

**Plant Growth Regulators Improving the Productivity of Queensland
Vegetable Producers: Broccoli as a proof of concept crop**

Clinton McGrath, Horticulture & Forestry Science

Agri-Science Queensland Innovation Opportunity

November 2016

This publication has been compiled by Clinton McGrath of Horticulture & Forestry Science, Department of Agriculture & Fisheries.

© State of Queensland, 2015

The Queensland Government supports and encourages the dissemination and exchange of its information. The copyright in this publication is licensed under a Creative Commons Attribution 3.0 Australia (CC BY) licence.

Under this licence you are free, without having to seek our permission, to use this publication in accordance with the licence terms.



You must keep intact the copyright notice and attribute the State of Queensland as the source of the publication.

Note: Some content in this publication may have different licence terms as indicated.

For more information on this licence, visit <http://creativecommons.org/licenses/by/3.0/au/deed.en>

The information contained herein is subject to change without notice. The Queensland Government shall not be liable for technical or other errors or omissions contained herein. The reader/user accepts all risks and responsibility for losses, damages, costs and other consequences resulting directly or indirectly from using this information.

Summary

Broccoli is a significant contributor to Queensland vegetable production and exports. A major problem faced by growers is irregular and non-uniform harvests, resulting in high labour costs and variable yield and supply volumes. A series of experiments were conducted to determine if plant growth regulators (PGRs) could be used to improve productivity of broccoli, in particular harvest uniformity and harvest manipulation. Key findings from this project indicate the PGRs prohexidione-Ca and uniconazole both could delay broccoli harvest. Prohexidione-Ca when applied one day prior to anticipated first harvest, and then harvest delayed for 7 days, resulted in 95% of heads in marketable size range. Further investigations and research are planned to follow up on these key findings.

Table of contents

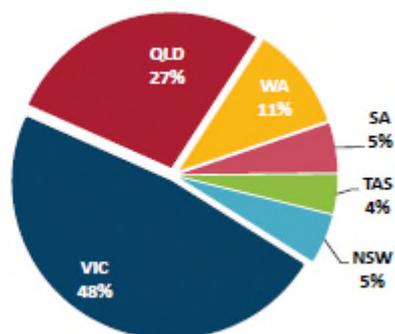
| | |
|---|---|
| Background | 1 |
| Project Objectives | 2 |
| Methodology | 2 |
| Results | 3 |
| Conclusions/Significance/Recommendations | 5 |
| Key Messages | 5 |
| Where to next | 6 |
| Budget Summary | 6 |
| Acknowledgements | 6 |
| Reference List | 6 |

| | |
|---|---|
| Figure 1 Australian broccoli production (tonnes) by state, 2014/15. | 1 |
| Figure 2 Broccoli harvest. Non uniform maturity results in multiple harvests resulting in increased labour costs. | 1 |
| Figure 3 Broccoli , Brisbane wholesale prices and volumes, demonstrating variable prices and supply primarily due to weather events (Marketinfo.com.au, 2016)..... | 2 |
| Figure 4 Results of head diameter and weight for broccoli in experiment 1, Stanthorpe, Treatment 1 - control, 2 - GA, 3- Prohexidione Ca, 4 - Uniconazole. | 4 |
| Figure 5 Visual demonstration of experiment 1 treatments in horizontal rows, vertical rows replicates. Top to bottom treatments, uniconazole, prohexidione-ca, Ga, control. Note field variability between replicates. | 4 |
| Figure 6 GA affect on broccoli florets (left) compared to control (right). Florets were beginning to open and soft and thus unsuitable for market. | 4 |
| Figure 7 Experiment 4 harvest uniformity 7 days after application of treatments. | 5 |
| Figure 8 Prohexidione-Ca treatment in experiment 4 showing no broccoli heads greater than 150mm, 7 days after application and intended first harvest. | 5 |

Background

Broccoli is an increasing popular crop in Queensland with production all year round with major production in through Autumn, Winter and Spring. In 2015, Queensland produced 27% of Australian broccoli production or 16,545 tonnes (Horticulture.com.au, 2016). Broccoli is the most exported vegetable crop from Queensland and Queensland exports the most broccoli for any state in Australia with 1840 tonnes exported primarily to Asian markets in 2015 (Horticulture.com.au, 2016).

2014/15 Fresh Broccoli Production by State



Sources: ABS; AUSVEG

Figure 1 Australian broccoli production (tonnes) by state, 2014/15.

Harvesting and packing labour is the major input cost in the production system contributing to 22% of variable costs in a typical Lockyer Valley broccoli gross margin (Appendix 1).

High variability in crop maturity contributes to increased labour costs, with most broccoli crops in Queensland requiring 3 – 4 passes to remove the heads at market quality (Figure 2). Various research projects and the development of a mechanical broccoli harvester have indicated harvest maturity as a major barrier to mechanical harvesting (Rogers et al., 2009).



High variability in market prices and supply volumes for broccoli also occur regularly due to weather events, in particular prolonged cold or hot weather (Figure 3).

Figure 2 Broccoli harvest. Non uniform maturity results in multiple harvests resulting in increased labour costs.

