Know-how for Horticulture

Management strategies for white blister (rust) in Brassica vegetables

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Purpose of project:
This project details the outcomes of a 3 year study on management strategies for white blister (rust) on brassicas which (i) developed an validated a seed health test; (ii) developed a rapid molecular test to distinguish races of *Albugo candida:* (iii) evaluated a disease predictive model; (iv) evaluated chemical control strategies; (v) examined the economics of controlling the disease and (vi) identified varieties more tolerant of white blister.

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Media Summary

Busting white blister

White blister is a fungal-like disease of brassicas that began devastating Victorian broccoli crops during the summer of 2001-02. It has since spread rapidly across Australia, despite the implementation of interstate trade barriers. The consequences for industry are year-round fungicide applications to control the unsightly white blisters and swellings on the leaves and heads.

With support of AUSVEG, HAL and the Victorian Government, researched at DPI Victoria has developed management strategies for white blister on seed, seedlings and in the field.

The major outcomes of this research project are:

- The world's first molecular test to distinguish white blister races. This tool enables the industry and regulators to identify races, to resolve issues around market access and the movement of infected produce, and to map pathogen populations and assess potential sources of inoculum from alternate hosts.

- A rapid DNA-based seed health test that has the potential to underpin seed-health audit schemes, which would help to eliminate inoculum sources in Australian grown and imported *Brassica* vegetable seeds.

- A series of national trials that identified cultivars of broccoli less susceptible to white blister on heads (by up to 100%).

- Options to control white blister with spray programmes based on the Brassica$_{Spot}$™ disease predictive model and 'Best bets' regimes were as effective as calendar-spray programmes. They reduced the number of sprays by 8-10 per crop. Economic analysis indicated that the main influence on profit was yield, not cost of the model, weather station or systemic fungicides.

- The introduction of exotic races of white blister is a potential issue for Quarantine authorities.

Recommendations for future R&D:

- Identify resistant cultivars of cauliflower, Brussels sprouts and cabbage.
- Validate the new version of the Brassica^{spot}II model which combines sporulation and infection models.
- Explore non fungicide options for control.
- Evaluate aerial spore sampling equipment.
- Determine efficacy and economics of various disease control measures.

Recommendations to industry:

Growers should use the seed test to ensure they start with "clean seed', grow less susceptible cultivars, avoid night irrigation and protect broccoli buttons from infection as they develop into heads. This approach will maximize the production of broccoli that meets the high aesthetic standards in the marketplace.

Technical Summary

The white blister epidemic of 2001/02, which spread Australia wide, had a dramatic impact on *Brassica* production nationally, resulting in an industry dependent on year round fungicide applications to control foliar and head diseases. The objective of this project was to identify management strategies for white blister on seed, seedlings and in the field. Investigations concentrated on the evaluation of cultivar susceptibility, fungicides, a disease predictive model, a seed health test and a rapid molecular test to differentiate races of *Albugo candida* on vegetable brassicas. The major outcomes of this study were:

- Identification of broccoli cultivars less susceptible to white blister by up to 100%, relative to the susceptible cultivar Greenbelt in national trials. The cultivar Belstar was consistently the least susceptible, but slower to mature in commercial production.
- Chemical options for white blister control on seed, seedlings and field grown broccoli were explored using various timings of systemic, protectant and soft chemical options (those having a short or zero with-holding period).
- Evaluation of a disease predictive model Brassica$_{spot}$™, linked to a weather station saved up to 8-10 protectant sprays while the 'Best Bets' program (which consisted of systemic sprays at 5 weeks and at button stage) saved up to 9 protectant sprays per crop relative to copper based calendar spray programmes, while providing equivalent disease control. White blister appeared in crops about 7 days after a high risk period, which correlated with the model.
- A measure of profitability, determined by a cost benefit analysis of chemical management practices for white blister, indicated that no single management practice was consistently superior. Less susceptible cultivars were generally more profitable than more susceptible cultivars.
- Race studies found no evidence to indicate that isolates from *C. bursa-pastoris* and *B. rapa* varieties identified as AC 4 and AC 7, respectively, contributed to the epidemic on broccoli. But *B. nigra* was more susceptible to races AC 7 and AC 9 than in overseas studies, suggesting that local isolates have higher virulence on that host.
- Development of a real-time PCR assay to detect and quantify oospores in seed-wash water down to levels as low as one oospore per 5 g, consequently providing a highly sensitive seed health test for industry.
- Identification of 6 sets of primers to differentiate the four most common AC races in Australia: radish AC 1, shepherds purse AC 4, Chinese cabbage AC 7, and broccoli AC 9 based on shotgun-sequencing. This assay is a tool for the Australian brassica industry to identify AC races, to resolve issues around market access, to map pathogen populations and assess potential sources of inoculum from alternate hosts.

