Parasitism of the Citrus Nematode, *Tylenchulus semipenetrans*, by *Pasteuria penetrans* in Iraq

F. A. Fattah, H. M. Saleh, and H. M. Aboud

**Keywords:** biocontrol, citrus, *Pasteuria penetrans*, *Tylenchulus semipenetrans*.

*Pasteuria penetrans* Sayre & Starr parasitizes several nematode species and is considered a promising biocontrol agent of the root-knot nematode, *Meloidogyne* spp. (1,7). Numerous plant-parasitic nematodes, including *Tylenchulus semipenetrans*, however, are seldom if ever infected by this biocontrol agent (3).

*Tylenchulus semipenetrans* Cobb is the most economically important and widespread nematode pest of citrus worldwide. In Iraq, it occurs in more than 90% of the citrus orchards and nurseries (4).

Specimens of *T. semipenetrans* infected by *P. penetrans* were detected during routine collection of soil and root samples from *T. semipenetrans*-infected citrus trees at Al-Dorah, Baghdad. *T. semipenetrans* motile stages were extracted from soil and roots by a modification of Cobb's sieving and decanting method (6) and from sedentary adult females by maceration or dislodging. Nematode stages infected with *P. penetrans* were examined in a water suspension through a compound microscope.

Only second-stage juveniles (J2) and adult males had *P. penetrans* spores affixed to their cuticles (Fig. 1A–C). Juveniles with attached spores tended to aggregate in groups of 2–5 nematodes and stick to each other. Similar observations of *Meloidogyne javanica* were made (3).

Endospores, sporangia, and other *P. penetrans* life stages were found inside the J2 bodies (Figs. 2A, 3) but not inside males or females, indicating that *T. semipenetrans* is a host of *P. penetrans*. *P. penetrans* appeared to prevent the normal development of infected J2. Specimens with advanced infections were sluggish or immobile and their internal organs were invaded or replaced by *P. penetrans* life stages (Fig. 2).

The spherical endospores and the crescent-shaped sporangia from this population of *T. semipenetrans* were smaller (2.6 μm) than those reported from *Meloidogyne* species (3.4 μm) (5) but were similar in size to those reported from *Pratylenchus* species (9). The mode of infection of *T. semipenetrans* by *P. penetrans* differed from that reported for *Meloidogyne* spp. Infection of *T. semipenetrans* and *Meloidogyne* spp. differed in that mature spores were observed in motile, soil-borne J2 of *T. semipenetrans* opposed to sedentary, adult females of *Meloidogyne* spp. Thus, *P. penetrans* may limit *T. semipenetrans* root invasion by infecting and killing nematodes in the soil before penetration occurs. In contrast, it suppresses *Meloidogyne* spp. root attack by limiting egg production after the nematode has parasitized the roots. High densities of *P. penetrans* spores may also suppress root invasion by *Meloidogyne* spp., because heavily encumbered J2 are less motile although they are not infected while in the soil (2).

An association between *P. penetrans* and *T. semipenetrans* was reported twice before. Mankau and Prasad (3) observed one *T. semipenetrans* with one spore on its cuticle but did not observe infection. They concluded that *T. semipenetrans* was not a host.
Sturhan (8) reported that *P. penetrans* was observed inside *T. semipenetrans* on Samoa Island but provided no details.

This study adds to the host range of *P. penetrans* and provides evidence of variable host preference in this biological agent.

**LITERATURE CITED**


---

**FIGS. 1-3.** 1) *Tylenchulus semipenetrans* infected with *Pasteuria penetrans*. A, B) *P. penetrans* spores attached to the cuticle of a second-stage juvenile. C) Posterior body of an adult male with *P. penetrans* spores attached to the cuticle. 2) *Tylenchulus semipenetrans* second-stage juveniles. A) *P. penetrans* sporulation inside the body. Note complete obliteration of digestive system. B) Noninfected specimen. 3) Ruptured *Tylenchulus semipenetrans* second-stage juvenile infected with *Pasteuria penetrans*. Inset is an enlargement of the spores.