FINAL REPORT

GRDC Grains Research & Development Corporation

Cropping options to limit root-lesion nematodes

DAQ00107

Project Details

- **Project Code:** DAQ00107
- **Project Title:** Cropping options to limit root-lesion nematodes
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Summary

Australia's northern grain-producing region is unique in that the root-lesion nematode (RLN), *Pratylenchus thornei* predominates. *P. neglectus* is also present. RLN cause substantial yield losses, particularly in wheat, but they reproduce on numerous summer and winter crops. Each nematode species prefers different crops and varieties. This project provides growers with a range of integrated management strategies to limit RLN (i.e. identify the problem, protect uninfested fields, rotate with resistant crops to keep populations low and choose tolerant crops to maximise yields). It also provides new information about soil-borne zoosporic fungi in the region.

Conclusions

The management strategies for limiting RLN developed in this project are effective and useful. The outcomes provide economic gains in terms of increased yields and are environmentally benign.

Crop losses due to RLN can be minimised by keeping nematode populations at low levels. This can be achieved by careful selection of resistant rotation crops and growing tolerant varieties of susceptible crops such as wheat and chickpea. Making successful management decisions relies on firstly knowing which fields are infested. Efforts can then be made to protect uninfested areas by cleaning farm machinery and limiting water run-off from infested areas to uninfested areas in infected fields. Identifying nematodes to a species level and determining the population size is necessary for correct crop and variety choice.

Glasshouse methods used for screening crops for resistance/susceptibility to RLN provide useful data that can be transferred successfully to the field. Our field work has provided valuable data for long-term rankings on crop tolerance to RLN. Although several field trials were hampered by very dry seasonal conditions early in the project, they provided a good demonstration of the remarkable survival of RLN and their ability to reproduce rapidly as soon as good seasonal conditions returned. RLN are persistent and resilient pests.

We have gained new knowledge about the presence of soil-borne zoosporic fungi such as *Pythium*, *Olpidium* and *Polymyxa* in the northern grain region. Winter cereals grew significantly better in pasteurised soil and results indicated an association between the presence of the stunt nematode (*Merlinius brevidens)* and increased infection of roots by zoosporic fungi. *Olpidium* and *Polymyxa* cause zoosporic root-rot and can transmit viruses. Their resting spores can survive for long periods, so being aware of their presence in the Northern Region (NR) and their potential to cause crop losses in winter cereals is important. Ongoing experiments will further investigate the impact of controlling the stunt nematode and zoosporic fungi on crop growth.

Delivery and extension of the management strategies for RLN to the grower community and scientific community are important for raising awareness and making informed management decisions.

Recommendations

Continuing to raise the awareness of the presence of and potential economic losses due to RLN in the northern grain region is critical. Further extension activities will be addressed in the new GRDC-funded Northern Integrated Disease Management project (DAQ154). Extension will need to be ongoing for the successful implementation of management strategies developed in this project.

Fostering good networks with advisers and researchers in the NR and beyond, particularly with increased interest in wheat production in northern Queensland, is recommended. These networks, combined with surveys, will allow us to respond to emerging diseases and conduct targeted research. Our ‘Test your farm for nematodes’ service provides an ideal point of contact with the grower community in the region.

Further research is needed on the presence of *Olpidium* and *Polymyxa* in cereal roots and the potential for interactions with nematodes in the northern grain region. Raising awareness in the community about these fungi and their potential for transmission of viruses that infect winter cereals is essential. These issues will be addressed in the follow-on project DAQ154

Ongoing screening of current and new varieties of crops that are susceptible to RLN is needed. We recommend regular publication of up-to-date information about the best varieties to choose for management of RLN. This screening should continue with input from crop breeders.

In a similar vein, we need to determinine the hosting ability of crops grown in the NR to the stunt nematode and the stubby-root nematodes (*Paratrichodorus sp.*). Once again this work will be captured in the DAQ154 project.

Research seeking and integrating resistance to RLN in wheat and chickpea is needed. Taking a leadership role in this area of research will have national significance and strong international appeal.

Outcomes

Economic benefits

RLN cost growers in the northern grain region $69 million p.a. in lost wheat yields and there are additional losses in intolerant crops such as chickpea (up to 20% yield loss) and mungbeans. RLN are distributed widely throughout the northern grain region. They have a broad host range and an excellent mechanism for survival between crops and in drought, making eradication of these pests unlikely.

We have identified resistant summer and winter crops that restrict RLN multiplication leading to lower populations, thereby limiting damage to subsequent crops. When these resistant crops are grown in rotation with wheat, yields and profit margins can be increased considerably.

