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Population Density and Diversity of Soil Mites (Order: acarina) in Grassland: Special Reference to Soil Temperature and Soil Moisture

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Abstract

Mites (Acari) are the most diverse and abundant arthropods in an Indian grasslands. These mites reproduce relatively slowly (k-strategic) as they typically feed on detritus and fungi. The reproduction rate of oribatid mites is low compared to other soil microarthropods (Travé et al. 1996; Maraun 2009), due to their longevity. Soil Acarina was the very small free-living soil and litter microarthropods which were most abundant and dominant group in grassland soils by maintaining the edaphic factors through decomposition and mineralization. Fluctuations in the population density and diversity of mites up to the depth of 10 cm of soil were determined over 12 months period in grassland soils at Aligarh Muslim University, Aligarh (U.P.), India. The objective of this study was to evaluate the population density and diversity of soil acarina in a semi arid zone of western U.P. in India. The extraction of soil Acarina 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. Pearsson correlation coefficient (r) was used to determine the relationship of Acari population densities with edaphic factors such as soil temperature, soil moisture, organic carbon content, available nitrogen etc. of soil. The result showed that among Acarina, Astigmata and Mesostigmata were the most-abundant when the soil temperature was 18˚C to 33˚C whereas, Cryptostigmata showed low population

Keywords: Soil acarina, Agroforestry, Cryptostigmata, edaphic factors

INTRODUCTION:

Soils originate and accumulate in a sequence of events that mark the stages of ecological succession, the development of biotic communities. Soil formation, or pedogenesis, involves a set of physical, chemical, and biotic processes. The soil is also a complex living body that breaths, assimilates organic and inorganic elements, breakdowns and mineralizes organic matters of biological origin, and stores reserves as organic matter. In soil, these functions are accomplished by organisms inhabiting through their metabolism. Soil is also an important for habitat for different groups of mesofauna. Grassland soils are among the most productive biomass, the rate of energy turnover is high and about 90% of their net primary productivity is decomposed in situ (Coleman et al 2004). Soil Mites (Acari) are one of the most abundant mesofaunal group within soil. Many studies have demonstrated that they are sensitive to modifications of the different physical (soil water content, temperature) and chemical [soil nutrients, organic matter, pH, N and carbon (C)] environmental factors (Chikoski et al. 2006; Nielsen et al. 2010, 2012; Kardol et al. 2011). Wood (1991) considered the biological quality of the soil in terms of the soil organism populations or of the processes accomplished by the organisms. When plants die, the above ground plant parts are distributed within the soil by gravity, water movement and by soil organisms. The Acari of the soil includes members that feed on dead plant materials, as well as on the microflora (bacteria, fungi); in addition, species of Prostigmata and Mesostigmata may prey upon elements of the micro-and mesofauna (e.g., nematodes, collembolans, enchytraeid worms (Wallwork, J.A1970, 1976 and Petersen 1982). The higher concentration of population density of soil acarina in the grassland soils attributed to the availability of food, accumulation of litter and optimum growth of acarine population while the disturbances in edaphic factors have a negative impact on soil mesofaunal population. The population density of soil Acarina 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.

MATERIAL AND METHODS:

The study was conducted in Aligarh Muslim university, 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 mites found in the depth of 0-10 cm of soil, soil mites were collected randomly with the help of a corer modified by Averbach and crossley (1960). The soil samples were collected bimonthly for a period of two years. 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, and 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.

RESULTS AND DISCUSSION:

The work carried out in a stipulated period for the assessment of population density and diversity of soil mites with special reference to soil temperature and soil moisture in the grassland soils gave the interesting results. The samples collected from the grassland yielded insects and mites. The total number of insects and mites showed the irregular trend of fluctuation during the sampling period. Acarina was found to be dominant group comprising 46.56% total soil microarthropods in the experimental year. 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. Chitrapati (2002) also reported that Acarina comprised 66% and 63% of total soil microarthropods. The higher density of microarthropods in Acarina in upper layer of the soil (0-5 cm) was characterized by favorable moisture condition, adequate living space aeration ratio and rich accumulation of organic debris (Peterson, 1980; Hagvar, 1983) had also observed higher density of microarthropod population in the upper layers of the soil.

The population of soil mites from this site comprised of Cryptostigmata, Mesostigmata, Prostigmata and Astigmata. There is either positive or negative correlation between temperature, moisture, pH, organic carbon and available nitrogen. The average soil temperature and moisture is recorded in grassland soils. Soil temperature exhibited an increasing trend along with the soil depth which may be due to rain that keeps the surface cooler than lower region. The slight decrease in temperature in 0-5 cm depth than 5-10 cm depth in rainy season is due to continuous rainfall that helps in raising temporary small vegetation cover that to keep the surface cool. Bhattacharya and Roy choudhuri (1979) studied the effect of temperature on the development of mite species Oppia nodosa Hamer. There was no reproduction at 8 °C while at 16 °C, 24 °C and 36 °C the duration of development was 54, 21 and 14 days, respectively indicating the effect of temperature on the development of mite.

