FINAL REPORT

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

DAS246

Disease resistance and management in faba beans, incorporating managing Ascochyta blight in chickpeas

PROJECT DETAILS

PROJECT CODE:	DAS246
PROJECT TITLE:	DISEASE RESISTANCE AND MANAGEMENT IN FABA BEANS, INCORPORATING MANAGING ASCOCHYTA BLIGHT IN CHICKPEAS
START DATE:	01.07.1997
END DATE:	30.06.2002
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Summary

The diseases, ascochyta blight (AB) and chocolate spot, are major constraints to faba bean production in southern Australia. Disease resistance is an important part of the management strategy of pulses and the National Faba Bean Breeding program aims to produce faba bean varieties with improved resistance to these diseases. A significant component of this project aimed to facilitate the development of faba beans with resistance to these major fungal diseases through close collaboration with the faba bean breeder.

This project included research on several facets of ascochyta management in chickpeas, a very destructive problem for the industry. The project developed a DNA based seed test that enabled the detection of very low levels of seed infection, which were known to be able to cause crop failures. Another emphasis was placed on identifying chickpea varieties with better resistance. A screening program was initiated in this project to evaluate some sources of resistance within the National Chickpea Breeding Program. However, since the major outbreak in 1998, GRDC funded an associated project DAS291 which focused on identifying sources of resistance in the germplasm collections and fungicide strategies for controlling this disease.

Improving grower and industry knowledge on disease identification and management in pulses was a major objective in this project. Information was extended through field days, workshops, reports and press releases. The research staff also provided technical support to the industry and breeding programs on disease management issues in pulse crops and advice on

disease priorities, threats and management.

Report Disclaimer

Copyright

Old or Archival Reports (Projects that concluded in 2007 or earlier)

The information contained in these older reports is now several years old, and may have been wholly or partially superseded or built upon in subsequent work funded by GRDC or others. Readers should be aware that more recent research may be more useful for their needs. Findings related to agricultural chemical use are also potentially out of date and are not to be taken as a recommendation for their use.

Conclusions

The project has been able to develop successful field and glasshouse methodologies to screen for resistance to AB and chocolate spot of faba beans.

A significant number of resistant lines have been identified in the faba bean breeding program. Selection of homogenous lines from segregating families has enabled the development of resistant lines from adapted material.

Resistance to both AB and chocolate spot has been combined in a number of breeding lines, and these are moving through the program.

Assessment of seed staining has identified further resistant material and also assisted with identifying the most efficient fungicide strategies to use in faba beans with differing resistances.

Breeding material resistant to rust and cercospora leaf spot has been identified.

A glasshouse method for screening chickpea lines for resistance to *Ascochyta rabiei* has been developed.

There was no variability between the South Australian (SA) *A. rabiei* isolates, suggesting firstly that the pathogen has had a single entry into the state, and secondly indicating little or no sexual recombination. The SA isolates were identical to the Pakistani isolate.

A DNA specific probe has been developed and a commercial 1,000 seed test developed for *A. rabiei* on chickpea seeds.

The impact of this disease on the chickpea industry in the southern states has been devastating. It is unlikely that growers will return to this crop until significant resistance is available in commercial varieties.

Recommendations

The continuation of the screening methodologies developed in this project will ensure the release of disease resistant faba bean lines, including lines with resistance to both ascochyta blight and chocolate spot.

The project should continue to monitor the levels of cercospora leaf spot in trials to ensure that highly susceptible lines are not released.

Fungicide strategies in faba bean crops need further studies to enable the most efficient strategies to be developed. Management requirements, in particular, need to be developed for new varieties that have a higher level of disease resistance.

The test for *A. rabiei* in chickpea seeds should continue to be promoted within the industry as low levels of seed infection can still devastate crops. Its continued presence in seeds ensures that the test is a vital part of disease management.

Outcomes

Economic Outcomes

Improved disease resistance in faba bean crops will enable growers to achieve higher yields as epidemics will be less severe. These yields will be more stable as they are not so widely influenced by disease epidemics. Overall, there will be greater economic gain to growers as the new resistant varieties become available. In addition, fewer fungicides will be required in the faba bean crops leading to smaller input costs and higher profits.

