FINAL REPORT

DAS00041

Pathology support for pulse crops in the southern region_ SA module

PROJECT DETAILS

PROJECT CODE:	DAS00041
PROJECT TITLE:	PATHOLOGY SUPPORT FOR PULSE CROPS IN THE SOUTHERN REGION_ SA MODULE
START DATE:	01.07.2003
END DATE:	30.06.2006
SUPERVISOR:	JENNIFER DAVIDSON (SENIOR PULSE PATHOLOGIST)
ORGANISATION:	SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE
CONTACT NAME:	JENNY DAVIDSON

Summary

Disease is one of the major yield constraints in pulse crops in Australian cropping systems. This project aimed to collect information on prevalence and severity of the pathogens on pulse crops in the southern regions, and to gather epidemiology data associated with these pathogens. From this information strategic management practices can be developed to reduce the level of disease in crops, thus making them more reliable and profitable.

Report Disclaimer

Level 4, East Building | 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 6166 4500 | f. +61 2 6166 4599 | grdc@grdc.com.au | grdc.com.au

Conclusions

In the course of this project, disease resistant pulse cultivars maintained their resistance and the virulence of the tested isolates were all similar. Isolates only varied in their aggressiveness. The exception was one isolate of *Ascochyta fabae* that caused severe infection on the previously ascochyta resistant Morava⏀ vetch.

Particular diseases were more prevalent than others, depending on environmental conditions, cultivars and management decisions. Bacterial blight on field peas was severe in frost prone areas and appeared to be particularly significant on the cultivar, Kaspa⏀ and other semi-leafless types. This may have been due to infected seed lines or the greater susceptibility of these lines. Further research is being coordinated through NSW Industry and Investment (I&I NSW, formerly NSW DPI), Victorian Department of Primary Industries (DPI Vic) and the South Australian Research & Development Institute (SARDI) to understand the factors influencing the severity of this disease. Cercospora leaf spot on faba beans has become more widespread and severe, and epidemiology studies are currently being undertaken by Rohan Kimber, SARDI, to identify possible management strategies and resistant germplasm. Dry springs lead to the low incidence of Botrytis diseases (i.e. Botrytis Grey Mould (BGM) of lentils and chocolate spot of faba beans) but in wet springs these pathogens quickly develop to damaging levels, sometimes in association with Sclerotinia. Forecasting systems that identify environmental conditions favourable to these diseases will greatly assist in determining the need for fungicide applications. Very little data on this could be collected during this project due to drier than average seasonal conditions.

Viral infection was found to be widespread in pulse crops, but severity fluctuated with seasons. Most damaging infection occurred in the Upper South East region of South Australia (SA) following aphid flights in the wet spring of 2005. The reservoir for these viruses is likely to come from permanent pastures in the region, and management strategies need to be identified to reduce the impact of these viruses.

Particular pathogens were reported for the first time in the southern region - *Pratylenchus thornei* on lentil, *Fusarium avenaceum* on lentils, and white leaf spot on canola. These pathogens will be observed in future seasons to identify their potential threat to the pulse industry.

Modelling of spore release data has indicated that the Blackspot spore maturation model from Department of Agriculture and Food, Western Australia (DAFWA) may also predict spore release in the southern region. Further validation of the model will enable researchers to predict best sowing dates and fungicide application dates in pulse crops, for a range of ascochyta

Level 4, East Building | 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 6166 4500 | f. +61 2 6166 4599 | grdc@grdc.com.au | grdc.com.au

type diseases.

