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Nematode community structure in crop fields near Yamuna in Faridabad, Haryana

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ABSTRACT

A survey of agricultural fields near Yamuna in Faridabad, Haryana was conducted to study the diversity and community structure of the soil inhabiting nematodes. A total of 32 genera belonging to 7 orders and 22 families were recorded. In terms of abundance, order Tylenchida was most abundant while in terms of number of genera, order Rhabditida was most frequent. Out of 32 genera, 10 *viz*., Pratylenchus, Psilenchus, Helicotylenchus, Hemicriconemoides, Hoplolaimus, Meloidogyne, Rotylenchulus, Tylenchorhynchus, Hirschmanniella, Xiphinema belonged to plant-parasitic nematodes. Overall Meloidogyne was the most abundant among all the nematode genera.

KEYWORDS

Community Analysis, Yamuna, Tylenchida, Rhabditida, Nematode

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Monitoring of soil quality and health provides critical insights into the performance of ecosystems. Soil nematodes are useful indicators of soil condition because they are ubiquitous, occupy a central position in the soil food web and comprise a range of functional or trophic groups and are convenient to work with (Yeates *et al*., 1993, Sieriebriennikov *et al.,* 2014). The contribution of soil nematodes to ecosystem processes and functions varies depending on the composition and diversity of the nematode community (Yeates *et al*., 2009; Costa *et al*., 2012, Porazinska *et al*., 2012). Nematode community composition is affected by fertilization, soil properties, vegetation and length of cultivation. The aim of the present study was to study the community structure of the soil inhabiting nematodes associated with crop fields near Yamuna river area in Faridabad, Haryana to assess the role of nematodes as indicators of soil condition.

MATERIALS AND METHODS

Soil samples from agriculture fields near Yamuna river area in Faridabad, Haryana were collected. Vegetables like Tomato (*Solanum lycopersicum*), Okra (*Abelmoschus esculentus*), Cauliflower (*Brassica oleracea*), Carrot (*Daucus carota*), Mustard (*Brassica juncea*), Chilli (*Capsicum* spp.), Eggplant (*Solanum melongena*), Cabbage (*Brassica oleracea* var. capitata), Potato (*Solanum tuberosum*), Coriander (*Coriandrum sativum*), Castor (*Ricinus communis*), Rose (*Rosa* spp.) etc. are grown in these fields. From each field soil samples were collected from a depth of 0-10 cm by using a hand spade. Samples were tagged, stored in sealed plastic bags and brought to laboratory for further processing. Nematodes were extracted from 100 cc. of fresh weight of soil using (Cobb's, 1918) sieving and decantation and modified Baerman's funnel techniques. All the nematodes from each extracted sample were counted and identified to genus level. Trophic groups were allocated according to (Yeates *et al*., 1993) and cp groups were assigned after (Bongers, 1990). Chemical analysis of the soil samples was done at soil testing laboratory, IARI, New Delhi. Nematode diversity was described using the Shanon's diversity index calculated at genus level (H'). Maturity index (MI) was calculated to estimate the relative state of two ecosystems studied. Trophic diversity was calculated by the trophic diversity index, (TDI) (Heip *et al*., 1988). All indices were calculated by using MS Excel. Differences with $P < 0.05$ were considered significant and $P < 0.01$ as highly significant. Detailed description of the formulae used are given below:

Shannon's diversity $(H') = -\Sigma (pi \ln pi)$

Trophic Diversity index (TDI) = 1/∑pi²
Where pi^2 is the proportional contribution of i^{th} trophic group.

Maturity Index $MI = \sum_{i=1}^{n} V(i).f(i)$
Where Vi= cp value of the i^{th} taxon.
f (i) the frequency of that taxon in a sample
* Maturity index (MI) is calculated as the weighted mean of the individual c-p value.

Plant Parasitic index $PPI = \sum PPiXi / \sum Xi$
Where, Ppi = PP value assigned to taxon i according to Bongers (1990).
Xi = abundance of taxon i in the sample.

