Indian Journal of Entomology, **81**(3): 000-000 (2019) DoI No.:

RELATIVE ABUNDANCE OF SOIL FAUNA IN ORGANIC FARMING WITH SOYBEAN

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ABSTRACT

In soybean like other crops, application of inorganic fertilizers lead to decline in the fertility of soil in addition to indirect negative effects on soil organisms. Organic manures increase the soil fertility, and the activities of soil fauna. This study is on the impact of application of organic manures and fertilizers on the relative abundance of soil fauna in soybean. Significant difference in the relative abundance of soil fauna was observed due to varied soil fertility levels. It was observed that the habitats supported seven families of beetles viz., Passalidae, Scarabaeidae, Nitidulidae, Staphylinidae, Tenebrionidae, Curculionidae and Chrysomelidae; and nine ant species along with the mesofauna like, Collembola, cryptostigmatids and other Acari (Mesostigmata, Prostigmata and Astigmata). Overall application of farm yard manure and chemical fertilizer combination treatments led to more relative abundance of fauna than use of fertilizer alone.

Key words: Soybean, fauna, relative abundance, soil fertility, Coleoptera, Collembola, Acarina, farm yard manure, chemical fertilisers

Soybean (*Glycine max*(L)Merril) is an important crop with high nutritive value (Liu,1997). In the soybean ecosystem organic amendments such as manure, compost, bio-solids and humic substances provide a direct source of carbon (C) for soil organisms as well as an indirect C source via increased plant growth and plant residue returns. Soil invertebrates are important components of a wide range of soil ecosystems. This diverse group of animals cover a range of taxa (Wallwork, 1976). Soil invertebrates have important functions in soil, and are essential components of agroecosystems, that could not sustain crop production. Soil macro and mesofauna (protozoan's, nematodes, micro arthropods and enchytraeids) are grazers of bacteria and fungi, and these stimulate microbial decomposition of dead organic matter (Ineson et al., 1982; Didden, 1993). A number of examples show that soil animals can increase nitrogen mineralization by 25.5% (Persson, 1983). Even though organic farming is safe and environmentally sustainable, it cannot meet the increased population demands. So, the study on the combination of inputs such as organic manures, fertilizers on the relative abundance of above and below ground arthropod population should be known. Keeping these in view, the present study on the relative abundance of soil fauna (meso and macro) in the soybean ecosystem.

MATERIALS AND METHODS

The evaluation of the relative abundance of soil fauna was carried out in soybean ecosystem where similar treatments were imposed from 2001. The study was initiated during 2013-2014 at the Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru. The soybean variety MAUS-2 was used and the soil belongs to Vijayapur series, classified as oxic Haplustalf. According to FAO classification, the soil is Ferric Luvisols. The initial soil properties like 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/100 g) and pH (5.92) were recorded in 2001. The experiment was done in a randomized complete block design with three replications, and the treatments include:

T1- Recommended fertilizers (25:60:25 NPK kg/ ha) + recommended FYM (10 t/ ha) + Phorate 10 G @ 1 kg a.i./ ha+ herbicide (Lasso 50EC @ 2.5 l/ ha)+ fungicide seed treatment (Thiram+ Bavistin- each 2 g/ kg of seeds). (University package practice for soybean); T2- 12.5 t of FYM/ ha + 75% of recommended fertilizer; T3- 15.0 t/ ha of FYM/ ha + 50% of recommended fertilizer; T4- 17.5 t of FYM/ha+ 25% of recommended fertilizer; T5- 20t of FYM/ ha; T6- 10t of FYM/ ha; T7- 10t of FYM/ ha (partially decomposed); T8- 10t tonnes of FYM/ ha+ mulching (Glyricidia 2 t/ ha.); and T9- Recommended fertilizer alone; T10- 5 t of FYM/ ha; Note: N- Nitrogen, P- Phosphorous, K- Potassium, T- Treatment, FYM- Farm yard manure

The mesofauna were extracted from the soil samples using Rothamsted modified Mac Fadyen high gradient funnel apparatus. The apparatus was allowed to run for 48 hr. The invertebrates passing through 2 x 2 mm sieve of the sample holder were collected in vials containing 70% ethyl alcohol fixed to the lower end of the funnel. A stereozoom microscope (35x) was used for sorting and identification of extracted soil invertebrates. One pitfall trap was placed in each treatment for collection of soil macrofauna. Each trap was filled with 50 ml of 75% ethyl alcohol as killing agent and few drops of glycerol as an attractant. Traps left for 48 hr and fauna was collected. Relative abundance of mesofauna and macrofauna like ants and beetles was calculated with the formula-

$$\text{Relative abundance (\%)} = \frac{\text{No. of individuals in particular group}}{\text{Total no. of individuals of all groups}} \times 100$$

Data were transformed using $\sqrt{X+0.5}$ transformations wherever necessary and statistically analyzed for ANOVA (Sundararaj et al., 1972).