Recommendations for future research

The areas of future research which would be of most benefit to the industry are:

1. Identification of cauliflower, Brussels sprouts and cabbage cultivars less susceptible to white blister, to avoid similar epidemics on these crops.
2. Validate the new version of the disease predictive model Brassica$_{spot}$II that contains a combination of the sporulation and infection models and is more reliant on protectant than systemic fungicides, consequently enhancing fungicide resistance management strategies.
3. Explore non fungicide options for AC control and their economics.
4. Develop a molecular test for 'subraces' of AC 9 and incorporate it into the seed health test, as they may pose a biosecurity issue for Australian *Brassica* production.
5. Evaluate the aerial spore sampling equipment developed by Warwick HRI as a predictive tool and compare its efficacy, accuracy and economics with the predictive model.

Chapter 8

Technology transfer and recommendations

Summary

The results of this research were reported nationally through field days, workshops and industry publications. Project management through the Steering Committee and the Industry Advisory Committee ensured that the project remained focused on the task, lead to a better mutual understanding between the science researchers and industry and enhanced the impact of project outputs within the industry. This chapter reports on the project's steering committees and the various methods used to deliver information to industry, such as meetings, field days, conferences, and in industry and technical publications. Recommendations for future research are listed at the end of the chapter.

8.1 Introduction

The involvement of the project steering committees and the former Brassica Industry Advisory Committee were an excellent means of ensuring research directions remained consistent with industry needs, engaging growers and accelerating the impact of R&D projects. Additionally the opportunity to report research nationally at seminars in conjunction with other *Brassica* projects such as the Better Brassicas Roadshow VG04014 and VG04004 the National Diamond Backed Moth project, presented to industry an holistic approach to *Brassica* IPM.

The project steering committee consisted of both vegetable growers and representatives from allied support businesses including crop advisers, nurserymen, seed suppliers, chemical manufacturers and chemical resellers. These groups provided an opportunity for researchers to present their work plans and results whilst the ensuing discussions gave everyone an chance to participate in the project. The group member's had diverse experience and their industry networks, both local and overseas, enhanced the project outcomes. This approach ensures an appreciation for the perspectives of the sector involved in *Brassica* production. Scientists are able to ensure research is relevant for industry, whilst industry has come to appreciate the scientific rigor and quality assurance behind the research.

The steering committee model has been successfully applied to other vegetable research projects including 'A scoping study for race identification, source of epidemic and management of white blister on brassicas' VG02118, 'Evaluation of a disease forecasting model to manage late blight (*Septoria*) in celery' VG04016, 'Scoping study to investigate management of root-rot diseases in parsley' VG04025, 'Bunching Vegetables' VG01045, 'Onion White Rot' VG01096, and the Lettuce Aphid advisory group under 'Lettuce Best Practice' VG01038.

8.2 Steering committee group members

Growing and marketing vegetables demands a great deal from growers and consequently many are unable to participate in steering committees. Growers often receive advice from vegetable agronomists and other service providers and hence the addition of these agronomists and similar "information retailers" to join with researchers and those growers prepared to plan and discuss the white blister problem first-hand, has proved a huge success.

The individual members who have contributed to the success of the White Blister Industry Steering Committee are:

- James Kelly – Operations Manager, Kelly Bros. Market Gardeners, Dandenong
- Mark Milligan – Operations Manager, A&G Lamattina & Sons, Rosebud

- Jo Kelly – Co-owner, Tullamore Gardens, Cranbourne
- Luis and Paul Gazzola – VGA President/Director and Marketing Manager, respectively, L&G Gazzola & Sons, Somerville
- Glenn Favero – Co-owner, Favero Gardens, Cranbourne
- Rob Nave – VGA committee and President Werribee Growers Group, Nave Produce, Werribee South
- Harry Velisha – Co-owner, Velisha Brothers, Werribee South
- Karl Riedel – Vegetable crop agronomist, E. E. Muir & Sons – Cranbourne
- Brian Brewer – Vegetable crop agronomist, Elders - Packenham
- Stephen Moore – Vegetable Agronomist - E.E. Muir & Sons - Werribee
- Ian Willert & Matt Newland – Nursery Managers – Boomaroo Nurseries - Lara
- David McDonald – Technical Manager- Brassicas - South Pacific Seeds - Dandenong
- Daniel Gleeson – Technical Manager - Broccoli - Henderson Seeds - Bulleen
- Dr Elizabeth Minchinton – Project leader- DPI-Knoxfield
- Joanna Petkowski – White Blister Project Officer- DPI-Knoxfield
- Dr Robert Faggian – Molecular Biologist - DPI-Knoxfield
- Slobodan Vujovic –Vegetable Extension Officer - DPI-Knoxfield

8.3 Dissemination of information to industry

Adults acquire information in different ways such as reading, talking and visual cues. Some forms of information distribution will be more useful or accessible than others. There are many methods to distribute information to growers, such as field days, industry publications, workshop meetings and steering committees. During the course of this project we have endeavoured to utilise a broad range of information delivery methods and take every opportunity to report to industry. The Appendix lists the steering committee meetings, field days, workshops, industry publications and technical publications.