Environmental Outcomes

Increased disease resistance will lead to a reduction in the use of fungicides. While many of the fungicides used in faba bean crops are less detrimental to the environment than many other chemicals, the reduction in any chemical use is a significant benefit to the environment.

Achievement/Benefit

The project aimed to minimise disease losses in pulses by:

1. Collaborating with the faba bean breeder to produce varieties with disease resistance.
2. Developing a screening test for ascochyta resistance in chickpeas and improving identification of ascochyta pathogens in faba beans, chickpeas and field peas.
3. Extending recommendations on disease management in pulses in collaboration with crop agronomists.

Resistance to AB and to chocolate spot in faba beans was identified in breeding lines and in new germplasm in a series of glasshouse and field trials which were run and assessed in collaboration with the breeder. More than 300 lines with moderate to high levels of resistance to both these diseases have been generated during the term of this project, with many more in the program. A number of these have resistance equivalent to that of the ascochyta resistant variety, Ascot[4], or the chocolate spot resistant variety, Icarus[4]. These varieties have been used in the breeding program for their resistance status, and new faba bean accessions have been identified and used as further sources of resistance. Identification of additional lines with resistance to diseases increases the opportunity for selecting disease resistant lines adapted to different cropping areas.

Efficient screening techniques were developed for identifying disease resistance to both diseases in the glasshouse. Glasshouse screening uses minimal seed and is suitable for early generation testing. A study by Master's degree student, Mr. Boaventura Nvunga, supervised by Dr. Eileen Scott (University of Adelaide (UA)) and Mark Ramsey (SARDI), found that the production of *Botrytis fabae* inoculum varied according to the fungal isolates used and was influenced by the culture media. A specific technique for producing inoculum has been developed that ensures the production of spores for glasshouse screening experiments. Further experiments found that plant age had no impact on chocolate spot resistance and that concentrations of inoculum above 10^3 were sufficient for infection. As there were problems maintaining older plants, the screening was conducted on seedlings at high concentrations of inoculum.

A study on the genetics of resistance to *Ascochyta fabae* was conducted by Masters student Uyek Yakop, supervised by Dr. Jeff Paull (UA) and Mark Ramsey. Reactions of three generations of material from crosses between Ascot and Icarus indicated

that a single recessive, or partially recessive, gene conferred resistance in Ascot. Six resistant accessions were concluded to carry a different resistant gene than the one in Ascot. The availability of alternative resistance genes will contribute to the durability of resistance, either by breeding a range of varieties with different resistant sources, or by pyramiding genes in one variety. This study also concluded that pathogenic variability exists in the Australian isolates of *A. fabae*. One isolate was identified that had the highest level of pathogenicity and allowed for the greatest differentiation between resistant and susceptible plants. Disease data were also collected on the resistance of individual plants which enables reselection within a line, and monitors segregation within breeding populations. It was established that high frequencies of resistant individual plants existed within Ascot, Fiesta, Fiord and SP95054, but there was little evidence of similar resistance within Manafest and Icarus. Individual resistant plants were retained for seed collection and were used to produce homogeneous resistant material with good agronomic potential. This material, particularly the resistant selection of Fiesta, has progressed through the breeding program.

A disease nursery was established each year at Turretfield Research Station for identifying ascochyta resistance in breeding lines. This was naturally infected with AB and resistance was assessed in late winter or early spring. In spring of 2001, after the ascochyta assessment had concluded, the nursery was inoculated with *B. fabae* and irrigated with a micro-jet irrigation system to encourage the chocolate spot epidemic. This has enabled the selection of lines with resistance to both diseases using the efficiency of one trial. The disease nursery has been re-designed in 2002 to further enhance the selection of lines that are resistant to both ascochyta and chocolate spot and will be repeated in subsequent seasons.