RESULTS AND DISCUSSION

A total of 32 genera belonging to 7 orders and 22 families were recorded from the soil samples collected from crop fields near Yamuna river area in Faridabad, Haryana (table 1). The number of genera varied from 4 to 17 per sample while in terms of abundance, the number varied from 175 to 1050 individuals per 100 cc of soil. In terms of number of genera (Fig. 1, A), the Order Rhabditida was most frequent (38%) with 12 genera under 4 families, followed by Tylenchida (32%) with 10 genera under 9 families, Dorylaimida (9%) with 3 genera under 2 families, Araeolaimida, Aphelenchida and Enoplida (6%) each with 2 genera under 2 families, while Monhystrida (3%) was represented by 1 genus. In terms of number of individuals (Fig. 1, B), Tylenchida (60%) was most abundant, followed by Rhabditida (22%), Aphelenchida (12%), Dorylaimida (4%), Monhysterida (1%), Araeolaimida and Enoplida (0.5% each). In terms of trophic diversity, the bacteriovores (44%) constituted the most dominant group in terms of number of genera (Fig. 1, C) followed by herbivores (35%), predators (9%), omnivores (6%) and fungivores (6%). In terms of number of individuals (Fig. 1, D) herbivores (62%) was the most abundant group, followed by bacteriovores (23%), fungivores (12%), predators (2%) and omnivores (1%). Among bacteriovores, *Acrobeles* was the most dominant genus while *Meloidogyne*, *Aphelenchus*, *Mesodorylaimus* and *Mononchoides* were most dominant genera among herbivores, fungivores, omnivores and predators respectively. Overall *Meloidogyne* was most abundant among all the nematode genera. The value of trophic diversity index (TDI) was 1.21 ± 0.27. Shannon's diversity (H') was calculated to assess diversity of nematode genera and it was 2.70 ± 0.42. The Maturity index (MI) was calculated to assess the maturity of the agro-ecosystem and it was 1.35 ± 0.30 while the plant parasitic index (PPI) was 2.65±0.41 (table 2).

Soil Nematode communities and their structural changes were found to be one of the best biological tools for assessing soil processes and plant conditions in terrestrial ecosystems (Wang *et al*., 2009; Pen-Mouratov *et al*., 2010). The soil environment significantly impacts on soil dwelling nematode communities. No single nematode index was universal in indicating the difference in soil health, but rather soil health requires a more indepth understanding of the nematode community composition, both trophic groups and life strategies (Pattison *et al*., 2004). Soil nematodes, as bioindicators of soil health, would not replace current soil chemical and physical tests, but would supplement information obtained and increase the understanding of the soil ecology and the effects of soil management. Nematodes respond differently to soil disturbance and therefore changes the nematode community composition (Gupta and Yeates, 1997; Yeates and Pattison, 2006). A low percentage of dorylaims in the crop field (4%) clearly indicates that the soil is more disturbed as cropping always involves ploughing and/or tilling together with addition of fertilizers, organic matter and pesticides/weedicides. The dorylaims appear to be susceptible to these activities as also shown by Thomas (1978) and Sohlenius and Wasilewska (1984). Hence, the sensitivity of the dorylaims is a good indicator of soil disturbance (Neher, 2001). In this study *Acrobeles* was the most abundant genus and confirms with the work of Yeates and Bongers (1999) and Gomes *et al*. (2003) where it is found that cephalobids were the most abundant bacterial feeders present in cropping systems. Shannon's diversity index (H') reflects diversity of nematodes in an ecosystem. Higher values of H' show highly diverse ecosystem while low values show the contrary. Hanel (1995) found H' in crop fields to vary between 2.66-2.83. In present work, the value of H' was 2.70 ± 0.42. This is in perfect agreement to earlier records where crop fields are found to be

Table 1. Population structure of soil inhabiting nematodes, their mean abundance per 100 cc soil ± SD (N = 40)

