FINAL REPORT

GRDC Grains Research & Development Corporation

Northern Integrated Disease Management + extension

DAQ00154

Project Details

- **Project Code:** DAQ00154
- **Project Title:** Northern Integrated Disease Management + extension
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Summary

Diseases have considerable impact on field crops in the GRDC northern region. The outputs from this project have resulted in significant contributions to the profitability and sustainability of farming enterprises in the region. They have been achieved by conducting targeted research and development (R&D) on the integrated management of important diseases of field crops, by gathering crop disease intelligence through surveys, diagnostic services and adviser networks, by responding in a timely and appropriate manner to significant disease outbreaks and by the extension of information to clients through electronic and print media and presentations at training courses, meetings and seminars.

Conclusions

Identification of pathogens: during this project significant contributions were made to the identification of causal species and pathotypes responsible for several significant diseases of northern region crops. Molecular techniques were used to identify the *Fusarium*, *Phomopsis* and *Botryosphaeria* species, and in the future there will be increasing reliance on this technology for species identification.

Resistance to pathogens: germplasm with improved resistance was identified in sorghum (*Fusarium* stalk rot and head blight), mungbeans (powdery mildew, tan spot, halo blight), sunflowers (*Phomopsis* stem canker), peanuts (leaf diseases), chickpea (*Phytophthora* root rot), and winter cereals and chickpea (*Pratylenchus* species). Many of these activities were conducted with the relevant national crop improvement teams, relationships that must be encouraged and maintained. Resistance could not be found in peanut germplasm to the emerging pathogen *Neocosmospora vasinfecta*.
Fungicides: the targeted use of efficacious fungicides remains an important component of IDM practices. The project identified new fungicides and/or the best time to apply fungicides for the following host-pathogen combinations—sunflower powdery mildew, mungbean powdery mildew and wheat stripe rust. However, in a climate of diminishing resources government agencies should limit their input in this area to providing data on the efficacy of new fungicides and identifying appropriate strategies, and not providing additional information for registration.

Agronomy: during the project, the Leslie Research Facility nematology group built on their previous findings (beginning in 1975) on rotational and varietal impacts on root lesion nematodes (RLN) (particularly *Pratylenchus thornei*). The incorporation of the group's activities into the national nematode program is welcomed.

Research conducted during this project resulted in the identification of over 15 new species of *Diaporthe*/*Phomopsis* on sunflowers, soybeans, mungbeans, maize and many common weeds. Some species were found on live and/or dead plants of many plant species. For example, *D. gulyae* is pathogenic on live sunflowers and soybeans but was also found on live and/or dead plants of maize and at least seven weed species across the northern region. These findings have significant implications for *Diaporthe* and similar pathogens which are known to have a saprophytic phase (e.g., *Fusarium* species) in northern farming systems, namely the role of stubble of ‘non-host’ plant species in survival and the real impact of crop sequences in management of such diseases.

Diagnostics, surveys and responses to outbreaks: during the project several new plant pathogen records for Queensland (QLD) and Australia more generally, were established—phasey bean virus, which can infect chickpeas and other crops, *Olpidium,* a vector of a plant virus on barley, and powdery mildew of soybeans. These discoveries were made during crop surveys and diagnostic activities, demonstrating their importance. Senior project staff (Drs Malcolm Ryley and Stephen Neate) led responses to eight large outbreaks of diseases on a variety of crops in the northern region, necessitating significant time inputs which impacted on other project activities. Diagnostic skills and the capacity to respond are dependent on competent and experienced staff, of which there is a shortage at present.

Recommendations

Future plant pathology capacity: tertiary students displaying a focussed interest in plant pathology and a good work ethic need to be identified early and encouraged to pursue a career in plant pathology, by providing more scholarships or other forms of support by governments, universities and funding bodies. Once these future pathologists are identified they need to be provided with mentors and also receive accelerated training in relevant national and international institutions and laboratories. Governments and universities also need to retain outstanding plant pathologists by rewarding excellence in performance through targeted promotion and access to international placements and conferences.

Relationships with other disciplines: advances in the identification of germplasm with improved resistance to significant pathogens have been achieved in this project through collaborations with personnel in public and private breeding programs. Also, the project had very close collaboration with mycologists (especially Dr Roger Shivas) and molecular biologists (e.g. Ms Yu-Pei Tan) within the Department of Fisheries and Forestry (DAFF) Queensland to identify species of *Fusarium*, *Diaporthe* and *Botryosphaeria*. These collaborations are vitally important and need to be maintained in future plant pathology projects. Young plant pathologists should be encouraged to establish formal col-

laborative relationships, including an allocation of time input into relevant breeding programs and molecular and traditional identification activities.
Fungicides: in an era of increasing focus on fungicide safety and residues, a co-ordinated national program for the identification of new efficacious fungicides, similar to that conducted for the control of ascochyta blight of chickpea after the 2010 season, is warranted. However, the program should focus entirely on the identification of new effective fungicides and strategic spray strategies, not generate additional data for registration (an activity for private business).

