

Cereal and pulse crops with improved resistance to *Pratylenchus thornei* are needed to maximize wheat production and expand crop sequence options

Kirsty Owen ^{1*}, Timothy Clewett ^{1,2}, Kerry Bell ³ and John Thompson ¹

¹ Centre for Crop Health, Institute for Agriculture and the Environment, University of Southern Queensland, Toowoomba, QLD, 4350 Australia; tim@clewett.net.au (T.G.C.); john.thompson@usq.edu.au (J.P.T.)

² (Retired) University of Southern Centre for Crop Health, Institute for Agriculture and the Environment, University of Southern Queensland, Toowoomba, QLD, 4350, Australia.

³ Leslie Research Facility, Department of Agriculture and Fisheries Queensland, Toowoomba, QLD, 4350. Australia; kerry.bell@daf.qld.gov.au

* Correspondence: Kirsty.Owen@usq.edu.au

Abstract: In the subtropical grain region of eastern Australia, two experiments were conducted, one initially with 2490 *P. thornei*/kg soil, the other with 8150 *P. thornei*/kg soil at 0–0.9 m soil depth. We determined the effects of *P. thornei*, residual from a weed-free fallow and pre-cropping with several cultivars each of barley (*Hordeum vulgare*), faba bean (*Vicia faba*), chickpea (*Cicer arietinum*) and wheat (*Triticum aestivum*) (Phase 1), on the growth of wheat cultivars with intolerance or tolerance to *P. thornei* (Phase 2). *Pratylenchus thornei* substantially increased after growing all cultivars of the Phase 1 faba bean, barley and most cultivars of chickpea and wheat, and decreased after two moderately-resistant wheat cultivars and the fallow treatment. The biomass of the Phase 2 tolerant cultivar ranged from 5070 to 6780 kg/ha and the intolerant cultivar, 1020 to 4740 kg/ha. There was a negative linear relationship between *P. thornei* population densities and biomass of the Phase 2 intolerant cultivar but not of the tolerant cultivar. Growers are at risk of financial loss because they are restricted in their choice of crops to reduce damaging population densities of *P. thornei*. The development of resistant and tolerant crop genotypes can maximize production in *P. thornei* affected farming systems.

Keywords: *Triticum aestivum*, chickpea, barley, faba bean, weed-free fallow, root-lesion nematode

1. Supplementary Material

Supplementary Table S1. Nematode populations and available water content (AWC, mm) at each depth interval sampled, one-month before sowing Phase 1 treatments in each experiment. Nematode data were transformed by $\ln(x+500)$ for Experiments 1 and 2. Numbers in parentheses are back-transformed means; SE, standard error of the mean; $n=9$ for each depth interval in each experiment.

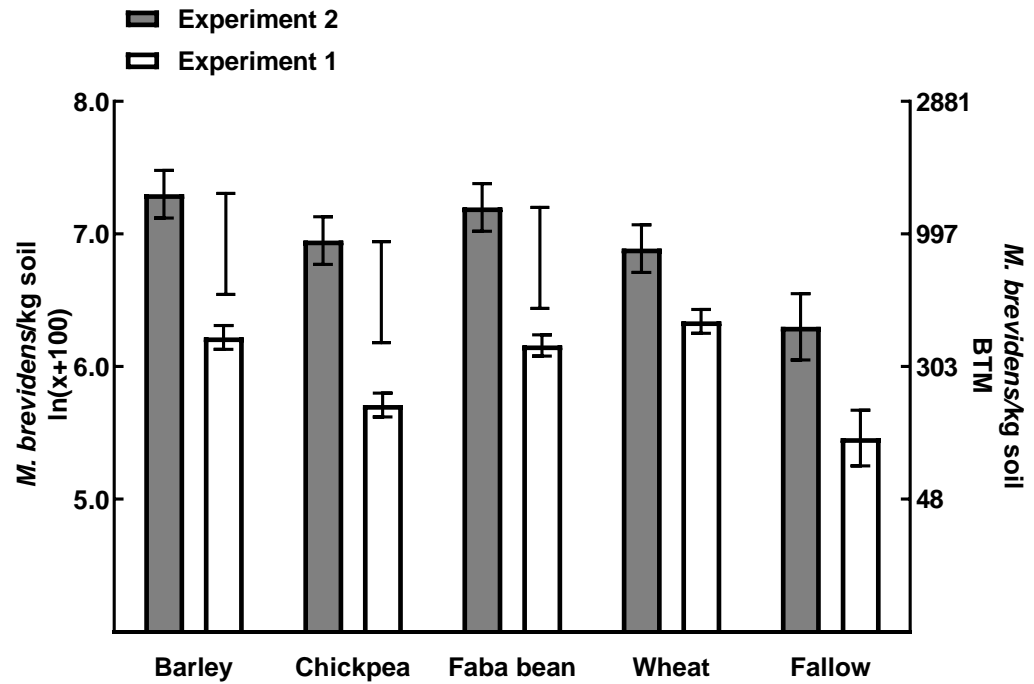
	Soil depth (m)	Nematodes/kg soil						AWC (mm)	SE
		<i>Pratylenchus thornei</i>	SE	<i>Merlinius brevidens</i>	SE	Free-living nematodes	SE		
Experiment 1	0–0.15	7.23 (10850)	0.13	6.28 (32)	0.09	7.51 (1330)	0.12	4.3	1.33
	0.15–0.30	8.10 (11952)	0.13	6.29 (39)	0.09	7.88 (2143)	0.12	18.8	1.33
	0.30–0.45	8.12 (9139)	0.13	6.60 (237)	0.09	7.53 (1371)	0.12	21.0	1.33
	0.45–0.60	8.31 (6777)	0.13	6.49 (159)	0.09	7.62 (1536)	0.12	43.1	1.33
	0.60–0.90	7.98 (5164)	0.13	6.91 (499)	0.09	7.69 (1688)	0.12	36.9	1.33
	lsd $P=0.05$	0.51		0.34		0.47		4.8	
Experiment 2	0–0.15	8.34 (880)	0.13	6.72 (325)	0.09	8.30 (3505)	0.12	11.2	1.98
	0.15–0.30	9.43 (2804)	0.13	6.67 (289)	0.09	7.74 (1789)	0.12	20.0	1.40
	0.30–0.45	9.17 (2851)	0.13	6.60 (235)	0.09	7.64 (1588)	0.12	19.7	1.36
	0.45–0.60	8.89 (3562)	0.13	6.90 (491)	0.09	7.59 (1482)	0.12	18.3	1.36
	0.60–0.90	8.65 (2422)	0.13	6.94 (531)	0.09	7.28 (953)	0.12	27.3	1.33
	lsd $P=0.05$	0.51		0.34		0.47		4.8	