Higher rainfall together with high relative humidity followed by vegetation growth leads to the increase of soil moisture content during rainy season. Rainfall and soil moisture were the major factors influencing the pattern of temporal variations in the abundance of most of the micro arthropod groups. The population density of soil Acarina of Himalayan ecosystem reached the maximum level in March, the spring season when organic carbon was at maximum level (Bhattacharya and Bhattacharya, 1987). In the present study, maximum population of Acarina during rainy season reached the peak in August-September followed by summer and winter season with minimum record during winter season in the month of December. Many earlier workers also reported greater abundance of Acarina in the upper soil layer than the lower depth (Wallwork, 1970; Niijima, 1971 and Alfred et al. 1991). In the present study, maximum population growth during rainy season reached the peak in August and September. This may be due to favorable, physico-chemical factors i.e. optimum condition of moisture, organic carbon content etc. during rainy season as the population buildup of soil microarthropods is influenced by a variety of factors viz., vegetation, soil, climate etc. and their interaction (Narula et al. 1998).

Soil Acarina in the upper soil layers was primarily found to be influenced by moisture content and secondarily by temperature conditions (Strong, 1967). In this study, soil samples were recorded lower mites density and diversity compared to the 5-10 cm depth . This could be attributed to regular cultivation resulting in disturbances. For instances, tillage has been demonstrated to have adverse effects on soil mites with 50% reduction in population immediately after tillage (Hülsmann and Wolters, 1998).

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). C.W. Maribie 2011 had also shown that the higher densities of micro-arthropods population occurred in the upper layers of the soil. Environmental factors such as high soil organic matter content, proper soil moisture conditions throughout the year, soil temperatures without heat extremes in summer, nearly neutral pH levels are favorable conditions for soil mite development. It is well known and documented that a high soil organic matter content is usually beneficial for most soil animal groups (Edwards and Lofty 1969, Ghilarov 1975, Bandyopadhyaya et al. 2002), and that biodiversity is relatively strongly linked to available energy resources and essential nutrients (Pokarzhevskii and Krivolutskii 1997).

The positive correlations of soil pH with total mite, mesostigmatid, and astigmatid densities seem to show a tendency toward a neutral pH preference of these taxa as a group. Although acidity is considered one of the major factors determining the species composition of soil invertebrate communities, responses of mites to pH is less clear than for other groups (Manu M. et al 2016). The Mesostigmata and Astigmata were the most-abundant group. These groups generally maintain the highest numerical abundance followed by the Mesostigmata, Prostigmata, and Astigmata (Davis 1963, Hermosilla and Rubio 1974, Hermosilla et al. 1977, Seastedt 1984, Curry and Momen 1988), and we found a similar pattern. In the present study, we found comparable proportions for the Mesostigmata and Oribatida, if the average of all samples is considered. This agrees with the observations of Bedano and Cantú (2003) and with those of Davis (1963) in natural grassland in the UK, where populations of Oribatida and Mesostigmata were relatively similar in magnitude to each other and more abundant than the other 2 suborders.

These mites are found with greatest density in mature, stable sites and are often the dominant components of the soil mite fauna in such environments (Curry 1988, Edwards and Lofty 1969, Siepel 1996, Hulsmann and Wolters 1998, Cancela da Fonseca JP, S Sarkar. 1998 Behan-Pelletier 1999).It has been suggested that microarthropod abundance tends to be greatest in spring and summer and lowest in winter (King and Hutchinson 1976, Wallwork 1976, Edwards 1991, Bardgett et al. 1993, Bardgett and Cook 1998). In general, seasonal fluctuations of Acari densities are associated with soil moisture, temperature, and litter availability (Wermelinger, B et al 1991) Low densities of mites during the winter in this study could be attributed to low soil temperatures rather than to the soil moisture regime. This assessment agrees with observations that temperature was more important as a regulator of microarthropod abundance than was soil moisture in some experimental studies Philpott, S et. al 2006.

CONCLUSION:

Soil temperature soil moisture affect the Acari population directly through physiological and mechanical ways and also indirectly through host quality changes. This study provides important information regarding soil mite populations in natural soils in grassland soils and represents useful reference data for soil degradation studies. Furthermore, this report is of special importance at the local and regional levels, due to the scarcity of information on soil mites of India, and it is a precursor to more detailed research at lower hierarchical taxonomic levels.

