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SOIL-INHABITING NEMATODES IN SRI LANKA

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ABSTRACT

Nematodes are one of the most numerous invertebrate groups inhabiting in the soil environment. In Sri Lanka, among the soil-inhabiting nematodes, information is mainly available on plant nematodes and to a lesser extent, entomo-pathogenic nematodes. Based on the so far published literature, two foliar-parasitic, *i.e. Ditylenchus* spp. and *Aphelenchoides* spp., and fourteen root-parasitic genera have been recorded. Among the root-parasitic nematodes, three different feeding groups *i.e.* endo-parasitic (05 genera), semi-endo-parasitic (03 genera) and ecto-parasitic (06 genera) have been reported, of which the endo-parasitic, root-knot nematode, *Meloidogyne* spp. is prominent. Altogether, six *Meloidogyne*species, *i.e. M. incognita*, *M. javanica*, *M. arenaria*, *M. hapla*, *M. brevicauda* and *M. graminicola* are prevalent in Sri Lankan soils. Of these, *M. brevicauda* is endemic and found in soils of tea plantations while *M. graminicola* seems to be restricted, particularly to rice fields. *Meloidogyneincognita*, *M. javanica*, *M. arenaria* and *M. hapla* are commonly found in vegetable fields and their distribution is widespread in the island. In case of entomo-pathogenic nematodes, two genera, namely *Steinernema* spp. and *Heterorhabditis* spp. have been isolated from the coastal areas of the island. The prevalence of these two genera was reported to be equal. Despite the great ecological importance, to date, hardly any information is available on free-living nematodes and whole soil nematode community in Sri Lanka indicating the gap of knowledge to be filled.

Key words: *Entomo-pathogenic nematode, plant-parasitic nematodes, soil*

GENERAL INTRODUCTION

Nematodes (round worms) comprise more than 90% of the metazoans in the world. They are bilaterally symmetrical, un-segmented and simple tubular organisms. Majority of nematodes are microscopic and usually colourless, transparent and lack appendages. Although, most nematodes are vermiform, some are swollen. Nematodes have established themselves successfully in all possible ecological niches and soil is an excellent habitat for them; hence, they represent a wide range of biodiversity. Several feeding groups of nematodes occur in the soil habitat. In a broader sense, nematodes can be categorised into two main groups, *i.e.* parasitic and free-living forms. Most kinds of soil nematodes are free-living and beneficial. In case of parasitic nematodes, adult plant and animal parasites as well as some of their life stages, *i.e.* juveniles, can be found in soil. In Sri Lanka, most of the nematological research work has been focused on plant-parasitic nematodes (excluding clinical nematology). In addition, a handful of studies have been addressed on the entomo-pathogenic nematodes. Hence, the aim of this paper is to provide information on these two groups of nematodes which inhabit the soil environment. However, prior to that, a brief introduction of these two nematode groups is presented.

All plant parasitic nematodes possess a stylet or mouth spear which is used to pierce plant cells. These nematodes reduce crop growth and yield and hence, a great threat in agro-industry particularly in tropics (Sasser and Freckman, 1987). Among the plant-parasitic nematodes, three different feeding groups can be distinguished, *i.e.* ecto-parasites, semi-endo-parasites and endo-parasites. In all plant nematodes, at least one life-stage inhabits soil, in particular, the infective stages. Ecto-parasites do not enter the plant tissues; they inhabit in soil and feed on plant tissues. In case of semi-endo-parasites, only the anterior part of the nematode enters the root, while the posterior section remaining in the soil. Among the endo-parasitic forms, infective juveniles of the sedentary nematodes inhabit the soil and invade host plants in which they lose their mobility and become sedentary. Migratory endo-parasites enter the host tissues from soil, move through the tissues and obtain nourishment. However, they can exit the tissues at any time into the soil environment to find new host plants. Majority of the plant-nematodes attack root systems (root-parasites). However, some species damage above ground plant parts. These foliar species may survive in soil or in shallow surface layers often in host plant residues. When a suitable host plant develops and favourable conditions prevail

these parasites crawl up the plants and mature in above ground plant parts. Among the plant nematodes, root-knot nematodes (*Meloidogyne* spp.) and cyst nematodes (*Globodera* and *Heterodera* spp.) which belong to sedentary endo-parasites, are widely distributed in tropical regions. *Pratylenchus* spp., *Radopholus* spp. and *Hirschmanniella* spp. are some examples for migratory root endo-parasites. *Aphelenchoides* spp. and *Ditylenchus* spp. are common foliar-dwellling species. *Trichorodrus* spp., *Criconemoides* spp., *Xiphinema* spp., *Logidorus* spp., *Hoplolaimus* spp. and *Helicotylenchus* spp. are polularly known soil-dwelling ectoparasitic species while *Tylenchulus* spp., *Scutellonema* spp. and *Rotylenchus* spp., are considered as semi -endoparasitic species.

Entomopathogenic nematodes (EPNs) are soil-inhabiting, obligate insect parasites belonging to the Steinernematidae (*Steinernema* spp.) and Heterorhabditidae (*Heterorhabditis* spp.).These nematodes are extraordinarily lethal to many soil insect pests and hence they are considered as biological control agents of insect pests (Kaya and Gaugler 1993).These Steinernematid and Heterorhabditid nematodes are exclusively soil organisms and they are found in a wide range of ecologically diverse soil habitats. The non-feeding infective juvenile seeks out insect hosts, especially in the soil environment. When a host has been located, the nematodes penetrate into the insect body. As soon as the infective juveniles enter the host, they initiate development and release a symbiotic bacterium (*Xenorhabdus* spp., and *Photorhabdus* spp.) into the body cavity of the insect. The bacteria start to multiply causing the death of the insect within 24 to 48 hours due to septicaemia. After the death of the host, nematodes continue to feed on the host tissue. The nematodes develop through four juvenile stages to the adult, and then reproduce. Depending on the available resources one or more generations may occur within the dead host and a large number of juveniles are eventually released into the soil where they infect new hosts (Kaya and Gaugler, 1993).

