount of damage and 10=a lot less damage). The grower respondents rated the damage less (7.2) compared to the agribusiness respondents (5.9). The top three types of damage due to western flower thrips mentioned was scarring (77.8%), loss of quality (59.3%), reduced yields (44.4%) and tomato spotted wilt virus (44.4%). More than one third (37.0%) said that there was no significant damage.

Introduction

The Department of Primary Industries and Fisheries have been undertaking projects for western flower thrips (WFT) for four years and silverleaf whitefly (SLW) for two and a half years (although pest and disease seminars have been run for 6-7 years). The aim of this document is to briefly summarise the results of the surveys undertaken (agribusiness and vegetable grower) as part of the summative evaluation of the "Provision of western flower thrips technology transfer services in Bundaberg and Bowen" (HAL project number - VG03099) project in lieu to the final reports in August 2008, and to complete requirements included in the evaluation proposal.

Background: Western Flower Thrips (WFT) Project

The Western Flower Thrips (WFT) project is also known as "Provision of western flower thrips technology transfer services in Bundaberg and Bowen". It aims *to modify technology and information generated in previous HAL and AUSVEG funded work for field grown vegetable crops in two regions of Queensland and encourage adoption and commercialisation of the technology and information.*

The WFT project focus is in the Bowen/Gumlu/Burdekin and Bundaberg areas, however crops that are susceptible to Western Flower Thrips are also grown in other locations. Its main extension strategies are:

i. Short workshops, seminars and farm walks to provide opportunities for discussion, training and information sharing with growers and their agribusiness advisors.
ii. Communication via newsletters and information leaflets.
iii. Support for commercialisation of services.

The main written communication is via the WFT Updates and information leaflets and two agribusiness firms were directly involved in the WFT project as project collaborators. This was to allow for *increased information sharing and more frequent contact with growers and for enabling faster integration of project outcomes in the consultants' IPM strategies.*

Key Evaluation Questions

An over-riding key question for the project was 'How successful has the commercialisation process been?' Overall questions for each of the survey groups were as follows.

Agribusiness:

- Awareness of the "3 spray strategy" – knowing what it is, why it is important and knowing where to put their hands on a copy?
- Whether they considered it when advising growers?
- Level of implementation on farms that they work with?
- Knowledge of non-chemical control methods – "get mean, keep clean" – controlling broadleaf weeds, getting rid of old crops, not planting new crops next to old, planting new crops up wind of old crops, hot spots on the farm – extra brownie points for four key weeds in Gumlu – blue butterfly pea, stinking passionflower, rubbervine, abutilon
- Link with tomato spotted wilt virus – have they seen a copy of the thrips and tospovirus booklet?

Growers:

- Awareness of the 3 spray strategy (expected to be lower)?
- Awareness of hygiene issues (keeping weeds down; particular weeds; destroying old crops etc)
- Awareness of implications of seasonal variations (more vigilant at times of seasonal abundance – more relevant to Gumlu growers due to crop and weed sampling done and results faxed out by BCMS)?
- Link with tomato spotted wilt virus – have they seen a copy of the thrips and tospovirus booklet?
- Awareness of resistance management issues?
- Levels of damage especially when compared to previous years (changes)?

Key questions relating to the WFT that will be discussed in this report are:

- What level of commercialisation was achieved?
- What strategies for achieving tech transfer worked?

- How could they be improved?
- What worked well?
- What didn't work so well?
- What is the level of adoption of the promoted practices?
- Where do they get information / advice from?
- What are the best methods for information delivery?

The survey instruments

Two surveys were designed, one for agribusiness contacts and the other for growers who were involved in either or both of the WFT and SLW projects. Both of the surveys have background and general sections and sections specific to each project (only filled out if relevant to respondent), which will both contribute to the final evaluation reports for WFT and SLW projects.

The questions were designed to address the key questions whilst minimising the size and complexity of the questionnaire.

Growers and agribusiness contacts were notified of the survey and that an interviewer would be contacting them soon. Questionnaires were completed by a trained interviewer who telephoned individuals and arranged a time to complete the appropriate sections of questionnaire with individuals, or used back-up individuals if the individual was not able to be contacted, refused to complete a questionnaire or has nothing to do with the projects or pests.

A copy of each of the questionnaires is in the Appendix.

Survey sample

The lists of agribusiness contacts and vegetable growers were compiled by the DPI&F project staff from a variety of mail, fax and email contact lists. Once an individual was identified to be in a sample, project staff then obtained telephone contact details.

The focus of the survey was to not proportionally sample the population across categories in general, but to focus on obtaining information across a variety of categories, which was seen as particularly important when the number of categories to sample was large (relative to the total number of individuals to sample).

The table below shows the sample numbers taken for growers and agribusiness (and the percentage of and total number of individuals from the contact lists in brackets – excluding names with unknown location details).

Location	Vegetable Growers	Agribusiness
North Queensland	26 (18.4%; N=141)	13 (25.5%; N=51)
Bundaberg	28 (12.3%; N=228)	10 (23.8%; N=42)
Lockyer Valley	28 (20.9%; N=134)	9 (25.7%; N=35)
Other Queensland and Interstate	8 (5.0%; N=161)	8 (6.7%; N=120)
Total	**90 (13.6%; N=664)**	**40 (16.1%; N=248)**

Treatment of non-respondents

Some individuals selected in the original sample could not be used due to incorrect contact phone numbers, unable to be contacted, refusal to complete the survey or did not have anything to do with either of the WFT or SLW projects. When this occurred the next individual was used from a randomly ordered list generated within each category. If there were no more individuals in a particular category then another category was used.

Sample of growers and response rates

Originally 30 vegetable growers were proposed to be sampled in North Queensland, Bundaberg and Lockyer Valley and none on a state-wide basis, but after collating the list of growers there was found to be a lot of cases in the fourth category of other Queensland and Interstate. After discussion with the project officers a sample was taken from this category by reducing the sample in the three regions so the total still remained at least 90.

Other categories used to stratify the sample included the potential projects (WFT and/or SLW, or unknown) the individuals may be involved in derived from the contact list they were sourced from, and secondly by the project they may have been involved in derived from the crops they have grown. Within each locality the samples were randomly chosen within these potential project categories. Particular focus was placed on including vegetable growers who use plant houses in the sample by including the use of plant houses as a category.

From 234 contact names used there was a 38.5% success rate. Another 42.7% were either not suitable or not interested in answering a questionnaire (14.1% of respondents were unsuitable to answer the survey as they weren't involved with crop vulnerable to western flower thrips or silverleaf whitefly, and 28.6% refused to complete the survey.); 16.7% of the contacts did not have accurate telephone contact details; and 2.1% were not available at the planned appointment time to answer the questionnaire. There were 30 Agribusiness respondents who were eligible to answer WFT section, with 23 actually doing so (in full or in part) and 50 Growers who were eligible to answer WFT section, with 24 doing so (in full or part). Some of the respondents who refused to answer the WFT section gave the reason that it wasn't relevant to them.

Sample of agribusiness contacts and response rates

The categories used to stratify agribusiness contacts were locality and the type of business (see table below). The sample was chosen to try to sample at least one individual per location / type of business category, then extra samples to concentrate on external consultants, resellers and chemical companies (because these groups are likely to have the biggest impact on pest management strategies used by growers) to obtain a total of 40 respondents. The project staff considered it important to focus on sampling across the type of business rather than trying to sample 10 individuals per location as originally stated in the evaluation proposal. Within each category individuals were chosen at random.

It was found with some responses that the category the respondent was originally thought to be in was found to be different, hence changing the distribution of respondents across categories originally sought after.

The table below shows the number of respondents in the final sample (followed by the number in the population in brackets).

Type of business	North Queensland	Bundaberg area	Lockyer Valley	Other Queensland and Interstate	TOTAL
Government and non-profit	1 (9)	2 (8)	2 (13)	2 (53)	7 (83)
Industry organisation	1 (3)	0 (6)	0 (1)	1 (17)	2 (27)
Farm staff/consultants	1 (5)	2 (6)	0 (2)	1 (1)	4 (13)
External consultants	2 (5)	2 (3)	2 (5)	2 (4)	8 (17)
Seedling nursery	1 (6)	1 (3)	1 (3)	0 (1)	3 (13)
Resellers	3 (18)	2 (12)	2 (9)	1 (7)	8 (46)
Chemical companies	2 (1)	0 (0)	1 (0)	0 (18)	3 (19)
Other	2 (4)	1 (3)	1 (2)	1 (19)	5 (27)
TOTAL	13 (50)	10 (41)	9 (35)	8 (119)	40 (245)

There were 40 agribusiness questionnaires completed out of 94 agribusiness contacts, which is a 42.6% response rate. Out of the remaining 54 contacts there were 16 that could not be contacted due to wrong number or did not answer, and 38 who refused to complete the questionnaire or were not involved with either of the projects.

Summary of results for Western Flower Thrips (WFT) Project

The information for this section is a subset of the combined growers and agribusiness surveys. Please note that there is some overlapping information that will appear in both the WFT and SLW summaries. There are 30 agribusiness and 50 growers where the WFT project is relevant to their business.

Background

Of the 80 respondents (30 agribusiness and 50 growers) to this survey the largest percentage were from North Queensland (41.3%). Approximately half (52.5%) of the grower and agribusiness respondents said that western flower thrips was an issue for the crops they grow or deal with in their work. 80.5% of the grower and agribusiness respondents (relevant to the WFT project) said that silverleaf whitefly was also an issue for the crops they grow or deal with in their work. The Lockyer Valley (100.0%) had a significantly higher percentage of SLW as a crop issue than other areas in Queensland and interstate.

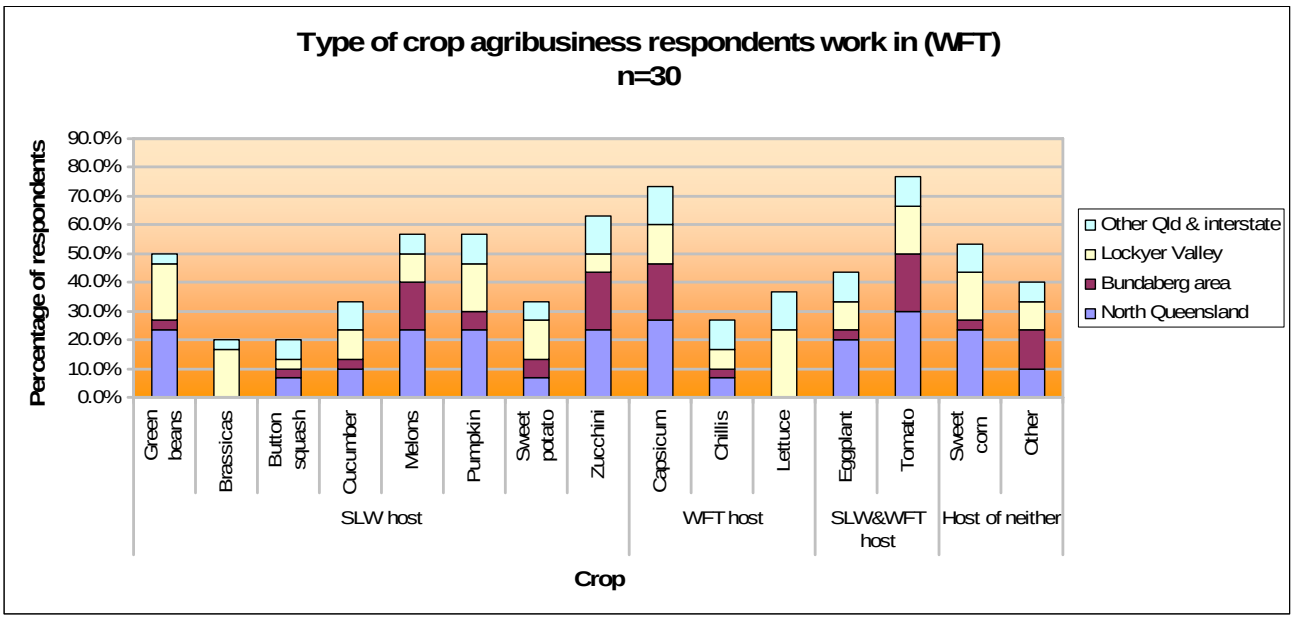
The distribution of respondents across the surveys and localities for the WFT project is shown in the table below.

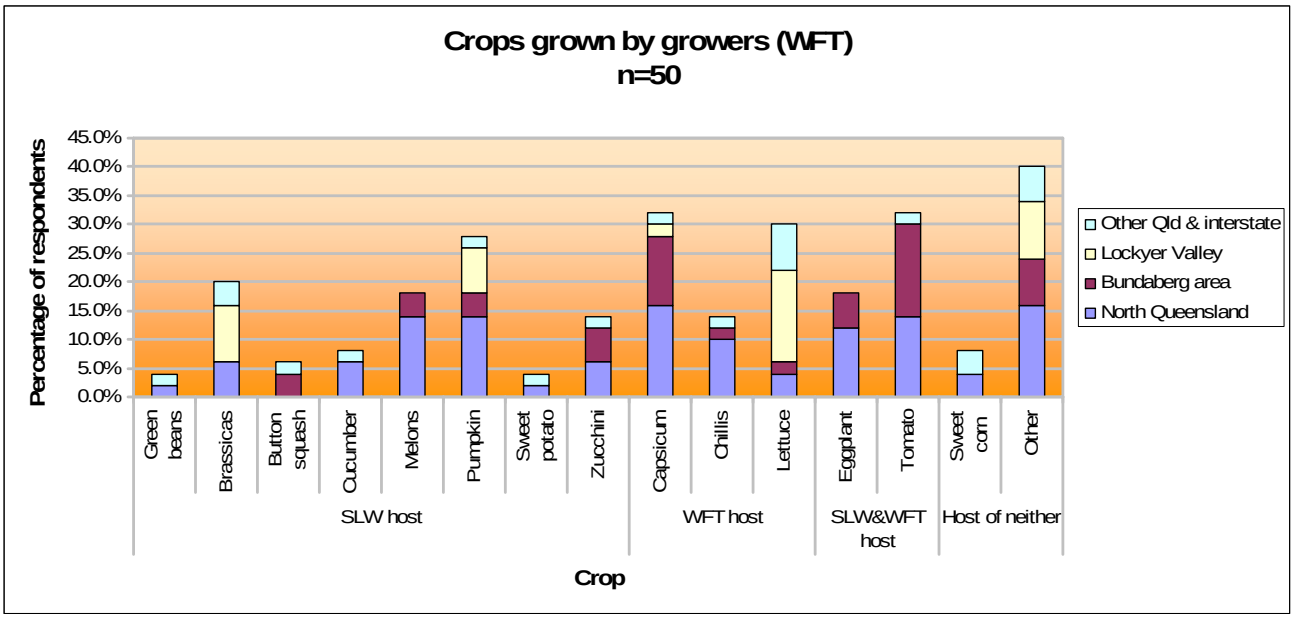
Survey	North Queensland	Bundaberg area	Lockyer Valley	Other Qld & interstate	Total
Agribusiness	10 (12.5%)	7 (8.8%)	8 (10.0%)	5 (6.3%)	30 (37.5%)
Growers	23 (28.8%)	15 (18.8%)	8 (10.0%)	4 (5.0%)	50 (62.5%)
Total	33 (41.3%)	22 (27.5%)	16 (20.0%)	9 (11.3%)	80 (100.0%)

The agribusiness respondents came from a variety of business types as shown in the table below.