Recommendations

1. Constant monitoring of pulse crops and field trials is required to detect any increase in aggressiveness and changes in virulence of individual isolates of the pathogens on pulse crops. Reports from the United Kingdom (UK) indicate that *Peronospora viciae* (downy mildew of field peas) is particularly able to produce strains with virulence against known resistance genes and also with resistance to metalaxyl# (pers. comm. J. Thomas, NIAB, Cambridge, UK). Currently there is no indication that this is happening in Australia but constant monitoring is required. Further work is required to identify which resistance genes are in Australian pea germplasm and what races exist in Australian populations of *P. viciae*, in order that the breeding program can make a strategic response to changes in the virulence pattern of the *P. viciae* populations.
2. The release of new chickpea cultivars with ascochyta resistance will put selection pressure on the *Ascochyta rabiei* population and variability in virulence may develop to overcome this resistance. The variability of this pathogen should be monitored on a national scale to identify resistance breaking isolates early in their evolution, in order that breeders may respond with alternative resistance sources.
3. Constant monitoring of pulse crops and field trials should be maintained to identify the presence of new incursions or emerging disease threats. This monitoring may also assist in achieving area freedom against specific pathogens, which are becoming more vital to maintain the export trade.
4. It is anticipated that the ascochyta data collected in this project will be used to validate spore dispersal models developed by Dr. Moin Salam, Department of Food and Agriculture, WA. This information will identify preferred sowing dates on a seasonal basis per region that minimise disease but maximise yields, and assist in developing fungicide regimes. Similar studies on *A. fabae* would enable the fungicide sprays to be targeted to spore release rather than calendar dates, as is the current practice.
5. Studies on the *Pratylenchus* nematodes on lentils are required to confirm the identification of the species found on the lentil plant and the potential damage the nematode may inflict. A survey should be conducted to identify the prevalence of this nematode in the lentil growing regions.

Outcomes

<u>Economic outcomes</u>

This project has identified the potential of using epidemiology models to target optimum sowing dates and timing of fungicide sprays to achieve the best disease control without compromising yield or gross margins. Conditions that promote particular pathogens were identified in the trap plant system, highlighting when fungicides are necessary or when they may be omitted. For example, powdery mildew on field peas is prevalent in warm, humid conditions meaning a fungicide spray may need to be applied on susceptible varieties. However if average temperatures fall below 20C this disease will not develop to yield-limiting level. Similarly, spraying a pre-canopy closure fungicide on lentils before the last week of August is generally unproductive, since (in this set of data) canopy closure on Northfield type cultivars occurs in the first week of September.

<u>Environmental outcomes</u>

The identification of Cercospora leaf spot and Bacterial blight as significant threats to the pulse industry has led to a coordinated approach to research these diseases through GRDC funding. Management strategies for these have been preliminarily identified based on existing knowledge from the literature, including rotations and use of pathogen free seed. Resistant germplasm has been identified in the relevant breeding programs.

A number of pathogens were identified as first reports for the southern region - *Pratylenchus thornei* on lentils, *Fusarium avenaceum* on lentils, and white leaf spot (*Pseudocercosporella capsellae*) on canola. These pathogens will be observed over the coming seasons to identify their prevalence and spread, and the potential threat they may have to industry.

Achievements/Benefits

Disease is a major factor that restricts yield in pulse crops in the southern region of Australia, and resistance is often not available, making crops unreliable. Strategic management is required to control disease but a number of these crops are relatively new to the Australian farming industry and the associated diseases were not well understood. A greater understanding was sought through surveys, investigating the prevalence and severity of pathogens. This information was aimed at providing timely and relevant advice on crop protection to growers and farm advisers, and at identifying new incursions at an early stage. In addition, a greater knowledge of the variability of pathogen species was sought to give an early warning of the development of resistance-breaking strains to maximise the chances of pulse breeding programs being able to respond quickly in disease resistance breeding. A better understanding of the biology of pathogens was sought to identify effective disease management strategies. Studies on aerial spore release were conducted using trap plants at a number of sites over the growing season, and results were linked to environmental data collected via automatic weather stations.

Isolate collections

Over the three-year period of the trial, a total of 235 isolates were collected from eight different crop species (faba beans, chickpeas, lentils, field peas, vetch, lupins, canola and medic pasture). These have been stored in the pathogen collection at SARDI, or in the case of obligate parasites, are maintained on living plants in the greenhouse. Representative isolates were tested in controlled conditions against current commercial cultivars with known resistance or susceptibility. No isolate was found that was able to overcome existing resistances, except for one isolate of *Ascochyta fabae* on the resistant cultivar Morava® vetch and a supposedly resistant advanced breeding line. This information has been relayed to the vetch breeder (Dr. Rade Matic, SARDI) and field trials are planned to investigate the effect of this isolate on yield of Morava⦶ vetch. An usually high ratio of *Phoma X* (part of the blackspot complex on peas originally identified as *Macrophomina phaseolina*) was isolated in 2003 from blackspot lesions i.e. 10 *Phoma X*: 3 *P. pinodella*: 1 *Mycosphaerella pinodes*. In 2004 a number of these isolates (still called *M. phaseolina*) from blackspot lesions on peas, were submitted to CSIRO Entomology, Canberra for DNA sequencing and compared with the known sequences on web databases and known *M. phaseolina* cultures from Queensland (donated by M. Fulhbohm, DPI Qld). The sequence in the pea pathogen was found to be distinctly different from *M. phaseolina* and the fungus has since been identified as a previously undescribed *Phoma* species by Dr. M. Priest (curator NSW Plant Pathology Herbarium) and Dr. Hans de Gruyter (world *Phoma* expert; Plant Protection Service, Netherlands).

