

FINAL REPORT

DAS291

Disease resistance and control of Ascochyta blight of chickpeas

PROJECT DETAILS

PROJECT CODE: DAS291

PROJECT TITLE: DISEASE RESISTANCE AND CONTROL OF ASCOCHYTA BLIGHT OF CHICKPEAS

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Summary

Ascochyta blight (AB) is one of the major diseases of chickpeas worldwide. The Australian chickpea industry has been severely affected by the disease, which was identified in South Australia (SA) in 1995 after having caused sporadic losses over several previous years. In 1998, it caused extensive crop damage throughout the southern and eastern states. Similar outbreaks occurred in Western Australia (WA) in 1999. As a result of the losses caused by these epidemics, the area sown to chickpeas in SA and Victoria (VIC) decreased from 95,000ha in 1998 to 18,000ha in 2001. All of the chickpea varieties currently grown in Australia are susceptible to AB. Varieties with resistance to the disease and better disease management strategies are essential for the industry.

Improving grower and industry knowledge on disease management and control of AB was a major focus of this project. Information was extended via field days, grower updates, press releases and workshops. The project collaborated with the National Chickpea Breeding Program (Coordinated Improvement for Chickpeas in Australia (CICA)) and interacted with an international initiative on AB of chickpeas coordinated by the International Centre for Agricultural Research in the Dry Areas (ICARDA) to capture the maximum benefit for Australia. Research staff on the project provided technical support to the chickpea industry and breeding programs on AB in chickpeas and provided advice on disease risk and management priorities.

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Conclusions

The project has developed successful field and glasshouse methodologies to screen for resistance to AB of chickpeas.

A significant number of lines with valuable resistance have been identified in the chickpea breeding program. These have been of fundamental importance in stabilisation of the industry after the epidemics of the late 1990s and have provided the foundation for commercial varieties that will be adopted in the future.

Extensive trials have demonstrated the importance of seed-borne inoculum in survival and spread of this disease. Low levels of seed infection (0.25%) can lead to an epidemic when seed dressings are not applied.

Spread of this pathogen from a focus of infection is dependent on wind driven rain and occurs over relatively short distances (0-20m). There is no evidence of spread from windblown spores.

Chlorothalonil[#] is the most effective foliar fungicide currently available and must be applied regularly before rain fronts throughout the growing season, commencing six weeks after sowing. Just a few infected seedlings can lead to rapid spread of the disease when weather conditions are favourable.

A DNA assay specific to *Ascochyta rabiei*, which causes chickpea AB, has been developed and is currently used in a commercial test to detect the pathogen on chickpea seed. This assay showed potential in quantifying inoculum levels on infested chickpea residue, where the fungus can survive for approx. two years.

Several fungicides for seed or foliage application were identified as potential alternatives to currently recommended fungicides, but require further study. Some of these are systemic in their mode of action, which would be beneficial in post-infection applications.

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

Recommendations

Continuation of screening methodologies, such as those developed in this project, will ensure the release of chickpea lines that are resistant to AB.

The adoption of varieties with improved resistance as they become available is the most important recommendation to the chickpea industry.

A clean seed approach is critical for effective management of this disease. A combination of nil or very low levels of seed infection and an effective seed dressing is essential.

Fungicide strategies in chickpea crops need further study to determine more efficient and economical strategies and management strategies need to be developed for new varieties with higher levels of disease resistance, as growers are often concerned at the cost of multiple fungicide applications.

The commercial test offered at the South Australian Research and Development Institute (SARDI), which uses the *A. rabiei*-specific DNA assay to detect the pathogen on chickpea seed, will continue to be promoted within the industry as low levels of seed infection can devastate crops. Survival of the pathogen in seeds for long periods of time ensures this test is a vital part of disease management.

There is scope for development of the DNA assay to provide a diagnostic soil-based test to quantify inoculum loads of infested chickpea residue in or on the soil profile. Such a test would provide an additional tool to reduce the risk of this disease through improved paddock selection.

AB can spread and develop rapidly when weather conditions are favourable, so with current varieties susceptible to the disease, application of foliar fungicides early in the growing season, from six weeks after sowing, is critical to its control.

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Outcomes

Economic Outcomes

Improved resistance to AB will reduce the impact of ascochyta epidemics, enabling chickpea growers to achieve higher yields. Chickpea varieties will be more stable because the crops will not be so influenced by the disease. Overall, there will be greater economic gain to growers as new resistant varieties become available. This is particularly relevant for growers in southern Australia. Improved chickpea varieties with higher levels of disease resistance will require fewer foliar fungicide applications leading to lower input costs and higher profits.

