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Soil Management Practices for Sustainable Agro-ecosystems in India

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Abstract

Today there is an urgent need of food demand for the next 50 years poses a huge challenge for the sustainability of both food productions for global and local environments. Today’s agricultural technologies may be increasing productivity but they may also be threatening agricultural ecosystems. This paper addresses the importance of soil mesofauna and management practices for improving the Soil health. The extraction of soil mesofauna was done by modified tullegren funnel and analyses of edaphic factors such as- soil temperature, soil moisture, organic carbon, available nitrogen, phosphate were done by standard laboratory methods. The result showed that Soil mesofaunal communities are influenced by some selected factors through management practices such as-cropping, tilling etc. which ultimately help in maintaining the soil health.

Keywords: Soil mesofauna, management practices, edaphic factors, Collembola, Acari.

INTRODUCTION

Soil mesofaunal population is an important component of the biodiversity of many ecosystems and their populations require proper management for sustainable land use. They include primarily invertebrates such as ants, earthworms, termites, amphipods, centipedes, millipedes, Collembola, Protura and Acarina. These organisms are affected by usuing some management practices such as- cropping, tillage, use of pesticides etc. Soil mesofauna are key organisms influencing decomposition and biodegradation of organic residues, soil organic matter dynamics, humification, and nutrient release and soil physical characteristics such as bulk density, porosity and water availability (Lee and Foster, 1991; Brussaard et al., 1993; Lavelle et al., 1992; TSBF, 1994; Tinzara and Tukahirwa, 1995; Black and Okwakol, 1999; Beare et al., 1997). Soil faunal population is key organism influencing decomposition and biodegradation of organic residues, soil organic matter dynamics, humification, nutrient release and soil physical characteristics such as bulk density, porosity and water availability (Lee and Foster, 1991; Brussaard et al., 1993; Lavelle et al., 1992; TSBF, 1994; Tinzara and Tukahirwa, 1995; Beare et al., 1997). In general, soil faunal population breakdown and redistribute organic residues in the soil profile, increasing their surface area for microbial activity. The subsequent deposition of faecal pellets also has important ecological implications (Lavelle et al., 1992). The influence of soil fauna on soil structural properties has been considered 4to be the best long-term indicator of soil quality (Linden et al., 1994) yet despite their role in maintenance of structure and function of the belowground ecosystems, their importance is often overlooked (Crossley et al., 1992) In India, limited research on soil mesofauna has been done. Some of the well studied mesofauna include termites, Collembola with most of the work concentrated in more or less natural habitats.

MATERIAL AND METHODS

The study was conducted in Aligarh Muslim University, A.M.U. Aligarh, U.P. (India) where the management practices applied on the study sites. There were two sites for study. Site A where the management practices applied and other site was Site B without any management practice. In this study, soil samples were collected from the depth of 0-5cm with the help of a corer modified by Averbach and Crossly (1960). The soil samples were collected bimonthly for a period of twelve months. Extraction of soil 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, pH, organic carbon content, 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

Soil Characterization:

Results of selected soil properties under different management practices systems are presented in Table 1. Soil pH levels in experimental site were ranged between 7.2 and 7.8. It was highest in site where the cropping and tilling practices applied (7.8), but lowest at on other site in (7.2) (Table 1). The highest level of % organic carbon was realized in the site where these management practices applied (0.72%), but lowest on the other hand. Available nitrogen was also highest at site A (310 ppm) but again lowest in site B (190 ppm). The level of phosphorous was lowest in site B (8.34 ppm) with the highest level being realized in the site A (12.54 ppm)

Soil mesofaunal population:

Soil mesofaunal diversity occurring in the different experimental sites studied is shown in Table 2. The diversity of soil mesofauna in experimental site was very rich where the management practices applied (Site A) as compare to other site (Site B). In general, the mesofaunal population was the most abundant in terms of both number and biomass at Site A. The work carried out in a stipulated period for the assessment of relationship of abiotic factors with soil mesofaunal population. The samples collected from the sites yielded insects and mites under the mesofaunal population. The total numbers of insects and mites show the irregular fluctuation during the samplingperiod.

