E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(8): 679-682
Received: 26-05-2024
Accepted: 29-06-2024

Girish BR
Research Associates, ZBNF Zone UAS, GKVK, Bengaluru, Karnataka, India

Manjunath KL
Research Associates, ZBNF Zone UAS, GKVK, Bengaluru, Karnataka, India

Nalini BS
Research Associates, ZBNF Zone UAS, GKVK, Bengaluru, Karnataka, India

Channamma
Research Associates, ZBNF Zone UAS, GKVK, Bengaluru, Karnataka, India

Krishna Desai
Research Associates, ZBNF Zone UAS, GKVK, Bengaluru, Karnataka, India

Naveesh YB
Senior Research Fellow, ZBNF Zone, UAS, GKVK, Bengaluru, Karnataka, India

Sanjay MT
Professor, Department of Agronomy, UAS, GKVK, Bengaluru, Karnataka, India

Prabhu C Ganiger
Entomologist, AICRP on Small Millets, UAS, GKVK, Bengaluru, Karnataka, India

Gangadhar Eswar Rao
Professor, Department of Agronomy, UAS, GKVK, Bengaluru, Karnataka, India

Lakshmipathi RN
Department of Agricultural Microbiology, UAS, GKVK, Bengaluru, Karnataka, India

Jahir Basha
Department of Plant Pathology, UAS, GKVK, Bengaluru, Karnataka, India

Mahin Sharif
Department of Agricultural Economics, UAS, GKVK, Bengaluru, Karnataka, India

Veeranagappa P
Department of Soil Science, UAS, GKVK, Bengaluru, Karnataka, India

Corresponding Author:
Girish BR
Research Associates, ZBNF Zone UAS, GKVK, Bengaluru, Karnataka, India

Impact of natural, organic and conventional farming practices on soil mesofauna population in redgram ecosystem

Girish BR, Manjunath KL, Nalini BS, Channamma, Krishna Desai, Naveesh YB, Sanjay MT, Prabhu C Ganiger, Gangadhar Eswar Rao, Lakshmipathi RN, Jahir Basha, Mahin Sharif and Veeranagappa P

DOI: https://doi.org/10.33545/2618060X.2024.v7.i8Si.1349

Abstract
A comparative study to know the variations in soil mesofauna population in redgram ecosystem grown under different farming practices *viz*., natural farming, organic farming, combination of organic + natural farming and conventional/ farmers practice/ chemical method of farming was carried out during *Kharif* 2020 and 2021 at RIOF, UAS, GKVK. The pooled data (two year) results revealed that highest soil mesofauna population in 500 g soil of redgram ecosystem was noticed in organic farming practice followed by combination of organic + natural farming practice, natural farming practice and absolute control treatments. However, least number of soil mesofauna was recorded in chemical /farmer's practice and UAS (B) package of practice respectively.

Keywords: Natural farming, organic farming, farmers practice, soil mesofauna, redgram

Introduction
Soil is a most important valuable resource and habitat for plants and animals. It is essential for entire plant life on which animals and human depends. Soil contains a wide array of organic and inorganic substances, water and gases, thus provides a unique medium for the growth and development of fauna and flora. The soil fauna occupy an important position in the soil ecosystem and play a significant role in the complex process of decomposition of organic matter, nutrient cycling, and primary production and thus improve the fertility status. Also, they play a precise and invaluable role in the maintenance of the biological, chemical and physical characteristics of the soil ecosystem which in turn influence the crop plants from insect pests attack (Srinivasa Reddy 2002) [9].

Soil fauna majorly includes microorganisms and soil invertebrates. In general, soil invertebrates are classified according to their size in three classes, *viz.*, microfauna, mesofauna and macrofauna. A soil mesofauna taxon (group) also known as microarthropods is an invertebrate group (aptera) found within terrestrial samples with the size ranging from 0.1-2mm which include organisms/orders like Acari, Collembolans, Proturans, Diplurans, Symphellids, Enchytriaeds etc. Large numbers of the microarthropod group (mainly mites and collembolans) are found in most types of soils (Dekkers *et al.*, 1994) [2].