Potential and emerging threats

A number of pathogens were detected at severe levels on individual crops as first reports for the southern region. The nematode *Pratylenchus thornei* was found at very damaging levels on four lentil samples submitted to the Pulse Pathology Lab at SARDI for diagnosis. Lentils had been presumed to be resistant to this pathogen up to this point. A number of lentil crops suffered from *Fusarium avenaceum* crown rot in the spring of 2002, but not in subsequent seasons, which indicates this was probably linked to the dry spring of that year. Severe levels of white leaf spot (*Pseudocercosporella capsellae*) were identified on several canola samples submitted to the laboratory for diagnosis. These were associated with close rotations of the crop.

Cercospora leaf spot on faba beans continued to increase in incidence and spread over the three years of the project, spreading to Victoria and Western Australia. Stem and pod lesions were noted for the first time in 2004. Rohan Kimber, SARDI, has begun studies on the epidemiology of this disease and early results suggest a yield loss between 7-11% and a linkage with crop rotation. A trial in 2005 found that carbendazim# is able to reduce disease levels, while chlorothalonil# has lower activity. The pathogen seems to have a short dispersal range and is more prevalent in paddocks with a three or four-year rotation of faba beans.

Bacterial blight on field peas was a sporadic problem in SA, Victoria and NSW, particularly in frost prone areas, and seemingly was more severe on Kaspa⦶ and other semi-leafless types. Bacterial isolates from SA were sent to Dr. Helen Richardson, Horsham DPI-Vic, as part of her research project on this disease. Dr. Richardson also provided specific races of the pathogen to SARDI to use in glasshouse resistance screening. A meeting attended by researchers from SARDI, DPI-Vic, and DPI-NSW, was held at Wagga Wagga NSW in Sep 2005 to coordinate the resistance-breeding and disease-management research for this disease across the southern region.

Trap plants

Trap plants - faba beans, lentil, field pea and chickpea seedlings - were grown at a number of sites over the three years of the project and weather data recording using automatic weather stations with the aim of determining key environmental conditions associated with aerial spore release of pathogens. It is assumed that the number of lesions on the seedlings in the traps represents the number of airborne infective propagules of the relevant pathogens. Since the methodology depends on using live plants, this data can only be collected over the growing season when rainfall and air temperatures permit the seedlings to stay alive. The spread of infective propagules over the dry, hot months from November to April is not recorded in this system.

Large numbers of blackspot lesions on field peas were detected each year, including in the autumn of 2003 following the drought of 2002. This suggests that a drought is no protection against inoculum for the following year. Blackspot data for the three years has been sent to Dr. Moin Salam, DAFWA, to compare with results from the blackspot spore maturation model he has developed using WA data. Early results suggest that the data fits the model and a national monitoring system of blackspot maturation has been proposed. This will enable identification of preferred sowing dates on an annual basis to avoid peak ascospore showers. Low blackspot numbers were detected in the autumn of 2005 and the model indicated that this was due to summer rains that had depleted the inoculum reservoir. The model would have predicted this at the time of summer rains and growers could have been informed that early sowing was feasible in 2005 to maximise yields without risking severe blackspot infection. A similar national monitoring system is proposed for *A. rabiei* of chickpeas, to focus on the detection and potential role of ascospores in spread of ascochyta blight on chickpeas.