The total mesofaunal population comprises Pterygote, Apterygote and Acari. The population of pterygotes from both the sites comprised of Diptera, Hymenoptera, Isoptera, Coleoptera, Collembola, Protura and Acarina. There is either positive or negative correlation with the edaphic factors. Generally Diptera was the most abundant of the mesofauna group constituting about 45% of the total followed by Coleoptera (39%), Isoptera (6%), Hymenoptera (5%), Collembola (3%), Protura(2%) and Acarina (1%). The other mesofaunal groups that comprised Hemiptera, Dictyoptera, each constituted <1% of the total mesofauna recorded (Figure: 1). Tripathi G. at al (2007) stated that the population of soil mesofauna and fluctuation in cast composition with seasons vary from species to species. The Apterygote and Acari population was quite variable.

When we compare the population with the edaphic factors it becomes clear that through the soil temperature and moisture was suitable for the mesofaunal population still they were not collected in large numbers. Reasons we tried to analyze. The population soil mesofauna from the experimental sites all were statistically proven to be falling in line with the observations of the previous workers. The low and high of the population is also interrelated with the edaphic factors. The soil moisture has a positive correlation on the population of the soil mesofauna. The population of Collembola, Diplura and Acari were moderate in the site A. 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). Now the next important edaphic factor is soil pH varied between 7.4 to 7.8. 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) and our earlier studies (Parwez H. and Sharma N. 2014(a)2014(b),2014(c),2015,2017(a),2017(b) and 2019) support the 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 256.2 ppm. 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. In Conclusion, we can say that management practices such as Cropping, Tilling etc. enhance the mesofaunal population by which the soil fertility increase.

Table 1: Seasonal variation in edaphic factors at experimental sites

Months	Soil temp (˚C)		Soil Moisture		pH		Organic Carbon(%)		Available Nitrogen (ppm)		Phosphate (ppm)	
	A	B	A	B	A	B	A	B	A	B	A	B
January	18	17	2.75	1.98	7.4	7.5	0.53	0.34	220	198	12.54	10.8
February	23	19	2.35	2.14	7.3	7.7	0.55	0.54	228	210	10.40	10.40
March	24	22	1.65	1.54	7.3	7.2	0.58	0.50	222	220	10.40	11.5
April	28	27	1.34	2.21	7.4	7.4	0.61	0.48	280	195	9.8	8.44
May	32	33	1.83	0.89	7.7	7.6	0.55	0.48	230	210	11.5	8.42
June	39	35	o.9	1.67	7.8	7.2	0.68	0.55	248	228	9.5	8.42
July	33	34	2.15	3.15	7.5	7.2	0.72	0.47	310	270	10.0	9.80
August	32.5	31	2.25	2.34	7.5	7.4	0.69	0.40	238	214	9.78	8.5
September	30	29	1.85	1.73	7.8	7.7	0.69	0.55	240	223	8.65	8.5
October	25.5	24	2.40	0.67	7.6	7.6	0.73	0.47	256	234	8.42	10.8
November	22	22	3.0	1.50	7.6	7.6	0.59	0.31	278	190	9.89	8.34
December	19	18.5	2.50	1.98	7.5	7.5	0.57	0.34	238	220	11.0	11.56

*****A- Site A where management practices applied.

B- Site B without management practices.

