Horticultural Pest Management Strategic Plan Review and on-going support

Janine Clark
Growcom

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HG08025

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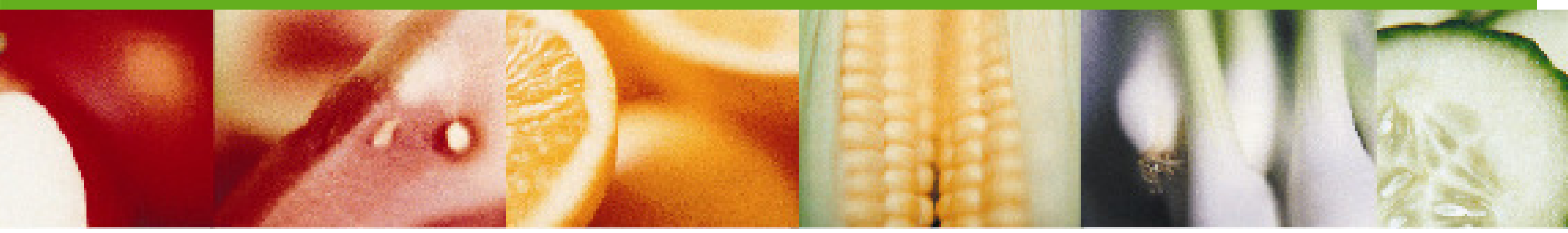

Project HG08025 (August 2011)

Horticultural Pest Management Strategic Plan Review & on-going Support

Final Report

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HG08025 | *Horticultural Pest Management Strategic Plan Review and on-going support*

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Project purpose:

This project aimed to maximize integrated pest management (IPM) for national horticultural fruit and vegetable industries based in Queensland through a strategic planning approach; and add value to the other Horticulture Australia Limited (HAL) plant health projects in the areas of pesticide regulation and pesticide access.

August 2011

Funding Sources:
This project has been funded by HAL using voluntary contributions from Growcom and matched funds from the Australian Government. The Australian Government provides matched funding for all Horticulture Australia Limited's R&D activities.

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Media summary

Effective pest management is critical to the success of the Queensland horticulture industry protecting productivity and the local environment. A number of important aspects of pest management were progressed through this project to ensure a sustainable and productive fruit and vegetable industry for the future.

The five key industry project components included:

1. the coordination of horticultural industries' involvement in silver leaf whitefly (SLWF) *Bemisia tabaci* (biotype B) management in the Burdekin;
2. development of Pesticide Good Agricultural Practice (PGAP) reports for the pineapple, eggplant and banana industries;
3. progression of market access issues relating to Queensland;
4. progression of chemical access priorities for the pineapple industry; and
5. the provision of support to the National Plant Health Coordinators to assist with regulation and pesticide access matters.

Key outcomes from the project included:

- the development of mechanisms enabling greater cooperation and coordination amongst the different industries affected by SLWF in the Burdekin;
- use of the Pineapple PGAP report to provide valuable information to the Australian Pesticides and Veterinary Medicines Authority (APVMA) in their review of the herbicide diuron;
- use of the Eggplant PGAP report to provide valuable information to the APVMA in their review of the insecticide dimethoate;
- the development of programs for the Potato Cyst Nematode (*Globodera rostochiensis* (Woll.) Skarbilovich) containment and the Phylloxera Exclusion Zone respectively.
- the development of eight minor use permits for alternative insecticides to dimethoate to manage fruit fly ; and
- the provision of advice and assistance to the pineapple industry in chemical access matters.

Although the project has reached its conclusion, elements of work developed throughout the project have ongoing capacity to assist Queensland's horticultural industries. Examples of this would be networks such as the Burdekin SLWF Technical Working Group that is now in place ready to be reactivated should a serious outbreak of SLWF or other cross commodity pest occur. Also, PGAP reports will potentially be used for future chemical reviews, such as fenthion.

It is recommended that other industries undergo the PGAP report production process to ensure they are on the "front foot" when chemicals are reviewed and it is also recommended that the Technical Working Group continue to meet on an as needs basis.

Containment programs and minor use permits generated through this project will enable Interstate Certification Agreements to be made and maintained, enabling market access to continue. Ongoing communication with affected industries and regulatory bodies is required to ensure that this process continues to run smoothly. An ongoing permit program is recommended for the horticulture industry.

Technical summary

This project was designed to ensure the retention of specialist expertise in pest management gained though previous projects[1] and to add value to the other Horticulture Australia Limited (HAL) plant health projects in the areas of pesticide regulation[2] and pesticide access[3].

Five key activities were identified that would achieve this:

Coordination of horticulture industries' involvement in silver leaf whitefly (SLWF) *Bemisia tabaci* (biotype B) management in the Burdekin: researchers in horticulture, grain legumes and cotton working on new and continuing SLWF and area wide management projects were connected via meetings and teleconferences to progress areas of common interest. These areas included the development of a national framework for resistance management, enhancing cross-commodity research and development, commodity collaboration and establishment of a common communication platform via a communications working group. This resulted in a cross-commodity communication plan being implemented with material[4] being circulated to stakeholders, a district cropping calendar[5] being designed.

HG08025 was not acting in a stand alone capacity to assist industry with SLWF issues. Whilst other work focussed on the development and promotion of Integrated Pest Management Strategies[6] (IPM), this project offered valuable support through creation of information sharing networks amongst key researchers and amongst growers in a cross commodity capacity. It helped to overcome barriers between broad acre and small crop producers by getting them to communicate more and work together to combat the pest across the Burdekin area.

The networks established by this project will be beneficial to affected growers and researches should SLWF or another cross commodity pest flare up again. Significant horticultural pests are cyclic in their nature of their rise and fall in importance to industry. At the conclusion of the project, stakeholders recommended that the focus of the Technical Reference Group needed to change from a single pest to an opportunity to discuss wider pest problems in a cross industry forum;

Development of reports on pesticide good agricultural practices (PGAP): the pineapple, eggplant and banana industries were surveyed on their work practices and work rates to generate the data sets for use in models such as the United Kingdom's Pesticide Operator Exposure Model (POEM)[7] to be modified and replicated here in Australia. The Pineapples PGAP report has been supplied to the Australian Pesticides and Veterinary medicines Authority (APVMA) as data supporting the retention of use

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[1] HG99034 – Development and implementation of pest management strategies for fruit and vegetable industries in Qld, HG03075 – Ongoing pest management strategy implementation, and HG05005 – Horticultural pest management strategic plan review and ongoing support, conducted by Growcom.
[2] AH09003 - Plant protection: Regulatory support and co-ordination, conducted by Kevin Bodnaruk AKC Consulting.
[3] MT10029 - Managing pesticide access in horticulture, Minor Use Coordinator Peter Dal Santo (Ag Aware Consulting Pty Ltd.
[4] The information circulated to affected industries is contained in Appendix 5 of this report.
[5] Please refer to Appendix 4 of this report.
[6] VG05050 – Development and promotion of IPM strategies for silverleaf whitefly in vegetable crops, Dr Siva Subramaniam et al.
[7] For further information on POEM refer to the Material and Methods section of this report.

patterns for diuron herbicide in that industry. The results of the review had not been released at the time of writing. The Eggplant PGAP report has been used in the review of dimethoate to assist industry with gaining a minor use permit for dimethoate to support market access to Victoria under ICA 26 and for trichlorfon (PER12442) as a suitable alternative chemical for fruit fly management. The data contained in the report was used to assess the number of sprays required to see the industry through their season without sustaining fruit fly damage. At the time of writing, the Banana PGAP report was yet to be used. It is recommended that other horticultural industries would also benefit from the development of PGAP reports;

Progression of market access issues relating to Queensland horticulture: involving coordination of the eggplant, table grape and potato industries' market access requirements. The Project Officer contributed to industry and government management plans such as Potato Cyst Nematode (*Globodera rostochiensis* (Woll.) Skarbilovich), and Phyloxora Exclusion Zone (PEZ) along with their implementation. Data was also provided to Biosecurity Queensland for major domestic plant entry conditions for fruit fly in eggplant. Further to this, permit applications were written for dimethoate[8] and trichlorfon[9] to manage fruit fly in eggplant and maintain market access in order to meet the plant entry (quarantine) conditions of the importing state. Ongoing support of the specialist expertise gained in this area is vital. It is recommended that Growcom maintain a role in this area;

Progression of chemical access priorities for the pineapple industry: industry priorities were refined through a workshop comprising industry technical experts aimed at keeping the focus on the problems in a pesticide regulation and market access context. A table of priorities is listed in this report along with associated activities undertaken on behalf of the industry. The project officer has worked towards the creation and support of several HAL funded projects[10] to generate supporting residue or efficacy data for the top three priority chemicals. Projects are continuing on from this work however, PER10457 for the use of dimethoate on red mite has been successfully converted from a Queensland Board Approval. The Project Officer has recommended to the pineapple industry that they undergo the Strategic Agrichemical Review Process (SARP) to further the work undertaken in this area; and

Supporting the Plant Health Coordinators by consulting with industry on regulation and pesticide access matters, with specific input on market access issues and writing of minor use permits for dimethoate and fenthion alternative options: eight minor use permit applications[11] were submitted to the APVMA for assessment, all of which are now in effect. More industry needs in this area continue to be identified and as a result more permits may yet be required. There will need to be an industry liaison to assist Biosecurity Queensland in dove-tailing theses permits into appropriate Interstate Certification Agreements. It is recommended that Growcom maintain a role in this area.

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[8] APVMA ref# 12506 – currently under assessment
[9] PER12442 valid 10/9/2011 – 31/5/2014
[10] PI07001 – generation of dimethoate residues in pineapples to maintain permitted pre-harvest use; PI08006 – Insecticide treatments for Symphylid control in pineapples; and PI09002 Pineapple Industry Technical Officer
[11] PER12439, PER12442, PER12450, PER12486, PER12590, PER12907, PER12940, PER13031,

Introduction

Growcom, in partnership with HAL, has a decade long history of strategic pest management planning for fruit and vegetables in Queensland. Projects such as HG99034, HG03075 and HG05005[12] resulted in many research[13] and development projects, hundreds of off-label permits (when counting permit applications and detailed information packages supplied to Crop Protection Approvals and AgAware Ltd), and some important label variations.

HG08025 *Horticultural Pest Management Strategic Plan Review and on-going support* was designed to complement the activities of the other current HAL Plant Health projects[14] in pesticide regulation and pesticide access, by covering areas of operation that fell outside their scope. It has achieved this though its five key activities:

- Coordination of horticulture industries involvement in silver leaf whitefly (SLWF) management in the Burdekin;
- Development of pesticide good agricultural practice reports for selected commodities;
- Progression of market access issues relating to Queensland;
- Progression of chemical access priorities for the pineapple industry; and
- Provision of support to the Plant Health Coordinators for industry consultation on regulation and pesticide access matters, with specific input on market access issues and writing of minor use permits for dimethoate and fenthion alternative options.

Through these activities, the project has aimed to improve plant industry relations amongst commodities in the Burdekin affected by SLWF through research and development commodity collaboration and communications back to growers. It also aimed to improve pesticide access, including reduced withholding periods for selected pilot industries by the provision of quality data to replace conservative default modelling. Improvements to domestic market access via better communication processes and cost effective methods of meeting jurisdictional plant entry conditions were also sought, along with improvements to chemical access for key pineapple pests, for a prioritised list of chemistry.

[12] HG99034 – Development and implementation of pest management strategies for fruit and vegetable industries in Qld, HG03075 – Ongoing pest management strategy implementation, and HG05005 – Horticultural pest management strategic plan review and ongoing support, conducted by Growcom.

[13] Two projects initiated from HG08025 are PI07001 – generation of dimethoate residues in pineapples to maintain permitted pre-harvest use; and TG06028 – Provision of dimethoate and fenthion residue data to maintain access to the pre-harvest use pattern in table grapes.

[14] Minor Use Coordinator funded through HAL project MT10029 Managing pesticide access in horticulture, conducted by Peter Dal Santo (Ag Aware Consulting Pty Ltd and AH09003 - Plant protection: Regulatory support and co-ordination, conducted by Kevin Bodnaruk AKC Consulting.

Materials and Methods

To undertake the five key activities of the project, linkages to existing or anticipated research in these areas was first examined.

Silverleaf Whitefly (SLWF) area wide management for the Burdekin:

Growcom has established links with the intensive plant industries of the Burdekin area though Queensland Farmers Federation (QFF), Commonwealth Scientific and Industrial Research Organisation (CSIRO), Grains Research and Development Corporation (GRDC), local crop monitoring consultant Bowen Crop Monitoring and Cotton Australia. These links were created through previous pest management projects and initiatives such as Reef Rescue[15] and other natural resource management collaborations, such as Caring for our Country.

The project officer utilized these links for the purposes of:

- Acquiring horticultural facilitators for Cotton Australia's SLWF mapping project;
- Linking SLWF and related research and development commodity projects under the CSIRO National Invertebrate Pest Initiative;
- Setting up the proposed cross industry technical working group for communications back to industry;
- Creating a cropping calendar and trigger points;
- Making a consistent approach to resistance management by affected food and fibre industries; and
- Creating SLWF good agricultural practice as per outcomes of the previous HAL projects with DPI&F Bowen.

With a sense of angst amongst cucurbit growers in the Burdekin area that SLWF numbers had increased in direct correlation to the trialling of coastal cotton growing in the area, the Project Officer acted to diffuse the situation as described below. Once contacted, all parties agreed that a cropping calendar should be produced to assist in understanding the dynamic of the cropping cycle and movement of the pest across crops. This was to dispel misconceptions about the perceived movement of SLWF.

Growcom was the holder of a number of minor use permits for use against SLWF. As a result of the work undertaken in this component of HG08025, it was agreed that all SLWF permits should be surrendered to a single entity as the permit holder to enable

[15] Reef Rescue is a key component of Caring for our Country, the Australian Government's over $2 billion, initiative to restore the health of Australia's environment and improve land management practices. It represents a new, coordinated approach to environmental management in Australia that is built on transparent and consistent national targets.

greater ease in updating resistance management strategies. The Project officer was compliant in this activity and all Growcom's SLWF permits were handed over to Horticulture Australia Ltd care of AgAware.

Activities undertaken:

27 August 2008

The Project Officer facilitated the establishment of a national Whitefly Technical Reference Group (WTRG) and a Burdekin Whitefly [Area Wide Management] Working Group (BWWG). A technical meeting was organised by Growcom and Cotton Australia with the aim of establishing a communications working group and was held in Townsville on the 27th August 2008. The technical meeting had a whitefly focus, but was viewed as an opportunity to sort out other bigger picture issues including:

- Crop forecasting: acreage, location, planting dates, harvest dates, fallows, weed hazards;
- Management of key pests common to most crops –based on existing resistance management strategies;
- Spraydrift management, 2,4-D and roundup;
- Resistance testing for mites insects and weeds;
- Pesticide resistance testing especially for indoxacarb;
- Prospects for area wide management –potentially as a collaborative project, across research and development corporations and aligned with existing pest management projects to maximize synergies.

The meeting also addressed silverleaf whitefly specific issues as follows:

- Silverleaf whitefly biotype (B or Q) testing;
- Future funding of the DPI&F Bowen insectary producing silverleaf whitefly parasites (*Eretmocerus hayati*); and
- Development of a communication strategy for the above.

The effectiveness of the working group was to be reviewed after a period of 12 months. The membership of the working group was to represent the supply chain and each plant industry was to nominate their grower representative at the first meeting. This was to ensure industry and community ownership in the development and adoption of industry management plans and area wide management. Further meetings were to be held on an as required basis.

9 October 2008

Dan Galligan of Cotton Australia organized a meeting on the 9th of Oct 2008 at DPI Ayr Research station to discuss the pest management interactions in the Burdekin particularly silver leaf whitefly and the pressure relationships between the different crops in the district.

20 February 2009

Technical support to the BWWG was then sought from the various relevant Research & Development Corporations (RDCs) at a meeting held at CSIRO Long Pocket on 20 February 2009.

17 April 2009
Following the establishment of the WTRG, a teleconference was held on 17 April 2009. The purpose of the meeting was to discuss the implications and management of the newly reported exotic plant pest *Bemisia tabaci* Biotype Q whitefly with reference to the Burdekin. Collaboration for spatial and temporal sampling between the cotton and horticulture industries was organised. Collaboration between Queensland Primary Industries and Fisheries (QPIF) Plant Science and horticulture to develop fact sheets for the intensive plant industries was organised. Fact sheets were disseminated to industry, and also distributed at the Ausveg Conference.

20May 2009
The first meeting of the Burdekin AWM Whitefly Working Group (BWWG) was held on 20 May 2009 at Claredale in north Queensland. As a result, a group was formed to meet as required to improve industry communications and collaboration. The BWWG discussed:

- Cross commodity and supply chain information sharing via local industry representatives;
- Communication of good agricultural practice learned from the previous whitefly projects, including the risks of planting horticultural crops early, management of whitefly when desiccating crops and farm hygiene;
- Advice to local industry representatives on the implications of the management of Biotype Q cf. Biotype B, including revised resistance management guidelines for cotton, grains and horticulture in Northern Australia;
- Documenting current knowledge and indentifying gaps; and
- Technical support from the Whitefly Technical Reference Group.

October 2009
Members of the Whitefly Technical Reference Group continued to update the Project Officer on findings relating to the potential new *Bemisia tabaci* Biotype Q whitefly. None had been detected as at October 2009.

Dr Siva Subramaniam of DEEDI (formerly DPI&F) in Bowen noted that for the 2008 – 09 season, SLWF numbers declined[16]. Although lacking strong data to prove lower numbers in the 2009-10 season, Dr Subramaniam felt that numbers of the pest continued to drop and thus grower interest in the pest was reduced for a period of time. As the working groups were intended only to meet on an as needed basis, no further meetings were organised for some months.

8 July 2010
The Project Officer requested permission from HAL to call another meeting to discuss: resistance management strategies; resistance monitoring; cross industry technology transfer /communication; Solenopsis mealybug[17] (*Phenacoccus solenopsis)*; and inviting Croplife or relevant plant science companies (Bayer, Cropcare, Sumitomo) to join the group. Due to a communication failure, no response was received on this matter until **29 November 2010**.

[16] Dr S.Subramaniam, Final report pp 83-92, VG05050 – Development and production of IPM strategies for silverleaf whitefly in vegetables.
[17] Solenopsis Mealybugs are small, sucking insects, related to aphids. These pests are known to affect a wide range of cultivated plants and weeds; occasionally, however, populations increase and damaging infestation or 'hotspots' can occur. This pest was on the rise in 2010.

Queensland experienced severe flooding in many parts of the state which affected numerous growers, thus grower focus was directed to flood related issues for a period of several months.

4 February 2011
The Project Officer made contact with the WTRG to establish their ongoing interest in SLWF issues as previously suggested to HAL.

14 July 2011
A further teleconference was held on 14 July 2011, discussing topics such as resistance management strategies, resistance monitoring, cross industry technical transfer / communication and another significant pest on the rise, Solenopsis mealybug. Minutes were taken and circulated to the group. A conclusion was reached that SLWF was not currently a pest of great significance but that it may flare again in the future. The consensus was that further meeting should be extended to a discussion on broader pest spectrum rather than limiting it to one pest. This was the final meeting of the group under the auspices of the project, which concluded 30th August 2011. It is anticipated that there is sufficient momentum within the group that should another cross commodity pest issue arise, they will take the initiative to meet again if appropriate. Growcom will maintain a watching brief and act as a point of contact.

Development of pesticide good agricultural practices reports for selected commodities

The basis for this work was the United Kingdom's Predictive Operator Exposure Model (POEM)[18], which is an Excel based questionnaire designed to predict worker exposure to pesticides through various application techniques and circumstances. The questionnaire developed through this project was not predictive but indicative of behaviours and practices undertaken in various industries. The data from the questionnaire were then compiled in to a report for each surveyed commodity group to record Good Agricultural Practice in pesticide use to enable the Australian Pesticides and Veterinary Medicines Authority (APVMA) to have better insight into likely worker or environmental exposure levels within those industries.

Indicative questions asked in the survey included: details about the location, size and number of the farm plots; which pesticides were typically used; whether tank mixing of pesticides was practiced; what application methods and equipment used; whether personal protective equipment was used; and the amount of time spent by workers applying pesticides.

Growcom has an extensive grower database which was an important tool for contacting growers of pineapples, eggplant and bananas. Being the Peak Industry Body for pineapples enabled direct links into a wide range of growers who were surveyed for the purposes of developing the pesticide good agricultural practices (PGAP) report.

To develop a template for the survey, the Project Officer consulted with both Kevin Bodnaruk (HAL) and Les Davies (APVMA). First, the PGAP questionnaire was developed so that it could be easily modified to suit a range of horticultural fruit and vegetable crops. The pineapples PGAP questionnaire was then sent to industry experts for feedback which was obtained prior to small scale testing.

Small scale testing of the PGAP questionnaire was conducted with growers onsite at several pineapple farms in South East Queensland and photographs were taken of pesticide application equipment typically used on farms, including large, medium and small scale operations. Following small scale on-farm testing, the PGAP questionnaire was then modified in regard to both layout and questions and an electronic database was then developed for the wide scale pineapple data collation. The results are recorded in the PGAP report for pineapples. See Appendix 1.

