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Effect of Horticulture practices on the population of Soil Microarthropods

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Abstract : **Microarthropods population within the soil include Collembolans, Proturans, Diplurans, Pauropods, Mites, pseudoscorpions and Nematodes and they play a vital role in evaluating the soil health and make them economically viable as well as economically sustainable. Economic viability and soil degradation are major issues in grassland ecozone of western plains of U.P. in India. The natural growth of grasses depends on the edaphic factors and the soil dwelling micro arthropods. The objective of this study was to identify the patterns of diversity in a below ground community of Microarthropods especially collembola at grassland site in a semi arid zone of western U.P. in India. 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 total number of Microarthropods obtained from this site showed an irregular trend of fluctuation during the investigation period .Among Apterygotes,the population of Folsomia candida (Isotomidae:Collembola) was recorded throughout the year. The maximum density (15.5) was recorded in the month of January .Among edaphic factors soil temperature varied between 17.0 to 30.5,soil moisture 0.80 to 4.16%,organic carbon 0.74 to 0.91% and available Nitrogen varied between 226.8 to 256.2ppm.This study strongly suggest that no single factor is responsible for the diversity of microarthropods population but all factors have a cumulative effect and soil microarthropods contribute in the healthy growth of the grasses .so, they are potentially valuable for monitoring the grassland health.**

Key words: Grassland, soil microarthropods, Collembola, Edaphic factors.

INTRODUCTION

Soil and litter habitats have become recognized as important repositories for biodiversity. They are also dominated by some of the smallest animals; the Microarthropods. Microarthropods inhabiting soil and litter include Springtails, mites, Diplurans, Proturans, Symphylids and Scorpions. Collembolans dominate this fauna in terms of abundance, biomass, species diversity and their effect on the nutrient cycling process. The majority of springtails feed on fungal hypai or decaying plant material. In the soil, they may influence the growth of mycorrhizae and control fungal diseases of some plants.soil microarthropods play vital role in maintaining soil fertility, health and productivity (NiwaChristineG.,Peck Robert W.et al 2001). In the present study an attempt has been made to study the qualitative and quantitative structure of soil microarthropod population specially Collembola of the grassland soil.

MATERIAL AND METHODS

In the present study, mineral soil samples were collected from depth of 5cm with the help of a corer modified by Averbach and crossley (1960). The soil samples were collected bimonthly for a period of three months. Extraction of microarthopods 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, pH, content of organic carbon, nitrate and phosphate were done by standard laboratory methods. Temperature was measured by directly inciating 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

The sample for the study collected at a depth of 5 c.m. from grassland yielded insects showed an irregular trend of fluctuation during the sampling period (from Mar2008 to Feb.2009) 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. The plantation done in the beds was also seasonal. The lawn grass was also trimmed mechanically by mowing machine. Secondly as a part of the campus, this place is used by students and passer bys regularly. Tree shade of huge trees is very less of only Goldmohar and Ashoka trees are planted on the road side. Therefore, there is no litter deposition either on the flower

beds on the lawns. The insects sampled from the soil of this site belonged to both the sub classes: the Pterygota and Apterygota. The Pterygote population was represented both the adult and larval forms. The Apterygote insects were dominated by the Collembolans and Diplurans.In comparison to other insects Collembola were present in large numbers. The total number of insects and mites obtained from this site showed an irregular trend of fluctuation, during the sampling period ranging from March 08 to Feb. 09. Among the adult Pterygotes, Isopterans were maximum in the month of August and September (Monsoon months) and minimum in April and May while totally absent in the months of March, July and August.

Dipterans were found maximum in May, August and September, where as minimum numbers were in March. They exhibited a gradual increase from March and attained a peak in August and September followed by gradual decline. Maximum population of Hymenoptera was record in December and minimum was in March and October while totally lacking in the months of April, June and September. The larval forms of coleopterans and dipterans were maximum in the monsoon months and minimum in summer and winter. Apterygote population was followed by orders Collembola and Diplura. Among the collembolans their number was maximum in January and minimum in the month of September, same as in case of order-Diplura. Diplurans were nil in the months of March, April, June, September and November. The edaphic factors also varied during this period. When the organic carbon and available nitrogen was lowest (0.43ppm and 226.8 ppm), the Isoptera were highest, this shows the insignificant relationship of Isoptera with organic carbon and available nitrogen. Similarly when the phosphate content was minimum, the Isopterans were lowest, it shows the significant relationship with Isopterans. Whereas Diptera shows the insignificant relationship with phosphate. Isoptera also shows significant relationship with potash content because when the potash becomes lowest, the number of Isopteran was also minimum. The soil biodiversity is richly supported by pterygote as well as apterygote insects and mites. The apterygote population, in this grassland site was represented only by order Collembola and Diplura.