Data were collected in field trials on the reaction of faba bean lines to cercospora leaf spot, rust, AB and chocolate spot in breeder trials and secondary field trials. Cercospora is not a major priority of the breeding program, but steps need to be taken to ensure that no highly susceptible varieties are released. It appears that current levels of resistance in varieties such as Aquadulce, Ascot, Icarus and Manafest are adequate, but differences in varietal reactions do occur. The varieties Icarus, Aquadulce, Toranto and the breeding lines Manafest and 1097 were identified as having useful resistance to rust. The resistance in families derived from Icarus crosses was intermediate between the reactions of the parents indicating that rust resistance in Icarus is not conferred by a single gene.

The reaction of varieties in field trials to seed staining caused by AB was determined. Seed staining reduces grain quality and affects markets for faba beans. A seed disease index was calculated based on prevalence and severity of staining expressed as a percentage of the worst possible level of infection. The rating scale was modified in 2001 to conform to silo receival standards and distinguishes between a level of staining that is just acceptable (rating 2) at the silo and just unacceptable (rating 3). Lines rated as three are important as they can be improved either through backcrossing or by fungicide programs. Late rain in the spring of 1999 resulted in high levels of seed staining in crops. Fungicides applied regularly after flowering in 1999 and in 2000, in fungicide by variety trials, reduced seed staining in susceptible varieties. However, a similar trial in 2001 found that a spray at eight weeks after sowing gave the most response, particularly in the susceptible variety Fiord. These trials indicate that the optimum fungicide strategies will vary with the seasons and responses will alter accordingly. A disease management guide for faba beans has been developed in association with Pulse Australia and national pulse pathologists and pulse agronomists that identifies best fungicide strategies for individual varieties in a range of environments (Panagiotopoulos, K., Davidson, J.A., Hawthorne, W., Bretag, T., Raynes, M., Nikandrow, A. and Carpenter, D. (2002) 'Faba Bean Disease Management Strategy for Southern Region GRDC, Pulse Australia and state departments' extension article).

A. rabiei was detected in twenty of the sixty chickpea crops surveyed in SA in 1997. Presence of the pathogen was also confirmed that year in Victoria (VIC). The disease caused severe epidemics in chickpea crops in SA, VIC and New South Wales (NSW) in 1998. All varieties were susceptible, but Desavic and Lasseter were the most severely affected. Outbreaks were mainly attributed to infected seed and a management plan was developed that focused on adopting less susceptible varieties, seed testing, fungicidal seed dressings and crop hygiene. Industry was informed through workshops, field days, press releases and seminars.

A glasshouse method for resistance screening was developed by UA PhD student, M. Khan, co-supervised by Dr. Eileen Scott and Mark Ramsey, who found that optimal conditions were 15-25°C, with 96 hours of wetness. Advanced chickpea breeding lines were screened for resistance to *A. rabiei* in glasshouse and field trials in 1998 and 1999, but only moderate to low resistance was found in sources like ICC3996 and 8511-19. Further sources of resistance were identified in chickpea germplasm in collaboration with project DAS291 'Disease resistance and control of ascochyta blight in chickpeas'.

A DNA probe for *A. rabiei* was developed in collaboration with Dr. Curran, CSIRO Entomology, Canberra and the South Australian Research and Development Institute's (SARDI's) Root Disease Testing Service. The methodology was published in

the proceedings of the 1999 ISTA Conference, Ames, Iowa, and was presented at the conference by Dr. Kathy Ophel-Keller. This test has increased sensitivity to *A. rabiei* detection compared to conventional seed tests, an important factor considering that *A. rabiei* epidemics can develop from very low levels of seed infection. Seed tests conducted in 1999 and 2000 represented approx. 30% of the area sown to chickpeas in Australia. Of these seed lots, 59% and 50% were infected, respectively. In 2001 and 2002, there was a reduced demand for the test reflecting the drop in chickpea plantings, particularly in SA and VIC. Sixty five percent of the tests performed in 2001 were positive, while 57% were positive in 2002. The continued presence of this pathogen in seed sources indicates the importance of seed testing before it is sown or sold as seed. A second DNA probe was developed by Honours student Don Gomez, supervised by Drs Eileen Scott and Peter Murphy (UA) and Mark Ramsey. This probe is free from commercial agreements, but at this stage has not been developed for a seed test.

