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Effect of organic manure and fertilizer on the abundance of collembola in soybean cropping system

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Abstract
Collembola represents one of the most abundant groups in soils, play an important ecological role, *viz.*, nutrient cycling, decomposition of organic matter and soil formation. It acts as bioindicators of environmental quality. A field experiment was conducted at GKVK, Bengaluru. Soil samples were drawn to extract mesofauna from before application of treatment up to 300 days after germination. The results revealed that best treatment for collembola abundance was recorded in 20 t of FYM (5.59 & 1.92 collembola/400 g soil) and T_3 (3.13 & 1.79 collembola/400 g soil) and followed by the plot treated with 17.5 tonnes of FYM + 25% recommended fertilizer (3.33 & 1.61/ collembola/400 g soil) both in cropping and non cropping season. Collembola population was significantly high at 60 DAG and lowest in 120 DAG. It may be due to better availability of food, optimum moisture and temperature in the soil.

Keywords: Collembola, mesofauna, organic manure, fertilizer, abundance

Introduction

Soil ecosystem services are reliant upon soil fauna, which benefit the human population. Collembolans are the most abundant soil-dwelling arthropods with densities up to several million individuals per square meter in soils [1]. It plays an important role in plant litter decomposition and in forming soil microstructure. They affect nutrient cycling through litter comminution, dissemination of microorganisms and grazing [2]. Fertilization may influence the population of collembolan communities in soil. The outcome is a result of the quality and quantity of fertilizer, thus affect the abundance and diversity of collembolan directly or indirectly, inturn influence the ecosystem function

The addition of organic residues increased faunal biomass substantially over the fertilized and unfertilized controls. Whereas, green manures like senna and tithonia increased total faunal biomass by 45% and 49% over the fertilized and unfertilized controls, respectively. They found significant variation in faunal biomass over time between green manures, fertilizers and no input control [3].

FYM application at 15 t / ha increased the NPK concentration in the soil as well as uptake by the plant in addition to the increase in residual NPK in soil. Continues organic manure application or in combination with inorganic fertilizers significantly influenced the uptake of nutrients, organic carbon, available N, P and K in soil, Microbial biomass C, Microbial biomass N, Microbial biomass P, over the100% [4].

Material and methods

The experiment was carried out at Gandhi Krishi Vignana Kendra campus of the University of Agricultural Sciences, Bangalore. This was a long-term experiment intiated in August 2001 studying the effect of organic manure and chemical fertilizers on the abundance of soil arthropods in soybean cropping system. The same was continued during current year. Experiment was laid out in a randomized complete block design with the following treatments which were replicated thrice. T1. Recommended fertilizers for soybean (25:60:25 NPK Kg per ha) + Recommended FYM (10 tonnes per ha) + Prorate 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 wasmixed thoroughly with one kg of soybean seeds. Treated seeds were dried under shade and used for sowing.

The soil samples were collected before imposition of treatments and on 10th, 20th, 30th, 45th, 60th, 75th, 90th and 105th day after germination from each treatment. Further, soil samples were also collected at 15 days interval during non-cropping season. The soil samples (400g at 0-10 cm depth) were collected using the 12cm diameter circular core sampler. The Cryptostigmatids were extracted from the soil samples using Rothamsted modified MacFadyen high gradient funnel apparatus and incandescent bulbs (25 W) fixed at the top in the baffle board served as the source of light and heat energy. The apparatus was run for 48 hours. The extracted fauna were separated under a stereobinocular microscope (35 X magnification).

The total number of individuals of all arthropods species, which appeared at the time of observation in each treatment was taken. The data were transformed using $\sqrt{X+0.5}$ transformation before statistical analysis [5].

Results and discussion

Significant difference in abundance of collembola was noticed among the treatments. Higher collembola abundance was recorded in 20 t of FYM/ha treated plot FYM (5.59 & 1.92 collembola/400 g soil) and T_3 (3.13 & 1.79 collembola/400 g soil) and followed by the plot treated with 17.5 tonnes of FYM + 25% recommended fertilizer (3.33 & 1.61/ collembola/400 g soil) both in cropping and non cropping season. Least collembola abunadance was recorded in T_{10} (1.96 & 0.87/400g) (Table 1 & 2).