S. No.	Genera	c-p Value	Order	N	Mean ± SD
	Bacteriovores				
1.	*Bursilla*	1	Rhabditida	7	4.2 ± 11.0
2.	*Mesorhabditis*	1	Rhabditida	14	7.7 ± 13.3
3.	*Distolabrellus*	1	Rhabditida	3	2.7 ± 10.6
4.	*Metarhabditis*	1	Rhabditida	6	2.1 ± 5.3
5.	*Rhabditis*	1	Rhabditida	2	0.3 ± 1.5
6.	*Acrobeles*	2	Rhabditida	30	25.1 ± 20.9
7.	*Acrobeloides*	2	Rhabditida	23	17.4 ± 18.0
8.	*Chiloplacus*	2	Rhabditida	6	3.6 ± 9.9
9.	*Eucephalobus*	2	Rhabditida	10	7.2 ± 14.6
10.	*Pseudacrobeles*	2	Rhabditida	2	1.3 ± 5.9
11.	*Zeldia*	2	Rhabditida	2	0.9 ± 3.9
12.	*Rhabdolaimus*	2	Araeolaimida	2	1.2 ± 5.3
13.	*Chiloplectus*	2	Araeolaimida	3	1.5 ± 5.7
14.	*Prismatolaimus*	3	Monhysterida	11	4.3 ± 8.4
	Fungivores				
15.	*Aphelenchoides*	2	Aphelenchida	23	19.2 ± 20.0
16.	*Aphelenchus*	2	Aphelenchida	26	20.9 ± 22.1
	Omnivores				
17.	*Mesodorylaimus*	4	Dorylaimida	6	4.0 ± 10.6
18.	*Minidorylaimus*	4	Dorylaimida	3	0.4 ± 1.4
	Herbivores				
19.	*Xiphinema*	5	Dorylaimida	13	10.0 ± 17.2
20.	*Pratylenchus*	3	Tylenchida	25	23.2 ± 23.6
21.	*Psilenchus*	2	Tylenchida	5	6.0 ± 18.4
22.	*Helicotylenchus*	3	Tylenchida	22	17.7 ± 23.1
23.	*Hemicriconemoides*	3	Tylenchida	2	0.8 ± 3.7
24.	*Hoplolaimus*	3	Tylenchida	26	29.0 ± 26.0
25.	*Meloidogyne*	3	Tylenchida	30	58.4 ± 46.6
26.	*Rotylenchulus*	3	Tylenchida	23	23.8 ± 25.9
27.	*Tylenchorhynchus*	3	Tylenchida	26	44.2 ± 41.2
28.	*Hirschmanniella*	3	Tylenchida	2	0.3 ± 1.4
29.	*Basiria*	2	Tylenchida	4	1.0 ± 3.4
	Predators				
30.	*Tobrilus*	3	Enoplida	3	1.1 ± 4.3
31.	*Mononchoides*	1	Rhabditida	3	0.5 ± 2.1
32.	*Trypla*	3	Enoplida	3	3.6 ± 13.1

Table 2. Ecological indices for assessing the nematode community dynamics.

S. No.	Indices	Values
1.	H’	2.70 ± 0.42
2.	TDI	1.21 ± 0.27
3.	MI	1.35 ± 0.30
4.	PPI	2.65±0.41

highly diverse in comparison to other ecosystems (Ferris *et al*., 2001, Tomar *et al*., 2006). The MI has been used successfully as indicators for disturbances (Yeates *et al.*, 1993; Korthals *et al*., 1998; Gorgieva *et al.*, 2002). Various case studies (Bongers *et al*., 2001) suggest that the MI is decreased by disturbances but increases during the colonization process. The lower values of MI in present study indicated a disturbed environment due to agricultural practices. The PPI is very good indicator of plant parasitic nematode resources. Pate *et al.* (2000) studied PPI values for crop fields as 2.3

