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Full Length Research Paper

Nematode biodiversity in a semi-arid pasture under different grazing regimes

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The study was conducted to explore the influence of over-grazing and ungrazing on nematode biodiversity in a semi-arid region pasture, in Adıyaman, Turkey, in 2008. Soil samples were taken in mid spring from a pasture that was previously divided into two sites, one is protected by fencing and the second is open to grazing, freely. Nematodes were extracted and allocated to trophic groups and both sites were compared regarding their abundance and diversity. A total of 19 nematode taxa were found in the study area. Plant parasitic nematodes 9 genera, bacterivores 6 genera, fungivores 3 genera, and predators and omnivores were represented by 1 order. *Rotylenchus*, *Tylenchus*, *Pratylenchus* and *Paratylenchus* were the abundant genera in plant parasitic group; *Acrobeloides* and *Cervidellus* were the abundant genera in bacterivore group; *Aphelenchoides* and *Ditylenchus* were the abundant genera in fungivore group. Nematode diversity and abundance were greatly affected by the vegetation status depending on the grazing pattern. Diversity and abundance parameters were lower under the over-grazed site. The study suggested that there was a tight connection between vegetation cover of the ecosystem and soil biodiversity beneath it.

Key words: Nematode biodiversity, pasture, trophic groups, grazing.

INTRODUCTION

Nematodes, represented by several trophic groups in high numbers, are one of the important components of the soil fauna across natural and agricultural ecosystems. There are connections between nematode biodiversity and soil health properties owing to their roles in ecosystem services (Bongers, 1990; Neher, 2001; Yeates, 2003; Neher et al., 2005). Therefore, most of the nematode biodiversity studies can be linked to the soil health and sustainable management of the lands which is one of the main concerns of the modern world today. Nematode diversity tends to be greatest in ecosystems with least disturbance, and bacterial-feeding nematodes make the greatest contribution to the decomposer food web in more intensively managed ecosystems (Yeates, 1999).

Soil nematode diversity and influencing ecological factors have been intensively studied (Yeates, 1984, 1999; Hanel, 2003; Shi et al., 2008). Furthermore, within the last two decades, studies related with soil nematode diversity and ecosystem functioning have had an increasing popularity among scientists and adopted by many, especially after the introduction of the Maturity Index concept by Bongers (1990), and the allocation of soil nematodes to colonizers-persister (C-P) levels by Yeates et al. (1993) facilitated to interpret the faunal composition and the interacting soil conditions.

It is widely accepted that free-living (FL) nematodes are good soil health indicators, due to their very nature that living in the soil pores deplete with the water reacting chemical, physical and biological any changes in various ways (Bongers, 1999). Soil nematodes occupy different trophic levels of soil food web and they are easily associated with their food sources by examining the morphology of their mouth parts. They are often divided into four trophic groups as bacterial feeding (bacterivores), fungal feeding (fungivores), nematodes that feed on other nematodes (predators) and nematodes that can feed on plants, fungi, bacteria and other nematodes (Yeates et al., 1993).

The degree and the scope of the disturbance that soil ecosystem faces can be estimated by examining the change of diversity and abundance of free-living nematodes. One of the factors affecting soil nematode communities that has been intensively studied is the vegetation cover of the ecosystem (Yeates, 1984; Yildiz, 2007; DuPont et al., 2009; Gruzdeva and Sushchuk, 2010; Sylvain and Wall, 2011). Kır et al. (2010) studied the effect of grazing on some yield and quality traits of a rotation pasture under Mediterranean conditions and suggested that rotation pasture mixtures was quite sustainable.

The objective of this study is to examine the influence of grazing regimes of a semi-pasture on soil nematode biodiversity.

MATERIALS AND METHODS

The study was conducted in a public pasture near Euphrates River, 40 km south of Adiyaman, Turkey. The site was previously divided into two identical parts to demonstrate local people the effect of grazing regimes on pastures in 2008. The first site was left as a stressed-land due to uncontrolled random grazing without any improvements and the second site was ungrazed by fencing for three years. Both sites received no irrigation and fertilizers during the study.