Further PGAP surveys were then adapted for the eggplant and banana industries using similar techniques. The data collected for each industry was then collated and respective PGAP manuals were written. See Eggplant PGAP report Appendix 2 and Banana PGAP report Appendix 3.

The APVMA recently reviewed the herbicide diuron which is a key crop protectant used by the pineapple industry. The Pineapple industry needed to prove that the application and production practices for the crop are likely to result in little runoff of pesticide into nearby waterway. The PGAP report was submitted to the APVMA to demonstrate the industry's herbicide application practices and comment was supplied on how these

[18] http://www.pesticides.gov.uk/uploadedfiles/Web_Assets/PSD/UK_POEM1.xls

practices limit pesticide runoff. The APVMA is yet to announce their findings from the review and, at the time of writing, were still assessing the submissions received.

The review of the insecticide dimethoate has been going on for nearly a decade, but recently the APVMA acted to suspend certain uses based on their deliberations and findings on consumer health risks. The Project Officer had been working to secure minor use permits for alternative crop protectants for industries affected by fruit fly. The information gathered in the Eggplant PGAP report was used to determine the number of sprays of trichlorfon that would be needed to adequately protect the industry between fruit set and harvest. This has resulted in the successful issuing of PER12442 for the industry.

At the time of writing the Banana PGAP report had not yet been referenced for chemical access purposes as the other reports. There are many potential uses for the PGAP reports and the information contained in them will be put to good use to benefit the industry when the time arises.

Progression of market access issues relating to Queensland Horticulture

The domestic horticultural trade sector is worth $6.5 billion per annum. It is the most important market destination for the majority of horticultural products, as opposed to the export market which is valued at $827 million per annum. Despite the significance of the domestic market, there are considerable impediments to interstate trading caused by an ad hoc domestic market access process and lack of ownership by national industries in an area that is seen traditionally as a state or territory matter.

Growcom identified that a number of commodities were in the process of conducting research and development to maintain market access, in particular fruit and vegetable fruit fly hosts. These coupled with the table grape and potato industries (which were also in the process of signing off on or complying with industry management plans that have ongoing survey and other operational requirements) were selected as needing assistance through HG08025.

The declaration of the Greater Sunraysia area as a Pest Free Area (PFA) caught eggplant growers unprepared with respect to maintaining market access for their produce into New South Wales (NSW) and Victoria. Due to NSW not having a state registration for the use of fenthion on eggplant to control fruit fly, the State Authority refused entry of eggplant into their fruit fly exclusion zone. The Project Officer acted as a liaison between industry and government to achieve appropriate market entry conditions.

Market access requirements for eggplant into Victoria changed in early 2008. One of the options for treatment was a pre-harvest cover spray with fenthion which had a withholding period (WHP) of 7 days. Eggplant growers indicated that due to the rapid growth in the fruit, harvest periods needed to be every 5 days, otherwise the fruit was too large for the Victorian market preferences. The Project Officer assisted in determining whether there was scope to reduce the WHP from 7 to 5 days. When this proved to be impractical, the Project Officer lobbied to have the time extended for the proposed changes to take affect so that the industry had more time to make changes to other acceptable treatment procedures and comply with the proposed changes. Working in conjunction with Biosecurity Queensland (BQ), the timeline for changes was successfully extended. The Project Officer then liaised with industry to ensure that growers were changing to suitable fruit fly treatment procedures so that they could maintain market access to the imposing State.

The Project Officer supplied production statistics to BQ to assist them in their negotiations to amend ICA26. Industry queries were also raised with BQ regarding potential changes to ICA01 and ICA02 to maintain entry into Victoria. To assist industry with their market access requirements, the Project Officer made an application for minor use permits for dimethoate and trichlorfon. At the time of writing, PER12442 for trichlorfon had been issued but APVMA ref# 12506 for dimethoate was under assessment.

The Project Officer assisted with the implementation of the table grape and potato industry management plans for interstate movement and area freedom of pests such as **Phylloxera** (*Daktulosphaira vitifoliae*) and **Potato Cyst Nematode** (*Globodera rostochiensis* (Woll.) Skarbilovich).

Phylloxera is an insect pest of grapevines. It can kill grapevines and reduce productivity. It occurs in New South Wales and Victoria in areas known as Phylloxera infested zones (PIZs). The Queensland table and wine grape industries are working with Biosecurity Queensland towards having the entire state declared a phylloxera exclusion zone (PEZ) or special control zone.

The project officer's role has been to coordinate the Queensland table Grape industry's interaction and contribution to the process with the lead agencies. The agencies included those within the Department of Employment, Economic Development & Innovation (DEEDI) i.e. Biosecurity Queensland and Queensland Primary Industries and Fisheries, as well as other participating and affected industry bodies, such as the Queensland Wine Industry Association and Nursery & Garden Industry Queensland.

The move to a Queensland PEZ is a staged process, region by region. In any one region, the process takes three years to complete. Stage 1 was completed in 2011 for the area of Queensland that includes the major table grape production districts of Emerald, Mundubbera and St George.

Table 1. Project Officer's activities with respect to the Central Inland Queensland PEZ:

Action item	Description
Communication	Establishing and chairing a joint industry and government Queensland PEZ. Upgrade Steering Committee to oversee the project and an Operations Committee to manage the survey logistics
Communication	Assisting DEEDI agencies in Queensland to put appropriate intrastate quarantine measures in place by seeking support from all plant industries involved in the Central Inland Queensland PEZ and with the development and publicising of the fact sheet (available)
Negotiation	Seeking assurance from Biosecurity Queensland that it has assurance from New South Wales and Victoria that both states will accept property freedom inspections as an entry condition for Queensland table grapes, on the basis that that the state is undertaking a nationally approved PEZ upgrade process.
Communication	Seeking industry endorsement for the Central Inland Queensland PEZ to cover the main table grape production regions, co-authoring and provided feedback on the cover letter for the Central Inland Queensland PEZ proposal (written by DEEDI agencies) to National Vine Health Steering Committee.
Communication	With DEEDI agencies, jointly setting up the Operations Subcommittee of Queensland PEZ Upgrade Steering Committee consisting of regional Biosecurity, Queensland Primary Industries and Fisheries and table grape grower representatives (industry's district coordinators) from all participating local government areas where table grape production occurs. This was to ensure the smooth rollout of the Stage 1 property freedom inspections for each season.
Communication	Proofing and publicising the industry awareness program organised by Biosecurity Queensland, ensuring all Queensland table grape growers received a copy of the PEZ fact sheet as part of the awareness program for the implantation of the Upgrade process.
Communication	Assisting Biosecurity Queensland to schedule the 2009-10 property freedom inspections. Inspections started in north Queensland from mid July, Charters Towers inspections were in August-September, Emerald inspections in September-October, Mundubbera inspections in October-early November, and St George inspections in November -early December.
Facilitation & communication	Facilitating and publicising a permit for glyphosate herbicide for removal of unwanted grapevines (PER11527 Glyphosate / Grapevine removal/destruction / Phylloxera) with Nufarm. The permit was applied for by Peter Dal Santo and allows for the legal destruction of unwanted vines.
Facilitation	Facilitating alternative market access mechanisms organised by DEEDI agencies, to meet key domestic market plant entry conditions.

Action item	Description
Facilitation & communication	Liaising with Kevin Bodnaruk, DEEDI agencies and the lead manufacturers regarding APVMA review of sulphur dioxide (SO2) labelling. Assisting in gaining SO2 efficacy endorsement by the National Vine Health Steering Committee Technical Reference Group (TRG), determining chain store requirements, and identifying inconsistencies in jurisdictional legislation in relation to legal access for the control of Phylloxera.
Permit application	Growcom requested a minor use permit for the use of the SO2 pads via the Horticulture Australia Ltd minor use permit coordinator, Peter Dal Santo.
Negotiation	Prompting Biosecurity Qld to ask South Australia, Victoria & New South Wales to include SO2 and carbon dioxide (CO2) fumigation in their plant entry conditions for PEZ table grapes.
Negotiation	Liaising with David Oag of DEEDI, who represented Queensland on the (now defunct) National Vine Health Steering Committee TRG to ensure TGR sign off on the efficacy of the SO2 pads for Phylloxera. This involved reviewing an industry request to add SO2-C02 fumigation as per the US table grape import protocol.
Negotiation	Coordinating industry and government negotiations between the industry district coordinators and DEEDI agencies to allow property access onto the properties of disinterested/non-participating/hostile landowners with unsurveyed grape vines within four areas of the Central Inland Queensland PEZ.
Facilitation	Jointly facilitating the privately funded vineyard destruction program offered to landowners with unwanted vines in two areas of the Central Inland Queensland PEZ.
Meeting	Attended the PEZ Status Upgrade Steering Committee meeting held 27th April, 2010.
Facilitation & communication	Organised the attendance of James Planck, surveillance systems Biosecurity Queensland and David Oag, DEEDI table grape market access project leader to update grape growers on progress at the GrapeConnect annual post-season Meeting.
Media	Assisted with articles for Grapegrowers and Vignerons, Australian Horticulture and Good Fruit and Vegetables and Fruit and Vegetable News magazines.

Potato cyst nematodes (PCN) are 1-mm long roundworms belonging to the genus *Globodera*. They live on the roots of plants of the Solanaceae family, such as potatoes and tomatoes. PCN cause growth retardation. At very high population densities, they also damage to the roots and early senescence of plants. The whole state of Queensland is a designated pest quarantine area. A pest quarantine area is a part of Queensland that has movement restrictions placed on it under Queensland legislation to control or restrict the spread of pests and diseases within the State.

Thorpedale in Victoria has been identified as an infested area and as such Inspector's Approval 9.28 "Introduction of potato tubers from within 20 km of the potato cyst nematode infestation at Thorpdale for culinary or ware use in Queensland", has been enacted to ensure that Queensland's pest free status is not compromised.

The Project Officer consulted with ware (fresh) and processing potato growers throughout Queensland and provided feedback to the PCN Plan technical committee via Biosecurity Queensland.

Despite the comprehensiveness of the plan, the Project Officer felt that growers were unlikely to accept grid sampling systems, on the expectation that this would be cost prohibitive. On the basis of this, the Project Officer argued for a survey of piler dirt (undergrader) sampling with a trace-back system (no bulking of samples) for proof of area freedom, property freedom and for verifying areas of low pest prevalence as a more acceptable alternative. The initial survey of piler dirt sampling is expected to be run as a HAL funded project which should enable industry and researchers to estimate the costs of implementing ongoing surveillance. Growers indicated they wanted to see a detailed of costing of the proposal before they agreed to the funding of it.

Progression of chemical access priorities for the pineapple industry

Growcom is the peak industry body representing the pineapple industry. The pineapple industry had a backlog of research and development (R&D) issues due to not previously having a national levy in place. In the past, most R&D was carried out by Golden Circle Limited (GCL) under the old grower cooperative structure. More recently, the pineapple industry's pest management needs were prioritised in the Horticulture Australia Limited (HAL) and Growcom Pest Management Strategies Update 2008 then updated by industry in January 2009. The pineapple R&D levy was also implemented in 2009.

The industry was approached to undertake the Strategic Agrichemical Review Process (SARP) for Horticulture, however declined due to the financial constraints. The consensus amongst the Pineapple Growers Advancement Group was that the information proposed to be gathered under the SARP had already been obtained via Growcom's Pest Management Strategic Plans and Strategy Updates through Horticulture Australia Ltd's (HAL):
HG99034 – Development and implementation of pest management strategies for fruit and vegetable industries in Queensland;
HG03075 – Ongoing pest management strategy implementation; and
HG05005 – Horticultural pest management strategic plan review and ongoing support.

The Pineapple Growers Advancement Group (PGAG) meeting at Bribie Island on 28 January 2009 reaffirmed the industry's Research and Development (R&D) priorities with minor changes. Because of limited interest from service providers following the HAL industry call, an R&D workshop for the supply chain was held at Growcom on 15 July 2009. The R&D priorities workshop was organised by the Project Officer and the Pineapple Industry Development Officer, Julie Moore.

It was facilitated by Growcom's Chief Advocate Rachel Mackenzie and had representation from growers, Good Laboratory Practice accredited service providers, the Queensland Department of Primary Industries & Fisheries (QPIF), marketers, processors and HAL. This workshop was held to fine-tune the priorities, because the information provided in the industry call did not attract sufficient interest from service providers. The Project Officer stressed the need to think about taking an integrated management approach for all issues, for example, phytophthora control should incorporate management site selection, cultural control (hilling, drainage) and develop root testing, not just reliance on Phosphorus acid sprays.

The Pineapple Pest Management Strategy had identified the pesticide access issues and prioritised them. The meeting noted that the top two chemical access priorities were:

- Lindane replacement for symphylid control; and
- The registration of dimethoate for mite control.

Work is already underway via HAL Voluntary Contribution projects to maintain access for the two top priority chemicals bifenthrin[19] and dimethoate[20]. The only change to the

[19] PI08006 Insecticide Treatments for Symphylid control in pineapples, with links to PI09002 Pineapple Industry Technical Officer.

existing priorities was to move metalaxyl up to priority five and prochloraz down to priority six.

Table 2. Pineapple industry pest management priorities

Pesticide (active) by rank	Target pest
Bifenthrin	Symphylids
Dimethoate	Red mites, flat mites
Phosphorus Acid	Phytophthora root rot
Ethephon	Pre-harvest de-green/ripen fruit
Metalaxyl	Phytophthora root rot
Algene	Sanitise spray tank water (Erwinia)
Prochloraz	Register for use as a post-harvest spray application.

The Project Officer oversaw of the pineapple pest management projects through membership of Pineapple Industry Technical Officer Steering Committee. The Committee met for Horticulture Australia Ltd (HAL) Milestone reporting and as required to progress the key research and development (R&D) projects of the registrations of Crop Care Talstar® for symphylid control and Agrichem's Agri-Fos® 600 systemic fungicide.

[20] Generation of dimethoate residues in pineapples to maintain permitted pre-harvest use. Completed, but the industry is pursuing further trials as directed by the APVMA post the review of dimethoate.

Table 3. Activities undertaken by the Project Officer on behalf of the pineapple industry

Action Item	Description
Research quotation	Summarising all research projects and providing an estimate of trial requirements and cost.
Meeting	Organising an R&D meeting to scope the requirements for a Phytophthora management project. Key supply chain personnel were present, including researchers, agronomist and a lead registrant. The focus was on multiple approaches to disease management, a commercial perspective on the realities of varying the registered use pattern of the phosphoric acid, and the world standard in chemical management of Phytophthora in intensive agriculture. The Project Officer sought registration of Phosphorus acid and crop safety and efficacy R&D commenced. Despite a meeting taking place between Growcom, the Pineapple Growers Advancement Group and Agrichem Australia at the CEO level, an agreement over ownership of the data to be generated caused the industry to seek an off label permit rather than pursue registration.
Meeting	Organising an R&D meeting with Bayer to develop a draft scope for ethephon R&D to allow its use for de-greening fresh market fruit. This draft was considered by industry to scope an R&D project with the supply chain, using a similar process as that for the Phytophthora project with funding at a later date, due to allocation of all levy money to other projects
Permit application	Progressing industry access to Quaternary Ammonium Compound (QAC) by permit as formerly held by Golden Circle Ltd, and negotiating with a participating registrant to transfer the use pattern to label with the assistance of the Australian Pesticides and Veterinary Medicines Authority (APVMA). Permit application was written and submitted, however the registrant concurrently submitted for label extension, thus the permit application was withdrawn. At time of writing, registration was pending;
Permit application	Pursuing the Growcom permit application for dimethoate / red mite / pineapples to replace the Queensland Board Approval. This application has now been granted by APVMA. PER10457 is valid to the 30th September 2013 and requires industry to generate further supporting residue data.
Representation	At the end of December 2009, Growcom agreed to be the industry nominated expert for Department of Agriculture Fisheries and Forestry (DAFF) reporting on progress to lindane alternates to the Stockholm Convention. Upon request the Project Officer has provided DAFF with updates on inventory levels and usage of lindane as well as progress in the registration of alternatives;
Representation	Seeking clarity on the Future of HJ Heinz Company Australia (Golden Circle) Maintain registration - Maintain is an important plant regulator used for the rapid multiplication of vegetative planting material and is used to speed up the introduction of new processing clones and fresh market varieties. The product is registered to HJ Heinz Company Australia, formerly Golden Circle Limited. The Project Officer wrote to Heinz seeking a formal response on whether they intended to continue to hold the Australian registration for Repar Corporation Maintain. And whether they would continue to supply Maintain to the wider Australian pineapple industry who may not be Heinz contracted growers.

Provision of support to the Plant Health Coordinators
Initially, HG08025 included an alternative component of data mining of Horticulture Australia Ltd's plant health projects. This activity was replaced with the provision of support to the Plant Health Coordinators. On the 30th April 2010, a meeting with Brad well, Gary Artlett and Janine Clark in attendance agreed that milestones 4 and 5 of this project would be changed to substitute data mining for Plant Health Coordinator support. This change was reflected in project milestone 104 which was approved 7th June 2010.

Table 4. Support provided to Plant Health Coordinators by Project Officer

Action item	Description
Data provision	The Project Officer used their extensive minor use network to provided data on the following information to Kevin Bodnaruk for the Australian Pesticides and Veterinary Medicines Authority's (APVMA) review of MCPA & 2, 4 -D on the use of hormone herbicides in sweet corn, rhubarb and pre-harvest citrus production systems.
Feedback / information provision	Feedback was supplied to Peter Dal Santo on expiring and expired permits from grower base and supply chain. Production information on minor use permit applications, including eggplant and rhubarb.
Information provision	Provision of persimmon pest management information to Peter Dal Santo.
Communications	Updates on the progress of the Horticulture Australia Ltd (HAL) / Growcom permit transfer and consolidation of surrendered whitefly permits. Despite this work, the transfer of permits owned by HAL and AUSVEG has now been turned over to Growcom.
Permit writing	The generation of minor use permit applications for various crops to use maldison and trichlorfon as suitable pre-harvest cover sprays to assist industry with replacement Inter-state Certification Agreements (ICAs) for dimethoate and fenthion were submitted to Peter Dal Santo for on-sending to APVMA. • **Trichlorfon / strawberries, Rubus & Ribes / fruit fly** – submitted to APVMA Sept 2010 • **Trichlorfon / tree fruit / fruit fly** - submitted to APVMA Sept 2010 • **Trichlorfon / table grapes / fruit fly** - submitted to APVMA Sept 2010 • **Trichlorfon / Eggplant, Pepino, Cape gooseberry / fruit fly** - submitted to APVMA Sept 2010 • **Maldison / stonefruit / fruit fly** – submitted June 2011 • **Maldison / strawberries & Rubus / fruit fly** – submitted June 2011 • **Maldison / capsicum cucumber / fruit fly** – submitted August 2011 • **Spinetoram / pome & stone fruit / fruit fly** – submitted August 2011
Information provision	Canvassing industry for an indication as to the importance of the various pests, where there are no or few alternatives to endosulfan. The Project Officer worked in conjunction with DEEDI to supply this information to Kevin Bodnaruk.

Results

The Project Officer met regularly with the Project Steering Committee to discuss progress of the project as per the milestone requirements. A noteworthy meeting was held on the 18/12/09 where the stop / go point of the project was assessed and it was decided to continue to the proposed conclusion date of 31 August 2011.

The merits of the project were initially assessed via the independent body, Schofield-Robinson Services. Peter Schofield of that organisation determined that Growcom had developed considerable expertise and capacity in pest management and in particular, minor use. The Schofield Robinson review was favourable and acknowledged the need to retain specialist expertise, but pointed to the need to have consistency across the three plant health projects and reduce areas of overlap. A meeting of the Horticulture Australia Ltd (HAL) Plant Health Project Leaders and managers took place to ensure that HG08025 was suitably refined to include a national focus, in line with HAL expectations. This was to eliminate overlap with existing national plant health projects and compliment the activities of those existing projects[21].

Further assessment at the completion of the project took place via individual approaches to key stakeholders. The Pesticide Good Agricultural Practice reports were assessed and approved by Peter Dal Santo and Kevin Bodnaruk. Dr Siva Subramaniam was contacted to gauge whether the project had achieved its purpose in terms of Silverleaf Whitefly area wide management in the Burdekin and Les Williams was asked to comment on the activities undertaken on behalf of the pineapple industry. Their comments are included in the following sections.

Silverleaf whitefly (SLWF) / area wide management for the Burdekin

The key result for this facet of the project lies in communication networks put in place between researchers and growers and between broad acre and horticultural commodity groups. As previously stated, the networks established by this project will be beneficial to affected growers and researches should SLWF or another cross commodity pest flare up again. Significant horticultural pests are cyclic in the nature of their rise and fall in importance to industry. At the conclusion of the project, stakeholders recommended that the focus of the Technical Reference Group needed to change from a single pest to an opportunity to discuss wider pest problems in a cross industry forum.

Along with improving communication amongst stakeholders, the project aimed to achieve a reduction in crop losses caused by SLWF to at or below economic levels (<3% loss) in the Burdekin. Feedback from key Department of Employment, Economic Development & Innovation (DEEDI) Entomologist and researcher, Dr Siva Subramaniam (Subra) was sought on the outcomes of this element of the project.