This set of trap plant did not detect any lesions of *A. rabiei* suggesting that at this stage ascospores are not an integral part of the epidemiology of this disease in SA. However ascospores have been detected on stubble from WA, Vic and southern Queensland and these may become more important as the pathogen adapts to the environment. No *A. lentis* was detected in the traps despite adjacent infected stubble in at least one site. Ascospores of this pathogen are known to exist in Australia, but spread of these spores has been shown to be limited to below 50m. The trap results suggest that stubble-borne inoculum is more of a problem as in situ inoculum rather than spreading to nearby paddocks and rotations will remain an integral part of controlling this disease. Similarly, very few *Cercosopora zonata* lesions were detected in the trap plants, despite adjacent infected stubble. This accords with trial data that the spores do not spread very far and that, as with *A. lentis*, *in situ* inoculum is more important than aerial spread. Trap plant data on faba beans indicates that ascospore maturation for *A. fabae* occurs later than for *M. pinodes* (blackspot), so delayed sowing of faba beans to avoid initial inoculum is not a possibility. Studies to model this pathogen would assist in targeting fungicides based on peak spore showers rather than using a calendar-based system as currently occurs.

Detection of downy mildew on field peas in many of the trap plants indicates this pathogen is widespread over the agronomic area of SA and that infection is dependent upon environmental conditions at the time of crop emergence. Powdery mildew on field peas was only detected in one season when temperatures were above 22C, in the presence of 13-19mm rain per week. Other seasons were too dry for this disease to develop, though in late spring of 2005 heavy rain (> 30mm) fell in temperatures above 20C. Heavy rain is known to wash conidia of this pathogen off of plants and it was concluded this happened in 2005.

Bacterial blight was detected on one set of trap plants in a week that suffered conditions of heavy rain and freezing temperatures providing further evidence of the importance of frost in this disease. Very few Botrytis species were detected in the trap plant system, despite the presence of infection in nearby crops, and the airborne nature of the spores. This suggests that the trap plant methodology does not suit this particular genus. A PhD study has been funded through the CRC National Plant Biosecurity to detect airborne spores in Burkard spores traps, using DNA assays to identify and quantify the pathogens. It is expected that eventually the spore trap system will replace trap plants and allow monitoring to be conducted all year round, and in remote locations.

<u>Virus surveys</u>

A survey was conducted across SA pulse crops in October each year, in association with Dr Mohammad Aftab, virologist DPI-Vic, to identify the prevalence and severity of virus infection in pulse crops across the region. Cucumber Mosaic Virus (CMV) was found in the majority of lentil crops, though at low levels in 2003 and 2004. Bean Leaf Roll Virus (BLRV) and Beet Western Yellows Virus (BWYV) were found in beans, peas, and lentils, in some cases the infection level in the crop was as high as 27%, which was damaging to yield. Following the heavy spring rains of October 2005, extensive aphid numbers led to severe virus infection (Alfalfa Mosaic Virus (AMV), CMV, BWYV and BLRV) in lupin and lentil crops in the upper south east of SA, leading to high yield losses. Discussions will be conducted with Dr. Angela Freeman and Dr. Mohammed Aftab, virologists, DPI-Vic, with respect to management of crops to minimise viral infection.

<u>Botrytis in lentils</u>

Surveys of the lentil crops across SA were conducted in association with Mr Kurt Lindbeck, lentil pathologist, DPI-Vic, to collect samples of Botrytis pathogens causing Botrytis Grey Mould (BGM). Very few epidemics of this disease developed over the three year period of this project due to the relatively dry springs, but isolates that were collected have been included in a molecular variability study as part of Mr. Lindbeck's PhD study. Both *B. fabae* and *B. cinerea* were isolated and it is assumed that both these species are causal agents of BGM, unlike other countries where only *B. cinerea* has been implicated. This difference is probably due to the inclusion of faba beans (host of *B. fabae*) in the cropping rotation. The current management of BGM in lentils includes a pre-canopy closure spray of fungicide to ensure coverage of the foliage. Studies on the timing of canopy closure were conducted to assist with the correct timing of this spray, as it had been observed that a number of growers were applying this fungicide far too early. Lentil crops sown in early to mid June (with 7" row spacing) were found to close canopies in the first week of September, indicating that the spray should be applied in last week of August, while those sown late June, closed over in the second week of September. May sown crops also closed over in the first week of September, but crops should be monitored through August to ensure this does not happen earlier. July sown crops did not reach canopy closure, so do not require the pre canopy closure spray, but since this late sowing reduces yield, it is not a practice that is likely to be widespread. A meeting of the Australian pulse pathologists was conducted at Horsham, DPI-Victoria, September 2004, to discuss and share information on the research being conducted in Australia on botrytis disease of pulse crops.

