First report of stubby root nematode, *Paratrichodorus teres* (Nematoda: Trichodoridae) from Iran

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Abstract During a survey of plant-parasitic nematodes in fruit tree nurseries in Iran, a species of the genus *Paratrichodorus* from the family Trichodoridae was found in the rhizosphere of apricot seedlings in Shahrood, central Iran, then subsequently in Karaj orchards. Morphological and morphometric characters of the specimens were in agreement with *P. teres*. The D2/D3 expansion fragment of the large subunit (LSU) of rRNA gene of the nematode was also sequenced. *P. teres* is considered an economically important species in agricultural crop, worldwide. This is the first report of the occurrence of *P. teres* in Iran.

Keywords Apricot · Fruit tree nursery · Iran · *Paratrichodorus teres*

Trichodorid nematodes are root ectoparasites, usually aggregating at the tip of the growing root. Upon direct feeding they cause abnormally stunted roots on host plants, a symptom that gave them the name of “stubby root” nematodes. However, the main economic importance of trichodorids lies in the fact that several species of

Trichodorus, *Nanidorus* and *Paratrichodorus* are natural vectors of the plant Tobraviruses occurring worldwide (Taylor and Brown 1997; Decraemer and Geraert 2006).

Eight species of the Trichodoridae family have so far been reported from Iran: *Trichodorus orientalis* (De Waele and Hashim 1983), *T. persicus* (De Waele and Sturhan 1987), *T. gilanensis*, *T. primitivus*, *Paratrichodorus porosus*, *P. tunisiensis* (Maafi and Decraemer 2002), *T. arasbaranensis* (Zahedi et al. 2009) and *P. minor* (now *Nanidorus minor*) (Pourjam et al. 2011).

Several species were detected in a survey conducted on plant-parasitic nematodes in fruit tree nurseries. Among them, a nematode population belonging to Trichodoridae was observed in the rhizosphere of apricot seedlings in Shahrood, Semnan province, central Iran, that was subsequently identified as *P. teres* (Hooper, 1962) Siddiqi, 1974. Another population of the nematode was also recovered from the rhizosphere of peach seedlings in Karaj, Alborz province, Iran.

Soil samples were collected from 10 to 40 cm depth of the rhizosphere of fruit tree nurseries with weed vegetation. Nematodes were extracted from soil by a centrifugal flotation technique (Jenkins 1964), fixed in heated TAF (triethanolamine 2 ml, formaldehyde 7 ml and distilled water 91 ml), transferred to dehydrated glycerine and mounted in dehydrated glycerine on glass slides (De Grisse 1969). The specimens were studied using a Olympus BH-2 light microscope provided with a drawing tube. The light microscopic photographs were taken with a digital camera linked to a computer.

Total DNA was extracted from hand-picked nematodes, according to Tanha Maafi et al. (2003). The forward D2A (5′-ACAAGTACCGTGAGGGAAAGTTG-3′) and reverse D3B (5′-TCGGAAGGAACCAGCTACTA-3′) primers (Subbotin et al. 2006) were used for amplification and sequencing of the fragment of the large subunit

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of rRNA gene. After purification of PCR products from the agarose gel slices using QIAquick gel Extraction Kit (Qiagen), the region was sequenced using standard procedures.

***Paratrichodorus teres* (Hooper, 1962) Siddiqi, 1974**

Measurements of Females; Shahrood population ($n=25$): $L=740\pm63.7$ (640–895) μm ; $a=22.8\pm1.8$ (18.5–25.6); $b=5.0\pm0.4$ (4.4–5.9); $V=54.3\pm1.8$ (50.5–57.4);

onchiostyle = 48.0 ± 2.5 (44.0–54.0) μm ; anterior end to S-E pore = 102.6 ± 5.8 (95.0–114.0) μm ; anterior end to guiding ring = 22.6 ± 1.9 (18–25), Karaj population ($n=12$): $L=714\pm44.7$ (649–787) μm ; $a=20.4\pm1.9$ (18.0–24.7); $b=4.9\pm0.3$ (4.6–5.2); $V=54.5\pm2.7$ (50.5–60.6); onchiostyle = 46.8 ± 1.5 (45.0–49.0) μm ; anterior end to S-E pore = 99.0 ± 2.5 (96–102) μm ; anterior end to guiding ring = 22.0 ± 1.2 (20–24).

Females largely cylindrical, almost straight when heat killed (Fig. 1a), pharynx with overlapping ventrosublateral pharyngeal glands. S-E pore opposite anterior end of pharyngeal bulb. Reproductive system didelphic-amphidelphic; uteri without sperm; vaginal sclerotizations minute, oval-shaped, well separated and oblique (Figs. 1b and 2b). Vulva a short longitudinal slit (Figs. 1d and 2c), vagina with characteristic shape (Figs. 1b and c and 2b and d). Male not found.

The Iranian populations of *P. teres* closely agree in measurements and morphological features with the description of *P. teres* in Decraemer (1995).

Permanent slides of *P. teres* females ($N=9$: slides TPT001 and TPT002) were deposited at the Nematode Collection of the Department of Plant Protection, Karaj, Iran and ($N=7$: slides 35GO 1 and 35GO 2) at the National Nematode Collection of the Nematology Department, Iranian Research Institute of Plant protection, Tehran, Iran. Additional slides of *P. teres* females ($N=8$: slides RIT822, RIT823 and RIT824) were deposited at the nematode collection of Royal Belgian Institute of Natural Sciences, Brussels, Belgium.

Fig. 1 *Paratrichodorus teres* from Iran (Female). **a** Total view; **b** and **c** Vaginal region; **d** Ventral view of vulva; **e** Anterior body region

Fig. 2 Light micrographs of the female of *Paratrichodorus teres* from Iran. **a** Anterior body region; **b** and **d** Vulva region showing vagina shape; **c** Vulva in ventral view

Partial amplification of the rRNA led to production of a 774 bp fragment that was deposited in the GenBank under accession number KF550304.

P. teres has been reported mainly from temperate regions (Decraemer 1995; Taylor and Brown 1997) although not exclusively (Karanastasi et al. 2005). The species can cause damage on host plants through direct feeding and also transmission of TRV, Tobacco Rattle Virus (Ploeg and Decraemer 1997). It is the first report of the occurrence of *P. teres* in Iran.

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