

# Proceedings of Workshop No. 1.



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# Purpose of the Workshop

This has been the first of 4 annual workshops involving project team members and other stakeholders in information exchange, and planning and review.

## Workshop Objectives

- To provide an update of project activities
- To facilitate communication about pest management in sweet corn between project team members, growers and other stakeholders, and
- To plan integrated project activities for the next 12 months

## Project Objectives

- Identify and apply Best management Options to the production of sweet corn
- Identify and promote integrated pest management systems for sweet corn
- Reduce the production risks , particularly for export oriented production systems
- Protect and increase the small range of insecticides used for insect pest management
- Test and promote the use of alternatives to broad spectrum insecticides
- Test and promote improved application techniques
- Identify cultivars for improved product and production characteristics for export and domestic markets
- Identify technology which can separate damaged and undamaged cobs during the grading and packing process

# Project Milestones

The following milestones are to be achieved by the set due dates for HRDC to provide continuing funding for this project until June 2001.

1. Agreement of project milestones and signature of Research Agreement.  
**Due date:- 31/10/97**
  
2. Documentation of the present pest management systems associated with sweet corn growing in the major regions of Eastern Australia; and the identification of Best Management Options (BMO) which will contribute towards an integrated approach to pest management.
  - a) A report titled "Pest management practices associated with the sweet corn industry in Australia" has been produced and made available to all stakeholders.
  - b) A document titled "Best Management Strategies for sweet corn pest management in Australia" has been produced in concert with all stakeholders. These strategies will be the basis for on-farm R & D. BMO's will be compared with standard farmer practice in these on-farm trials. **Due date:- 30/4/98.**
  
3. All major stakeholders in the sweet corn industry have been identified and a mechanism for information exchange has been developed.
  - a) A list of names, addresses, etc of the project team and other stakeholders has been compiled.
  - b) The first yearly meeting of all stakeholders has been arranged in a growing region in Australia.
  - c) A mechanism, such as fax/email/newsletter is in place, for the exchange of information between each yearly meeting of stakeholders.  
**Due date:- 31/8/98.**
  
4. Commonly used pesticide application techniques have been tested for efficiency in targeting of insecticides to silks of sweet corn. Improved application techniques have been identified and promoted at farm walks and field-days.
  - a) Improved application equipment and/or techniques will have been identified and promoted. These techniques and equipment will enable improved targeting of insecticides to the silks of sweet corn.
  - b) Farm walks will have been conducted in all major production areas to demonstrate the efficiency of pesticide application equipment and techniques. **Due date:- 30/4/99.**
  
5. Insect scouting protocols have been documented for each of the major sweet corn production regions in Australia.
  - a) A report on insect scouting protocols has been produced covering each of the major sweet corn producing regions of Eastern Australia. **Due date:- 30/9/99.**
  
6. Best Management Options (BMO's) have been compared with standard grower practice in each of the major production regions in Eastern Australia.

- a) On-farm trials, comparing BMO's and grower practice, have been completed in all major production regions of Eastern Australia.
  - b) Field-days associated with these on-farm trials have been conducted in all major production regions of Eastern Australia. **Due date:- 30/4/2000.**
7. Establish cultivar evaluation trials in major production regions. Cultivars to be evaluated for quality, yield and tolerance to pest and disease.
- a) Improved varieties identified for disease resistance, tolerance to heliothis and yield and quality parameters.
  - b) Farm walks have been conducted and industry has evaluated varieties.  
**Due date:- 30/9/2000.**
8. The practicalities, commercial potential and reliability of techniques for mechanically sorting damaged and undamaged cobs in a sweet corn pack-house have been assessed.
- a) Near infra-red equipment has been assessed for its ability to identify damaged and undamaged cobs.
  - b) Commercial suppliers of this equipment have been identified and assessments made on the practicality of incorporation of near infra-red equipment into the sorting line of a sweet corn packing shed. **Due date:- 30/4/2001.**
9. Final Report Due. **Due date:- 30/9/2001.**
10. Final Report accepted **Due date:- 31/10/2001**

## What has been Achieved to May 1998

# Present Pest Management Systems and Best Management Options (Milestone Number 2)

Compiled by Peter Deuter, Principal Horticulturist, QHI, Gatton Research Station

### • What we did?

Present pest management systems associated with the sweet corn industry were documented for the major regions of Eastern Australia; and Best management Options (BMO) which will contribute towards an integrated approach to pest management were identified for Bowen, the Lockyer Valley and East Gippsland.

### • Why did we do it?

1. To clearly define the starting point of this project, **pest management practices** used in the sweet corn industry in Eastern Australia were identified and documented during the 97/98 sweet corn season.

The information was collected by project team members in all Eastern Australian sweet corn production districts by way of phone and/or personal interviews with growers, crop consultants, field officers and other appropriate stakeholders.

- a) This process provided an opportunity to undertake promotion of the project objectives and identify co-operating growers in each district for on-farm trials.
- b) This baseline data of current pest management practices in sweet corn will be used in project evaluation, against which gains and improvements in sweet corn pest management can be judged.
- c) Follow up interviews and data collection will occur towards the end of the project to record changes in the industry standard practice.

2. Using the above baseline data and current knowledge of pest management in sweet corn and other industries where similar pests, mainly *Heliothis* occur, **Best Management Options** (BMO) for pest management in sweet corn have been developed. These BMO's are practical strategies, and include a broad range of appropriate pest management options, including the strategic application of synthetic and biological insecticides, improved pesticide application techniques, insect scouting and crop monitoring procedures, and introduction, protection and fostering of naturally occurring and inundatively released beneficials.

These BMO's will be the basis of Research Station and on-farm trials in selected sweet corn production districts in Eastern Australia. These trials will compare the pest management outcomes of BMO's with present management practices relevant to the production district.

The results of these comparisons will be promoted to the industry through farm walks, reports and technical notes and at industry conferences and workshops.

These BMO's will serve as an indicator to the industry as to where improvements might reasonably be made in achieving improved pest management in the short term.

- **What did we find?**

The Australian sweet corn industry exists in a range of differing environments from the dry tropics of North Queensland to temperate Victoria and Tasmania. The timing of production is significantly influenced by these different environments. Insect pest pressure and control measures also differ as a consequence of these different environments.

Summer production in the semi-tropics of SE Queensland has presented the greatest opportunities to a range of insect pests because of the high temperatures often accompanied by high humidity and rainfall events. The winter environment of North Queensland, which usually has mild temperatures and low rainfall, results in less difficulties in managing pests in this crop. In both districts extreme difficulties resulting in 100% crop losses at times, have occurred since 1992.

Summer temperatures in NSW, Victorian and Tasmanian production districts are more moderate (generally) than those in more northern districts. Combined with lower rainfall probabilities during the production season, pest management has also been at less extreme levels.

The pest management practices documented, reflect the 'ease' or 'difficulty' in managing insect pests, especially heliothis, by the sweet corn industry in Eastern Australia. The choice of materials and techniques varies with the severity of the problem and the environmental and management factors influencing their effectiveness.

eg. Aerial application of pesticides is the standard for much of the industry in Queensland and NSW, especially where large areas are planted at each sowing date and fields are not adjacent to residential areas. Ground rigs are used in more intensive farming areas and where smaller fields exist often in close proximity to residential areas.

The market destination of the product also has an influence over the level of pest control required by the industry in these locations.

All production districts have varying degrees of difficulty in controlling pests, especially heliothis. These difficulties first arose in Southern Queensland in 1992, and have been progressively felt in all districts as insecticide resistance has increased, coupled with other factors such as temperature, intensity of crop monitoring and effectiveness of spray coverage.

The cultivars chosen by growers and processing companies in the various regions are those which perform best in the respective environment and meet the market specification. Pest management considerations are taken into account after these conditions are satisfied. eg. In South-East Queensland, the cultivar H5 (which is Johnson Grass Mosaic Virus resistant) is grown during the mid-season production window, as temperate cultivars more closely meet the market specification for early plantings and JGMV is not a problem until mid-summer.

- **Where does this lead us?**

This is the starting point of this project and a description of those aspects of the production system which contribute towards pest management. From the experiences of other industries (eg Brassica vegetable industry) where similar problems have occurred in recent years, the following issues are most likely to lead to an improvement in pest management and the reduction of risks of production in sweet corn in Australia:-

- Reduce the dependence on synthetic insecticides and introduce biological insecticides where possible.
- Protect naturally occurring beneficials where possible.
- Improve targeting of insecticides (both synthetic and biological) to improve their efficiency.
- Improve timing of insecticide applications through the use of scouting and decisions based on this scouting information.
- Use cultivars which are both acceptable to the market and tolerant to pests and diseases when available.
- Test potential changes to pest management systems on farm with farmer evaluation and input.

# Communication and Information Exchange (Milestone 3)

**Larissa Bilston, CTPM, St Lucia, Queensland.**

- **What did we do?**

**Criterion 1.**

A database has been developed containing names, addresses and phone numbers of sweet corn stakeholders in Eastern Australia. Team members in Eastern Australia have identified stakeholders in their region and provided details for inclusion in the database.

The database is regularly up-dated and continues to grow, with just over 200 contacts currently listed.

**Criterion 2.**

This is it folks! The first yearly meeting of all stakeholders was arranged for Gatton, Queensland in May 1998. All stakeholders were invited to attend through the first project news sheet “The Sweet Corn Ear.”

**Criterion 3.**

The mechanism for the exchange of information between stakeholders throughout the year involves mailing news sheets called “The Sweet Corn Ear” whenever project team members have something newsworthy to report. Colour letterhead paper containing a title banner and the project logo has been printed for the publication. Email is the main method for communication between team members in between annual workshops.

- **Why did we do it?**

Communication between team members and stakeholders is critical for ensuring the project addresses the needs of stakeholders. “The Sweet Corn Ear” provides team members an opportunity to share their news and results with a wide range of stakeholders around Australia without having to publish, maintain a database and distribute individual newsletters. “The Sweet Corn Ear” is also sent to rural newspapers and magazines, providing a mechanism for communicating with a wider audience.

Annual workshops involving all team members and interested stakeholders allow us to see the project’s work as a whole, share ideas and plan future work together. This activity has met the 3 criteria for fulfilling Milestone 3 “All major stakeholders in the sweet corn industry have been identified and a mechanism for information exchange has been developed”, which is due on 31/8/98.

- **What did we achieve?**

The stakeholder database now contains over 200 contacts and continues to grow, thanks to the input of all team members. It has developed into a valuable resource which will assist the team to communicate efficiently with stakeholders.

The first edition of “The Sweet Corn Ear” contained information about the project, its objectives and team members. It generated about a dozen requests for more information on the project and the first workshop.

- **Where does it lead us?**

We now have a centralised communication system in place to link the team with stakeholders. This is designed to make it easier for team members to share their plans and the project outcomes with people around Australia. Larissa Bilston is involved in this project to help facilitate communication, and part of her role will be to maintain contact with each of the regions looking for news to circulate. Your continued updating of the database, and letting her know what’s going on in your region will help her to help you communicate to a wide audience.

# **A. Field evaluation of naturally occurring Trichogramma and larval parasites on *Helicoverpa spp.* and the population dynamics of these in North Queensland.**

**J. D. Brown and A. Horsfield, QHI, DPI, Ayr, Queensland.**

## **• What did we do?**

Sampling for heliothis eggs and larva to recover parasites from them has been carried out on a range of crops in the Burdekin and Bowen areas on a regular bases.

Egg collections were made by searching crops and cutting plant discs with the egg attached and holding these in the laboratory in separate containers for approximately two weeks. The containers were then examined to note parasite emergence. Parasites were removed from these containers and held for identification. At times when it was very difficult to find eggs in the field we have seeded crops with newly laid heliothis eggs attached to cards. These were left in the field for two days and returned to the laboratory to note the percentage parasitism. Production of the eggs has been possible by establishing and maintaining a heliothis population in the laboratory.

Collections of larva have been made from the field, held individually on an artificial diet and reared in controlled temperature incubators in the laboratory until the emergence of the adult moths. Those containers where the adults did not emerge were examined for parasites.

Sampling of crops other than sweet corn has been necessary as sweet corn crops have not been planted for the 1998/99 cropping period in this area until recently. As these other crops were not under our supervision, applications of insecticides were made to some of these and could be influencing results.

## **• Why did we do it?**

The aim of these studies is to build up information on the parasites of heliothis, a major pest of sweet corn, which is necessary in the development of sound integrated pest management strategies. Some of the data required in reaching this goal of evaluating parasites as a tool in the management strategy is discussed below and in most cases it refers to both the egg and larval parasites.

(a) *The identification of the parasites that already influence heliothis populations that occur in this area needs to be known.*

It has been shown in crops grown in other areas that when populations of parasites are introduced they do not always remain as the dominant species. This is due to a number of reasons but the main one is that they do not adapt readily to different

climatic conditions. If the identification of the local and established species is different from those species available commercially it may be possible that these could be bred up and used in preference to the introduced species which may not adjust to the local climatic conditions. Just to know which species are present in an area is important in any research therefore the number of different species and their identification is critical and needs to be known before a lot of the other research can be undertaken.

(b) *The seasonal patterns of the host species and the parasites and how this affects the parasite activity needs to be known.*

It is known that there are a number of egg and larval parasite groups that occur in heliothis populations in this and other areas. The need to understand each of these groups and also establish when the parasites exert their influence on the heliothis populations is required so that the best result can be achieved if and when introductions are made. Whether there are a number of species or only a single species present at any given time will be gained from these collections and it will be shown which species need to be involved. The seasonal activity and species abundance of the hosts will also need to be studied as these will have an influence on when populations of the parasites are present.

(c) *The percentage parasitism that each species can reach in a given population will need to be studied. Also the host instar affected will also be important.*

From the sampling we will be able to determine the percentage parasitism that each species can reach in a given heliothis population and what influence this parasitism level has on future heliothis populations. Which instar that the larval parasites causing feeding to cease will also be an important factor. Also from this data we will be in a position to categorise each species as to their benefit in controlling populations in sweet corn crops.