Dr Subra commented that the type of outcomes listed were difficult to achieve and measure in a quantitative way. Such an assessment would require extremely close contact with affected growers on a one-to-one basis. HG08025 has not operated in a

[21] Minor Use Coordinator funded through HAL project MT10029 Managing pesticide access in horticulture, conducted by Peter Dal Santo (Ag Aware Consulting Pty Ltd) and AH09003 - Plant protection: Regulatory support and co-ordination, conducted by Kevin Bodnaruk (AKC Consulting).

stand alone capacity with respect to SLWF management improvement and has contributed to a greater body of work undertaken across a number of projects.

Subra commented that a reduction in crop losses to SLWF at or below economic levels (<3% loss) in the Burdekin is unrealistic and too hard to achieve for the whole Burdekin region. The average crop losses, even with regular chemical control practices, were between 10-50% during 2008 period. Bringing this down to below 3% was deemed to be impossible without radical new chemistry options.

The best results that Subra had witnessed were to reduce damage levels from 30-50% in 2008 to 5-8% in 2010. However this required extreme amounts of effort from DEEDI staff along with project resources[22].

Despite this, the contribution of the project did improve communication amongst stakeholders and result in agreement on a cropping calendar for the area. These are valuable tools in the overall strategy to improve SLWF management strategies and also managed to calm inter-industry blame shifting for the problem.

Development of pesticide good agricultural practices reports

The project aimed to improve pesticide access, including reduced withholding periods for selected pilot industries by the provision of quality data to replace conservative default modelling.

Surveys returned useful data towards this goal however the amount of natural disasters in Queensland since December 2010 made it impractical and insensitive to place too many follow up questions with many industries as they were battling with the devastation of their crops, homes and infrastructure.

The documents were submitted to the project management team which included Kevin Bodnaruk (AKC Consulting) Peter Dal Santo (AgAware), who were both enthusiastic about the content and its ability to better serve the subject industries with provision of information to the Australian Pesticides and Veterinary Medicines Authority (APVMA).

The areas where this will be of greatest assistance will lie in environmental reviews and assisting in the development of industry codes of practice. Instead of using default models reliant on old information, reviewing authorities will be able to refer to more current data that captures a more accurate snapshot of pesticide application.

This may have a positive affect for industry with the decrease of buffer zones by supplying data on spray drift reduction practices. It may also allow industries the opportunity to draw on this information for the purposes of developing industry codes of practice, having identified what is the standard industry practice for pesticide application.

Practical applications for two of the three reports include submission of the pineapple PGAP report to APVMA on the review of the herbicide, diuron and use of the Eggplant PGAP report in the review of the insecticide, dimethoate. There is potential for the

[22] Pers. Comms via e-mail 9/6/11

information in these reports to be used in future reviews of chemistry, for example, fenthion. The reports are attached as appendices. Please refer to:
Appendix 1– Pineapple PGAP report;
Appendix 2 – Eggplant PGAP report; and
Appendix 3 – Banana PGAP report.

Progression of market access issues relating to Queensland horticulture

The project aimed to improve domestic market access via better communication processes and cost effective methods of meeting jurisdictional plant entry conditions.

The project officer assisted to coordinate the eggplant, table grape and potato industries' market access requirements, including industry and government management plans such as Potato Cyst Nematode and major domestic plant entry conditions, chemical access and chemical regulation issues, in order to meet the plant entry (quarantine) conditions of the importing state.

Growers of eggplant now have market access pathways to New South Wales, Victoria and South Australia. The project Officer assisted Biosecurity Queensland with their amendments for Interstate Certification Agreement (ICA) 01, ICA02 prior to the announcement of the review of dimethoate and ICA26 to include eggplant. The industry also has access to the use of trichlorfon via PER12442 which is in the process of being included into ICA26 at the time of writing.

Table grape production districts of Emerald, Mundubbera and St George have now received national recognition for the area as a PEZ as defined in the agreed rules for managing phylloxera in Australia. Achieving PEZ status for grape production districts in Queensland will have the following major benefits for the industry:

- Improved market access and protection from phylloxera;
- A substantial reduction in the costs of complying with interstate quarantine requirements;
- Unrestricted movement of table grapes into southern states.

Progression of chemical access priorities for the pineapple industry

Pineapple Grower Advancement Group (PGAG) member and Research and Development Representative, Les Williams has over seen the activities of the PMO and has expressed satisfaction with the outcomes for industry. Although we are yet to see the conclusion of a number of the activities undertaken, they have progressed so that they are closer to the desired result.

Discussions with the Australian Pesticides and Veterinary Medicines Authority (APVMA) over the status of pineapples as a minor crop have not resulted in them accepting minor use permit requests. However it has served to keep the issue front of mind and may yet influence the decision on the status of pineapples as a minor crop. Some consideration has been given by the APVMA towards some of the requirements for trial replicates (fewer are required for minor crops, which means less cost to industry) but this has been on a case by case basis. The industry mostly applies for trial permits so that they can undertake research to enable registration and thus has not greatly tested the situation with minor use permits.

Obtaining registration for a phosphoric acid product is still being pursued. Although registration with Agrichem was unsuccessful, there is still an opportunity to progress to registration with another registrant and negotiations are underway[23]. The Project Officer has also offered valuable assistance in sourcing potential chemical registrants to approach for joint research and development projects for dimethoate and bifenthrin. Consequently, the Project Officer's discussions with Horticulture Australia Ltd, Department of Agriculture Fisheries and Forestry and the APVMA on the potential problems that could arise should industry funded data be given exclusively to a chemical registrant who then has a change in commitment to the ongoing registration of that product, have highlighted the need for industry to maintain access to such data. This was an issue previously unrecognised by all parties.

With the potential impact of certain chemical reviews being faced i.e. dimethoate, fenthion and diuron, the Project officer has kept the industry abreast of development and likely consequences of these reviews which has helped them prepare for future possible circumstances. Growcom has also made submissions to the APVMA supplying scientific argument and supporting data with the purpose of maintaining use patterns for the industry. The APVMA are currently assessing the dimethoate and diuron submissions and will advise of their decision in due course.

[23] A Category 25 application is being sought where the APVMA assesses the permit and if acceptable, the use pattern is then offered to all registrants of the active ingredient to update their label.

Discussion

The implications for Australian horticulture based on the outcomes of this project are as follows:

- Benefits to growers in the Burdekin area through greater linkages with other industries affected by silverleaf whitefly leading to the creation of a suitable cropping calendar to diffuse tensions between horticultural and broad acre growers and a more consistent approach to resistance management. As a consequence of our partnerships with Queensland Farmers Federation, Growcom was uniquely positioned to bring the commodities together which led to useful working partnerships.

- Benefits to the surveyed commodities of pineapples, bananas and eggplant through the supply of up-to-date data to the APVMA for assessment in reside, spray drift and worker occupational health and safety practice assessments. This data will allow assessors a better look at the reality of pesticide use in these industries and will hopefully result in lesser restrictions on chemical use (without compromising safety standards) due to the illustration of precautionary practices undertaken. The pesticide Good Agricultural Practice (PGAP) report for pineapples was referenced in the review of diuron herbicide. The templates used for the surveys used to make the PGAP manuals could also benefit other industries wishing to do the same as they can easily be adapted to other commodities.

- Benefits to the pineapple industry are in the form of resolved or improved research and development issues and general pest management needs being met in a more planned and strategic way.

- Benefits to the Plant Health coordinators through assistance with the provision of information towards: chemical reviews; minor use permit applications; crop pest management; and pesticide good agricultural practice.

- Benefits to industry in improved market access lie in the assistance given to Government management plan development and implementation and the inclusion of certain commodities or treatment processes in Interstate Certification Agreements.

Technology Transfer

Technology transfer of research and development outputs has been carried out during the life of the project. The Project Officer has maintained communication linkages with stakeholders in each of the research areas and has advised of outcomes and outputs as they occurred.

<u>Phylloxera Exclusion Zone development</u>

The Project Officer had considerable input into the creation of the Phylloxera Exclusion Zone (PEZ) in Queensland, undertaking extensive communications with table grape growers for the purposes of arranging property freedom inspections. This involved individually contacting growers to determine if they were still in the industry, then arranging the inspections with the relevant authorities on the properties. All growers were given a copy of the PEZ fact sheet as part of the awareness program for the implementation of the upgrade process. Growers were notified of grapevine destruction / removal tools such as the permit authorizing the use of glyphosate. For further details refer to *Table 1. Project Officer's activities with respect to the Central Inland Queensland PEZ* in this report.

<u>Silverleaf Whitefly area wide management for the Burdekin</u>

Silverleaf Whitefly area wide management for the Burdekin also involved considerable elements of technology transfer. The project Officer brought together key researchers in a variety of horticultural and broad acre commodities. This facilitated information transfer between stakeholders at a research and development level which was then passed on to affected growers. Refer to Appendix 5 *Silverleaf whitefly management in vegetable crops*, which was distributed to growers and participants at the Ausveg conference by the Project Officer. Appendix 4 *Burdekin Cropping Calendar*, was also disseminated to growers post its development at the May 2009 Burdekin Whitefly working group at Claredale.

<u>Potato Cyst Nematode Plan</u>

The Project Officer consulted with ware (fresh) and processing potato growers throughout Queensland and provided feedback from to the Potato Cyst nematode Plan technical committee via Biosecurity Queensland.

<u>Pineapple industry priorities</u>

The project officer gave presentations to the pineapple industry at the Pineapple Growers' Advancement Group (PGAG) on key projects that were initiated through HG08025 on the development of use patterns for phytophthora management with phosphorous acid and ethephon for use in de-greening. Industry was also kept abreast of developments and progress on minor use permits sought for the industry via this project. Updates were given verbally to PGAG member and R&D representative, Les Williams. They were also publicized in the industry newsletter, Pineapple Press (refer to *Media* below).

Assistance to Plant Health Coordinators

Minor Use permits relating to fruit flies generated from the Project Officer's efforts in this area of the project were advertised to stakeholders in Growcom's e-magazine, *Horticulture Now* and circulated to its readership. Peter Dal Santo was also provided with copies of the permits which he then circulated amongst his distribution list. The permits were also given to Ryan Genero of DAFF to place on share point for the Dimethoate and Fenthion Response Coordination Committee (DFRCC) for members to have easy access. The Project Officer also attended multiple teleconferences for the DFRCC and gave input into the planning process for the response to the review and reported outcomes back to growers via Growcom's media channels.

Media

The Project officer also promoted project outcomes and activities via articles in Growcom's magazine, Fruit and Vegetable News as follows:

Grape meeting (*efforts to create Phylloxera Exclusion Zone for Qld's table grape industry*), F&V News vol 80, no. 4 April 2009

Pest-free zone for table grape industry (*Phylloxera Exclusion Zone*), F&V News vol 80, no. 6 June 2009

Progress on Qld's PEZ upgrade plan (*Phylloxera Exclusion Zone*), F&V News vol 80, no. 9 September 2009

The Project Officer also assisted with information provision in articles of a similar nature published in *Grapegrowers and Vignerons*, *Australian Horticulture* and *Good Fruit and Vegetables*.

Potato Cyst nematode Plan, F&V News vol 80, no. 2 February 2009

Group aims to tackle whitefly (*Whitefly technical reference group WTRG*), F&V News vol 80, no. 6 Jun 2009

Banana industry survey underway (*Production of pesticide good agricultural practice report*), F& V News vol 81, no. 8 September 2010

Chemical Update *(information on dimethoate permit for mites in pineapples)*, Pineapple Press October 2011

As minor use permits relating to market access were issued, they were publicized in Growcom's e-magazine, *Horticulture Now* and circulated to its readership.

Industry uptake

Industry uptake can be measured by the use of project outputs such as off-label permits, which have been swiftly used by industry as they were anxiously awaiting their availability. Outputs such as the Pesticide Good Agricultural Practice manuals will be supplied to the Australian Pesticides and Veterinary Medicines Authority APVMA for use as they are required. The PGAP for pineapples has already been referenced by APVMA in their review of the herbicide diuron, as has the Eggplant PGAP for the review of the insecticide, dimethoate.

Recommendations

The pineapple industry has benefitted greatly from the assistance of the Project officer as Growcom's Pest Management Officer (PMO), in progressing chemical access priorities for the industry. The role and function of the PMO is a valuable one which has been available to all horticultural industries via Growcom for the last decade under the auspices of several consecutive HAL funded projects. It is a vital resource that should not be lost. It is recommended that it be maintained. Growcom is also considering its options to fulfil this recommendation.

In an attempt to overcome market access issues, Growcom developed an independent project proposal for the national Coordination of Domestic Market Access (CDMA) for all of horticulture. The CDMA concept is consistent with Horticulture Australia Limited's (HAL) management of complex problems affecting multiple horticultural industries which are covered by the HAL Across Industry Program (AIP). However this project was unsuccessful.

The progression of market access issues for Queensland is an ongoing need to address. This has been echoed on a national scale within the Plant Health Australia National Plan Biosecurity Strategy where the solution to addressing present and future challenges in this area is addressed via the suggested adoption of nationally consistent plant biosecurity legislation, regulations and approaches. These harmonized laws will assist domestic trade and help Australia comply with its rights and obligations in international trade.

It is recommended that the project proposal for the national coordination of Domestic Market Access be revised and resubmitted for assessment. Growcom is considering its options to fulfil this recommendation.

Acknowledgements

The Project Officer would like to acknowledge the input and assistance of a number of Department of Employment, Economic Development & Innovation personnel Dr Siva Subramaniam, Iain Kay and Zara Hall for their assistance with silverleaf whitefly related matters; Kevin Bodnaruk (AH09003 - Plant protection: Regulatory support and co-ordination, conducted by AKC Consulting) and Les Davies (APVMA) for their assistance in the development of the Pesticide Good Agricultural Practice survey; and Col Scott, Les Williams and Julie Moore for assistance in the pineapple research and development progression.

Appendix 1.
Pineapple Pesticide Good Agricultural Practice report

Appendix 2.
Eggplant Pesticide Good Agricultural Practice report

Appendix 3.
Banana Pesticide Good Agricultural Practice report

Appendix 4.
Burdekin Cropping Calendar

Appendix 5.
Silverleaf Whitelfy management in vegetable crops

Pesticide Good Agricultural Practice in the Australian pineapple industry.

Report for the Australian pineapple industry December 2009.

TABLE OF CONTENTS

Introduction

This document was produced as part of Industry and HAL funded project HG08025 *Horticultural Pest Management Strategic Plan Review and on-going support.* The project aimed to improve pesticide access, including reduced withholding periods for selected pilot industries by the provision of quality data to replace conservative default modeling. Surveys returned useful data towards this goal however the amount of natural disasters in Queensland since December 2010 made it impractical and insensitive to place too many follow up questions with many industries as they were battling with the devastation of their crops, homes and infrastructure. Draft copies of the produced document were submitted to the project management team which included Kevin Bodnaruk (AKC Consulting) Peter Dal Santo (AgAware), and both were enthusiastic about the content and its ability to better serve the subject industries with provision of information to the APVMA. The areas where this will be of greatest assistance will lie in environmental reviews and assisting in the development of industry codes of practice. Instead of using default models reliant on old information, reviewing authorities will be able to refer to more current data that captures a more accurate snapshot of pesticide application. This may have a positive affect for industry with the decrease of buffer zones by supplying data on spray drift reduction practices. It may also allow industries the opportunity to draw on this information for the purposes of developing industry codes of practice, having identified what is the standard industry practice for pesticide application.

Pesticide Good Agricultural Practice in the Australian pineapple industry.

Surveys to determine Pesticide Good Agricultural Practice (PGAP) in the Australian pineapple industry were conducted as face to face and telephone surveys in July and December 2009, with some follow-up questions in January 2010.

Survey Purpose

The participating pineapple growers were advised that the survey results would be compiled into a confidential report for use by the Australian pineapple industry for the purpose of gaining new chemical registrations and maintaining existing ones, especially when older chemistry came under review by the Australian Pesticides & Veterinary Medicines Authority (APVMA).

Method

A qualitative PGAP questionnaire was developed and tested on-farm with respondents from cooperating pineapple production businesses. The questionnaire was then modified to improve data capture and relevance in response to input from the test businesses.

Being a qualitative survey, the aim is information to show trends in pesticide use rather than provide a statistical analysis.

Grower recruitment

Growers attending the 2009 Pineapple Field Day from all major pineapple production regions in Queensland were approached to participate in the PGAP process. Additional businesses were recruited at the December 2009 South East Queensland study group, to ensure adequate representation of the smaller producer businesses dominant in the industry.

A total of 17 pineapple businesses participated in the PGAP telephone survey. While most respondents were able to answer most of the questions, not all respondents were able to answer 100 percent of the questions. Where appropriate, the number of respondents who answered the question is shown in brackets. The data was complied and transcribed into an Excel spreadsheet and checked for integrity. Rudimentary analysis of the data was done and is presented below.

It is estimated that there are 150 businesses growing pineapples on 4,500 hectares in Australia. The survey covered businesses with farms varying in size from <20 hectares up to farms <400 hectares. While the survey only covered nine percent of the pineapple industry, those 17 respondent businesses hereafter referred to as ‘the respondents’, collectively farmed an estimated 2,012 hectares, representing 44 percent of the national pineapple production area.

Australian Pineapple industry: background

Statistics:
Common name: Pineapple
Scientific name: *Ananas comosus* var. *comosus*
Family: Bromeliaceae
Plant part analysed: whole commodity after removal of crown (Codex 2000).
Codex Classification: Group 14 – Assorted Fruit -Inedible peel (Codex 2000).
Farmgate Value: $65-70M (DPI&F 2007).
Average Total Quantity Grown per annum: 125,000 tonnes, consisting of:
Processing; 85,000 tonnes (60,000 bulks, 15,000 juice).
Fresh market; 40,000 tonnes.

Value of pineapples by region:
There are approximately 150 businesses growing pineapples in Queensland in seven production regions. However, 80 percent of the fruit for both fresh market and processing production comes from the Cooloola - Sunshine Coast region and is estimated to be worth $40M (CDI Pinnacle Management & Street Ryan & Associates 2004).

Pineapples for processing are generally not grown past the Wide-bay Burnett region due to prohibitive transport costs, whereas the higher value fresh market hybrid pineapples are produced as far north as the Atherton Tableland. The pineapple production from the Sunshine Coast and Cooloola Regions is worth $44 million (CDI Pinnacle Management & Street Ryan & Associates 2004).

Characteristics of pineapple farms:
Of the estimated 150 pineapple growing businesses, most are small family run operations, employing less than 25 people with most small (<20ha) to medium farms (<100ha) employing five to 10 people, a third of which tend to be casuals hired for harvesting and sometimes planting, but usually only when the two operations coincide.

Production:
Queensland is the main producer of pineapples, with negligible quantities produced in Northern NSW and the NT. The area planted to pineapples is currently 4,500ha, down from a peak of 5,870ha in 1993-4 (Nick McCleod, 1994, cited by Simon Newett 2007). Approximately 1,000 ha are planted annually. The industry is still 75% processing and 25% fresh market, with most of the recent contraction occurring in the processing sector (Tim Wolens, pers. comm. 2008).

Crop cycle:
There are two production phases; the plant crop and a ratoon crop. The plant crop is typically ratooned twice. The average crop is 18 months from planting to harvest. The average ratoon crop is 16 months from the plant crop harvest to the ratoon crop harvest.

Varieties:
The major varieties grown are Queensland Cayenne and Smooth Cayenne. Newer varieties, such as Bethonga Gold (7350) and Mareeba Gold (MD2) are being grown specifically for the fresh market. Although pineapples are available all year, the peak canning season is from January to March while the peak season for fresh fruit is from October to December. Pineapples are produced year round in Queensland and grow slightly faster in North Queensland and Far North Queensland compared to South East Queensland.

Processing varieties are based on cloned selections of smooth cayenne. Anecdotal evidence suggests that there is some variation between clones in susceptibility to the disorders translucency and black heart and to the virus disease mealy bug wilt (Newett *et al*. 2006, chapter. 6, p.3).

Fresh market varieties are still dominated by smooth cayenne processing clones, and smaller quantities of rough leaf pineapples, but this is changing with the marketing of branded topless guaranteed sweet hybrid pineapples, such as 70-30, MD2. More hybrids are being evaluated and a suite of locally bred Queensland Primary Industries and Fisheries (QPIF) hybrids are set to be introduced soon. Again there are some minor variations in susceptibly of the hybrids to blackheart, translucency, fuitlet core rot and Phytophthora (Newett *et al*. 2006, chapter. 7, pp. 3-6). Hybrid pineapples appear to be more susceptible to pineapple fruit mite, but this needs to be confirmed (Tim Wolens, Simon Newett, pers. Comm. 2005).

Description of pest problems:
The pineapple belongs to the hardy Bromeliad family, but is still subject to a number of serious pests. Pineapples are attacked by invertebrate soil dwelling pests, symphylids, white grubs, African black beetle and nematodes. The main foliage and fruit pests are red mite, mealybugs (which vector mealybug wilt) and ants which tend mealybugs.