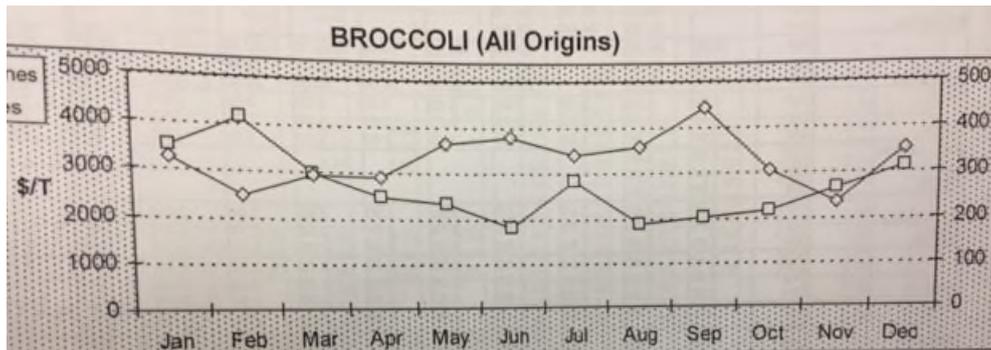


Figure 3 Broccoli , Brisbane wholesale prices and volumes, demonstrating variable prices and supply primarily due to weather events (Marketinfo.com.au, 2016).

Increasing broccoli harvest uniformity and the possibility of manipulating harvest time to manage supply could contribute significantly to broccoli productivity and profitability for Queensland producers.

This project aimed to identify and demonstrate if plant growth regulators (PGRs) could contribute to improving uniformity and manipulating maturity.

Project Objectives

The primary purpose of this project was to assess if PGRs could in broccoli ;

- Manage harvest maturity, and
- Improve harvest uniformity.

Methodology

Literature review of previous work on broccoli using PGRs and select suitable PGRs.

Field trials to determine if these PGRs could manage harvest maturity

A total of 4 replicated field trials were conducted in two production regions of the Lockyer Valley and Granite Belt. The first three trials were focussed on determining if PGRs could advance or delay harvest, the last experiment was focussed on improving harvest uniformity.

Results

Literature Review Key points

PGRs are widespread use around the world for many applications and many types of PGRs are listed.

Limited research is available for the use of PGRs on broccoli production.

Some Australian research has looked at PGR application at seedling stage to improve uniformity, however no significant results were achieved.

Research in India has identified Gibberellic Acid (GA) as a potential product to advance maturity and increase yield. Gibberellic Acid (ProGibb®) is registered in Australia for use in grapes, citrus and prunes (Sumitoma chemicals, 2016).

Prohexidione Calcium (Regalis®) is used widely in the Queensland apple industry for reduction in shoot growth and is readily available locally (BASF Australia, 2016).

Uniconazole-P (Sumagic® and Sunny®) is registered in Australia for the reduction of plant height in poppies and reduction of vegetative growth in avocados (Sumitoma chemicals, 2016b).

For the experiments in this project GA, Prohexidione Ca and Uniconazole were selected primarily because of local availability, use method (foliar application), potential human safety factors and the fact registration of the product for other crops has occurred in Australia.

“The products used in the experiments are not registered for use on broccoli in Australia”

Field trials

A total of four field experiments were conducted at three sites on the Granite Belt and one site in Gatton.

The PGRs were applied at the rates recommended for other crops on their appropriate labels. A non-ionic surfactant was used at label rates.

Results tabulated below in figure 4 show the effects of applying the PGRs 7 days before anticipated harvest

This experiment and consistent with other experiments, showed that the PGRs Prohexidione CA and Uniconazole, could reduce the rate of broccoli growth (head size and diameter) compared to the unsprayed control. GA was shown in the first experiment to increase head size, however it had adverse effects on the quality of the broccoli heads by causing floret openings, which resulted in reduced marketable quality (figure 6).

All experiments indicated high variability in broccoli generally across and within the trials at harvest.

Experiment 4 measured uniformity and application of PGRs 1 day prior to anticipated first harvest with harvest then delayed for 7 days. The aim was to measure if harvest uniformity could be increased by measuring how many heads were in marketable range (100mm – 150mm) 7 days after application. Prohexidione CA had 95% of heads in this range compared to control with 88% and uniconazole 90%. The control had 10% heads greater than 150mm and uniconazole 7.5%. No heads in the

prohexidione – Ca treatment were greater than 150mm. These results can be seen in figure 7. Figure 8 shows the prohexidione-Ca treatment at harvest.

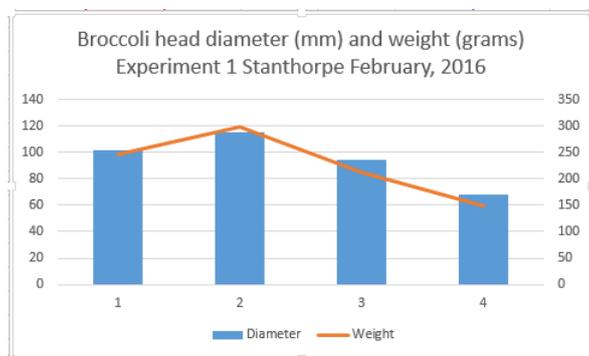


Figure 4 Results of head diameter and weight for broccoli in experiment 1, Stanthorpe, Treatment 1 - control, 2 - GA, 3- Prohexidione Ca, 4 - Uniconazole.