(d) *Populations dynamics in sweet corn and other vegetable crops.*

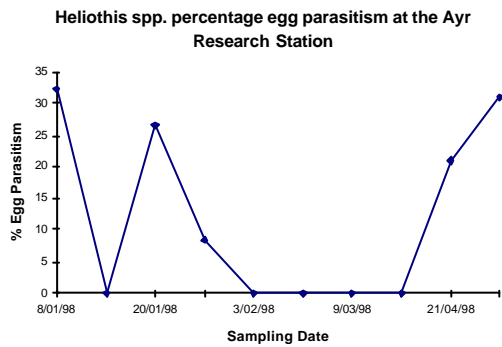
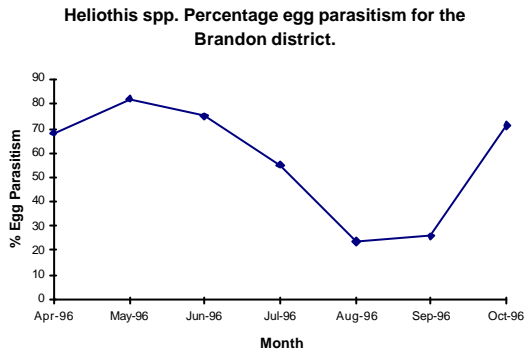
As sweet corn is grown in major vegetable production areas in this district, the need to understand the influence of these other crops as reservoirs for both the pest and parasites will need to be considered. This part of the study does not need to be on a major scale but it must be considered in the overall picture in developing control strategies.

(e) *Effect of insecticides on populations.*

At this stage differences in treated or non treated crops has not been undertaken. Crops have now been planted to evaluate the affect of insecticides on these parasites populations and at the same time evaluate the use of pesticides in combination with the parasites on heliothis populations.

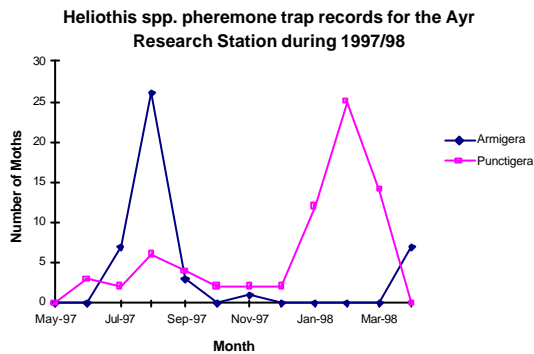
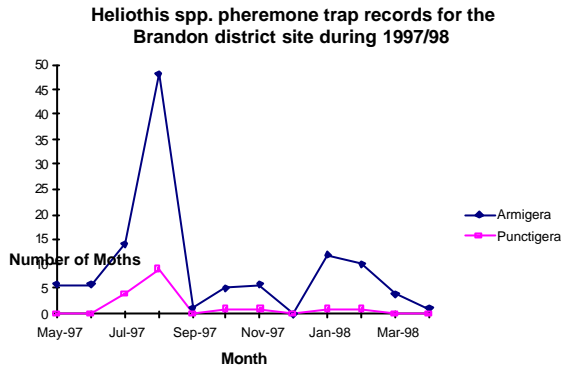
- **What did we find?**

Some of the results on percentage parasitism recorded in the Burdekin region are as follows:-



Though these results have been obtained from crops other than sweet corn it does show the level of parasitism that does occur throughout different periods. These counts are for total parasites and involve a number of species.

In the following graphs, the changes in the population of heliothis adults collected in pheromone traps are shown. From these graphs it can be seen that there are similarities and differences occurring in these populations. Populations of *H. armigera* peaked around July at both sites but there were major differences in the species that were recorded in the January - March period.



- **Where does this lead us?**

The results collected to date will be enhanced by further studies now being conducted in sweet corn crops that have been planted in this area. Both commercial planting's and research blocks are now available and the majority of the research over the next six months will be conducted in these crops. At the end of the sweet corn growing season we will continue to collect from other crops.

We will be maintaining routine collections of heliothis eggs and larvae to build up our data base / knowledge on the parasite species that are native to this area and at the same time monitor their activity throughout the year. At times when heliothis populations are low we will be placing cards with eggs on them into the field to maintain this monitoring. Notes on the growing practices employed in these crops will be recorded together with their affect parasite populations.

Depending on the outcome of the studies over the next few months we may need to evaluate the introduction of other parasite species that have been beneficial in crops in other areas. It has been reported that a Trichogramma species introduced into Northern Australia and later into the Lockyer Valley a number of years ago has now been found to be exerting high levels of parasitism in sweet corn planting's. As this is a high temperature species it could be useful in this area if introductions are found wanting.

We will be noting the heliothis instars that are attacked by larval parasites as this will be important in determining their value as a control agent.

As our data base grows we will be able to monitor other crops to note their value as reservoirs for maintaining populations of both pest and beneficials.

From these results we will be testing and evaluating the different species as potential control agents and in what ratios or combination they may be needed to be effective beneficials.

Also as these studies progress the affect of different pesticides and application methods will be evaluated on these parasite populations.

## **B. Resistance Monitoring**

Samples of heliothis larvae are to be collected throughout the growing season and sent to Dr. R. Gunning at Tamworth for testing for resistance development.

Resistance to all groups of pesticides will be requested.

# Incorporating *Trichogramma* wasps into sweet corn IPM programs

Richard Llewellyn, BioResources Pty Ltd May 1998

## Summary

Egg parasitism levels of *Heliothis* were monitored in a range of crops from Mid - October 1997. Levels were found to be moderate to high and by December very high in the Gatton area. The dominant species was subsequently identified as *T. pretiosum*, a species released in the Lockyer Valley by Brad Scholz three years previously. Further monitoring at a number of sites in the Lockyer district revealed that this species was gradually dominating the local species *Trichogrammatoidea bactrae*. By March, *T. pretiosum* was so numerous and active that several sweet corn growers completely ceased spraying (even with biological insecticides) and crops have suffered less damage as a result.

This project had planned to monitor releases of mass reared *Trichogramma* and to test various application methods. The project has evolved somewhat differently due to the very high levels of natural parasitism encountered in the Lockyer Valley. The work has therefore focused more on monitoring the spread and level of egg parasitism in a range of crops including sweet corn. A number of trials compared local *Trichogramma* with NPV versus conventional chemical insecticides. Findings were relayed to growers and scouts as they occurred so that growers could obtain immediate benefits. A large sample of *T. pretiosum* was obtained from the field and a mass culture established. *T. pretiosum* is now available for further trial work and for commercial sales.

## Results

A summary of data from field trials and various egg collections made in sweet corn is as follows:

### Trial 1 Processing sweet corn Tent Hill SE Qld

Mid October. A week off tasselling the egg pressure was 2 per plant. Egg parasitism was higher than expected for this time of year at 41% with all this the result of *Telenomus*. It was clear that to apply a "soft" chemical at this stage would be preferable to the application of a broad spectrum chemical insecticide. A small quantity of Gemstar® (NPV) was obtained from the QDPI. The first NPV spray produced a low mortality of larvae: 19%, 28% and 29% for 2nd, 3rd and 4th instar larvae respectively. Samples taken after the second application showed much higher levels of mortality: 100%, 89% and 82% for 2nd, 3rd and 4th instar larvae respectively.

Harvest assessment:

Insecticide Block: 50% cobs with side damage. 42% cobs with grubs present.

NPV Block: 28% cobs with side damage. 17% cobs with grubs present.

Egg parasitism in the NPV block increased to 56%. The proportion caused by *Telenomus* dropped from 100% on 18 Oct to only 14% by 7 Nov with *Trichogrammatoidea* spp. and *Trichogramma* spp. accounting for the remainder but

the proportions were not recorded. The effects of *T. pretiosum* was not anticipated at this stage.

### **Trial 2 Seed sweet corn Lowood SE Qld**

This seed crop was grown under very hot conditions and failed to pollinate successfully. Egg sampling data was useful in showing that *Trichogramma* were still very active at high temperatures with parasitism at 100% on one occasion. On another occasion parasitism dropped to 29% after an application of mancozeb. Whether the mancozeb was the cause or perhaps some chemical residue in the spray tank? NPV was applied but the low number of grubs present prevented an assessment.

### **Trial 3 Fresh market sweet corn Mulgowie SE Qld**

Larvae samples were taken from a site at Mulgowie to assess NPV efficacy. The crop had three applications of NPV at 500 ml /ha from the air. Results were not as good as the Tent Hill site but still okay: 82%, 71% and 53% mortality for 2nd, 3rd and 4th instar larvae respectively.

Egg parasitism was monitored and increased to 88% by silking with egg pressure around 5 per plant. The crop however had about 80% damage but this was similar to the chemical treatment.

### **Trial 4 Processing sweet corn Lake Clarendon Rd Gatton**

This trial planned to compare NPV and the local *Trichogramma* with a conventional insecticide treatment (identical plots each 4 ha). The first egg collection was made two weeks before tasselling when plants were 600 mm high and yielded 92% parasitism with an egg pressure of 2 per plant. Egg pressure increased to 10+ eggs per plant at silking in both sites and parasitism increased to 95+% in both sites (chemicals not being applied in the chemical site until silking). As expected parasitism levels dropped to less 48% after the first insecticide application. In the no chemical site, percent parasitism remained in the high 90's. One NPV was applied just as egg pressure increased but very few grubs were found and it is unknown just how much the NPV contributed to the good result. The egg parasitism data and the harvest assessment conclusively demonstrated the negative effects of chemical application in a situation of high egg pressure and very high egg parasitism:

No Chemicals Block - nil damage 62%; side damage 23%; cobs with grubs 14%.

Chemical Block nil damage 9%; side damage 73%; cobs with grubs 51%.

### **Other egg collections in sweet corn**

**Bathurst:** collected 29 Jan 1998 33% parasitism, all *Telenomus* spp. (n= 48)

**Pittown:** collected 30 Jan 1998 1.5% parasitism, one by *Telenomus* (n = 72)

**Cowra:** collected 6 Feb 1998 nil parasitism (n = 50)

### **Farm A, Gatton, SEQ.**

The first collections made at Farm A in pre tassel corn on 6 Feb yielded only 20% parasitism. Egg pressure was low at this stage. Only *B.t.* was used from this time. Egg pressure jumped in early March. Monitoring commenced in another crop on 6 March at 1 egg per plant and yielded 100% parasitism. Egg pressure jumped to 16/plant while parasitism remained in high 90's. At this time Farm A ceased *B.t.* also. The crop had around 10% damage at harvest which was considered by the grower to be very low under such high egg pressure.

### **Farm B, Mulgowie SE Qld**

Collections were made in early March in pre tassel and silking corn under very heavy pressure (15+/pl) and yielded close to 100% parasitism, all from *T. pretiosum*. This farmer believes damage would be 100% if chemicals are used when egg pressure is this high. At this stage chemical spraying ceased and damage levels dropped significantly. However, yellow peach moth has emerged as problem in some plantings with damage to 25% on one occasion. Also thrips can be a problem. Golden Sweet plantings in spring will be the next test for the biological program.

### **Farm C, Elimbah SE Qld**

Like other growers, Farm C had high damage levels (60%-80%) through the season in spite of regular chemical applications. The crop treated with NPV was the last grown. Egg pressure remained very high (15+/pl) through tasselling and silking with egg parasitism around 75%. NPV was applied from the ground at tasselling at 500 ml/ha and then every 3 days. The local *Trichogramma* -NPV combination resulted in only 15% damage even under this heavy pressure.

### **Implications for sweet corn**

IPM programs will need to differ greatly from one district to another. Which beneficial species are present and their level of activity is central to deciding which approach to take. The egg pressure usually encountered and the end user's tolerance to damage will all need to be considered. The high levels of egg pressure and of parasitism encountered in SE Qld should be considered in IPM programs and new registrations for NPV provides a promising combination. Selecting, planting and locating crops in such a way as to encourage the movement of *Trichogramma* from one crop to the next is likely to be a consideration in future, in the Lockyer at least. The low levels of egg parasitism encountered at the sites in NSW demand different approaches. Higher levels of parasitism are found further inland and will require yet another approach.

The success of *T. pretiosum* in the Lockyer raises many questions:

Was there something unique about the past season in the Lockyer Valley?

Will it be repeated?

Or is there something about the Lockyer Valley which has facilitated the high activity?

Can we introduce mass reared *T. pretiosum* in spring to accelerate the build up?

If *T. pretiosum* is released in other areas, will it perform as well as in the Lockyer Valley?

# Comparison of a Best Management Option with Standard Practice for the Management of *Helicoverpa armigera* (Heliothis) in Sweet Corn.

## Introduction

*Helicoverpa armigera* (heliothis) is the major insect pest of sweet corn. Heliothis in sweet corn has traditionally been controlled by the use of synthetic chemicals, however heliothis control has been variable in recent years, probably due to factors such as insecticide efficacy/resistance and application. A range of chemical and non-chemical control options have potential as part of an integrated heliothis management strategy for sweet corn in North Queensland. The objective of this trial was to devise a “Best Management Strategy” and compare it to the Standard Practice for heliothis management in sweet corn in North Queensland. The trial was designed to investigate the following factors:

1. The effect of GemStar applications pre-tasselling on the larval population at tassel emergence and ultimately on cob damage levels.
2. The efficacy of GemStar and egg parasite releases during silking.
3. The effect of increased water volume for application of insecticides during silking.