Pineapples are susceptible to a range of diseases including phytophthora (heart rot and root rot), water blister, fruitlet core rot, leathery picket, yeasty rot and urea heart rot. Pineapples are also affected by a number of physiological disorders including, translucency and black heart as well as the virus disease mealybug wilt.

Occasionally vertebrate pests such as crows, rodents (especially rats), wild pigs and a range of native fauna (such water hens) can be serious pests in some districts.

Broadleaf and grass weeds, notably giant paspalum, Gatton panic, nut grass and ageratum are high priority pests in pineapple crops. Finding alternative management systems including herbicides to reduce industry's reliance on diuron is a priority, as the likely outcome of the Australian Pesticides and Veterinary Medicines Authority (APVMA) Review of diuron will see restrictions put on the amount of active used per hectare.

The severity of the abovementioned pests will vary significantly between and within districts, with many pests being soil/site specific.

Pest control in practice: an overview.

The pineapple industry is currently reliant on chemical pest control options, but has the potential to adopt integrated pest management (IPM) practices from other industries to improve pineapple IPM. The current key chemicals for invertebrate pests are organochlorines and organophosphates, of which most are under APVMA review Stockholm Convention for persistent organic pollutants (POPs Convention). These need to be replaced with more IPM compatible pesticides to enhance IPM and biocontrol.

Lindane is the main control option for Symphylids and chlorpyrifos is widely used for white grub management. However Lindane has been nominated to the Persistent Organic Pollutants (POPs) Convention and industry has almost exhausted stocks from the last import in 2007 (Redox 2009 pers. Comm.).

Growcom and Horticulture Australia Limited in partnership with Crop Care are investigating bifenthrin as an alternative to lindane and are in the process of registering Talstar® 200EC for pre and post plant symphylid control.

Pineapple mealybug control is obtained mainly through use of diazinon and chlorpyrifos. Chlorpyrifos is also used to control ant populations which tend the mealybugs. Dimethoate used under permit is the major control for red spider mites and a R&D project is underway to register the use pattern.

Soil fumigation is an important practice within the pineapple industry, with the main products used being 1, 3-dichloropropene / chloropicrin and sodium metham. Nematode management involves use of either of these soil fumigants or fenamiphos. Research into using organic matter to stimulate soil biology and help manage nematodes has been completed and a monitoring system to monitor and manage both nematodes and Phytophthora has been developed, but there has been almost no long-term adoption of this R&D.

Cultural practices such as avoiding surface water and erosion and maintaining the correct soil pH are of great importance in managing diseases in pineapples. Phytophthora is treated with both systemic and curative fungicides (phosphoric acid and metalaxyl respectively) and sodium metham has a label claim for control of phytophthora.

The pineapple industry has a new research project to improve phytophthora management and investigate the efficacy of the phosphonate use pattern.

Varietal selection (high acid fruit) and improved harvest management assist in managing yeasty rot which is a problem associated with advanced ripening or fruit cracking. Quaternary ammonium is used to treat urea heart rot, triggered by bacteria reacting with ammonia commonly found in stored surface water.

Management of weeds is through cultivation, soil fumigation (metham sodium) and herbicides including bromicil, diuron and ametryn. Reduction of weeds on headlands is an aid to rodent management in addition to the coumatetralyl bait stations used around crops. Management of birds and larger mammals is difficult due to licensing requirements and the prohibitive cost of netting.

Post harvest

Prochloraz is the main control option for water blister, and avoidance of irrigation during flowering is the only known prevention or treatment for fruitlet core rot / leathery pocket. However, management of mites and other insects, which crawl into blossom cups, is likely to minimize disease transmission. Propiconazole is a post-harvest treatment used to control base rot.

Pineapple Production Operations: a Summary.

The following information on production practices is only to provide context for good agricultural pesticide practice in the Australian pineapple industry. Detailed information on all aspects of production including farm layout, crop cycles by region, plant densities, varieties nutrition, can be found in the Pineapple Best Practice Manual (Newett, Sanewski, & Wassman 2006).

The pesticide practices used in the Australian pineapple industry were determined by conducting a survey of 17 pineapple business comprising 44 percent of the national production. The survey covered enterprises from <20 hectares up to farms <400 hectares.

Pineapple farms are typically set out in semi-permanent to permanent roads, drains and blocks. Over the four year crop cycle, blocks may either contain plant crop, ratoons (two) at various stages or be fallow. Depending on the size of the operation, pineapple blocks may vary in size from 0.4 hectare up to 10 hectares on the larger farms, with the industry average being 1.7 hectares.

Most pineapples in Australia (80 percent) are grown as a dryland crop, which is atypical of most horticultural crops. The pineapple is a bromeliad with long rosette leaves which overlap with each other as they grow. This crop architecture makes the use of post-plant granular fertilisers almost impossible to use.

The industry is therefore reliant on the use of hydraulic booms to apply foliar fertilisers at high volume during the crop cycle. Pesticides are often applied as tank mixtures with fertilisers.

Land preparation

Blocks are typically prepared by rotary hoeing in cover crops or the decomposed trash from the previous crop. Blocks that have a history of nematodes or problem weeds are usually fumigated with either metham sodium or 1, 3-dichloropropene plus chloropicrin.

Bedforming

Pre-plant insecticides and the post-plant fungicide metalaxyl are commonly applied before or as part of the bedforming operation using an implement mounted sprayer. It is uncommon for residual herbicides to be applied at this stage.

Typically a spray bar with four to five flat fan nozzles is mounted in front of the rotary hoe blades. A low flow pump of 200 to 400 litres is used to apply pesticides at low to medium volume. It is uncommon for residual herbicides to be applied pre-plant.

The few businesses that do not use implement mounted sprayers, apply pesticides using a hydraulic boom spray. Except for some of the biggest pineapple farms, typically only two to three hectares are prepared for planting at a time. This is because many pineapple soils types crust over after a few days, especially after rain and it becomes too hard to plant the pineapple crop.

Types of pesticides typically applied during bedforming are tank mixtures of chlorpyrifos and metalaxyl. Less common were tank mixtures of lindane and metalaxyl. This is to be expected as all commercial stocks of lindane have now been exhausted. Several businesses reported that they had successfully experimented with bifenthrin as a lindane replacement for symphylid control in their plant crop.

Some businesses that apply chlorpyrifos pre-plant and regularly (thee to six times) during the crop cycle at high volume claimed not to have a symphylid problem. This is a reasonable premise, given that chlorpyrifos is registered for symphylid control in sugarcane, albeit at a different rate.

Worker re-entry after application of pre-plant insecticides ranged from 2 hours up to one week. The main reason for re-entry was for planting.

Planting

Most growers use a planting aide to plant the crop. There are two types of planters. The spade planter and the drag planter ((Newett *et al.* 2006 Ch 9 p.5). The spade planter digs individual planting holes in the bed holes the drag planter makes a planting furrow on the top of the bed. Typically three people to five people are involved in planting, one driver and 2 planters, for tractor drawn planters and one driver/planter and three planters for self propelled machines.

Post-plant operations

Hydraulic boom sprays are universally used for most post plant operations; weed control, foliar and soil pest control and plant growth regulation.

Weed control

Immediate post-plant weed control

Residual herbicides are commonly applied immediately post-planting. Tank mixtures of the pre-emergents bromicil and diuron are widely used by industry and applied at high volume (3,774L/ha average).

The average work rate to apply post-plant herbicides via hydraulic booms at high volume is 1.57 hectares/hour.

Plant crop cycle

The amount of herbicides used in both the plant crop and ratoon cycles is highly dependant on rainfall. The wetter the season, the more weeds become a problem.

There are registrations for post-emergent selective herbicides for pineapples however they are rarely used on their own. More commonly, post-emergent herbicides are mixed or 'spiked' with pre-emergent herbicides such as diuron.

The average work rate to apply tank mixtures of pre and post-emergent herbicides in the crop cycle is 1.8 hectares/hour.

Ratoon cycle

The frequency of use of herbicides in the ratoon crop is highly dependant on rainfall and the time of year the block is planted. In dry years, herbicides may not be used at all in ratoons. The frequency of herbicide use in ratoons 0.7.
Of the 17 respondents interviewed, 35 percent had one other agricultural enterprise, with 11 percent having more than one agricultural enterprise.

Staffing

The 17 respondents surveyed collectively employed 184 staff, an average of 11 people per farm. Most of which were seasonal casual labour for harvest. Collectively the businesses employed 115 permanent staff, an average of 7 people per farm. Most permanent staff are family members.

Spray operators

All 17 respondents employed one or more spray operators with a number of respondents reporting they had a principal spray operator who did 90+ percent of all spraying. The average number of spray operators per business was two. The principal spray operator (n=7) sprayed an average of 52 hours per month.

Only 18 percent of the respondents employed mixer-loaders, with most respondents employing the spray operator to mix and load the pesticides.

All 17 of the respondents employed spray operators with level III minimum in pesticide application & safety training. Some employees did not have Level III training, but they were supervised by Level III staff within line of sight during spot spraying operations.

Unless restricted chemicals are used, it is not compulsory in Queensland for non-commercial spray operators to be licensed. The pineapple industry rarely if at all uses restricted chemicals, yet 88 percent of the spray operators held current certificates in pesticide application & safety training.

41 percent of the surveyed businesses were accredited under the Telone Training Program, but not all of these businesses currently used it.

None of the respondents employed spray contractors.

Personal protective equipment

The respondents were questioned about their use of personal protective equipment (PPE). This is a topic where respondents often tell researchers what they want to hear. To minimize this respondents were asked to be frank and were questioned on use of PPE at two different times during the questionnaire, so their answers could be compared. Many respondents made the point that under state and federal workplace health and safety laws, they provided a complete range of PPE, instructed employees on its use and required them to use it.

When questioned on what PPE was used when mixing and loading, 94 percent of respondents reported always using long gloves, compared to 64 percent who always used a face mask/respirator when mixing and loading pesticides. Only one respondent reported using a face shield when mixing toxic 6 pesticides.

When spot spraying herbicides, only 12 percent of respondents reported using overalls and only one respondent reported using waterproof boots.

Agricultural Chemical Infrastructure in the Australian Pineapple Industry

AGVET chemical stores

The Australian pineapple industry supplies product through the major fresh market channels of chain stores and central markets and to the processor Golden Circle. To be able to sell product, pineapple businesses must conform to supplier codes of practice, all of which require lockable chemical stores designed to Australian standard. Therefore it was assumed that respondents to the PGAP survey would comply in this area.

Filling stations

All respondents used filling stations when mixing at loading insecticides and 60 percent (n.15) reported that the filling points had wash down facilities. In addition 24 percent of respondents used water tankers to refill the boom sprayer onsite, however only 18 percent (n. 11) used the tankers to transport pre-mixed pesticides.

Machinery commonly used to apply pesticides in the Australian pineapple industry

In line with other Australian horticultural industries, the Australian pineapple industry is highly mechanized.

Fumigation

Fumigation in the pineapple industry is typically a one person operation. Fumigation for pineapple production is typically applied by shank injection using custom built three point linkage mounted rigs. Metham sodium is typically applied broadacre with press wheel rollers behind the shanks to seal in the fumigant.

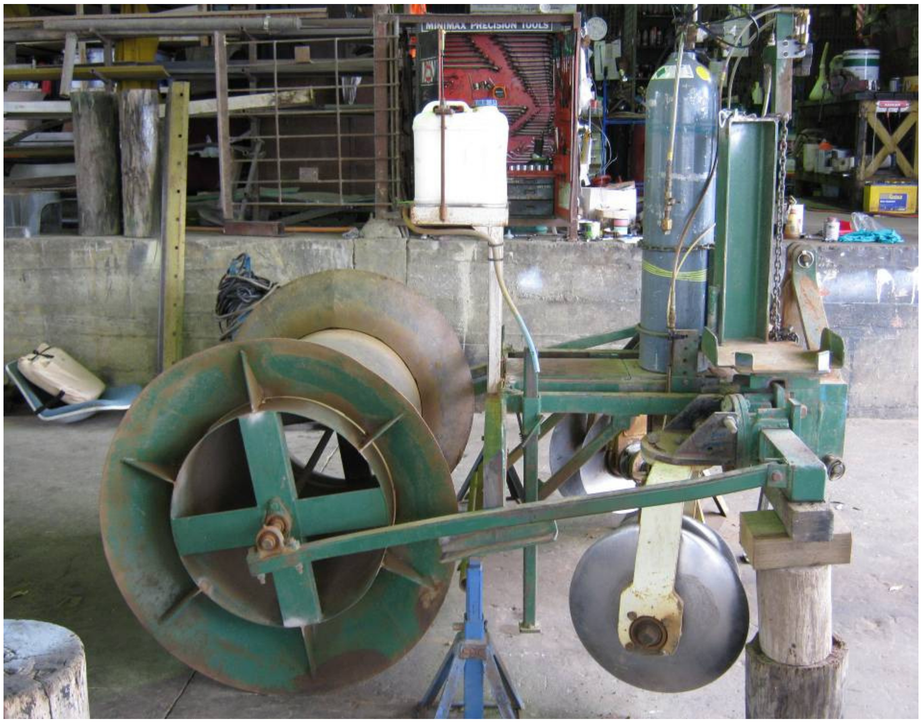


Photo 1 Telone fumigation rig

Because metham is used as a broadacre treatment, typically large tractors are used to pull the rig and these typically have enclosed cabs with charcoal filtration.

The metham is delivered to the injection shanks from 1,000 litre shuttles using a lock and load system.

The fumigant 1, 3-dichloropropene plus chloropicrin (Telone) is also typically applied by shank injection as a strip treatment. Press wheels or cotton reel rollers are typically used to seal the soil surface. Operators using 1, 3-dichloropropene plus chloropicrin must be accredited under the Dow Telone training program.

Telone is typically applied as a strip treatment using open cab tractors or enclosed cab tractors with charcoal filtration. The fumigant is delivered to the shanks from cylinders with the aid of liquid nitrogen. A coupling system is used to connect the cylinders to the fumigant lines.

Worker re-entry after fumigation is a minimum of seven days but more typically either 14 or 21 days after treatment (DAT). This is to ensure maximum efficacy and dispersal of the fumigant. The main reason for re-entry is for bed forming.

Implement mounted pre-plant sprayers

Implement mounted sprayers are commonly used throughout the pineapple industry to apply pre-plant pesticides, with 76 percent of respondents using spray bars mounted on rotary hoes.

Photo 2 Implement mounted pre-plant sprayer.

Some respondent's rotary hoes have been modified to include a bed former.
12 percent of respondents used open cab tractors to apply pre-plant pesticides with implement mounted sprayers.

When applying pre-plant pesticides with implement mounted sprayers, enclosed cabs were used by 70 percent of respondents, however 18 percent of the respondents cabs did not have charcoal filtration.

The above 70 percent of respondents using enclosed cabs with charcoal filtration included 2 respondents (12 percent) that applied pre-plant pesticides with boom sprays, rather than with an implement mounted sprayer, but excluded respondents that did not apply any pre-plant pesticides.

One respondent (five percent) did not apply any pre-plant pesticides because they were using new ground.

The average tank capacity of the implement mounted sprayers (n=13) was 485 litres. The average number of (n=11) of litres per hectare applied for pre-plant insecticide, excluding boom spray application was 755 litres.

Commonly used pre-plant pesticides

94 percent of respondents used a tank mixture of chlorpyrifos EC plus metalaxyl EC. Twelve percent of respondents used a tank mixture of lindane EC plus metalaxyl. Two respondents had started using bifenthrin EC in their plant crop.

Work rate

The average (n=11) work rate for mixing, loading and applying pre-plant insecticides with implement mounted sprayers was 3 hours per hectare.

Re-entry period

The most common reason given for re-entry into the insecticide treated area was for bed-forming 41 percent (n=14). Other reasons included planting (n=2) and fumigation (n=2) 12 percent respectively. The average re-entry period varied greatly and the average was 63 hours (n=14).

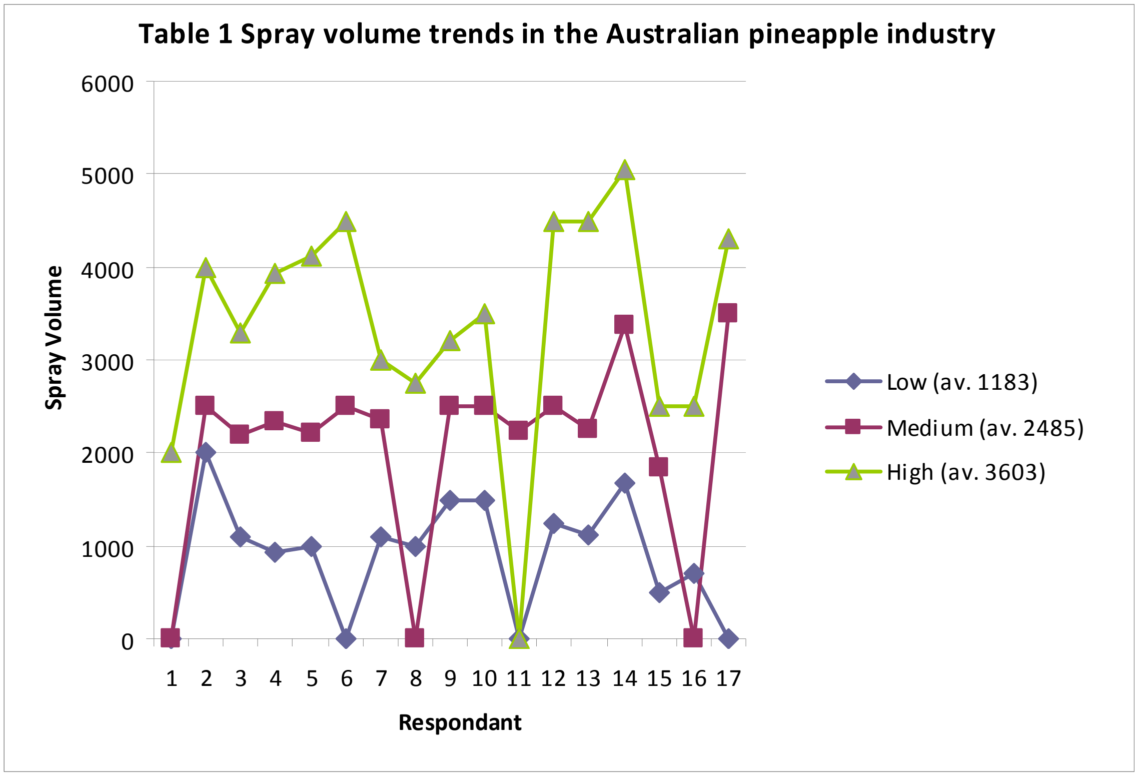
Post-plant insecticides

Pesticide application water volumes commonly used in the Australian pineapple industry

The pineapple industry is known for using hydraulic boom sprays to apply pesticides in high volumes of water, often tank mixed with fertilisers. This is reflected on the labels of many products registered for control of key pineapple pests, such as chlorpyrifos for mealybug and ant control; “apply in a minimum of 3,000L of spray/ha”.

However there does not seem to be industry consensus on definitions of low, medium and high volume spraying. Therefore respondents were asked if they used different water volumes when spraying and if they did, to define them into low/medium/high categories, see Table 1.

Illustration 1.



The industry spray volume averages were obtained only from the respondents that provided a definition per category. From Table 1 it can be seen that:

- Low volume spraying was defined as 1,183 L/ha average (range 500-2,000) (n=13).

- Medium volume spraying was defined as 2,485 L/ha average, (range 1,842-3,368) (n=14).

- High volume spraying was defined as 3,603 L/ha average (range 2,000-5,052) (n=16).

Many respondents claimed to use low volume for certain key operations such as ethephon for fruit ripening. Respondents typically used high volume spraying for flower induction, weed control with residual herbicides and soil-borne pest control. Medium volume spraying was used by many respondents to apply certain pesticides tank mixed with fertilizers.

All respondents used hydraulic boom sprayers to apply post-plant pesticides. All the respondents' boom sprayers were tractor drawn as opposed to custom built self propelled units. The boom sprayers tank capacity varied from <2000 litres to

7,000 the average tank capacity being 4,500 litres. Thirty-three (33) percent of respondents' booms (n=12) had on-board wash water.

Mixing and loading pesticides.

Respondents were asked how they mixed and loaded pesticides. All respondents reported using jug/scales to measure / mix insecticides. One respondent mixed pesticides at ground level and used an induction mixer (hopper) to load the pesticides into the tank. All other respondents mixed and loaded the pesticides on a tank platform, pouring them directly into the tank while the pump agitated the water.

No respondents used direct transfer methods such as stirrup pumps to load pesticides.