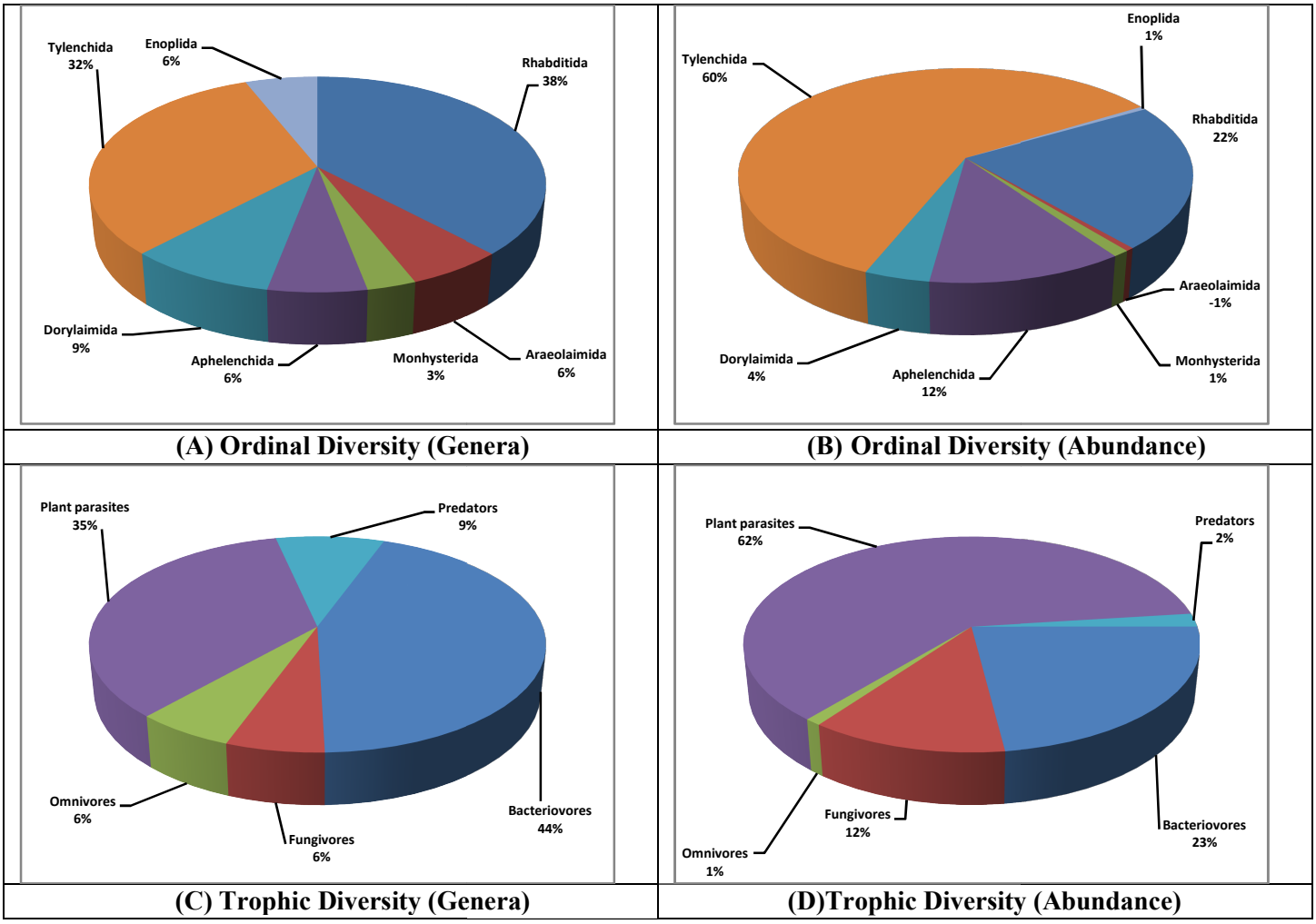

Fig. 1. Ordinal diversity (genera and abundance) (A and B) and Trophic diversity (genera and abundance) of nematodes.

while Neher and Campbell (1994) recorded PPI as 2.82 and 2.51 in soybean plantations. The PPI values for present study in agree with earlier records. The indices that are calculated from analysis of nematode genera provide an excellent and responsive indication of the effects of soil management on soil ecology. Nematode community analysis is a powerful tool that can be used together with more conventional soil physical and chemical tests to develop a deeper understanding of how soil management impacts on the health of the soil.

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