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Effect of Management Practices on the Population Dynamics of Soil Mesofauna in An Agroforestry Land

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Abstract—*The variety of life in the soil encompasses not only plants but also the soil invertebrates and micro-organisms that are independent on each other. Micro arthropods population within the soil include Collembolans, Proturans, Diplurans, Pauropods, Mites, pseudo scorpions and Nematodes and they play a vital role in evaluating the soil health and make them economically viable as well as economically sustainable. Among all these micro organisms, soil micro arthropods are important biological indicators of soil quality and productivity in an agro ecosystem.. This study summarizes the information on the effect of management practices such as tilling, manuring, use of pesticides etc. on the population of soil micro arthropods and also on the edaphic factors .The extraction of soil microarthropods were done by modified Tullegren funnel and analysis of edaphic factors such as soil temperature, soil moisture, organic carbon, organic matter, Available nitrogen were done by standard laboratory methods. The result showed that the population of dipteran and collembolan was more in the soil. The maximum population density (38.5/m^2) of diptera and 18.5/m^2 collembola was recorded throughout the experiment.*

1. INTRODUCTION

Soil is part of dynamics, living, natural terrestrial ecosystem. In practical terms, soil consists of four major components: aerial materials, organic matter, water and air (Buckman and Brady 1960). An important component which is often overlooked is the biological aspect. Essential parts of the global Carbon, Nitrogen, Phosphorus, Sulphur and water cycle are carried out in soil largely through microbial and faunal interactions with soil physical and chemical properties (Doran and parkin 1994). It has become clear that economics of agricultural production depends heavily on well-maintained soil productivity. This attention has focused on soil management programmes that promote sustainable soil quality, productivity and health (Magdoff 1992; Doran and Jones 1996; Pankhurst et al. 1997). A number of ways has been suggested including alternative tillage practices, cover and rotational crop schemes, use of various compost and mulches, planting systems etc. The effect of such alternative practices is directly or indirectly on the soil faunal population especially on the microarthropod diversity and density. Diversity of soil micro arthropod has impressed many soil biologists and Anderson (1975) was among the first ones to formulate hypotheses to explain the enormous diversity.

Soil micro arthropods play an indispensable role in litter decomposition and mineral cycling (Seastedt, 1984). They decompose litter and crop-residue and increase the soil fertility. Their role in arable soils has received attention only recently (Edwards et al., 1988; Mueller et al., 1990). With the popularization of low-input and conservation tillage agriculture, studies on soil invertebrates of arable soils have increased (Crossley et al., 1989). These micro arthropods are adversely affected when soil is disturbed with various soil management practices such as tillage, which leads to sudden changes in the soil physico-chemical environment (Wallwork, 1976). On the other hand, conservation tillage or no-tillage and organic manure treatments increase the soil biotic interactions providing shelter for these soil arthropods by altering the soil environment (Crossley et al., 1984, Hendrix et al., 1986 and House et al.. 1989) and enhancing the soil organic matter. Although considerable research work has been done on the effects of various soil management practices on soil arthropods in temperate agroecosystems, little is known of these aspects In tropical and subtropical agroecosystems. This paper reports the impact of soil management practices such as tillage, application of pesticides on the community structure of soil microarthropods.

2. MATERIALS AND METHODS

This experiment was conducted at department of Zoology, Aligarh Muslim University, Aligarh, U.P. (India). The plain of Aligarh district, like a true representative of the gangatic plan, is generally level with imperceptible slope from north to south. The study site was grassland and this site was under the supervision of lands and garden department of the university, hence it received a regular look after by the gardeners. This site also received regular ploughing, manuring and weeding

Three soil core samples were taken randomly in the central area of each plot leaving 2 m from each side in order to avoid edge effects. The soil samples were processed through

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Tullgren funnel apparatus for 72 hours and the soil microarthropods were extracted in 80% alcohol. They were identified into major taxa, enumerated and data were converted into densities m". Statistical analysis (analysis of variance) of the data was accomplished within the factorial to show the effect of pesticides.

3. RESULT AND DISCUSSION

Soil microarthropods were collected for a period of 12 months from a depth of 10 cm throughout the sampling period. The microarthropod population thus collected day one and 14 days after the use of insecticide. A total of 24 collections were made for each site. Then we preserved, identified, counted and finally we calculated their diversity and density. The observations are based on the density individual orders. During the experimental period, the total number of microarthropod collected from the experimental plot was divided into Collembolans, Proturans, Diplurans, Pauropods, Mites, pseudoscorpions and Nematodes. Among Pterygotes, Diptera were more in the soil. Among Apterygotes, Springtails insects in the order Collembola were dominating. Mites and Coleopterans were the second group in terms of number of individuals in experimental plot.