Figure 5 Visual demonstration of experiment 1 treatments in horizontal rows, vertical rows are replicates. Top to bottom treatments, uniconazole, prohexidione-Ca, GA, control. Note high field variability between replicates.



Figure 6 GA effect on broccoli florets (left) compared to control (right). Florets were beginning to open and soft and thus unsuitable for market.

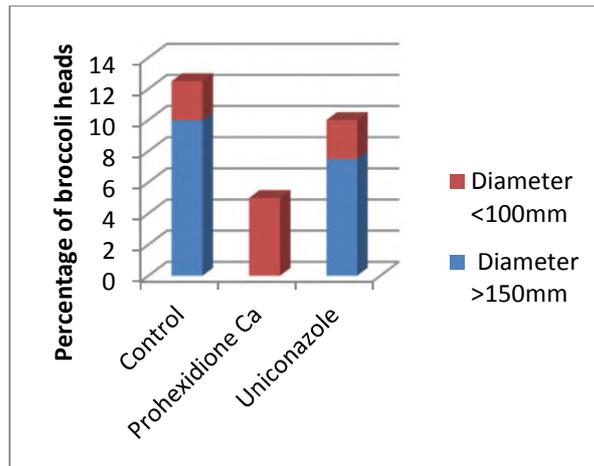


Figure 6 Experiment 4 harvest uniformity 7 days after application of treatments.



Figure 7 Prohexidione-Ca treatment in experiment 4 showing no broccoli heads greater than 150mm, 7 days after application and intended first harvest.

Conclusions/Significance/Recommendations

PGRs may have significant applications in broccoli production in particular with broccoli harvest manipulation and uniformity.

The results indicated that PGRs can manipulate harvest maturity in broccoli, in particular delay of harvest with products prohexidione-Ca and uniconazole. This could be useful for farmers when situations of forecast hot weather, poor prices or lack of labour exist.

Prohexidione-Ca had an exciting result when applied 1 day prior to anticipated first harvest, resulting in 95% of heads in marketable range, at an intended harvest 7 days later. This could result in farmers significantly reducing the number of harvests or potential for mechanical harvesting in broccoli.

Key Messages

PGRs can manipulate harvest timing, in particular delay of harvest.

Indications that PGRs can improve harvest uniformity.

Where to next

Discussions with growers have shown interest in harvest manipulation and improved uniformity. Prohexidione-Ca will be applied in a small scale trial on farm again in 2016/17 to determine potential further follow up.

Results of the project have been shown to the chemical companies who own the PGRs for their consideration of future work and possible registrations.

Discussions with UQ researchers and lecturers, has resulted in a concept project produced for potential Honours students to investigate.

Budget Summary

Total budget \$897.00

GA spray \$66.00

Regalis \$400.00

Measuring rings and scales \$428.00

Acknowledgements

Rugby Farms, Taylor Family Produce and Winpak Farms for trial sites and discussions on results.

Sumitoma and Vedelago farms for donation of trial products.

Reference List

Anon, (2016). [online] Woolworths Fresh specs; Broccoli Grade 1, Available at: <https://www.wowlink.com.au/cmgt/wcm/connect/01cf7e00433d350483579ba521a80a40/Broccoli+20160630.pdf?MOD=AJPERES> [Accessed 4 Nov. 2016].

BASF Australia, (2016). *Regalis Plant Growth Regulator*. [online] Available at: http://www.agro.basf.com.au/images/pdf/labels/REGALIS_59683_58702_TXT_Label.pdf [Accessed 6 Nov. 2016].

Horticulture.com.au. (2016). *Horticulture Innovation Australia | Australian Horticulture Statistics Handbook*. [online] Available at: <http://horticulture.com.au/australian-horticulture-statistics-handbook-201415/> [Accessed 6 Nov. 2016].

Marketinfo.com.au. (2016). *About Market Information Services*. [online] Available at: <http://www.marketinfo.com.au/> [Accessed 6 Nov. 2016].

Rogers, G., Titley, M., Giggins, B. and Kimpton, T. (2016). Agronomic programme to improve the uniformity of broccoli for once-over mechanical harvesting [online] Available at: <http://ausveg.com.au/intranet/technical-insights/docs/VG06053.pdf> [Accessed 4 Nov. 2016].

Sumitoma chemicals, (2016). *ProGibb label*. [online] Available at: http://www.sumitomo-chem.com.au/sites/default/files/sds-label/progibb-sg_label.pdf [Accessed 6 Nov. 2016].

Sumitoma, (2016b). [online] Sunny Plant Growth Regulator. Available at: http://www.sumitomo-chem.com.au/sites/default/files/sds-label/sunny_label.pdf [Accessed 6 Nov. 2016].