Supplementary Table S2. Grain yield (kg/ha) of the Phase 1 winter crop cultivars. For barley, there was a significant effect of experiment x cultivar, $n=6$; for all other crops, there was significant effect of cultivar only, $n=12$; number in parentheses is average standard error of difference.

Crop	Cultivar	Grain yield (kg/ha)	
		Experiment 1	Experiment 2
Barley	Commander	3189	2981
	Gairdner	3458	2533
	Grimmett	3131	2771
	Grout	3417	2856
	ND-19119-05	3272	3090
	Hindmarsh	2339	2131
	l.s.d. $P=0.05$	340 (170)	
		Mean of Experiments	
Chickpea	Amethyst	1952	
	Tyson	1979	
	Yorker	2200	
	PBA HatTrick	2261	
	Sona	2323	
	Gully	2349	
	l.s.d. $P=0.05$	259 (182)	
Faba bean	Ascot	321	
	Rossa	713	
	Cairo	969	
	Fiesta	993	
	AF03109	1131	
	Doza	1141	
	l.s.d. $P=0.05$	144 (101)	
Wheat	Petrie	2356	
	Kennedy	3045	
	GS50a	3149	
	EGA Wylie	3873	
	QT9050	3909	
	l.s.d. $P=0.05$	314 (220)	

Supplementary Table S3. Standard error of the mean (SE) for each data point plotted in Figure 1. *Pratylenchus thornei*/kg soil to 0.9 m soil depth 6 months after harvest of the Phase 1 crops (2 months prior to sowing the Phase 2 wheat) for cultivars of (a) barley, (b) chickpea, (c) faba bean and (d) wheat; with the weed-free fallow treatment shown in each figure as a broken line. Means from analysis across the two experiments are presented. Points are plotted on the transformed scale with the back-transformed means indicated on the horizontal axis. Bar markers, l.s.d. ($P=0.05$) for each soil depth x first year cultivar, $n=12$ for each Phase 1 treatment.

Crop	Cultivar	SE for <i>P. thornei</i> /kg soil at each soil depth				
		0-15	15-30	30-45	45-60	60-90
Barley	Commander	0.109	0.110	0.108	0.109	0.113
	Gairdner	0.114	0.115	0.112	0.113	0.113
	Grimmett	0.109	0.110	0.108	0.109	0.117
	Grout	0.109	0.110	0.108	0.109	0.113
	ND-19119-05	0.109	0.110	0.108	0.109	0.113
	Hindmarsh	0.109	0.110	0.108	0.109	0.113
Chickpea	Amethyst	0.109	0.110	0.108	0.109	0.113
	Gully	0.114	0.115	0.112	0.113	0.113
	PBA HatTrick	0.114	0.115	0.112	0.113	0.118
	Sona	0.109	0.110	0.108	0.109	0.113
	Tyson	0.109	0.110	0.108	0.112	0.113
	Yorker	0.109	0.110	0.108	0.109	0.113
Faba bean	AF03109	0.109	0.110	0.108	0.109	0.113
	Ascot	0.109	0.110	0.108	0.109	0.113
	Cairo	0.109	0.110	0.108	0.109	0.113
	Doza	0.109	0.110	0.108	0.109	0.113
	Fiesta	0.109	0.110	0.108	0.109	0.113
	Rossa	0.109	0.110	0.108	0.109	0.113
Wheat	EGA Wylie	0.109	0.110	0.108	0.109	0.113
	GS50a	0.109	0.110	0.108	0.109	0.113
	Kennedy	0.109	0.110	0.108	0.109	0.113
	Petrie	0.109	0.110	0.108	0.109	0.113
	QT9050	0.109	0.110	0.108	0.109	0.113
Fallow		0.109	0.110	0.108	0.109	0.113



Supplementary Figure S1. *Merlinius brevidens*/kg soil at 0–0.9 m soil depth, 6 months after harvest of the Phase 1 treatments (2 months prior to sowing the Phase 2 wheat cultivars). Bar marker above barley, chickpea and faba bean indicates l.s.d. ($P=0.05$) experimental site \times crop; BTM, back-transformed means; error bar indicates standard error of the mean; $n=36$ for barley, chickpea and faba bean, $n=30$ for wheat, $n=6$ for fallow.