The collembolans and Diplurans were found maximum during mansoon months. Their population was maximum in the months from March to July. During these months the atmospheric temperature is very high and the relative humidity is also very high (44^{o}C and 100%) the weather is dry. Extreme dryness and heat effects the growth of grasses. The grassland becomes dry and without grass absence of soil moisture also results in low population of soil microarthropods. 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 55^{o}C in desert (William et al 1987). Earlier reports of collembolan thriving at 55^{o}C were given by Agrell (1941) and Davis (1963). The thermal preferences of Collembola and Acari were investigated within a temperature gradient (-3 to +13^{0}C) under 100% relative humidity conditions, by Hayward S.A.L. et al. (2003).

The soil moisture also has a positive correlation on the population of the soil insects. The population of Collembola, Diplura and Acari were moderate in the grassland. When the soil moisture was maximum in the month of January, the population of Collembola was highest. Our observations fall in accordance with the findings of Block W. (1981), Verhoef, H.A. and Van Sleen A.J. (1985), coulson S.J. et al. (1995), Huhta Veikko and Hanninen Sanna – Maria (2001) and Lindbery N. and Bengtsson (2005). The collection of *Folsomia candida* (order: Collembola) in a large number in the month of January, is supported by the finding of (Bakonji, G 1989) where the microbial biomass of the grassland supports rich population of Collembola.

Now the next important edaphic factor is soil pH varied between 7.4 to 7.7. It had little or direct effect on the population of soil microarthropods. 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 except in Coleoptera and Acari. Choudhoury and Roy (1972) support our findings in which they observed either positive or negative correlation of collembolan population with phosphate content. The amount of available nitrogen which ultimately changes into nitrate through the process of Nitrification varied between 226.8 ppm to 256.2ppm. There was an increase in the nitrogen content of the soil during rainy season because with the decrease in temperature during rainy season caused an increase in the population of Collembolan; subsequently followed by the breakdown of dead arthropods exclave by the soil bacteria finally increased the Nitrogen content of the soil. Belfield (1970) has observed excreta of arthropods unaffected by the bacteria during dry season when subjected to rapid bacterial action induces population rise through increase in nitrogen content. The available nitrogen being the most essential macronutrient for the plants probably exerts its influence on soil insects and mite population. The physical and chemical factors of the soil have direct or indirect effect on the population of these insects. Secondly here litter decomposition and humus formation was negligible. As we know that collembolans and diplurans are a strong pillars of decompositions community. When liter is not available, even the soil moisture is not helping the soil microarthropods to increase in number. Thirdly, absence of fungi and algae from the site. The collembolans feed on fungus So Scarcity of food was one of the reason for their low population .Acari was

good in number in the plantation site, as they feed on collembolans. The subsoil food web is a short food chain but a strong food chain. In this work we have tried to assess the insectan population of the soil and also the interrelationship of the population with different physical and chemical factors. We came to a conclusion that a single factor is not responsible for the seasonal variation of the insectan population, but all factors together have a cumulative effect.

Order	Variation ratio F	
	Between Columns	Between rows
PTERYGOTE		
Isoptera	448.39	1.33
Diptera	109.05	3.53
Coleoptera	681.03	3.99
Hymenoptera	920.06	1.69
APTERYGOTE		
Collembola	931.64	1.64
Diplura	1048.99	2.71
ACARI	274.20	5.16

Table 1. Significance of population fluctuations of various insect groups as determined by ANOVA test during 2008-09 at Grassland site.

Diversity / Months	Diversity index (H)	Evenness (E)
Mar.08	1.19	0.48
Apr.	1.22	0.36
May	1.70	0.45
Jun.	1.45	0.38
Jul.	1.34	0.37
Aug.	1.52	0.41
Sep.	1.36	0.37
Oct.	1.55	0.40
Nov.	1.58	0.39
Dec.	1.52	0.34
Jan.09	1.42	0.30
Feb.	1.72	0.44

Table2. Monthly variation in species diversity of different insectan groups represented by Shannon Wiener diversity index (H) and Evenness (E) during 2008-09 at grassland site.