The present modern agricultural practices have a major impact on the soil environment. Excessive uses of fertilizers such as urea, nitrate, phosphorous along with many other pesticides have negatively affected the air, water, soil biodiversity, fertility and quality (Gruzdeva *et al.*, 2007) [3]. Alternative management practices like organic farming, natural farming practices are gaining importance and were promoted on the basis that they are more environmentally benign and enhances the soil and water quality relative to conventional farming practices. Organic and natural farming practices often increase the abundance and diversity of soil microorganisms and in turn soil fertility increases. Organic fields had significantly higher number of soil arthropods compared with conventional fields (Salavuddin, 2016) [8].

Pigeon pea, *Cajanus cajan* (L.) also known as red gram, tur, arhar, is the second most important pulse crop grown in India, after gram (chickpea). It is the most important delicious 'Dal' (pulse) of the entire country which contributes 15.5 per cent and 18.6 per cent of total pulse area as well as production of India. In recent days the productivity of regram was drastically decreased. The reason may be due to decrease of soil mesofaunal population in farmers fields. Hence, the present research was undertaken to know the influence of different farming practices on soil mesofauna population in redgram ecosystem.

Materials and Methods

A field experiment was conducted during *Kharif* 2020 and 2021 to know the variations in soil mesofauna population to natural farming, organic farming, combination of organic and natural farming and conventional farming practices of redgram ecosystem. The experiment was taken up on a gross plot sizes of 51.3 m^2 (5.4mX9.5m: each plot) at research institute of organic farming (RIOF), University of Agricultural Sciences (UAS), Bangalore. The soil of the experiment site was red type. Redgram variety BRG-4 was sown at a spacing of 60 cm X 30 cm. totally six treatment combinations which are replicated five times in RCBD.

Treatment details:

T_1: Farmers practice: Treatment is based on operations carried out by the farmers in their field, FYM applied at 5 tonnes ha^{-1}, 2.5 bag of DAP and two hand weedings at 20 and 40 DAS

T_2: Organic production system: Seed treatment with rhizobium, FYM applied based on N equivalent (25 kg N ha^{-1}), weeding at 30 DAS, straw mulching (4 tonnes ha^{-1}) and need based plant protection using organic materials.

T_3: Natural Farming Practice (Natural Farming protocol as given by Shri. Subhash Palekar): ghanajeevamrutha application at 1000 kg ha^{-1}, seed treatment with beejamrutha, application of jeevamrutha at 15 days interval at 500 litres ha^{-1} and straw mulching (4 tonnes ha^{-1}). Need based plant protection measures using preparations like neemastra, agniastra, shuntiastra etc.

T_4: Recommended package of practices (POP) of UAS, GKVK, Bangalore: Seed treatment with Rhizobium, FYM application at 7.5 tonnes $ha^{-1}$and NPK (25:50:25 kg ha^{-1}), spraying of pre-emergence herbicide (pendimethalin 30% E.C @ 1000 ml ha^{-1}.) followed by one hand weeding at 30 DAS.

T_5: Absolute control: Only sowing of seeds. All other inputs and practices are nil.

T_6: Bridge between organic farming and natural farming: Seed treatment with rhizobium, FYM applied based on N equivalent (25 kg N ha^{-1}), application of jeevamrutha at 15 days interval at 500 litres ha^{-1} and straw mulching (4 tonnes ha^{-1}).

Estimation of soil mesofauna /soil arthropod population

To count the soil mesofauna /soil arthropod population, the soil samples were collected from redgram crop which was grown in natural, organic, combination of organic and natural farming and conventional farming systems along with absolute control from before sowing and till up to harvest of the crop. Soil sampling was done by using an hole auger; 500 g of soil was collected from each spot on dry weight basis. The meso fauna were extracted from the soil samples by using modified Berlese-Tullgren funnels apparatus (Plate 1). Five hundred gram of the collected soil samples were placed in the Berlese funnels apparatus up to 48 h. The apparatus consisted with light source (25 Watt light bulb) at the top and the soil containing funnel with 240mm diameter steel sieve with size 22 was fitted at the bottom, directly exposed to the light source. At the narrow mouth end of the funnel, the container with 70 per cent alcohol was kept which acted as both preservative as well as killing agent. As the surface of the soil sample becomes heated and desiccated, the heat generated from the bulb diverts soil meso-arthropods to drown in to the container since; the meso-arthropods are photophobic and hydrophilic in nature. Each soil sample was replicated three times. After 48 h the meso-arthropods collected from each sample were sorted out into major groups done by using the stereo binocular microscope.

