A comparative study of Soil mesofaunal population abundance and diversity under HARELA programme in the Northern state of India (Uttar Pradesh)

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Abstract

The role of socio-cultural values in biodiversity conservation is an integral part of the people living in India. This study summarizes a comparative study of population abundance and diversity of soil mesofauna under the HARELA programme. Result showed that the population abundance and diversity of soil mesofaunal population was higher at HARELA site as compare to another site. The physio-chemical parameters such as-organic carbon content, soil temperature, soil moisture, available nitrogen, phosphate and potash content were determined according to the standard laboratory methods. They were also higher on HARELA site as compare to other site.

Keywords: Soil Mesofauna, edaphic factors, Soil temperature, Organic Carbon, HARELA.

INTRODUCTION

Qualitative and quantitative studies of soil fauna, particularly the mesofauna from Indian soils began from the mid-sixties, although ecological studies were initiated much earlier (Trehan, 1945). However, major contributions have been from the agricultural fields, grasslands and gardens and very few from any plantation site in the semi arid zone of India. While, the mesofaunal studies from various sites included those of Banerjee (1972), Choudhuri (1961 & 1962), Hazra (1978), Bisht & Chatteraj (1986 & 1998). From the above literature it was assumed that the research works on Soil-Biology have tried to assess the impact of different biotic and abiotic factors on the abundance and diversity of soil mesofauna. In India, the study of soil fauna and flora concerning with any cultural ideology are very scanty. To promote the awareness towards soil flora there is a famous festival called HARELA. This traditional festival is one of the festivals in the state of Northern India (Uttarakhand)
which encourages people to conserve, manage their traditional crops and plantation also. Now-a-days this festival in the form of a mission has widely spread in other state of Northern India (Uttar Pradesh) also due to the strain of some social reformers. Peoples are actively taking part in the plantation to save the environment in the name of HARELA. These kind of the activities of the people need to be emphasized in detail, keeping in view that rapid socio-economic and caring nature about the environment taking place in the societies. In this study, plantation area “THE HARELA SITE” the soil fauna becomes very rich because abundance and diversity of this mesofauna is regulated by edaphic factors and these edaphic factors are directly related to the green belt. The Soil fauna is essential for ecosystem dynamics as it is involved in biogeochemical processes, promotes nutrient availability and affects the animal communities. There is increasing research interest and focus on the roles of soil mesofauna in above and belowground processes and their interactions (Johnson et al., 2013). The population density of soil mesofauna depends on various physico-chemical properties of soil such as porosity and permeability of the soil, soil temperature, soil moisture and the presence of inorganic elements and components, organic matters and the pH of the soil.

In temperate agroecosystem, little is known to these aspects in tropical and subtropical agroecosystems. This work reports the population abundance and diversity in areas which are used for plantation area known as HARELA SITE. The studies on the population densities of the soil mesofauna in India came to the *Kishore Bharati Bhagini Nibedita College, Behala, Kolkata-700 060. **23/2, Siddhinath Chatterjee Road, Kolkata-700 060. 2 Rec. zool. Surv. India limelight of scientific investigation chiefly through the works of Singh and Mukherjee (1971), Singh and Pillai (1975), Bhattacharya, Joy and Joy (1981) etc.

In this study, the aim of the present investigation was to determine the relationship between soil mesofauna and the soil environmental variables such as soil temperature, soil water content, pH, Available nitrogen, Organic carbon content which may affect the mesofaunal population within two different types of sites, a less studied in Northern India and indeed more widely in India. Besides this, being human there should be our first priority to promote such revolutionary movements at global level which are helping hand to our green and clean environment.

MATERIAL AND METHODS

The study was conducted in Aligarh (India).The climate of the area is semi arid characterized by low precipitation, high evaporation hot summer days and moderate winter temperature. The soil through the study area is clay loam. To determine the population density of soil mesofauna found in the depth of 0-10 cm of soil, soil mesofauna was collected randomly with the help of a corer modified by Averbach and crossley (1960). The soil samples were collected bimonthly for a period of twelve months at both the sites. Extraction of mesofauna was done in a modified Tullegren-Funnel. The insects collected were preserved in 70% alcohol and identified in a steriozoom microscope. Analysis of edaphic factors such as soil temperature, soil
moisture, and pH, content of organic carbon, nitrate and phosphate were done by standard laboratory methods. Temperature was measured by directly inserting the soil thermometer into the soil up to the required depth, Relative humidity by a Dial Hydrometer, pH by electric pH meter and soil moisture (water content) by Dowdeswell’s (1959) method. Organic carbon was estimated by rapid titration method as described by Walkey and Black (1934), Nitrogen content (N) by Jackson (1966) method, Phosphorus content (P) by Molybdenum blue test and Potash content (K) by Jackson (1966) method.