<u>Pathogen carryover</u>

Carryover of *A. lentis* and *A. fabae* on seed was investigated in glasshouse trials. Seeds of the susceptible lentil cultivar, Cumra $^{\Phi}$ with 60% ascochyta infection, were sown into potting soil and grown in the glasshouse for six weeks. No disease appeared on the seedlings. Overseas data (Gossen and Morrall 1986, Canadian Journal of Plant Pathology 8: 28-32) indicates that seed to seedling transmission is reliant upon low temperatures that were not available in this test. Seed to seedling transmission of *A. fabae* was recorded as 10% when seed had extremely high infection levels (recorded as 5 on 1-5 scale) and 2% when seed infection was moderate (rated as 4). Low seed infection (rated as 3) led to zero transmission of the disease. Farmers would reject seeds with severe ascochyta infection, so the study suggests that seed infection is unlikely to initiate ascochyta epidemics. Laboratory tests on lentil seed collected from 2002 and 2003 season have found that the dry growing seasons have negated any seed transmission of BGM. Further studies on the survival and carryover of pulse pathogens on seed, stubble and in soil are planned following the development of DNA assays for pulse pathogens to enhance this work. A project has been funded by South Australian Grains Industry Trust (SAGIT) to develop DNA assays for pulse pathogens, initially concentrating on *Cercospora zonata* and *Phoma X*.

Other research

1. The trap plant system was used to estimate aerial dispersal of pathogens. It is assumed that the number of lesions on the seedlings in the traps represents the number of airborne infective propagules of the relevant pathogens. Since the methodology depends on using live plants, these data can only be collected over the growing season when rainfall and air temperatures permit the seedlings to stay alive. The spread of infective propagules over the dry, hot months from November to April is not recorded in this system. A PhD has been funded by CRC National Plant Biosecurity to develop PCR methods to identify airborne pathogen spores that are trapped using Burkard Spore traps. The trap plants will be run in conjunction with Burkard spore traps while the method is being developed. This system will allow spore traps to be run over all seasons and in remote locations for epidemiology and biosecurity studies.

2. Studies in Israel by Shtienberg *et al* (2000) found that ascochyta blight of chickpea could be managed by integration of genotype resistance and application of fungicides. Dr Shtienberg proposed this concept for Australian chickpeas while on sabbatical at the Waite Campus in 2004-2005, with Dr Eileen Scott (University of Adelaide) and Jenny Davidson (SARDI). Fungicides are applied ahead of forecasts of specific rainfall amounts i.e. 10mm for susceptible varieties, 20mm for moderately resistant and 50mm for resistant cultivars. These figures were devised by measuring disease spread in field conditions. It is proposed that epidemics in naturally or artificially infected breeding or agronomy trials of chickpeas and faba beans could generate similar epidemiological data to determine fungicide applications in Australian conditions.

Similarly, environmental data during spring has been linked to outbreaks of Botrytis grey mould in lentils and a conference paper on this was delivered by Ms. Davidson to APPS in Geelong 2005. The model provides a starting point to develop early warning systems for botrytis diseases of both lentils and faba beans. Data from breeding and agronomy trials in SA and Victoria will continue to be collected to further develop this concept.

3. Surveys of breeders' plots and commercial crops identified *Cercospora zonata* on faba beans as widespread and occurring with increasing severity across the SA, Vic and WA. Funding was initially made available through the Faba Bean Breeding Program for Rohan Kimber (SARDI) to investigate this disease and subsequent funding has been made available through the

GRDC funded project 'Pathology in Pulse Crops in the Southern Regions-SA module'.

Additional information is provided as an attachment to this project:

- **Attachment DAS41 Pathology support for pulse crops in the southern region_SA module**

Aerial dispersal of ascochyta spores from infested pea stubble