

FINAL REPORT

Facilitating IPM adoption in northern region broadacre farming systems

DAQ00074

Project Details

- **Project Code:** DAQ00074
- **Project Title:** Facilitating IPM adoption in northern region broadacre farming systems
- **Start Date:** 01.07.2004 **End Date:** 30.06.2009
- **Supervisor:** David Murray (Principal Entomologist)
- **Organisation:** Queensland Department of Employment, Economic Development and Innovation
203 Tor St Toowoomba QLD 4350
- **Contact Name:** Melina Miles
Phone: 07 4688 1369
Email: Melina.miles@deedi.qld.gov.au

Summary

The principal aim of the project was to contribute to the continuing adoption of integrated pest management (IPM) by grain growers in the GRDC's northern region, specifically, the Darling Downs and Central Queensland.

This project provided an ongoing commitment to the development and refinement of pest management tactics, and continued support for the grower community by raising awareness of management options and strategies for their implementation. This outcome was achieved through facilitated learning by growers and their advisers via grower group meetings, field day demonstrations, technical literature and presentations by entomologists at technical forums.

Report Disclaimer

This document has been prepared in good faith on the basis of information available at the date of publication without any independent verification. Grains Research & Development Corporation (GRDC) does not guarantee or warrant the accuracy, reliability, completeness or currency of the information in this publication nor its usefulness in achieving any purpose. Readers are responsible for assessing the relevance and accuracy of the content of this publication. GRDC will not be liable for any loss, damage, cost or expense incurred or arising by reason of any person using or relying on information in this publication. Products may be identified by proprietary or trade names to help readers identify particular types of products but this is not, and is not intended to be, an endorsement or recommendation of any product or manufacturer referred to. Other products may perform as well or better than those specifically referred to. Check www.apvma.gov.au and select product registrations listed in PUBCRIS for current information relating to product registration.

Copyright

Grains Research and Development Corporation. This publication is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced in any form without written permission from the GRDC.

Old Reports

The subject matter in this report may have been revisited or may have been wholly or partially superseded in subsequent work funded by GRDC or others (check completion date).

Conclusions

Predator gut contents were analysed using polymerase chain reaction (PCR) techniques. Two experiments showed that prey DNA was not detected in gut contents more than four hours after consumption. This finding suggests that the application of this technique for predator/prey field studies has limited field application.

Results from the threshold trials clearly identified damage potential of Rutherglen bug (RGB) on flowering grain sorghum. The newly defined thresholds for RGB on grain sorghum were very timely given the serious outbreaks in 2007. These thresholds have been adopted by industry.

At this stage there are no new candidate products for bug management that suit replacement of pyrethroids. While some products may offer similar efficacy, they are no less disruptive to natural enemies and cost significantly more than the pyrethroids.

The *Helicoverpa* thresholds in chickpea changed from a nominal two larvae per square metre to the new dynamic model based on consumption of two grams of grain per larva. The refinement of the threshold, together with identifying crop stages where yield loss is unlikely, have led to the approach where one well timed spray during podfill is now widely adopted by industry.

The active development and extension (D&E) role of the project team facilitated adoption of tactics that in most cases meet the challenges of improved IPM practice. Some frustrations persist, such as the position of pyrethroids and organophosphates as the preferred products for caterpillar (armyworm) and bug (RGB, mirids, green vegetable bug and aphids) management in pulse and grain crops. The project team greatly expanded the information that is available to growers and agribusiness and developed innovative ways to better inform their clients.

Recommendations

Ongoing interest should be maintained for new products for management of sporadic pests such as RGB, armyworms and cereal aphids. We should maintain a watching brief and respond appropriately with trials.

There is a need to conduct some further investigation of the RGB thresholds in grain sorghum as they relate to the development of immature populations on post-flowering crops.

Linkages should be maintained with agrochemical companies where new *Helicoverpa* insecticides may have a role in grains. With Tracer[®] no longer available, there is now a strong dependence on Steward[®] in pulse crops. More softer options would be desirable.

Silverleaf whitefly (SLW) poses a serious threat to some crops e.g. soybean. Adoption of IPM tactics under the banner of 'Whitefly - The IPM Enforcer[®]' is the mainstay of whitefly management as no products are registered in grains for SLW management. Some evaluation of suitable products would be desirable.

The Grains Industry should maintain its representation on the Transgenic and Insecticide Management Strategy (TIMS) Committee as conventional insecticides remain vitally important for the management of *Helicoverpa armigera*.