Abundance of soil collembola in soybean cropping system differed significantly among the intervals. It varied from 1.86 (20 DAG) to 5.80 collembola /400 g of soil (60 DAG). Collembola population was significantly high at 60 DAG followed by 75 DAG (5.80). Significantly least collembola was observed at 20 DAG which was on par with BAT, 10, 30, 45 and 105 DAG (2.66 collembola /400 g of soil) (Table 1). In non-cropping season collembola population was significantly high at 120 DAG followed by 135 DAG (1.76) and150 DAG (1.46). Significantly least collembola was observed at 255 DAG (0.72) which was on par with 240, 225, 210, and 270 DAG (0.99 collembola /400 g of soil) (Table 2). This fluctuation of soil invertebrates population in soybean ecosystem due to sufficient food availability with optimum moisture in food, soil moisture and lower soil temperature (Fig.1)

Soil application of 20t of FYM per hectare along with native soil fauna recorded significantly higher abundance of collembolan. Further, it may be due to abundant food supply (organic matter and microbial biomass), optimum moisture and temperature in the soil. Further, it may be due to periodic addition of senescent leaves with petiole to the soil. Similarly, several earlier investigators viz., [3, 6, 7, 8, 9]. have recorded increase of nearly all invertebrate group following manuring. The results are similar to the investigation of [10] where they concluded that by adding organic amendments resulted in increased numbers of micro-arthropods, springtails as well as mites.

There was no significant difference in collembola abundance among the treatments at BAT. However, highest soil collembola abundance was recorded in T_8 (2.66) and least in T_7 (1.00). Significant difference in collembola abundance was noticed among the treatments at 30 DAG. Highest collembolan population was recorded in T_5 (6.66) compared to T_{10}, T_4 and T_1. Least collembolan abundance was recorded in T_1 (1.00) which was on par with rest of the treatments. Significantly higher abundance of soil collembola was recorded in T_5 (13.00) than other treatments at 75 DAG. Treatment with 10 tonnes of FYM/ha applied plot showed least collembola (2.33) which was on par with rest of the treatments except T_3 and T_2 (8.00) (Table 1).

The present studies also in close conformity with the result of [6] where he concluded that the response from a combination of manures and fertilizers to be additive, only slightly surpassing that produced by either amendments applied alone. Similarly [6, 7, 8, 9]. also recorded a good amount of soil fauna from FYM alone and FYM + fertilizers treated plots.

Table 1: Impact of organic manure and fertilizers on the abundance of Collembola in soybean ecosystem during cropping season

Treatments		Number of collembola / 400g of soil at days after germination								
	BAT	10	20	30	45	60	75	90	105	Mean
T_1	2.33 (1.54)	1.00 (1.17)	1.33 (1.26)	1.00 (1.09)	2.66 (1.73)	3.66 (2.00)	4.00 (2.11)	2.33 (1.67)	4.66 (2.24)	2.55 (1.65)^{bc}
T_2	2.00 (1.46)	2.00 (1.92)	1.66 (1.35)	2.66 (1.76)	1.00 (1.17)	3.66 (2.01)	8.00 (2.82)	2.33 (1.54)	3.33 (1.93)	2.96 (1.73)^{bc}
T_3	2.33 (1.38)	2.33 (1.67)	1.00 (1.17)	2.66 (1.55)	2.00 (1.46)	4.33 (2.19)	8.00 (2.82)	3.66 (1.86)	2.66 (1.73)	3.22 (1.76)^{bc}
T_4	1.33 (1.28)	1.33 (1.26)	2.00 (1.42)	3.00 (1.61)	2.66 (1.73)	7.00 (2.65)	2.66 (1.71)	6.66 (2.61)	3.33 (1.77)	3.33 (1.78)^{b}
T_5	2.66 (1.71)	3.00 (1.85)	2.66 (1.71)	6.66 (2.25)	2.33 (1.54)	10.66 (3.31)	13.00 (3.60)	4.66 (2.17)	4.66 (1.25)	5.59 (2.27)^{a}
T_6	2.00 (1.55)	2.00 (1.55)	3.00 (2.85)	1.33 (2.26)	1.00 (1.17)	4.66 (2.21)	2.33 (1.59)	1.00 (1.17)	1.33 (1.26)	2.07 (1.51)^{c}