## Materials and Methods

### *Trial Design*

Three plots, 16 rows x 60m (0.1 ha), were sown on 13 March, 1998. Plots were separated 3m of roadway (bare ground) to enable the spray rig to move between plots and to limit drift/contamination between plots. Three heliothis management strategies were evaluated:

(i) **Standard Practice** - No treatment was applied pre-tasselling<sup>1</sup>. The first application was made at tasselling and then the timing of subsequent applications during silking were based on the results of the regular monitoring. The Standard Practice plot was sprayed with the carbamate insecticide methomyl (Nudrin) at the recommended label rate of 2.0L/ha, applied in a spray volume of 450L/ha. Treatments were applied using a tractor-mounted high clearance boom fitted with hollow cone nozzles. Six methomyl applications were made from tasselling through to the end of the trial (Table 1).

(ii) **Best Management Strategy** - The Best Management Strategy was based on application of a commercial heliothis nuclear polyhedrosis virus (NPV) product (GemStar) and the inundative release of the egg parasite, *Trichogramma pretiosum*. GemStar was applied at a rate of 0.5L/ha ( $7.5 \times 10^{11}$  PIBs/ha), applied in a spray

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<sup>1</sup> Standard practice in North Queensland does involve insecticide applications for heliothis control pre-tasselling, however for the purposes of this trial, no treatments were applied.

volume of 450L/ha. Treatments were applied using a tractor-mounted high clearance boom fitted with hollow cone nozzles. Two GemStar applications were made pre-tasselling and a further five GemStar applications were made during silking (Table 1). GemStar applications were timed to coincide with egg hatch. *T. pretiosum* were released at a rate of 250,000 wasps/ha as pupae in parasitised *Sitotroga cerealella* eggs mounted on paper release cards. Forty-eight release cards were distributed uniformly throughout the plot and stapled to corn foliage. Releases were made late afternoon on 40 DAS and 52 DAS.

(iii) Untreated Control: No action was taken in this plot.

DAS	Best Management Strategy	Standard Practice
18	GemStar	
28	GemStar	
39	GemStar	Nudrin
40	<i>T. pretiosum</i> release	
42	GemStar	Nudrin
45	GemStar	Nudrin
47		Nudrin
49	GemStar	Nudrin
52	<i>T. pretiosum</i> release	
55	GemStar	Nudrin

**Table 1.** Time of applications/releases for Best Management Strategy and Standard Practice plots, Bowen 1998.

### *Sampling*

#### **Heliiothis**

Heliiothis eggs and larvae were assessed twice weekly pre-tasselling and three times per week from tasselling through to harvest. Assessments were made by counting the numbers of eggs (white, brown and black (parasitised)) and larvae (very small <3mm; small 3-7mm; medium 7-20mm; large >20mm) on each of four consecutive plants at five randomly selected locations per plot. Counts were averaged to obtain a mean number per plant for each plot. Observations of beneficial insect activity were recorded in conjunction with the routine monitoring.

#### **Egg Parasitism**

A sample of 100 heliothis eggs were taken from the outside rows of the Best Management Strategy block prior to the release of the first *T. pretiosum* release on 40 DAS. A post spray sample was made two days later. A second release was made on 52 DAS and a post-release sample taken two days later.

## Damage Assessment

A damage assessment was made 62 DAS by randomly sampling 100 cobs from each plot. Each cob was assessed for feeding damage by heliothis and for the presence of larvae in cobs.

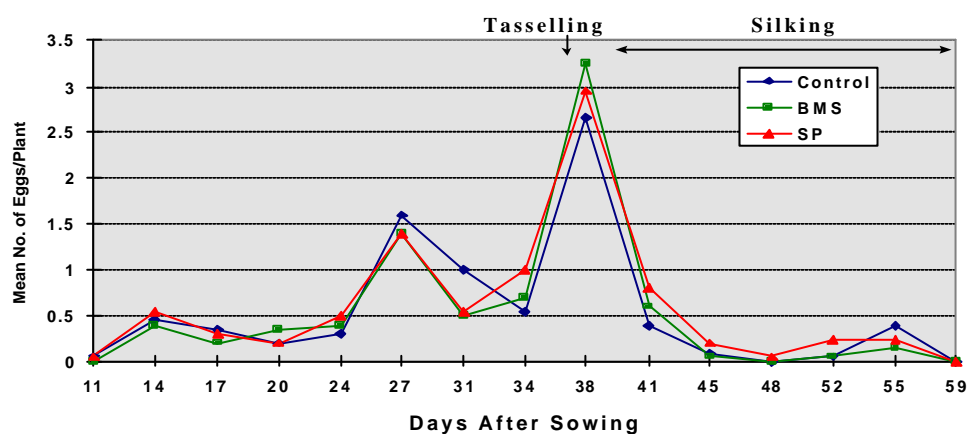
## Rainfall

Rainfall recorded during the trial was as follows:

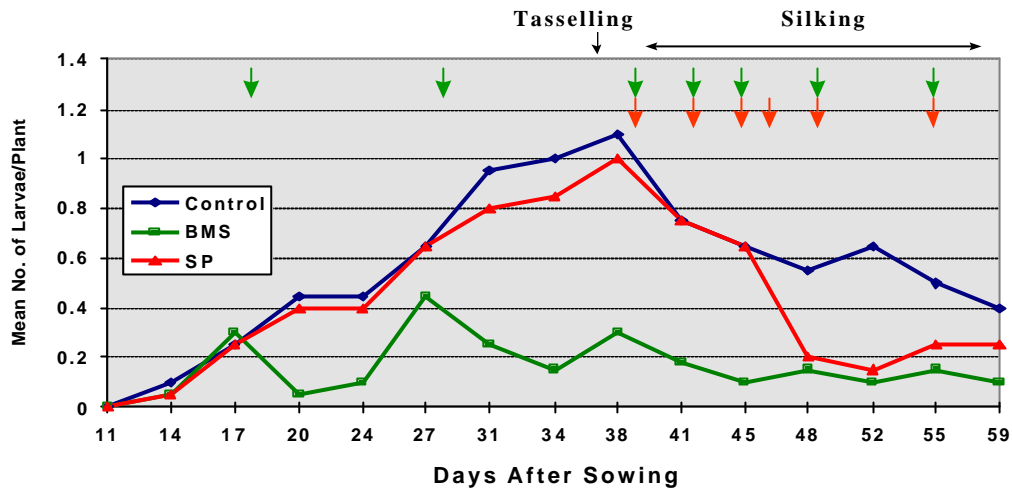
23 April (41 DAS)	- 28mm	2 May (49 DAS)	- 10mm
1 May (48 DAS)	- 2mm	4 May (51 DAS)	- 105mm

## Results and Discussion

Levels of heliothis eggs and larvae recorded during the sweet corn trial are shown in Figures 1 and 2. Egg numbers pre-tasselling were low prior to a peak on 27 DAS of approximately 1.5 eggs/plant, and declined again before tassel emergence. Larval numbers increased steadily throughout the pre-tasselling period in all but the Best Management Strategy (BMS) plot. Two applications of GemStar timed to coincide with peak egg hatch resulted in a 70% reduction of larval numbers at tasselling in the BMS plot relative to the Standard Practice and Control plots. Larvae present at tasselling in the BMS plot were exclusively large larvae, indicating that these larvae resulted from egg lays in very young corn prior to the first GemStar application. In contrast, larvae of all ages were recorded in tassels in the Standard Practice and control plots.



**Figure 1.** The mean number of *H. armigera* (heliothis) eggs in the sweet corn trial, Bowen 1998.



**Figure 2.** The mean number of *H. armigera* (heliiothis) larvae in the sweet corn trial, Bowen 1998.

Legend:- Arrows on top line represent GemStar® applications  
 Second line of arrows represent methomyl applications

Larval numbers peaked at tassel emergence before declining during silking. Larvae in Control and Standard Practice plots declined at a similar rate in early silking, indicating that the decline was due to larvae leaving the plant to pupate rather than the impact of methomyl applications. Application of GemStar had no effect on large larvae. Larvae feeding on emerging silks and penetrating into young cobs was evident in all plots, but widespread in Standard Practice and Control plots where larval numbers were higher.

Egg numbers peaked at between 2.5 and 3.5 egg/plant at tassel emergence and then decreased dramatically and remained at low levels during silking. Wet weather conditions are likely to have contributed to the low heliothis pressure during silking. Heavy rain and strong winds on two occasions during silking resulted in severe lodging of plants. Although the plants recovered to some degree, and egg numbers were low during silking, larval control during this period may have been compromised. The lodging of plants did prevent UV dye assessments of spray coverage to be carried out. Therefore, the effect of increased spray volume on target coverage and larval control could not be established.

The impact of *T. pretiosum* releases in the BMS plot is difficult to assess in this trial due to rain at the time of both wasp releases. The initial pre-release sample of eggs indicated no natural parasitism at all, and samples taken after release were similarly all parasitism free. General beneficial insect activity was low throughout the trial and is unlikely to have had a major impact on heliothis control in this trial. More information about beneficial insect activity in this region is required before being considered as a component of a heliothis management strategy. This would need to be done by monitoring unsprayed sweet corn blocks throughout the growing season in commercial cropping areas in Bowen and the Burdekin.

Treatment	No Damage (%)	Silk Damage Only (%)	Cob Damage (%)	Cobs With Larvae (%)
Untreated Control	17	0	83	23
BMS	78	1	21	0
Standard Practice	48	8	44	9

**Table 2.** Results of damage assessment showing levels of larval infestation and damaged cobs at harvest.

### *Damage Assessment*

The results of the damage assessment are shown in Table 2. The BMS plot had the highest number of cobs free of damage (78%) compared to Standard Practice (48%) and Untreated Control (17%). The results of the damage assessment demonstrate the impact of the larval population present at tasselling. It is significant that the level of cob damage in the BMS plot is roughly equivalent to the number of larvae present at tasselling in that plot. Where no treatment was applied pre-tasselling, damage levels are higher as a result of higher larval populations at tasselling. The vast majority of damaged cobs contained no larvae, and the damage had clearly been inflicted early in cob development. Significantly more cobs in the Control plot contained larvae than in either the Standard Practice or BMS treatments. The impact of these larvae in the Standard Practice has been reduced to some degree by the six methomyl sprays, whereas where no treatment was applied, 83% of cobs were damaged. Only a quarter of these damaged cobs contained larvae at harvest, indicating that the damage was inflicted in the period of early silking by larvae moving down from tassels. It is estimated that only 10% the of damaged cobs in the control plot was due to larvae hatching during silking.

### **Conclusion and Recommendations**

The results of the trial demonstrate the impact of larvae developing pre-tasselling on the overall damage levels in sweet corn in North Queensland. GemStar applications timed to coincide with egg hatch during pre-tasselling, particularly early egg lays in young corn, can drastically reduce this damaging larval population present at tasselling. Implementation of the pre-tasselling GemStar application strategy in commercial crops has been highly successful, resulting in very low numbers of larvae at the start of silking.

The efficacy of GemStar applications and *T. pretiosum* releases during silking is still not established because of unfavourable conditions during the trial. Similarly, the effect of increased spray volumes on target coverage and heliothis control could not be evaluated successfully during this trial for the same reason. Both require future investigation. However, it is felt from the results and observations made during this trial, and in extensive crop monitoring of commercial sweet corn, that the issue with the highest priority with respect to heliothis management in sweet corn in North

Queensland is spray application. It is proposed that the next phase in the development of a Best Management Strategy for North Queensland should focus on spray application, particularly during silking. Industry stakeholders have identified this issue as of immediate priority and will be addressed in the next stage of Best Management Strategy development.

### **Acknowledgments**

QDPI Bowen staff, Ross Wright and Graham MacGregor, and Stationhands, Ron and Joe, are acknowledged for their cooperation and assistance with the organisation and spraying of the trial. Richard Llewellyn (BioResources Pty Ltd) provided the *Trichogramma pretiosum* (from Bugs for Bugs) for release during the trial.

# IPM of heliothis in Lockyer Valley Sweet Corn.

**Brad Scholz**, Entomologist, Farming Systems Institute QDPI, PO Box 102,  
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## **Introduction:**

The corn earworm or heliothis caterpillar (*Helicoverpa armigera*) is a major pest of sweet corn in the Lockyer Valley region of south east Queensland. This pest has been managed by chemical insecticides for many years, but is now becoming more difficult to control due to widespread resistance problems. Growers are keen to adopt new pest management practices to reduce the current dependence on chemicals. The QDPI has been evaluating control tactics that have potential for use in integrated pest management (IPM) programs. IPM involves using a number of tactics to managed pests, with reduced reliance on broad spectrum chemical insecticides.

Some of the newest insecticides being developed are ideal for inclusion in IPM programs because they kill heliothis while not harming predatory or parasitic insects. The action of these natural enemies supplements the mortality caused by the insecticide, and can sometimes effectively control heliothis.

A new insecticide called Success<sup>®</sup> has recently become available for evaluation against heliothis. This product belongs to a group of chemicals known as 'spinosyns' and can be used to kill caterpillars without killing predatory insects and spiders. The effects of Success<sup>®</sup> applications against heliothis in sweet corn were evaluated at QDPI Gatton Research Station.

The trial consisted of four bays of H5 sweet corn 180 m long (each representing a replicate) and 10 rows wide. Each bay was separated by six rows of buffer corn that were not treated. There were five treatment plots 25 m long and 10 rows wide in each bay, separated by 15 m of buffer corn. The five treatments were: 1) unsprayed control, 2) Decis<sup>®</sup> (deltamethrin) applied at 12.5 g.a.i./ha, 3) Success<sup>®</sup> (spinosyn) applied at 48 g.a.i./ha, 4) Success<sup>®</sup> applied at 96 g.a.i./ha, and 5) Success<sup>®</sup> applied at 192 g.a.i./ha. Insecticides were applied four times to all sprayed plots (57, 61, 64 and 71 days after sowing) using a Stihl blower mister. The numbers of heliothis eggs and larvae, and the numbers of predators, were counted on corn plants weekly. Paper cards containing 10-40 heliothis eggs were stapled to corn leaves, and collected after 2 days. The numbers of eggs on the cards before and after collection were recorded, and the numbers of eggs that hatched or were parasitised after collection were also noted.