RESULT AND DISCUSSION

Plantations are a part of Agroforestry schemes planned by the government to save the environment and create a green belt. There were two sites for study. The first site of our experiment was grassland in which, *Saraca asoca* (the ashoka tree) *Dalbergia sissoo*, as North Indian rosewood, *Mangifera indica*, as mango plants , among flowering plants Rose (*Hibiscus Rosa-Sinesis*), Marigold, Bougainvillea, sunflowers etc. were planted under programme named HARELA SITE (HS). Whereas, another site was without plantation named NON- HARELA SITE (NHS). During the experimental period at both the sites, the total number of mesofauna collected from the experimental areas was grouped into the following categories: Pterygote, Apterygote and Acari. Among Pterygote, Dipterans and coleopterans were found to have the highest number and among Apterygotes, the dominant order was Collembola followed by Acari . Among Pterygote, Dipterans and coleopterans were found to have the highest number and among Apterygotes, the dominant order was Collembola followed by Acari. This was in agreement to the work of Reddy (1984) and Adeniyi (2009) in which collembolans were observed to be the most abundant taxa. Ford (1935) had emphasized on the influence of presence or absence of grasses on the fluctuation in the populations of Collembola and Acari. The average population densities of total mesofaunal population (Apterygote, Pterygote, Acari) were higher in the winter followed by post-monsoon and lowest in the pre-monsoon season (Table 1).

Among the soil mesofaunal population, Collembola and Acari are the most often studied group, due to their high abundance and diversity, important role in key biological processes such as, catalyzing organic matter decomposition and central role in the soil food web, making them suitable organisms for use as bioindicators of changes in soil quality, especially due to land use practice and pollution (Rombke, 2006). Collembola density was weakly significantly different according to site use (p<0.1). Average population density of Collembola was higher in HS as compared to NHS in all the seasons (Table 1). Low abundance and diversities of mesofaunal population including Diptera, Collembola, and Mites during the pre-monsoon month of April was probably due to low soil moisture content, higher temperature and recent tillage operations at Harela site (HS). The decrease in mesofaunal populations caused by tillage practices can be attributed to the destruction of microhabitat, changes in temperature, humidity, and pore size distribution, and decrease in organic matter content (Heisler and Kaiser, 1995, Loring, 1981, Perdue and Crossley, 1989). Further, environmental factors, such as water and nutrient contents, are important factors
affecting the populations of soil microarthropods (Klironomos, 1995 and Tadeka, 1987).

**Table 1:** Pearson Correlation between soil mesofaunal population and edaphic factors at experimental site during sampling year.

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<tr>
<td></td>
<td>HS</td>
<td>NHS</td>
<td>HS</td>
<td>NHS</td>
<td>HS</td>
<td>NHS</td>
<td>HS</td>
<td>NHS</td>
<td>HS</td>
<td>NHS</td>
</tr>
<tr>
<td>Pterygote</td>
<td>0.240</td>
<td>0.428</td>
<td>-0.627*</td>
<td>0.656*</td>
<td>0.252</td>
<td>0.156</td>
<td>0.656*</td>
<td>0.436</td>
<td>-0.456</td>
<td>-0.116</td>
</tr>
<tr>
<td>Apterygote</td>
<td>-0.635*</td>
<td>0.688*</td>
<td>0.630*</td>
<td>0.226</td>
<td>0.255</td>
<td>0.643*</td>
<td>0.226</td>
<td>0.456</td>
<td>-0.579</td>
<td>0.241</td>
</tr>
<tr>
<td>Acari</td>
<td>-0.579*</td>
<td>0.072</td>
<td>0.118</td>
<td>0.413</td>
<td>0.081</td>
<td>0.164</td>
<td>0.374</td>
<td>0.081</td>
<td>-0.207</td>
<td>0.164</td>
</tr>
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**HS**-Harela Site

