First record of stubby-root nematode (*Paratrichodorus porosus*) associated with barley in Australia

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Abstract. High populations (5000 to 20 000/kg soil) of the stubby-root nematode *Paratrichodorus porosus* were identified morphologically from soil samples taken under patches of poorly growing barley in a field between Yuleba and Surat in western Queensland, Australia. Lower populations (<4000/kg soil) were recovered from soil samples taken from asymptomatic barley. This is the first record of this nematode species on barley in Australia.

In 2008, a 130-ha irrigated crop of barley (*Hordeum vulgare* cv. Dictator) being grown for hay on a brown Kandosol (Isbell 2002) (pH 6.0; 88% sand; 5% silt; 7% clay) between Yuleba and Surat, Queensland (26.98547°S 149.27344°E, 244 m elevation) had large patches of poor growth over a 20-ha portion of the field. The crop had been planted on June 14 with 40 kg/ha monoammonium phosphate (MAP: 10% N, 22% P, 1.5% S) and fertilised with 200 kg/ha urea (46% N) on July 15 and then irrigated. At the beginning of anthesis, asymptomatic plants had normal growth, biomass and a height over 1 m, whereas symptomatic plants were visibly stunted (<30 cm high) with severely reduced biomass. Three samples each of symptomatic and asymptomatic groups of whole plants from 20 cm of row and soil to 15-cm depth were collected from different areas within the 20-ha portion.

Each soil and root sample was thoroughly mixed with roots cut into ~1-cm lengths. Gravimetric moisture content was determined by drying a 100-g subsample at 105°C for 48 h. Nematodes were extracted from a 200-g subsample from each soil sample using the Whitehead tray method (Whitehead and Hemming 1965) for 48 h at 22°C and collected on a 20-µm-aperture sieve. Samples were stored in ~15 mL of water at 3°C. Nematode populations were counted under a compound microscope (100×) using a Hawksley slide counting chamber of 1-mL capacity. After assessment, nematodes were submitted to the Australian National Insect Collection (Canberra, Australia) for species identification.

Morphological identifications were conducted initially on immobilised specimens in water. Identifications were confirmed on specimens fixed in formaldehyde for 2 weeks, then processed to glycerol by the slow method and mounted on permanent slides (Hooper 1986).

The nematodes were on average 353 µm long (307–378 µm), average vulval position of 54% (52–56%), had onchiostyles

between 42 and 50 µm long, excretory pore anterior to pharynx base, medioventral body pores, anterodorsal overlap of intestine, oesophageal bulb, no males, pore-shaped vulva in ventral view, oval, oblique and separated vaginal cuticular pieces and a convex-conoid tail. The most distinctive diagnostic characters were the excretory pore much anterior to the oesophago-intestinal junction, the anterodorsal overlap of the oesophagus of the intestine and the absence of males. Female body length was shorter than, but vulval position was consistent with published ranges; however, neither trait is generally considered diagnostic (Decraemer 1995). Of the seven species of *Paratrichodorus* identified in Australia (*P. minor*, *P. lobatus*, *P. porosus*, *P. renifer*, *P. queenslandensis*, *P. orrae* and *P. mirzai*) (Decraemer and Reay 1991; McLeod *et al.* 1994), this combination of characters is present in *P. porosus* only (Table 1).

P. porosus populations were 5053, 10139 and 20216/kg soil (oven-dry equivalent) in samples from areas with symptomatic plants and 320, 507 and 4101/kg soil in samples from areas with asymptomatic plants. Examination of the root systems showed that asymptomatic plants had normal root development while symptomatic plants had severe root damage including black lesions, stunting of lateral roots and absence of root-hairs.