## **Results:**

The level of heliothis egg laying peaked at approximately 4 eggs/plant one week before silking commenced. There were negligible numbers of larvae counted throughout the trial. The numbers of predators increased markedly from 6 weeks after planting (Figure 1). The most abundant predators were ladybird beetles, pirate bugs, black mirid bugs and spiders, and these ate approximately 60% of all eggs placed in unsprayed plots (Figure 2A). A list of species observed feeding on egg cards, or commonly recorded, is provided in Table 1. The majority of eggs remaining were

parasitised by natural populations of *Trichogramma pretiosum* (Figure 2B). The numbers of predators in the Decis<sup>®</sup> treated plots fell to almost zero as soon as spraying with the chemical commenced (Figure 1).

There were no significant differences between the level of control achieved by the different rates of Success<sup>®</sup>. All rates were effective against heliothis and only 1-2% of cobs in the Success<sup>®</sup> treated plots were damaged, while 18% and 22% of cobs in the control and Decis<sup>®</sup> plots respectively were damaged (Figure 3A). Similarly, larval infestation was negligible in the plots treated with Success<sup>®</sup> and significantly higher in the Decis<sup>®</sup> treated and unsprayed (control) plots (Figure 3B). Only 5% of cobs in the unsprayed plots were infested with heliothis, but an additional 6% were infested with either yellow peach moth or sorghum head caterpillar.

### Discussion

The data indicate that Success<sup>®</sup> has potential for heliothis management in sweet corn, particularly in crops where predator and *Trichogramma* activity is high. It is less disruptive on predators than conventional broad spectrum insecticides. In addition, Success<sup>®</sup> is effective against a range of caterpillar pests, and this feature may be useful in the event of a secondary pest outbreak, e.g. yellow peach moth.

The disruptive nature of the synthetic pyrethroids was again obvious in this trial. The numbers of predators counted on plants fell to almost zero as soon as spraying with Decis<sup>®</sup> commenced. With few predators (and reduced *Trichogramma* activity) 22% of cobs were damaged by heliothis. There were no yellow peach moth or sorghum head caterpillars found in the Decis<sup>®</sup> treated plots, suggesting that the product is effective against these insects. However, heliothis infestation was significantly higher in the Decis<sup>®</sup> plots than in the Success<sup>®</sup> treated plots.

Natural enemies continue to have an important regulatory impact on heliothis in the Lockyer Valley. *Trichogramma pretiosum* has become a particularly effective naturally occurring egg parasitoid and, where possible, pest management practices that do not disrupt this wasp should be employed. The heliothis nuclear polyhedrosis virus (GemStar<sup>®</sup>) and the bacterium *Bacillus thuringiensis* (*B.t.*) do not harm *Trichogramma*. Other data suggest that Success<sup>®</sup> is harmful to *Trichogramma*. Despite this, very high levels of heliothis control were recorded in the Success<sup>®</sup> treated plots, and the product has considerable potential for inclusion in IPM programs due to its safety on predatory beetles, bugs and spiders.

**TABLE 1**

Species of insects observed feeding on heliothis egg cards, or commonly observed, at Gatton. Their potential to reduce egg numbers, based on field observations, is also provided.

<b>PREDATOR</b>	<b>POTENTIAL<sup>A</sup></b>
<b>Coleoptera (Beetles):</b>	
<i>Anthicus sp.</i>	Brown Anthicid Beetle *
<i>Chauliognathus pulchellus</i>	Green Soldier Beetle *
<i>Coccinella transversalis</i>	Transverse Ladybird **
<i>Coelophora inaequalis</i>	Variable Ladybird *
<i>Dicranolaius bellulus</i>	Red and Blue Beetle *
<i>Diomus notescens</i>	Two Spotted Ladybird **
<i>Harmonia octomaculata</i>	Three Banded Ladybird **
<i>Harmonia conformis</i>	Spotted Ladybird *
<i>Micraspis frenata</i>	Striped Ladybird **
<b>Hemiptera (bugs):</b>	
<i>Campylomma liebknechti</i>	Apple Dimpling Bug **
<i>Deraeocoris signatus</i>	Brown Smudge Bug **
<i>Geocoris lubra</i>	Bigeyed Bug *
<i>Nabis kinbergii</i>	Damsel Bug *
<i>Orius sp.</i>	Pirate Bug ***
<i>Tytthus chinensis</i>	Black Mirid ***
<b>Hymenoptera (wasps and ants):</b>	
<i>Iridomyrmex sp.</i>	Black Ant ***
<i>Pheidole megacephala</i>	Coastal Brown Ant *
<b>Neuroptera (lacewings):</b>	
<i>Mallada sp.</i>	Green Lacewing *
<i>Micromus tasmaniae</i>	Brown Lacewing *
<b>Orthoptera (grasshoppers, crickets, locusts):</b>	
<i>Pteronemobius sp.</i>	Pygmy Cricket *

<sup>A</sup> \* minor, \*\* moderate, \*\*\* high.

# **Sweet corn Research in NSW 1997/98**

**Dr Sandra McDougall and Clarrie Beckingham NSW Agriculture,  
Yanco and Bathurst.**

## ***Communication to Growers and Industry***

The project was presented to growers at two large forums, NSW Farmers Vegetable Conference (August 1997) and at a Simplot Sweet Corn Symposium (September 1997). We also contacted people directly who were involved in scouting sweet corn for the scouting workshop and Clarrie interviewed a number of growers from the main sweet corn growing areas in NSW.

We are wanting to work collaboratively with growers and industry to pool knowledge, focus trials, give support to growers own experimentation and to have active networks so new information can travel rapidly. Both presentations were well received and both growers and industry people expressed a desire to participate. One very positive outcome was Simplot deciding to employ a scout in the Cowra area for the 1997/98 season. The Scout Workshop was a good opportunity to go into greater detail with the participants on *Heliothis* management. Subsequent to the scouting workshop I have had a number of growers express interest in future workshops.

In August 1998 we are having a follow-up for participants in the scout workshop and the next day will be the NSW Farmers Vegetable Meeting which will largely be devoted to Sweet Corn this year. It is anticipated that we will be holding another scout workshop in late November, early December.

## ***Improving or introducing Scouting***

We conducted a Scouting Workshop for ourselves, growers, scouts and industry people, 19 people were present on the day. We wanted to bring together people interested in scouting to pool knowledge and to agree to a common scouting protocol. The workshop was held over a short day in Narromine (area with the earliest sweet corn plantings). Brendan Nolan shared his experience in scouting sweet corn and was a wealth of information. At the end of the day we had an agreed protocol. The biggest gap was what is an appropriate action threshold.

### Consensus Protocol

<b>Sampling frequency</b>	every 3 days at critical period, once/wk other times
<b>Critical period</b>	emergence 1-2 week prior silking => wk prior harvest
<b>Pattern of sampling</b>	10 dispersed sites
<b># of plants sampled</b>	2 plants/ site & 4 silks
<b>Plant parts sampled</b>	seedling tassel - whole plant silks + 10cm either side of silks
<b>Insects assessed</b>	soil insects: (cutworm, wireworm, African black beetle) Heliothis
<b>Records</b>	keep records, 1 copy to S. McDougall for analysis
<b>Thresholds</b>	your own until we have more data

Clarrie put together and distributed a crop-checking book that people agreed to fill out and a carbon copy was to be returned to myself for analysis. Feedback I received during the season was that the protocol helped a lot in checking a crop because it was systematic. I was also told that the records had helped highlight an application problem that wouldn't have otherwise been picked up. With respect to improving the protocol or helping in identifying action thresholds this season doesn't appear to be as good as it promised. Of the books received the results are a little disappointing in that most crops were only scouted on one or two occasions. What I take this to highlight is that people support the concept but that the cost of hiring someone or taking the time to scout is greater than the real or perceived benefit. We will have more feedback and analysis at a follow-up meeting on August 4<sup>th</sup>.

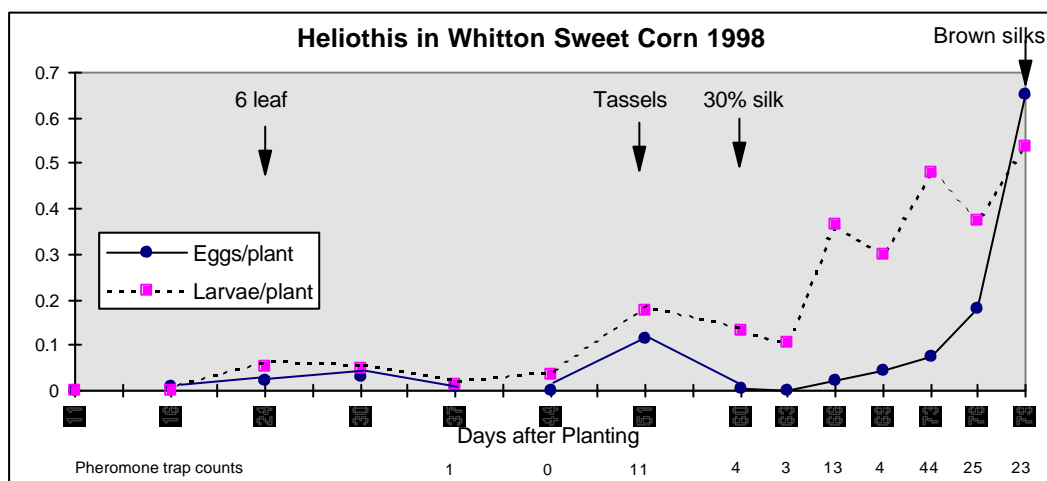
### ***Field trials of Biologicals***

Two on-farm trials were conducted this season, one at Whitton in the Riverina and one at Bathurst. The trials were conducted to investigate the potential for using biological pesticides for the control of *Helicoverpa armigera*. In the Whitton trial we were also interested in what arthropod species lived on or visited the sweet corn plants and assess whether there is a potential for encouraging beneficial insects to enhance pest control. The Whitton trial compared virus, Trichogramma (*T. brassicae*), Bt (MVP), chemical to an unsprayed control. Sampling was done weekly until silking at which point we sampled every three days until harvest. We visually assessed the entire plant of 30 plants/plot for all insect fauna. We sampled the same plants each weekly assessment. At harvest we sampled 50 top cobs/plot. The harvest assessment count number with damaged silks, number of damaged cobs, number of tip, side or both damage sites, and took total cob weight, weight of damaged cobs and weight of the damaged portion.

Heliothis numbers were relatively low over the early part of the season and in late January were increasing rapidly. The treatment program was to be a Trichogramma release 2-3 weeks prior silking, Trichogramma and Virus 1 week prior silking. During silking a threshold of 0.1 egg/plant was to be a guide for subsequent Virus, Bt and

Chemical sprays. On three occasions was the threshold exceed and two of those occasions were outside silking [see Figure 1]. Nevertheless we were observing large numbers of larvae and decided to treat anyway to at least see what effect the treatments may have on larvae. The first release of *Trichogramma* (57 DAP) was washed out. The two subsequent releases of *Trichogramma* were made on 61 DAP and 65 DAP. Virus was sprayed at 61, 65, 71 and 78 DAP. and 65 DAP. Bt was applied at 71 and 78 DAP. Esfenvalerate and Methomyl were applied as a tank mix on 73 DAP. All treatments were applied only to the respective treatment plots. Only a single parasitised egg was observed in the field however samples of eggs returned to the laboratory for hatching revealed 0% parasitism before *Trichogramma* releases. Eggs sampled after the second and third *Trichogramma* releases revealed 66.7% and 75% of eggs collected from the *Trichogramma* plots were parasitised. Unfortunately I haven't comparisons for other treatment plots to compare against. At 78 DAP 10 eggs were collected from each treatment revealing 28.6%, 16.7% and 44.4% parasitism for the *Trichogramma*, Unsprayed and Chemical plots, the remaining treatments had 0% parasitism. We collected at least 10 5-6<sup>th</sup> instar larvae each week to rear out in the laboratory but observed no parasitism.

Figure 1 *Helicoverpa armigera* egg and larval numbers per plant averaged over all plots at Whitton



At harvest the proportion of cobs with heliothis damage ranged from 0.48 (Virus plots 1&2) to 0.92 (Unsprayed plot 3) [see Table 1]. Using the percentage damage used by the processors to assess damage the virus plot had 3.1% damage that was significantly lower than the 6.6% damage of the unsprayed treatment.

Table 1 Summary Harvest Data – Whitton

Treatment	#Cobs	Damaged cobs	Damaged Silks	Cobs with larvae	Damaged cob-tips	av. Cob (g)	Damage by weight of sample
Best Bet	200	75% ab	60%	38%	98% a	196.46	5.1% ab
Bt	200	74% ab	65%	34%	95% a	193.04	5.5% a
Chemical	200	66% ab	61%	27%	95% a	202.66	4.5% ab
Trichogramma	200	80% a	71%	44%	94% a	189.26	5.2% ab
Unsprayed	200	79% a	71%	41%	93% a	192.91	6.6% a
Virus	200	59% bc	53%	27%	93% a	190.72	3.1% bc

LSD 95%, Treatments with the same letters are not significantly different.

At least 19 species of Beneficial arthropods and 20 species of Pest arthropods were regularly observed at the sweet corn site in Whitton [see Table 2].