RESULTS AND DISCUSSION

Faunal abundance and soil fertility

Study has shown that there are significantly higher population of soil arthropods was noticed in the combination of fertilizer and FYM treatments. Among soil mesofauna relative abundance of Cryptostigmatids (Oribatida) and other Acari (Mesostigmata, Prostigmata and Astigmata) was higher in recommended package of practices (T1) and 10 t of FYM /ha (partially decomposed) (T7) treated plots, respectively (Table 1). Many earlier studies had observed increases in Acari population following fertilization under agricultural and forestry conditions. Nitrogenous fertilizers increased mite populations in agricultural (Muller, 1957) and in forest soils (Mayer- Krapoll, 1963). Marshall, 1977 reported that with fertilizers the Oribatei tend to respond less rapidly than the other Acari.

Collembola were relatively more abundant in plot treated with recommended fertilizer alone (T9) which was on par with the combinations of fertilizer and manures. Least relative abundance was noticed in plot treated with recommended package practices (T1). Earlier studies reveal that fertilizers that neutralise soil reaction can be expected to favours directly collembolans (Christiansen, 1964). In contrast, N addition, had little effect on micro arthropod community structure, but did increase Mesostigmata richness and Collembola abundance. Maximal species richness of micro arthropod groups overall occurred in undisturbed plots, suggesting that the micro arthropod community was negatively affected by disturbance (Cole et al., 2008). Similarly, Bandyopadhyaya (2002) found that application of organic manures or its combination with mineral fertilizer induces higher density of Collembola than manured or unmanured soil. The present study reveals that other invertebrates are relatively more abundant in recommended package practices (T1) and least in the plot treated with 10 t of FYM/ ha (partially decomposed) (T7) (Table1). Similarly, Franz (1953) and Ben et al. (2007) noticed a positive effect for enchytraeids, collembolans and mites 10 years after application of NPK. It was also noted that the overall micro arthropod community is more in the plots which are with organic manures.

The habitats supported different level of ant and beetle species richness, as shown by the relative abundance of ground crawling ants and beetle families captured by pitfall trapping (Table 2). Ants belonging to nine species were collected belonging to three subfamilies viz., Formicinae, Myrmicinae and Ponerinae. Among these are *Camponotus compressus, Monomorium* sp.*, Tetramorium* sp.*, Leptogenys processionalis, Myrmicaria brunnea, Pheidole* sp.*, Polyrachis* sp.*, Crematogaster* sp. and *Solenopsis geminata*.

Relative abundance of *C. compressus* was more in the plot with recommended fertilizer (T9) (25.36%)

Table 1. Organic manure and fertilizers vs. relative abundance of soil mesofauna

	Relative abundance (%)									
Mesofauna	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Collembola	27.27	35.44	34.34	38.36	38.93	36.97	33.63	34.22	49.16	34.87
Cryptostigmatids	34.50	29.31	30.10	26.07	26.45	26.04	27.35	28.52	21.94	31.17
Other Acari	30.16	27.96	30.50	28.86	28.80	32.40	35.20	32.44	24.16	29.09
Other invertebrates	8.05	7.27	5.05	6.70	5.80	4.57	3.81	4.81	4.72	4.84

Table 2. Organic manure and fertilizers vs. relative abundance of ants and beetles