The highly valued D&E activities should continue. These include involvement in existing training courses (chickpea, mungbean and soybean) which build regional capacity. New courses should also be developed (e.g. sunflower).

The IPM blogsite and IPM website should be maintained and expanded as greater adoption of e-extension methods is sought.

Some attention should be given to maintaining research, development and extension (RD&E) capacity as senior staff approach retirement. Efforts should centre on replacement under the Graduate Recruitment Program.

Outcomes

Increased adoption of integrated pest management (IPM) by grain growers in the GRDC's northern region, specifically, southern and Central Queensland, with flow into other areas within the region. Benefits of increased IPM adoption

will accrue to growers and the environment from an increased use of host-specific soft options, and reduced use of broad spectrum insecticides. Group activities build social capital.

Economic

It is reasonable to project that the adoption of IPM in grain crops (winter cereals, summer grains and pulses) would deliver up to a 50% reduction in the number of insecticides required in any crop (a reduction from two sprays to one spray in many cases). On the Darling Downs, this would equate to an annual saving of \$20M in insecticide costs alone. It does not include benefits of increased productivity as a result of improved timing of management, and flow on benefits of natural enemy activity on minor pests. The development of economic thresholds for *Helicoverpa* in chickpea and Rutherglen bug in sorghum are two important findings contributing to this economic benefit.

Environmental

The development of improved thresholds in chickpea has led to a management approach using one well-timed spray. In many cases this has reduced the number of sprays from two to one, with flow on economic, environmental and social benefits. Project staff worked closely with agribusiness to support the continued adoption of 'clean and green' Nucleopolyhedrovirus (NPV) in grain sorghum and other crops.

Social

The project supported the adoption of safer and less disruptive insecticides and promoted the responsible use of insecticides under an IPM program. These developments have contributed to reduced residues and trade issues.

The project aided capacity building and enhanced social capital through training of rural producers in IPM courses and Industry Accredited Agronomist Training Courses.

Achievement/Benefit

The principal aim of the project was to contribute to the continuing adoption of integrated pest management (IPM) by grain growers in the GRDC's northern region, specifically, the Darling Downs and Central Queensland

While *Helicoverpa* spp. have been the primary target of RD&E for many years, other pests (armyworms, Rutherglen bug, mirids, stink bugs, aphids) are increasingly included in management considerations. This project provided an ongoing commitment to the development and refinement of pest management tactics, and continued support for the grower community by raising awareness of management options and strategies for their implementation. This outcome was achieved through facilitated learning by growers and their advisers via grower group meetings, field day demonstrations, technical literature and presentations by entomologists at technical forums e.g. Grower and Adviser Updates.

A range of insect pest management tactics is currently available for growers of winter cereals, summer grains and pulses (e.g. economic thresholds, sampling techniques, biopesticides). However, many growers and agronomists are not sufficiently familiar, or experienced, with these management tactics to implement them confidently. Consequently, many are persisting with the use of highly disruptive broad spectrum products, applied with less than optimal precision. The consequence of this continued use of 'old' products and management techniques is an ongoing risk of insecticide resistance, poor control, and the 'flaring' of pest species that would otherwise be controlled by the activity of natural enemies. At risk is the ability of grain growers to manage economic losses due to pest activity and their ability to manage their insect pests into the future.

An emphasis on extending and demonstrating IPM strategies has facilitated the adoption of not only individual recommendations, but a year-round approach to pest management within the context of the farming systems. Promoting conservation of natural enemies is a key component of IPM programs. This project raised awareness of the benefits of IPM and supported growers in their endeavours to implement IPM tactics. Management recommendations for insect pests have been revised in light of interactions with other farming practices where appropriate. This information was extended and available for use across the northern grain region, but principally in southern and Central QLD.

The project was initially a three year project, but the severe impact of drought resulted in unexpended funds that allowed the project to be extended for two additional years. There were a number of staff changes during the course of the project.

While Denaturing Gradient Gel Electrophoresis (DGGE) was initially identified as a suitable tool to search gut contents of predators for DNA of prey species, this technology has been superseded by PCR techniques. Two experiments demonstrated the feasibility of PCR analysis of predator gut contents. However, the longevity of prey DNA in predator gut contents is relatively short-lived (up to four hours) and suggests the utility of this technique is limited in application.

