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Influence of soil chemical parameters and abiotic factors on cryptostigmatid mites

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Abstract

Cryptostigmatid mites play an invaluable role in the maintenance of the physical, chemical and biological characteristics of the soil ecosystem. The activity of these alters the physic-chemical properties of the soil. Climatic factors play an important role on the soil and litter dwelling cryptostigmatids. With this concept a field experiment was carried out with varied doses of organic and inorganic fertilizer at GKVK Bangalore. The results revealed that cryptostigmatids indicated a significant positive relation with exchangeable calcium (0.59), exchangeable magnesium (0.51), available phosphorus (0.47), available potassium (0.32), available nitrogen (0.25), soil organic carbon (0.27) microbial biomass carbon (0.39) and soil pH (0.25). The results of the multiple linear regression analysis showed that the influence of these soil chemical parameters on the abundance of soil cryptostigmatids was up to 43 percent. The impact of abiotic factors on cryptostigmatids was 64 percent.

Keywords: Cryptostigmatid mites, chemical, abiotic, mesofauna, correlation

Introduction

Abiotic factors play an important role on soil meso-fauna. Occurrence of cryptostigmatid mites depends on soil type and climate interaction. Rainfall and soil moisture were the major factors influencing the pattern of temporal variations in the abundance of most of the mites groups. Acari and Collembola represented more than 75% of the total soil fauna. Decrease in the population of soil mites significantly correlated with lower soil temperature and soil humidity at greater soil depth [1].

The population of cryptostigmatid mite is changing continuously with the change in season and environment [2]. The population density of soil Acarina of the Himalayan ecosystem reached the maximum level in March, the spring season when the organic carbon was at maximum level.

Soil mites play precise and invaluable role in the maintenance of the biological, chemical and physical characteristics of the soil ecosystem. The activity of these alters the physic-chemical properties of the soil. High diversity and density of soil fauna was associated with high organic carbon. The high fertility and organic carbon content of the soil attributed to the presence of the diverse soil fauna which assist in humus formation [3].

Material and methods

The experiment was carried out at Gandhi Krishi Vignana Kendra campus of the University of Agricultural Sciences, Bangalore. The experimental site is located at 13^0 0^1 latitude and 77^0 35^1 longitude and at an altitude of 930 m above mean sea level (MSL). The soil belongs to Vijayapur series and is classified as Oxic Haplustalf and according to FAO classification, the soil is Ferric Luvisols. Soil is reddish brown, lateritic derived from granite gneiss under subtropical semi-arid climate. The initial soil chemical properties *viz.*, organic carbon (0.34%), available phosphorus (11.69 kg/ha), available potassium (120.50 kg/ha), exchangeable calcium (6.6 meq/100g.), exchangeable magnesium (3.62 meq/100g.) and pH (5.92) were noticed during 2001. The current field experiment was laid out in a randomized complete block design with the following treatments with 3 replications. T1. Recommended fertilizers for soybean (25:60:25 NPK Kg per ha) + Recommended FYM (10 tonnes per ha) + Phorate 10 G @ l kg *a.i.* per ha + herbicide (Lasso 50 EC @ 2.5 l per ha) + fungicide seed treatment (Thiram + Bavistin- each 2g/kg of seeds), T2. 12.5 tonnes of FYM/ha + 75 percent of recommended fertilizer, T3. 15 tonnes of FYM/ha + 50 percent of recommended fertilizer, T4. 17.5 tonnes of FYM/ha + 25 percent of recommended fertilizer, T5. 20 tonnes of FYM/ha, T6. 10 tonnes of

FYM/ha, T7. 10 tonnes of FYM/ha (partially decomposed), T8. 10 tonnes of FYM/ha + mulching (Glyricidia 2 tonnes per ha.), T9. Recommended fertilizer alone and T10. 5 tonnes of FYM\ha. The soybean variety Hardee was sown with a spacing of 30cm×10 cm in 6m×3.6 m sub plot on 6th August 2011 and crop was raised under rainfed conditions. Seeds were treated with *Rhizobium* (500g/ha) before sowing.