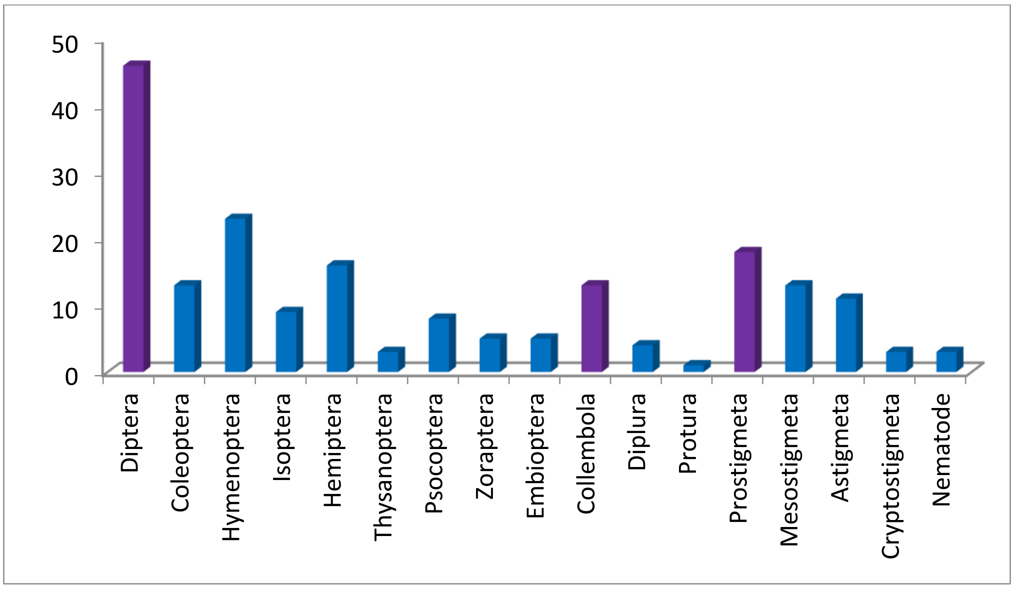

Figure 1: Dominant orders of soil Mesofauna at experimental sites from the depth of 0-5cm.

Table 2: Significance of population fluctuations of various soil mesofaunal groups as determined by ANOVA test in experimental site at the depth of 0-5 cm.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	245.4167	3	81.80556	21.11111	1.27E-08	2.816466
Within Groups	170.5	44	3.875			
Total	415.9167	47				

REFERENCES

[1] **Averbach, S.I. Crosslay, D.A; (1960).** A sampling device for soil microarthropods. Acarologia, 2; 279-287

[2] **Beare, M.H., Reddy, M.V., Tian, G. and Scrivasta, S.C. (1997)**. Agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of decomposer biota. Applied Soil Ecology, 6: 87-108.

[3] **Beare, M.H., Reddy, M.V., Tian, G. and Scrivasta, S.C. (1997)**. Agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of decomposer biota. Applied Soil Ecology, 6: 87-108.

[4] **Black, H.I.J. and Okwakol, M.J.N. (1999).** Agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of decomposer biota. Applied Soil Ecology, 6: 37-53.

[5] **Block W. (1981).** Low temperature effects on microarthropods. *Journal of thermal biology, 6(4); 215-218.*

[6] **Brussaard, L.,Hauser, S. and Tian, G. (1993)**. Soil fauna activity in relation to the sustainability of agricultural systems in the humid tropics. In: Mulongoy, K. and Merckx, R. (eds), Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture, pp. 455-460. WileySayce, New York.

[7] **Brussaard, L.,Hauser, S. and Tian, G. (1993).** Soil fauna activity in relation to the sustainability of agricultural systems in the humid tropics. In: Mulongoy, K. and Merckx, R. (eds), Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture, pp. 455-460. WileySayce, New York.

[8] **Choudhuri D.K. and Roy S. (1972).** An ecological study on Collembola of West Bengal, India,*Ric. Indian Museum India*, 66(1-4); 81-101.

[9] **Coulson S.J., Hodkinson I.D., Block W., Webb N.R. and Worland M.R. (1995)**. Low summer temperatures: a potential mortality factor for high arctic soil microarthropods. *Journal of Insect Physiology*, 41(9): 783-792.

[10] **Crossley, D.A., Mueller, B.R. and Perdue, J.C. (1999)**. Biodiversity of microarthropod in agricultural soils: relations to processes. Agriculture, Ecosystems Environment, 40: 37-46.

[11] **Dowdeswell W.H. (1959).** Practical Animal Ecology. *Methuen and Co. Ltd.*

London

[12] **Hunta Veikko and Hanninen Sanna – Maria (2001).** Effect of temperature and moisture fluctuations on an experimental soil microarthropods community. *Pedobiologia; 45(3); 279-286.*

[13] **Jackson M.L. (1966)** “soil chemical analysis” Prentice – Hall Inc Englswod Cliffs, New Jersey.