T_7	1.00 (1.17)	2.66 (1.71)	1.33 (1.34)	3.00 (1.83)	3.33 (1.88)	8.33 (2.84)	3.33 (1.89)	2.66 (1.71)	1.66 (1.38)	3.03 (1.75)^{bc}
T_8	2.66 (1.71)	1.66 (1.46)	2.33 (1.56)	2.66 (1.77)	5.00 (2.19)	7.33 (2.75)	2.33 (1.64)	7.33 (2.77)	2.00 (1.55)	3.70 (1.93)^{ab}
T_9	1.66 (1.46)	1.66 (1.46)	1.00 (1.09)	1.00 (1.17)	4.66 (2.02)	3.00 (1.49)	2.66 (1.71)	1.00 (1.09)	1.00 (1.17)	1.96 (1.41)^{c}
T_{10}	2.33 (1.67)	1.33 (1.28)	2.33 (1.67)	1.00 (1.17)	3.00 (1.72)	5.33 (2.35)	6.00 (2.28)	2.00 (1.46)	2.00 (1.46)	2.81 (1.68)^{bc}
Mean	2.03 (1.49)	1.90 (1.49)	1.86 (1.44)	2.50 (1.55)	2.76 (1.66)	5.80 2.38)	5.23 (2.22)	3.36 (1.81)	2.66 (1.67)	
									S.Em±	CD @ 5%
Treatment									0.12	0.35
Days									0.11	0.33
Interaction									0.37	1.05

Note: Figures in the parentheses are $\sqrt{X+0.5}$ transformed values, BAT = before application of treatments

Table 2: Impact of organic manure and fertilizers on the abundance of collembola in soybean ecosystem during non cropping season

Treatments	Number of collembola / 400g of soil at days after germination												
	120	**135**	**150**	**165**	**180**	**195**	**210**	**225**	**240**	**255**	**270**	**285**	**300**	**Mean**
T1	5.66 (2.46)	3.00 (1.85)	2.00 (1.55)	1.00 (1.17)	1.00 (1.09)	1.00 (1.17)	0.66 (1.05)	0.33 (0.87)	0.00 (0.70)	0.00 (0.70)	0.33 (0.87)	0.33 (0.87)	0.66 (1.05)	1.23 (1.19)
T2	4.66 (2.27)	3.33 (1.95)	2.33 (1.67)	1.66 (1.38)	0.66 (1.05)	0.33 (0.87)	0.66 (0.99)	0.00 (0.70)	0.33 (0.87)	0.00 (0.70)	0.66 (0.99)	0.00 (0.70)	1.00 (1.17)	1.20 (1.18)
T3	9.66 (3.13)	4.33 (2.18)	3.66 (2.01)	1.33 (1.26)	1.00 (1.17)	1.00 (1.17)	0.66 (0.99)	1.00 (1.17)	0.33 (0.87)	0.00 (0.70)	0.66 (0.99)	0.33 (0.87)	1.00 (1.17)	1.79 (1.36)
T4	8.33 (2.96)	4.66 (2.17)	1.33 (1.28)	1.66 (1.38)	1.33 (1.26)	1.00 (1.09)	0.33 (0.87)	0.66 (0.99)	0.33 (0.87)	0.00 (0.70)	0.33 (0.87)	0.66 (1.05)	0.33 (0.87)	1.61 (1.26)
T5	9.33 (3.12)	4.66 (2.25)	1.66 (1.44)	1.33 (1.28)	2.00 (1.46)	1.00 (1.17)	0.66 (0.99)	0.33 (0.87)	0.00 (0.70)	0.00 (0.70)	0.33 (0.87)	1.00 (1.17)	1.00 (1.17)	1.62 (1.32)
T6	8.33 (2.94)	1.66 (1.38)	2.00 (1.46)	2.33 (1.56)	1.00 (1.17)	1.00 (1.17)	0.33 (0.87)	0.66 (0.99)	0.33 (0.87)	0.00 (0.70)	0.33 (0.87)	0.00 (1.05)	1.00 (1.17)	1.51 (1.25)
T7	7.33 (2.75)	1.66 (1.38)	2.00 (1.48)	1.66 (1.35)	0.33 (0.87)	1.00 (1.17)	0.00 (0.70)	0.33 (0.87)	0.00 (0.70)	0.00 (0.70)	0.33 (0.87)	0.00 (1.05)	0.33 (0.87)	1.20 (1.14)
T8	6.33 (2.60)	1.66 (1.38)	2.33 (1.67)	1.66 (1.38)	0.00 (0.70)	1.66 (1.35)	0.33 (0.87)	0.66 (0.99)	0.00 (0.70)	0.33 (0.87)	0.33 (0.87)	1.00 (1.17)	1.00 (0.17)	1.33 (1.21)
T9	6.00 (2.51)	1.66 (1.44)	0.66 (1.05)	1.00 (1.09)	0.33 (0.87)	1.00 (1.17)	0.33 (0.87)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.33 (0.87)	1.00 (1.17)	0.33 (0.87)	0.97 (1.08)
T10	3.66 (2.03)	2.66 (1.64)	0.66 (0.99)	1.00 (1.09)	0.66 (1.05)	0.66 (1.05)	0.33 (0.87)	0.33 (0.87)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.66 (28.1)	0.66 (0.99)	0.87 (1.06)
Mean	6.93 (2.68)	2.93 (1.76)	1.86 (1.46)	1.46 (1.29)	0.83 (1.07)	0.96 (1.14)	0.43 (0.91)	0.43 (0.90)	0.13 (0.77)	0.03 (0.72)	0.36 (0.99)	0.63 (1.01)	0.73 (1.05)	
													S.Em±	CD@5%
Treatment													0.10	0.18
Days													0.09	0.20
Interaction													0.32	0.65