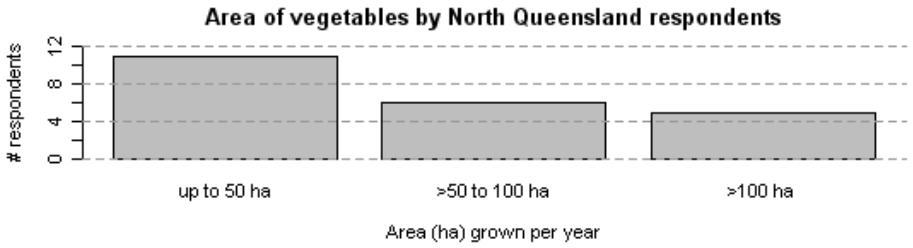
Type of business
Chemical Company
Consultants
Farm
Government & non-profit
Industry organisation
Other
Resellers
Seedling nursery

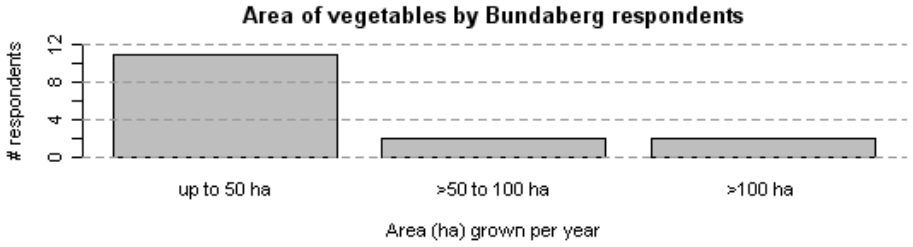
The types of crops the respondents are involved in tend to extend over both SLW and WFT vulnerable crops. The graphs below show the crops that agribusiness respondents work in and the crops growers produce.

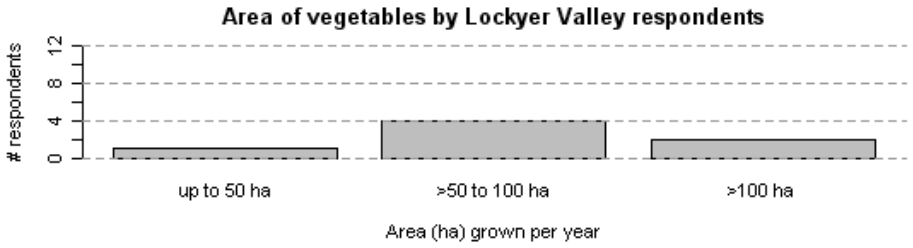


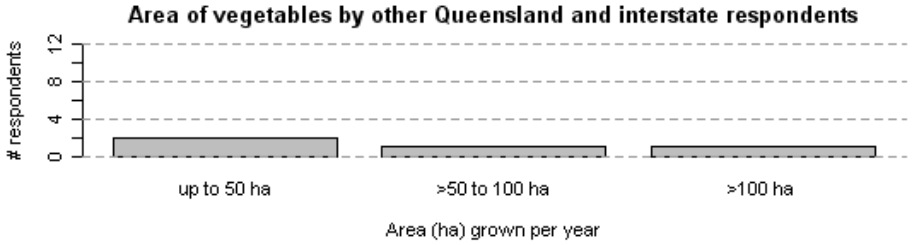


The overall median area for grower vegetables was 48 hectares (n=48). For North Queensland the median was 49 ha (n=22), Bundaberg area 20 ha (n=15), Lockyer Valley 80 ha (n=7) and other areas in Queensland and interstate 52 ha (n=4).









Forty percent of the agribusiness respondents said they worked with crops in plant houses (North Queensland 20.0% (n=10), Bundaberg area 71.4% (n=7), Lockyer Valley 37.5% (n=8) and other areas in Queensland and interstate 40.0% (n=5)). Twelve percent of growers produced crops in plant houses (North Queensland 8.7% (n=23), Bundaberg area 13.3% (n=15), Lockyer Valley 0% (n=8) and other areas in Queensland and interstate 50.0% (n=4)).

Approximately half (52.5%) of the grower and agribusiness respondents said that western flower thrips was an issue for the crops they grow or deal with in their work. The agribusiness respondents thought western flower thrips was more of an issue (66.7%) than the grower respondents (44.0%). The difference between growers and agribusiness was approaching significance (p=0.066).

	% respondents where WFT is an issue				
Survey	**North Queensland**	**Bundaberg area**	**Lockyer Valley**	**Other Qld & interstate**	**Total**
Agribusiness	80.0% (n=10)	74.4% (n=7)	50.0% (n=8)	60.0% (n=5)	66.7%
Growers	47.8% (n=23)	60.0% (n=15)	25.0% (n=8)	0.0% (n=4)	44.0%
Total	57.6%	63.6%	37.5%	33.3%	52.5%

It is interesting to note that 80.5% of the grower and agribusiness respondents (relevant to the WFT project) said that silverleaf whitefly was an issue for the crops they grow or deal with in their work. There wasn't any significant difference between the growers (75.0%) and the agribusiness (89.7%) response to this issue. There was however a significant difference between localities with the Lockyer Valley (100.0%) having a higher percentage than other areas in Queensland and interstate.

	% respondents where SLW is an issue				
Survey	**North Queensland**	**Bundaberg area**	**Lockyer Valley**	**Other Qld & interstate**	**Total**
Agribusiness	100.0% (n=10)	100.0% (n=7)	100.0% (n=7)	40.0% (n=5)	89.7%
Growers	77.3% (n=22)	71.4% (n=14)	100.0% (n=8)	25.0% (n=4)	75.0%
Total	84.4%	81.0%	100%	33.3%	80.5%

General background information

Summary

Sources of information: Agribusiness respondents rated (out of 10) the following sources of information about managing pest and diseases as the top four most useful; their own experience (8.4), grower/peers (7.7), DPI&F officers (7.5) and Bowen Crop Monitoring Services (7.5). Growers found other crop consultants (8.8), Bowen Crop Monitoring Services (8.2) and their own experience (8.2) as the three most useful sources of information.

Newsletter and leaflets: Agribusiness respondents preferred to receive the colour newsletters and leaflet (56.7%) via emails as well as notifications about seminars and workshops (76.7%). Growers however preferred post for both these sources of information (68.0% colour newsletter and leaflet, 42.0% notification of seminars and workshops).

Pest and disease management seminars and meetings: Over three-quarters (78.8%) of the respondents (relevant of WFT project) were aware of the pest and disease management seminars and meetings run by DPI&F. Of these, nearly three-quarters (74.6%) had attended at least one of seminars and meetings and overall rated them as moderately useful with an average rating of 6.2 out of 10.

Sources of information about managing pests and diseases

The sources for useful information about managing pests and diseases mentioned by the agribusiness respondents (relevant to WFT project) without prompting were DPI&F officers (53.3% of respondent mentioned), chemical companies (16.7%), Bowen Crop Monitoring Services (13.3%), other crop consultants (10.0%), Websites/Internet (10.0%), respondents own experience (6.7%), resellers/distributors e.g. Landmark,

Elders (6.7%) and Crop Tech (now T Systems) at Bundaberg (3.3%). Note there was no mention of seminars/meetings/field days/ farm walks, industry publications (e.g. Fruit&Vegetable news, Good Fruit&Vegetables) and newsletters/leaflets (e.g. Updates).

The table below lists the sources that the agribusiness respondents (relevant to WFT project) mostly get their useful information about managing pests and disease. The values are ratings out of 10 where 0=not very important, 5=moderately important and 10=extremely important.

Sources of information for agribusiness	North Queensland	Bundaberg area	Lockyer Valley	Other Qld & interstate	Overall
Own experience	8.7 (n=9)	8.6 (n=7)	8.0 (n=8)	8.0 (n=4)	8.4 (n=28)
(Other) growers/ peers	7.8 (n=9)	6.4 (n=7)	8.2 (n=6)	8.8 (n=4)	7.7 (n=26)
Bowen Crop Monitoring Services	8.0 (n=7)	6.5 (n=2)	6.0 (n=1)	0.0 (n=)	7.5 (n=10)
DPI&F officers	8.1 (n=10)	6.7 (n=6)	7.2 (n=6)	7.7 (n=3)	7.5 (n=25)
Chemical companies e.g. Syngenta, Bayer	8.6 (n=7)	5.3 (n=7)	8.3 (n=6)	7.0 (n=2)	7.3 (n=22)
Seminars/ meetings/ field days / farm walks	7.4 (n=10)	7.2 (n=6)	6.3 (n=7)	8.0 (n=3)	7.1 (n=26)
Websites/internet	6.4 (n=8)	7.2 (n=6)	7.4 (n=7)	6.7 (n=3)	6.9 (n=24)
Newsletters/leaflets (e.g. Updates)	6.9 (n=10)	6.0 (n=7)	7.1 (n=7)	6.0 (n=4)	6.6 (n=28)
Other crop consultants (specify below if applicable)	6.7 (n=7)	4.3 (n=4)	8.2 (n=5)	6.5 (n=4)	6.6 (n=20)
Industry publications (e.g. Fruit&Vegetable news, Good Fruit&Vegetables)	6.0 (n=9)	5.9 (n=7)	7.4 (n=8)	6.0 (n=4)	6.4 (n=28)
Resellers/Distributors e.g. Landmark, Elders etc (specify below if applicable)	6.0 (n=7)	5.4 (n=5)	7.2 (n=6)	6.8 (n=4)	6.3 (n=22)
Crop Tech (now T Systems) at Bundaberg	4.8 (n=6)	6.8 (n=6)	4.5 (n=2)	0.0 (n=)	5.6 (n=14)

Specific agribusiness individuals and companies were mentioned by name.

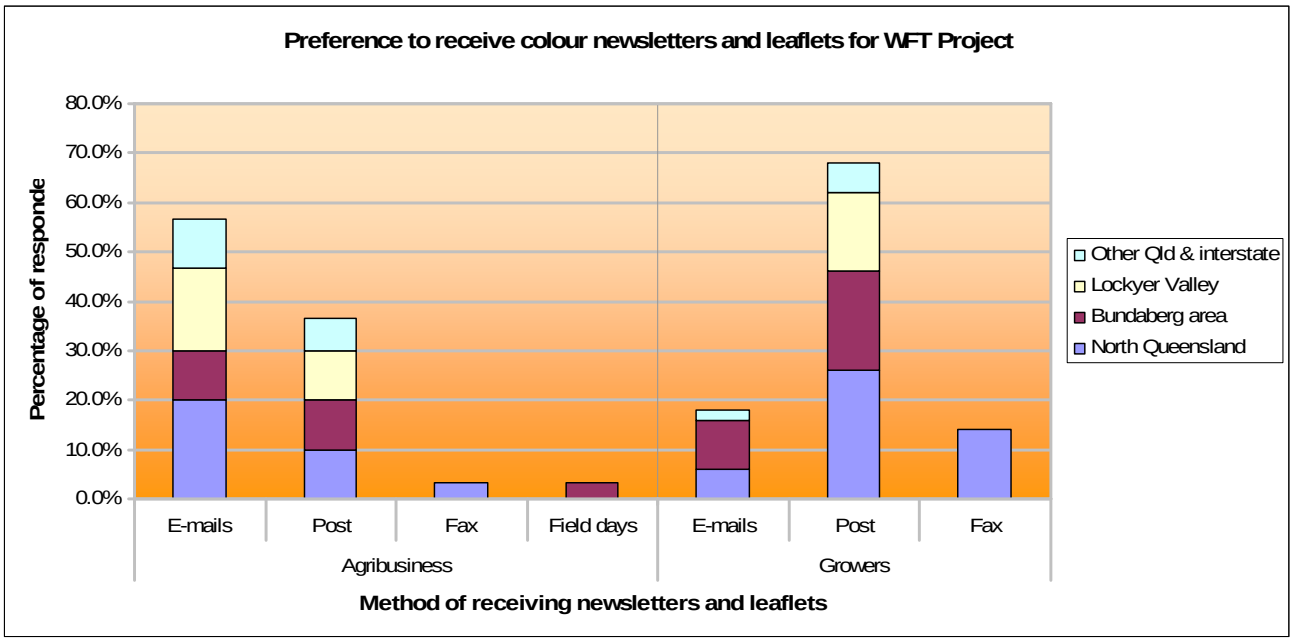
Similarly the table below lists the sources that the grower respondents (relevant to WFT project) mostly get their useful information about managing pests and disease. The values are ratings out of 10 where 0=not very important, 5=moderately important and 10=extremely important.

Sources of information for growers	North Queensland	Bundaberg area	Lockyer Valley	Other Qld & interstate	Overall
Other crop consultants	8.8 (n=4)	7.5 (n=2)	9.5 (n=2)	10.0 (n=1)	8.8 (n=9)
Bowen Crop Monitoring Services	8.1 (n=8)	0.0 (n=)	9.0 (n=1)	0.0 (n=)	8.2 (n=9)
Own experience	7.7 (n=20)	8.3 (n=9)	8.6 (n=7)	9.5 (n=4)	8.2 (n=40)
Seminars/ meetings/ field days / farm walks	6.7 (n=13)	7.9 (n=8)	7.6 (n=8)	7.0 (n=2)	7.3 (n=31)
Crop Tech (now T Systems) at Bundaberg	5.0 (n=2)	7.8 (n=5)	9.0 (n=1)	0.0 (n=)	7.3 (n=8)
DPI&F officers	7.3 (n=16)	5.5 (n=4)	8.2 (n=5)	7.3 (n=3)	7.2 (n=28)
(Other) growers/ peers	6.2 (n=12)	8.3 (n=7)	7.0 (n=7)	4.5 (n=2)	6.8 (n=28)
Resellers/Distributors e.g. Landmark, Elders etc	6.8 (n=18)	6.2 (n=6)	7.4 (n=5)	5.0 (n=2)	6.6 (n=31)
Newsletters/leaflets (e.g. updates)	6.2 (n=16)	5.8 (n=8)	7.4 (n=7)	7.0 (n=2)	6.4 (n=33)
Chemical companies e.g. Syngenta, Bayer (specify below if applicable)	6.0 (n=12)	5.4 (n=5)	8.5 (n=4)	5.0 (n=1)	6.3 (n=22)

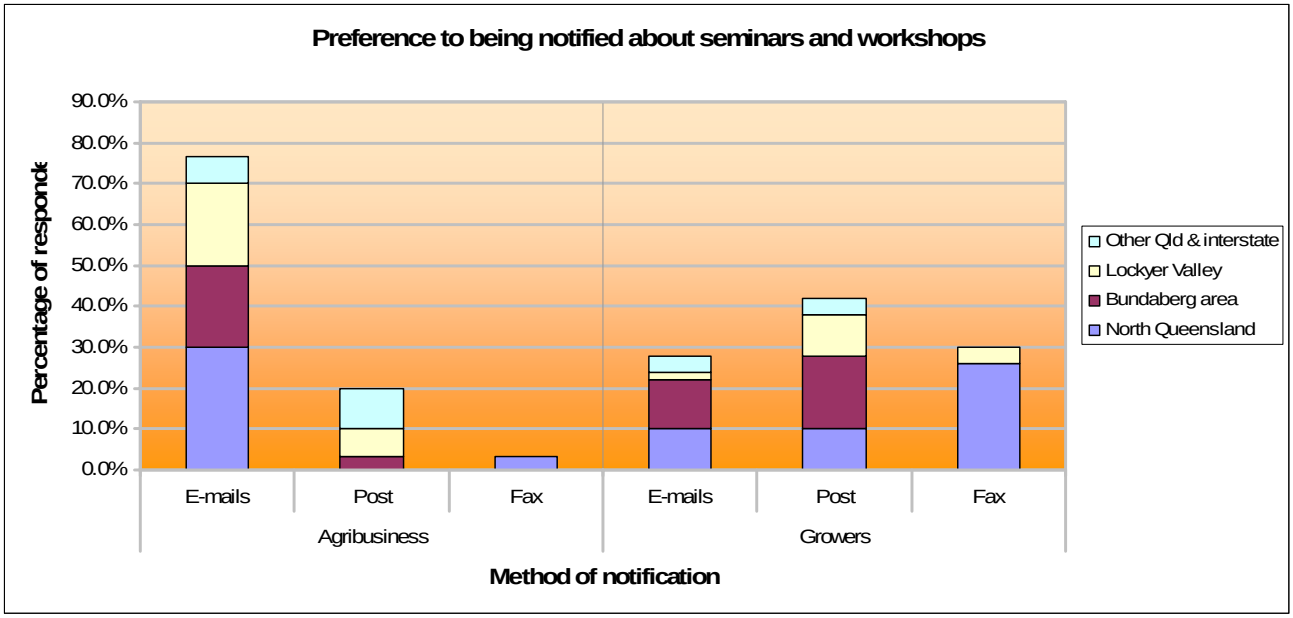
Industry publications (e.g. Fruit&Vegetable news, Good Fruit&Vegetables)	5.6 (n=16)	6.3 (n=9)	7.4 (n=7)	6.5 (n=2)	6.2 (n=34)
Websites/internet	6.2 (n=9)	4.8 (n=5)	6.0 (n=2)	5.7 (n=3)	5.7 (n=19)

A range of specific sources of useful information from growers was provided including specific individual consultants, service companies and grower organisations.