Further investigation was done in a glasshouse pot study using pregerminated barley cv. NRB04182 plants in 7-cm-square by 15-cm-high plastic pots containing 330 g of remnant soil from the poor growth area with a *P. porosus* concentration of 5053/kg. Each pot was fertilised with 1 g of Osmocote® Native Gardens plus micronutrients (17–1.6–8.7 NPK) slow-release fertiliser mixed through the soil and grown on glasshouse benches fitted with a bottom watering system regulated by a float valve set to a water tension of 2 cm. After 10 weeks growth, root systems were visually examined and a 1-g subsample stained for root-infecting fungi (Phillips and Hayman 1970). No evidence of phytoparasitic fungi was observed on the root systems of the glasshouse-grown

Table 1. Distinguishing features of Australian species of *Paratrichodorus* (after Decraemer and Reay 1991; Decraemer 1995)

Species	Female body length (µm)	Onchiostyle length (µm)	Excretory pore position	Body pores	Vulva shape in ventral view	Overlap of oesophagus and intestine	Males	Vaginal cuticular pieces shape	Vaginal cuticular pieces orientation	Vaginal cuticular pieces spacing	Sperm
<i>porosus</i>	420–867	39–58	Nerve ring	Median	Pore	Usually dorsal	Rare	Oval	Oblique	Separated	Not thread-like
<i>minor</i>	460–710	26–47	Pharynx base	Absent	Transverse	Ventral or absent	Rare	Rod	Parallel	Close	Globular or thread-like
<i>lobatus</i>	535–1051	44–58	Pharynx base	Lateral	Longitudinal	Ventral	Common	Oval	Parallel	Separated	Not thread-like
<i>mirzai</i>	450–630	29–37	Bulb region	Lateral	Longitudinal	Ventral or absent	Common	Small circular	–	Separated	Not thread-like
<i>orae</i>	455–790	38–47	Bulb region	Lateral	Longitudinal	Dorsal or absent	Common	Oval	Oblique	Separated	Large not thread-like
<i>queenlandensis</i>	460–655	46–55	Nerve ring	Lateral	Longitudinal	Absent	Common	Oval	Oblique	Separated	Not thread-like
<i>renifer</i>	420–560	31–33	Pharynx base	Absent	Transverse	Absent	Rare	Reniform	Oblique	Close	With thread-like bodies

Fig. 1. Root system of barley cv. NRB04182 showing blackening, stunting of lateral roots and no root-hair production after 10 weeks glasshouse growth in field soil infested with 5053 *Paratrichodorus porosus*/kg.

barley cv. NRB04182, which displayed similar symptoms to the barley cv. Dictator root systems observed from symptomatic field plants (Fig. 1).

P. porosus has previously been recorded in Queensland, New South Wales and Western Australia (McLeod *et al.* 1994) with the most recent report specifically identifying *P. porosus* in a survey of Queensland sugarcane fields where it occurred in <1% of samples (Blair *et al.* 1999). However, *Paratrichodorus* spp. have previously been associated with sugarcane (*Saccharum* sp.) (Blair *et al.* 1999; Blair and Stirling 2007), citrus (*Citrus* spp.) (Brown 1978; Walker and Morey 1999) and other fruit trees (Sauer 1981), leeks (*Allium ampeloparsum*) (Hall *et al.* 2007), grapes (*Vitis* sp.) (Stirling 1976; Harris 1983), carrot (*Daucus carota*) (Walker 2004) and wheat (*Triticum aestivum*) (Suatmadji 1984). These reports have identified *Paratrichodorus* spp. in a range of soil types; however, high sand-content soils were most common with Blair *et al.* (1999) finding that the mean densities of *Paratrichodorus* spp. were significantly higher in sandy loams with greater than 75% sand (coarse and fine) than all other soil types. A recent review by Hodda and Nobbs (2008) found that of the seven species of *Paratrichodorus* present in Australia, only *P. minor* and *P. porosus* have been associated with damage of major agricultural species outside the Australasian region.

This is the first report of *P. porosus* associated with poor growth of barley in Australia. Observations by the property owners suggested that barley cv. Fitzroy and a mixed planting of barley cvv. Mackay and Grout also suffered from patchy poor growth during 2007 and 2009, respectively. Little is known of the distribution of *P. porosus* in broadacre cropping systems or the host status of many of the economically important crops in Queensland. Initially, glasshouse studies would be valuable to assess the host status of economically important crop species and cultivars. Additionally, targeted sampling of lighter-textured soils would be useful to ascertain the extent of *P. porosus* distribution.

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