Note: Figures in the parentheses are $\sqrt{X+0.5}$ transformed values

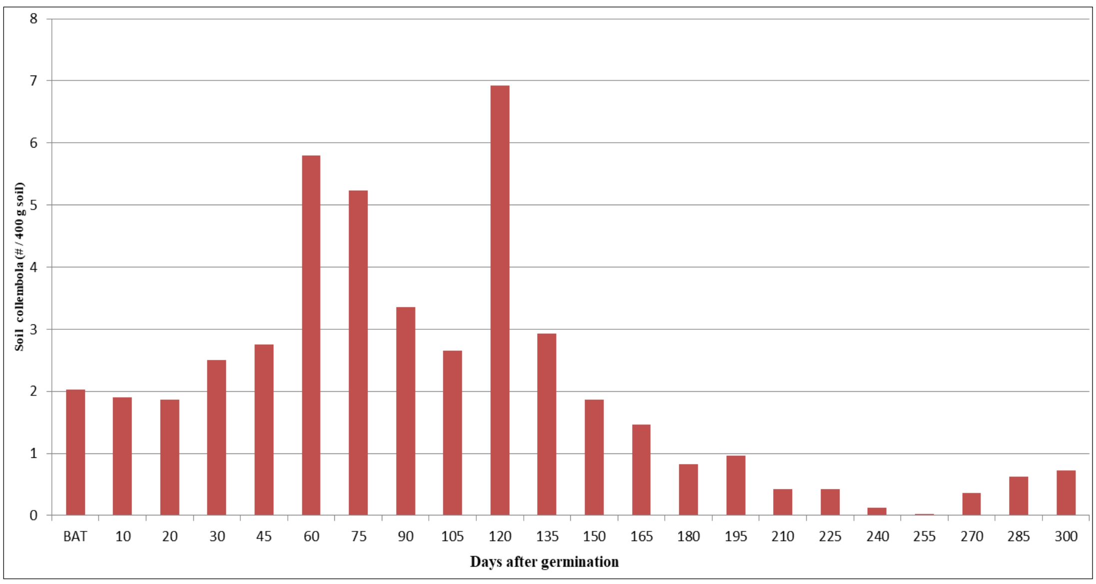

Fig 1: Abundance of collembola in different intervals both in cropping and non-cropping season

Conclusion

Sufficient diversified food supply enhance the collembola population in the soybean ecosystem compared to inorganic fertilizer alone treatments. Gradual reduction in application of inorganic fertilizer by enhancing FYM dose supports mesofaunal population.

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