Table 2 Arthropods monitored in Sweet corn trial, Whitton

Beneficial Insects		Pest Species	
Spiders		Two Spotted Mite	<i>Tetranychus urticae</i>
Earwigs		Corn Aphids	
Brown Lacewings	<i>Micromus tasmaniae</i>	Thrips	
Green Lacewings	<i>Mallada spp.</i>	Vegetable Leafhopper	<i>Austroasca viridigrisea</i>
Big Eyed Bug	<i>Geocoris spp.</i>	Brown Leafhopper	<i>Orosius argentatus</i>
Glossy Shield Bug	<i>Cermatulus nasalis</i>	Pale Leafhopper	
Predatory Shield Bug	<i>Oechalia schellenbergii</i>	Green Planthopper	
Damsel Bug	<i>Nabis spp.</i>	Brown Planthopper	<i>Exitianus plebeius</i>
Assasin Bug	Reduviidae	Yellow Mirid	<i>Campylomma liebknechti</i>
Pirate Bugs	<i>Orius sp.</i>	Green Mirid	<i>Creontiades dilutus</i>
Rove Beetle	<i>Staphilinid spp.</i>	Brown Mirid	<i>Creontiades pacificus</i>
Ground Beetle	<i>Carabid spp.</i>	Rutherglen Bug	<i>Nysius vinitor</i>
2-spot Ladybeetle	<i>Diomus notescens</i>	False Wireworm Beetle	<i>Pterohelaeus darlingensis</i>
Striped Ladybeetle	<i>Micraspis frenata</i>	Wireworm	<i>Agrypnus spp.</i>
Transverse Ladybeetle	<i>Coccinella transversalis</i>	Flea Beetles	Halticinae
Red & Black Beetle	<i>Dicranolaius bellulus</i>	Flower Beetles	<i>Carpophilus spp.</i>
Hover Fly larvae	Syrphidae	Cutworm	<i>Agrotis spp.</i>
Large Orange & Black wasp	<i>Podalomia tydei</i>	Looper	
Small parasitic wasps		Corn Earworm	<i>Helicoverpa armigera</i>
		Ladybeetle parasitoid	Braconid

In addition to the Jubilee on-farm field trial we had small (12 rows by 30m) sweet corn plantings on the research station, two Bicolour Supersweet varieties (Cabaret and Golden Pearl) and one popcorn variety (for baby corn). These were similarly sampled weekly and then every three days after silking. 20 plants per plot were visually assessed for all insect fauna. Cabaret was planted on 21<sup>st</sup> November, two releases of *Trichogramma brassicae* (50 and 60 days after planting), and a single application of virus (Gemstar) full-silk. Heliothis pressure was highest at 48 and 63 days after planting with 0.7 larvae & eggs per plant, at harvest 28% of cobs were damaged with approximately 5% damage on the infested cobs. The popcorn variety grown for baby corn was planted on the 28<sup>th</sup> November and detasselled on the 27<sup>th</sup> January, harvested on 2<sup>nd</sup> February. At tasselling an egg lay was observed (1.2 eggs/plant) which dropped off the following week after which the plants were detasselled and then harvested. Ovipositioning moths were attracted to the Golden Pearl, planted 15<sup>th</sup> December just as the tassels were beginning to emerge and continued to lay in large numbers until harvest. *Trichogramma* were released on 20<sup>th</sup> January and then a series of five virus applications were made (46, 53, 56, 60 and 63 days after planting). At harvest 68% of

cobs were damaged, with damage to an average of 3.5% of a infested cob. Some of the parasitism observed in these plots came from *Telenomus spp.* (native), some from *Trichogramma brassicae* (released species) and some from *Trichogrammanza spp.* (a native species).

At Bathurst the trial compared virus and Trichogramma to a chemical control. The initial intention was to evaluate the potential of the Niger, Coriander, Borage and Buckwheat as border insectary crops for Trichogramma however none of these crops germinated. Instead the 4ha commercial processing sweet corn plot was divided into two plots: 350ml/ha and a 500ml/ha Gemstar plot. Over the road a section of a 40ha conventionally treated (methomyl and esfenvalerate mix) sweet corn crop was used as a control plot. Both crops were planted within 24 hours of each other and similarly the virus and chemical sprays were applied within a 24 hour period. A single application was applied of each treatment at 80% silking. The plots were scouted as per the agreed protocol. *Trichogramma pretiosum* were released in a 1 ha plot within the 350ml/ha rate plot on 29<sup>th</sup> January. Prior to the Trichogramma release 43 viable heliothis eggs were collected of which 32.6% were parasitised by *Telenomus spp.* At harvest 63.3%, 55.5% and 86.0% of cobs were damaged in the of 350ml/ha Gemstar, the 500ml/ha Gemstar and the conventional plots respectively.

## Future

This season was primarily a test run for Tony Napier (Technical Officer) and myself to familiarise ourselves to the system. We think it would be beneficial to re-run the Whitton trial. Other replicated larger plot trials should be run in Bathurst, Cowra or Narromine comparing the Virus with Chemical treatments, and evaluating Trichogramma strains..

Some thoughts/questions:

- Virus appeared to have highest larval kill
- Eggs were not being detected early on yet we were seeing larvae
- Is treating the tassels as they emerge a benefit in reducing larval numbers?
- Are moths preferentially attracted to pre-tasselling and tasselling corn over later stages of corn?
- What is a reasonable action threshold?

## ***Heliothis Pupal sampling***

Immediately after harvest a number of quadrats were scraped of soil to a depth of 10cm to count heliothis pupae. The quadrat size was taken from the centre of adjacent furrows across the intervening beds (1m or 75cm depending on the site) for 1m along the beds. The results are summarised in the following table:

Date	Region	Variety	Site	Quad m <sup>2</sup>	Reps	Pupa/m <sup>2</sup>	Larvae/m <sub>2</sub>
23/02/98	Cowra	Jubilee	Mulyah	0.75	4	0.67	0.00
23/02/98	Cowra	Jubilee	Delany	0.75	4	0.33	0.00
10/03/98	Bathurst	Jubilee	George Smith	0.75	4	3.00	1.00
10/03/98	Bathurst	Jubilee	Clive Bourke	0.75	4	5.33	1.33
10/03/98	Bathurst	Jubilee	over fence	0.75	4	3.33	0.67
13/03/98	Yanco	Golden Pearl SS	YAI	1	4	0.25	0.25
9/02/98	Whitton	Jubilee	Whitton	1	10	4.60	1.40

### **Resistance Monitoring**

High resistance was observed in the central west for synthetic pyrethroids and carbamates. Not good news for sweetcorn growers. Egg samples were taken from Bathurst (1), Cowra (3), Narromine (2) and Riverina (1) and sent to Robyn Gunning at Tamworth for resistance testing. Egg samples were taken from Bathurst (1), Cowra (3), Narromine (2) and Riverina (1) and sent to Robin Gunning at Tamworth for resistance testing. Results are:

Date	Site	SP	Carbamate	OP
18/02/98	Cowra	90%	81%	0%
26/02/98	Bathurst	100%	100%	no data
6/03/98	Bathurst	95%	75%	no data
13/01/98	Macquarie	100%	97%	0%
20/01/98	Macquarie	94%	73%	7%
5/02/98	Macquarie	96%	83%	9%
18/02/98	Macquarie	97%	81%	4%
3/05/98	Macquarie	89%	68%	0%

No data could be obtained from any of the other samples sent. Robin included data for the Macquarie Valley.

### **Moth Traps**

Despite good intentions only three funnel traps with *H. armigera* lures were put approximately 20m from the sweet corn plots, one at Whitton and two at AI. The trap data at the Whitton site gave some indication of heliothis pressure [see Figure 1]. The traps at AI gave no indication at all of moth presence or numbers. Simian Duffed, CSIRO Griffith, has been doing quite detailed studies of the relative catches of heliothis in different traps and corroborates most of the available data that suggest that moth catches cannot be correlated with egg lays. The general feeling is that they indicate big flights but the AI traps didn't even monitor those. My feeling is that if we are monitoring the crop then the traps are obsolete and that there is not enough consistency to substitute traps for monitoring.

## ***Grower Interviews***

Essentially the points that came out of the interviews were in accordance with project aims:

- pesticide application
  - ⇒ timing
  - ⇒ water rates
  - ⇒ time of day
  - ⇒ application means i.e. ground rig, aerial etc
  - ⇒ getting access to spray equipment when needed
- need for better monitoring
- need for work on biologicals
- need training in monitoring and handling of biologicals
- Influence of neighbouring crops
- Variety resistance
- Mite and aphid problems on H5
- Acceptance of tip damage

# PESTICIDE APPLICATION

## **Robert Battaglia QHI, QDPI, Centre for Pesticide Application and Safety, Gatton Campus.**

The following trials in relation to pesticide application assessment have been undertaken in the Locker Valley (South Qld) :

1. Fluorescent tracer technique for quantitative spray deposit assessment.
2. Aircraft pattern testing.
3. Uniformity trial in a commercial sweet corn crop.

### **1. Fluorescent tracer technique for quantitative spray deposit assessment.**

**What was done ?** Evaluation of a fluorescent tracer for quantitative spray deposit analysis in sweet corn (fluorometric analysis).

**Why was it done ?** To validate the technique in sweet corn and determine what difficulties may be encountered with sampling different parts of the corn canopy (eg. tassels, silks and leaves). Using this method the distribution of applied pesticides within a canopy can be determined. The spray recovery can be expressed as the volume ( $\mu\text{L}$ ) of spray deposit or weight (ng) of dye deposit per unit area of leaf.

**What was achieved ?** The technique was successful however there were some complications associated with the method. When a large surface area of leaves is washed ( $>100\text{cm}^2$ ) chlorophyll is extracted and this has the effect of quenching the fluorescent display. Unlike leaves the surface area of silks and tassels is difficult to quantify.

**Where does it lead us ?** The fluorometry technique using “Helios’ as a tracer can be used successfully to determine the spray distribution within a sweet corn canopy. The effect of chlorophyll quenching on the fluorescence display can be overcome by diluting the solution prior to measurement.

### **2. Aircraft pattern testing.**

**What was done ?** Pattern testing of a Pawnee aircraft using water sensitive paper.

**Why was it done ?** The testing was done to assess the uniformity of the spray deposit pattern for placement spraying and determination of the optimum flight lane separation for that aircraft.

**What was achieved ?** The aircraft was set up to apply 60 L/ha using a lane separation of 18m. The aircraft boom did not contain conventional nozzles. It contained a series of small holes at 18.5cm spacing in the left and right hand boom. Such a setup results in a solid stream of liquid. When the jet of liquid enters the surrounding air stream at 85 knots the liquid is sheared into droplets. The deposit pattern was assessed using a single line of water sensitive paper placed at two meter intervals. Software was used to overlap the deposit pattern from a single pass. A spray deposit pattern from a single pass of the aircraft is shown in Figure 1. This figure show the aircraft in relation to the ground deposit pattern. A simulated overlapped analysis of the single deposit pattern is shown in Figure 2. The overlapped analysis shows the deposit level (droplets/ $\text{cm}^2$ ) and coefficient of variation assuming a racetrack pattern is flown for a range of swath width (8m to 40m). For

placement spraying a coefficient of variation of less than 30% is desirable, this occurred at a swath width of approximately 16m.

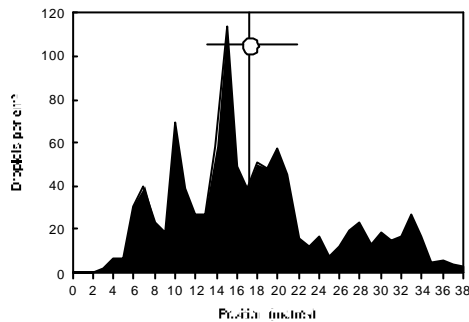


Figure 1. Ground deposit pattern on water sensitive paper from a single pass of an aircraft.

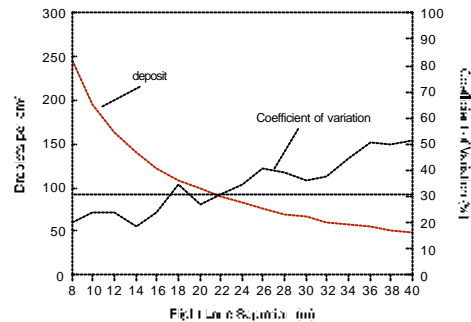


Figure 2. An overlapped analysis of the deposit pattern..

### Where does it lead us ?

The range of droplet sizes recovered on the water sensitive cards varied considerably with this aircraft setup. This operator does have an alternative boom comprising of Micronair AU5000's. They have also considered setting up a boom with CP nozzles. These other nozzle systems are commonly used by aerial operators and need evaluating as they offer the advantage of being able to vary droplet size by rotational speed (Micronair) or deflector setting (CP nozzle). This may assist with improving the uniformity of the deposit pattern

### 3. Aircraft Spray Deposit Trial - Uniformity Trial

#### What was done ?

Using the aircraft tested previously a spray deposit trial was conducted in a commercial sweet corn crop

#### Why was it done ?

This trial was conducted to determine the uniformity of deposit across the crop as well as the distribution of spray within the plant canopy.

#### What was achieved

The spray deposit was assessed by using a fluorescent tracer. No monitoring of biological efficacy was undertaken during the trial. The aircraft applied water only and dye at 60 L/ha using a swath width of 18m. The layout consisted of two transects, 35m long and separated by 10m. At least two swaths were flown over the transects. Within each transect individual plants were sampled every 5m, thus giving a total of 16 datum plants. Tassels, silks, leaves surrounding the cob, and all leaves above the cob were washed in a solvent and a fluorometer used to determine the total dye recovery. In addition, a continuous length of cotton string was placed above the canopy and at cob height.

Figure 3 shows the average spray deposit from the two transects as recovered from a unit length of silk and Figure 4 shows the average spray deposit per square cm of tassel. These figures show that the deposit levels on the silks and tassels vary by up factor of 4. This could equate to variable or ineffective pest control. The variation in deposit is most likely associated with insufficient overlap, ie. too wide a swath being flown. The positions of low deposit occur at about 9m from the aircraft centreline, this is exactly where two overlapping patterns meet.