Preferences to receiving colour newsletters and leaflets
The main preference for receiving colour newsletters and leaflet (for WFT relevant respondents) was emails (56.7%) for agribusiness respondents and post (68.0%) for growers. Receiving colour newsletters and leaflets between growers and agribusiness was significantly different, mainly due to the lower preference of receiving emails by growers.



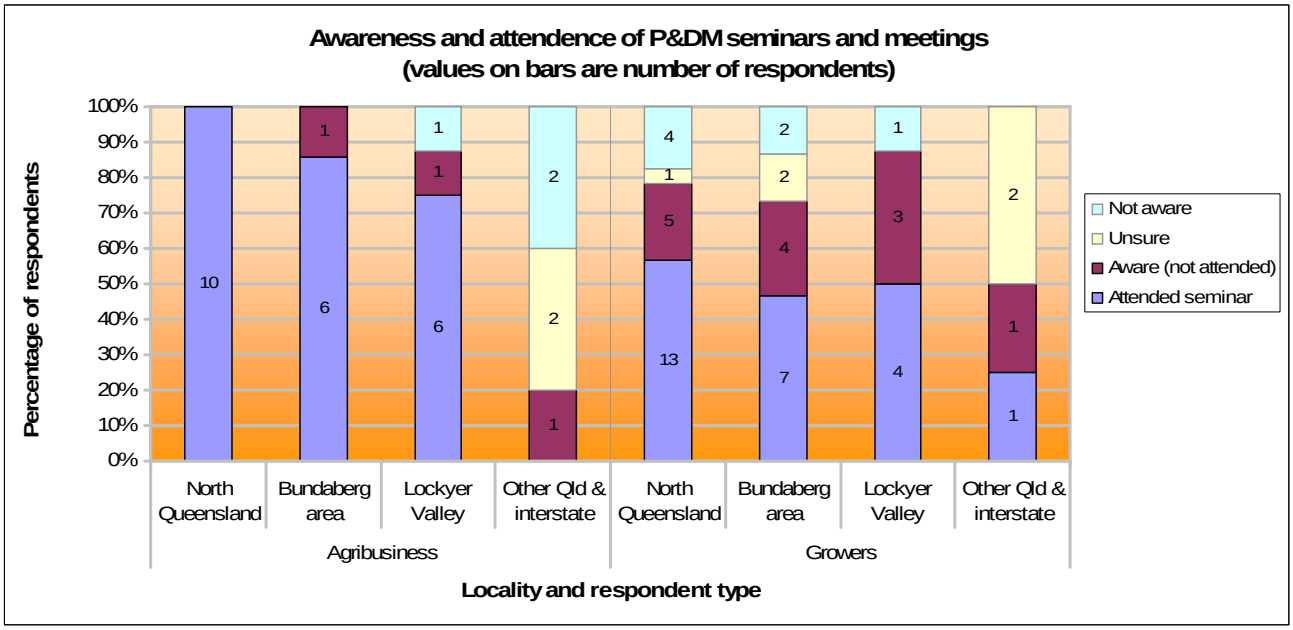
Preferences to being notified about seminars and workshops
Over three-quarters (76.7%) of agribusiness respondents preferred to be notified about seminars and workshops by email, while the main preference by growers was to be notified by post (42.0%). The method of being notified about seminar and workshops between growers and agribusiness was significantly different mainly due to the lower preference of receiving emails by growers.



Pest and Disease Management seminars and meetings

Over three-quarters (78.8%) of the respondents (relevant of WFT project) were aware of the pest and disease management seminars and meetings run by DPI&F. This percentage of awareness changed little between the agribusiness (83.3%) and grower (76.0%) respondents. Another 8.8% were unsure (agribusiness 6.7% and growers 10.0%) and 12.5% were not aware of the seminar and meetings (agribusiness 10.0% and growers 14.0%).

Of the respondents who were aware of the seminars, nearly three-quarters (74.6%, n=63) had attended at least one of them. This percentage was not significantly different between growers (65.8%, n=38) and agribusiness (88.0%, n=25) respondents. The graph below shows the breakdown of the respondents for awareness and attendance of the pest and disease management seminars and meetings.



Of the respondents who attended a seminar or meeting, the average number of seminars attended per respondent was 4.5 over the life of the project. Note that not all respondents provided the number of workshops or meetings they attended.

The respondents overall rated the seminars and meetings 6.2 out of 10 (0=not useful, 5=moderately useful and 10=extremely useful). The ratings of the seminars and meetings were not significantly different across the respondent type (grower or agribusiness) or the locality.

The table below shows the number of seminars or meetings attended and the rating of usefulness.

Respondent type	Locality	Total seminars/meetings attended (n)	Average seminars/meetings per respondent	Average rating for seminars/meetings (n)
Agribusiness	North Queensland	31 (n=5)	6.2	5.8 (n=10)
	Bundaberg area	26 (n=4)	6.5	4.8 (n=6)
	Lockyer Valley	14 (n=4)	3.5	7.2 (n=6)
	Other Qld & interstate	-	-	-
Growers	North Queensland	34 (n=9)	3.8	6.6 (n=13)
	Bundaberg area	10 (n=3)	3.3	6.1 (n=7)
	Lockyer Valley	-	-	8.0 (n=4)
	Other Qld & interstate	3 (n=1)	3.0	2.0 (n=1)

Comments on the number of seminars attended include:

- Attended all; too short a notice sometimes can't attend; work commitments (Agribusiness, Bundaberg area)
- Only when they are good if they are experienced (Agribusiness, Lockyer Valley)
- Attended 1seminar at the start on both pest program they were very helpful; haven't for the past couple of years owing to lack of time; took part in trial for fruit fly (Growers, North Queensland)
- All been informative; helpful (Growers, Bundaberg area)
- Important to our business; pretty busy short staffed but very important to attend; seem to be on when we are busy (Growers, Lockyer Valley)

The table below are comments on the pest and disease management seminars.

Respondent type	Locality	Comments about seminars and meetings
Agribusiness	North Queensland	Well run through the DPI and do a fantastic job.
		Thought it was very good in particular the farm we went to it had a lot of variety of insects to discuss.
		Very poorly attended by growers.
		Share an office with the people who are involved with this project.
		Good for business to go and learning valuable also listening to peoples problems for seedlings production. They are not always convenient and always getting a good grower turnout but they do the right thing.
		I used to run the seminars. Very important.
	Bundaberg area	Information is very relevant and use if when considering sprays timing etc.
		Depends on the relevance at the time.
		For the growers it remains a very effective way of communicating.
	Lockyer Valley	Quite interesting.
		Some not beneficial in relation to the time spent listening. The seminars have a lot of revision as you already have the information but sometimes you can pick up on some things so you can't afford not to go.
		They are useful only if they are grower orientated.

Growers	North Queensland	Depending on the context.
		Find not much information for Egg fruit about.
		Parts were good and parts were poor. Some of the extension officers DPI&F are getting slack not enough industry experience knowledge.
		WFT we don't have and they repeat themselves at every seminar.
		Always talk to other growers it is good to hear what others are working their problems out.
	Bundaberg area	Then good don't need to be any longer.
		Don't understand not in layman language.
		Farm employees go to these seminars.
	Lockyer Valley	Rehash of everything.
		You get to talk to different people so you always come up with something communication is a big thing in our business.

The following reasons were given from respondents who were aware of the pest and disease management seminars and meetings but did not attend.

Respondent type	Locality	Comments on why they didn't attend seminars/meetings
Agribusiness	Bundaberg area	Lack of time - work commitments.
	Lockyer Valley	I never get invited and usually find out about seminars from Growers and I don't know it is on.
	Other Qld & interstate	In Sydney but I am sure the Queensland person would have been.
Growers	North Queensland	Concentrate on field tomatoes and not green house. Contact Subra at the DPI rather than go to the seminars which I feel are for the bigger farms I am only a small farm. Lack of time. Put all my trust in the crop consultant Chris Monsour so we don't have the time to go to them. Seminars are not a lot of use because we are growing egg fruit not a lot of seminars on the subject.
	Bundaberg area	Didn’t see the need for it as we don't have the time of either WFT or SLW. Don’t suit what I am growing. The subject is not on what I am growing .Not much done on hydroponic crops in seminars. Timing is wrong when they are on.
	Lockyer Valley	Couldn't get there. Haven't had the time. The money should be spent more hands on the farm trials.
	Other Qld & interstate	By word of mouth.

Use of a consultant

The use of a consultant by agribusiness respondents from farms or seedling nurseries is listed below:

- Bowen Crop Monitoring Services (North Queensland)
- Crop Tech (= T Systems) (Bundaberg area)
- Other Crop Consultant – not specified (Bundaberg area)
- In-house agronomist (Bundaberg area, Other Qld and interstate)

Twenty-seven of the 50 growers indicated that they used an external or internal consultant.
The use of a consultant by grower respondents includes:

- Bowen Crop Monitoring Services (North Queensland (6))

- Crop Tech (= T Systems) (Bundaberg area (6))
- Other Crop Consultants (8)
    - North Queensland (4): Independent Crop Consultant from Tully, Prospect Agriculture, PT Limited
    - Bundaberg area: Private
    - Lockyer Valley: Westfarmers
    - Other Queensland and interstate (2): Contag Solutions, Matthew Holdings/ Matt Foster Elders

Other people used for checking crops for pest and disease on a regular basis are:

- Resellers (4)
    - Elders and Landmark (Lockyer Valley)
    - Landmark (Lockyer Valley)
- Staff members (Bundaberg area)
- In house agronomists (Bundaberg area, Lockyer Valley (2))
- Family member (North Queensland (4), Bundaberg area)
- Grower themselves (North Queensland (3), Bundaberg area (5), Other Qld & interstate)

Western Flower Thrips awareness, knowledge and practice

Summary

Overall 78.3% of the respondents said they were aware of the project.

Newsletter: A similar percentage of respondents (73.9%) had seen the newsletter '*Western Flower Thrips Updates*', and gave an overall usefulness rating of 5.9 out of 10. After the agribusiness respondents have read the *WFT Updates* – most (89.5%) filed them away, just under half (47.4%) referred to them regularly, 21.1% took them out to growers to use as a business tool and a small number (5.3%) sent them on to colleagues.

3-spray insecticide strategy: Overall 57% of the agribusiness and grower respondents said that they were aware of the 3-spray insecticide strategy for western flower thrips. The top three descriptions given by respondents for what they saw as most important for keeping western flower thrips at low levels were:

- 'Good farm hygiene' (96.3%);
- 'Monitor/check crops on a regular basis' (92.6%);
- 'Spray with insecticide' (66.7%);

Broadleaf weeds: Just over 56.5% of agribusiness respondents that said they were aware of the broadleaf weeds that harbour western flower thrips.

Crop damage: On average grower and agribusiness respondents rated the damage done to crops by western flower thrips (compared to several years ago) as having decreased - 6.6 out of 10 (0=much more damage, 5=same amount of damage and 10=a lot less damage). The grower respondents rated the damage less (7.2) compared to the agribusiness respondents (5.9). The top three types of damage due to western flower thrips mentioned was scarring (77.8%), loss of quality (59.3%), reduced yields (44.4%) and tomato spotted wilt virus (44.4%). More than one third (37.0%) said that there was no significant damage (37.0%).

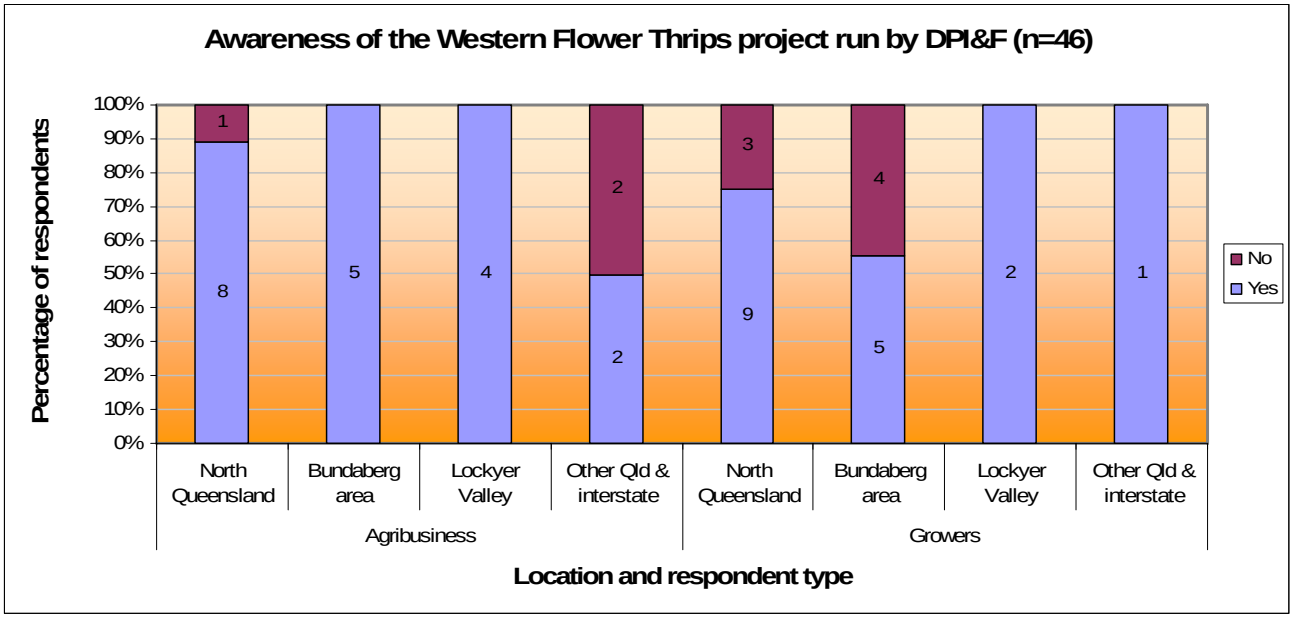
Practice change: Approximately forty percent (40.7%) of agribusiness and grower respondents have changed the way they recommend or manage western flower thrips, with 40.7% said that they monitor crops for WFT levels, 29.6% use a 3-spray strategy on detection of WFT and one quarter (25.9%) of respondents reduce insecticide resistance by rotating insecticides.

Both agribusiness and grower respondents on average rated their own research / information seeking / trials (agribusiness 8.1, growers 8.3) and experience (agribusiness 8.1, growers 8.3) as the top two factors prompting change in practices for WFT. Agribusiness respondents next rated information about WFT that arrived on the farm from DPI&F (8.1) and discussions with crop consultants (7.9) and growers next rated Pest and Disease Seminars (7.8) and discussions with crop consultants (7.4) as prompters of change.

Note that in this section not all respondents chose to complete the questions, which may cause bias in some results.

Awareness of the Western Flower Thrips project

Overall 78.3% of the respondents said they were aware of the project. (Note that there may be some upward bias in this result due to some respondents choosing not to answer the question. If the respondents who didn't answer the question were considered as 'no' responses the percent would be 45.0%.) The awareness for the main areas for WFT was 75% for North Queensland and 100% for Bundaberg. The graph below shows the results over the different respondent types and localities.