Results indicated that during the investigation period, when insecticide applied at practical rates under the management practices, had negative effect on total population of microarthropods. The insecticide contamination in the ecosystem may produce secondary ill effects especially when the amount of chemical is below the lethal limits of the organism (Badji, 2007). The other reason may lie in the differences in physical properties of soil. Results showed that the soil moisture content was lower in experimental plot. These results are in agrees with Klironomos and Kendrick (1995) ,they reported on the most important variable that influenced microarthropod community structure as soil temperature, moisture content, soil pH and microbial community. Relative humidity observed in treated plot not in high proportion so it could be another reason for lowering the mesofaunal population.

Table 1: Climatological data at experimental site.

Months	**Temperature (˚C)**		**Relative humidity (%)**		**Dew point**		**Total rainfall (mm)**	**Total rainy days**
	Minimum	Maximum	Morning	Evening	Morning	Evening		
January	5.48	19.5	89.39	56.32	10.8	11.2	-	-
February	9.6	20.8	82.68	41.79	12.0	10.3	57.0	06
March	14.5	30.0	70.23	59.8	14.6	23.7	3.6	02
April	26.4	33.8	55.0	52.5	16.8	26.4	16.0	02
May	27.0	36.2	34.48	48.5	19.9	24.0	45.0	09
June	26.72	38.0	84.0	72.6	26.8	28.5	98.0	14
July	26.23	33.4	87.3	77.0	24.9	22.8	365.8	21
August	24.56	31.3	85.62	78.43	27.3	24.1	234.4	23
September	22.5	30.8	81.0	64.2	22.6	21.3	75.6	09
October	20.0	31.0	74.34	37.9	18.8	15.6	-	-
November	14.2	28.5	79.0	41.8	12.8	13.0	-	-
December	9.3	21.7	84.54	50.0	11.0	10.2	-	-

Table 2: Population density of soil microarthropods.

Orders	**Population Density/m²**	
	0-5 cm	5-10cm
1. Diptera	21.0	38.5
2. Coleoptera	3.5	7.0
3. Hymenoptera	10.0	15.0
4. Isoptera	3.5	15.5
5. Hemiptera	8.0	12.0
6. Psocoptera	0.5	1.0
7. Embioptera	0.0	1.5
8. Diplura	1.5	0.0
9. Collembola	6.5	18.5
10. Protura	1.5	0.5
11. Prostigmeta	5.5	6.5
12. Mesostigmata	3.0	2.5

Though, the soil fauna is large assemblage of insects from microscopic Springtails (0.2 mm-2.0 mm) to Coleopterans and their larval forms to Dipterans and Isopterans. But the above mentioned orders are those which were sampled from the sampling site throughout the investigation period. In the experimental plot, among Pterygotes, Dipterans were most abundant in the soil and among Apterygotes, Springtails (order: Collembola) dominated throughout the investigation period. Carter (1993) also reported that about 90% of a microarthropod community in nature is composed of these two groups'i.e. Dipteran and Collembolan while the remainder includes Protura, Diplura and Pauropoda.

Among Acarina, Prostigmata was dominated throughout the investigation period. These results are in conformity with Seastedt (1984) who reported that collembolan (springtails) and Acari (Mites) usually account for up to 95% of total numbers of microarthropod. In temperate grasslands the biomass of mites and springtails is often reported to be similar,

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where as in tropical grassland the biomass of mites can be two the five times that of springtails (Luxton 1982).

Results of present investigation indicated that the population density was higher in 5-10 cm depth as compare to 0-5 cm depth .It may be due to the application of insecticide, microarthropodes moved downwards. So, it becomes clear that insecticide could have negative effect on mesofaunal population diversity since the value was higher from 5-10 cm, depth than 0-5 cm depth. These results are supported by Atlas (1984) who reported that the disturbance can alter the diversity of an ecosystem directly by affecting survivorship of individuals or indirectly by changing resources levels (Hobbs and Huenneke 1992). Potter (1993) also reported that under management practices such as application of chloropyrifos for reduced population of predatory mites in plots of Kentucky bluegrass for 6 weeks and similar application of Isofenphos reduced the population of non oribatid mites, Collembolan, Millipedes and Diplurans. Insecticide applications usually have a stronger negative impact on arthropods and also reduce biological pest control potentials (Sheals J.G.1953, Thomas et al. 2011, Fukada et al. 2011 and Nascimbene et al. 2012). Thus the richness of soil fauna was related to the difference of soil management. This is agreeable to other reports in relation to soil fauna to soil management. (Nakamura 1998and Nakamura et al. 2000). Peterson (1980) has also shown that the higher densities of microarthropods population occurred in upper layers of the soil.

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