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- Increasing energy efficiency and assessing an alternate energy option for Australian protected cropping.

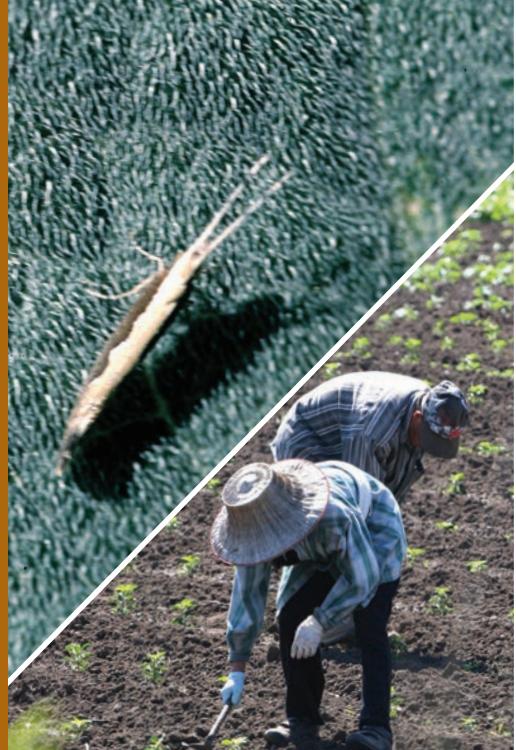
HAL R&D project number: VG09124

Project VG09124 sought to identify and assess alternate energy options for the greenhouse industry with the aim of establishing a first step to improving energy management in this industry.

- Mechanisms and management of insecticide resistance in Australian Diamondback moth.

HAL R&D project number: VG08062

Project VG08062 investigated the management of resistance in Australian Diamondback moth in Australian brassica vegetable crops.





Increasing energy efficiency and assessing an alternate energy option for Australian protected cropping.



Somersby Energy trial.

Facilitators:

Milestone 106 of Project VG09124 has been completed by Primary Investigator Jeremy Badgery-Parker at Primary Principles Pty Ltd (formerly of NSW DPI) and the final stages of this project are now underway.

Introduction

Management of energy and environmental emissions is a significant challenge and opportunity for all horticulture, including the protected cropping sector.

Energy is a significant input in controlled environment horticulture and an important source of environmental emissions. It underpins the horticulture industry's capacity to provide a consistent supply of food, and will become an increasingly important factor in determining enterprise profitability as energy prices rise.

Currently, Australian enterprises that employ protected cropping technology in their production processes have not fully benefited from new, innovative technologies and techniques that have been implemented internationally.

To reduce emissions by a projected 60 per cent on 2000 levels by 2050, the Australian industry requires a substantial research and extension effort in order to find solutions to improve energy efficiency in the greenhouse.

About the project

"The issue of energy efficiency will further swell in importance over the coming two to five years at industry level with the focus on energy efficiency in order to reduce costs and minimise carbon emissions," Primary Investigator Jeremy Badgery-Parker said.

"At an individual enterprise level, rising energy costs are seriously eroding enterprise profitability."

Mr Badgery-Parker said the controlled environment horticulture (greenhouse) industry was exceptionally well placed to mitigate many of the challenges that climate change would have on food security.

Today, there are existing technologies enabling the use of



Controlled environment horticulture.

alternative sources of energy. To aid growers in reducing costs and carbon emissions, and generating better energy (heating) investment decisions, Mr Badgery-Parker and his research team are providing growers with easy-to-use and reliable tools for finding ways to save energy.

Additionally, they aim to determine the cost-to-benefit ratio of alternative energy systems and any necessary requirements for the industry.

Two energy innovations have been identified for further investigation in Project VG09124, being geothermal heat pump systems (GHP) and phase change materials (PCM).

Major project findings

Since the project's initiation in 2010, a demonstration site at Somersby, NSW has generated significant energy data used to measure and calculate both the in-field performance and costs of the technology options.

To-date, grower extension activities on energy efficiency and the potential for new energy options have been conducted in NSW, SA, VIC and QLD.

A model greenhouse on the NSW Central Coast was used to assess geothermal heat pump systems.

Real-time hourly field data provided the basis for the greenhouse heat load figures and hourly temperature and humidity data offered an accurate determination of the heat loads.

"Costs of different heating options were assessed against meeting this heat demand," Mr Badgery-Parker said.

"An initial analysis confirms the geothermal heat pump system as a cost effective option with important advantages compared with conventional natural gas and LPG. Direct heating with electricity was used as a benchmark," he said.

"The net present value over 10 years of the GHP is more than \$354,000 while the natural gas fired hydronic heating system is \$370,000."

"By comparison, LPG would cost just under \$500,000 over this period and direct heating would cost almost \$1.3 million to heat the same greenhouse."

Mr Badgery-Parker said PCM as a greenhouse energy buffer remained "very promising, but a different strategy for its use is proposed."

Early results illustrate a daytime cooling effect resulting from the PCM absorbing heat and a night-time heating effect as the PCM releases heat.

The final stage of this project involves a series of workshops in key locations, delivering information materials and tools for industry, including a newly published energy efficiency guidebook, assessment workbook and a "greenhouse heating estimator."

The workshops also aim to increase awareness of heat pump systems as a viable heating option and promote the economic benefits of improving energy efficiency.

Further analysis of phase change materials is being completed to determine whether there is a feasible application for greenhouse enterprises, which will be reported on in late 2013.

Conclusion

Project VG09124 has signified that the Australian protected cropping industry is well placed to shift its focus from fossil fuels to alternative energy options including solar and geothermal.