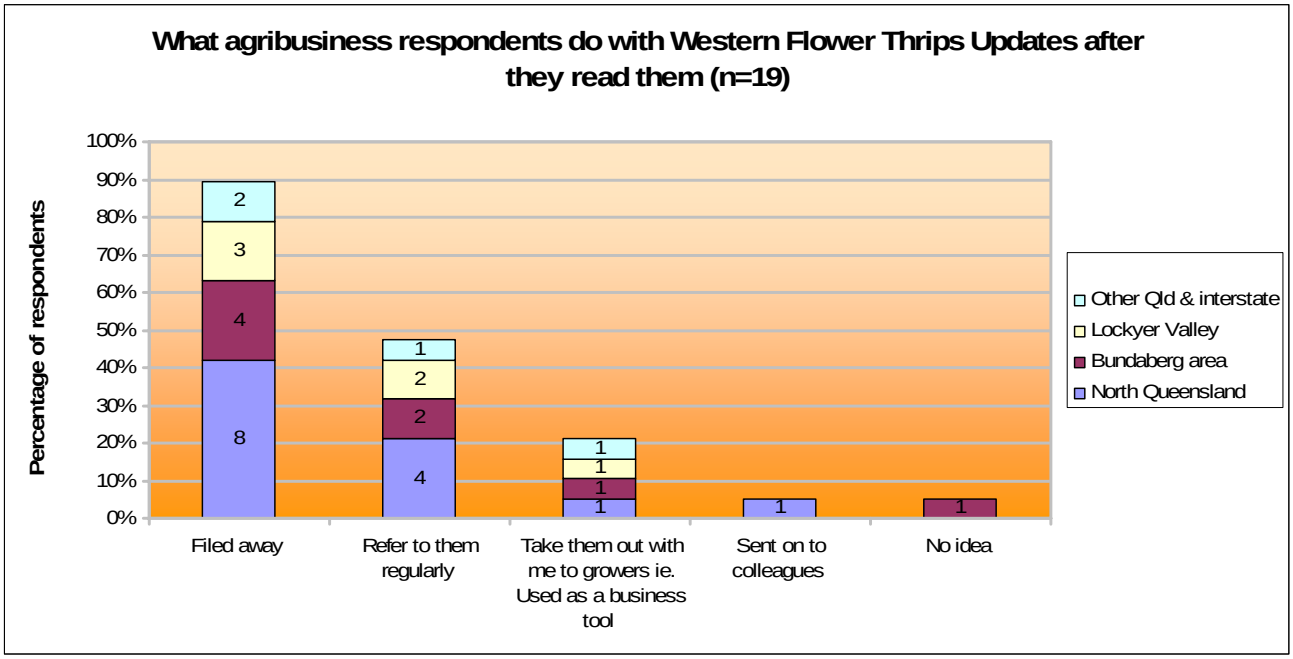
Nearly three-quarters of the respondents (73.9%, n=46) had seen the newsletter '*Western Flower Thrips Updates*', and gave an overall rating of 5.9 (n=34) where 0=not useful/relevant and 10=very useful/relevant. There was no significant difference in the average rating across type of respondent and locality.

Respondent type	Locality	% respondents who had seen the *WFT Updates*	Average rating of *WFT Updates* for useful and relevant information
Agribusiness	North Queensland	100% (n=9)	5.3 (n=9)
	Bundaberg area	100% (n=5)	6.4 (n=5)
	Lockyer Valley	75% (n=4)	5.0 (n=3)
	Other Qld & interstate	50% (n=4)	8.0 (n=1)
Growers	North Queensland	58.3% (n=12)	5.3 (n=8)
	Bundaberg area	66.7% (n=9)	7.3 (n=6)
	Lockyer Valley	50% (n=2)	8.0 (n=1)
	Other Qld & interstate	100% (n=1)	4.0 (n=1)

Comments on the *WFT Updates* with the rating of their usefulness and relevance (when provided) are listed in the table below.

Respondent type	Locality	Rating	Comments on *WFT Updates*
Agribusiness	North Queensland	2 9	Don't receive them regularly. Very important.
	Lockyer Valley	5	I haven't read it as yet but I can handle WFT myself. Not in the particular area. Upgrade the mailing list as I don't receive them.
	Other Qld & interstate	8	General good round up on the research going on. I run a project in NSW which is similar to Queensland.
Growers	North Queensland	4 7 2 9	Depend on Chris to know what is happening he knows what is going on as he does other farms updated in chemicals etc and does trials at the DPI. Good to have reference for the chemicals. Not sure when the last one came out. Very useful.
	Bundaberg area	 5	Last year. Not recently. They are short and to the point.
	Lockyer Valley		No such a problem for the area so not sure if I have actually read it.

After the agribusiness respondents have read the *WFT Updates* 89.5% filed them away, 47.4% referred to them regularly, 21.1% took them out to growers to use as a business tool and 5.3% sent them on to colleagues. The graph below shows the breakdown of the uses over the locations, with the number of respondents written on the bars.



Awareness of the 3-spray insecticide strategy

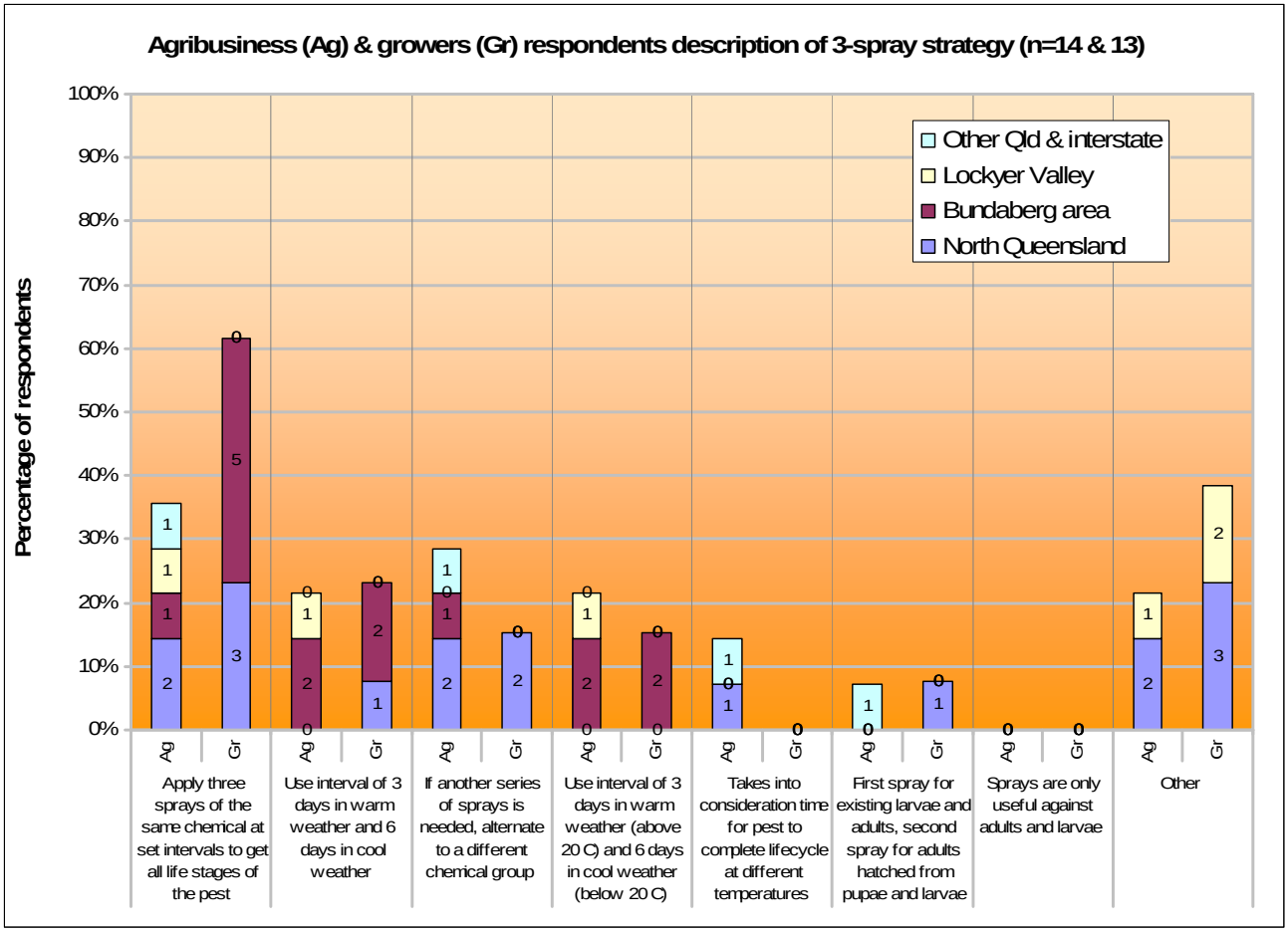
Overall 57.4% (n=47) of the agribusiness and grower respondents said they were aware of the 3-spray insecticide strategy for western flower thrips.

Respondent type	Locality	Awareness of the 3-spray insecticide strategy for WFT
Agribusiness	North Queensland	55.6% (n=9)
	Bundaberg area	80% (n=5)
	Lockyer Valley	40% (n=5)
	Other Qld & interstate	75% (n=4) (Unsure 25%)
Growers	North Queensland	50.0% (n=12) (Unsure 8.3%)
	Bundaberg area	55.6% (n=9) (Unsure 11.1%)
	Lockyer Valley	100% (n=2)
	Other Qld & interstate	0% (n=1)

The respondents who were aware of the 3-spray insecticide strategy for western flower thrips were asked to describe it. Overall the most common description of the 3-spray insecticide strategy was:

- 'Apply three sprays of the same chemical at set intervals to get all life stages of the pest' with 48.1% of the respondents mentioning it in that manner;
- 'Use interval of three days in warm weather and six days in cool weather' (22.2%);
- 'If another series of sprays is needed, try to alternate to a different chemical group' (22.2%);
- 'Use interval of three days in warm weather (above 20 C) and six days in cool weather (below 20 C)' (18.5%);
- 'takes into consideration time it takes for pest to complete its lifecycle at different temperatures' (7.4%); and
- 'First spray for existing larvae and adults, second spray for adults hatched from pupae and larvae hatched from eggs; third is a clean up spray for any remaining larvae and adults' (7.4%).

The graph below shows the breakdown of respondents across the different descriptions of the 3-spray insecticide strategy. Note that the sixth description on the x-axis is truncated due to its length.



The other descriptions mentions were:

- Do what crop monitoring people advise (Agribusiness, North Queensland)
- farm supervisor takes care of this (Agribusiness, North Queensland)
- monitoring (Agribusiness, Lockyer Valley)
- don't used (Growers, North Queensland)
- label (Growers, North Queensland)
- no problems (Growers, North Queensland)
- setting traps (Growers, Lockyer Valley)
- spray with confidor (Growers, Lockyer Valley)*

Other comments made when asked about the 3-spray insecticide strategy were:

- I am with Land mark so I advise the growers (Agribusiness, North Queensland)
- Listen to our consultants and use what they recommended (Agribusiness, North Queensland)
- Not applicable in my case Chemical Company (Agribusiness, North Queensland)
- strategy is unmanageable because of chemical rotations (Agribusiness, other Qld or interstate)
- monitor these traps to go to Tasmania (Grower, other Qld or interstate)
- no problems at the moment don't need do anything else (Grower, North Queensland)
- One application of Confidor at planting or in the nursery (Grower, other Qld or interstate)*
- use label on the bottle of chemical (Grower, North Queensland)
- what ever is recommended by Crop Tech (Grower, Bundaberg area)

[*Note – Confidor was mentioned by these WFT respondents – even though it is applicable to SLW.]

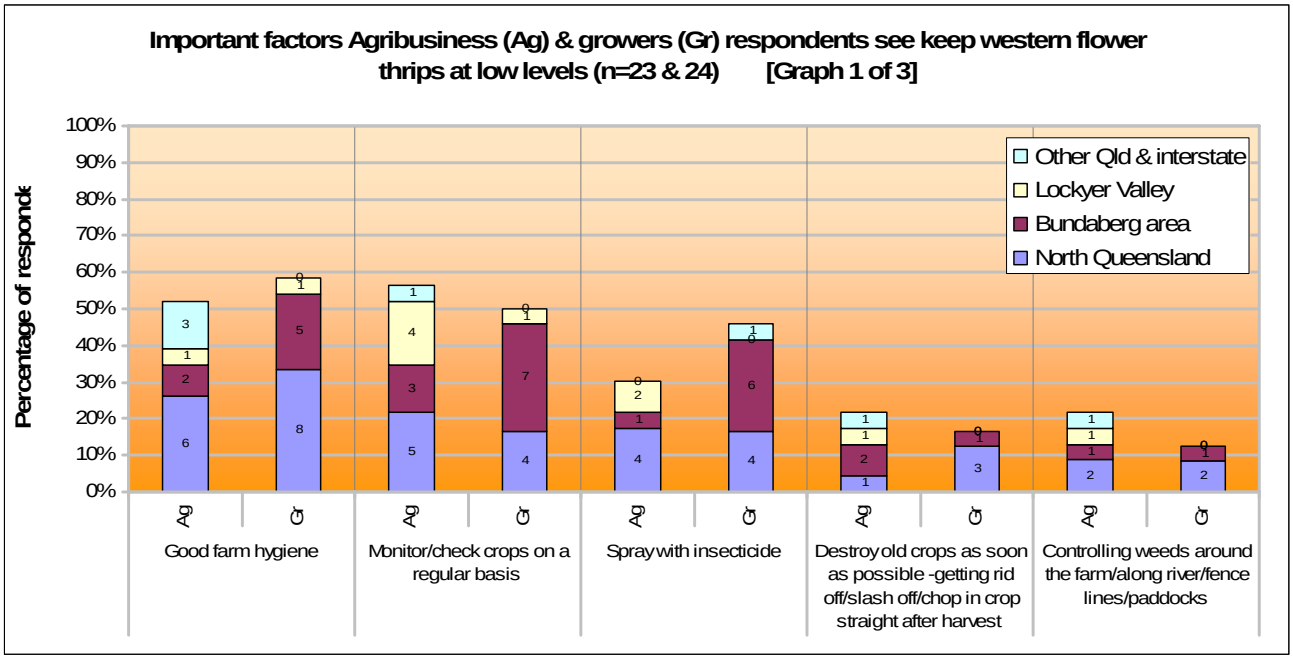
Most important ways to keep WFT at low levels

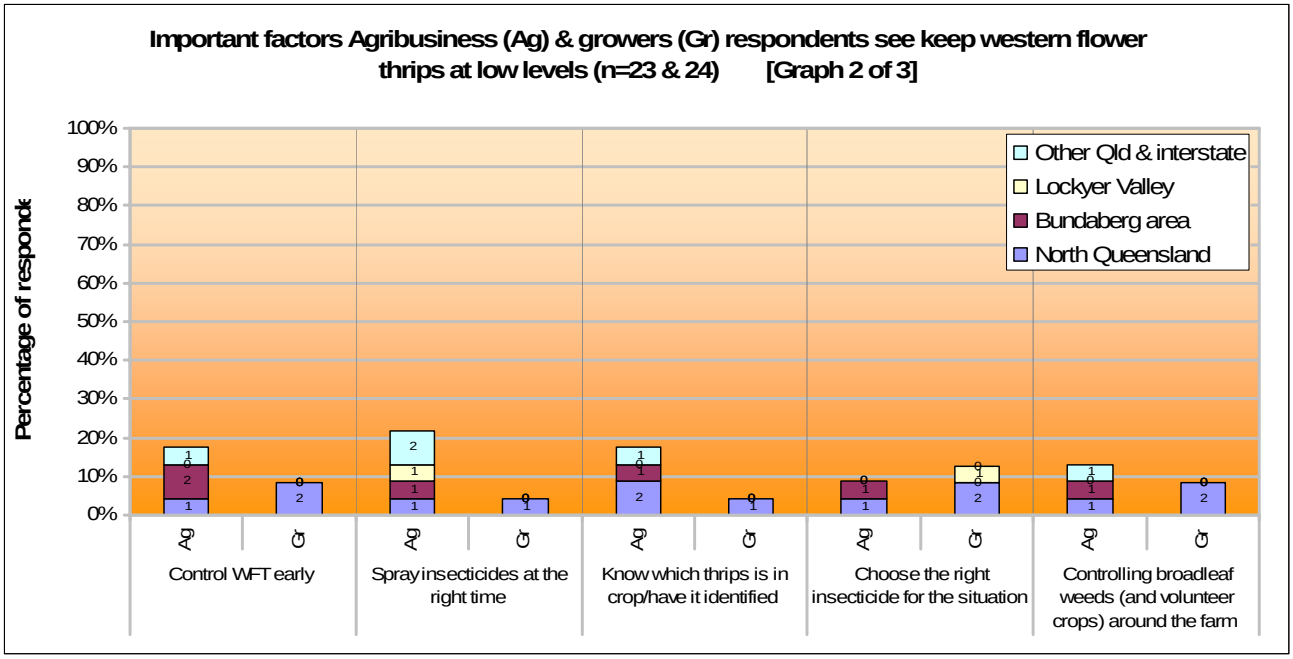
When respondents were asked what they saw as most important for keeping western flower thrips at low levels, the descriptions given in most popular order were:

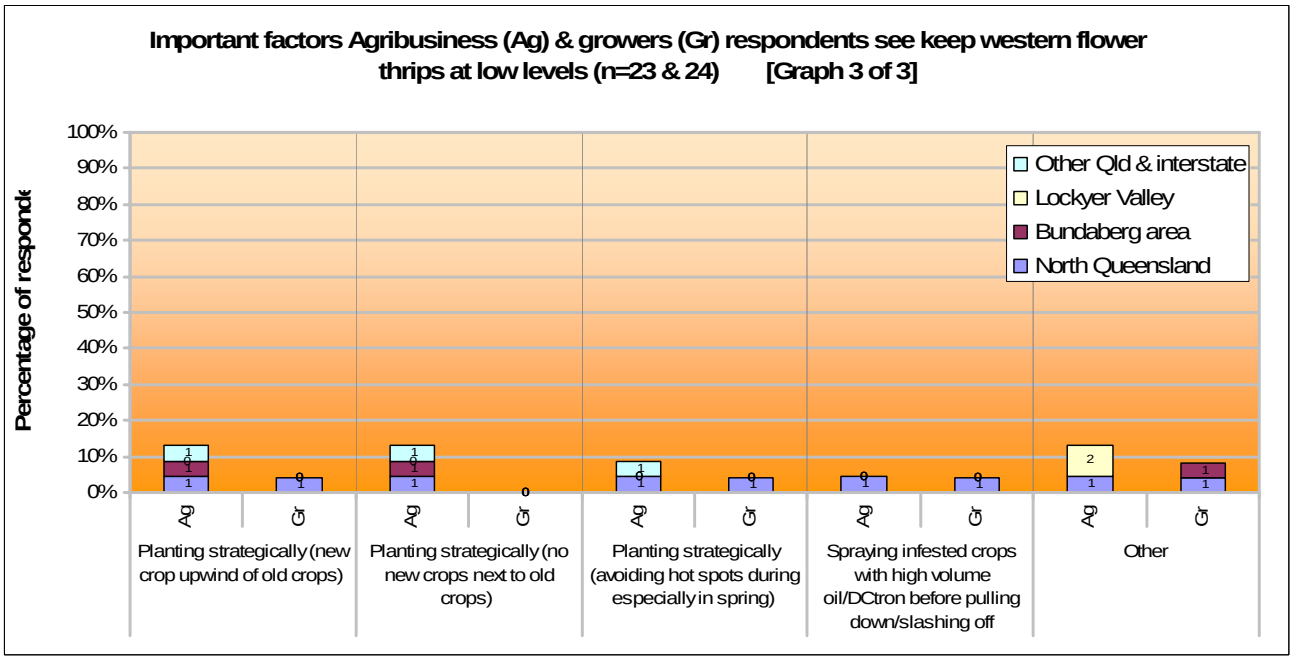
- 'Good farm hygiene' (96.3%);

- 'Monitor/check crops on a regular basis' (92.6%);
- 'Spray with insecticide' (66.7%);
- 'Destroy old crops as soon as possible -getting rid off/slash off/chop in crop straight after harvest' (33.3%);
- 'Controlling weeds around the farm/along river/fence lines/paddocks' (29.6%);
- 'Control WFT early' (22.2%);
- 'Spray insecticides at the right time' (22.2%);
- 'Know which thrips is in crop/have it identified' (18.5%);
- 'Choose the right insecticide for the situation' (18.5%);
- 'Controlling broadleaf weeds (and volunteer crops) around the farm' (18.5%);
- 'Planting strategically (new crop upwind of old crops)' (14.8%);
- 'Planting strategically (no new crops next to old crops)' (11.1%);
- 'Planting strategically (avoiding hot spots during especially in spring)' (11.1%); and
- 'Spraying infested crops with high volume oil/DCtron before pulling down/slashing off crop/chopping in crop' (7.4%).

The graphs below show these descriptions across the respondent type and locality.







The other descriptions or comments relating to keeping western flower thrips at low levels were:

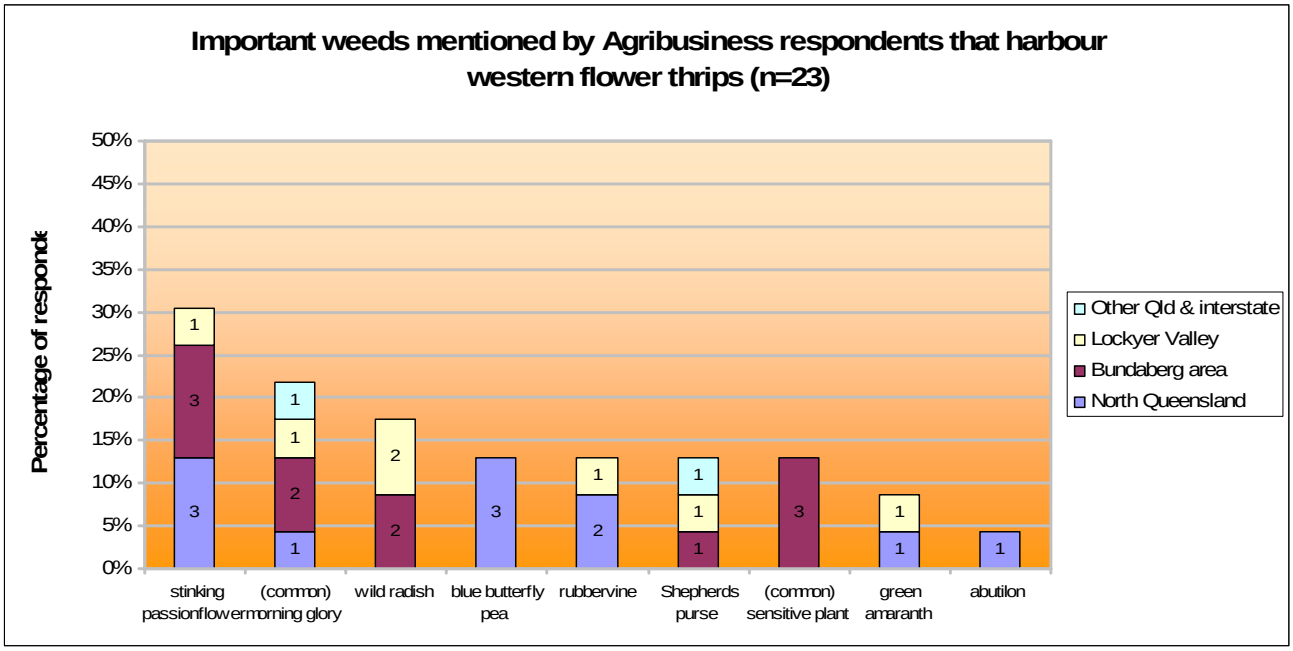
- All depends on the conditions as they don't like getting wet so if it rains we don't have to spray etc and some of the crops have irrigation in green house (Agribusiness, Bundaberg area).
- Appropriate selection and timing of chemicals (Agribusiness, North Queensland).
- Check what the neighbours are spraying for (Agribusiness, Lockyer Valley).
- Combination of all factors (Agribusiness, North Queensland).
- Educating the growers as DPI & F need to get more growers to attend farm days or they should get out around them more (Agribusiness, Lockyer Valley).
- Not as big a pest in a lot of the crops we have up here some in the avocados (Agribusiness, North Queensland).
- Recommending appropriate strategies to prevent the levels increasing (Agribusiness, North Queensland).
- Action when necessary monitoring in the area generally (Growers, Bundaberg area).
- Don't use sprays (Growers, North Queensland).

- Lettuce we do confidor (Growers, other Qld and interstate).
- Rely on Bowen Crop monitoring services (Growers, North Queensland).
- Sulphur is cheap (Growers, Bundaberg area).

Awareness of the main broadleaf weeds that harbour WFT
There were 56.5% of agribusiness respondents (n=23) that said they were aware of the broadleaf weeds that harbour western flower thrips. The table below shows the percentage awareness for each locality. Note that growers were not asked this question.

Respondent type	Locality	Awareness of the main broadleaf weeds that harbour western flower thrips
Agribusiness	North Queensland	44.4% (n=9)
	Bundaberg area	60% (n=5)
	Lockyer Valley	60% (n=5)
	Other Qld & interstate	75% (n=4)

The specific weeds that the agribusiness respondents mentioned are listed in the graph below.



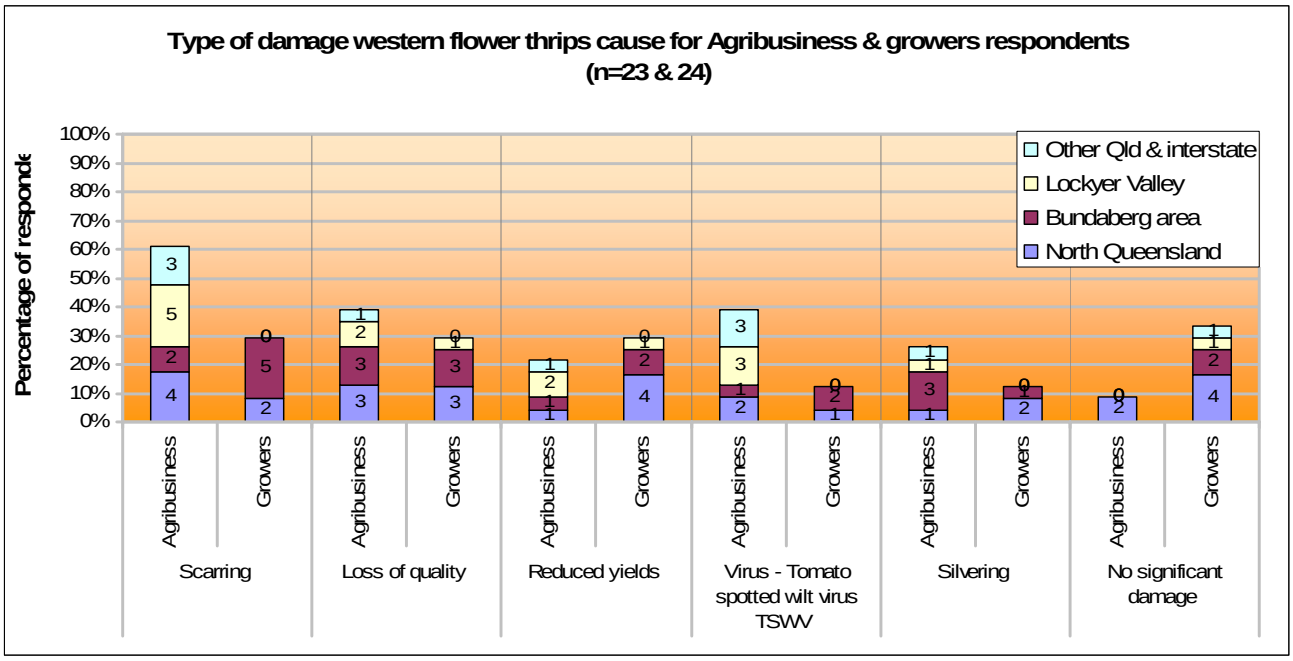
Other weeds that were mentioned are:
- any plant with flowers, billy goat weed actively growing (North Queensland)
- seasonal alternate hosts (Lockyer Valley)
- snake weed (North Queensland)
- Sow Thistle (Other Qld or interstate)
- white clover (Other Qld or interstate)

Damage done to crops by WFT (compared to several years ago)
The grower and agribusiness respondents rated the damage done to crops by western flower thrips (compared to several years ago) an average rating of 6.6 out of 10 (0=much more damage, 5=same amount of damage and 10=a lot less damage). The grower respondents rated the damage higher at 7.2 (n=24) compared to the agribusiness respondents 5.9 (n=20), which was close to being significantly different (p=0.051).

Respondent type	Locality	Average rating of damage done to crops by western flower thrips
Agribusiness	North Queensland	5.8 (n=6)
	Bundaberg area	5.8 (n=5)

	Lockyer Valley	6.6 (n=5)
	Other Qld & interstate	5.0 (n=4)
Growers	North Queensland	6.6 (n=12)
	Bundaberg area	7.2 (n=9)
	Lockyer Valley	9.5 (n=2)
	Other Qld & interstate	9.0 (n=1)

Types of damage due to western flower thrips mentioned by respondents was scarring (77.8%), loss of quality (59.3%), reduced yields (44.4%), tomato spotted wilt virus (44.4%) and silvering (33.3%). It was mentioned by 37.0% that there was no significant damage (37.0%). The graph below shows the mentions of damage across locations.



Other types of damage mentioned by the agribusiness respondents were:

- Blemish in apples (Other Qld or interstate)
- Bronzing (Bundaberg area)
- Distort fruit (North Queensland)
- Distortion of capsicum (Bundaberg area)

Other comments about damage caused by western flower thrips include:

- Crops get downgraded price wise in the market places (Agribusiness, North Queensland).
- Western flower thrips damage is not applicable in my business (Agribusiness, North Queensland).
- Damages the middle of the lettuce (Grower, Bundaberg area).
- Hadn't had to spray for thrips this year (Grower, North Queensland).
- Haven't identified WFT in crops there are other pest though (Grower, North Queensland).
- In egg fruit (Grower, North Queensland).
- Looks 2nd grade veg. (Grower, North Queensland).
- Scarring on capsicum (Grower, Bundaberg area).
- Tomatoes don't seem to have a problem but egg plant seem to be the one with the problem (Grower, Bundaberg area).

Changes to the way that WFT is managed or recommended to manage

The ways that the grower and agribusiness respondents have changed the way they recommend or manage western flower thrips is shown below in decreasing popularity (unprompted):

- Haven't changed (59.3%)
- Monitor crops for WFT levels (40.7%)

- 3-spray strategy on detection of WFT (29.6%)
- Reduce insecticide resistance by rotating insecticides (25.9%)
- Good farm hygiene: Slash / destroy old crops as soon as possible (18.5%)
- Plant strategically: be aware of hot spots around farm and avoid during spring and problem times (11.1%)
- Plant strategically: don't plant new crops next to old crops (7.4%)
- Plant strategically: plant new crops up wind of older crops/problem areas (7.4%)
- Good farm hygiene: Control broadleaf weeds around the farm (7.4%)

Other changes mentioned were:

- Rotating chemicals (Agribusiness, North Queensland).
- Gone organic (Grower, North Queensland).
- Introduced Confidor (Grower, Lockyer Valley)*.
- Pre plant with confidor (Grower, Lockyer Valley)*..
- Keep spraying sulphur (Grower, Bundaberg area).