8.4 Recommendations

The major outcomes of this project are improved management strategies for white blister control in brassicas. These strategies are growing more tolerant cultivars, avoidance of evening irrigation and applications of systemic fungicides according to either the $\text{Brassica}_{\text{spot}}$ disease predictive model, the 'Best Bets' program or on a calendar basis. This project developed a molecular test to distinguish races 1, 4, 7 and 9 of *A. candida* and developed a seed health test which is sensitive to one oospore per 5 g of seed.

It was established that inoculum from the common weed Shepherd's purse (*C. bursa-pastoris*) and from crops of Chinese cabbage (*B. rapa*) does not currently cause white blister on broccoli (*B. oleracea*) in Australia. However, as inoculum from shepherd's purse does cause disease on broccoli overseas, weed hosts should be removed to reduce the probability of similar situation developing in Australia.

Areas of future research which would benefit the industry are:

(i) Identification of cultivars of cauliflower, Brussels sprouts and cabbage which are less susceptible to white blister. This would prepare the industry for the probable future introduction of exotic strains of AC virulent on cauliflower, Brussels sprouts and cabbage.

(ii) Validation of the new version of the disease predictive model $\text{Brassica}_{\text{spotI}}$I, which contains the sporulation and infection models. The new model has reportedly enabled UK growers to move away from reliance on systemic fungicides back to preventative fungicides which may be more cost effective, and reduces the risk of fungicide resistance developing. This would extend the life of the systemic fungicides.

(iii) Identification of more soft option chemicals, those with a short or no with-holding periods, for their efficacy in controlling white blister as calendar sprays or in conjunction with the disease predictive model or 'Best Bet' strategic spray program.

(iv) Develop a molecular test for variants of Race 9 of *A. candida* which may pose a biosecurity issue for Australian *Brassica* production. In Australia Race 9 is very aggressive on broccoli but not cabbage, whilst in Europe Race 9 is very aggressive on cabbage and Brussels sprouts. A molecular test may be able to prevent aggressive variations of Race 9 entering the country and causing epidemics of white blister on cabbage and Brussels sprouts, similar to the epidemic which occurred on broccoli in 2001/02.

(v) Roy Kennedy's group at Warwick HRI UK have developed aerial spore sampling equipment which can be used as an early warning for diseases with air-borne spores. Although only developed for gray leaf spot (*Alternaria*) of *Brassica*, it could potentially be used as a predictive tool for outbreaks of white blister and may be more economical to run than the current- predictive model.

8.5 Appendix

Steering committee meetings

Cranbourne and Werribee - 5, 6 May 2004
Cranbourne and Werribee - 5, 6 January 2005
Bairnsdale, Cranbourne and Werribee - 12, 15 September 2005
Cranbourne and Werribee - 16 August and 15 September 2006

Brassica Working Group Sydney - 20 October 2004
Brassica Working Group Sydney - March 2006
White blister international meeting DPI Knoxfield - 4 May 2007

Workshops and meetings

WA Wanneroo, Manjimup vegetable growers - 23, 24 August 2004
Vic Bairnsdale, Werribee and Cranbourne - 13, 16, 17 August 2004
NSW Cowra, Bathurst vegetable growers - 12, 13 October 2004
National Vegetable Expo Werribee - 5-6 May 2005
National Vegetable Expo Werribee & White Blister Forum - 3 May 2007

Better Brassicas Roadshow VG 04014, 2005
- Vic Cranbourne, Werribee, Bairnsdale - 4, 6, 7 October
- WA Wanneroo, Manjimup - 12, 13 October
- NSW Penrith, Bathurst - 17, 18 October
- Qld Gatton, Stanthorpe - 26, 27 October
- SA Virginia - 4 November
- Tas Devonport -10 November

National DBM project VG04004, 2007
- SA Virginia – 2 July
- WA Manjimup, Wanneroo – 10, 11 July
- VIC Cranbourne, Werribee – 19, 20 July
- TAS Devonport – 26 July

AUSVEG Conference
- Brisbane 10-12 May 2007
- Sydney 30-31 May 2007

Field days

White blister crucifer workshop 15th Australasian Plant Pathology Society, Geelong Vic, 25 Sept 2005
Forthside Research and Demonstration Station Devonport Tas, 9 June 2006
Manjimup Horticultural Research Institute Manjimup WA, 14 June 2006
Werribee South Vic, 15 August 2006
Werribee Expo site Vic, 28 June 2007

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