Treatments	Relative abundance (%)															
	Ants species										Beetle Families					
	Camp	*Phei*	*Sol*	*Lepto*	*Myrmi*	*Tetra*	*Cre*	*Pol*	*Mono*	Pass	*scar*	*niti*	*tene*	*curcu*	*chry*	*sta*
T1	23.91	24.79	28.71	7.50	5.60	3.51	3.00	1.82	1.01	17.02	0.00	29.78	12.76	2.12	8.51	29.78
T2	23.71	26.21	25.60	7.90	5.83	3.37	2.63	2.36	2.36	0.00	11.76	17.64	35.29	0.00	11.76	23.52
T3	23.54	27.31	23.08	9.52	5.34	3.71	1.93	3.09	2.47	46.15	0.00	0.00	15.38	15.38	7.69	15.38
T4	21.99	25.97	28.85	5.00	6.24	4.79	2.65	3.32	1.10	0.00	11.11	33.33	0	11.11	0.00	44.44
T5	21.29	23.50	23.29	12.82	6.66	5.18	2.86	2.84	2.65	3.22	3.22	6.45	29.03	0.00	3.22	54.83
T6	21.82	28.0	24.71	7.61	5.12	4.82	4.89	2.11	0.90	0.00	11.76	11.76	35.29	0.00	5.8	35.29
T7	20.81	26.79	25.51	9.81	6.96	4.0	2.0	2.19	1.81	14.28	7.14	7.14	7.14	0.00	0.00	64.28
T8	22.56	27.36	23.01	9.37	6.14	4.24	2.47	2.09	2.69	11.11	11.11	0	33.33	0.00	0.00	44.44
T9	25.36	28.50	21.73	8.57	6.40	3.14	1.93	2.65	1.62	0.00	0.00	0.00	10	10	30	50
T10	22.10	27.48	25.84	9.79	3.95	3.53	2.79	2.71	1.72	28.5	7.14	7.14	7.14	7.14	7.14	35.71

Camp: *Camponotus compressus*; Phei: *Pheidole* sp., Sol: *Solenopsis geminate*, Lepto: *Leptogenys processionalis*, Myrmi: *Myrmicaria brunnea*, Tetra: *Tetramorium* sp., Cre: *Crematogaster* sp, Pol: *Polyrachis* sp., Mono: *Monomorium* sp., Pass: Passalidae, Scar: Scarabidae, Niti: Nitidulidae, Tene: Tenebrionidae, Curcu: Curculionidae, Chry: Chrysomilidae, Sta: Staphylinidae

and less in 10 t of FYM/ ha (partially decomposed) (T7) (20.81%). Relative abundance of *Pheidole* sp. was also highest in T9 (28.50%) and least in 20 t of FYM/ha (T5) (23.50%). *Solenopsis geminata* was observed more in 17.5 t of FYM/ ha+ 25% of recommended fertilizer (T4) (28.85%) and less in T9 (21.37%). *Myrmicaria brunnea*, *Tetramorium* sp., *Monomorium scabriceps, Crematogaster* and *Polyrachys* sp. were relatively less abundant compared with the *C. compressus* and *Pheidole* sp. *C. compressus*, *S. geminata* and *Pheidole* sp. were active in all the treatments (Table 2). These results corroborate with those of Theodore et al. (2011) that ants and termites increase wheat yield by 36% from increased soil water infiltration due to their tunnels and improved soil nitrogen.

Among the Coleoptera, relative abundance of passalids, scarabaeids, nitidulids and staphylinids were more in the treatments which are combinations of increased quantity of FYM and fertilizer. Higher Passalidae and Curculionidae activity was observed in 15 t of FYM+ 50% of recommended fertilizer (T3). Scarabaeid population was relatively more abundant in 10 t of FYM/ha (T6). Higher nitidulid population was noticed in 17.5 tof FYM+ 25% of recommended fertilizer (T4). Tenebrionidae and Chrysomelidae were relatively more abundant in 12.5 t of FYM+ 75% of recommended fertilizer (T2) treated plot. More staphylinid population was noticed in 20 t of FYM/ ha (T5) treated plot. This might be due to availability of adequate amount of required food (detritus, microbes, prey etc) in the soil. Least abundance of beetles was found in plot treated with recommended fertilizer alone (T9) (Table 2). These results agree with few previous studies that maintaining available organic matter, essential nutrient sources in the soil are connected with biodiversity maintenance (Pokarzhevskii and Krivolutskii, 1997).

The study revealed that application of farmyard manure along with or in combination with fertilizers was better than the use of fertilizer alone. Combination treatments increased the soil health in terms of chemical properties, soil meso and macrofaunal relative abundance. The application of inorganic fertilizers alone had deleterious effects but applied along with organic manures nullified the effects of inorganic fertilizers.

ACKNOWLEDGEMENTS

The authors thank the Department of Entomology, UAS, GKVK, Bengaluru for facilities and Dr.Mushtaq Ali T M, for ants identification.

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(Manuscript Received: February, 2019; Revised: August, 2019;
Accepted: August, 2019; Online Published: August, 2019)