[*Confidor comments were again made by these growers in relation to WFT]

General comments made were:

- Advising growers to keep the program up to date (Agribusiness, North Queensland).
- Always follow the recommended details given by the DPI & F (Agribusiness, Lockyer Valley).
- Don't have a farm working in the chemical advisory side of things (Agribusiness, Lockyer Valley).
- Hope all projects regarding WFT get funded as we are only just getting this problem under control (Agribusiness, Other Qld & interstate).
- Made us more aware to look for them than in the past and taking action when required (Agribusiness, North Queensland).
- More aware of it (Agribusiness, Other Qld & interstate).
- More awareness (Agribusiness, Bundaberg area).
- Not involved in that side of things agronomist (Agribusiness, Bundaberg area).
- Rotation of sprays such as success and the organic success as well (Agribusiness, Lockyer Valley).
- Besides growing under netting we are isolated here from other growers (Grower, Bundaberg area).
- Bowen Crop Monitoring keep an eye on it for us (Grower, North Queensland).
- Do what Chris tells him to do and run clean farm. (Grower, North Queensland).
- Dog inspects crops owner is too blind and if dog relieves himself owner knows he is trying to flush them out. (Grower, Bundaberg area).
- Use magnifying glass to make sure WFT they aren't in the crops (Grower, Bundaberg area).
- If you try to buy the chemical you recommend costs a fortune but if they get too bad I will spray success. (Grower, Bundaberg area).
- Introduced using confidor (Grower, Lockyer Valley).
- Organic (Grower, North Queensland).
- Use the sprays that DPI&F recommends (Grower, North Queensland).
- Using softer chemicals (Grower, Bundaberg area).

Factors influencing change in practices (or recommendations) for controlling WFT

The grower and agribusiness respondents were asked to rate the importance of each factor in prompting or convincing them of changing practices for recommending or managing western flower thrips. The scale is 0=had no influence to 10=the main reason they changed. The table below lists the influences in order of highest to lowest overall rating. There were no significant differences in the average ratings across type of respondent and locality.

Survey	Factor prompting change in practices for WFT	North Queensland	Bundaberg area	*Lockyer Valley	Other Qld & interstate	Overall
usine ss	Own research/information seeking/trials	8.0 (n=5)	7.7 (n=3)		10.0 (n=1)	8.1 (n=9)
	Experience	8.6 (n=5)	6.7 (n=3)		10.0 (n=1)	8.1 (n=9)

	Information about WFT that arrived on the farm from DPI&F	8.3 (n=4)	8.0 (n=3)			8.1 (n=7)
	Discussions with crop consultants	8.8 (n=5)	6.3 (n=3)			7.9 (n=8)
	Pest and Disease Seminar attended	6.8 (n=4)	6.3 (n=3)			6.6 (n=7)
	Direct contact with DPI&F	7.5 (n=4)	5.7 (n=3)			6.7 (n=7)
	Discussions with other growers	5.8 (n=5)	6.7 (n=3)		5.0 (n=1)	6.0 (n=9)
	Discussions with reseller/company rep	5.8 (n=5)	7.0 (n=3)			6.3 (n=8)
Growers	Own research/information seeking/trials	8.0 (n=4)	8.3 (n=4)	10.0 (n=1)		8.3 (n=9)
	Experience	8.0 (n=6)	8.2 (n=5)	10.0 (n=1)		8.3 (n=12)
	Information about WFT that arrived on the farm from DPI&F	7.4 (n=5)	6.6 (n=5)	10.0 (n=1)		7.3 (n=11)
	Discussions with crop consultants	6.4 (n=5)	7.8 (n=6)	10.0 (n=1)		7.4 (n=12)
	Pest and Disease Seminar attended	6.7 (n=3)	8.0 (n=4)	10.0 (n=1)		7.8 (n=8)
	Direct contact with DPI&F	6.8 (n=4)	6.0 (n=3)	10.0 (n=1)		6.9 (n=8)
	Discussions with other growers	6.7 (n=6)	8.3 (n=4)			7.3 (n=10)
	GUMLU only - Information about WFT that arrived on the farm from Bowen Crop Monitoring Services that included a map on thrips densities in Gumlu	6.3 (n=4)				6.3 (n=4)
	Discussions with reseller/company rep	5.0 (n=5)	7.0 (n=3)	10.0 (n=1)	0.0 (n=)	6.2 (n=9)

* Please note that the Lockyer Valley results were made up from two respondents, one who selected 3 and the other 4 points (none overlapping).

Conclusions

Level of crop damage and insect control

Approximately half (52.5%) of the grower and agribusiness respondents said that western flower thrips was an issue for the crops that they grow or deal with in their work (80.5% - and 100% in the Lockyer Valley - of these said that silverleaf whitefly was also an issue for the crops they grow or deal with in their work).

On average grower and agribusiness respondents rated the damage done to crops by western flower thrips (compared to several years ago) as having decreased - 6.6 out of 10 (0=much more damage, 5=same amount of damage and 10=a lot less damage). The grower respondents rated the damage less (7.2) compared to the agribusiness respondents (5.9). The top three types of damage due to western flower thrips mentioned was scarring (77.8%), loss of quality (59.3%), reduced yields (44.4%) and tomato spotted wilt virus (44.4%). More than one third (37.0%) said that there was no significant damage.

Although there is no direct benchmark to measure changes in the level of damage, survey respondents considered retrospectively that damage by Western Flower Thrips had decreased over recent years. Scarring was the major damage reported.

Information sources

Top sources

Agribusiness respondents rated (out of 10) the following sources of information about managing pest and diseases as the top four most useful; their own experience (8.4), grower/peers (7.7), DPI&F officers (7.5) and Bowen Crop Monitoring Services (7.5). Growers found other crop consultants (8.8), Bowen Crop Monitoring Services (8.2) and their own experience (8.2) as the three most useful sources of information. These were the same top main sources of information for growers that was noted in the WFT needs analysis in 2005.

DPI&F Officers are seen as the major source of information on WFT by Agribusiness and playing a critical role in the information system. Growers are relying more on the crop consultants as their primary information source. This highlights the impact of the commercialisation route.

Newsletters

A high percentage of survey respondents (73.9%) had seen the newsletter '*Western Flower Thrips Update*', and gave an overall usefulness rating of 5.9 out of 10. After the agribusiness respondents have read the *WFT Updates* – most (89.5%) filed them away, just under half (47.4%) referred to them regularly, 21.1% took them out to growers to use as a business tool and a small number (5.3%) sent them on to colleagues.

A January 2006 project management leaflet for the WFT project described the main purpose of the WFT Updates and Information leaflets *is to keep in touch and keep our target groups informed about project progress, particularly those that are unlikely to participate in workshops and seminars.* There was little expectation that this strategy would induce practice change as this was *more likely to happen via commercialisation activities (whether via consultants, resellers, agronomists or other sectors of the agribusiness community) which focus on one on one interaction between growers and their agribusiness advisors.*

A small survey conducted in 21 February 2006 by the project team found that *agribusiness people find the newsletter of value and that it is an important tool for supporting the commercialisation process of the project.* Suggested improvements were including grower case studies and testimonials. Growers' response was less clear to the survey as a smaller number were interviewed. Fifty percent of growers read the newsletter and found some value and the rest *either do not remember reading the newsletter or do not receive it as someone else in the business/household deals with this type of information.*

The needs analysis completed in 2005 of North Queensland and Bundaberg respondents for the WFT project showed that emails were the most preferred way to receive information for **agribusiness** (which was not significantly different from this survey). It also showed that **growers** mostly preferred fax and mail (compared to this survey the desire for fax has significantly dropped and post has increased, while emails has stayed the same).

In this 2008 survey, **Agribusiness respondents** preferred to receive the colour newsletters and leaflets (56.7%) as well as notifications about seminars and workshops (76.7%) via email. For colour newsletters and leaflets this result did not differ significantly from the 2005 WFT needs analysis results, however there was a change in preference away from fax to email for how agribusiness preferred to be notified about seminars and workshops.

Grower respondents however, continued to prefer post for both these sources of information (68.0% colour newsletter and leaflets, 42.0% notification of seminars and workshops). Receiving colour newsletters and leaflets by post had not significantly changed from the 2005 WFT needs analysis. The preference for receiving notification about seminars and workshops also changed significantly with a decreased preference for fax (75% to 28%) over mail (6% to 42%) and preference for emails being similar. There was some variation between locations with more North Queensland growers preferring fax.

The Western Flower Thrips Updates newsletter had a high penetration level in the industry and was rated as moderately useful. Agribusiness continued (from 2006) to value and utilise the information from the newsletter in their commercial activities with growers. Agribusinesses prefer e-mail as an information distribution mechanism and growers generally preferred post.

Pest and disease management seminars and meetings

Over three-quarters (78.8%) of the respondents (relevant of WFT project) were aware of the pest and disease management seminars and meetings run by DPI&F. Of these nearly three-quarters (74.6%) had attended at least one of seminars and meetings and overall rated them as moderately useful with an average rating of 6.2 out of 10.

There was a high level of awareness and participation of the pest and disease management seminars by growers affected by WFT with a little over half of respondents having attended one or more meeting. They clearly play an important role in information sharing and skill development.

Levels of Awareness of Strategies – Agribusiness and growers

Three-spray strategy

The 3-spray strategy is about making sure all stages of the WFT lifecycle are exposed to a chemical to get effective control and minimise resistance problems. The strategy includes elements of:

- Apply three sprays of the same chemical at set intervals to get all life stages of the pest
- Use interval of three days in warm weather and six days in cool weather
- Use interval of three days in warm weather (above 20 C) and six days in cool weather (below 20 C)
- If another series of sprays is needed, try to alternate to a different chemical group
- Takes into consideration time it takes for pest to complete its lifecycle at different temperatures
- Sprays are only useful against adults and larvae
- First spray for existing larvae and adults, second spray for adults hatched from pupae and larvae hatched from eggs; third is a clean up spray for any remaining larvae and adults

Overall 57% of the agribusiness and grower respondents said that they were aware of the 3-spray insecticide strategy for western flower thrips. Elements of the strategy described by respondents included:

- 'Apply three sprays of the same chemical at set intervals to get all life stages of the pest' with 48.1% of the respondents mentioning it in that manner;
- 'Use interval of three days in warm weather and six days in cool weather' (22.2%);
- 'If another series of sprays is needed, try to alternate to a different chemical group' (22.2%);
- 'Use interval of three days in warm weather (above 20 C) and six days in cool weather (below 20 C)' (18.5%);
- 'Takes into consideration time it takes for pest to complete its lifecycle at different temperatures' (7.4%); and
- 'First spray for existing larvae and adults, second spray for adults hatched from pupae and larvae hatched from eggs; third is a clean up spray for any remaining larvae and adults' (7.4%).

Overall management

The top three descriptions (unprompted) given by respondents for what they saw as most important for keeping western flower thrips at low levels, were: 'Good farm hygiene' (96.3%); 'Monitor/check crops on a regular basis' (92.6%); and 'Spray with insecticide' (66.7%). Just over 56.5% of agribusiness respondents that said they were aware of the broadleaf weeds that harbour western flower thrips.

There was a high level of awareness and understanding of the 3-spray strategy amongst growers and Agribusiness. Good farm hygiene and crop monitoring were seen by almost all respondents as most important in controlling WFT. Just over half of respondents were aware of the broadleaf weeds that harboured WFT.

Levels of Adoption of Practices

Main changes

Approximately forty percent (40.7%) of agribusiness and grower respondents have changed the way they recommend or manage western flower thrips, with 40.7% said that they monitor crops for WFT levels, 29.6% use a 3-spray strategy on detection of WFT and one quarter (25.9%) of respondents reduce insecticide resistance by rotating insecticides.

Causes of change

Both agribusiness and grower respondents on average rated their own research / information seeking / trials (agribusiness 8.1, growers 8.3) and experience (agribusiness 8.1, growers 8.3) as the top two factors prompting change in practices for WFT. Agribusiness respondents next rated information about WFT that arrived on the farm from DPI&F (8.1) and discussions with crop consultants (7.9) and growers next rated Pest and Disease Seminars (7.8) and discussions with crop consultants (7.4) as prompters of change.

Thirty percent of enterprises now use a 3-spray strategy on detection of WFT with 40% now monitoring for WFT and a quarter rotating chemicals to reduce resistance. 60% have not made a change in the way they recommend or manage WFT in the last few years.

It is clear that personal experience and observation are major factors in prompting change by both Agribusiness and growers. DPI&F provide a major stimulation via their information provision to Agribusiness and through the pest and disease seminars for growers.

Recommendations

1. The high level of awareness of the WFT project and its key messages with its impact on practice change is significant and should be acknowledged.

2. There is further work to be done to increase the uptake of the 3-spray strategy by Agribusiness and growers from that gains that have already been made.

3. The approach that DPI&F has taken to target Agribusiness and commercialization as an industry adoption strategy is working and should be continued.

4. Newsletters are highly regarded and should be continued as an extension mechanism with agribusiness receiving them by e-mail and growers by post.

5. Pest and Disease workshops do play an important role and should be continued – with an emphasis on linking to local successful examples.

6. The high reliance on personal experience and observation by both Agribusiness and growers highlight the importance of field demonstrations/trials and providing local case studies for growers to gain confidence in the newer approaches.

Appendix. Questionnaires for Agribusiness Contact and Vegetable Growers.

Questionnaire for Agribusiness

Western Flower Thrips (WFT) and Silverleaf Whitefly (SLW) projects

April 2008

Introduction

The current Western Flower Thrips (WFT) and Silverleaf Whitefly (SLW) projects have been run by the DPI&F since 2005 and are due to finish in November this year.

You may have read in a leaflet sent by the Department of Primary Industries and Fisheries that a survey is being conducted to evaluate these two projects. You have been randomly chosen to participate in this survey and we would really value your feedback in determining the level of success of these projects and what future/additional work is needed. Your comments will remain anonymous and be collated with those from other participants of the survey.

The survey should take around 25-30 minutes to complete.

Background

1. Name (optional) : _____
   a. Sampling Code: _____

2. Organisation: _____

3. What region do you work in {re-confirm against sampling list information}?

☐ North Queensland (Burdekin including Clare, Giru, Ayr)
☐ North Queensland (Bowen)
☐ North Queensland (Gumlu)
☐ North Queensland (Mareeba including Tableland)
☐ Bundaberg (including Childers and Gin Gin)
☐ Lockyer Valley
☐ Other (please specify): _____

4. What crops do you work in? (Tick all applicable.)

☐ Doesn't wish to OR can't provide these details (Thank interviewee and go to next person on list)

Crop	Section to complete	Crop	Section to complete
☐ Green beans	SLW	☐ Capsicum	WFT
☐ Brassicas (please specify): _____	SLW	☐ Chillis	WFT
☐ Button squash	SLW	☐ Lettuce	WFT
☐ Cucumber	SLW		
☐ Melons	SLW	☐ Eggplant	Both
☐ Pumpkin	SLW	☐ Tomato	Both
☐ Sweet potato	SLW		
☐ Zucchini	SLW	☐ Sweet corn	None
☐ Other (please specify): _____		☐ Other (please specify): _____	

5. Do you work with any of these crops in greenhouses?
   ☐ Yes (please specify) _____ ☐ No

6. Is Western flower thrips an issue for the crops you deal with in your work?
   ☐ Yes ☐ No ☐ Unsure ☐ Sometimes?

7. Is Silverleaf whitefly an issue for the crops you deal with in your work?
   ☐ Yes ☐ No ☐ Unsure ☐ Sometimes?

General

8. Where do you mostly get useful information about managing pests and diseases? [Identify information sources from respondent unprompted and rate, then rate remainder of the options] Rate out of 10 where: 0 = not very important; 5= moderately important; 10= extremely important

Unprompted

- ☐ ___ / 10 Bowen Crop Monitoring Services
- ☐ ___ / 10 Crop Tech (now T Systems) at Bundaberg
- ☐ ___ / 10 Other crop consultants (specify if applicable) _____
- ☐ ___ / 10 Chemical companies eg. Syngenta, Bayer (specify if applicable) _____
- ☐ ___ / 10 Resellers/Distributors eg Landmark, Elders etc (specify if applicable)
- ☐ ___ / 10 DPI&F officers
- ☐ ___ / 10 Newsletters/leaflets (eg updates)
- ☐ ___ / 10 Websites/internet
- ☐ ___ / 10 Industry publications (eg Fruit&Vegetable news, Good Fruit&Vegetables)
- ☐ ___ / 10 Seminars/ meetings/ field days / farm walks
- ☐ ___ / 10 Own experience
- ☐ ___ / 10 (Other) growers/ peers
- ☐ ___ / 10 Other (please specify): _____

9. How do you prefer to receive **colour** newsletters and leaflets? [Unprompted - tick one option.]
   - ☐ Don't want newsletters / updates
   - ☐ Post
   - ☐ Fax
   - ☐ E-mails
   - ☐ Other (please specify): _____

10. How do you prefer to be **notified** about seminars and workshops? [Unprompted - tick one option.]
    - ☐ Don't want to be notified
    - ☐ Post
    - ☐ Fax
    - ☐ E-mails
    - ☐ Other (please specify): _____

11. Are you aware of the Pest and Disease Management seminars and meetings run by the DPI&F for vegetable crops? Prompt: Bundaberg, Bowen, Gumlu & Ayr - these seminars included sessions on WFT and SLW; Lockyer Valley – these include workshops and shed meetings on SLW

    ☐ No ☐ Unsure ☐ Yes (proceed to a)

    a. If yes (were aware), did you attend any of these seminars over the last 3 years? If yes how many?