Applying Post plant Pesticides in the Australian Pineapple industry

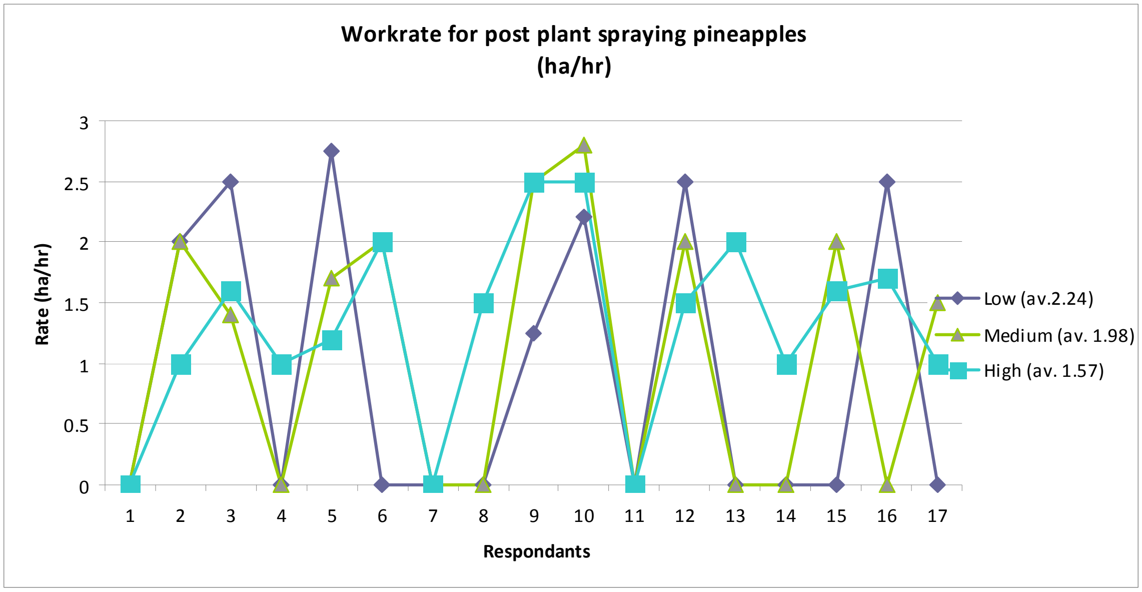
All respondents used custom built tractor drawn hydraulic booms to apply post plant insecticides. No respondents used self-propelled spray units.

Photo 3 Tractor drawn hydraulic boom spraying pineapples (Plant crop).

Work rates

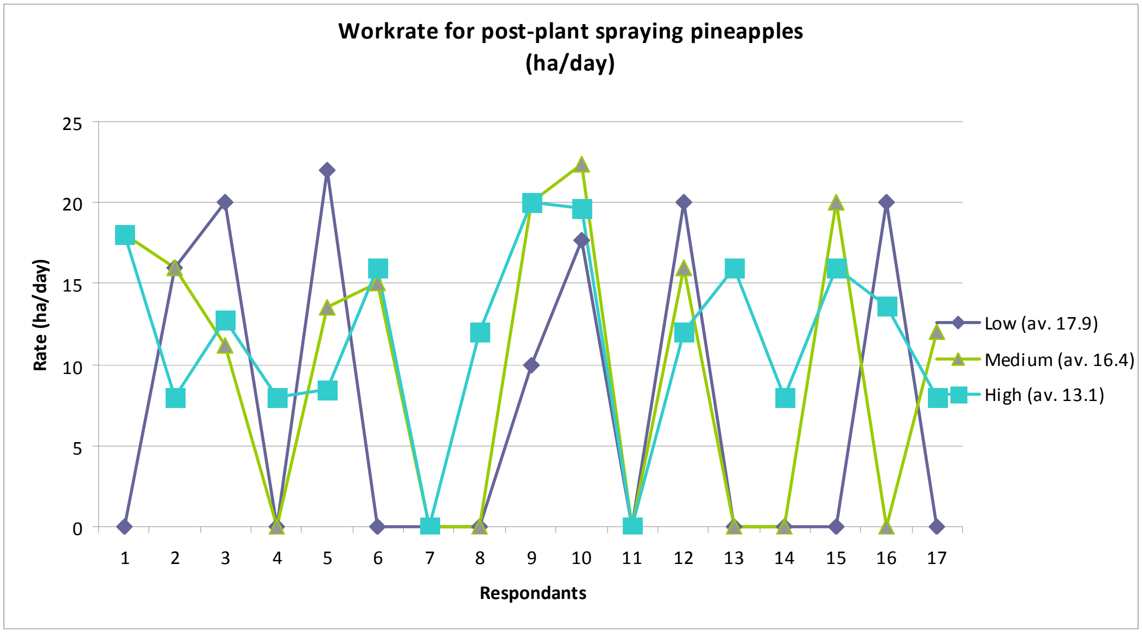
Respondents were asked to provide information on how long it took to mix and apply post-plant pesticides. The results are presented as the average number hectares sprayed per hour (refer Table 2) and the average number of hectares sprayed per eight hour day (refer Table 3) for low, medium and high volume spraying respectively. The averages in both Tables 2 and 3, are based only on the respondents that answered the question. Not all respondents used all three spray volume categories (low, medium, high). One respondent's work rate data was excluded on the basis that was outside the industry norm.

Illustration 2. Work rates in hectares per hour



Caution must be applied when interpreting work rates on a per day basis. As mentioned above, for some operations such as immediate post-planting applications of herbicides, typically only the freshly planted area – one or two blocks of one to two hectares or less – is treated at a time, not the whole farm. For these operations, the hourly work rate is relevant.

Illustration 3. Work rates in hectares per day



Weed control: Farm infrastructure

Calendar or routinely scheduled applications of certain pesticides are commonly used in the Australian pineapple industry. For example, diazinon, chlorpyrifos, metalaxyl and phosphonic acid, are often applied quarterly and large parts of or even the whole farm at times may be treated during one application 'round', generally over several days. In this instance daily work rates are relevant. Information has been provided on:

- Average pineapple farm size and number of blocks
- The average area of, number of and months pineapple blocks are planted.
- The average number of spray operators, average monthly hours worked by the principal spray operator.
- The average frequency of use of commonly used pesticides.

This information should allow the reader to interpret when hourly versus daily work rates are relevant.

Commonly used pesticides in Australian pineapple production: Post planting.

Respondents were asked about the frequency of their use of key post plant pesticides, the results are summarised in Table 1 below. To obtain realistic trends on industry averages of the frequency of pesticide use, respondents were asked to exclude any fertilizer only sprays. A separate sub-questionnaire on the use of ethepon was also conducted.

Diazinon

The average number of diazinon applications for all respondents was 3.5 in the plant crop, or two per annum.

Four of the respondents did not use diazinon. For those respondents that did, the 'average' number of diazinon applications in the plant crop cycle was 5, or 3 applications per annum (n=13).

Metalaxyl (Ridomil)

Metalaxyl is commonly used in the pineapple industry contrary to label instructions as a pre-plant application. The label recommends it as a post-plant treatment to be applied yearly, instead of applied in alternate years in rotation with other fungicides as is the industry practice. Because no specific 'DO NOT' statements are contravened, growers may have a defence to prosecution under Section 13B of the ***Chemical Usage (Agricultural and Veterinary) Control Act 1988.*** However, growers would need to seek expert legal advice first.

Several respondents made the point that in wet years more applications of metalaxyl will be made compared to dry years. Where respondents commented that metalaxyl was used 'as required' in the ratoon crop, this was counted as one application. All respondents used metalaxyl post plant, with an average of five applications in the plant crop or an average of three applications per annum. The respondents used an average of 2 treatments in the ratoon crop.

Phosphonic acid

Contary to label instructions, Phosphonic acid was used for control of Phytophthora throughout the crop cycle by most respondents. *Growers may have a defence to a prosecution as outlined above. The industry is undertaking research to address best practice Phytophthora management.

Plant Growth regulators

Respondents using the following plant growth regulators:
Ethephon 100 percent
Maintain 57 percent (n=14).

Table 1 Frequency of use of key post plant pesticides in the Australian pineapple industry

	Plant Cycle		Plant p.a.		Ratoon cycle		Ratoon p.a.	
	Mean Av All	Mean Av >0	Mean Av All	Mean Av >0	Mean Av All	Mean Av >0	Mean Av All	Mean Av >0
Diazinon	3.5	4.6	2.2	2.8	1.8	2.5	1.2	1.7
Metalaxyl	5.2	5.2	3.4	3.4	1.9	2.3	1.3	1.6
Phosphonic acid	6.8	7.2	4.3	4.5	5.2	5.9	3.5	4.0
Bromicil	1.4	1.4	1.2	1.2	0.6	1.0	0.4	0.8
Diuron	2.1	2.1	1.3	1.4	0.6	0.9	0.6	0.8
Ametryn	0.9	1.2	0.5	0.8	0.4	1.1	0.4	0.9
Nemacur 400 liquid	0.8	1.8	0.6	1.3	0.2	1.0	0.1	0.8
Dimethoate	2.2	3.1	1.5	2.6	0.5	1.8	0.5	1.7
Chlorpyrifos	3.2	3.9	2.0	2.4	1.0	2.8	1.4	1.9
Fusilade (FLUAZIFOP-P)	0.6	1.3	0.4	0.9	0.1	0.8	0.1	0.8

Respondents use of ethephon:

- Average (n=13) water volume (induction) = 2,587L/ha

- Average (n=12) water volume (ripening) = 1,3826L/ha.

- When timing ethephon induction sprays, 20 percent of respondents monitored temperature.

- 67 percent of respondents only applied or applied the bulk of their ethephon induction sprays at night.

- 80 percent of respondents (n=15) used split applications of ethephon for flower induction of cannery fruit.

- Compared to 12 percent of respondents (n=15) who used split applications of ethephon for ripening.

- 44 percent of respondents (n=16) used split applications of ethephon for flower induction of fresh market fruit.

- Compared with 13 percent of respondents (n=15) who used split applications of ethephon for ripening of fresh market fruit.

- When asked how they determined when to pick the crop, 13 percent of respondents (n=15) monitored brix.

- Compared to 20 percent of respondents (n=15) who used visual / olfactory methods i.e. full eyes, cut fruit, juice running, taste test.

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Pesticide Good Agricultural Practice in the Australian eggplant industry.

Report for the Australian eggplant industry May 2010.

TABLE OF CONTENTS

Introduction

This document was produced as part of Industry and HAL funded project HG08025 *Horticultural Pest Management Strategic Plan Review and on-going support.* The project aimed to improve pesticide access, including reduced withholding periods for selected pilot industries by the provision of quality data to replace conservative default modeling. Surveys returned useful data towards this goal however the amount of natural disasters in Queensland since December 2010 made it impractical and insensitive to place too many follow up questions with many industries as they were battling with the devastation of their crops, homes and infrastructure. Draft copies of the produced document were submitted to the project management team which included Kevin Bodnaruk (AKC Consulting) Peter Dal Santo (AgAware), and both were enthusiastic about the content and its ability to better serve the subject industries with provision of information to the APVMA. The areas where this will be of greatest assistance will lie in environmental reviews and assisting in the development of industry codes of practice. Instead of using default models reliant on old information, reviewing authorities will be able to refer to more current data that captures a more accurate snapshot of pesticide application. This may have a positive affect for industry with the decrease of buffer zones by supplying data on spray drift reduction practices. It may also allow industries the opportunity to draw on this information for the purposes of developing industry codes of practice, having identified what is the standard industry practice for pesticide application.

Pesticide Good Agricultural Practice in the Australian eggplant industry.

Surveys to determine Pesticide Good Agricultural Practice (PGAP) in the Australian eggplant industry were conducted as telephone surveys in April and May 2010, with some follow-up questions in June 2010.

Survey Purpose

The participating eggplant growers were advised that the survey results would be compiled into a confidential report for use by the Australian eggplant industry for the purpose of gaining new chemical registrations and maintaining existing ones, especially when older chemistry came under review by the Australian Pesticides & Veterinary Medicines Authority (APVMA).

Method

A qualitative PGAP questionnaire was developed and tested via telephone with respondents from cooperating eggplant production businesses. The questionnaire was then modified to improve data capture and relevance in response to input from the test businesses.

Being a qualitative survey, the aim is information to show trends in pesticide use rather than provide a statistical analysis.

Grower recruitment

Growers were selected by the Pest Management Officer, from the Growcom database.

A total of 7 eggplant businesses participated in the PGAP telephone survey. While most respondents were able to answer most of the questions, not all respondents were able to answer 100 percent of the questions. Where appropriate, the number of respondents who answered the question is shown in brackets. The data was complied and transcribed into an Excel spreadsheet and checked for integrity. Rudimentary analysis of the data was done and is presented below.

Australian Eggplant industry: background

Statistics:

Common Name: Eggplant (Aubergine)
Scientific name: *Solanum melongena*
Family: Solanaceae

Codex Classification: Group 7 – Fruiting Vegetable – Edible Peel (Codex 2000).
Edible Plant part: Whole commodity after removal of stems (Codex 2000).
Value (state): $22M+ (Industry estimate).
Grown: ~260ha
Average yield: 23.5 tonnes/ha

Queensland Production

Value of eggplant by region

Bundaberg 30ha ($2.4M) (Lovatt 2006).
Bowen 120ha (Industry estimate).
Gumlu 30ha (Industry estimate).
Burdekin 110ha (Industry estimate).
Other 20ha (Industry estimate).

Characteristics of eggplant farms

It is difficult to estimate how many eggplant farms are in operation, as the numbers have greatly reduced over the last 10 years. The Growcom database listed 129 businesses that grew eggplant. Many growers have since retired or ceased to grow the crop. However the 7 farms interviewed are all small family operated businesses that are staffed by 3 to 4 family members and employ up to 20 workers during peak season. The farms of the survey respondents range in size from 1.5 to 14.5 hectares. Only one surveyed business grows under a protected cropping system. Respondents' farms varied in the number of blocks allocated to eggplant production from 2 blocks to 18. The size of these blocks was also quite variable, ranging from 0.16 to 2.5 hectares.

Production

Due to the climatic requirements of the crop, Queensland is the main producer of eggplant with the majority of production in the Burdekin area. It is also grown in smaller pockets of the country, such as the Sydney basin, Mildura, Perth and Carnarvon. Queensland farmers who grow eggplant tend to grow other small crops as well, frequently other fruiting vegetables such as chillies, zucchinis and pumpkins. One rather large business in that area has had a significant impact on other smaller businesses, causing many to cease growing the crop due to production competition. The owner of this business was unable to be contacted for this survey.

Crop cycle

Queensland planting times appear to have no set pattern amongst the growers surveyed. Growers either have one larger growing period (6-7 months) or two shorter ones (2 months), with the majority growing within the months of January to August. Carnarvon plantings occur from January to April and July to mid August. Crops in the Perth metropolitan area are usually planted from September to December. Sydney plantings occur through November to April.

Fruit in traditional teardrop shape fruit varieties are ready for harvest 50–70 days after transplanting or one month after fruit set. These varieties can crop for up to five months. Long, slim, cylindrical varieties can be picked when 1–2 cm in diameter and 5–10 cm long. Eggplants will crop over a long period of time and yield 5000–8000 18 L cartons (6–8 kg) containing 12–20 fruit per carton. (Agfact H8.1.29, third edition 2003)

Varieties

The most common commercially produced eggplants are the large teardrop dark purple varieties. The market currently prefers medium sized dark shiny skinned varieties. However, different varieties of eggplant can have noticeably different levels of damage susceptibility to western flower thrips and melon thrips, but some of the more resistant types tend to have a matt skin rather than a shiny skin, as sought by the market.

Description of pest problems

Eggplant belongs to the Solanaeace family and is affected by many of the same pests as tomatoes and capsicums. While the pest spectrum can vary slightly between production districts, the main arthropod pests are two spotted mites (TSM), tomato leaf miner, heliothis, silverleaf white fly (SLWF), eggfruit caterpillar, western flower thrips, melon thrips, onion thrips and aphids. While eggplant is considered a poor fruit fly host by regulatory authorities, it has been elevated to fruit fly host for the purposes of trade to Victoria to meet the requirements of the Greater Sunraysia Pest Free Area. Soil dwelling pests such as cutworms, army worms and wireworms can be a major issue in some districts. Broad mite is a sporadic pest of the crop.

Bacterial and Verticillium wilt are major disease problems of eggplant in the important production districts of Bundaberg, Bowen-Gumlu and the Burdekin and can make eggplant production on infected ground uneconomic. Fusarium and anthracnose are moderately important disease pests of the crop. Nematodes are a problem on lighter sandy soils, especially in Bundaberg.

The important foliar diseases of eggplant include Phomopsis blight and to a lesser extent Alternaria and Cercospora leaf spot.

Broadleaf weeds and grasses are an issue for the crop, with blackberry nightshade, marshmallow, small and giant pigweed the most important pests.

Pest control in practice: an overview

The industry is constrained in its ability to implement good crop management systems including integrated pest management (IPM) practices by the lack of narrow spectrum chemicals registered for use in eggplant crops.

The Bowen-Gumlu production area has implemented voluntary two month season break over the summer when it is too hot to grow vegetables, which has helped in the management of SLWF. By comparison, Bundaberg, with a slightly milder climate, has continuous vegetable production 12 months of the year. The naturalisation of the introduced silverleaf whitefly parasite *Eretmocerus hayti* has noticeably reduced SLWF populations in Bundaberg and the Lockyer Valley over the past two years, reducing the population spikes, but problems can still arise if blocks are kept too long.

The following research development and extension has been conducted on integrated crop management including on major pests of eggplant and related Solenaceous crops, for example, VX99029 - *Monitoring and diagnostic aids for predicting and managing soil-borne diseases in fresh tomatoes* and VG502 - *A production-break strategy for tomato leafminer in Queensland,* VG96008 *Eggfruit caterpillar (Sceliodes cordalis (Doubleday)) pheromone development and control methods*; VG00026 *Development and implementation of IPM systems in eggplant and capsicu*m; VG05052 *Refining IPM of eggfruit caterpillar* and VG03099 *Provision of western flower thrips technology transfer services in Bundaberg and Bowen* (in progress at time of writing).

Compliance with Interstate Certification Assurance (ICA) protocols limits and/or negates the success of IPM strategies, as they often require harsh knockdown chemicals. For example ICA -26 *Pre-harvest Treatment of Tomatoes, Capsicums, Chillies and Eggplant,* requires the pre-harvest use of disruptive organophosphate insecticides for market access to Victoria (DPI&F 2008).

Soil-borne diseases can be managed by following the principles of integrated disease management. On farm biosecurity measures and farm management planning can help reduce the introduction/incidence of soil-borne and weed pests.

The use of grafted rootstocks to manage bacterial wilt (*Ralstonia solanacearum)*, is not practical, however, research from Australian Centre for International Agricultural Research, (ACIAR) project SMCN/2000/114: *Evaluating biofumigation for soil-borne disease management in tropical vegetable production* has shown that bacterial wilt can be successfully managed using brassica mulches which contain biocidal compounds (isothiocyanates).

Long crop rotation with sugarcane (four years crop, one year fallow) with a non-host crop has been observed to considerably reduce bacterial wilt incidence to commercially acceptable levels, but not for verticillium wilt. All short and long-term management options need further investigation, especially biofumigant control of soil-borne diseases and nematodes in the sub-tropics and tropics.

Cultural methods for weed control include strategies, which are generally used in the course of production as ‘good management practices’. Crop rotations and hygiene, maintaining crop health and correct pest identification all fall within this category.

Plastic mulch is commonly used for weed control, but disposal of plastic is becoming a serious problem, especially in Bowen and Gumlu. Trials of biodegradable plastic mulch products made of 100% cornstarch have been conducted in Bowen and have shown early promise of providing a cost effective alternative to traditional plastics, when comparing the cost of removal and disposal of conventional polyethylene film.

Post harvest

The majority of the surveyed growers were not applying any post-harvest treatments to their fruit. Only one respondent was dipping fruit as per ICA01 with Dimethoate or Fenthion.

Eggplant Production Operations: a Summary

Seedlings are planted when they are between 6-10 weeks old in blocks of between 1 to 2 hectares. Growers tend to stagger their planting times at monthly intervals over their chosen planting period. Farm sizes are relatively small, with the area under production for eggplant ranging from 1.5 to 14 hectares. As most operations are of a small scale, the application of pesticides tends to be undertaken by the owner or a family member on staff. None of the surveyed growers employ spray contractors or mixer / loaders to apply their pesticides and fertilizers. Pesticide application is either the role of one or two people, usually the owner of the business and a designated family member. Most of the surveyed growers are using tractor drawn boomsprays to apply pesticides and are applying fertilizer though trickle irrigation systems; the exception being the protected cropping respondent who uses a self propelled hand held spray rig. Prior to harvest, two of the seven respondents mentioned they are applying Fenthion as per ICA26, one stated he is using a chlorine wash. The others did not stipulate. Only one of the surveyed growers is dipping fruit as per ICA01 with Dimethoate or Fenthion.

Land preparation

Land preparation starts several months before transplanting. Eggplants are best transplanted into raised beds for better drainage and only when soil temperature is above 20℃. Black plastic mulch is widely used in early crops to help to raise soil temperatures and control weeds. (Agfact H8.1.29, third edition 2003). None of the respondents reported using pre-plant spraying or fumigation. However, one respondent uses Nemacur as a granular application and 2 other respondents apply Metham through the trickle as their pre-plant treatments.

Post-plant operations

Most of the respondents are using tractor drawn boomsprays to apply pesticides with the specific addition of shielded sprayers for herbicide application and are applying fertilizer though trickle irrigation systems; the exception being the protected cropping grower who uses a self propelled hand held spray rig. Tank mixing occurs mostly with insecticides used for whitefly control and copper based fungicides. Applications are either at medium to high volumes. Re-entry times are determined by the withholding period (WHP) on the product label.