PLANT-PARASITIC NEMATODES - SRI LANKA

Investigations on plant nematodes in Sri Lanka date back to 1953 with the detection of new root-knot nematode species, *Meloidogyne brevicauda* on tea plants (Loss, 1953). Since then up to the year 1978, *M. arenaria*, *M. incognita*, *M. javanica*, *M. hapla*, *Helicotylenchus multicintus*, *Hoplolaimus pararobustus*, *Pratylenchus curvitatus*, *P. loosi*, *Radopholus similes* and *Scutellonema brachyurum* have been recorded (Hutchinson, 1961; Sivapalan, 1978). Later, Lamberti and Ekanayake (1981) reported two foliar nematodes *Aphelenchoides besseyi* and *Ditylenchus* spp. as well as some other root-parsitic nematodes, *i.e. Criconemoides, Hirschmanniella, Logidorus, Rotylenchus, Trichodorus, Tylenchulus* and *Xiphinema.* Thereafter, Lamberti *et al.*, (1987), four common *Meloidogyne* species, *M. incognita, M. arenaria* and *M. javanica,* have been recorded associated with vegetables such as beans, egg plant, beet and tomato in North (Jaffna and Puttalam districts) andcentral parts (Kandy district) of Sri Lanka. Later, Ekanayake (1990) reported that *Hirschmanniella oryzae* was widespread in rice cultivation causing severe damage in Sri Lanka. Meanwhile, Ekanayake and Toida (1997) reported *Globodera rostochiensis* (cyst nematode), *M. arenaria, M. brevicauda, M. incognita, M. javanica, M. hapla, M. graminicola, R. similes, R. reniformis, P. loosi, A. besseyi* and *H. oryzae*, as economically important nematodes based on the crop injury and geographical distribution. Moreover, in a survey conducted in Trincomalee region during 1980-1981, *Aphelenchoides besseyi* has been detected from onion fields (Lamberti *et al.,* 1996). Further, Ekanayake and Toida (1997) detected *Meloidogyne graminicola* associated with rice cultivation in many areas of the country. During, 2006-2010, our research group (Department of Zoology, University of Ruhuna, Matara) conducted an extensive survey in Matara and Hambanthota districts to study the prevalence of root-knot nematodes associated with commonly grown vegetable fields. The findings showed that three *Meloidogyne* species, *M. incognita, M. javanica* and *M. arenaria* were prevalent and *M. incognita* was found to be the predominant species in all infested vegetable species (Premachandra *et al.,* 2007a; Premachandra *et al.,* 2007b; Premachandra and Gunasekara, 2010). Moreover, Vitharana and Amarasinghe (2011) reported *Helicotylenchus multicinctus*, *Radopholus similes* and *Hoplalaimus* spp. on Banana cultivations in Gampaha district. Very recently, it has been reported that the commercial Guava cultivation in north-central and western provinces of the country has been seriously affected by root-knot nematode attacks (Nimalananda, 2011). All these findings confirmed that all the above mentioned nematode species were prevalent in the soils where the investigations have been conducted; implying soil is the source for nematode infestation on various plant species. Among the above mentioned nematodes, *Meloidogyne* nematodes cause severe growth reduction and substantial yield losses in Sri Lanka (Lamberti *et al.,* 1980; Lamberti and Ekanayake, 1983). Thus, in order to adopt control measures against nematode infestations, soil should be the main target.

ENTOMO - PATHOGENIC NEMATODES (EPNs) - SRI LANKA

In Sri Lanka, the first extensive survey on EPNs was conducted from July 1991-August 1992. In this investigation, 318 sites representing ecologically diversified habitats, *i.e.* tea plantations, grasslands, natural forests, vegetable fields and coastal areas, in three agro-ecological zones, *i.e.* wet, dry and intermediate, were explored for the presence of EPNs (Amarasinghe *et al.*,1994). The findings showed that two genetic types of *Steinernema* and *Heterorhabditis* were prevalent only in the coastal areas. Altogether, 38 nematode isolates were detected, of which 17 were Steinernematids and the rest was Heterorhabditids. No EPNs were found in inland sampling sites. In addition to this investigation, our research group (Department of Zoology, University of Ruhuna) conducted a survey along the southern coastal belt, *i.e.* from Ahangama to Hambanthota during 1997-1999 to identify and determine the distribution of EPNs. Similar to the previous study, both *Heterorhabditis* (*H. indicus*) and *Steinernema* spp. were recovered from the southern coastal belt (Premachandra *et al.*, 1997, 1998). Among the *Steinernema* spp., a new isolate was detected (coded as Ruhuna-isolate).

GAPS TO BE FILLED

To date, no research work has been focussed on free-living nematode fauna and whole soil nematode community in Sri Lanka. Free-living nematodes are of great ecological importance as they involve in nutrient recycling in the soil environment. In addition, these nematodes can be used as bio-indicators to assess the pollution conditions of the soil environment. Determination of the whole nematode community is also important to identify the trophic relationships. Hence, investigations are urgently needed to fill this gap of knowledge. In order to fulfil this, trained personnel are urgently needed for the country.

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