    ☐ 0 - No (proceed to d) Number of seminars: _____ (proceed to b)

    b. If you attended one or more of these seminars, please give an overall rating of their usefulness to you and your business?

    ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10

    Not useful Moderately useful Extremely useful

    c. Any comment on your answer?

    d. If no, (were aware but did not attend) any comments on your decision/reasons?

12. {Only complete if from Farm or Seedling Nursery}. Do you employ a consultant? If so, who? (Tick as many as appropriate.)
    - ☐ Don't employ a consultant (proceed to a)
    - ☐ Bowen Crop Monitoring Services
    - ☐ Crop Tech (= T Systems) at Bundaberg
    - ☐ Other crop consultant (specify if applicable) _____
    - ☐ In-house agronomist
    - ☐ Other (specify) _____

    a. If no (don't employ a consultant), do you get anyone else to check crops for pests and diseases on a regular basis?
    - ☐ No
    - ☐ Reseller (specify if applicable) _____
    - ☐ Staff member
    - ☐ In house agronomist
    - ☐ Family member
    - ☐ Grower themselves
    - ☐ Other (specify if applicable) _____

Western Flower Thrips (WFT)

This WFT section is only to be completed if relevant crops are indicated in question 3, and are from Bundaberg, Bowen, Burdekin or Gumlu regions.

WFT Activities and Reactions

13. Are you aware of the Western Flower Thrips project run by the DPI&F? Yes / No

14. Have you seen the newsletters for the project, the Western Flower Thrips Updates? Yes / No
    a. If yes, how do you rate them in terms of useful and relevant information?

    ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10

    Not useful/relevant Very useful/relevant

    b. Comments:

    c. If yes, what happens to the Updates after you have read them? (Tick as many as applicable - unprompted)
    - ☐ No idea
    - ☐ Thrown away
    - ☐ Filed away
    - ☐ Put on display
    - ☐ Sent on to colleagues
    - ☐ Refer to them regularly
    - ☐ Take them out with me to growers ie. Used as a business tool
    - ☐ Other (please specify) _____

KASA (Knowledge, Attitudes, Skills, Aspirations) and Practice Change

15. Are you aware of the 3-spray insecticide strategy for Western flower thrips? [If need further prompting: 'It about making sure all stages of the WFT lifecycle are exposed to a chemical to get effective control and minimise resistance problems)

    ☐ Yes (go to a) ☐ No ☐ Unsure

    a. If you recommend or apply this strategy, could you describe what you do? (Unprompted – tick relevant responses)?

    - ☐ Apply three sprays of the same chemical at set intervals to get all life stages of the pest
    - ☐ Use interval of three days in warm weather and six days in cool weather
    - ☐ Use interval of three days in warm weather (above 20 C) and six days in cool weather (below 20 C)
    - ☐ If another series of sprays is needed, try to alternate to a different chemical group
    - ☐ Takes into consideration time it takes for pest to complete its lifecycle at different temperatures
    - ☐ Sprays are only useful against adults and larvae
    - ☐ First spray for existing larvae and adults, second spray for adults hatched from pupae and larvae hatched from eggs; third is a clean up spray for any remaining larvae and adults
    - ☐ Other _____

Comments:

16. What do you see as most important for keeping Western flower thrips at low levels? [Unpromted]

- ☐ Spray with insecticide
- ☐ Monitor/check crops on a regular basis
- ☐ Know which thrips is in crop/have it identified
- ☐ Control WFT early
- ☐ Spray insecticides at the right time
- ☐ Choose the right insecticide for the situation
- ☐ Good farm hygiene
- ☐ Destroy old crops as soon as possible -getting rid off/slash off/chop in crop straight after harvest
- ☐ Spraying infested crops with high volume oil/DCtron before pulling down/slashing off crop/chopping in crop
- ☐ Controlling weeds around the farm/along river/fence lines/paddocks
- ☐ Controlling broadleaf weeds (and volunteer crops) around the farm
- ☐ Planting strategically (no new crops next to old crops)
- ☐ Planting strategically (new crop upwind of old crops)
- ☐ Planting strategically (avoiding hot spots during especially in spring)
- ☐ Other/comments:

17. Are you aware of the main broadleaf weeds that harbour Western flower thrips?

☐ Yes (proceed to a) ☐ No ☐ unsure

a. Which weeds do you think are the most important? (unprompted)

☐ Can't remember right now

For Bowen/Gumlu/Ayr:

☐ blue butterfly pea ☐ rubbervine ☐ abutilon ☐ stinking passionflower

For Bundaberg:

☐ wild radish, ☐ green amaranth ☐ Shepherds purse ☐ (common) morning glory,

☐ (common) sensitive plant

☐ Other (please specify):_____

Practice Change and End Result

18. Rate the amount of damage to crops you deal with from Western Flower Thrips compared to several years ago?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10

Much more damage Same amount of damage A lot less damage

a. Could you describe the damage that Western flower thrips cause in your crop? [Unprompted, tick as many as appropriate.]

- ☐ No significant damage
- ☐ Reduced yields
- ☐ Loss of quality
- ☐ Scarring
- ☐ Silvering
- ☐ Virus - Tomato spotted wilt virus TSWV
- ☐ Other (please specify) _____

Comments:

19. How have you changed the way you recommend or manage WFT over the last few years? [Unprompted, tick as many as appropriate.]

- ☐ Haven't changed
- ☐ Monitor crops for WFT levels

If monitor crop for WFT levels, how do you get the thrips identified?

- ☐ 3-spray strategy on detection of WFT
- ☐ Plant strategically: don't plant new crops next to old crops
- ☐ Plant strategically: plant new crops up wind of older crops/problem areas
- ☐ Plant strategically: be aware of hot spots around farm and avoid during spring and problem times
- ☐ Good farm hygiene: Slash / destroy old crops as soon as possible
- ☐ Good farm hygiene: Control broadleaf weeds around the farm
- ☐ Reduce insecticide resistance by rotating insecticides
- ☐ Maintain and calibrate spray equipment so it gives best coverage possible

☐ Other / Comments:

20. If you changed one or more practices, how important were the following factors in prompting or convincing you of this change? (Go through each item. Importance on a scale of 0-10 where 0=had no influence, 10=the main reason I changed)

___/10 Pest and Disease Seminar attended
___/10 Information about WFT that arrived on the farm from DPI&F
___/10 GUMLU only - Information about WFT that arrived on the farm from Bowen Crop Monitoring Services that included a map on thrips densities in Gumlu
___/10 Discussions with crop consultants
___/10 Discussions with reseller/company rep
___/10 Direct contact with DPI&F
___/10 Discussions with other growers
___/10 Own research/information seeking/trials
___/10 Experience
___/10 Other (please specify): _____

Silverleaf Whitefly (SLW)

This SLW section is only to be completed if relevant crops are indicated in question 3.

SLW Activities and Reactions

21. Are you aware of the Silverleaf Whitefly project run by the DPI&F? Yes / No

22. Have you seen the newsletters for the project, the SLW Updates?
☐ Yes (proceed to a) ☐ No ☐ unsure

a. If yes, how do you rate them in terms of useful and relevant information?
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10
Not useful/relevant Very useful/relevant

b. Comments:

c. If yes, what happens to the Updates after you have read them? (Tick as many as applicable)
☐ No idea
☐ Thrown away
☐ Filed away
☐ Put on display
☐ Sent on to colleagues
☐ Refer to them regularly
☐ Take them out with me to growers ie. Used as a business tool
☐ Other (please specify) _____

23. There is also a Silverleaf Whitefly website. Have you visited this website? If yes, how often?
☐ Never
☐ Once or twice (proceed to a)
☐ 2 to 5 times (proceed to a)
☐ More than 5 times (proceed to a)

a. If visited website, how do you rate the website for usefulness and relevance in finding information to control silverleaf whitefly?
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10
Not useful/relevant Very useful/relevant

b. Comments:

KASA

24. What do you see as the most important strategy for slowing the movement of Silverleaf whitefly from one crop to the next? [Unprompted, tick as many as appropriate.]

- ☐ Spray with insecticide
- ☐ Monitor/check crops on a regular basis
- ☐ Spray insecticides before SLW reaches high levels
- ☐ Getting rid off/slash off/chop in crop straight after harvest
- ☐ Spraying infested crops (insecticide mixture or petroleum oil high volume), then slashing off crop a few days later (the clean up strategy)
- ☐ Controlling weeds around the farm
- ☐ Planting strategically (don't plant new crops next to old crops)
- ☐ Planting strategically (plant new crops upwind of old crops/problem areas)
- ☐ Planting strategically (be aware of hot spots around farm and avoid during spring and problem times)
- ☐ Other/comments:

25. Are you aware of the Silverleaf whitefly clean up strategy? [Prompt: It is used to reduce migration of SLW from old crops into younger crops.]

☐Yes (go to a) ☐ No ☐ Unsure

a. If you use the strategy, could you describe what you do? (Unpromted – tick as many as appropriate)

- ☐ Spraying out old crop with insecticide
- ☐ Spraying off harvested crop with quick action herbicide (eg Sprayseed)
- ☐ Getting rid off/slashing off/ ploughing or discing in crop straight after harvest
- ☐ Spraying and cleaning up old crops straight after harvest
- ☐ Spraying crops (insecticide mixture or oil high volume), then slashing off/pulling down crop few days later
- ☐ No SLW - slash in crop after harvest;
- ☐ low SLW - spray with high volume oil then pull down/slash/ disc in crop 2 to 3 days later;
- ☐ high SLW spray with high volume SP/ OP mixture (Talstar / Chlorpyrifos mixture) then pull down/slash/ disc in crop 2 to 3 days later
- ☐ Other: _____

Comments:

26. Which insecticide was most important to you for controlling Silverleaf whitefly last season? [Unprompted, tick as many as appropriate.]

- ☐ Unsure
- ☐ Applaud (buprofezin) – how many sprays per crop?
- ☐ Admiral (pyriproxyfen)– how many sprays per crop?
- ☐ Confidor (imidacloprid) - (foliar)
- ☐ Confidor (on soil) with trickle
- ☐ Confidor (on soil) in furrow
- ☐ Confidor (on soil) in plant hole drench
- ☐ Chess (pymetrozine) – how many sprays per crop? (put answer in comments)
- ☐ DCtron or other oil
- ☐ Talstar / Synergy mixture
- ☐ Other/comments

a. Is this a change from the year before (2006)? Yes/No
b. Please comment:

27. Are you aware of the insecticide resistance management strategy for Silverleaf whitefly in your district? [Prompt: It is the area wide window strategy DPI&F have promoted over the last five years
    Yes (go to a) No Unsure

    a. If you use the strategy, could you describe what you do or recommend? (unprompted – tick as many as appropriate)

Rotate chemicals according to the windows
Using only chemicals allowed at different times of the season
Only spraying Applaud/Admiral/IGR once or twice per crop
Treating Admiral and Applaud as the same chemical (in same chemical group)
Only using Confidor in the later part of the season (NQ winter/spring; SE summer/autumn)
Using DCtron or other oils for low SLW infestations
Avoiding broad spectrum insecticides (to protect beneficials)
Use non-chemical/ integrated pest management strategies (please specify):

Other/comments

28. What issues might prevent you from using the Resistance Management Strategy? [Unprompted, tick as many as appropriate.]

Don't know anything about it
Don't know enough about it
Too time consuming
Too restrictive
Too expensive
Don't think it works
Not flexible enough
Nothing
Other (please specify): _____

Any comments:

29. Have you heard or are you aware of a program to release parasitic wasps/parasitoids that attack Silverleaf whitefly in your district? [*Eretmocerus hayati* in case someone asks.]
    Yes (proceed to a) No (proceed to c) Unsure (proceed to c)

    a. If yes, how would you or recommend to protect or preserve them? [Unprompted, tick as many as appropriate.]
        - Don't do anything in particular
        - Accepting a low level of damage in crops (beneficials need something to feed/breed upon – also reduces amount of chemical going into the system)
        - By only spraying at-risk plantings rather than the whole crop (economic damage)
        - Avoiding use of broadspectrum/toxic chemicals eg. Nitofol, Folidol, Lannate/Nudrin, Talstar, Confidor foliar
        - Plant a small "refugee area" for them to breed and disperse within the farm
        - Other (please specify):_____

    b. Comments?

Practice Change and End Result

30. Rate the amount of damage to crops your deal with from Silverleaf Whitefly compared to 3 years ago?

0	1	2	3	4	5	6	7	8	9	10
Much more damage					Same amount of damage					A lot less damage

    a. Comments (including comments on damage differences between crops):

31. How have you changed the way you manage or recommend to manage Silverleaf Whitefly over the last few years? [Unprompted, tick as many as appropriate.]

☐ Nothing
☐ Monitor crops for SLW levels/employ a consultant to do this for me
☐ Preserve/protect parasitoids/natural enemies/beneficials
☐ Use softer chemicals to protect parasitoids
☐ Injecting or drenching Confidor at planting (as preventive approach)
☐ Planting Confidor treated seedlings (specially for LV Brassicas)

☐ Reducing OP insecticide use in the crops
☐ Clean up strategy: spray out infested crop before slashing a couple of days later
☐ Good farm hygiene: Slash / destroy old crops as soon as possible
☐ Good farm hygiene: Control weeds around the farm
☐ Planting strategically (don't plant new crops next to old crops)
☐ Planting strategically (plant new crops upwind of old crops/problem areas)
☐ Planting strategically (be aware of hot spots around farm and avoid during problem times)
☐ Use resistance management strategy for district/follow guidelines for insecticides
☐ Reduce insecticide resistance by rotating insecticides
☐ Use oils for low pest levels/ reduce insecticide use
☐ Other / Comments:

32. If you changed one or more practices, how important were the following factors in prompting or informing this change? (Go through each item. Importance on a scale of 0-10 where 0=had no influence, 10=the main reason I changed)

___/10 Pest and Disease Seminar attended
___/10 Information about SLW that arrived on the farm from DPI& F
___/10 Discussions with crop consultants
___/10 Discussions with reseller/company rep
___/10 Direct contact with DPI&F
___/10 Discussions with other growers
___/10 Own research/information seeking
___/10 Years of experience
___/10 Other (please specify): _____

Questionnaire for Growers

Western Flower Thrips (WFT) and Silverleaf Whitefly (SLW) projects

April 2008

Introduction

The current Western Flower Thrips (WFT) and Silverleaf Whitefly (SLW) projects have been run by the DPI&F since 2005 and are due to finish in November this year.

You may have read in a leaflet sent by the Department of Primary Industries and Fisheries that a survey is being conducted to evaluate these two projects. You have been randomly chosen to participate in this survey and we would really value your feedback in determining the level of success of these projects and what future/additional work is needed. Your comments will remain anonymous and be collated with those from other participants of the survey.

The survey should take around 25-30 minutes to complete.