Weed control

Herbicides such as Basta™, Round Up™ and Sprayseed™ are commonly used within the industry. Application is via tractor pulled boomsprays with shielded sprayers, except for protected cropping where a hand operated knapsack sprayer is used.

Staffing

The seven respondents collectively employed fifty-nine staff, an average of eight people per farm. Most of which were seasonal labour for harvest. Collectively the businesses employed twenty-five permanent staff, an average of three per farm. Most permanent staff are family members.

Spray operators

None of the respondents employed a spray contractor, with all respondents reporting the owner or a family member being the principal spray operator. Three respondents shared the spray duties with another staff / family member, with the principal spray operator undertaking 60% of the spraying. The principal spray operator sprayed an average of nineteen hours per month.

None of the respondents employed mixer-loaders. All respondents reported using measuring jugs and scales to mix their pesticides. Five of the respondents mix their pesticides at ground level while two use a tank platform.

All but one respondent stated that their spray operators were Chemcert accredited, with intentions of gaining accreditation in the near future for the one that didn’t have it.

Respondents were asked to comment on the number of hours per month that spraying took place. The results didn’t seem to follow any trends and ranged from two hours to forty-eight hours per month. The respondent with the smallest farm area (in field production) stated they sprayed two hours per month, where as the protected cropping respondent with a slightly smaller area than that, sprayed significantly more at forty hours per month.

Personal protective equipment

The respondents were questioned about their use of personal protective equipment (PPE). This is a topic where respondents often tell researchers what they want to hear. To minimize this, respondents were asked to be frank, and were questioned on the use of PPE at two different times during the questionnaire, so their answers could be compared.

All respondents reported using gloves and a mask when mixing pesticides, however their method of pesticide application affected the use of PPE during spraying. For example, one respondent applies pesticides using a boom pulled by a tractor which has an enclosed cab fitted with charcoal filters. Thus they feel that they are not exposed to the spray and do not use PPE during spray application.

Goggles and face shields seem to be the least frequently used PPE item, with three out of seven respondents wearing them. Two respondents reported not wearing overalls when either mixing or applying pesticides. Respondents were asked if they wear waterproof boots as PPE and although all respondents stated they wore boots or enclosed footwear, only four of the seven respondents stated that their boots were waterproof.

PPE such as gloves was stated as being used during fruit packing by two respondents.

Agricultural Chemical Infrastructure in the Australian Eggplant Industry

Filling stations

All but two respondents reported using a filling station for mixing and loading pesticides. One respondent stated they have two filling stations, the others (n=4) all have one. Those with filling stations have some kind of wash down facility or a tap / hose close by.

Re-entry period

Respondents were questioned about their re-entry periods after crop spraying. The label withholding period was cited as the appropriate length of time. If nematicides were applied, the main reason for re-entry was planting.

Post-plant insecticides

Pesticide application water volumes commonly used in the Australian eggplant industry

Open field growing respondents apply their pesticides using boom sprays with tank capacities between 800L to 2,000L. Three of these have onboard wash water, with one respondent signalling their intention to install it in the near future.

Respondents use spray volumes that they describe as either medium (approx 600 - 800L/Ha) or high (approx 1,000 - 1,500L/Ha). Three respondents, including the protected cropping grower solely use high volume spray applications; three use solely medium volume applications; and one uses both.

Mixing and loading pesticides.

None of the respondents employed mixer-loaders. All respondents reported using measuring jugs and scales to mix their pesticides. Five of the respondents mix their pesticides at ground level while two use a tank platform.

Applying Post plant Pesticides in the Australian eggplant industry

Work rates

Respondents were asked to provide information on how long it took to mix and apply post-plant pesticides. The respondents were questioned about their work rates at two separate times in the survey and their answers compared. Questions relating to work rates were poorly answered and at first, three growers were unable to give an answer to the question at all. This improved to one grower being unable to answer the question the second time it was asked.

From the answers given, the work rate appears quite low due to the small size of the farms. It would seem that growers could easily spray two hectares in an hour, with the maximum farm size being 14ha. However respondents may only spray one or two blocks within a month, thus only a portion of their total cropping area. The tank capacity also influenced the number of tanks they used, but because of the small area involved, most respondents would only use part of a tank.

Nozzle types commonly used

Respondents reported using a variety of cone and fan nozzles for the pesticide application. One respondent was unable to answer and despite follow up did not supply the relevant information. Nozzle types included:

- Size 2 yellow fan T-jet;
- Fan jets (unspecified type);
- Fan nozzle, air inducted;
- Cone hardy;
- Cone – red nozzle, hardy; and
- Ceramic D3 equivalent.

Operating spray pressure

The rate of spray pressure used amongst the respondents was quite varied. Respondents' understanding of low, medium and high pressure was questionable. No respondents reported using low pressure in their spray operations. 57% (n=4) of respondents reported using medium pressure, 28% (n=2) used high pressure and one was unable to answer. Values quoted ranged between 300kpa to 1723kpa with the lowest value interpreted as high pressure by the respondent.

Commonly used pesticides in Australian eggplant production: Post planting

Respondents were asked to give information on the frequency of use, volume of application and tank mixing for key post-plant pesticides. These questions were answered poorly with very little information given on the frequency of use.

Table 1. Commonly used pesticides in Australian Eggplant production

Chemical	Responses	Alternative chemistry used
Trichlorfon (e.g. Dipterex)	100% Not used	Spinosad (Success), spirotetramat (Movento), fenthion (Lebaycid), dimethoate, chlorpyrifos (Lorsban)
Frequency	-	
Volume	-	High – Spinosad (Success), spirotetramat (Momento), fenthion (Lebaycid), Med – chlorpyrifos (Lorsban), fenthion (Lebaycid), dimethoate
Tank mixed	No	Yes – dimethoate with Cu fungicide (1)
Trifluralin / **glyphosate (Roundup)** / **paraquat (Sprayseed)** / **glufosinate-ammonium (Basta)**	Not used 57% use 28% use 57% use	
Frequency	Paraquat (Sprayseed) – 2 sprays per season (1)	
Volume	High – Paraquat (Sprayseed) Med – glufosinate-ammonium **(**Basta), glyphosate (Roundup)	
Tank mixed	No	
Zineb	14% use	Sulfur
Frequency	-	
Volume	-	High - Mancozeb (Dithane), chlorothalonil (Barrack)
Tank mixed	No	
Chlorothalonil (e.g. Bravo)	57% use	
Frequency		
Volume	High (1) Med (1)	
Tank mixed	Yes - Nitrasoap (1) Yes – Bifenthrin (Talstar) (1) Yes – Cu fungicides (1) No (4)	

Table 1. Cont…

Chemical	Responses (# respondents)	Alternative chemistry used
Copper fungicides	100% use	
Frequency	Occasionally after rain (1)	
Volume	High (2) Med (1)	
Tank mixed	Yes – chlorothalonil (Barrack or Bravo) ((1) Yes – methomyl (Lannate), Dimethoate (1) Yes – bifenthrin(Talstar), spinosad (Success), beta-cyfluthrin (Bulldock), pymetrozine (Chess) (1) Yes – mancozeb (Dithane) (1)	
Endosulfan	42% use	
Frequency	Sparingly, has 10L left to use up (1) Rarely (1) 2 sprays per crop (1)	
Volume	High (1)	
Tank mixed	Yes – methomyl (Lannate)	
Other chemistry used		Fenthion (2)
		Methomyl (Lannate) (2)
		Fenthion (Lebaycid) (2)
		Dimethoate
		Bifenthrin (Talstar) (2)
		Pymetrozine (Chess) (3)
		Bts
		Imidacloprid (Confidor) – thru trickle
		Indoxacarb (Avatar)
		Spinosad (Success) (2)
		Pirimicarb (Pirimor)
		beta-cyfluthrin (Bulldock)
		Pyriproxyfen (Admiral)

When discussing pesticide use with respondents, it was noted that several pesticides they claimed to use were not registered for use in eggplant. However, these responses came from those respondents that grew other crops as well as eggplant. Investigation proved that the pesticides in question were registered for use on their other crops. It would appear that at the time of questioning, they may have had some confusion over which crops they were referring to with their pesticide use.

Trichlorfon:

None of the respondents reported using this pesticide. Trichlorfon is registered for use in vegetables against Cabbage white butterfly, cabbage moth, green vegetable bug and Rutherglen bug. Respondents suggested

alternative chemistry such as: Success; Lebaycid; Lorsban; Movento and Dimethoate. There is speculation that respondents were mislead by the question explanation that Trichlorfon was used on fruit fly.
Success is registered to control similar pests, but is only registered for use in vegetables to control Potato moth, Heliothis and Western Flower Thrips on eggplant.
Lebaycid is registered to control fruit fly on eggplant, but not other lepidopteran pests mentioned on the Trichlorfon label.
Lorsban (chlorpyrifos) is registered to control field crickets and mole crickets on eggplant.
Dimethoate is registered to control Aphids, Thrips, Leafhoppers (including Jassids), Mites and Green Vegetable Bug on eggplant.
Movento is relatively new chemistry that is registered for use against thrips and sucking pests in a variety of crops including brassica vegetables, lettuce, cucurbits, brassica leafy vegetables and leafy vegetables. The grower who suggested this use also grows zucchinis.

Herbicides: trifluralin, Roundup, Sprayseed & Basta

Respondents reported using at least one of the herbicides listed above. Two reported using both Basta and Roundup. Paraquat and Gramoxone were also used by one respondent. Applications of herbicides were stated as being high and medium volume by two respondents respectively. One respondent stated they apply two sprays per season of Sprayseed.
Paraquat is registered as a pre-crop emergent weed control in vegetable crops.
Gramoxone is registered for use in Vegetables as a pre-planting and pre-crop emergence, post-emergence, inter-row weed control, seedling weeds and older weeds herbicide.

Zineb:

Zineb is available for use on Anthracnose (*Colletotrichum spp*) in eggplant under PER8768 and for control of Early Blight, Late Blight as per the product label. Only one respondent reported using this product. Others suggested that they use Sulphur, Dithane (mancozeb), Barrack (chlorothalonil) as suitable alternatives.
Sulphur is registered for use on vegetables to control Powdery Mildew and Rust in Queensland.
Dithane is registered for Downy Mildew in cucurbits, however, not for eggplant. The respondent that cited this product also grows zucchinis, on which he may use Dithane.
Barrack as a brand of chlorothalonil is not registered for use on eggplant, however the grower in question also grow zucchinis, for which it is registered.
It was noted that another respondent stated they did use zineb on their chillies, but not their eggplant crop. This is perhaps a memory lapse on which product is used on which crop and not an actual contravention of the label.

Chlorothalonil:

Respondents reported using this fungicide (Bravo) although PER11083 for the control of *Botrytis cinerea* in eggplant has expired and the use is no longer sanctioned by a permit. One respondent acknowledged that another permit is required for this use, along with one for Bayfidan. Another respondent stated that he used Bravo on his chillies, but did not specify whether he used it on eggplant. Two of the seven respondents stated that they don't use chlorothalonil at all, but it is obvious that it is being used and that it is still required by industry. Two respondents tank mix chlorothalonil with other pesticides; one with Natrasoap and the other with Talstar. Applications of chlorothalonil were stated as being high and medium volume by two respondents respectively.

Natrasoap is registered for use on vegetables for the control of Aphids, Thrips, Mealybug, Two Spotted Mite, Spider-mite and Whitefly.

Talstar PER10058 permits the use of Talstar on eggplant for use against Silverleaf Whitefly, however it has expired as of 30 April 2010.

Copper fungicides:

Respondents stated that they use copper hydroxide, kocide, copper blue and Coppox as specific types of copper fungicides. Four respondents tank mix their fungicides with other fungicides such as Dithane, Barrack or Bravo or insecticides such as Lannate, Dimethoate, Talstar, Success, Bulldock or Chess. Applications of copper fungicides were stated as being high (2) and medium (1) volume by three respondents respectively.

Lannate (methomyl) is permitted for use against Heliothis *(Helicoverpa spp.),* Cucumber moth *(Diaphania indica*), and Cluster caterpillar (*Spodoptera litura)* in eggplant under PER10334. This is due to expire 30 September 2010.

Bulldock (beta-cyfluthrin) appears not to be registered or permitted for use on eggplant or any of the other crops that the respondents are growing.

Chess (pirimacarb) was available for use on eggplant to control Silverleaf Whitefly under PER10678. However this expired 30 April 2010.

Endosulfan:

Three respondents stated they are using endosulfan. The protected cropping grower stated that it is banned in greenhouses, thus he doesn't use it; another respondent rarely uses it; and one made comment that they no longer use it. One respondent applies it twice per crop. Only one respondent tank mixes endosulfan with another insecticide, lanate.

Other chemistry:

Respondents stated that they are using the following pesticides other than those they were specifically questioned about: Fenthion; Lannate; Lebaycid; Dimethoate; Talstar; Chess; Bts; Avatar; Success; Pirimor; Bulldock; and Admiral. Where uses were permitted by permits that have expired, it is assumed that the industry requires renewals for those permits and or progression to labelled use. Although some ambiguity exists over the use of certain chemicals, it is assumed that a grower spraying one crop (other than eggplant) would like to use the same pesticide on their eggplant crop.

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Pesticide Good Agricultural Practice in the Australian banana industry.

Report for the Australian banana industry July 2010.

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Introduction

This document was produced as part of Industry and HAL funded project HG08025 *Horticultural Pest Management Strategic Plan Review and on-going support.* The project aimed to improve pesticide access, including reduced withholding periods for selected pilot industries by the provision of quality data to replace conservative default modeling. Surveys returned useful data towards this goal however the amount of natural disasters in Queensland since December 2010 made it impractical and insensitive to place too many follow up questions with many industries as they were battling with the devastation of their crops, homes and infrastructure. Draft copies of the produced document were submitted to the project management team which included Kevin Bodnaruk (AKC Consulting) Peter Dal Santo (AgAware), and both were enthusiastic about the content and its ability to better serve the subject industries with provision of information to the APVMA. The areas where this will be of greatest assistance will lie in environmental reviews and assisting in the development of industry codes of practice. Instead of using default models reliant on old information, reviewing authorities will be able to refer to more current data that captures a more accurate snapshot of pesticide application. This may have a positive affect for industry with the decrease of buffer zones by supplying data on spray drift reduction practices. It may also allow industries the opportunity to draw on this information for the purposes of developing industry codes of practice, having identified what is the standard industry practice for pesticide application.

Pesticide Good Agricultural Practice in the Australian banana industry.

Surveys to determine Pesticide Good Agricultural Practice (PGAP) in the Australian banana industry were conducted as telephone surveys in June, July and August 2010.

Survey Purpose

The participating banana growers were advised that the survey results would be compiled into a confidential report for use by the Australian banana industry for the purpose of gaining new chemical registrations and maintaining existing ones, especially when older chemistry came under review by the Australian Pesticides & Veterinary Medicines Authority (APVMA).

Method

A qualitative PGAP questionnaire was developed and tested with respondents from cooperating banana production businesses. The questionnaire was then modified to improve data capture and relevance in response to input from the test businesses.

Being a qualitative survey, the aim is information to show trends in pesticide use rather than provide a statistical analysis.

Grower recruitment

A list of banana growers was made from Growcom's membership database. Growers were then telephoned and asked to take part in the survey.

A total of nine banana businesses participated. While most respondents were able to answer most of the questions, not all respondents were able to answer 100 percent of the questions. Where appropriate, the number of respondents who answered the question is shown in brackets. The data was compiled and transcribed into an Excel spreadsheet and checked for integrity. Rudimentary analysis of the data was done and is presented below.

It is estimated that there are 324 businesses growing bananas on 11,540 hectares in Queensland alone. The survey covered businesses with farms varying in size from five hectares up to farms 600 hectares. While the survey only covered 10 percent of the banana industry listed on the Growcom database, those 9 respondent businesses hereafter referred to as 'the respondents', collectively farmed an estimated 2,745 hectares, representing 24 percent of the Queensland banana production area. (Based on ABGC 2008-09 statistics) The respondents include several larger businesses that operate on multiple farms, thus although there may have only been 9 farm owners surveyed, the information gathered covers 14 farming locations throughout the state.

Australian Banana industry: background

Statistics:
Scientific name: *Musa* spp.
Family: Musaceous
Codex Classification: Group 14 – Assorted Fruits – Inedible Peel (Codex 2000).
Plant part analysed: whole commodity after removal of crown tissues and stalks.
Value (state): $340M
Grown: 265,000 tonnes (20.4M 13kg Cartons). (ABGC 2008).
Production area: 14,000 ha.
Average national yield: 29 tonnes/ha.
Average number of plants/ha: 1,500-2000.
Per captia consumption: 14kg/p.a.

National production by region
Northern Coastal Wet Tropics: 237,000 tonnes av. yield 35t/ha.
Subtropical east coast (Bundaberg, Sunshine & Gold Coasts): 1,137ha av. 26,151 tonnes yield 23t/ NSW North coast 12,57423t/ha
Western Australia and Northern Territory: 23t/ha (modified from ABGC 2008 and industry sources).

Queensland Production:
Queensland is the largest producer of bananas with 90% of national production coming from Northern Coastal Wet Tropics and four percent from the subtropical east coast region. The remaining production comes from Northern NSW (3%) and Western Australia and the Northern Territory (3%). However, the Northern Territory industry is being crippled by panama 'Tropical' race 4 disease and faces an uncertain future.

Characteristics of banana farms.

Production

Crop cycle

Crop cycles of two to three years are used in tropical North Queensland. This is due to compaction and machine access being hampered due to the crop 'walking' off row as the crop is rattooned with new sucker selections. In south East Queensland crops are rattooned up to 15 years with an average cycle of five to seven years. Replant times are longer due to less use of mechanization. Nematode buildup and the need to synchronise production are other factors in deciding when to replant (Office of the Gene Technology Regulator 2008).

Banana row spacing varies with ratoons. In SEQ they are commonly on 5.5m spacings compared to tropical north Queensland which are commonly on 6.5 to

7.0m spacings. Wider spacings can improve disease control (Office of the Gene Technology Regulator 2008).

The first harvest is about 16-18 months after planting, but can be as early as 12 months. The ratoon crops are harvested six to 12 months after sucker set. Or both crops harvest is about 90-120 days after the flowers have opened (Office of the Gene Technology Regulator 2008).

Marketing and Exports

Queensland is the largest supplier of bananas to domestic markets in all states. Queensland bananas have market access to all states under the interstate certification assurance (ICA) system, via either ICA-06 *Hard Green Condition of Bananas* for Cavendish only, accepted by all states except NT, or ICA-16 *Certification of Mature Green Condition of Bananas* for all varieties, accepted by all states except WA (DPI&F 2000, DPI&F 1997). Currently there are very few opportunities for exports of Australian bananas, due to the difficulty in competing with low cost of production countries.

Recently New Zealand market access for Australian bananas has been reopened following eradication of papaya fruit fly. Only one or two pallets/week were being shipped at the time of writing.

Varieties

The Cavendish type accounts for 95% of production, with next most important varieties, Lady finger, Ducasse and Goldfinger accounting for only four percent and specialty varieties such as Red Dacca, Sucrier and Plantain accounting for less than one percent of total production. (ABGC 2008).

The two biggest Cavendish production areas are Innisfail and Tully districts in North Queensland. They are also grown on the Atherton Tablelands, along with Ladyfinger, which cannot be commercially grown on the coast due to the spread of Panama races 1 and 2. Lady finger bananas are also produced in the subtropical east coast districts.

The supply chain infrastructure is set up to ripen and market large volumes of Cavendish fruit and is unsuitable for handling other varieties. There is a little interest in infrastructure investment in minor varieties, so the market is likely to remain limited to Cavendish in the near future (ABGC 2008).

Description of pest problems

Pest control in practice - an overview
The Queensland banana industry has been very proactive in adopting IPM and most production is managed by commercial or 'in-house' consultants using IPM principles and procedures as detailed in Bananas: insect & mite management (Pinese & Piper 1994). Other important banana IPM references include; Tropical banana information kit (Lindsay et al. 1998), Tropical Banana Information Kit Annual Update 1998/89, (Lindsay et al. 1999), the Subtropical banana grower's handbook (Broadly et al. 2004) and the Banana root and soil health user's manual (Pattison & Lindsay 2006).

The above publications, while either out of date or out of print, still contain relevant information on banana pest management but are in urgent need of updating as part of documentation of industry good agricultural practice.

The Queensland banana industry has access to new planting material from Department of Primary Industries & Fisheries (DPI&F) accredited QBAN nurseries, which are accredited to produce true to type high health plants tissue culture plants from a from QBAN laboratory. There has been an increase in uptake of tissue culture over the use of bits and suckers (which carry the risk of contamination with soil-borne diseases and viruses). This trend is evident in North Queensland, since Cyclone Larry whereas previously lack of virus problems and the endemic nature of burrowing nematode meant the scheme lacked the driver that Banana Bunchy Top Virus provided in Southern Queensland (Sharon Hamill pers. comm., 2008).