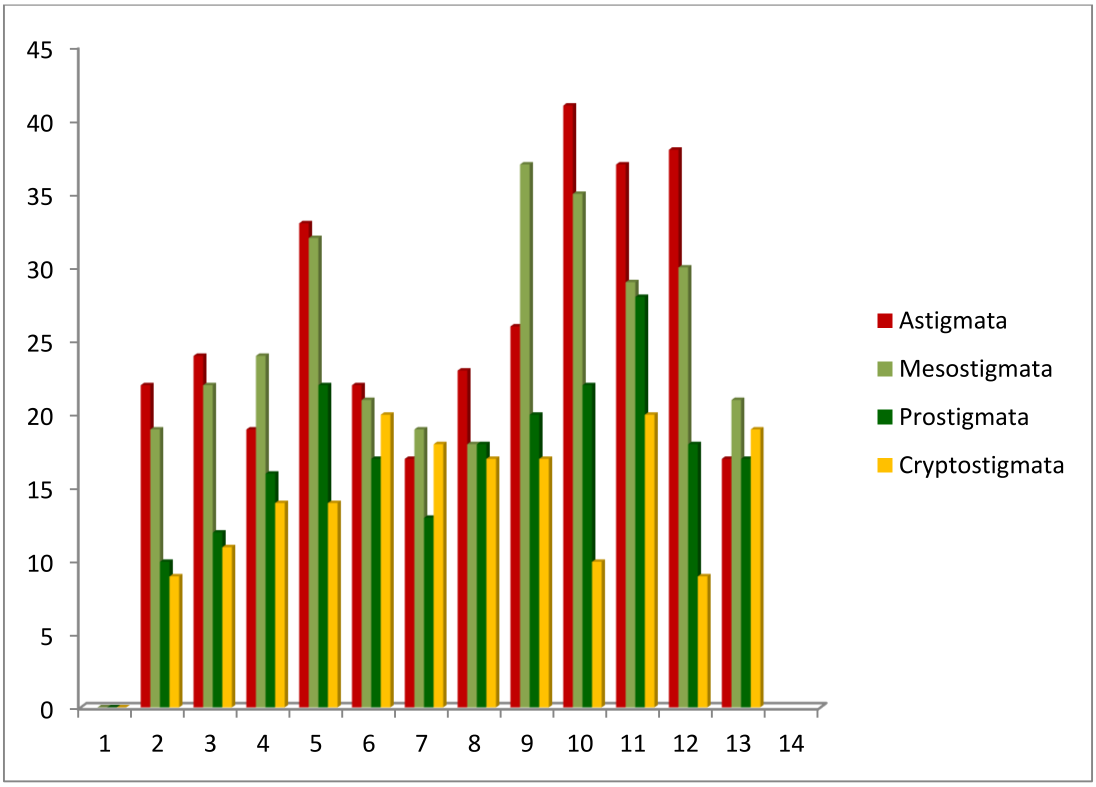

Figure 1: Mean population of Soil Acarina during the experimental period.

Table1 (a): Pearson Correlation between Acarina population and edaphic factors during experimental

Soil Acarina / Edaphic factors	Cryptostigmata		Mesostigmata	
	0-5cm	**5-10cm**	**0-5cm**	**5-10cm**
Soil Temperature	0.118	-0.379	0.532	**0.716****
Soil Moisture	0.173	0.184	**0.612***	0.274
Relative Humidity	**0.639***	-0.389	**0.638***	-0.145
pH	-0.219	0.367	-0.180	-0.174
Organic Carbon	0.164	**0.578***	-0.319	-0.239
Organic Matter	**0.576***	-0.169	**0.589***	-0.221
Electrical Conductivity	0.027	**-0.615***	**-0.549***	-0.378
Available Nitrogen	-0.208	-0.337	-0.480	-0.536
Phosphate	**0.716****	-0.174	-0.286	-0.174
Potassium	0.278	-0.229	0.170	-0.139

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

****.** Correlation is significant at the 0.01 level (2-tailed).

Table1 (b): Pearson Correlation between Acarina population and edaphic factors during experimental year

Soil Acarina / Edaphic factors	Prostigmata		Astigmata	
	0-5cm	**5-10cm**	**0-5cm**	**5-10cm**
Soil Temperature	0.178	0.249	0.012	-0.140
Soil Moisture	0.156	**0.639***	-0.141	0.082
Relative Humidity	**0.592***	0.194	0.358	0.072
pH	**0.628***	0.447	0.417	**0.716****
Organic Carbon	0.249	**0.999***	-0.146	-0.256
Organic Matter	0.254	**0.639***	-0.424	**-0.627***
Electrical Conductivity	**0.578***	0.391	-0.218	0.082
Available Nitrogen	0.159	0.288	0.058	-0.142
Phosphate	0.288	0.058	-0.286	-0.155
Potassium	0.536	0.164	0.194	0.358

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

**. Correlation is significant at the 0.01 level (2-tailed)

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