Diagnostics and plant pathogen records: currently in Australia there are many plant disease databases used for specimen tracking, and/or the recording of the presence/absence of crop diseases. A national, coordinated diagnostic management system needs to be established to ensure that such records can be shared between states and the Australian government agencies. This system would be supported by a single online database for specimen tracking and disease outbreaks (including non-occurrence), online mapping capacity, remote microscope diagnostics, handheld data capture technology and other technologies such as remote sensing using satellites and drones.

Outcomes

Economic benefits: it has been estimated that savings of over $1.25 million will be made in fungicide savings alone by reducing the number of sprays from two to one and by using more resistant varieties to manage the powdery mildew diseases mungbean and sunflower, and stripe rust of wheat. This figure assumes 50% adoption over the next five years, and in the case of wheat, 20% of the area in the northern region being grown to varieties with moderate susceptibility (MS) or lower resistance to stripe rust. With contributions from rotations for RLN (particularly *P. thornei*) and other soilborne pathogens, and from improved resistance in mungbeans, peanuts have been estimated at well over $20 million.
Environmental benefits: R&D activities during this project and the extension of the findings to growers has had, and will have, significant environmental outcomes through the targeted and strategic use of fungicides for management of diseases, including the powdery mildew pathogens of sunflower and mungbean and stripe rust of wheat. Reduced and strategic fungicide usage results in fewer chemical residues in the environment and reduces the risk of fungicide contamination of harvested seed. In addition, a focus on other management options, including the identification of germplasm with high levels of resistance or tolerance to significant pathogens of mungbean, chickpea, sunflower, peanut and other field crops, and the role of rotations in minimising the impacts of RLN, further reduces the detrimental impacts of pesticides.

Social benefits: extension activities conducted by staff over the life of the project have built the capacity of advisers, growers and other agriculture industry personnel to better understand the causes, biology and management of major diseases of summer and winter field crops in the northern region. Over 130 presentations were made to a wide audience of clients at grower meetings, field days, GRDC updates and training courses, with the focus of all being the integrated management of field crop diseases. Disease modules were developed and delivered at 26 training courses, empowering 195 participants at sunflower courses, 139 at mungbean courses, 120 at winter cereal foliar disease workshops, 72 at soybeans course and 49 at chickpea courses. These courses were facilitated by Pulse Australia, the Australian Oilseeds Federation (AOF) and GRDC.

Achievement/Benefit

Wheat, sorghum, pulses (chickpea, peanut and mungbean) and sunflowers are important components of the GRDC northern region farming systems, with a combined farmgate value of well over $1 billion pa. The first two crops are the mainstays of these systems, with pulses and sunflowers not only providing niche opportunities but also being break crops with significant impacts on soil nutrition and biology. Diseases of these crops have considerable impacts on crop profitability and farm enterprise sustainability.
This project has focussed on a) the development and extension of Integrated Disease Management (IDM) packages for key diseases of major grain, pulse and oilseed crops; b) the surveillance for endemic and exotic plant pathogens, through targeted surveys, diagnostic activities and adviser networks; and c) the rapid response to significant disease outbreaks in the GRDC northern region. Project staff have diagnosed the causes of disorders on over 1,500 submitted plant samples, identified and quantified nematodes in over 3,000 soil samples and provided relevant and timely