On-farm biosecurity is important to the banana industry, but has not been universally adopted. For example, some growers on the Tableland have implemented measures such as restricting vehicle movement to manage the risk of Panama Race 1 affecting Ladyfinger production. Wider adoption of on-farm biosecurity would be of benefit.

The banana leaf spot diseases yellow Sigatoka and leaf speckle are under official control in Queensland, both within the Northern Pest Quarantine Area (NPQA) which is between Cooktown and Carmilla, as well as throughout the rest of the state. Leaf spot levels cannot exceed five percent in the NPQA, or 15 percent for the rest of the state, otherwise fruit cannot be sold under ICA -06 due to mixed ripening as a result of the infection. A comprehensive program of de-leafing, protectant and systemic fungicides should be applied as set out in 'A guide to banana leaf spot regulations' (Leutton et al. 2008).

The use of calendar spraying is required to comply with banana leaf spot regulations and produce a healthy crop. This amounts to about 20-25 sprays in North Queensland, and four to six sprays for south East Queensland. Narrow range petroleum oils are used in combination with protectant and systemic fungicides for control of yellow sigatoka. The fungus Deightoniella spp. is controlled with mancozeb dust, currently via minor use permit.

Significant reductions in pesticide use have resulted from the widespread adoption by the early 1990s of targeted spraying (bell injection) for control of bunch pests which has replaced the expensive and disruptive practice of cover spraying pesticides. A downside of targeted spraying is reduced volumes has meant that is harder to get new or existing pesticides registered for bunch pest control.

Weed control in bananas is critical and weeds are managed using post emergent herbicides.

Banana Production Operations - a summary

Planting

Due to the practice of using ratoon crops, planting may only be done once every 2-5 years unless growers are starting a new block. The aftermath of Tropical Cyclone Larry then T.C. Yasi meant that many plantations were entirely destroyed and the North Queensland industry has finally started to recover. Re-planting was deliberately staggered to prevent a glut in the market and give all growers the chance at making some profit post the disaster.

Soil applied, pre-plant insecticides and nematicides are not commonly used within the surveyed group. The majority of growers use true-to-type planting material. These are generally planted without any treatments. However 45% (4) respondents reported dipping sucker bits in tanks of either insecticide (Lorsban) or a nematicide, then planting. The process is done with the use of a tractor arm to lower a bag or mesh cage of planting material into the tank, where it is submersed for 15-20minutes then removed to dry prior to planting.

Post-plant operations

Immediate post-plant weed control

For inter-row weed management, respondents predominantly use applications of Basta® (glufosinate-ammonium). Some alternate with brands of paraquat as dichloride, such as Gramoxone®. Stomp®, Diuron and Sprayseed® were other brands listed for inter-row weed control. Practices such as slashing are often applied to grassy headlands to assist in rodent management. Respondents also reported using glyphosate products, such as Roundup® as spot spray treatments around farm infrastructure.

Post-plant insecticides

Banana bunch pests have been successfully controlled over the past 15 years primarily by the strategic use of organophosphate and carbamate insecticides applied as a bell injection or bunch treatment at the bagging stage. Unfortunately these insecticides have poor environmental profiles and high mammalian toxicity making them unsuitable for use in an IPM strategy. The lack of registered insecticides with different modes of action means that developing an insecticide resistance management strategy for the industry is impossible. Chlorpyrifos is the most heavily relied upon insecticide for bunch pest control and is currently being reviewed by the Australian Pesticide & Veterinary Medicines Authority (APVMA). The identification of insecticides with new modes of action and low mammalian toxicity has become a high priority for the Australian banana industry. The major bunch pests include:

- Banana scab moth (*Nacoleia octasema* (Meyrick) (Lepidoptera: Pyralidae); and
- Banana rust thrips (*Chaetanaphothrips signipennis* (Bagnell) (Thysanoptera: Thripidae)

These are responsible for up to 90% of all bunch damage. Banana flower thrips (*Thrips hawaiiensis* (Morgan) (Thysanoptera: Thripidae) and sugarcane bud moth (*Opogona glycyphaga* Meyrick) (Lepidoptera: Tineidae) are also becoming increasingly important pests to control.

Trials were undertaken to determine the most effective new insecticide treatments for *Nacoleia octasema* control. A HAL funded QDPI project tested the following chemistry:

- emamectin benzoate (Proclaim®),
- tebufenozide (Mimic®),
- indoxacarb (Avatar®), and
- Thiamethoxam

The results suggested that all were all equally as effective as the chlorpyrifos (Lorsban 750 WG®) standard with less then 5% bunch damage in the field trials. Survey results indicate that despite the findings of this research, published in 2004, growers continue to use chlorpyrifos for bunch pest treatments.

The pseudo biopesticide, spinosad (Success®) was the most effective treatment against all bunch pests and is now registered as a bunch treatment for the control of *Opogona glycyphaga* and *Chaetanaphothrips signipennis*. Most respondents (60% or 6) reported not using Success.

In the insecticide impregnated plastics trial the diazinon and suSCon® strips as well as the chlorpyrifos impregnated bunch covers were equally as effective as dusting and spraying with chlorpyrifos and achieved less than 5% bunch damage against all pests. 100 per cent of respondents do not use these products.

There is a known difference in practices for bunch pest control between the growing areas of Tully and Innisfail. Tully growers tend to use reusable bunch covers and spray the bunch, where as Innisfail growers use single use bunch covers and chlorpyrifos dust.

Growers who favour dusting tend not to use suSCon® strips instead, as the ribbons will only give good bunch pest control during low thrips pest pressure conditions. The major production areas such as Tully and Innisfail experience high bunch pest pressure, hence their low uptake of this product.

There is a belief amongst some grower groups that the use of chlorpyrifos dust gives excellent coverage of all the fingers in the banana bunch, translating to very high degrees of pest control, as opposed to spraying practices which require 360 degrees of coverage, otherwise pests can survive and damage unsprayed portions of the bunch. Chlorpyrifos can also be alternated with spinosad WP formulations for resistance management purposes.

Chlorpyrifos dusting is a practice used by an estimated 20% of growers on 15-20% of production area in North Queensland. It is used to manage bunch pests such as banana scab moth and banana rust thrips. Growers mix chlorpyrifos WP at a rate of 100 grams product with 5 kg talc. (From PER10578 justification) Due to the powder nature of the dust, care with personal protective equipment at mixing and loading is essential. A dust mask or half face respirator, cotton overalls, hat, gloves and goggles are all recommended attire. The use has been sanctioned in Queensland under the Queensland Board Approval (#70022) system since 1992 and was converted to an APVMA permit in May 2009 (PER10578).

Dust applications are very quick, lasting less than 3 seconds per applications. The dust remains in the bag, allowing the applicator time to move on from the area before it begins to swirl out of the bag opening. Dust does not clump and is used throughout the year. Bunches are washed at the packing shed, which reduces the risk of pesticide residues.

Growers in NSW and SEQ often plant on steep hillsides for frost protection. Dusting eliminates the need for the use of ladders, which the application of suSCon® strips would require, thus reducing potential workplace health and safety issues associated with ladder use.

Fungicide use

Fungicide application methods vary with location and topography. In Far North Queensland, which is the main banana production area, respondents reported predominantly using aerial contractors to apply their fungicides, however there is also significant use of ground application via misting or airblasting. Respondents from southern Queensland reported that topography influenced the method of application causing them to apply fungicides via ground based methods.

The following fungicides are typically used by respondents:

Table 1. Fungicide use

Active ingredient	% of respondents using	Frequency of sprays	Tank mixed with other pesticides
Chlorothalonil	22% (#2)	**Up to 8/year;** Occasional use for resistance management; **Used in other crops grown.**	1 of the 2 respondents using chlorothalonil tank mixes with folicur.
Copper based fungicides	22% (#2)	Occasional; Sporadic.	no
Mancozeb	89% (#8)	**20-26 sprays/year;** 16 sprays/year; **Every 3 weeks;** **3 sprays alternated with other fungicides applied sporadically;** 6 sprays/year; Alternate with other products for resistance management as per Bayer's RM strategy.	Only with oil
Propiconazole	78% (#7)	**20-26 sprays/year;** 2 – 6 sprays/year; Every 3 weeks, alternate with other fungicides; **3 sprays alternated with other fungicides applied sporadically;** 2 sprays/year; **1 spray/year;** Not much.	no
Tebuconazole	67% (#6)	**Aerial spraying, alternate with others;** 6-8 sprays/year; **2 sprays/year;** Every 3 weeks, alternate with other fungicides; **Used once and caused crop burn (discontinued);** 2-8 sprays/year alternating with 4 other fungicides.	chlorothalonil

Respondents reported following a specific fungicide application schedule developed by Bayer CropSciences, however the official industry resistance management plan for Leaf Diseases is via Crop Life and can be located at: http://www.croplifeaustralia.org.au/files/2009%20Fungicide%20Resistance%20Management%20Strategies-Website.pdf

Staffing

Surveyed businesses range in their staffing levels. Small family owned farms are predominantly run by family members and may have as few as two or three people on staff. The larger sized businesses and consortiums employ a much greater number of staff consisting of itinerant backpackers and permanent employees. The numbers varied depending on the size of the farm, from 20 to 175.

Applying post plant pesticides in the Australian banana industry

Work rates

Respondents were asked about the number of hours per month that were typically spent in pesticide spraying. The answers received were quite varied and dependent of the pesticide application task. Most respondents reported working an 8 to 10 hour day for spraying / pesticide treatment which included mixing and re-loading. The greater the farm size the greater the time spent to treat the area. Often pesticide application tasks were carried out by multiple workers at the same time. Getting a clear indication of time spent on each pesticide application task was difficult and most respondents could only approximate. Some gave an overall estimate in hours per month, then specified tasks individually but in hours per day or per week. The following table outlines the responses given. These have been expressed as hours per month where possible. If a field has been left blank it is because they simply answered that they do undertake the task in question but did not specify a time frame to complete it.

Table 2. Work rates per month for pesticide application tasks

	Fungicide application	Herbicide application	Butt injection	Bell injection	Butt spraying	Dusting
Respondent 1	6 hrs/month		*5 hrs/month	^80 hrs/month	n/a	n/a
Respondent 2	12 hrs/month		Seasonal, 10hr/day (Nov – Feb)	10hr/day	n/a	n/a
Respondent 3	Aerial spraying done over a weekend	2 people spraying 158ha in a week every 8 weeks	n/a	^ 16–38 hrs/week	#4hrs/month	n/a
Respondent 4	1/2hr every 3 weeks, aerial		n/a	8 hrs/ week or 32 hrs/month	Jan – Mar, 2 applications in that period	n/a
Respondent 5	10hrs/month		n/a	32hrs/month	24 - 48 hrs/month	24 hrs/month
Respondent 6	~20 hrs/ month (**total for all pesticide application tasks**)		n/a			n/a
Respondent 7	4 hrs/month (**total for all pesticide application tasks**)			2 hrs/day	3 hrs/ day	n/a
Respondent 8	120 hrs/month (**total for all pesticide application tasks**)		Twice /year, 2 months of continual work, 30 acres/day		As required	1-2 seconds / bag. 500 bags/day, 8hrs/day
Respondent 9	35 hrs/month month (**total for spraying tasks**)		2-3 times /year. 4-8 hrs spread over 3 weeks.	160 hrs/month	2-3 times /year. 4-8 hrs spread over 3 weeks.	n/a

* equated from estimates for an annual figure. Task performed once per year spread over 7 days working 8hr days.
^ task done concurrently with bagging.
#equated from an annual figure. Task performed twice per year over 3 days working 8hr days.
~ Respondent did not specify times for individual pesticide application tasks.

It is estimated that some 85% or greater of the industry use dust and 98% of these plantations use either 4x4 bagging machines with air compressor driven dust applicators or small portable air compressor dusters fitted to 4 wheel bikes. Most new bagging machines also incorporate automatic string dispensers. Older machines have operators manually cut the string. String use can affect time spent by workers on bagging bunches as much as doubling it. A competent bagger will bag and dust on average 650 bunches per day in dry conditions. Those workers that do contract bagging can be efficient enough to bag and dust up to 800 bunches per day. Using string brings that number down to 450 bunches per day.

In a 5 day week a contract bagger may bag 4,000 bunches. Contractors use only 4x4 self propelled machines and on average give only one or two seconds burst of dust per bag. Calculations performed by D. Doolan give the average dust application per bunch as being 2.5g.

Using the worst case scenario, 2.5g x 800 bunches per day = 2,000 g or 2kg of talc dust mix applied, thus giving 10kg talc mix per week. It is estimated that 30% of the 2.5g in the bag drifts out of the bottom. Baggers predominantly work facing into the wind and move on quickly from the treated bag, however the potential is that they may be exposed to 0.8g of dust. Time trials on dust drift emerging from the bag have shown an average of 3-4 seconds post application to emergence, by which time the operator has moved away. Whist it is true that the initial mixing of talc dust can be a little messy, it is suggested that in the paddock the operator gets far less exposure to dust due to the mechanization of the application method than they would with bunch spraying techniques. (Pers Comms. D. Doolan GF Rural Supplies, Innisfail)

Spray operators

Within the smaller farms of the respondents, dedicated spray operators are limited to one or two people, with the principal spray operator frequently being the male of the family / survey respondent. In these smaller operations, respondents stated that the principal spray operator undertook between 70 to 100% of the pesticide treatments on farm. Those respondents with farms in Far North Queensland reported using aerial spraying for fungicide application which is done via the use of contractors. Respondents with farms in South-east Queensland (2) did not use aerial fungicide application and sited slope of their topography for their reason.

Of the respondents with larger or multiple farms, the number of spray operators ranged from 4 to 30 people. Respondents with multiple farms reported no principal spray operator. All reported using application for fungicides done via contractors. These respondents divided the pesticide application tasks amongst small groups e.g. some spraying, some bagging, some injecting and so on.

Personal protective equipment

Because the bulk of the banana industry is situated in Far North Queensland, the tropical conditions play a large part in influencing the use of PPE. High temperatures, rainfall and humidity make wearing some items unpleasant for workers and even though businesses provide them, PPE items are not always worn. Respondents stated that PPE items were used in all aspects of pesticide preparation and application however the concession towards aprons instead of overalls was noted. The respondent with the greatest number of farms stipulated that their PPE items were provided but did not clearly state that they were always worn.

Of the respondents, one stated they were not using a mask at any stage in their pesticide preparation or application. This respondent and another also stated they did not use face shields or goggles. Both were owners of smaller sized farms. Some respondents specified that particular items of PPE were used during particular tasks, such as a mask for mixing pesticides or gloves while packing.

Because of the labour intensive nature of the crop, in years where rodent populations are high, the banana industry tends to experience an elevated number of Leptospirosis cases. The Leptospirosis organism is transferred to workers via contact with rodent urine and faeces. PPE use within the industry is a key element to reducing such infections. During drought years when rodent numbers are lower, causing leptospirosis cases to be fewer, such precautions have the potential to be overlooked.

Agricultural chemical infrastructure in the Australian banana Industry

AGVET chemical stores

Filling stations

All respondents reported having filling stations for mixing and loading pesticides. Some further stipulated responses such as having one main facility plus fill up points or separate areas for different procedures such as bagging, bell injecting, hormone treatment and tractor loading.

Machinery commonly used to apply pesticides in the Australian banana industry.

In line with other Australian horticultural industries, the Australian banana industry is highly mechanized.

Nozzle types used on spray equipment

Respondents were asked about the nozzle types they used for their spray applications and 5 were able to answer the question. The following responses were supplied:

- Off centre OC3 fan;
- No nozzle used, run through last two jets of mister
  Mister – red all buzz hollow cones;
- Flood jets;
- Mister – Airmist nozzle AU8120 atomiser micron air for fungicide
  Black 400 fan jet nozzle for herbicides;
- Mister – hollow or solid cones;
  Boom – flat fans for herbicides or off-sets for insecticides.

Boom heights for spray equipment

Respondents were asked the height of the boom for their spray operations that used a boom spray. Five respondents did not use boom spray equipment, two stated that it was set at 50cm from the ground and the remaining two were unable to answer.

Pesticide application water volumes commonly used in the Australian banana industry

Respondents were asked what spray volumes they used in their post plant spraying operations. Responses varied widely. Volumes differed for particular spraying operations and amongst pesticide types applied. Some quantified their answers stating the volume of spray in L/ha others simply answered with yes or no as the levels of low, medium or high were stated. Responses where qualifications were offered are as follows:

- Low – 250L/Ha; 370 L/Ha; butt spray 70mL/stool
- Medium – fungicides 375L/Ha; Yes for herbicide application; 250-600L/Ha for misting
- High – Yes for fungicides and insecticides.

Mixing and loading pesticides.

Respondents were asked how they mixed and loaded pesticides. All respondents reported using jug/scales to measure/mix insecticides. All respondents mixed pesticides at ground level. No respondents used direct transfer methods such as stirrup pumps to load pesticides, although one respondent did report using a specially manufactured vacuum pump.

Initial mixing for chlorpyrifos dusting is done in the majority of plantations by the farm manager or owner. In the case where contractors are employed, the mix is done for them by the plantation manager / owner. During busy parts of the season, the larger plantations usually ensure 1 weeks supply is made in advance. (Pers Comms. D. Doolan GF Rural Supplies, Innisfail)

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Management Options for Banana Bunch Pests, Technical summary, David Astridge Agency for Food and Fibre Sciences, Department of Primary Industries and Fisheries HAL Project Number **FR00013**

71210DO001_200809 Agricultural Commodities, Australia, 2008-09 Released at 11:30 am (Canberra time) Fri 9 Apr 2010 Table 4 AGRICULTURAL COMMODITIES, STATE AND NRM REGION–Queensland–2008–09
Supplied via e-mail by ABGC

ICA-06 *Hard Green Condition of Bananas*
ICA-16 *Certification of Mature Green Condition of Bananas,* (DPI&F 2000, DPI&F 1997)

The Biology of Musa L. (banana) Office of the Gene Technology Regulator 2008

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Subtropical banana grower's handbook (Broadly et al. 2004)

Banana root and soil health user's manual (Pattison & Lindsay 2006).

A guide to banana leaf spot regulations (Leutton et al. 2008).

Fungicide Resistance Management Strategies, *Developed by the CropLife Australia Fungicide Resistance Management Review Group and industry researchers* Valid as at 15 September 2009
http://www.croplifeaustralia.org.au/files/2009%20Fungicide%20Resistance%20Management%20Strategies-Website.pdf

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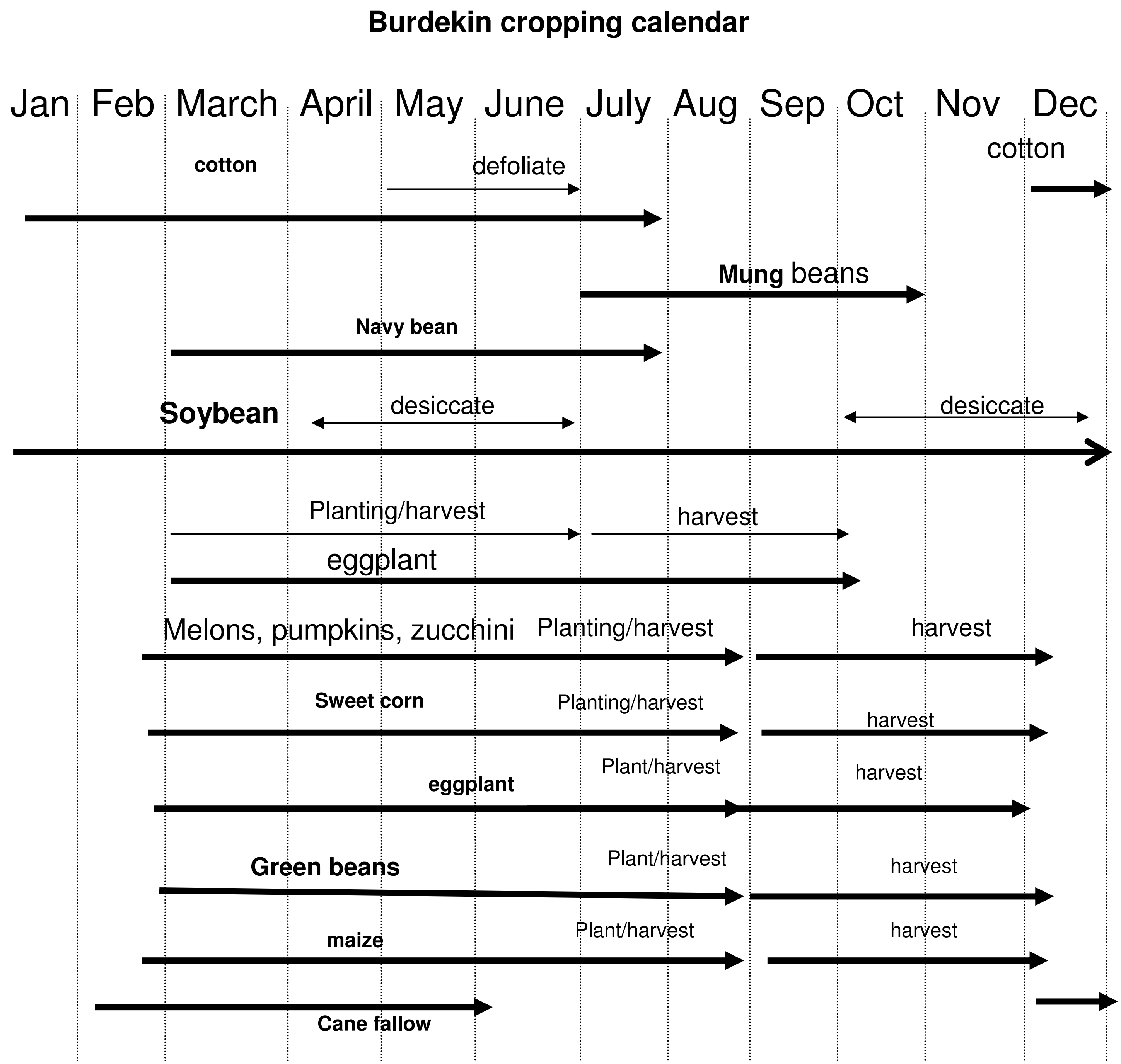
Comments supplied via fax, David Doolan, GF Rural Supplies P/L Innisfail June 2008



Burdekin cropping calendar
Jan
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Nov
Dec
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cotton
Mung beans
Navy bean
Soybean
desiccate
desiccate
Planting/harvest
harvest
eggplant
Melons, pumpkins, zucchini
Planting/harvest
harvest
Sweet corn
Planting/harvest
harvest
Plant/harvest
eggplant
harvest
Green beans
Plant/harvest
harvest
maize
Plant/harvest
harvest
Cane fallow

Silverleaf whitefly management in vegetable crops

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Introduction

Silverleaf whitefly (SLW), *Bemisia tabaci* Biotype B, (also named *Bemisia argentifolii* in USA) is a serious pest of many vegetable crops, including tomato, eggplant, cucurbits, sweetpotato, brassicas and beans.