Environmental benefits

Management of RLN requires an integrated approach involving careful selection of resistant crops to reduce populations, choosing tolerant crops that will yield well despite the presence of RLN and preventing spread of the nematodes to uninfested paddocks by cleaning machinery and controlling water run-off from infested to uninfested areas. These strategies offer sound, environmentally benign tools for growers.

There are currently no nematicides registered for use in cereals in the northern grain region. Nematicides are highly toxic and offer only partial control of RLN because the nematodes are often found deep in the soil profile where chemicals cannot penetrate. Reducing RLN damage to plant roots means plants use soil nutrients and water more efficiently. Careful selection of rotation crops will maintain beneficial soil organisms such as mycorrhiza.

Achievement/Benefit

Background

Root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*) are widespread in soils across the northern grain region and cause substantial yield losses in susceptible crops such as wheat and chickpea. However, RLN have a broad host range and each species of nematode will attack different crops and even different varieties within those crops.

Our broad aim for the ‘Cropping options’ project was to provide management strategies for RLN in the NR. We did this through experiments in the field and glasshouse in tandem with delivery of this knowledge to our peers in science, plant breeders and the farming community of the northern grain region. A third output responded to concerns raised by our adviser and grower networks in the region about poor growth of winter cereals. These concerns prompted us to investigate the presence and interaction of some soil-borne fungi and nematodes and led to the identification of several soil-borne fungi not previously recorded in the region. Additionally a new nematode pathogen was identified in the region.

Major achievements

- Management of RLN in the northern grain region.

There are no nematicides registered for use for control of RLN and chemical control is often ineffective for nematode eradication, and unsafe and harmful to the environment. Therefore, management depends on:

- knowing which nematode species are present
- protecting ‘clean’ fields from contamination
- growing tolerant varieties of susceptible crops so yields are maximised
- rotating with resistant crops to reduce nematode populations.

Multiple opportunities for communication of these management options were sought throughout the project and culminated with the production of a comprehensive Queensland Primary Industries and Fisheries (QPIF) information brochure on RLN.

In order to address the first stage of RLN management, our group provides a nematode identification service. The benefits of this service are numerous providing excellent networks with advisers and growers in the region, particularly in identifying and addressing new problems (see sections below on interactions and new threats). It also helped confirm the ongoing threat of RLN within the NR.

Crop tolerance, or the ability of a crop to yield well despite the presence of RLN, has been an integral part of the project and an important management tool.

The tolerance of several varieties of wheat, chickpea, mungbean, barley and sorghum has been tested in the field at our *P. thornei* and *P. neglectus* sites. Although crop growth and nematode populations were severely restricted by dry seasonal conditions during the project, the growth of varieties of these crops on nematode-infested land has contributed to our long-term resistance and tolerance rankings for these varieties.

The survival of the nematodes in the dry conditions and the rapid increase in populations when conditions improved was remarkable. In 2008, seasonal conditions were reasonable and we conducted successful barley, chickpea, mungbean and sorghum field trials. We identified a broad range of varietal responses from these experiments. A nematicide trial at our *P. thornei* site demonstrated mungbean grain yield increases of up to 30 per cent from control of the pest.

The benefits to the industry from our tolerance research are economic gains. If RLN are present, we have identified which varieties will continue to yield well.

Crop resistance, or the ability of a crop to reduce nematode reproduction, was another important part of the project. In glasshouse experiments we screened commercial, advanced lines, and for some crops parental lines, of mungbean, sorghum, faba bean and barley for resistance to *P. thornei* and *P. neglectus*. We confirmed previous findings of the contrasting responses to each nematode species. For example, sorghum is resistant to *P. thornei* but susceptible to *P. neglectus*; mungbean and faba bean are susceptible to *P. thornei* but resistant to *P. neglectus,* and barley was moderately resistant to moderately susceptible to *P. thornei* and *P. neglectus*. These resistance experiments also demonstrated the large range of susceptibility within crops, even for barley, providing an additional benefit from this work.

The economic benefits to industry from our resistance experiments are realised when growers choose the most resistant crop variety to rotate with valuable but susceptible crops such as wheat. These resistant crops will reduce RLN populations to below economic thresholds for damage. Growing resistant crops has long-term benefits to the environment because it is superior (in terms of efficacy and safety) to chemical control.

In the tolerance and resistance experiments, we discussed our experimental set-up with relevant plant breeders to ensure we were testing the current cultivars, long-term controls and parental lines.