From the video monitoring evidence it can be implied that predators of *Helicoverpa* pre-pupae have the potential to reduce the density of field populations of pre-pupae at the wandering stage, and may ultimately reduce the numbers of pupae formed. Mice were identified as the most important predator in the range of crops examined during the period of study.

Preliminary evaluation of more selective insecticides for the management of Rutherglen bug (RGB) indicated that the standard pyrethroid was far superior to all other products tested. As a result, research emphasis was placed on determining threshold values so that sprays will be applied only when necessary. Thresholds were determined for flowering sorghum and information widely disseminated to industry. Control is warranted if there are more than 20-25 adult RGB per head during the flowering to milky dough stage. During the hard dough stage, control is warranted if more than 30-50 RGB per head are present. Infestations during the hard dough stage had no impact on yield or quality post physiological maturity.

A series of field experiments in southern and central QLD determined threshold values for *Helicoverpa* in chickpea. One larva consumes 2 g of grain in its lifetime. The study also showed that controlling larvae at flowering does not result in a significant increase in yield or quality over delaying control until podset.

More selective options for the control of armyworms in winter cereals remain an important target for future evaluation of insecticides. There are some new generation insecticides under development, and these should be evaluated as a matter of priority when trial opportunities present themselves.

Investigations into thresholds and management of cereal aphids commenced during the final year of this project. Cereal aphids are sporadic pests that have attracted more attention during recent years. There are no regional specific data on thresholds, and local information on species distribution, abundance and impacts are lacking. This activity will continue into the next project.

Project staff continued to represent the Grains Industry on the TIMS Committee and provide input as part of the annual review and ratification of the Insecticide Resistance Management Strategy (IRMS). Monitoring of resistance to conventional insecticides (conducted by Dr Louise Rossiter, NSW Industry & Investment) has shown resistance to most products has stabilised or declined. This is good news for conventional insecticides, but the future unavailability of Tracer[®] will place increased pressure on the other remaining key selective product, Steward[®]. More soft alternatives are needed.

Data on pest activity collected over a number of years has potential to provide a valuable historical perspective on *Helicoverpa* and natural enemy abundance and crop use. However, over the period of collection, these data have enough variability in the way they were stored to make the development of a useful database a significant technological challenge. To date it has been advised that the available resources are not sufficient to enable the standardisation of the data into a useable database. The issue continues to be discussed with colleagues and new contacts and pursued into the next project if a suitable solution can be found.

Farmscaping has been proposed as a useful approach for growers to adopt in order to increase the biodiversity, particularly of natural enemies, on their farms. Increased levels of ecosystems services (predation, pollination) are thought to arise from increased on-farm biodiversity. Research on a landscape level was well beyond the scope of this current project. A literature review of international literature was undertaken to identify key aspects of farmscaping theory that would have application to the farming systems of the northern grain region.

The project has had a major emphasis on D&E activities. Publication and distribution of the four *Helicoverpa* brochures prepared under project DAQ539 were completed. A brochure on *Helicoverpa* management in chickpea was

also prepared. Comprehensive course notes were prepared for the Insect Management Modules of the Chickpea and Mungbean Industry Certified Training Courses, and the Soybean/Pulse IPM Training Courses. These were done in collaboration with Hugh Brier (DAQ00086).

While the Area Wide Management groups established under project DAQ539 somewhat disbanded in 2005, information flow was maintained by circulation of The Beat Sheet Newsletter as an electronic publication. In July 2007 The Beat Sheet IPM news blogspot became the primary tool for distribution of timely insect management information. This blogsite continues to perform a very useful function.

Funding from the National Invertebrate Pest Initiative (NIPI) partly supported the development of the IPM website on the Queensland Primary Industries & Fisheries (QPIF) internet site. There were some delays in making the IPM website fully functional, but now the site is well established and being maintained with the most up to date information.

Project staff actively engaged industry in the course of the project. They attended and addressed agribusiness meetings, GRDC Grower and Adviser Updates, field days and farm walks.

Staff actively published in both refereed scientific journals and the popular press, disseminating their research for peer review and scrutiny.

The annual Northern Farming Systems IPM Forum was convened at Toowoomba. This gathering has served as a highly regarded forum at which latest research results are presented, and serves to establish and maintain networks and linkages between IPM researchers, mainly in the northern GRDC region. In 2009 this forum was scaled down to be a project review and planning meeting for project staff, reflecting the changed operational base where the Toowoomba and Kingaroy activities were rolled into a single project after June 2009.

