Department of Primary Industries
Department of Regional NSW

NSW research results

RESEARCH & DEVELOPMENT – INDEPENDENT RESEARCH FOR INDUSTRY

The following paper is from an edition of the Northern or Southern New South Wales research results book.

Published annually since 2012, these books contain a collection of papers that provide an insight into selected research and development activities undertaken by NSW DPI in northern and southern NSW.

Not all papers will be accessible to readers with limited vision.
For help, please contact: Carey Martin at carey.martin@dpi.nsw.gov.au

©State of NSW through the Department of Regional New South Wales, 2023

Published by NSW Department of Primary Industries,
a part of the Department of Regional New South Wales.

You may copy, distribute, display, download and otherwise freely deal with this publication for any purpose, provided that you attribute the Department of Regional New South Wales as the owner. However, you must obtain permission if you wish to charge others for access to the publication (other than at cost); include the publication advertising or a product for sale; modify the publication; or republish the publication on a website. You may freely link to the publication on a departmental website.

Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing. However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Regional New South Wales or the user's independent adviser.

Any product trade names are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product name does not imply endorsement by the department over any equivalent product from another manufacturer.

The impact of waterlogging on phytophthora root rot resistance in chickpea

Nicole Dron[1], Sean Bithell[1], Tim Sutton[2,3] and Kristy Hobson[1]

[1] NSW DPI Tamworth

[2] South Australian Research and Development Institute, Adelaide SA

[3] School of Agriculture, Food and Wine, University of Adelaide, SA

Key findings

- The level of waterlogging tolerance in Pulse Breeding Australia (PBA) chickpea material is minimal.
- A source of phytophthora root rot (PRR) resistance in the wild *Cicer* backcross 04067-81-2-1-1(B) has positive waterlogging tolerance and outperformed the moderately resistant variety Yorker$^{(P)}$ and the susceptible Rupali$^{(P)}$ following two days of waterlogging and *Phytophthora* in combination.
- In the presence of PRR (*Phytophthora medicaginis*), inoculum dry root weight decreased in the wild *Cicer* backcross by 26% (93.7 mg) after incurring an additional two days waterlogging, and 51% (62.3 mg) after six days waterlogging when compared to and inoculated control under normal soil moisture conditions (126.2 mg)

Introduction

This controlled environment seedling experiment investigated the effect of waterlogging on PRR resistance, ranking material from the PBA chickpea breeding program. Material included the wild *Cicer* backcross PRR resistant 04067-81-2-1-1(B) and the moderately resistant *Cicer arietinium* Yorker$^{(P)}$; along with D09024B>F6RIL>040 and D09024D>F6RIL>028, the elite progeny of this parental cross. The information gained from this experiment will be used to understand the waterlogging tolerance mechanisms involved and whether pyramiding this tolerance will improve chickpea PRR resistance. Figure 1 demonstrates the scale of crop loss in a high rainfall season due to both waterlogging and PRR.

Figure 1 Damage across a chickpea trial paddock after 370 mm in-crop rainfall, Moree 2016. Photo credit: Michael Nowland

Site details	Location	Glasshouse – Tamworth Agriculture Institute, Tamworth
	Trial design	Randomised complete block design with waterlogging and PRR treatments as the main blocks and varieties as sub-blocks; three full replicates with two pseudo-replicates at the variety level.
Treatments	Varieties and breeding lines (8)	04067-81-2-1-1(B), Yorker$^{\Phi}$, Rupali$^{\Phi}$, Kyabra$^{\Phi}$, D09024B>F6RIL>040, D09024D>F6RIL>028, D10075>12F3TMWR2AB016, and D11042>13F3HRMT4PR024
	PRR Treatments (4)	PRR inoculated PRR inoculated, plus two days waterlogging PRR inoculated, plus four days waterlogging PRR inoculated, plus six days waterlogging

Results

Dry root weight

Waterlogging had a major effect on the reduction of dry root weights due to extensive root rot. After four days of waterlogging with PRR present, all material except 04067-82-2-1-1(B) and 04067-82-2-1-1(B)/Yorker$^{\Phi}$ progeny D09024B>F6RIL>040 had significantly lighter dry root weights when compared with the inoculated PRR controls (Table 1). D09024B>F6RIL>040 had no significant difference in dry root weight after six days of waterlogging.

Kyabra$^{\Phi}$, a PRR-susceptible variety, unusually after six days waterlogging had a significantly higher dry root weight when compared with four days waterlogging. The experiment will need to be repeated as most varieties had a reduced dry root weight as flooding period extended. Preliminary evidence from this experiment (data not shown) indicated that inoculum levels across three tested varieties reduced significantly under waterlogging conditions and this will be further investigated.