SLW life cycle

Adult whiteflies are more active during the morning. They often concentrate on the undersides of younger leaves. Figure 1 shows the SLW life cycle.

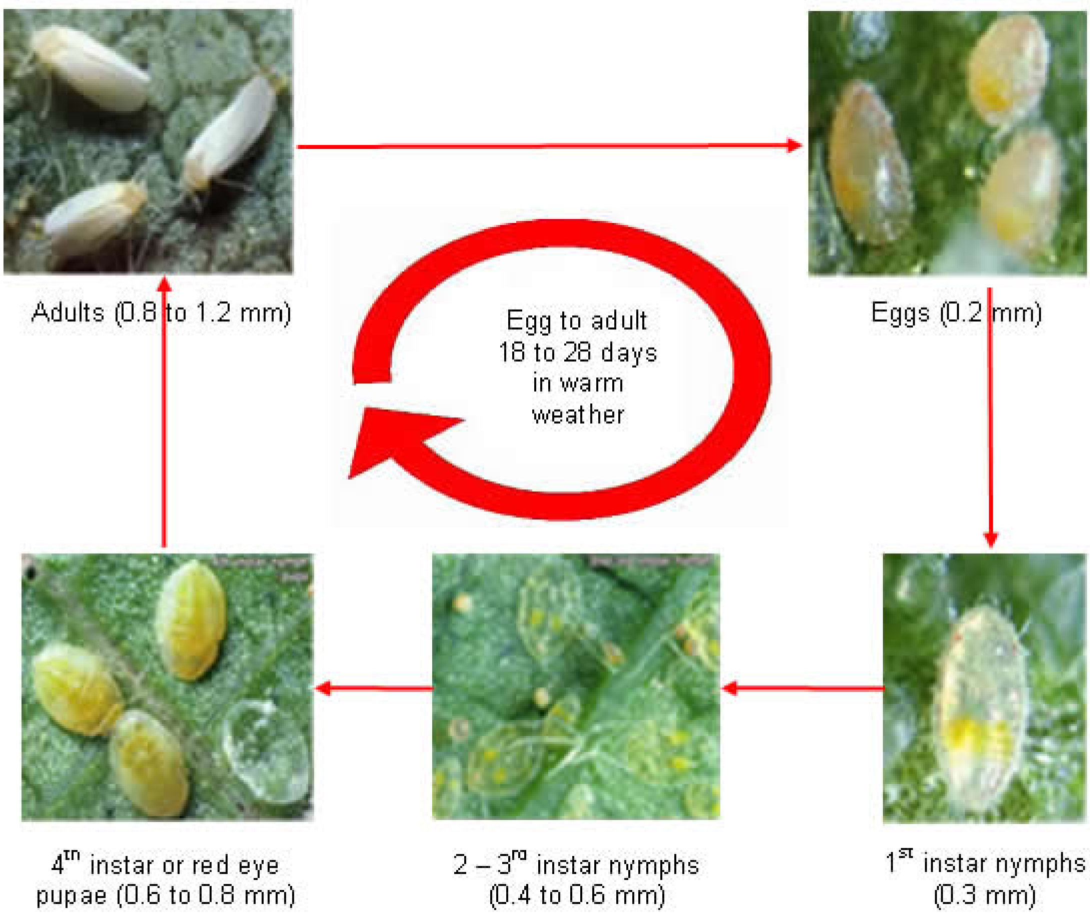

Figure 1. SLW life cycle

The eggs have a pointed end that is attached to the underside of the leaf surface, usually the youngest leaves where the adults congregate. Each female lays between 50 and 300 eggs (average 160) on the leaf surface. New eggs are whitish yellow. They turn brown and hatch within seven to 10 days.

There are four nymphal stages. Crawlers or first instar nymphs are greenish-yellow and flattened. They crawl a short distance until they tap into a sap source in the plant tissue. Second and third instar nymphs are attached to the leaf surface and suck sap from the plant. They are light yellow and their legs are not visible. Fourth instar nymphs are referred to as red-eyed nymphs or pupae and their body is dark yellow. Late in the fourth instar they stop feeding and develop into an adult before emerging from the pupal case. The empty white cases (exuviae) the adults emerged from can be seen on the leaf surface.

It takes 18 to 28 days from egg to adult in warm weather and 30 to 48 days in winter. The number of eggs produced peaks in warm weather and can reach 300 eggs per adult female. SLW populations build up rapidly during spring and summer. In Queensland the pest can complete eight to 12 generations in a year.

SLW damage

SLW can cause severe damage to vegetable crops in four different ways:

1. Direct feeding: SLW adults and nymphs (Figure 2) suck the sap from the plant causing reduced plant vigour, stunting, poor growth, defoliation and reduced yields. High populations may result in plant desiccation and death.

Figure 2. SLW nymphs and pupal stages on a broccoli leaf

2. Injecting toxic saliva: While feeding, SLW inject toxic saliva into the plant causing physiological changes to plant tissue. On the outer skin of tomato fruit the external symptoms are green, yellow or orange streaks or blotches (Figure 3a). Internally, the affected fruit have white or yellow tissues (Figure 3b). In some tomato varieties the external symptoms may not be obvious, but internal damage is often very apparent once the fruit is cut open.

Figure 3a. Irregular ripening

Figure 3b. Internal white tissue in tomato

Silvering of leaves is a common symptom on pumpkin, zucchini and squash (Figure 4) and fruit discolouration occurs in cucurbits and beans, pale stalks on broccoli and leaf yellowing and blanched stalks of lettuce.

Figure 4. Leaf silvering of pumpkins

3. Honeydew contamination: Both adults and nymphs excrete honeydew. This sugary substance can promote the growth of sooty moulds which affects the marketability of product. Sooty mould also reduces plant photosynthesis and the effectiveness of insecticides (Figures 5 and 6).

Figure 5. Sooty mould on a sweetpotato leaf

Figure 6. Sooty mould on tomato fruit

4. Transmission of viruses: SLW adults are efficient vectors in spreading Gemini viruses from infected plants into healthy crops. Gemini viruses include tomato leaf curl virus (TLCV) and tomato yellow leaf curl virus (TYLCV) that infect beans, capsicums, tomatoes and a wide range of ornamentals and weeds. More information on these diseases can be found in the DEEDI Notes listed below under Further information.

Monitoring and sampling

Regular counts of adults and nymphs on leaves should form the basis of deciding how and when to apply control measures. Adults congregate and lay eggs predominantly on the undersides of younger leaves. The majority of the eggs and young nymphs are found on the young leaves while older nymphs are usually found on older leaves.

To determine the numbers of adult SLW gently turn over young leaves and count the adults on the underside. Adults should be sampled during morning hours (7 to 9 a.m.). Rapid adult migration usually occurs when infested crops are in decline or about to be destroyed.

To assess nymph populations, sampling should focus primarily on the mature leaves. A hand lens (10 x) is necessary when inspecting leaves for the presence of eggs or small nymphs. Large nymphs can be counted with the unaided eye.

Yellow sticky traps

Yellow sticky traps (Figure 7), are useful for monitoring whitefly adult movement or dispersal, especially the movement of SLW from mature or older neighbouring crops and host weeds.

Yellow plastic boards (Norwood®) size 15 x 10.5 cm, coated with sticky glue (e.g. Tangle-trap Brush On®) can be used to detect the adults. Around three to five traps should be placed in a crop of 2 to 3 ha. Place them level with the tops of the plants, as whiteflies are most attracted to young foliage (Figure 8).

Adult numbers on the traps will give an early warning of population increases within crops and an indication of the need for regular monitoring for nymphs.

Figure 7. Yellow sticky traps for adult monitoring

Figure 8. SLW adults on a bean leaf

Managing silverleaf whitefly

Controlling whitefly populations before they reach large numbers in crops is very important for successful management. If the adults occur in large numbers it becomes more difficult to control the nymphal stages. Adults move between successive crops, so management approaches must be employed in all crops within the area.

To reduce early season populations, best management practices require consideration of several management approaches including the use of pest-free seedlings, weed management, chemical control and cleaning up crop residue.

1. Pest free (clean) seedlings

Seedlings are potentially a major means of spreading whiteflies and leaf curl viruses into new plantings. Young plants are more susceptible to damage from SLW, so early infestations need to be avoided. Clean seedlings can be the first line of protection against the development of damaging populations.

Growers should check their suppliers to determine how the seedlings are grown and what measures are being used to protect against whitefly infestation. Inspect transplants carefully upon arrival for whitefly eggs, nymphs and adults.

2. Weed management

The availability of a continuous source of hosts, whether they are crops, weeds or abandoned crops, is the major contributing factor to a severe whitefly problem. Even a small area of a favoured host can maintain a significant whitefly population.

Minimising whitefly hosts is important in reducing the base population at the start of the cropping season. A smaller base population then will delay the time it takes for SLW numbers to reach significant levels, reducing the number of sprays needed to control whitefly.

Common weed species that carry high numbers of SLW include sow thistle (Figure 9), bladder ketmia, bell vine, burr gherkin, native rosella (Figure 10) and star burr. Milk or sow thistle is a regular weed host for whitefly and is common in Queensland vegetable production areas. Control these weed species in farming areas and seedling nurseries to minimise a build-up in SLW populations.

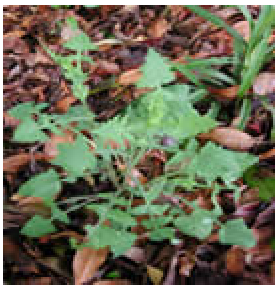

Figure 9. Sow thistle, favoured host of SLW

Figure 10. Native rosella

3. Using parasitoids

Several parasitic wasps and predatory bugs attack SLW in vegetable crops. *Eretmocerus hayati*, an exotic parasitoid wasp originally from Pakistan, attacks SLW nymphs more readily than local species. *E. hayati* is a minute wasp, 0.8-1.0 mm long. Females have bright yellow bodies with clubbed antennae and males are dark yellow brown. Males and females occur in almost equal numbers.

E. hayati females very effectively search for whitefly nymphs on the underside of the leaves. On finding a suitable nymph, the wasps insert a single egg between the host and the leaf surface. As the parasitic larvae grow inside nymphs they stop the whiteflies' development. One female wasp can parasitise over 40 whitefly nymphs during its lifetime (Figure 11).

Figure 11. *E. hayati* pupae inside the nymph of a SLW

After completing development, the adult wasp chews a round hole to emerge from the whitefly remains. The newly emerged wasp mates and then begins to search for new whitefly nymphs to attack. During the warmer months the wasps take around 13 to 20 days to complete their lifecycle.

In addition, female wasps require protein in their diet which they acquire by feeding on the whitefly nymphs' body fluid (called host feeding). They cause significant mortality in whitefly nymphs (recorded between 15 to 40% in experimental crops) through host feeding (Figure 12).

Figure 12. *E. hayati* female feeding on whitefly nymph

Field evaluation results show that the parasitic wasp has established in Bowen, Burdekin and Bundaberg regions where parasitism levels ranged between 30 and 85%. The high level of parasitism was often recorded in minimally sprayed crops. Broad spectrum insecticides sprays such as dimethoate, trichlorfon, methomyl and methamidophos are highly toxic to the wasps and their application often flares up whitefly populations. Some new generation insecticides such as Movento, Admiral, Coragen and Belt are less toxic to the parasitic wasps.

Avoiding highly toxic pesticides during early part of the crops will help in establishing the parasitoid populations.

4. Chemical control

Selecting the correct insecticides and applying them at the appropriate time is very important, both for achieving good SLW management and minimising the development of resistance to the insecticides. A spray program should be based on the results of monitoring.

Insecticides vary in their efficacy on adult and immature SLW. Select insecticides according to the growth stage of whitefly, the infestation level, the age of the crop and the type of crop. Information on how to select insecticides for controlling SLW is provided in Table 1. A link to the table in a printable PDF format is provided under Further information.

Good spray coverage, particularly of the underside of leaves, is very important when using contact insecticide applications as SLW adults, eggs and nymphs are found predominantly on the underside of leaves. Spray equipment should be correctly calibrated so that the correct amounts of insecticide are applied efficiently.

Imidacloprid is a systemic insecticide that can be applied to some crops as a foliar spray, or as a soil treatment through sub-surface drip irrigation tubing, as a furrow spray or as a plant hole drench. Soil applications are more efficient than foliar sprays and are made shortly before, at or shortly after planting. READ THE LABEL before use for crops, application directions, rates and timing.

Table 1. A guide to choosing insecticides for silverleaf whitefly control in vegetables - 2011

Product (active)	**Action**	**Activity against life stages**			**Comments**
		Eggs	**Nymphs**	**Adults**	
Admiral (pyriproxyfen)	translaminar	**	**	N M	Slow acting and interrupts SLW life cycle. Apply to young crops. Safe on parasitoids and bees.
Applaud (buprofezin)	contact vapour	*	**	N M	Use 600 mL/ha rate for SLW control. Slow acting. Safe on parasitoids and bees.
Confidor Guard (imidacloprid)	systemic	N M	**	**	Only for soil application. Apply at planting.
Chess (pymetrozine)	translaminar	N M	N M	**	Stops adult feeding. Use at flowering stage in cucurbits. Less toxic to bees and parasitoids.
Movento (spirotetramat)	2-way systemicity	NM	***	NM	More effective against young nymphal stages. Use a spray adjuvant (e.g. Hasten) for better penetration.
DC Tron (petroleum oil)	contact	*	*	*	Good coverage essential. Take care when mixing with soap and fungicides.
Talstar + Synergy (bifenthrin + piperonyl butoxide)	contact + synergist	*	*	***	Controls SLW adults. Use only in later part of crop if SLW in high numbers. Toxic to beneficial insects.

Efficacy rating : NM = no direct mortality; *** = best; ** = good; * = fair

Disclaimer: The information in Table 1 above is based on HAL funded experiments conducted in Bowen over the last 5 years. It is provided solely on the basis that the readers will be responsible for making their own assessment of the content and seek professional advice as needed. Chemical registrations and APVMA permits for SLW control do not apply to all vegetable crops. **Users must check the label for registration or permit status of the insecticides before use on a specific crop.**

Short residual contact insecticides (such as bifenthrin), mainly control adults and are less effective against immature stages. Systemic insecticides (imidacloprid) can control both adults and nymphs. Organophosphate insecticides used alone provide no control for silverleaf whitefly.

Under the APVMA emergency permit system several chemicals have been approved against SLW for use in a range of vegetable crops. A few chemicals are registered for SLW control. Before use read the APVMA permit and product label for directions. Table 2 lists the chemicals registered or with APVMA permits at the time of publication. A link to the table in a printable PDF format is provided under Further information.

Table 2. Insecticides for silverleaf whitefly control in vegetables in Queensland - 2011

Active ingredients	**Product(s)**	**Chemical group**	**Crops**	**WHP (days)**	**Rate of product**	
REGISTERED INSECTICIDES There are two formulations of imidacloprid (200 SC for foliar spray and 350 SC for soil application) registered for use against silverleaf whitefly on some vegetables. A range of products containing bifenthrin, petroleum oil, piperonyl butoxide, pyriproxyfen, spirotetramat and thiamethoxam are also registered for use on some vegetable crops. There are also a number of other chemicals registered on a range of vegetables for use against any of the many types of whiteflies. These chemicals may or may not be effective against silverleaf whitefly (*Bemisia tabaci* Biotype B).						
PERMITS						**Permit No. & expiry date**
buprofezin (440 g/L)	Applaud (IGR)	chitin inhibitor (17A)	leafy and woody herbs when grown as annuals	3	30 mL/ha of water	**Per 8576** (30/08/12)
emulsifiable botanical oil (850 g/L)	Eco-oil Miticide/Insecticide Botanical Oil Concentrate	spray adjuvant	green house and hydroponic capsicums,	NS	375 - 500 mL/100 L of water	**Per 10311** (30/09/13

			cucumbers and lettuce			)
imidacloprid (200 g/L)	Confidor 200 and others	chloronicotinyl (4A)	**seedlings of:** tomatoes & peppers (excluding seedlings for hydroponic production)	NA	40 mL per 1000 seedlings, applied as a seedling drench	**Per 11936** (28/02/13)
potassium salts of fatty acids (285 g/L)	Natrasoap Insecticidal Soap Spray and others	insecticide	glasshouse and hydroponically grown capsicums, cucumbers and lettuce	NS	1.5 – 3 L/100 L of water	**Per 10184** (28/02/13)
pymetrozine (500 g/kg)	Chess	feeding inhibitor (9A)	head lettuce	7	200 g/ha	**Per 11988** (30/04/11)
			broccoli	5		
			cucurbits, eggplant, tomatoes	3		
pyriproxyfen (100 g/L)	Admiral (IGR)	juvenile hormone mimic (7C)	leafy and woody herbs when grown as annuals	1	500 mL/ha	**Per 8601** (30/08/12)
pyriproxyfen (100 g/L)	Admiral (IGR)	juvenile hormone mimic (7C)	cucurbits, eggplant	1	500 mL/ha	**Per 10764** (30/09/12)

NA = not applicable, NS = not supplied; IGR = Insect Growth Regulator

Note: The information above is a guide only. **All users should read, or have read to them, the**

details and conditions of the permit and/or product label before using the product. The permits are available on the Australian Pesticides and Veterinary Medicines Authority (APVMA) website.

5. Clean-up crop residues

Movement of SLW adults from older crops and crop residues is the main source of infestation for younger crops. Post-harvest destruction of heavily infested crops often causes mass migration of SLW adults into adjacent crops. Therefore it is important to control adult whiteflies before they move into young crops.

Clean-up strategies for old crops/crop residues:

- For moderate whitefly infestations, use an insecticide effective against adults or 2% D-C-Tron Plus® oil.
- Use high spray volumes, normally around 600 to 1000 L/ha for better coverage.
- Plough in the crop within three days to kill all remaining nymphs on the crop foliage.
- Remember that withholding periods still apply and that produce should not be taken from the fields for consumption. Don't feed crop residues to livestock.

Further information

Further information on SLW management can be obtained from:

- The silverleaf whitefly in Queensland home page.

Information on tomato leaf curl disease is available in the following DEEDI Notes:

- Tomato leaf curl virus (TLCV)
- Tomato yellow leaf curl virus (TYLCV)

Follow the links below for PDF copies of the insecticide Tables 1 and 2.

Table 1. A guide to choosing insecticides for silverleaf whitefly control in vegetables - 2007 (77 KB)
LINK TO TABLE 1 - 2011

Table 2. Insecticide permits for silverleaf whitefly control in Queensland - 2011 (45 KB)

For more specific information contact:

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- Iain Kay, Principal Entomologist, Agri-Science Queensland, Bundaberg Research Facility - (07) 4155 6244

DEEDI information and services

- To access DEEDI's information and services, Queensland residents can contact the **Customer Service Centre** on **13 25 23** for the cost of a local call, from 8 am to 6 pm Monday to Friday (excluding public holidays). E-mail callweb@deedi.qld.gov.au. Non-Queensland residents phone (07) 3404 6999.

- Current national information on agricultural chemicals registered for use on all crops is available on the Infopest DVD. Write to DEEDI, GPO Box 46, Brisbane, Qld 4001, E-mail infopest@deedi.qld.gov.au, visit the Infopest web page, or phone (07) 3239 3967 for further information.

Industry links

- Industry links is a page of links to various sites of interest to horticultural growers.

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