information on identification and management to clients. These diagnostic activities, together with crop surveys and information from grower and adviser networks, have enabled rapid and appropriate responses to eight significant endemic disease outbreaks in the northern region during this project.
Project staff provided support for pulse and wheat breeding and pre-breeding programs through the development of reliable and innovative germplasm screening techniques for rust and leaf spot pathogens of peanut, the halo blight pathogen of mungbean (*Pseudomonas savastanoi pv. phaseolicola*), *Fusarium* species causing stalk rot and head blight on grain *sorghum*, *Phomopsis* species causing stem canker on sunflower, and the white grain pathogen (*Botryosphaeria* spp.) on winter cereals. Peanut, mungbean, sorghum and sunflower germplasm with high levels of resistance to these respective pathogens have been identified and are being used in national improvement programs.
In collaboration with the New South Wales Department of Primary Industries (NSWDPI), the relative resistances of chickpea varieties and selected breeding lines to the *Phytophthora* root rot pathogen (*Phytophthora medicaginis*) have been quantified in field trials.
New species and pathotypes of important pathogens were discovered during the project, including a) three new species of *Phomopsis* on sunflower, with several more species soon to be described; b) phasey bean virus on chickpea and other hosts (first world record); c) *Polymyxa graminis*, a vector for several exotic cereal viruses (first record in Australia);d) the soybean powdery mildew pathogen *Erisyphe diffusa* (first record in Australia); and e) a new pathotype of the mungbean halo blight pathogen (first record in Australia). The incidence and distribution of *Fusarium* species responsible for stalk rot and head blight of sorghum in the GRDC northern region was also elucidated. Trials identified the best time for application(s) of fungicide sprays for the management of rust diseases of wheat, and for the powdery mildew pathogens of sunflower and mungbean. In rotation trials, wheat, barley, chickpea, faba bean, soybean and mungbean caused RLN populations (*P. thornei*) to increase, resulting in yield losses in intolerant wheat varieties the following year. Also varieties and breeding lines of these crops varied in their resistance to *P. thornei*. The importance of choosing a crop sequence that will reduce the impact of RLN on susceptible crops and varieties was demonstrated. Research found that many *Phomopsis* species have a wide host range, including field crops and weeds, and that species could colonise dead plant residues. This finding may have implications for the effectiveness of crop rotations and weed management in control of *Phomopsis* and other stubble-borne pathogens such as *Fusarium* species, in the region.
Results from our R&D activities were incorporated into IDM packages and extended to clients in over 130 presentations at field days, conferences, GRDC updates and other forums, and over 170 publications in the print and electronic media. Project staff provided training in disease identification and management to over 570 advisers and growers at 24 industry-facilitated agronomy courses on sunflower, mungbean, chickpea, soybean and winter cereals in the northern region. This empowered the clients with the latest information on IDM for these crops.

Other Research

The finding of *Diaporthe*/*Phomopsis* species on live and dead plants of known hosts and on plant species not considered to be hosts (‘non-hosts’) may have significant implications on northern region farming systems. Several other genera of plant pathogens, including *Fusarium* which causes serious losses in many crops - crown rot (CR) and head blight in winter cereals, stalk rot and head blight in sorghum, ear rot and stalk rot in maize, and newly emerged root rot of mungbeans - and *Neocosmospora*, a newly emerged pathogen of the roots of peanuts, also have saprophytic phases. The ability of some of these species to invade the stubble of non-hosts has been established, but the importance of this colonisation in their epidemiology has not been studied. It is very possible that the impact on crop sequences has been underestimated. Consequently, an understanding of the colonisation of stubble by such pathogens, their survival in stubble and the roles they play in the infection of crop plants needs urgent investigation. In DAQ00186, project staff will investigate these aspects of epidemiology for *Diaporthe*/*Phomopsis* on sunflower, soybeans and other crops, *Fusarium* species on sorghum and *N. vasinfecta* on peanuts.

The formation of multi-discipline teams including agronomists, breeders, crop protectionists, plant physiologists and extension specialists using expertise from government, universities and private businesses to focus on farming systems R&D needs to be considered. Currently, farming system groups are primarily focussed on agronomic issues, while crop protection issues are addressed almost exclusively by the relevant discipline. A whole of farming system approach needs to be taken, particularly in light of the initial findings of the role of non-host stubble of weeds and crops in the survival of some types of plant pathogens. Investigations on the role of strategic tillage in the manage-

ment of stubble-borne diseases, soil-borne insects and weeds would be an important priority of these multidisciplinary teams.

Intellectual Property Summary

Collaboration Organisations

International collaboration during this project was primarily in the area of sunflower pathology conducted by Ms Sue Thompson, Plant Pathologist. Activities in this area included:
1. Exchange of information and images for diagnosis -Dr Tom Gulya, USDA, Fargo, North Dakota USA, Dr Rikus Kloppers, Pannar Seeds, South Africa, Dr Misirovic, Yugoslavia
2. Study tour -Ms Thompson had a two week visit to Dr Tom Gulya in North Dakota in September–October 2011, funded primarily by the Australian Oilseeds Federation (AOF) where she assisted with rating entries in six *Phomopsis* and *Sclerotinia* field trials across North and South Dakota and Minnesota, delivered two oral presentations on her R&D activities in Australia, had two-way information meetings with other pathologists, breeders and personnel involved in the American sunflower industry about *Phomopsis* stem canker and other diseases, and learnt techniques to identify resistance and pathotypes of sunflower downy mildew, which is exotic to Australia.
3. 18th International Sunflower Conference, Argentina - in recognition of her work on *Diaporthe*/*Phomopsis* species, Ms Thompson was invited to present an oral presentation at the 18th International Sunflower Conference, Argentina in February 2012.
4. APS Compendium of Sunflower Disorders - Ms Thompson has been invited to contribute to the planned APS Compendium of Sunflower Disorders, due to be published in 2014.

Additional Information

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