Table 1 Dry root weights (mg) of varieties and PBA breeding lines under different treatments. l.s.d. (P<0.05) = 36.6 mg/plant

	PRR only	PRR plus 2 days waterlogging	PRR plus 4 days waterlogging	PRR plus 6 days waterlogging
04067-81-2-1-1(B)	126.2	93.7	99.5	62.3*
Yorker	134.6	90.4*	57.1*	66.1*
Rupali	109.0	74.1*	36.7*	43.8*
Kyabra	122.4	93.0	50.4*	92.5
D09024B>F6RIL>040	82.9	72.5	60.8	79.1
D09024D>F6RIL>028	114.8	99.4	62.0*	60.9*
D10075>12F3TMWR2AB016	162.4	86.1*	83.4*	69.7*
D11042>13F3HRMT4PR024	137.0	104.9	58.9*	59.9*

*Dry weights for these treatments differ significantly from the PRR-only treatment for that line.

Root disease score

Table 2 indicates the material's root disease score. A score of one is free of disease and nine indicates the presence of severe disease symptoms (Figure 2). The number of days of waterlogging for the maximum level of root disease varied between lines indicating that there could be differing mechanisms and levels of tolerance and/or resistance to waterlogging and PRR. 04067-81-2-1-1(B) was the only line not to have a significant increase in root disease after six days of waterlogging.

Table 2 Root disease score (1–9 scale) of varieties and PBA breeding lines exposed to Phytophthora and Phytophthora with waterlogging for 2, 4, and 6 days.
l.s.d. (P<0.05) = 1.7/plant

	PRR only	PRR plus 2 days waterlogging	PRR plus 4 days waterlogging	PRR plus 6 days waterlogging
04067-81-2-1-1(B)	2.3	3.2	2.7	3.3
Yorker	2.5	3.2	4.8*	4.2*
Rupali	4.0	4.8	7.9*	7.2*
Kyabra	2.2	2.6	5.7*	4.2*
D09024B>F6RIL>040	1.1	3.9	5.2*	3.3*
D09024D>F6RIL>028	1.7	3.5*	3.8*	4.0*
D10075>12F3TMWR2AB016	2.7	5.0*	5.3*	6.0*
D11042>13F3HRMT4PR024	2.3	3.7	5.2*	4.8*

* Root disease score for these treatments differ significantly from the PRR-only treatment for that line.

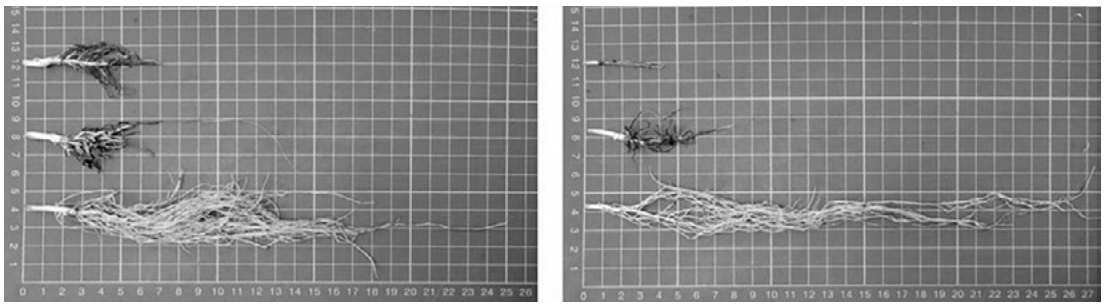

Figure 2 04067-82-2-1-1(B) on the left and Rupali(Φ) to the right. Top: roots after four days waterlogging; middle: two days waterlogging with PRR; bottom: a control with no waterlogging or PRR. Images were taken from a previous experiment.

Conclusions

The experiments confirm that waterlogging increases the susceptibility of chickpea to PRR. The ability of 04067-82-2-1-1(B) and its progeny to maintain resistance and root mass consistently is an indication that waterlogging tolerance could contribute to PRR resistance. A population developed from the cross of 04067-82-2-1-1(B) and Yorker(Φ) will be further investigated to identify and measure traits that could confer waterlogging tolerance, and how these traits affect chickpea susceptibility or resistance to PRR. Traits include:

- root length
- presence of adventitious roots
- cell wall and root exudate composition.

Growers should avoid paddocks prone to waterlogging or flooding if a high rainfall season is predicted and there is an identified presence or history of PRR. The moderate resistance levels of released varieties (PBA HatTrick(Φ), and PBA Seamer(Φ)), which rate similarly to Yorker(Φ) for PRR resistance, can suffer significant yield losses under the combination of the two stressors. PRR presence in a chickpea crop can be determined using the Primary Industries and Regions SA (PIRSA) PREDICTA® B DNA-based soil testing service. Details can be found at the PIRSA website (https://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b).

Acknowledgements

This experiment was part of the 'Grains and Pathology and Pathology Partnership project Improving phytophthora root rot resistance through waterlogging tolerance in chickpea', BLG302 2017-23, DAN00212. Part of a GAPP scientific capacity building PhD scholar program, jointly funded by the NSW Department of Primary Industry Industries (NSW DPI) and Grains Research Development Corporation (GRDC).

Contact

Nicole Dron
Tamworth Agricultural Institute, Tamworth
nicole.dron@dpi.nsw.gov.au
0439 548 044