Delivery to our scientific peers, crop breeders, growers and advisers in the northern grain region were key outputs throughout the project. The knowledge we gained from our experiments and surveys was published widely. We publisjhed six manuscripts in peer-reviewed journals (with two more currently under review and another in preparation) with a highlight being an invited review article on nematodes in the northern grain region for a special edition of Australasian Plant Pathology that was released to coincide with the International Congress of Nematology in Brisbane 2008. Six conference abstracts for poster and oral presentations were published. During the Nematology Congress in 2008, international and national nematologists toured our *P. thornei* field site and gained an informative insight into our nematology work.

Our interactions with breeders, within QPIF and nationally, on crops that were a focus within the project were both positive and rewarding and included two publications with faba bean breeders, Jeff Paull from the University of Adelaide and Ian Rose, of CSIRO. Many breeders were surprised at the extent of susceptibility of ‘their’ crops but were encouraged by the range of responses when several varieties were tested.

Delivery of information to growers and advisers specifically in the NR was achieved through diverse media outlets. Highlights included very well-received presentations at the GRDC Northern Adviser Update in 2008, several articles in Ground Cover, preparation of a GRDC Fact Sheet in July 2009 and a comprehensive QPIF brochure on RLN management launched at a Nematode Field Day in mid-September 2009.

- Fungal/Nematode interactions survey and glasshouse experiment

We conducted a targeted survey of nine farms in the northern grain region to gain knowledge about the presence of the stunt nematode and zoosporic fungi such as *Olpidium* (zoosporic fungi are characterised by the production of spores called zoospores which have flagella and are motile in water). Reports in the literature suggested an interaction between these nematodes and fungi and we had been contacted by growers and advisers who had reported poor growth of winter cereals for which no obvious cause could be found. The survey confirmed the wide distribution of RLN and the stunt nematode. Zoosporic fungi such as *Olpidium* and *Pythium* were identified.

We conducted an experiment with pasteurised and non-pasteurised soil from the farms surveyed at two water tensions (to determine the effect of soil moisture) with wheat, oats and barley. There was a large growth response to soil pasteurisation in soil from seven of the nine farms (see 2009 Conference Abstract attachment).

Root-lesion and stunt nematodes were present in unsterilised soil and the zoosporic fungi *Olpidium*, *Pythium, Polymyxa* (a new report for the region) and mycorrhizae were observed in roots. *Polymyxa graminis* has been putatively identified in one sample by the presence of characteristic resting spore balls and we are expecting the results of species identification shortly. Infection of roots with the fungi was greater at eight weeks growth if the stunt nematode was present. Wetter soil had greater populations of fungi and nematodes.

Polymyxa and *Olpidium* both produce resting spores that survive for long periods in soil. *Olpidium* can transmit viruses in broad-leafed crops and *Polymyxa graminis* can transmit a range of viruses including soil-borne wheat mosaic virus, wheat spindle streak mosaic virus and barley yellow mosaic virus. We have not observed symptoms of viral infection in the field or glasshouse, but being aware of the potential for viral transmission by these organisms is important for safe-guarding crops. No viral particles were detected in electron microscopy in one barley crop with *Polymyxa* in its roots.

This experiment has revealed a complex interaction between nematodes and zoosporic fungi that will be further assessed in the GRDC-funded project, Northern Integrated Disease management (DAQ154).

- New nematode threat?

The stubby-root nematode was identified in a soil sample from a barley crop sent to our testing service from a western area of the northern grain region. This is a new report of this pathogen in the NR and it has the potential to cause substantial damage to winter cereals. Further research will be carried out in the follow-on project DAQ154.

Other Research

Following the identification of high populations of the stunt nematode associated with poor growth of winter cereals in soil samples submitted by growers and advisors in the NR, an E-concept was submitted to GRDC in 2008 to investigate this further. Aspects of the E-concept will be captured in the nematode program of the DAQ154 project which began in July 2009.

In 2008 and in 2009, we provided nematode expertise to the Northern Grower Alliance. We advised the group on wheat tolerance to RLN for field trials in northern New South Wales and assessed their field sites for nematode populations.

Also in 2008 and 2009, we provided nematology expertise to Dr Phil Banks, QPIF, on the GRDC-funded project ‘Adaptation of cereals to north and coastal Queensland’ (DAQ140) by characterising field sites for nematode populations in northern Queensland.

In addition, we have established a relationship with Dr Mike Hodda, a nematology taxonomist, CSIRO Canberra, with a view to further collaboration in the nematology program of DAQ154 project. Dr Hodda's expertise in nematode identification, particularly to species level, will be important in survey work.

Additional Information

Additional information is provided as an attachment to this project:

- Attachment DAQ00107 - conference abstracts