Background

33. Name (optional) : _____
    a. Sampling Code: _____

34. What region are you in {re-confirm against sampling list information}?

☐ North Queensland (Burdekin including Clare, Giru, Ayr)
☐ North Queensland (Bowen)
☐ North Queensland (Gumlu)
☐ North Queensland (Mareeba including Tableland)
☐ Bundaberg (including Childers and Gin Gin)
☐ Lockyer Valley
☐ Other (please specify): _____

35. What crops do you grow? Clarify that we are asking about last season and this coming season. (Tick all applicable.)

☐ Doesn't wish to OR can't provide these details (Thank interviewee and go to next person on list)

Crop	Section to complete	Crop	Section to complete
☐ Green beans	SLW	☐ Capsicum	WFT
☐ Brassicas (please specify): _____	SLW	☐ Chillis	WFT
☐ Button squash	SLW	☐ Lettuce	WFT
☐ Cucumber	SLW		
☐ Melons	SLW	☐ Eggplant	Both
☐ Pumpkin	SLW	☐ Tomato	Both
☐ Sweet potato	SLW		
☐ Zucchini	SLW	☐ Sweet corn	None
☐ Other (please specify): _____		☐ Other (please specify): _____	

36. How many hectares of vegetables do you grow per year/did you grow last season? _____ha

☐ Doesn't wish to OR can't provide these details

37. Do you grow any of these crops in greenhouses?
    ☐ Yes (please specify) _____ ☐ No

38. Is Western flower thrips an issue for the crops you grow?
    ☐ Yes ☐ No ☐ Unsure ☐ Sometimes?

39. Is Silverleaf whitefly an issue for the crops you grow?
    ☐ Yes ☐ No ☐ Unsure ☐ Sometimes?

General

40. Where do you mostly get useful information about managing pests and diseases? Rate out of 10 where: 0 = not very important; 5= moderately important; 10= extremely important. [Identify information sources from respondent unprompted and rate.]

___ / 10 Bowen Crop Monitoring Services
___ / 10 Crop Tech (now T Systems) at Bundaberg
___ / 10 Other crop consultants (specify if applicable) _____
___ / 10 Chemical companies eg. Syngenta, Bayer (specify if applicable) _____
___ / 10 Resellers/Distributors eg Landmark, Elders etc (specify if applicable)
___ / 10 DPI&F officers
___ / 10 Newsletters/leaflets (eg updates)
___ / 10 Websites/internet
___ / 10 Industry publications (eg Fruit&Vegetable news, Good Fruit&Vegetables)
___ / 10 Seminars/ meetings/ field days / farm walks
___ / 10 Own experience
___ / 10 (Other) growers/ peers
___ / 10 Other (please specify): _____

41. How do you prefer to receive **colour** newsletters and leaflets? [Unprompted - tick one option.]
☐ Don't want newsletters / updates
☐ Post
☐ Fax
☐ E-mails
☐ Other (please specify): _____

42. How do you prefer to be **notified** about seminars and workshops? [Unprompted - tick one option.]
☐ Don't want to be notified
☐ Post
☐ Fax
☐ E-mails
☐ Other (please specify): _____

43. Are you aware of the Pest and Disease Management seminars and meetings run by the DPI&F for vegetable crops? Prompt: Bundaberg, Bowen, Gumlu & Ayr - these seminars included sessions on WFT and SLW; Lockyer Valley – these include workshops and shed meetings on SLW
☐ No ☐ Unsure ☐ Yes (proceed to a)

a. If yes (were aware), did you attend any of these seminars over the last 3 years? If yes how many?
☐ 0 - No (proceed to d) Number of seminars: _____ (proceed to b)

b. If you attended one or more of these seminars, please give an overall rating of their usefulness to you and your business?

☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	5	☐ 6	☐ 7	☐ 8	☐ 9	10
Not useful					Moderately useful					Extremely useful

c. Any comment on your answer?

d. If no, (were aware but did not attend) any comments on your decision/reasons?

44. Do you employ a consultant? If so, who? (Tick as many as appropriate.)
    - ☐ Don't employ a consultant (proceed to a)
    - ☐ Bowen Crop Monitoring Services
    - ☐ Crop Tech (= T Systems) at Bundaberg
    - ☐ Other crop consultant (specify if applicable) _____
    - ☐ In-house agronomist
    - ☐ Other (specify) _____

    b. If no (don't employ a consultant), do you get anyone else to check crops for pests and diseases on a regular basis?
    - ☐ No
    - ☐ Reseller (specify if applicable) _____
    - ☐ Staff member
    - ☐ In house agronomist
    - ☐ Family member
    - ☐ Grower themselves
    - ☐ Other (specify if applicable) _____

Western Flower Thrips (WFT)

This WFT section is only to be completed if relevant crops are indicated in question 3, and are from Bundaberg, Bowen, Burdekin or Gumlu regions.

WFT Activities and Reactions

45. Are you aware of the Western Flower Thrips project run by the DPI&F? Yes / No

46. Have you seen the newsletters for the project, the Western Flower Thrips Updates? Yes / No
    a. If yes, how do you rate them in terms of useful and relevant information?

    ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10

    Not useful/relevant Very useful/relevant

    b. Comments:

KASA (Knowledge, Attitudes, Skills, Aspirations) and Practice Change

47. Are you aware of the 3-spray insecticide strategy for Western flower thrips? [If need further prompting: 'It about making sure all stages of the WFT lifecycle are exposed to a chemical to get effective control and minimise resistance problems)

    ☐ Yes (go to a) ☐ No ☐ Unsure

    a. If you use this strategy, could you describe what you do? (Unprompted – tick relevant responses)?

    - ☐ Apply three sprays of the same chemical at set intervals to get all life stages of the pest
    - ☐ Use interval of three days in warm weather and six days in cool weather
    - ☐ Use interval of three days in warm weather (above 20 C) and six days in cool weather (below 20 C)
    - ☐ If another series of sprays is needed, try to alternate to a different chemical group
    - ☐ Takes into consideration time it takes for pest to complete its lifecycle at different temperatures
    - ☐ Sprays are only useful against adults and larvae
    - ☐ First spray for existing larvae and adults, second spray for adults hatched from pupae and larvae hatched from eggs; third is a clean up spray for any remaining larvae and adults
    - ☐ Other _____

    Comments:

48. What do you see as most important for keeping Western flower thrips at low levels on your farm? [Unpromted]

- ☐ Spray with insecticide
- ☐ Monitor/check crops on a regular basis
- ☐ Know which thrips is in crop/have it identified
- ☐ Control WFT early
- ☐ Spray insecticides at the right time
- ☐ Choose the right insecticide for the situation
- ☐ Good farm hygiene
- ☐ Destroy old crops as soon as possible -getting rid off/slash off/chop in crop straight after harvest
- ☐ Spraying infested crops with high volume oil/DCtron before pulling down/slashing off crop/chopping in crop
- ☐ Controlling weeds around the farm/along river/fence lines/paddocks
- ☐ Controlling broadleaf weeds (and volunteer crops) around the farm
- ☐ Planting strategically (no new crops next to old crops)
- ☐ Planting strategically (new crop upwind of old crops)
- ☐ Planting strategically (avoiding hot spots during especially in spring)
- ☐ Other/comments:

Practice Change and End Result

49. Rate the amount of damage to your crops from Western Flower Thrips compared to several years ago?

☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	5	☐ 6	☐ 7	☐ 8	☐ 9	10
Much more damage					Same amount of damage					A lot less damage

a. Could you describe the damage that Western flower thrips cause in your crop? [Unprompted, tick as many as appropriate.]

- ☐ No significant damage
- ☐ Reduced yields
- ☐ Loss of quality
- ☐ Scarring
- ☐ Silvering
- ☐ Virus - Tomato spotted wilt virus TSWV
- ☐ Other (please specify) _____

Comments:

50. How have you changed the way you manage WFT over the last few years? [Unprompted, tick as many as appropriate.]

- ☐ Haven't changed
- ☐ Monitor crops for WFT levels

If monitor crop for WFT levels, how do you get the thrips identified?
_____

- ☐ 3-spray strategy on detection of WFT
- ☐ Plant strategically: don't plant new crops next to old crops
- ☐ Plant strategically: plant new crops up wind of older crops/problem areas
- ☐ Plant strategically: be aware of hot spots around farm and avoid during spring and problem times
- ☐ Good farm hygiene: Slash / destroy old crops as soon as possible
- ☐ Good farm hygiene: Control broadleaf weeds around the farm
- ☐ Reduce insecticide resistance by rotating insecticides
- ☐ Maintain and calibrate spray equipment so it gives best coverage possible
- ☐ Other / Comments:

51. If you changed one or more practices, how important were the following factors in prompting or convincing you of this change? (Go through each item. Importance on a scale of 0-10 where 0=had no influence, 10=the main reason I changed)

___/10 Pest and Disease Seminar attended
___/10 Information about WFT that arrived on the farm from DPI&F
___/10 GUMLU only - Information about WFT that arrived on the farm from Bowen Crop Monitoring Services that included a map on thrips densities in Gumlu
___/10 Discussions with crop consultants
___/10 Discussions with reseller/company rep
___/10 Direct contact with DPI&F
___/10 Discussions with other growers
___/10 Own research/information seeking/trials
___/10 Experience
___/10 Other (please specify): _____

Silverleaf Whitefly (SLW)

This SLW section is only to be completed if relevant crops are indicated in question 3.

SLW Activities and Reactions

52. Are you aware of the Silverleaf Whitefly project run by the DPI&F? Yes / No

53. Have you seen the newsletters for the project, the SLW Updates?
☐ Yes (proceed to a) ☐ No ☐ unsure

a. If yes, how do you rate them in terms of useful and relevant information?
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10
Not useful/relevant Very useful/relevant

b. Comments:

54. There is also a Silverleaf Whitefly website. Have you visited this website? If yes, how often?
☐ Never
☐ Once or twice (proceed to a)
☐ 2 to 5 times (proceed to a)
☐ More than 5 times (proceed to a)

a. If visited website, how do you rate the website for usefulness and relevance in finding information to control silverleaf whitefly?
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10
Not useful/relevant Very useful/relevant

b. Comments:

KASA

55. What do you see as the most important strategy for slowing the movement of Silverleaf whitefly from one crop to the next? [Unprompted, tick as many as appropriate.]

☐ Spray with insecticide
☐ Monitor/check crops on a regular basis
☐ Spray insecticides before SLW reaches high levels
☐ Getting rid off/slash off/chop in crop straight after harvest
☐ Spraying infested crops (insecticide mixture or petroleum oil high volume), then slashing off crop a few days later (the clean up strategy)
☐ Controlling weeds around the farm
☐ Planting strategically (don't plant new crops next to old crops)
☐ Planting strategically (plant new crops upwind of old crops/problem areas)
☐ Planting strategically (be aware of hot spots around farm and avoid during spring and problem times)
☐ Other/comments:

56. Are you aware of the Silverleaf whitefly clean up strategy? [Prompt: It is used to reduce migration of SLW from old crops into younger crops.]
    Yes (go to a) No Unsure

    a. If you use the strategy, could you describe what you do? (Unpromted – tick as many as appropriate)

Spraying out old crop with insecticide
Spraying off harvested crop with quick action herbicide (eg Sprayseed)
Getting rid off/slashing off/ ploughing or discing in crop straight after harvest
Spraying and cleaning up old crops straight after harvest
Spraying crops (insecticide mixture or oil high volume), then slashing off/pulling down crop few days later
No SLW - slash in crop after harvest;
low SLW - spray with high volume oil then pull down/slash/ disc in crop 2 to 3 days later;
high SLW - spray with high volume SP/ OP mixture (Talstar / Chlorpyrifos mixture) then pull down/slash/ disc in crop 2 to 3 days later
Other: _____
Comments:

57. Which insecticide was most important to you for controlling Silverleaf whitefly last season? [Unprompted, tick as many as appropriate.]
    Unsure
    Applaud (buprofezin) – how many sprays per crop?
    Admiral (pyriproxyfen)– how many sprays per crop?
    Confidor (imidacloprid) - (foliar)
    Confidor (on soil) with trickle
    Confidor (on soil) in furrow
    Confidor (on soil) in plant hole drench
    Chess (pymetrozine) – how many sprays per crop? (put answer in comments)
    DCtron or other oil
    Talstar / Synergy mixture
    Other/comments

    a. Is this a change from the year before (2006)? Yes/No
    b. Please comment:

58. Are you aware of the insecticide resistance management strategy for Silverleaf whitefly in your district? [Prompt: It is the area wide window strategy DPI&F have promoted over the last five years
    Yes (go to a) No Unsure

    a. If you use the strategy, could you describe what you do? (unprompted – tick as many as appropriate)

Rotate chemicals according to the windows
Using only chemicals allowed at different times of the season
Only spraying Applaud/Admiral/IGR once or twice per crop
Treating Admiral and Applaud as the same chemical (in same chemical group)
Only using Confidor in the later part of the season (NQ winter/spring; SE summer/autumn)
Using DCtron or other oils for low SLW infestations
Avoiding broad spectrum insecticides (to protect beneficials)
Use non-chemical/ integrated pest management strategies (please specify):

Other/comments

59. What issues might prevent you from using the Resistance Management Strategy? [Unprompted, tick as many as appropriate.]

☐ Don't know anything about it
☐ Don't know enough about it
☐ Too time consuming
☐ Too restrictive
☐ Too expensive
☐ Don't think it works
☐ Not flexible enough
☐ Nothing
☐ Other (please specify): _____

Any comments:

60. Have you heard or are you aware of a program to release parasitic wasps/parasitoids that attack Silverleaf whitefly in your district? [*Eretmocerus hayati* in case someone asks.]

☐ Yes (proceed to a) ☐ No (proceed to c) ☐ Unsure (proceed to c)

a. If yes, how would you / do you protect or preserve them? [Unprompted, tick as many as appropriate.]
   - ☐ Don't do anything in particular
   - ☐ Accepting a low level of damage in crops (beneficials need something to feed/breed upon – also reduces amount of chemical going into the system)
   - ☐ By only spraying at-risk plantings rather than the whole crop (economic damage)
   - ☐ Avoiding use of broadspectrum/toxic chemicals eg. Nitofol, Folidol, Lannate/Nudrin, Talstar, Confidor foliar
   - ☐ Plant a small "refugee area" for them to breed and disperse within the farm
   - ☐ Other (please specify):_____

b. Comments?

Practice Change and End Result

61. Rate the amount of damage to your crops from Silverleaf Whitefly compared to 3 years ago?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 10

Much more damage Same amount of damage A lot less damage

a. Comments (including comments on damage differences between crops):

62. How have you changed the way you manage Silverleaf Whitefly over the last few years? [Unprompted, tick as many as appropriate.]

☐ Nothing
☐ Monitor crops for SLW levels/employ a consultant to do this for me
☐ Preserve/protect parasitoids/natural enemies/beneficials
☐ Use softer chemicals to protect parasitoids
☐ Injecting or drenching Confidor at planting (as preventive approach)
☐ Planting Confidor treated seedlings (specially for LV Brassicas)

☐ Reducing OP insecticide use in the crops
☐ Clean up strategy: spray out infested crop before slashing a couple of days later
☐ Good farm hygiene: Slash / destroy old crops as soon as possible
☐ Good farm hygiene: Control weeds around the farm
☐ Planting strategically (don't plant new crops next to old crops)
☐ Planting strategically (plant new crops upwind of old crops/problem areas)
☐ Planting strategically (be aware of hot spots around farm and avoid during problem times)
☐ Use resistance management strategy for district/follow guidelines for insecticides
☐ Reduce insecticide resistance by rotating insecticides
☐ Use oils for low pest levels/ reduce insecticide use
☐ Other / Comments:

63. If you changed one or more practices, how important were the following factors in prompting or informing this change? (Go through each item. Importance on a scale of 0-10 where 0=had no influence, 10=the main reason I changed)

___/10 Pest and Disease Seminar attended
___/10 Information about SLW that arrived on the farm from DPI& F
___/10 Discussions with crop consultants
___/10 Discussions with reseller/company rep
___/10 Direct contact with DPI&F
___/10 Discussions with other growers
___/10 Own research/information seeking
___/10 Years of experience
___/10 Other (please specify): _____