Environmental Outcomes

Increased disease resistance will lead to a reduction in the number of foliar fungicide applications. While many of the fungicides used in chickpea crops are less detrimental to the environment than many other chemicals, any reduction in chemical use is a significant benefit to the environment and the user.

established in four seasons (1999 to 2002). Germplasm screened included material from Australia's national chickpea improvement program, more than 300 kabuli lines from Turkey and ICARDA collections, 128 desi lines from India (ICRISAT) and selected advanced chickpea material from WA, New South Wales and SA. Disease levels were assessed at the peak of the epidemic in all seasons. More than 560 lines with potentially valuable sources of resistance to ascochyta blight moderately susceptible (MS) desi line identified as 8511-19 in early screening trials, which was commercially released in 2001 as the variety Howzat

in 2001 and 2002 respectively. Research from this project was also presented at the Australasian Plant Pathology Conferences in 1999 and 2001 and at the 8th International Congress of Plant Pathology in 2003. This established contacts and facilitated discussion between pulse researchers nationally and internationally.

Achievement/Benefit

This project aimed to:

- Determine the importance of seed and stubble as sources of AB inoculum causing disease outbreaks in chickpeas.
- Evaluate chickpea lines from the national breeding program for AB resistance in field and greenhouse trials.
- Develop integrated management strategies for AB in chickpeas based on seed treatments, foliar fungicides and crop management practices.

The role of infected seed and infested crop residues in the spread of AB within Australian farming systems was investigated. This particular aspect of research was conducted during the past 18 months of the project by the appointed research officer, Mr Rohan Kimber, as part of an honours degree at the University of Adelaide (UA). The project was supervised by Dr Eileen Scott (University - AME department), Mr Mark Ramsey (Animal and Plant Control Commission) and Dr Kathy Ophel-Keller (SARDI). Mr Kimber was awarded a first class honours in December 2002.

The role of infected seed in dissemination of the pathogen was investigated in a series of trials in the field, greenhouses and growth rooms. It was established that the frequency of disease transmission from seed infection is very low and that the incidence of disease increases with seed infection level. Disease transmission in seedlings was not significantly influenced by sowing depth or variety susceptibility (from highly susceptible (HS) to moderately resistant (MR)) and there was no obvious link to soil temperature. The low rate of transmission from infected seed was offset by the rapid spread of disease to surrounding plants which can start as early as seven weeks after sowing. These results apply to varieties ranging from HS to moderately susceptible (MS) to the disease, a range representative of the level of resistance in current commercial varieties. The development of an ascochyta epidemic is closely linked to rain events in association with prevailing winds. There was no evidence of disease introduced via air-borne spores.

A DNA-based method of detecting *A. rabiei* developed in 1999 in a collaborative effort between CSIRO Entomology (Canberra) and the Root Disease Testing Service (SARDI) is being used in a commercially available seed test for detection of the pathogen on chickpea seed samples. This assay was validated for quantifying *A. rabiei* DNA on infested stubble. Biological methods of detection were used to determine the disease potential of infested stubble and these results were compared to those achieved with the DNA assay. Results showed that the DNA assay could be used as a diagnostic tool to predict the inoculum potential of infested stubble and so may have potential as the base for a diagnostic tool capable of quantifying infested stubble in extracts of soil. This work also showed the pathogen could survive on dry chickpea residue for more than two years.

Survival studies conducted in the greenhouse indicated that the pathogen has the ability to survive on residue of a range of crop types other than its natural chickpea host. *A. rabiei* was isolated from residues of inoculated wheat, field peas, vetch and lucerne and survived on these residues for as long as 18 months. Further study is needed to investigate the impact of this source of inoculum in the field.

Several fungicides applied as seed dressings and as foliar treatments were evaluated for their efficacy in controlling *A. rabiei*. P-Pickel T[®], Thiraflo[®] and three experimental products provided significant control of pathogen growth on artificial media and reduced disease development on seedlings grown from artificially inoculated seed. Several experimental foliar fungicides including Amistar[®] and Switch[®] (Syngenta) were effective in preventing pathogen development on amended agar media. Amistar[®] also showed some efficacy in controlling the disease in a foliar fungicide trial conducted in 1999, but further development of this product may be unlikely due to high costs. These trials identified new fungicide products with efficacy in control of this disease and the relevant chemical companies were notified. Further investigations may provide alternatives to currently recommended fungicides.

Trials investigating in-crop management of the disease showed that commercially available foliar fungicides Bravo[®] (chlorothalonil[®]) and Dithane[®] (mancozeb[®]) were effective in controlling the disease in seasons when disease pressure was low to moderate. These trials were conducted over three years and controlled the disease when spraying continued through pod development. Dithane[®] was not as effective, even when applied at the highest recommended rate. When disease pressure is high, as in trials conducted in 1999 and 2001, yield losses of 60%-100% occurred in susceptible varieties regardless of fungicide applications.