**NHS**-Non Harela Site

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).
Comparing both the sites, mean population densities of Diptera, Collembola and Acari were highest at the Harela Site (Table 1). This could be attributed to higher organic content and moisture, and slightly lower temperature and bulk density at Harela site as compared to Non-Harela site (Table 1). The seasonal variation of Acarina in the present investigation was attributed to cumulative effect of all physicochemical factors rather than a single factor influence (Parwez H. and Sharma N 2014 and Sharma N. and Parwez H.2017). According to Begum et al. (2011) these differences are likely relate to microhabitat, and the differences could reflect the soil abiotic factors such as differences in temperature, soil moisture, bulk density, changes in food sources and SOC.

The collembolans (Apterygotes) and Dipterans (Pterygotes) were found maximum during monsoon months. During these months the atmospheric temperature is very high and the relative humidity is also very high (42°C and 100%) the weather is dry. Extreme dryness and heat effects the growth of grasses and plants also. The grassland becomes dry and without grass absence of soil moisture also results in low population of soil mesofauna in summers. Similarly Tsiafouli Maria A. et al. (2005) studied on the responses of soil microarthropods to experimental short term manipulations of soil moisture and gave their opinion that drought decreased soil water content as well as microarthropod species richness and increased maximum soil temperature. Collembolans are known to with stand a wide range of temperature of 55oC in desert (William et al 1987). The soil moisture also has a positive correlation on the population of the soil mesofauna. The population of Collembola, Diptera and Acari were moderate at NHS as the soil moisture was also on lower side. Our observations fall in accordance with the findings of Block W. (1981), Verhoef, H.A. and Van Sleen

Table 2: Average densities of different soil micro arthropods in different seasons and land use system

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<tr>
<th></th>
<th>Pre-Monsoon</th>
<th>Post-Monsoon</th>
<th>Winter</th>
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<tr>
<td></td>
<td>Harela Site (HS)</td>
<td>Non-Harela Site (NHS)</td>
<td>Harela Site (HS)</td>
</tr>
<tr>
<td>Mesofaunal Population</td>
<td>93±26</td>
<td>45±25</td>
<td>128±60</td>
</tr>
<tr>
<td>Dipterans</td>
<td>31±10</td>
<td>22±11</td>
<td>53±30</td>
</tr>
<tr>
<td>Collembolans</td>
<td>22±10</td>
<td>12±6</td>
<td>31±14</td>
</tr>
<tr>
<td>Acari</td>
<td>11±6</td>
<td>7±4</td>
<td>38±18</td>
</tr>
<tr>
<td>Nematodes</td>
<td>8±4</td>
<td>7±1.5</td>
<td>10±8</td>
</tr>
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</table>

Now the next important edaphic factor is soil pH varied between 7.3 to 7.8. It had little or direct effect on the population of soil mesofauna. Our results are supported by the observations of Bath (1980) who stated that acidification also has a marked influence on the sub-soil insects. Now it is an established fact that phosphate which is present in very low amount has positive correlation with some insects. It seems that there was little variation between the phosphate constituent of soil. So there is insignificant relationship between the soil faunal population and the phosphate content. Choudhoury and Roy (1972) support our findings in which they observed either positive or negative correlation of collembolan population with phosphate content.

The minima of the total mesofaunal population at NHS as compared to HS, though correlated with the dry conditions, lack of moisture and high atmosphere temperature but the most important reason could be scarcity of plants. As in dry conditions there were no humus layer and fungal mycelium is also retarded. The absence of fungal population in the soil may be one of the causes responsible for such a minima (Wallwork 1967).

CONCLUSION

When compared both the sites, soil mesofaunal population was highest at the plantation site. The seasonal variations in soil mesofaunal population groups were largely due to climatic fluctuations. Spatial and temporal variability of soil biological as well as physicochemical properties affected soil performance, ecosystem services and environmental processes. Understanding changes in soil biological indicators is, therefore, important to minimize the environmental degradation and improve the productivity and sustainability of agro-ecosystems in the northern part of India (Uttar Pradesh). Therefore, there is an urgent need to investigate spatial and temporal variability of the dynamics soil attributes to refine the plantation practices for sustainable management of agro-ecosystem. Long-term monitoring is required to fully understand the impact of plantation and seasons on soil faunal abundance and diversity.

ACKNOWLEDGEMENT:

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