Other Research

There are still a number of sporadic pest species that can cause significant disruption to IPM. Armyworm and aphids in winter cereals and Rutherglen bug in sorghum are important pests in this category. Some other pests frequently requiring management intervention include mirids and stink bugs (e.g. green vegetable bug). Other projects were the subject of research to manage these latter pests. There are currently no IPM-compatible options for the control of these pests. Ongoing investigation of softer options for such species is warranted to ensure IPM is a viable year-round strategy for the majority of growers. There also remains an ongoing requirement for the integration of any newly registered insecticides into a Farming Systems Insecticide Resistance Management Strategy.

Additional Information

Publications

Miles, M.M., Baker, G.J. and Hawthorne, W. 2007. Pulses - winter. In *Pests of field crops and pastures. Identification and control*. P. T. Bailey (Ed.) CSIRO Publishing. pp. 259-278.

Murray, D.A.H. 2007. Maize. In *Pests of field crops and pastures. Identification and control*. P. T. Bailey (Ed.) CSIRO Publishing. pp. 121-134.

Sharma, H.C., Gowda, C.L.L, Stevenson, P.C, Ridsdill-Smith, T.J., Clement, S.L, Rango Rau, G.V., Romeis, J., Miles, M.M., and El Bouhssini, M. (2007). Host plant resistance and insect pest management in chickpea. Chapter 25 pp. 520-537. In Yadav, S.S, Reddens, R.J., Chen, W. and Sharma, B. (eds) *Chickpea breeding and management*. CAB International.

Scientific Papers

Brier, H.B., Murray, D. A. H., Wilson, L. J., Nicholas, A. H., Miles, M. M., Grundy, P. R. and McLennan, A. J. 2008. An overview of integrated pest management (IPM) in north-eastern Australian grain farming systems: past, present and future prospects. *Australian Journal of Experimental Agriculture* 12:1574-1593.

- Franzmann, B.A., Hardy, A.T., Murray, D.A.H. and Henzell, R.G. 2008. Host-plant resistance and biopesticides: ingredients for successful IPM in Australian sorghum production. *Australian Journal of Experimental Agriculture* 12:1594-1600.
- Lloyd, R.J., Murray, D.A.H. and Hopkinson, J.E. 2008. Abundance and mortality of overwintering pupae of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) on the Darling Downs, Queensland, Australia. *Australian Journal of Entomology* 47:297-306.
- Buerger, P., Hauxwell, C. and Murray, D. 2007. Nucleopolyhedrovirus introduction in Australia. *Virologica Sinica* 22:173-179.
- McLennan A.J. 2006. Before, during and after the crisis: 8 years of extension for IPM adoption in southern Queensland farming systems (1998-2006) in Practice change for sustainable communities: Exploring footprints, pathways and possibilities. Petheram R.J. and Johnson R.C. (Ed.). APEN 2006 International Conference, La Trobe University, Beechworth, Victoria, Australia, 6-8 March 2006. Published online at www.regional.org.au/au/apen/2006
- Cleary, A.J., Cribb, B. and Murray, D.A.H. 2006. *Helicoverpa armigera*: can wheat stubble protect cotton plants against attack? *Australian Journal of Entomology* 45:10-15.
- Christian, P.D., Murray, D.A.H., Aigner, R., Hopkinson, J.E., Gibb, N.N. and Hanzlik, T.N. 2005. Effective control of a field population of the cotton bollworm using the small RNA virus, *Helicoverpa armigera* Stunt Virus (Omegatetravirus, Tetraviridae). *Journal of Economic Entomology* 98:1839-1847.
- Scott, K.D. Lawrence, N., Lange, C.L., Scott, L.J., Wilkinson, K.S., Merritt, M.A., Miles, M., Murray, D. and Graham, G.C. 2005. Assessing moth migration and population structuring in the cotton bollworm *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) at the regional scale: Example from the Darling Downs, Australia. *Journal of Economic Entomology* 98:2210-2219.
- Murray, D.A.H., Lloyd, R.J. and Hopkinson, J.E. 2005. New insecticides for *Helicoverpa* spp. (Lepidoptera: Noctuidae) management in grains. *Australian Journal of Entomology* 44:62-67.

More recent research is being undertaken in project DAQ00153 'Northern Grains and Pulse IPM'.