Study area has a semi-arid climate features that is hot and dry during the summer and cool and mostly rainy in the winter, with average annual temperature of 16.71°C, 46.83% relative humidity and 665 mm average annual precipitation. Soil type can be defined as ¾ clay-loams on limestone with reddish brown in color, pH slightly alkaline (7.60), salinity (EC_{25} 10^3 mmohs/cm) 1, organic matter is low (~1%). Plant composition of ungrazed site was mostly cereals, legumes and other plants; plant stand was 50 to 70 cm high and had 90% surface coverage. On the other hand, open (grazed) site was dominated by cereals with 5 to 10 cm plant stand and had 60% surface coverage.

Samples were taken once, at the end of the three year demonstration, of the fenced area. A pair of 300 m long and 10 m wide parallel stripes were marked from each site, leaving a 30 m distance between them. Thus, only the vegetation cover of the ecosystem was kept as a variation source. Thirty set of 10 m^2 plots were established from each site, a plot skipped un-sampled between two sampled plots thus, 30 plots were sampled. Soil removed from 5 different spots of each plots in 20 cm depth with a shovel to form a composite sample, then, a subsample of 1 kg soil taken to the laboratory.

Nematodes were extracted from 100 g soil samples by using modified-Baerman funnel method based on the active motion of nematodes that migrate toward the water. Extracted nematodes were allocated to the trophic groups according to Yeates et al. (1993) and counted to genera level. Interaction of nematode community structure and pasture status were compared by calculating species richness (SR), Shannon diversity index (H'), Shannon Evenness index (E), and Maturity Index (MI) as described in Neher et al. (2004) and Shannon (1948). The degree of difference in two sites was performed by applying T test for the variables.

RESULTS AND DISCUSSION

Nematode genera and abundance for both sites are given in Table 1. Eighteen genera and one order totaling nineteen nematode taxa were found from the study sites. Plant parasitic nematode fauna is dominated by genera *Rotylenchus*, *Tylenchus*, *Pratylenchus* and *Paratylenchus* in both sites. However, in the ungrazed site, these nematodes have significantly higher population densities than they have in the grazed site ($P < 0.05$). This may be directly attributable to the plant coverage and vigor of the ungrazed site. Since the parasitic nematodes are primarily depended on the roots of vegetation. Free-living nematode fauna is also depended on the plants for their food, but not as directly as the herbivores. Therefore, plant parasitic nematodes reflect the difference more clearly than the free-living fauna does.

Free-living fauna is dominated by Cephalobid bacterial feeders in both sites with the genus *Acrobeloides* in the highest density and frequency. Fungivores are stable and represented by 3 genera. Predators are very rare and omnivores are represented by the large bodied Dorylaimids. In this study, plant-parasitic, fungivore and bacterivore nematodes are the abundant trophic groups, respectively, in both sites. Abundances of all trophic groups are greater in ungrazed site than they are in grazed site (Figure 1). Plant parasitic nematodes are significantly more abundant in ungrazed site than the other trophic groups. Free-living nematodes, however, are slightly different in both sites. These results are in agreement with the studies suggesting that diversity of nematode fauna alters with the status of vegetation cover of the ecosystem (Yeates, 1984; Popovici and Ciobanu, 2000; Zolda, 2006; Yildiz, 2007; McSorley, 2011).

There are meaningful differences in values of diversity indices for two sites indicating a weaker faunal composition in over-grazed site (Table 2). These results again suggest that ecosystems vegetation stand and coverage greatly affects nematode biodiversity beneath it. The results are in agreement with (Li et al., 2007; Shi et al., 2008; McSorley, 2011).

The influence of ecosystem's plant coverage and plant stand on nematode community composition from a pasture land of two different regimes was studied. One is a stressed pasture ecosystem by over grazing and the other is a protected land from animal and human intervention. In conclusion, over-use of pastures has dramatic results immediately on biodiversity of soil organisms and subsequently on ecosystem productivity and sustainability. Pastures, like in this case, in semi-arid regions should be receiving more care than in the temperate climates because they are more easily degraded and exposed to erosion due to the harsh environmental conditions. More specifically, they should be grazed in a controlled manner to keep them functional for the future.

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Table 1. The abundance of nematodes in the study sites (in 100 g soil).