Don Gomez studied the pathogen diversity of *A. rabiei* isolates using specific polymerase chain reaction (PCR) tests and random amplified polymorphic DNA (RAPD) analyses. This included 25 isolates from SA and VIC and five overseas isolates. All SA isolates were genetically similar to the Pakistani isolate tested, and showed little variability, suggesting a single introduction of the pathogen.

Information on disease resistance and disease management was reported to industry via GRDC Updates, TOPCROP meetings, field days and through press releases in rural press and rural radio. Progress on this work was also presented at numerous workshops for advisers, industry agronomists and to growers. Jon Lamb Communications was contracted during 2000 and 2001 to facilitate timely dissemination of research outcomes to industry. Articles appeared in Australian Grain magazine on faba bean resistance breeding (2000) and ascochyta in chickpeas (2001). In 1997, a workshop on pulse diseases was organised prior to the Australasian Plant Pathology Conference in Perth in collaboration with Drs. Sweetingham and Jones, Agriculture Western Australia (WA). The workshop established contacts and facilitated discussion between pulse researchers internationally.

Other Research

- Epidemiology studies and linkage to climatic studies leading to the development of disease risk indices would assist growers to determine the strategic use of fungicides. The indices would be dependent upon varietal resistance, agronomic management and climatic data.
- Epidemiological studies of the survival and spread of *A. fabae* and *B. fabae* would enable more targeted control strategies to be developed, particularly in terms of rotations and paddock selection with other pulse crops as alternative hosts.
- Further understanding of the genetics of resistance to *A. fabae* and *B. fabae* would enable a targeted approach in terms of the material used in the crossing program.

Intellectual Property Summary

The project will lead to the development of faba bean germplasm that may be progressed to commercial release according to policies of GRDC and the National Faba Bean Breeding Program as it applies to its collaborating parties. There are no known restraints to commercialisation by Plant Breeder's Rights (PBR) of varieties arising directly or in crossbreds of germplasm arising from this project.

Additional Information

Publications

Gomez DR (2000). Diversity amongst South Australian isolates of *A. rabiei*, Honours Thesis, University of Adelaide (UA).

Khan MSA, Ramsey MD, Scott ES (1997). Evaluation of resistance to Ascochyta blight of chickpea in Australia, 11th Biennial Conference, Australasian Plant Pathology, Perth, pp. 116.

Khan MSA, Ramsey MD, Corbiere R, Infantino A, Porta-Puglia A, Bouznad A, Scott ES, (1999). Ascochyta blight in chickpea in Australia: Identification, Pathogenicity and mating type, Plant Pathology, 48,230-234.

Khan MSA, Ramsey MD, Scott ES (1999). Host range studies with an Australian isolate of *A. rabiei*, Australasian Plant

Pathology, 28, 170-173.

Khan MSA (1999). Epidemiology of Ascochyta blight of chickpea in Australia, PhD Thesis, University of Adelaide (UA).

Nuvunga BS (1998). Resistance of Faba Bean (*Vicia faba* L.) to Chocolate Spot (*B. fabae* Sardina), Masters Thesis, University of Adelaide (UA).

Paull JG, Yakop UM and Ramsey MD (1999). Ascochyta blight resistance of faba beans, 11th Australian Plant Breeding Conference, Adelaide, pp193-194.

Yakop UM (1998). Resistance of faba beans to Ascochyta blight, Masters Thesis, University of Adelaide (UA).

Attachments

1. 'Fungicide Strategies for the Control of Ascochyta in Chickpeas' (1999) J. Slatter, Pulse Australia.

2. 'Ascochyta Blight in Chickpeas' Farm Advice Sheet 1999.

3. 'Harvest fabas early to avoid staining' in Australian Grain August-September 2000, pp3-4.

4. 'Faba Beans for Quality Markets' GRDC Advice Sheet December 2000.

5. 'Field trial results put confidence back into chickpea production' in Australian Grain December 2000- January 2001, pp8-9.

6. Ascochyta seed staining rating scale on Faba Bean.

7. Panagiotopoulos, K., Davidson, J.A., Hawthorne, W., Bretag, T., Raynes, M., Nikandrow, A. and Carpenter, D. (2002) 'Faba Bean Disease Management Strategy for Southern Region GRDC, Pulse Australia and state departments extension article.