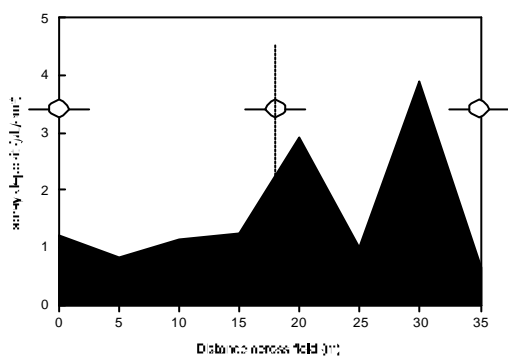


Figure 3. Deposit on silks.

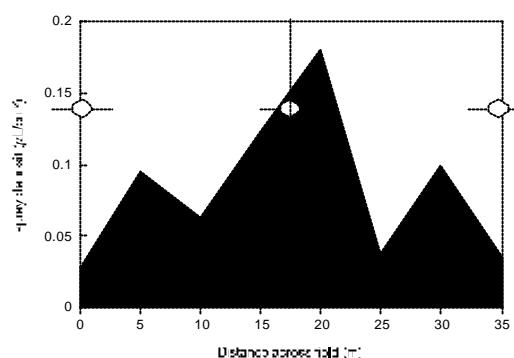


Figure 4. Deposit on tassels.

The spray deposit level on various targets within the canopy and the estimates of total recovery are shown in Table 1. Of those targets sampled, 27% of the applied volume was accounted for. A majority of the applied volume is being recovered on the leaves and there is very little of applied volume reaching the silks (<0.5%).

Table 1. Estimates of spray recovery on various parts of a sweet corn canopy and losses to ground.

Target	Deposit level	L/ha	% of 60 L
Bare ground (loss)	0.00352 $\mu\text{L}/\text{cm}^2$	0.35 L	0.6 %
Leaves (average surface area 7,500 $\text{cm}^2$ /plant)	0.066 $\mu\text{L}/\text{cm}^2$	14.8 L	25 %
Tassel	21 $\mu\text{L}/\text{tassel}$	0.63 L	1 %
Silk	3.88 $\mu\text{L}/\text{silk}$	0.23 L	0.4 %
	Total		27 %

Several measurements were taken from the trial site to calculate the estimates shown in Table 1, these were an average of 3 plants per metre with a row spacing of 0.83m (approx. 30,120 plants per hectare). Not all parts of the canopy were measured. The main stem was not washed, leaves beneath the lowest cob were also not washed and additional tillers off the main stem were also not washed. This may account for some of the applied volume, however there is still a large percentage not accounted for.

#### Where does it lead us ?

This trial did not link biological efficacy with spray deposit levels. Further trials will be conducted to determine whether the irregularities in spray deposit across the swath of the aircraft influence the mortality of heliothis larvae. If low levels of spray deposit results in reduced mortality then there is a need to ensure agricultural aircraft are correctly calibrated and setup to achieve uniform application across a field. A similar trial will be conducted with a boom sprayer to compare the deposit levels and distribution of spray within the canopy.

# ***Helicoverpa* Management in Victoria - 1998**

**R Dimsey, P Ridland and Siva-Subramaniam**

## **Why have we done it?**

East Gippsland produces 70% of the Victorian sweet corn crop (6,000 tonnes in 1996). In 1991, *Helicoverpa armigera* posed major problems with high levels of larval damage in crops, poor control and growers applying large numbers of sprays with apparently little effect. Crops at this time were grown solely for processing at the Gardenland factory.

The following year, pest pressure was much lower. Some pheromone trapping was carried out and samples of larva were taken for resistance testing. High levels of resistance to synthetic pyrethroids were identified and some interim crop management guidelines were developed. In 1992, the factory closed; corn production was reduced and some corn in the 1992/93 season was grown for fresh market. Consequently, the issue of *Helicoverpa* damage became more important. Corn production for fresh market has continued to increase every year since 1993. Some corn was produced for vacuum packing in 1996 and 1997.

***There was a lack of*** knowledge about *Helicoverpa* activity within the region. Was there an endemic population of moths or was the problem due to migration of moths from other areas, or both? State-funded programs of pheromone trapping, crop scouting and resistance monitoring have been carried out over the last 4 years to develop background information to manage the pest. Samples have been taken from around the state and other key growers in the state involved in the monitoring process. The pest has become entrenched and subsequent resistance monitoring has confirmed widespread resistance to synthetic pyrethroids and carbamates, typical of eastern Australian *Helicoverpa*.

The management program has been one of preventative spraying and identifying key application times. Each year, in consultation with industry, management strategies have been revised based on growers' experiences and results from the monitoring program. The issue has become more important since the Victorian crop is now targeted at fresh domestic and export markets.

## **What have we done?**

Our aim was to develop a picture of activity within the various regions with emphasis on East Gippsland. and to develop a strategy to manage the pest.

Since 1995, we have undertaken:

- Pheromone trapping of moths.
- Scouting for eggs on crops.
- Recording sprays used and frequency on the range of crops within the regions.
- Assessment of damage levels to crops.
- Evaluation of tobacco as an indicator plant for egg lays.
- Monitoring of insecticide resistance levels across the state.

- Developed best management strategy guidelines in consultation with industry.
- Convened a sweet corn industry workshop in 1997 to identify and prioritise key issues of the sweet corn industry in Victoria.
- Held information nights and scouting field days.
- Made a late season release of *Trichogramma pretiosum* in April 1998.

The main emphasis has been on the trapping and scouting programs with the aim being to identify the potential of using traps as an indicator of egg lays and whether or not these can be used as thresholds.

#### *Trapping Program*

Several different types of pheromone traps have been used including the Texas Trap, the Pot Trap and, in the last 2 seasons, the Scentry Trap (a smaller version of the Texas Trap) imported from USA. The Pot Traps have now been discarded due to variability and reduced effectiveness compared to the Texas Traps. The pattern of moth catches in the Scentry Traps is very similar to that observed in the Texas Traps (Figure 2).

#### *Scouting Program*

Scouting of crops has been carried out over the last 2 years in order to identify any possible correlation with moth counts in the traps. Egg lays are generally of relatively low levels (<1 egg per 10 plants) (Figure 3). While higher egg lays are usually associated with periods of significant flight activity at early silking, observed egg numbers overall were very difficult to relate directly to moth numbers in traps.

#### *Resistance Assessment*

For several years, populations of larvae collected from sweet corn at different locations around the state have been tested by Dr Robin Gunning, Agriculture NSW Tamworth. There are few differences in results between locations in the state. There is a very high frequency of fenvalerate resistance (>95% with resistance factors ranging from 15-25%) and a variable frequency of carbamate resistance (26-70%). Typical results are shown in Table 1.

**Table 1 Insecticide resistance data for *Helicoverpa armigera* collected from sweet corn at various Victorian locations in 1997. Testing undertaken by Dr Robin Gunning, Senior Research Scientist, NSW Agriculture, Tamworth**

Site	Collection Date	endosulfan	fenvalerate	bifenthrin	larvin/methomyl	Comments
		% resistance				
Lindenow	8 May 1997	32	100	45	60	Fenvalerate resistance factor 15X. Heterozygous for carbamate resistance.
Wemen	16 April 1997	50	95	43	26	Fenvalerate resistance factor 15X. Heterozygous for carbamate resistance.
Dalmore	2 May 1997	25	100	65	64	Fenvalerate resistance factor 25X. Heterozygous for carbamate resistance.
Cardinia	24 April 1997	29	100	47	52	Fenvalerate resistance factor 15X. Heterozygous for carbamate resistance.
Corop	30 April 1997	40	96	40	70	Fenvalerate resistance factor 15X. Heterozygous for carbamate resistance.

## Achievements

- Development of baseline data on pest activity.
- Identification of a critical period around mid February in East Gippsland (Figure 1) when trap counts start to rise and increased pest pressure and damage is observed in *subsequent* crops (Figure 4).
- Increased monitoring of crops by growers although there is a lack of confidence in scouting for eggs and monitoring is usually for larvae.
- Increased recognition of importance of application timing and methods.
- Assessment of resistance levels around the state to a range of pesticide groups.
- Observations that egg numbers were generally substantially lower than reported in Queensland and the lack of reliability of this as a measure of pest pressure in the crop.
- Identification of effective trapping methods for monitoring *Helicoverpa*.

Using these results as a guideline, we have consulted with industry to develop a strategy for pest management of *Helicoverpa*. To date the strategy is generally being followed by growers. Industry is generally happy with the preventative strategy although pest control in the latter half of the season is still very difficult. Some growers remain concerned about quantities of pesticides they have to apply.