Plant parasitic	**Ungrazed**	**Grazed**
Tylenchus	300.0±11.5^{A}*	116.0±9.0^{B}*
Helicotylenchus	22.0±3.8^{A}	46.0±6.2^{A}
Rotylenchus	375.0±12.1^{A}	194.0±14.3^{B}
Pratylenchus	263.0±17.8^{A}	20.0±5.2^{B}
Pratylenchoides	10.0±4.6^{A}	16.0±5.5^{A}
Geocenamus	38.0±5.5^{A}	8.0±4.4^{B}
Tylenchorhynchus	24.0±5.6^{A}	28.0±5.7^{A}
Paratylenchus	122.0±8.4^{A}	72.0±10.8^{A}
Longidorous	51.0±5.5^{B}	24.0±6.0^{A}
Bakterivore		
Monhystera	12.0±5.20^{A}	18.0±5.0^{A}
Cephalobus	40.0±7.40^{A}	0.0±0.0^{B}
Eucephalobus	8.0±5.02^{A}	10.0±4.6^{A}
Acrobeloides	394.0±15.30^{A}	198.0±13.4^{B}
Cervidellus	140.0±9.30^{A}	110.0±10.5^{A}
Wilsonema	4.0±2.90^{A}	12.0±5.2^{A}
Fungivore		
Aphelenchoides	346.0±14.8^{A}	212.0±11.0^{A}
Aphelenchus	74.0±7.1^{A}	26.0±5.3^{B}
Ditylenchus	348.0±8.9^{A}	288.0±13.7^{A}
Predator &Om		
Dorylaimida	110.0±6.4^{A}	52.0±8.9^{B}

A,B: Values in columns with different superscripts are significantly different ($P<0.05$).

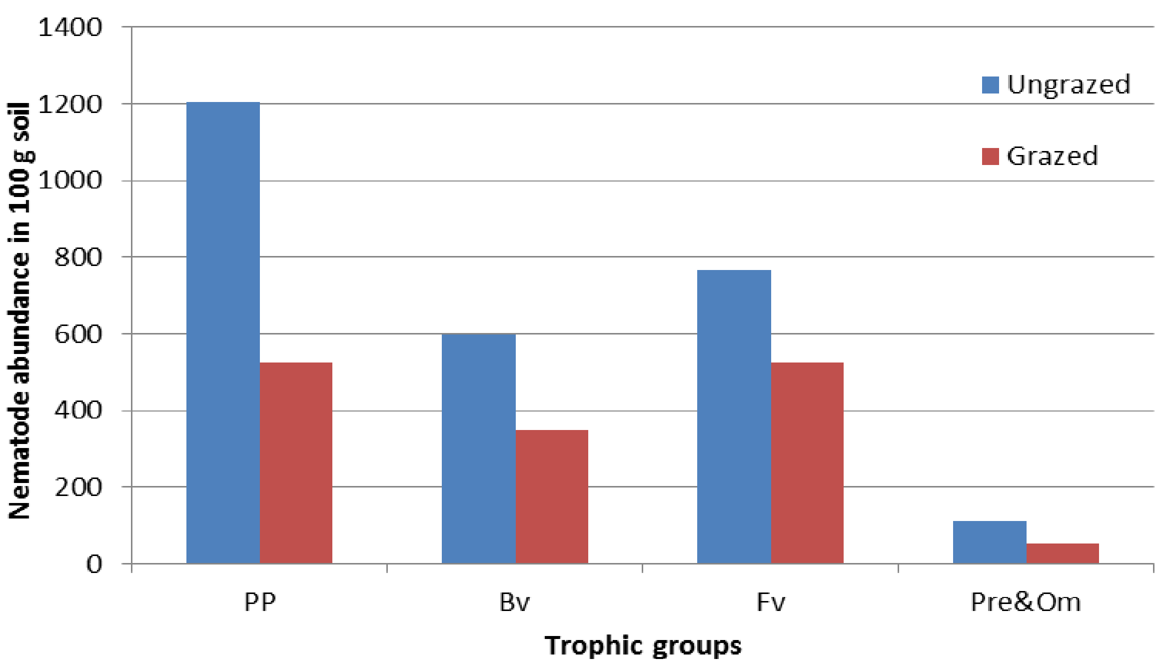

Figure 1. Abundance of trophic groups in both sites (PP: Plant parasitic, Bv: Bacterivores, Fv: Fungivores, Pre&Om: Predators and Omnivores).

Table 2. Mean values of diversity indices.

Parameter	SR	H'	E	MI
Ungrazed	19	2.41	0.81	2.24
Grazed	18	2.27	0.78	2.16

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