"While these technologies offer real opportunities, significant gaps exist in industry awareness, technical integration and information on real costs and benefits," Mr Badgery-Parker said.

In the long-term, this project will not only reduce the industry's carbon footprint but will bring a significant reduction in operating costs for the average enterprise.

THE BOTTOM LINE: VG09124

- A new guide and workbook to assess energy use and efficiency.
- Information workshops are being run in key locations from July-September 2013.
- Greenhouse energy (heating) calculators are now available for growers.
- Keep up-to-date: <https://sites.google.com/site/greenhouseenergyefficiency/>

Acknowledgements

This project was funded by HAL using the vegetable levy, voluntary contributions from industry and matched funds from the Australian Government.



Mechanisms and management of insecticide resistance in Australian Diamondback moth

Diamondback moth.

Facilitators:

Project VG08062 has recently been completed by Primary Investigator Greg Baker at the South Australian Research and Development Institute.

Introduction

The Diamondback moth (DBM) is the main pest of Brassica vegetable crops in Australia and has international notoriety for rapidly acquiring insecticide resistance. The organism's resistance to older insecticide classes is widespread in Australia and consequently, the choice of insecticides for its effective control is increasingly limited to several newer pesticides and *Bacillus thuringiensis* products.

Project VG08062 was undertaken to better equip the Australian Brassica industry with knowledge of the current state of resistance levels in DBM strains and of the processes that lead to the development of resistance.

About the project

Project VG08062 conducted bioassays to measure resistance levels in field strains of DBM to five different pesticides - emamectin benzoate (Proclaim®), indoxacarb (Avatar®), spinosad (now replaced in the Australian market by the closely-related spinetoram) (Success™ NEO), chlorantraniliprole (Coragen® and Durivo®) and *Bacillus thuringiensis* var. *kurstaki* (BtK) (range of registered products).

Mr Baker said the research also focused on investigating the role of inducible tolerance mechanisms in the development of resistance and the levels of tolerance that DBM could potentially

acquire through repeated exposure to low doses of insecticide.

"We were also interested in testing whether cross-resistance occurred between any of the newer DBM insecticides," he said.

"From this, the research team could devise ways to overcome the emergence of high levels of resistance."

Project VG08062 originally proposed to benchmark resistance levels in Brassica vegetable field populations to three synthetic insecticides. However, during the course of the project, a new group of synthetic insecticides, the Group-28 diamides, was introduced into Australia for the control of caterpillar pests in Brassica vegetable crops.

Major project findings

Mr Baker said the benchmarking study was conducted to provide a measure of the resistance levels that are developing in DBM populations on Brassica vegetable properties in Australia to the new synthetic insecticides.

"Given that historically in Australia, DBM insecticidal resistance has been first observed in the Lockyer Valley, Queensland, we focused the study on field collections from this production region, but also included several properties in New South Wales, Victoria and South Australia," he said.

Mr Baker said key findings revealed that some field populations of Diamondback moth had developed significant levels of resistance to two important groups of these new insecticides, IRAC Groups 6 (emamectin benzoate) and 28 (chlorantraniliprole and flubendiamide (Belt®)).

"These resistance levels are already capable of reducing the field control achieved with these Group 6 and 28 insecticides," he said.

The project also demonstrated that high levels of resistance could result in the laboratory from repeated exposure to low concentrations of an insecticide. This occurred with both the synthetic insecticide and the microbial insecticide used in this study.

"During this selection study the research team found that in the early stages of the tolerance acquisition, a new inducible tolerance mechanism was involved," Mr Baker said.

As the selection process with the synthetic insecticide progressed, a combination of induced metabolic tolerance and genetic mutations were found to contribute to the resistance.

Specifically, the induced insects showed significant tolerance without initially displaying mutational changes in a major resistance gene locus.

Studies are continuing to identify the full implications of the inducible tolerance process to resistance management.

In separate findings, cross-tolerance relationships between most of the tested insecticides were also established. However the full nature of the cross-resistance relationship between the Group 6 and Group 28 insecticides is still being investigated.

"Once these cross-resistance relationships are fully resolved, it may be necessary to alter the placement of some products in the CropLife DBM 'Two-Window' IRM strategy," Mr Baker said.

Conclusion

Mr Baker predicts that in the near future, the Australian Brassica industry is likely to experience declining efficacy with a number of important synthetic insecticides, most notably, Group 6 and 28 insecticides.

"However, more extensive studies of field strains from all major production areas are required to determine the immediacy and magnitude of the threat," he said.

"In addition, new non-insecticidal technologies for DBM management in Australian Brassica vegetables, such as mating disruption, lure and kill, inundative release of biocontrol agents, must be developed to help preserve the diminished range of effective insecticides and provide sustainable crop production practice."



Diamondback moth.

THE BOTTOM LINE: VG08062

- Increasing levels of resistance to several of the newer DBM insecticides pose an imminent threat to the Australian Brassica vegetable industry.
- An inducible tolerance mechanism contributes to the development of resistance but further studies are needed to determine the full implications of this process.
- A better understanding of cross-resistance relationships for a number of DBM insecticides is important for the design of an effective resistance management rotation strategy.

Acknowledgements

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Photo credits:

VG09124 photos credit: Jeremy Badgery-Parker

VG08062 photos credit: Whitney Cranshaw, Colorado State University, Bugwood.org, David Cappaert, Michigan State University, Bugwood.org

Please contact Hugh Gurney at AUSVEG on 03 9882 0277 or email hugh.gurney@ausveg.com.au to submit topics for potential inclusion in future editions of vege^{notes}.

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Larvae damage on cabbage.