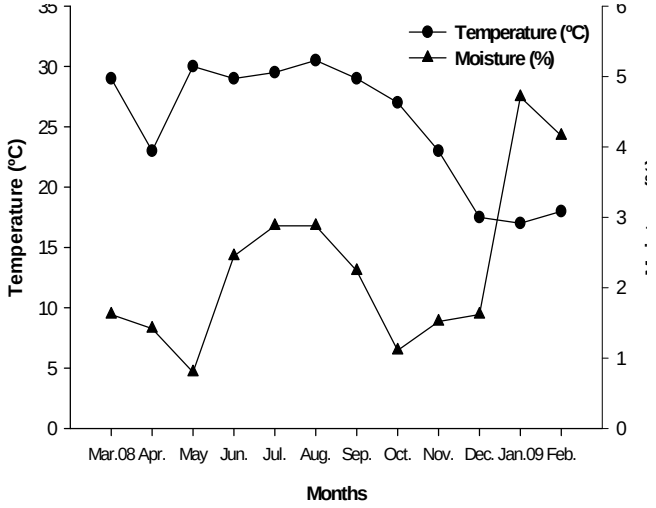


Fig (a) Correlation between soil temperature and soil moisture at grassland site.

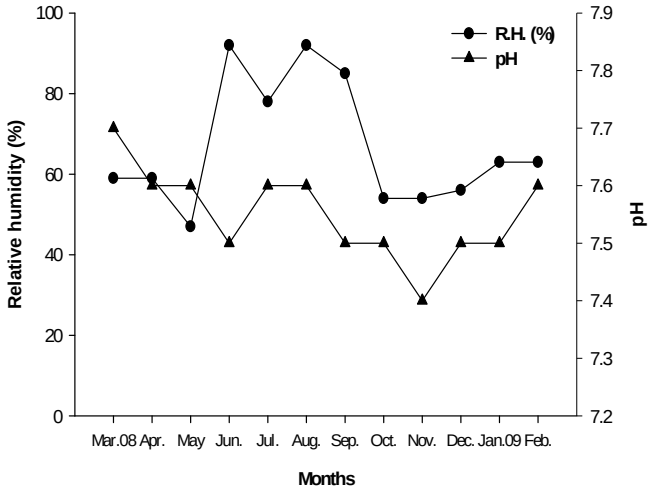
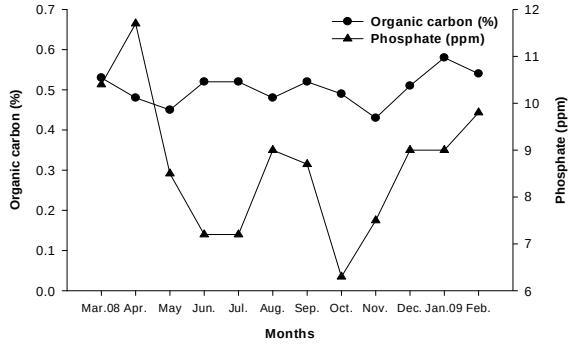
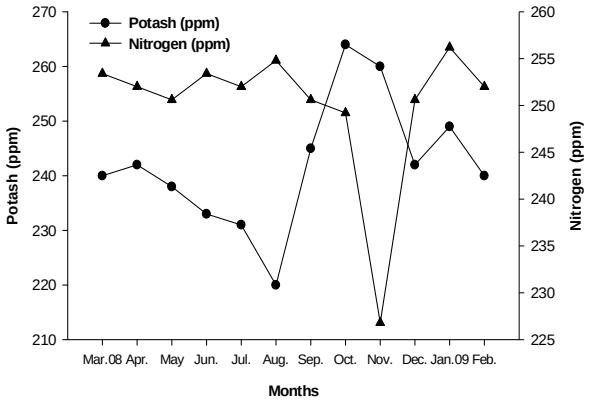


Fig (b) Correlation between relative humidity and pH at grassland site.



Fig(c) Correlation between organic carbon and phosphate at grassland site**.**



fig(d) Correlation between potash and nitrogen at grassland site.

Months / Orders	Mar.08	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.09	Feb.
Pterygote												
Isoptera	–	5	2	–	5	2	4	4	–	1	2	4
Diptera	5	20	11	30	22	24	16	17	14	16	13	3
Coleoptera	2	15	2	11	13	12	12	9	10	11	9	9
Hymenoptera	19	–	–	–	–	–	–	3	1	–	–	–
Apterygote												
Collembola	4	–	–	1	–	2	1	5	–	3	7	8
Diplura	45	–	–	1	–	3	2	4	2	–	–	2
Acari	3	3	3	1	7	24	5	9	4	12	26	26

Table 3. Mean value of insectan population of mineral soil upto 5 cm depth during 2008-09 at grassland site.

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