SEVERE DAMAGE CAUSED BY THE ROOT-LESION NEMATODE, *PRATYLENCHUS THORNEI*, IN AEROBIC RICE IN INDIA

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Received: 19 March 2012; Accepted: 21 May 2012.

Summary. Severe damage to aerobic rice caused by the root lesion nematode, *Pratylenchus thornei*, was observed in India. Infected plants showed retarded growth, chlorotic leaves and roots with too many branches and necrotic lesions throughout the cortex, compared to apparently healthy plants of a nearby rice crop. The nematode populations were 406 specimens per 200 cm^3 soil and 32 specimens per 0.5 g roots. This is the first report of *P. thornei* damaging aerobic rice.

Keywords: *Oryza sativa*, upland rice, yield loss.

In Asia, 75% of rice is produced in irrigated lowland fields with high irrigation requirements to sustain a layer of ponded water for most of the growing season (Bouman and Tuong, 2001; Maclean *et al.,* 2002; Bridge *et al.,* 2005). However, irrigation water is becoming increasingly scarce. Tuong and Bouman (2003) estimated that about 2 million ha of Asia's dry-season irrigated rice area will suffer water shortages by 2025. One of the adaptation strategies for water shortage areas is the system of aerobic rice (Bouman *et al*., 2005, 2006; Yang *et al*., 2005). Aerobic rice is a water-saving rice production system for water-short environments with favourable soils and adapted, potentially high-yielding varieties that are direct dry seeded. Soils remain aerobic (not saturated) but supplementary irrigation is applied as necessary. In light soils with high seepage and percolation rates, aerobic rice has an advantage over systems that include saturated or partially flooded soil conditions (Wang *et al*., 2002).

Lesion nematodes are widely distributed in the world and mainly inflict damage to direct-seeded rainfed rice. In India, *P. indicus* Das and *P. zeae* Graham have been recorded on rice in Andhra Pradesh, Assam, Gujarat, Kerala, Orissa, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal (Prasad *et al*., 1987). Damage by *P. thornei* to chickpea (Di Vito *et al*., 1992), mung bean and wheat (Nicol *et al*., 1999; Nicol and Ortiz-Monasterio, 2004) have been reported. The nematode has already been reported to damage the rice-wheat-legume cropping sequence in India (Dwivedi and Upadhyay, 1998), but never upland rice. In rice, *P. thornei* was first reported by Oteifa (1962) from Egypt.

Lately, rice plants in upland rice fields at the Indian Agricultural Research Institute, New Delhi, India, were found severely stunted and chlorotic. Generally, these symptoms are due to iron deficiency. Further investigations revealed no iron deficiency. This prompted us to study the nematode infestation, if any, affecting aerobic rice plants. In these fields, the previous crop sequence was fallow followed by maize and then the aerobic rice cv. PRH 10 was direct seeded. Soil and root samples were collected 35 days after sowing.

A total of five soil samples (four from the corners and one from the centre) were collected from each of the three fields (A, B, C). Each sample was mixed in a 24-inch plastic bowl and a sub-sample of 200 cm^3 was processed by Cobb's sieving and decanting method (Cobb, 1918) combined with modified Baerman funnel technique (Southey, 1986). Three 1-ml aliquots of the nematode water suspension were observed under a stereo-microscope and the nematodes counted. The predominant plant nematodes were of the genus *Pratylenchus*. They were killed by adding to the water suspension an equal amount of boiling water and fixed in 2.5% formalin. The nematode specimens were then hand-picked, processed by Seinhorst's method (1959) and mounted in dehydrated glycerine.

Infected yellow and stunted plants were carefully uprooted and the roots were washed gently in tap water and stained in a boiling 0.1% acid fuchsin solution. The stained roots (0.5 g) were observed under a stereo-microscope and the nematodes teased out with the help of needles and counted.

The nematodes were then observed (12 specimens) under a microscope and identified to species level according to the key of Singh and Gill (1986). Because of the presence of three lip annules, stylet length of 15-16.8 μm, vulva position at 74-80 %, total body length of 0.46-0.69 mm, post-uterine sac of 11-30 μm, spermatheca empty, lack of males, and truncate non-annulated tail, the specimens were identified as *P. thornei* Sher *et* Allen, 1953.