Statistical analysis

The obtained data was statistically analysed by adopting two way ANOVA (RCBD) using Web Agri Stat Package (WASP-2) developed by Indian Council of Agricultural Research, Research complex, Goa. To check the significant differences between the treatments means, the data were subjected to Duncan's Multiple Range Test (DMRT).

Plate 1: Tullgren funnels extractor (Soil Mesofauna Extractor)

Results and Discussion

The results pertaining to the present study on impact of natural, organic and conventional farming practices on soil mesofauna population in redgram ecosystem was presented in table 1. The two year pooled data revealed that soil mesofauna population in 500 g soil of redgram ecosystem varied significantly among different treatments (farming practices) at different dates of collection. Overall, the organic farming practice, natural farming practice and combination of organic + natural farming practice recorded significantly higher meso-arthropods population. The maximum population was recorded of collembolans and mites (cryptostigmata/ mesostigmata/ prostigmata) (Plate 2).

Before sowing of the redgram crop, the highest soil mesofauna population (no/500 g of soil) was recorded in organic practice treatment (11.20) which was on par with natural farming practice (10.80) and combination of organic + natural farming treatment (10.30) followed by absolute control (9.30). Whereas, least number of soil mesofauna was recorded in farmer's practice (1.90) and UAS (B) package of practice (2.20). Similar trend observed in 30 DAS.

During 60 DAS, the highest soil mesofauna population was recorded in combination of organic + natural farming treatment (20.50) followed by natural farming practice (18.20) which was on par with organic practice treatment (16.90) and absolute control (15.90). Whereas, least number of soil mesofauna was recorded in farmer's practice (3.80) and UAS (B) package of practice (4.60), respectively. At 90 DAS, 120 DAS and at 150 DAS, higher number of soil mesofauna was observed in organic

practice treatment followed by combination of organic + natural farming treatment, natural farming treatment and absolute control. But, farmer's practice and UAS (B) package of practice recorded least number of soil mesofauna. The reason may be use of FYM, compost, vermicompost, mulching and biofertilisers in organic plots acts as a source of food for soil mesofauna. Hence, the multiplication of these soil mesofauna will be more. Similarly, in natural farming plots application of ghanajeevamrita, jeevamrita and mulching also acts as a source of food. Hence, these two treatments were on par with respect to soil arthropod population. The present findings are supported by earlier reports of Abilasha *et al.,* (2013) [1] and Narasa Reddy *et al.,* (2013) [7] who reported that a relatively higher abundance of meso-arthropods (collembolan, cryptostigmatids, other acari and other invertebrates) was recorded with heavy application of Farm Yard Manure (FYM, 20 t/ha) in fields compared to recommended fertilizer alone.

However, in conventional farming system /farmer's practice and UAS (B) package of practice treatments recorded least number because using of fertilizers and pesticide application affect the soil arthropod population in soil. The results are in line with the earlier reports of Letourneau and Bothwell (2008) [6] who reported that the higher input of chemical fertilizers and pesticides decline biological diversity. Also, mechanical and chemical perturbations produced by conventional agricultural management practices and by particular abiotic soil conditions present in the intensively managed sites that are unfavorable for collembolans, pauropods and mites densities etc. (Jose *et al*., 2006a and Jose *et al*., 2006b) [4, 5].