[14] **Lavelle, P., Spain, A.V., Blanchart, E., Martin, A and Martin, P.S.(1992)**. Impact of soil fauna on the properties of soils in the humid tropics. In: Sanchez, P.A and Lal, R. (eds), Myths and Science of soils in the tropics. Soil Science Society of America, Special publication. No. 29, Madison, USA, pp. 157-185.

[15] **Lavelle, P., Spain, A.V., Blanchart, E., Martin, A and Martin, P.S. (1992)**. Impact of soil fauna on the properties of soils in the humid tropics. In: Sanchez, P.A and Lal, R. (eds), Myths and Science of soils in the tropics. Soil Science Society of America, Special publication. No. 29, Madison, USA, pp. 157-185.

[16] **Lee, K.E., and Foster, R.C., (1991)**. Soil fauna and structure. Australian Journal of Soil Research, 9: 754-760.

[17] **Lindberg N. and Bengtsson J. (2005)**. Population responses of oribatid mites and collembolans after a drought disturbance.*Applied Soil Ecology, 28; 163-174.*

[18] **Linden, D.R., Hendrix, P.F., Coleman, D.C. and van Vliet, P.C.J. (1994)**. Faunal indicators of soil quality. In: Doran, J.W., Coleman, D.C., Bezdicek, D.F. and Stewart, B.A. (eds). Defining Soil Quality for a Sustainable Environment. SSSA Special Publication, No. 35, pp. 3-22

[19] **Parwez H. and Sharma N. (2014)** Effect of Edaphic Factors on the population density of soil micro arthropods. *Journal of Agroecology and natural Resource Management. Vol-1;187-190*

[20] **Parwez H. and Sharma N. (2014)** Circannual Variation and Interrelationship of Edaphic Factors With the Soil Micro Arthropods in Agro Forestry Habitats. *International journal of scientific research. Vol-3;25-27*

[21] **Parwez H. and Sharma N. (2014)** Comparative Assessment on the Effectiveness of Rainfall on Soil Microarthropods Population .*International journal of science and research. Vol-3;2775-2779*

[22] **Parwez H. and Sharma N. (2014)** Effect of horticulture practices on the population of soil microarthropods. *International Journal of Basic and Applied Biology, Vol-2(1);40-43*

[23] **Sharma N. and Parwez H. (2017)** Seasonal Dynamics and Land use Effect on Soil Microarthropod Communities in the Northern Indian State of Uttar Pradesh (India). *International Journal of Applied Agricultural Research,*

Research India Publications, Vol-12;371-379

[24] **Sharma N. and Parwez H. (2017**) Population density and diversity of Soil mites (Order: Acarina) in agroforestry habitat: Relationship to Soil temperature and Soil moisture. *International Journal of Applied Environmental Sciences, Research India Publication*s, *Vol-12;1449-1460*

[25] **Sharma N. and Parwez H. (2019**).Effect of management practices(Pesticide application) on soil mesofaunal population. *Journal of Agroecology and natural resources management(JANRM),Vol 6;144-148*

[26] **Tinzara, W. and Tukahirwa, E.M. (1995)**. The effects of soil macrofauna on soil properties in a banana cropping system, Masaka District, Uganda. TSBF Afnet V Report. Nairobi, Kenya. pp. 23.

[27] **Tinzara, W. and Tukahirwa, E.M. (1995)**. The effects of soil macrofauna on soil properties in a banana cropping system, Masaka District, Uganda. TSBF Afnet V Report. Nairobi, Kenya. pp. 23.

[28] **Tripathi, G., R. Kumari and B.M. Sharma(2007):** Mesofaunal biodiversity and its importance in Thar Desert. J. Environ. Biol., 28, 503-515.

[29] **TSBF (1994)**. Tropical Soil Biology and Fertility Programme. Annual Report, pp 52, Nairobi, Kenya. 52p

[30] **Verhoef H.A. and Van Selm A.J. (1983)**. Distribution and population dynamics of Collembola in relation to soil moisture.*Ecography, 6 (4); 387.*

[31] **Walkley A. and Black I.A. (1934).** An examination of the degtjareff method for determining soil organic matter and a proposed modification of the chromatic acid titration method. *Soil Sci., 37: 29-38.*