Symptoms of lesion nematode (as with most nematode-induced diseases) often go unrecognized initially as the above ground symptoms are often general symptoms of plant root stress. The nematode populations in soil and roots were 406 per 200 cm^3 soil and 32 nematodes per 0.5 g roots in the severely damaged field C

Fig. 1. Damages caused by *Pratylencus thornei* to rice. Left, patchy growth of infected plants. Right, plants with chlorotic leaves.

(Fig. 1). Only 12 nematodes per 200 cm^3 soil occurred in a nearby field B, previously left fallow, in which rice was showing normal growth and no chlorosis (Table I). Infested roots showed characteristic necrotic lesions (darkened areas of dead tissue) on the surface and throughout the cortex (Fig. 2). The lesions turned from reddish-brown to black and were spotty along the root surface. Root growth was reduced and small lesions also formed on young roots. The lesions may also lead to secondary infections by fungi or bacteria, thus increasing damage severity (Agrios, 2005). In turn, this results in poor plant growth, reduced yield or even complete crop failure.

Crop damage is related to the soil nematode population density at germination. Usually, the root damage, and possible eventual plant death, becomes obvious by 30-40 days after germination. Sowing of upland rice is done with the onset of first showers and seedling survival and yields are completely dependent on the progress of the rainy season. If plant death occurs in irrigated rice gap filling is possible, but this is not possible in upland rice in which plants having damaged roots will not recover because of the limited water resources.

Nombela *et al*. (1998) reported much lower populations (relative abundance 0.41 ± 0.06) of *P. thornei* following summer fallow compared to wheat or vetch (relative abundance 0.87 ± 0.07). In our study, the rather high soil population of *P. thornei* in an aerobic rice field could be due to the preceding maize crop, compared to fallow land preceding aerobic rice in another two fields showing low nematode soil population densities.

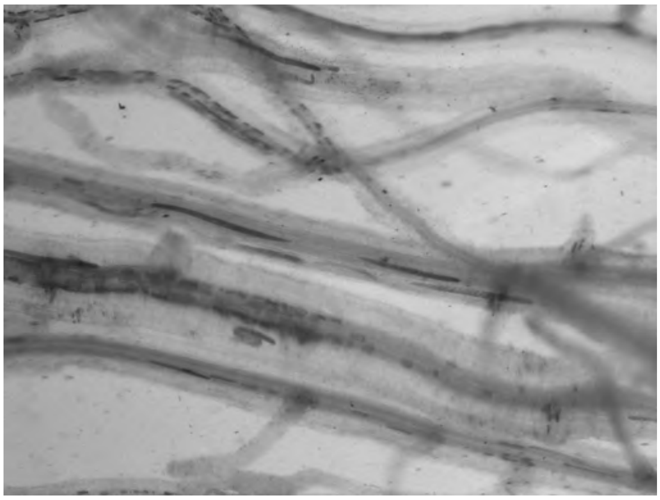

Fig. 2. Specimens of *P. thornei* in rice roots showing dark lesions.

Table I. Nematode population in three experimental fields.

Field	Previous crop	Nematode population	
		per 200 cc soil	per 0.5 g root
A	Cowpea	23 (4.89)^b	3 (2.0)^d
B	Fallow	12 (3.60)^b	00 (1.0)^d
C	Maize	406 (20.17)^a	32 (5.74)^c

Figures in the same column followed by the same letter do not differ significantly at P = 0.05 according to Duncan's multiple range test.
Figures in parentheses are sqrt x+1 transformed values.

Pratylenchus thornei may easily spread in rice fields with water and soil and, therefore, there is high potential for the infested area in the country to expand, which would result in severe yield losses to rice, particularly under sub-optimal management conditions (Pankaj *et al.*, 2006a, b).

Because of the above, farmers should be advised to avoid crop sequences leading to large soil population densities of *P. thornei* before cultivating upland rice under tropical conditions. However, further investigations under Indian rice cropping conditions are suggested to obtain more insights on the ecology and management of the nematode.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Mangu Singh and Mr. Khajan Singh, Division of Nematology, IARI, New Delhi for their help in collecting and processing root and soil samples.

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