FYM was applied to the respective plots one week before sowing. Chemical fertilizers N, P, K (Urea, DAP, MOP) were applied in recommended proportions at the time of sowing in furrows. Soil insecticide (phorate 10G) was applied in the furrows at the time of sowing. Seeds were treated with fungicide (Thiram + Bavistin - 2g each/kg) before sowing. Herbicide (Lasso) was applied in the soil on the day of sowing as a pre-emergent in treatment 1. The soil collected from the adjacent undisturbed grasslands was applied to all the treatments at the rate of 4.63 t ha^{-1} to introduce native soil faunal diversity on 7 DAG. Required quantity of fungicides (thiram + bavistin**)** was mixed with 20 ml of water plus gum arabica solution (2 ml) and this slurry was mixed thoroughly with one kg of soybean seeds. Treated seeds were dried under shade and used for sowing.

Soil samples were drawn to extract mesofauna from before application of treatment up to 300 days after germination at 15 days interval during cropping and non-cropping season. Mesofauna were extracted from the collected soil samples using Rothamsted modified MacFadyen high gradient funnel. The apparatus was run for 48 hours. The extracted fauna were separated under a stereobinocular microscope (35 X magnification).

The collected soil samples were dried under shade. The samples were crushed and passed through 2 mm sieve. Further the samples were subjected to analyse for organic carbon was estimated by wet oxidation method that was proposed by [4], similarly available nitrogen by alkaline potassium permanganate method [5] available phosphorus by ascorbic acid method [6]. available potassium by flame photometer [6] and exchangeable calcium and magnesium by Versenate titration method [6] and microbial biomass C was estimated by following fumigation and extraction as proposed by [7].

Weather parameters such as soil temperature and soil moisture were recorded at each sampling time in experimental site. Abiotic factors *viz.*, atmospheric temperature (maximum and minimum), sunshine hours and rainfall in the experimental location were obtained from the meteorological station GKVK, UAS Bengaluru.

The best treatment favouring mesofauna (T_5) was correlated with the soil chemical parameters and abiotic factors of the experiment location. The correlation coefficients were worked out by adopting multiple correlation analysis to find out the relationship between the abundance of mesofauna population, soil chemicals, soil microbial biomass C and weather parameters.

Results and discussion

Relationship among cryptostigmatid mites and soil chemical parameters

Cryptostigmatids indicated a significant positive relation with exchangeable calcium (0.59), exchangeable magnesium (0.51), available phosphorus (0.47), available potassium (0.32), available nitrogen (0.25), soil organic carbon (0.27) microbial biomass carbon (0.39) and soil pH (0.25) (Table 1).

The results of the multiple linear regression analysis showed that the influence of exchangeable calcium, available potassium and available phosphorous on the abundance of soil mesofauna was up to 43 percent. Further, the results indicated that with an unit increase of available potassium would leads to 16.441 units decrease in the abundance of cryptostigmatid mites. However, a unit increase of exchangeable calcium and available phosphorous would lead to 431.634 and 59.752 units increase in the abundance of cryptostigmatid mites respectively (Table 2).The present findings were closely related with the findings of [8] where he reported significant relation between soil chemical parameters and soil invertebrates. Further, he also noticed >50% of influence of soil chemical parameters (especially microbial biomass carbon) on soil invertebrates.

Table 1: Correlation among cryptostigmatid mite, soil microbial biomass C and soil fertility

Parameters	Organic carbon	Available nitrogen	Available phosphorus	Available potassium	Exchangeable calcium	Exchangeable magnesium	Soil pH	Soil microbial biomass C
Cryptostigmatids	0.270	0.250**	0.472**	0.329**	0.597**	0.511**	0.254**	0.397**

* Significant at p=0.05% ** Significant at p=0.01%

Table 2: Stepwise regression analysis showing the significant variables against soil cryptostigmatid mites

Variables	Multiple regression co-efficient	Standard error	't' value	'F' value	R^2 value
X_4= Available phosphorous	59.752	17.465	3.421**	22.432	0.439
X_5= Available potassium	-16.441	2.900	-5.670**		
X_6= Exchangeable calcium	431.634	109.730	3.934**		