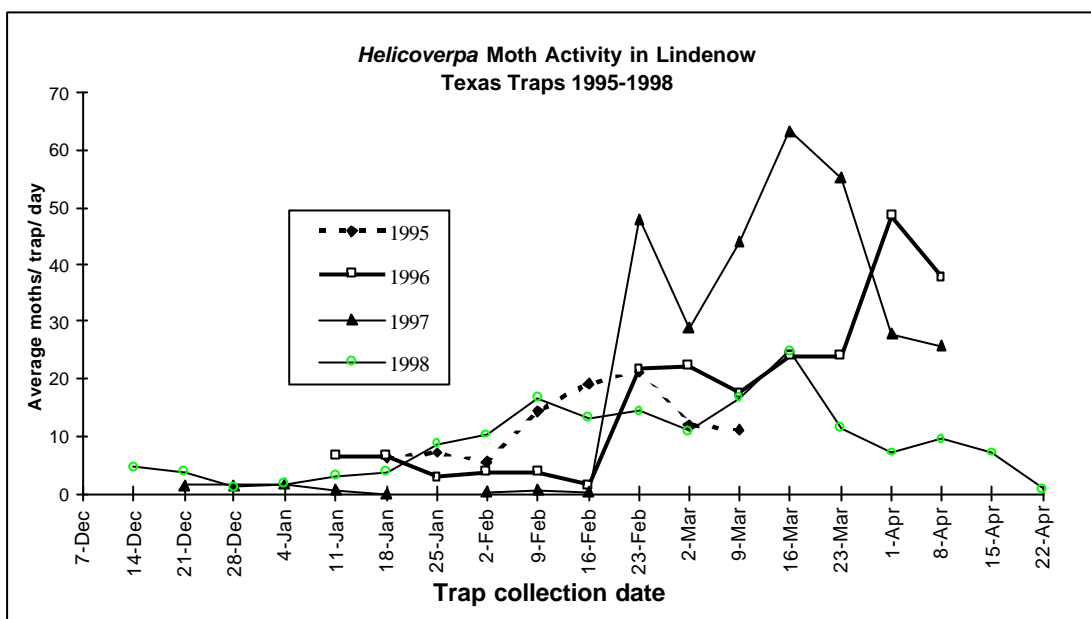


Figure 1 *Helicoverpa armigera* moth activity in Lindenow, Texas Traps 1995-1998

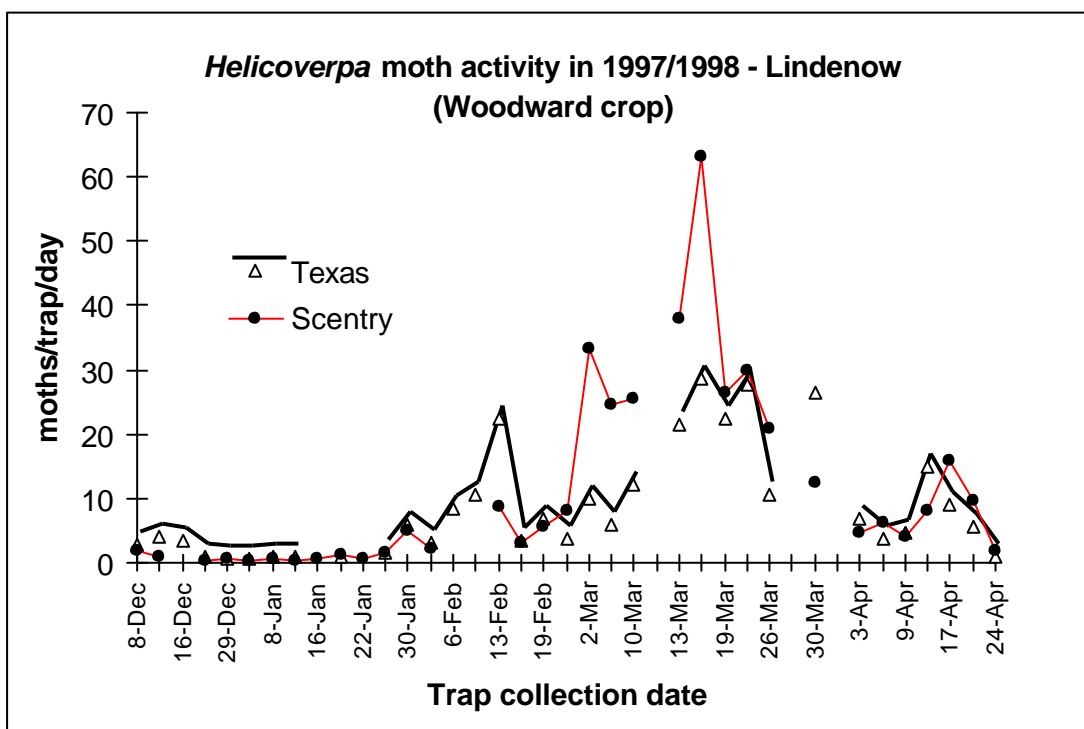
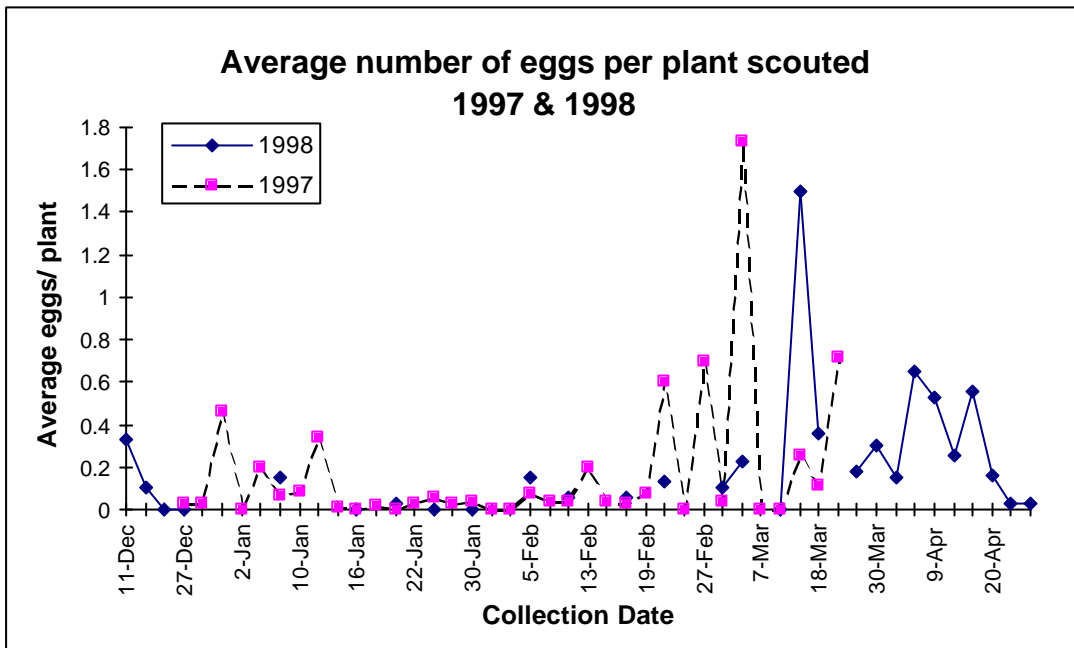
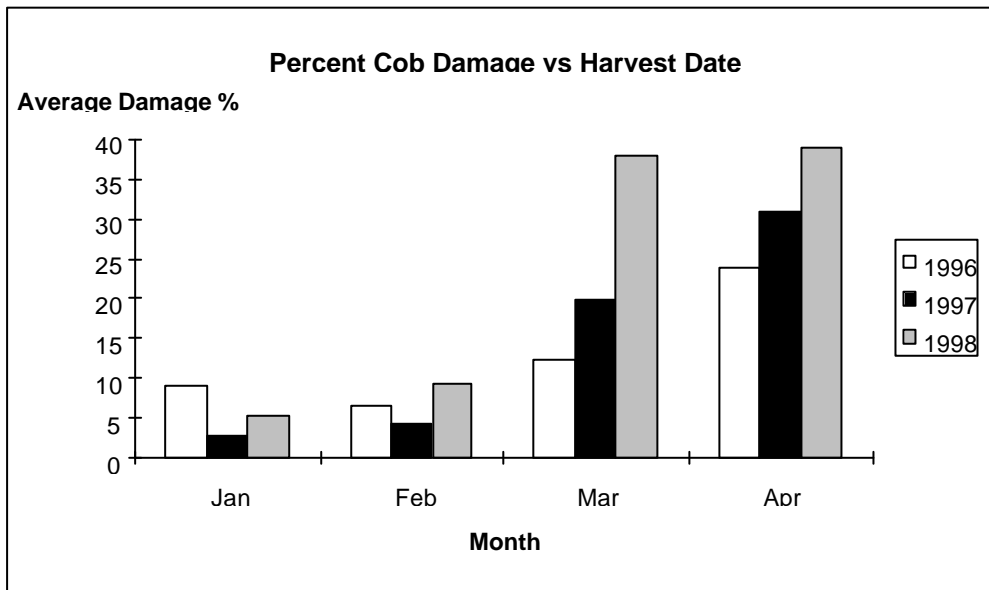


Figure 2 Comparison of average daily moth catch between a Texas trap and a Scentry trap at Lindenow (Woodward property) 1997/1998



**Figure 3** Average number of eggs per plant scouted at Lindenow, 1997 & 1998 (30 plants per sample)



**Figure 4** Percent cob damage, averaged from crops at Lindenow, and harvest date in 1996, 1997 and 1998

# Use of Lepton Test Kit to Determine the Seasonal Abundance of Heliothis.

Julian Winch, Valley Crop Monitoring Service, Gatton, Qld.

- **What we did?**

Heliothis eggs and larvae were collected from a range of crops (including sweet corn) from November 1997 to April 1998 (29 assessments). The proportion of *Helicoverpa armigera* in each sample were determined using the Lepton test kit.

This small project is being funded by the Cooperative Research Centre for Tropical Pest Management (CTPM).

- **Why have we done it?**

Lepton test kits have been available for use by cotton consultants to assist in making pest management decisions for a number of years. In the vegetable industry, consultants have not used this kit regularly. Pest management outcomes could be improved in summer vegetable cropping, especially if *H. punctigera* is predominant. "Softer" pesticides could be chosen and other conservative options contemplated.

Anecdotal evidence to date indicates that *H. punctigera* does not attack sweet corn.

- **What have we achieved?**

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### Lepton Results (for Sweet Corn)

Date	Location	Eggs/Larvae	Crop Stage	% <i>H. armigera</i>
4/12/97	farm 1.	100 eggs	late silking	99
3/2/98	farm 2*	62 eggs	late silking	76
3/2/98	farm 2*	32 larvae (sml - med)	late silking	78
6/2/98	farm 2*	100 larvae (med)	late silking	84
20/2/98	farm 2*	100 larvae (large)	after silking (cob fill)	84

\* eggs and larvae collected from the same sweet corn field.

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- **Where does this lead us?**

Both *H. armigera* and *H. punctigera* eggs and larvae were found on sweet corn silks on two farms in the Lockyer Valley in the 5 Lepton tests conducted over the past summer. This is contrary to the accepted situation of *H. armigera* being the only species attacking sweet corn.

The spray decisions made in relation to the scouting dates associated with the eggs and larvae collected for these Lepton tests were not influenced by the Lepton results. This was because of the level of egg lays and the high % of *H. armigera* in all instances. It is envisaged that a different decision might be made if *H. punctigera* was dominant and egg lays were lower.

These tests have demonstrated that *H. armigera* is not the only species attacking sweet corn. The importance of this knowledge will only be realised if further regular Lepton assessments are made, the dominant species is *H. punctigera* and egg lays are low. Under these circumstances "softer" options may be considered.

# Sweet Corn Cultivars and heliothis Susceptibility in Bowen

R.M. Wright, QHI, DPI, Bowen, Queensland

## What have we done?

An experiment has been sown using the major commercial sweet corn cultivars grown in Queensland to evaluate their attractiveness to heliothis. The cultivars are all supersweet types and have been selected from temperate, tropical and temperate x tropical breeding programs. The cultivars selected in this first trial are *Goldensweet*, *Gladiator*, *Florida Staysweet*, *Pac 377*, *Punchline* and *H5*. They have been sown over a period of seventeen days in order to have each cultivar flowering at the same time. No pesticides are being applied to the trial and the level of heliothis and other insect damage will be recorded along with yield measurements and disease incidence.

## Why have we done it?

Anecdotal evidence suggests that quite large differences exist between some sweet corn cultivars in terms of their susceptibility to heliothis injury. Testing this under experimental conditions may provide some information on the nature of any differences in susceptibility between the different cultivars. These experiments refer to milestone 7.

## What has this achieved?

This first experiment is currently mid-way through and it is too early to have made any assessments.

## Where does this lead us?

The often wide differences in results experienced by growers using similar practices and the huge seasonal variation in insect activity make for a complicated picture. However there are strong indications that over-reliance on chemical control has led to mixed and unreliable results in the control of heliothis. A wider range of strategies which reduce reliance on chemicals, incorporate some biological control methods and utilise some methods of making the crop less attractive to insects need to be explored. Early warning systems and some predictive methods of likely incidence of heliothis on a regional and seasonal basis is desirable.

# Insecticide Resistance in *Helicoverpa armigera*

Iain Kay, QHI, QDPI, Bundaberg Research Station

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## What did we do?

*H. armigera* (heliiothis) collections from most of the sweet corn growing districts were sent to Robin Gunning and to Neil Forrester for resistance testing. We very gratefully acknowledge the generosity of the cotton industry and its funding bodies for doing this testing through its Resistance Testing Program. Robin Gunning's team tests for resistance to conventional insecticides while Neil Forrester's team tests for resistance to *Bacillus thuringiensis* (Bt).

Collections have been submitted from the NSW districts of Riverina, Cowra, Bathurst and Narromine, and from the Qld districts of Bowen (in late 1997) and Bundaberg (from tomatoes). A collection from the Lockyer Valley was submitted in late summer 1998 but larvae did not survive for testing. Collections from Victorian sweet corn districts also have been tested.

## Why did we do this?

Obviously the problem of resistance to insecticides in heliothis is a major concern in all crops that are attacked by the insect. Again obviously, as heliothis is the major pest of sweet corn resistance is a major problem for this industry, and it was an important stimulus for this project. To quote the funding application "These (export attempts) have been largely discontinued due to the inability to produce cobs free from heliothis larvae and larval damage. This is due entirely to the high levels of insecticide resistance which occur in *Helicoverpa armigera* (heliiothis)."

While a major aim of the project is to find alternatives to insecticides for heliothis management in sweet corn, undoubtedly conventional insecticides will still be needed in some measure. It is important to know the resistance status of these insecticides so that effective ones are used.

Bt is one of the softer options being considered, but the development of resistance to Bt in heliothis is a real possibility.

## What has been achieved?

The available results for conventional insecticides in Queensland districts are given in Table 1. The Darling Downs is included as an area close to the Lockyer Valley and to give figures for a cotton/field crop area for comparison. Victorian results are presented in the paper by Dimsey *et al.* in these proceedings, while the results for the NSW districts are not available yet. These results have been extracted from the CRC for Sustainable Cotton Production web page ([www.mv.pi.csiro.au/ozcotrt/News/resflier.htm](http://www.mv.pi.csiro.au/ozcotrt/News/resflier.htm)). They have been transposed from graphs so they are not exact, and any errors and omissions are mine. Some data are missing from the table (eg % homozygotes) as some old figures are not retained on the web page.

Some other insecticides are tested in some areas on some occasions. These include profenofos, chlorpyrifos, pyrrole and amitraz. Resistance levels of up to 20-25% have been recorded for profenofos, and some pyrrole resistance has been found in cotton growing areas.

Very low levels of resistance to Bt (<1%) have been recorded from cotton areas and from Bundaberg (N. Forrester pers. comm.). It is believed this is true resistance rather than avoidance of dosing.

## Where does this lead us?

Although we do not have figures for all areas here it probably is safe to assume that the figures are similar to those presented.

The resistance figures confirm that resistance to the pyrethroids and the carbamates is a problem, but we must remember that the bare figures in the table do not tell the whole story. The resistance factor is important for pyrethroids (values of around 25-28 were recorded for the last collections tested from Bundaberg and Darling Downs) as is the % homozygotes for the carbamates, as these measures are more likely to indicate field problems. Field rates of pyrethroids should still kill small resistant larvae provided the resistance factor is low (<25 fold), while homozygotes carry two genes for resistance and are highly resistant to field rates of carbamates (Gunning 1997).

That low levels of resistance to organophosphates and to new chemical groups like the pyrroles are being found should be of concern. Similarly we need to take be aware of the potential for resistance development to Bt.

The sweet corn industry should be careful in its use of insecticides so that resistance problems are not made worse. However, due to the small areas of crop compared to the vast areas of cotton and heliothis-susceptible field crops, sweet corn is likely to be both a victim and a beneficiary of the approach to resistance management taken by the field crops industries. It is essential that we liaise on matters of heliothis management with these industries.

Heliothis from the sweet corn producing districts should be monitored for resistance each season, and funds are provided in the project for this. We depend on the cotton research teams to do the actual testing so we must be as cooperative and helpful to them as possible.

### Reference

Gunning, R. (1997). *Helicoverpa* resistance for 1996-97. *The Australian Cotton Grower* **18 (3)**: 48, 50.

Table 1: Resistance data for *H. armigera* collections from sweet corn growing districts.

Area	Date of collection	Percentage resistance			
		fenvalerate	bifenthrin	endosulfan	thiodicarb
Bowen	15/10/1997	80	62	40	60
Bundaberg	13/10/1997	100		20	50
	8/12/1997	100	38	25	78
	23/2/1998	100	50	61	53
	16/3/1998	100	38	57	81
	6/4/1998	100	80	72	94
Darling Downs	mid/11/1997	90		30	70
	8/1/1998	100	40	40	30
	19/2/1998	100	75	18	70
	8/3/1998	100	50	50	80
Riverina					
Cowra					
Bathurst					
Narromine					

# Near Infra-red Spectroscopy to detect insect (corn earworm) / insect damage in sweetcorn cobs

J.A. Guthrie DPI, Rockhampton

Near infra-red reflectance spectroscopy (NIRS) is a nondestructive procedure that uses optical data rather than wet chemistry methods to analyse both liquid and solid products for chemical composition. Near infra-red reflectance spectroscopy has been used for over twenty years to analyse grain products for protein, oil and moisture (Shenk and Westerhaus 1993). The use of the technique however has been limited to low moisture materials, as water absorbs strongly in the NIR region. The advent of powerful personal computers and chemometric software packages has allowed the technique to be applied to high moisture materials (such as fresh whole fruit) in the last decade.

What is near infra-red spectroscopy? NIR is a small part of the spectrum of light (700 - 2500 nm). At one end of this spectrum are the high energy waves such as x-rays and gamma rays, while at the other end of the spectrum are the low energy waves such as micro waves and radio waves. Near infra-red is between the visible and the infra-red.

As mentioned, the area of the electro-magnetic spectrum we are interested in is between 700 and 2500 nm and concerns the bending and stretching of electronic bonds. These bonds are involved in most organic compounds, such as sugars, protein fats and water. NIR is a secondary method of measurement and so must be calibrated against a primary or reference method, such as a refractometer reading ((Brix). But is only cost effective with large sample numbers.

