VG16070 – Research and operations to trial innovative glass and photovoltaic technologies in protected cropping

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Facilitators

Project VG16070 is being undertaken by a team of researchers led by Professor David Tissue at the Hawkesbury Institute for the Environment at Western Sydney University.

Introduction

According to Protected Cropping Australia, the protected cropping industry is the fastest growing food production sector in Australia, valued at around $1.8 billion at the farm gate per annum. Although greenhouses deliver higher outputs with less risk and significantly smaller footprints than outdoor farms, their high energy requirements and the subsequent costs can be a barrier for many vegetable growers.

Innovations in glass technology are helping to improve the efficiency of greenhouses, with less energy needed to maintain optimal growth conditions. Standard glass and plastic coverings transfer heat, but products such as 'smart glass' contain a thin film coating that passively limits heat load inside the glasshouse during sunny days, reducing energy costs. It can also act as an insulator, retaining heat at night and during cooler winter conditions.

Researchers at Western Sydney University are testing the performance of various crops grown under this low thermal emissivity (low-e) glass coating to determine how to reduce internal heat load and energy costs without affecting crop quality or yields.

About the project

Project VG16070 is trialling existing and in-development 'smart glass', semi-transparent photovoltaic glass and solar thermal collector technologies to assess their use and value to protected cropping under Australian conditions.

"The aim of the research project is to assess the impact of smart glass versus current hazed glass on plant growth, physiology, crop yield and quality in a controlled CO_2, temperature, nutrient and irrigated environment," post-doctoral researcher Dr Sachin Chavan explained.

The first experiment involved eggplant crops that were grown for two growth seasons in four glasshouse rooms within the National Vegetable Protected Cropping Centre funded by Hort Innovation and Western Sydney University. Two of the four glasshouses had smart glass film applied to the hazed glass panels, and researchers measured and compared various growth, physiology, productivity and quality parameters.

The investigation is now being expanded to include capsicums and leafy greens. The ultimate aim is to determine the optimum balance of colour and/or intensity of transmitted light so that growers can achieve consistent improvements in temperature regulation at no cost to crop production.

Major findings

Preliminary findings have indicated that smart glass can reduce the energy costs in the glasshouse. During the eggplant trials, the smart glass required 10 per cent less energy for cooling and 18 per cent less irrigation (fertiliser and water). The fruit quality parameters tested revealed no negative impact on overall quality. Smart glass did, however, appear to affect crop productivity, with an increased rate of fruit abortion in modified light resulting in a 25 per cent drop in average eggplant yields.

Dr Chavan says further investigation is needed to establish whether the yield reduction has been driven by light quality or light quantity.

"We know that plants don't need the full spectrum of light to grow, but we need to make sure that the light they are receiving is useful light," he said.

Early research suggests that the smart glass film may need alterations to optimise the light spectrum available for the plants to use – more red elements rather than blue elements, for instance, to make photosynthesis more effective.

"We also need to confirm whether other vegetable or fruiting varieties, besides eggplants, also record similar reductions in yield; eggplant yield was negatively affected due to fruit abortion, but leafy green crops such as lettuce may not exhibit negative impacts on yield because they do not produce fruits," Dr Chavan said.

Conclusion

Achieving the optimum balance of colour and/or intensity of transmitted light through low-e glass coating is still a work in progress. While smart glass coatings can be highly effective in reducing internal heat load and energy costs without affecting crop quality, further research is required to assess whether average yields will be maintained or increased.

Project VG16070 is ongoing, with an aim to deliver a reliable and comprehensive evaluation guide to using these innovative technologies, so that Australian growers can ultimately reduce energy expenses. It's expected that a smart glass product for greenhouses will be commercially available in 5-10 years.

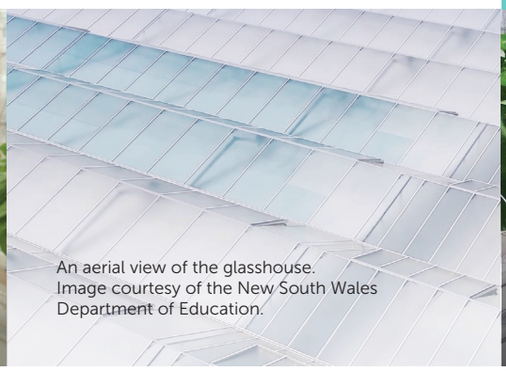
Acknowledgements

This project has been funded by Hort Innovation using the vegetable research and development levy and contributions from the Australian Government.

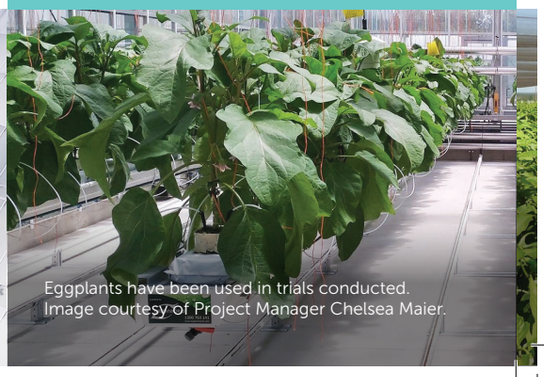
Further information

For more information, please contact Dr Sachin Chavan at Western Sydney University on 0469 276 218 or s.chavan@westernsydney.edu.au.