** Significant at p=0.01%, Regression equation: $Y = 484.320 + 59.752X_4 - 16.441X_5 + 431.634X_6$

Relationship between cryptostigmatid mites and abiotic factors

Significant relationship existed between the abundance of cryptostigmatid mite and abiotic factors. Maximum atmospheric temperature (-0.637), soil temperature (-0.575) and insitu soil temperature (-0.534) showed a significant negative correlation with cryptostigmatid mite. Maximum and minimum relative humidity (0.614 and 0.600) had significant positive correlation. Similarly, positive non significant correlation was observed with total rainfall and and soil moisture (0.382). However, remaining sunshine hour (-0.275) and mimimum temperature (-0.182) had negative correlation with the cryptostigmatid mites (Table 3). Similar negative correlation with soil temperature was recorded for Acari in deciduous forest and soil insects in *Dalbergia sissoo* [9]. Maximum relative humidity, minimum relative humidity and soil moisture showed a positive relationship with soil mesofauna abundance. Similar results were obtained by earlier scientists *viz.*, Collembola and Cryptostigmata in waste land, Acari in forest; total soil fauna in forest; cryptostigmatid mites in forest; Acari in forest [10]; Collembola in rubber [11] mites and soil insects in Dalbergia sissoo [9]; Collembola in agro-forestry; Precipitation was significantly correlated with Collembola [12]. However, in the present study total rainfall had positive relation but it was non-significant and indirectly it showed significant with moisture.

The contribution of abiotic factors on the abundance of cryptostigmatid mite was 64 percent **(**Table 4**).** Data was subjected to multiple linear regression analysis, results showed that the influence of the maximum temperature on the abundance of cryptostigmatid mite was up to 40 percent. Further, the results indicated that with a unit change of maximum temperature would lead to decrease of 1.585 units in cryptostigmatid mite abundance (Table 5). Similarly, [13] also observed 40% impact of abiotic factors on the abundance of soil mesofauna, other acari in soybean.

Table 3: Correlation between cryptostigmatid mites and abiotic factors in soybean ecosystem

Particulars	Maximum temperature	Minimum temperature	Maximum RH	Minimum RH	Sunshine hours	Total rainfall	Soil moisture	Soil temperature	Insitu[1] Soil Temp
Cryptostigmatids	-0.637**	-0.182	0.614**	0.600**	-0.275	0.140	0.382	-0.575**	-0.534*

** Significant at 0.01% level. * Significant at 0.05% level.

Table 4: Regression equation between cryptostigmatid mites and abiotic factors in soybean ecosystem

Particulars	Regression equation	R^2 value
Cryptostigmatids	$Y=-55.710 + 1.297X_1 – 0.029X_2 – 1.986X_3 +0.915X_4 - 0.042X_5 - 0.125X_6 – 2.125X_7 + 1.064X_8 – 0.404X_9$	0.644

X_1= Maximum temperature, X_2= Minimum temperature, X_3= Maximum relative humidity

X_4= Minimum relative humidity, X_5= Sunshine hours, X_6= Total rainfall

X_7= Soil moisture, X_8= Soil temperature, X_9= Insitu soil temperature

Table 5: Stepwise regression analysis showing the significant abiotic variables against cryptostigmatid mites.

Particulars	Variables	Multiple regression coefficient	Standard error	't' value	'F' value	R^2 value	Regression equation
Cryptostigmatids	X_1 = Maximum temperature	-1.585	0.429	-3.692**	13.627**	0.405	$Y=56.078-1.585X_1$

* Significant at p=0.05%, ** Significant at p=0.01%

Conclusion

In the present study gradual reduction in application of inorganic fertilizer by enhancing FYM dose supports cryptostigmatid population. Total rainfall had positive relation but it was non significant and indirectly it showed significant with soil moisture and also present investigation revealed that the soil fauna was predominant during rainy season (July to December) with a peak population in the month of October in soybean ecosystem.

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