Preliminary laboratory work has involved scanning an area (approx. 9cm in diameter) of the tip of whole sweetcorn cobs, using a post-dispersive NIR spectrophotometer. Unfortunately the samples contained only a few contaminated or insect damaged cobs. Therefore insufficient data was available for any worthwhile chemometric analysis.

However, published scientific literature indicates the possibility of using NIRS to detect the presence of insects and subsequent insect damage. Ridgway and Chambers (1996) used NIR reflectance spectroscopy to detect external and internal insect (grain weevil) infestation of intact wheat kernels. Large spectral differences were observed between uninfested kernels and kernels infested internally with *Sitophilus granarius* (L) (grain weevil) larvae or pupae, arising from both a changed chemical composition and physical structure. Single uninfested and infested kernels were discriminated by their second derivative (d<sup>2</sup>) spectra. For both external and internal infestation there was substantial evidence that insect protein and/or chitin and moisture were being detected. NIR should be useful as a rapid method of detection. Further work by Chambers and Ridgway (1995) with single wheat grain kernels internally infested with pupal stages of the grain weevil showed the possibility of detecting such infestation by measuring just two NIR wavelengths.

Future work will involve scanning contaminated and uncontaminated sweetcorn cobs using the latest in post-dispersive instrumentation. In our work with intact fruit we have evaluated several small, low cost, rapid NIR spectrophotometers. These instruments are capable of attaining NIR spectra in milliseconds and will be initially incorporated into our prototype 'at-line' fruit quality assessing unit. This unit will be placed in a melon packing shed in June. Also we are negotiating with external funders to purchase an additional research instrument. This instrument has a high intensity light source, fibre optics, rapid spectra acquisition time and an InGaAs linear detector array and could be used in this project.

## Appendix 1. Workshop Agenda

### Tuesday 19<sup>th</sup> May

8.30 am	Arrive Gatton Research Station
8.45am	Welcome & why we are here (Peter Deuter, Project Leader)
8.50 am	Introductions and overview of process (timetable) (Larissa Bilston)
9.00am	<b>Presentations</b> on project activities & results to date (What have we done? Why did we do it? What did we find and what does it mean? Where to from here? (Peter Deuter)
10.30 am	Morning tea
11.00 am	<b>Presentations</b> cont.
12.30 pm	Lunch
1.30 pm	Develop regional timelines, marking on existing milestones - focus on next 12 months but can forecast if plans in place (4 regional teams) (Larissa)
2.00 pm	Discussion about overall project goal and 8 objectives. Are they still appropriate and do we need to add any? (Peter)
2.30 pm	List activities by objective (work planned + new ideas/suggestions) and person responsible or activity. (Larissa)
3.00 pm	Afternoon tea
3.30	pm Have we missed anything? Will these activities meet our objectives and HRDC milestones? Will the objectives meet the goal? Do we need any new objectives or activities?
3.50 pm	Identify the highest and lowest priority activities for each objective (which are essential, which could be left out if we don't have enough time, money or expertise?) (Kristel Whittacker)
4.30 pm	Make some preliminary decisions about activities will go ahead and which should be left out (if any) (Peter).
5.00 pm	Close

### Wednesday 20<sup>th</sup> May

8.30 am	Board bus at Gatton Research Station
9.15 am	Arrive at local sweetcorn grower's farm
11.15 am	Depart farm
12.00 pm	Lunch
12.30 pm	Objective based small group discussion on how to link activities across regions and between projects to best utilise resources, avoid duplication, learn from each other and achieve milestones and objectives. Identify who will take overall responsibility for communication and reporting on each objective at a national level and agree on action plans for linking. (Larissa/Peter)
1.30 pm	Report back to whole group.
2.30 pm	Refine individual and regional work plans. Update timelines
3.00 pm	Afternoon tea
3.30 pm	Continue individual and regional work plans.
5.00 pm	Close (Peter)

## Appendix 2.

### Workshop Participants

#### NORTH QUEENSLAND

- Ross Wright, Senior Horticulturist, Queensland Horticulture Institute, Centre for Vegetable Crops, Bowen Research Station
- John Brown, Principal Experimentalist, QDPI, Ayr
- Johnny Andersen, Senior Extension Horticulturist, QDPI, Ayr
- Chris Monsour, Bowen Crop Monitoring Services, Bowen
- John Guthrie, Principal Food Technologist, QDPI, Rockhampton

#### SOUTH QUEENSLAND

- John Duff, Entomologist, Queensland Horticulture Institute, Centre for Vegetable Crops, Gatton Research Station
- Bronwyn Houlding, Entomologist, Queensland Horticulture Institute, Centre for Vegetable Crops, Gatton Research Station
- Brendan Nolan, Experimentalist, Queensland Horticulture Institute, Centre for Vegetable Crops, Gatton Research Station
- Peter Deuter, Principal Horticulturist, Queensland Horticulture Institute, Centre for Vegetable Crops, Gatton Research Station
- Brad Scholz, Entomologist, QDPI, Toowoomba
- Robert Battaglia, Horticulturist, QDPI, Centre for Pesticide Application and Safety, University of Queensland, Gatton Campus
- Iain Kay, Senior Entomologist, QDPI, Bundaberg Research Station
- Tom Franklin, Executive Engineer, QDPI, Queensland Horticulture Institute, Centre for Amenity Horticulture, Redlands Research Station.
- Larissa Bilston, Research Scientist, Cooperative Research Centre for Tropical Pest Management, University of Queensland, St Lucia
- Dr Peter Room, Chief Research Scientist, CSIRO, Long Pocket, Qld.
- Richard Ties, “Rugby Farms”, Gatton, Q
- Warren Ford, Vecon, Gatton, Q
- Rod Emerick, Mulgowie Farming Co, Mulgowie, Q
- Greg Wells, DowElanco, Toowoomba, Q
- Richard Llewlyn, BioResources, Toowoomba, Q
- Brendan White, Rhone Poulenc, Q
- Duncan McGregor, Rhone Poulenc, Q
- Jules Guerassimoff, Rhome & Hass, Brisbane, Q
- Peter Chronin, QHI, Indooroopilly, Q
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#### NEW SOUTH WALES

- Clarrie Beckingham, District Horticulturist, NSW Agriculture, Bathurst, NSW
- Dr Sandra McDougall, Entomologist (Vegetables), Yanco Agricultural Institute, NSW
- Tony Napier, Technical Officer, Yanco Agricultural Institute, NSW
- Merv Tasker, Cowra Export Packers, Cowra, NSW

#### VICTORIA/TASMANIA

- Dr Peter Ridland, Entomologist (IPM Vegetables), Institute for Horticultural Development, Knoxfield, Vic
- Rob Dimsey, Horticulturist, Agriculture Victoria, Bairnsdale, Vic
- Dr Siva Subramaniam, Scientist, Agriculture Victoria, Bairnsdale, Vic
- Lionel Hill, Entomologist, DPI, Devonport, Tas
- Barry Donahoe, S&G Seeds, Dandenong South, Vic
- Dr Mark Smith, Program Manager, HRDC, Institute for Horticultural Development, Knoxfield, Vic
- Andrew Young, Robinvale, Vic

## **Appendix 3.**

### **Experimental protocols for sweet corn**

#### EXPERIMENTAL PROTOCOLS FOR SWEET CORN TRIALS

**By**

Brad SCHOLZ

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June 1998

Following are some notes on the protocols that I been using in sweet corn trials. I'm not suggesting that this is the only way to carry out trials, but some of these notes may be useful to those of you who have not conducted trials in corn before. You will have to come up with your own experimental protocols to suit your cropping situation and resources.

#### **Trial Design**

I use randomised complete block designs with four replicates. Plots are usually 25 m long and 10-12 rows wide (this evolved as a result of the maximum amount of land I could get at QDPI Gatton research farm; you may have access to bigger trial sites). Plots were separated by 15 m of buffer longitudinally (they consisted of 10 m of crop and two 2.5 m cleared walk ways) and 6 rows of crop buffer laterally. In my last trial I used a single planting of H5 for both buffers and trial work, and I marked the first and last rows of each plot (both ends) with flagging tape. I also used plastic plot labels at one end of each plot. In previous trials I have used maize (Hycorn 83) for the buffers. This may work out cheaper (e.g. for seed), and can make it very easy to visually separate the plots from the buffers (Hycorn was taller than H5).

The cleared walkways between blocks of plots make access easier. They are also important if you are working with NPV. The virus can be easily transferred between plots if sprayed leaves touch unsprayed leaves etc.. If you are using virus, always work in your control plots first, then your standard chemical plots, then progress from low rate to high rate virus plots. This will prevent contamination of your non-virus plots. In addition, be careful not to wear overalls that may be contaminated back to your lab environment – particularly if you are rearing heliothis. We have a 'clean' lab and a 'dirty' lab in our complex. No plant or insect material taken from virus trials is permitted in the 'clean' lab. Everything that may have been exposed to virus is rinsed or wiped with bleach (e.g. forceps, paint brushes, eskies) to prevent contamination.

## Sampling

I usually sample once per week up to silking; and thereafter twice per week. You may want to consider sampling twice per week for the first couple of weeks (as suggested by Brendan Nolan) if you think you may have problems during the establishment stage of the crop. In my last trial I sampled the entire site as a bulk planting up until silking commenced because I didn't actually start spraying until the crop commenced silking.

I carried out heliothis and beneficial counts on three consecutive plants at three randomly selected sites per plot. Heliothis eggs were recorded as white, brown or black parasitised (it may be worthwhile including a 'black head' stage as well in some regions). Heliothis larvae were recorded according to size.

Plant No.	heliothis eggs			heliothis larvae				Ladybirds and other Beetles					Predatory Bugs					Lacewings	Flies	Ants	Spiders	Others															
	white	brown	black parasitised	very small (0-3 mm)	small (3-7 mm)	small medium (7-13)	medium large (13-23)	large (> 23 mm)	Transverse Ladybird	Striped Ladybird	Three Banded Ladybird	Variable Ladybird	Spotted Ladybird	Two-spotted Ladybird	Ladybird Larvae	Red and Blue Beetle	Green Soldier Beetle	Pirate Bug, <i>Orius</i> sp.	Damsel Bug, <i>Nabis kinbergii</i>	Bigeyed Bug, <i>Geocoris tubra</i>	Brown Smudge Bug	Apple Dimpling Bug	Black Mirid, <i>Tytilus chinensis</i>	Broken Back Bug	Brown Lacewing Adult	Green Lacewing Adult	Lacewing Larvae	Hover Fly Adult	Hover Fly Larvae	Stilt Fly Adult	Black and Red Ant	Spiders					
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This is the data sheet I used in my last trial (made in excel). I photocopied a few of these and bound them into books (using a spiral binder) with a site plan on the front page and a clear (photocopy sheet) cover. Brendan recommends photocopying onto yellow paper to reduce glare when you're working in the field – it's a good idea.

## Heliothis Egg Cards

Lately I've been using heliothis egg cards to assess egg parasitism and predation. Our heliothis oviposition chambers essentially consist of a standard roll of paper towelling pulled tightly around a couple of aluminium hoops – forming a paper cylinder. The moths lay eggs on one side of the paper roll. The paper (containing the eggs) is pulled out of the system daily. I always use eggs that are less than 24 hours old (it's okay if they have been cold stored for a few days – but I rarely use eggs that have been cold stored for more than 5 days).

I cut the paper towelling into long strips and staple them to strips of white photocopy paper (7 cm wide – 3 strips can be made from one sheet of A4 paper). The egg cards are made by cutting between the staples – you are left with cards approximately 7 x 1.5 cm. Count the number of eggs on each card under a stereomicroscope and write that number in pencil (remember ink runs if it gets wet!) on each card. I usually put out 9-12 egg cards per plot every week; and collect them after two days exposure. I only use cards that have at least ten eggs on them – the average is about 25 eggs per card.

After collection, I count the number of eggs remaining on each card – it is then possible to get an estimate of predation. Those eggs eaten by chewing predators are either missing or have obviously been eaten (there are pieces of the egg shell remaining on the card). There are also some eggs that have collapsed – I use this as an estimate of predation by sucking predators (it's probably an over estimate because some eggs may have collapsed due to other reasons). As I count the number of eggs remaining I use a biro to identify each 'healthy' egg, by simply putting a dot beside each egg. Next I hold the egg cards at 25 deg C for 4-5 days to determine the numbers of eggs parasitised. I store all egg cards in labelled bry-nylon bags and hang them in our CT room. As the unparasitised eggs hatch the larvae crawl out of the bags through the holes in the bry-nylon material. If you put the egg cards in vials you will have to remove the hatching larvae or they will feed on the parasitised eggs. After 4-5 days I count the number of parasitised, hatched or collapsed (after collection) eggs. You can then determine the fate of all eggs placed in the field.

### Heliothis Larval Collections

If you are working with NPV, sample your control plots first; then standard chemicals; and then your NPV plots from lowest to highest rates. I collect larvae from the field directly into 28 mL plastic diet cups containing a small amount of navy bean based diet (based on Bob Teakle's diet), and place them in labelled bags in an esky until I return to the lab. On returning to the lab, a dissecting needle is used to punch 8-10 ventilation holes in the lid of each diet cup. The lids are then numbered with a felt pen, and data sheets are kept for each individual cup. The size of each larva is also recorded (NPV is more effective against young instars). The larvae are examined daily, and their fate is recorded as healthy; NPV death; or other death. It usually takes about 5 days before infected larvae start to die from NPV, however it may take longer if field temperatures

were cool. NPV deaths are easily recognised – the larvae become brown bags of ‘mush’ and eventually explode on the side of their diet cup.

I hope that the above notes are of use to some of you. If you want to discuss any of the above information, or if you have other questions, please contact me at:

Telephone: (07) 4688 1312

E-mail: [scholzb@dpi.qld.gov.au](mailto:scholzb@dpi.qld.gov.au)

Good luck with your trials!!