Dr Sachin Chavan. Image courtesy of D. Randall.



An aerial view of the glasshouse. Image courtesy of the New South Wales Department of Education.



Eggplants have been used in trials conducted. Image courtesy of Project Manager Chelsea Maier.

VG04010 – Australian vegetable crops – maximising returns from water

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Facilitators

Project VG04010 was undertaken by a team led by Mark Hickey, a former district horticulturalist at Yanco Agricultural Institute, New South Wales Department of Primary Industries.

Introduction

Water use efficiency is a critical issue for yield and profit in the vegetable industry. Apart from the water savings possible from the introduction of methods like sub-surface drip irrigation and computer-controlled overhead sprinklers, precise water management also helps to achieve high product quality. The take-up of more efficient high-tech irrigation systems in all Australian vegetable production regions remains ongoing, with some growers yet to be convinced that the benefits outweigh the set-up costs.

About the project

Project VG04010 delivered a series of reports (covering six states, with an additional national snapshot and one technical report) detailing water use in the major vegetable production regions and associated river catchments. The value of output and a description of market orientation including domestic, processing and exports was also covered.

Four farms representing different crop types in different vegetable growing regions were used as case studies to measure the potential economic and environmental benefits of conversion to a more efficient irrigation system. The case studies were designed to give some indication of the type of investment required for new, more water-efficient irrigation systems.

Major findings

This project confirmed that the productivity increases achieved by the vegetable industry can be largely attributed to increased use of water-efficient delivery systems such as drip irrigation, increased use of recycling on-farm, wide-scale adoption of irrigation scheduling and soil moisture monitoring, and a tendency towards whole farm planning and soil mapping. It also highlighted the ongoing challenges created by a lack of actual water use data for many vegetable production enterprises, and the need for detailed studies into the threshold cost of water, beyond which vegetable growing becomes uneconomic.

"To demonstrate relative efficiencies for water use, it is essential that growers measure the amount of water applied," Project Lead Mark Hickey explained.

"More accurate on-farm data in relation to water use will help set benchmarks to continuously improve water management in the larger regional vegetable production areas in Australia."

One of the aims of the project was to identify irrigation technologies most suited to different crops grown in vegetable growing regions in Australia. The case studies undertaken demonstrated that although the benefits accrue over a number of years, in many cases, the additional investment can be returned within 2-3 years, providing the production and quality benefits are significant.

"In the case of the Queensland lettuce and broccoli grower, the "no change" alternative (for example, continuing to sprinkler irrigate) for the grower would have resulted in a depletion of the aquifer to a point where irrigation was not possible. With drip irrigation, he was able to maintain his cropping area by making the available water irrigate a larger area compared to sprinklers," Mr Hickey said.

While project VG04010 was completed in 2006, a follow-up project completed in 2015-2016 entitled *The Review of Current Vegetable Irrigation Technologies* (VG14048) aimed to give growers a deeper understanding of available and emerging irrigation practices and technologies, and to further support the uptake of more efficient water practices. Irrigation Australia Limited partnered with the New South Wales Department of Primary Industries and Greater Sydney Local Land Services to deliver the project nationally, conducting a review of current and emerging irrigation technologies as well as key management practices with the potential to maximise productive water use. Consultation took place with growers, researchers, consultants and manufacturers. The research revealed nine areas that can be addressed to improve water efficiency, with the findings extended to growers via three online videos and 19 workshops across the country.

Conclusion

Increased demand for water and greater production efficiencies have made the Australian vegetable industry aware of the need for improvements to their irrigation systems. Successful implementation of sub-surface drip irrigation, computer-controlled overhead sprinklers and soil moisture monitoring equipment generally involves significant initial capital investment, replacement and maintenance costs, making it important for growers to know the type of technology most suited to their crop.

While this equipment is known to produce high-yielding quality crops, the uptake of irrigation technologies and management practices by the Australian vegetable industry remains relatively slow, with further investigation needed in order to identify the specific barriers to adoption.

Use of shade shelters has been used in various industries in recent years to reduce evapotranspiration and wind rub on fruit as well as optimise crop yields. NSW DPI Irrigation Officer Robert Hoogers is pictured at a trial site in Griffith.

Acknowledgements

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Further information

Videos reviewing current and emerging irrigation technologies are available at the following links:

- youtube.com/watch?v=rfTdodKR2Jw
- youtube.com/watch?v=CCDJLSp_Moo&feature=youtu.be
- youtube.com/watch?v=THPrFvLsQUQ

The final report for this project is available on InfoVeg. Readers can search 'VG04010' on the InfoVeg database: ausveg.com.au/infoveg/infoveg-database.