Advanced chickpea lines were evaluated for disease in secondary variety evaluation trials conducted by SARDI's Field Crop

Evaluation Program during 1999, 2000 and 2001. The levels of AB varied between trials and seasons. The disease devastated current commercial lines at several sites when weather favoured epidemics. Strategic fungicide applications, which became essential for disease management in these trials, reduced disease severity significantly, particularly in lines with better resistance.

More than 3,700 chickpea lines from local and overseas collections were screened in disease nurseries established in four seasons (1999 to 2002). Germplasm screened included material from Australia's Chickpea Improvement Program, more than 300 kabuli lines from Turkey and ICARDA collections, 128 desi lines from India (International Crops Research Institute for the Semi-Arid Tropics) (ICRISAT) and selected advanced chickpea material from WA, New South Wales (NSW) and SA. Disease levels were assessed at the peak of the epidemic in all seasons. More than 560 lines with potentially valuable sources of resistance to AB were established in four seasons (1999 to 2002). Germplasm screened included material from Australia's national chickpea improvement program, more than 300 kabuli lines from Turkey and ICARDA collections, 128 desi lines from India (ICRISAT) and selected advanced chickpea material from WA, NSW and SA. Disease levels were assessed at the peak of the epidemic in all seasons. More than 560 lines with potentially valuable sources of resistance to AB were identified, including the MS desi line identified as 8511-19 in early screening trials, which was commercially released in 2001 as the variety Howzat[®].

In addition, more than 1,400 chickpea lines from the national breeding program germplasm collections, 300 kabuli lines from Turkey and ICARDA and 128 desi lines from India (ICRISAT) were screened in replicated trials in the greenhouse. Moderate levels of resistance to *A. rabiei* were identified in 23 lines from the local germplasm and 58 lines from overseas collections. These lines rated approx. 3 on a 1-9 scale where 1=highly resistant and 9=highly susceptible. No lines were highly resistant.

Information on varieties with improved resistance and aspects of disease management were reported to industry via GRDC Updates, field days and through press releases in rural press and 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. Fact sheets entitled 'Strategies for controlling foliar diseases in chickpeas' were developed as a joint initiative between Pulse Australia and all state agencies in 2000 and 2001. Articles on AB in chickpeas were published in 2001 and 2002, respectively. Research from this project was also presented at the Australasian Plant Pathology Conferences in 1999 and 2001 and at the 8th International Congress of Plant Pathology in 2003. This established contacts and facilitated discussion between pulse researchers nationally and internationally.

Other Research

- Epidemiology studies and linkage to climatic studies leading to the development of disease risk indices would assist growers with decisions about the strategic use of fungicides. The indices would need to take account of varietal resistance, agronomic management and climatic data.
- Studies investigating the air-borne stage of this disease, which was only recently recorded in WA (Galloway & MacLeod; Australasian Plant Pathology, 2002, 32, 127-28), are critical as this holds the potential for long distance dispersal of the pathogen. Further research must determine how widespread this aspect of the pathogen lifecycle is, how to identify whether or not the second mating type is present and its impact on management strategies of the disease.
- Explore alternative fungicides with different modes of action to provide more options in managing this disease. Effective systemic foliar fungicides would be greatly beneficial as systemic action would allow applications to be made before or after pathogen infection of the host to prevent disease development.
- Epidemiological studies of the survival and spread of *A. rabiei* on infested residue of chickpeas and alternative hosts would enable development of more targeted control strategies, particularly in terms of rotations and paddock selection.
- Further understanding of the genetics of resistance to *A. rabiei* would enable chickpea breeders to target generation of material that is highly resistant to the disease.

Intellectual Property Summary

The project will lead to the development of chickpea germplasm that may be progressed to commercial release, as provided for in the policies of GRDC and the National Chickpea Breeding Program as they apply to collaborating parties. There are no known restraints to commercialisation of varieties arising directly or in parental crossings of germplasm arising from this

project. Most of the information generated in this project regarding disease management remains in the public domain.

Additional Information

Publications

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Kimber RBE (2002). Survival and transmission of *A. rabiei* (ascochyta blight) of chickpea. Honours Thesis, Department of Applied and Molecular Ecology, The University of Adelaide (UA).

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Ramsey M, Davidson J, Kimber R. Pulse Diseases - Potential problems for 2000 - South Australian Cropping Systems Update. Adelaide, 16-17 February 2000. pp 58-59.

Craddock T, Kimber R, Hawthorne W. Chickpeas. Primary Industries and Resources South Australia (PIRSA) Crop Harvest Report, 1999/2000 release, pp 74-81.

Davidson J, Kimber R, (2002). Pulse Diseases in 2001 Season. South Australian Cropping Systems Update. Adelaide, 20-21 February.

Attachment

Various publications including Update papers, Australian Grain articles, media articles.