Table 1: Status of mesofauna in organic, natural farming and package of practice fields in redgram ecosystem (Two year data: Pooled)

Treatments	Mesofauna (No./ 500 g of soil)								
	Before sowing			30 DAS			60 DAS		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1-FP	1.40^{b}	2.4^{d}	1.90^{c}	1.80^{b}	3.0^{b}	2.40^{b}	3.40^{b}	4.2^{d}	3.80^{c}
T_2-OF	11.00^{a}	11.4^{a}	11.20^{a}	13.20^{a}	13.4^{a}	13.30^{a}	17.40^{a}	16.4^{bc}	16.90^{b}
T_3-NF	10.80^{a}	10.8^{ab}	10.80^{ab}	12.20^{a}	12.6^{a}	12.40^{a}	20.40^{a}	16.0^{c}	18.20^{ab}
T_4-POP	1.80^{b}	2.6^{d}	2.20^{c}	2.80^{b}	3.0^{b}	2.90^{b}	5.60^{b}	3.6^{d}	4.60^{c}
T_5-AC	9.40^{a}	9.2^{c}	9.30^{b}	11.80^{a}	12.0^{a}	11.90^{a}	13.40^{a}	18.4^{ab}	15.90^{b}
T_6-OF+NF	11.00^{a}	9.6^{bc}	10.30^{ab}	12.40^{a}	12.6^{a}	12.50^{a}	20.60^{a}	20.4^{a}	20.50^{a}
S.E.m ±	0.61	0.53	0.54	0.71	0.70	0.67	1.11	0.80	0.83
CD (p = 0.05)	1.80	1.55	1.58	2.09	2.05	1.97	3.28	2.35	2.46
CV (%)	18.08	15.35	15.73	17.51	16.54	16.21	18.47	13.57	14.00

Treatments	90 DAS			120 DAS			150 DAS		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1-FP	2.60^{b}	4.4^{c}	3.50^{d}	7.00^{c}	4.8^{c}	5.90^{c}	7.20^{c}	6.2^{c}	6.70^{d}
T_2-OF	31.80^{a}	26.6^{a}	29.20^{a}	29.60^{a}	30.0^{a}	29.80^{a}	30.20^{a}	31.4^{a}	30.80^{a}
T_3-NF	27.60^{a}	22.8^{b}	25.20^{b}	27.40^{a}	28.6^{a}	28.00^{a}	27.60^{a}	29.8^{a}	28.70^{ab}
T_4-POP	5.80^{b}	5.0^{c}	5.40^{d}	4.80^{c}	6.2^{c}	5.50^{c}	5.20^{c}	6.8^{c}	6.00^{d}
T_5-AC	14.20^{a}	19.6^{b}	16.90^{c}	15.00^{b}	20.4^{b}	17.70^{b}	15.20^{b}	22.2^{b}	18.70^{c}
T_6-OF+NF	27.80^{a}	27.2^{a}	27.50^{ab}	28.00^{a}	28.2^{a}	28.10^{a}	27.80^{a}	28.8^{a}	28.30^{b}
S.E.m ±	1.33	1.24	0.99	1.65	1.35	0.97	1.40	1.50	0.85
CD (p = 0.05)	3.92	3.66	2.91	4.86	3.97	2.87	4.12	4.42	2.49
CV (%)	16.23	15.74	12.29	19.77	15.28	11.35	16.54	16.06	9.51

Means followed by same letters do not differ significantly by DMRT (P=0.05)

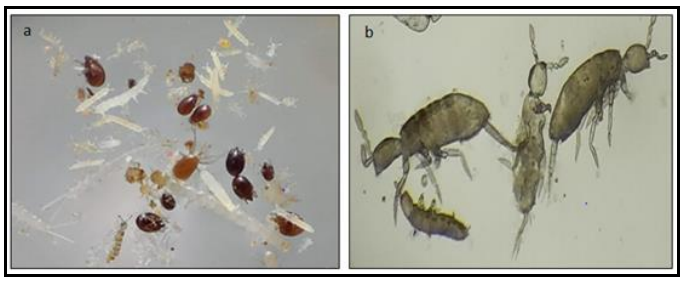

Plate 2: A microscopic view of soil mesofauna observed during the study

Conclusion

Soil mesofauna are important part of the terrestrial ecosystem which perform and regulate the organic matter decomposition**,** nutrient recycling through physical and chemical processes. So they are considered as 'Ecosystem webmasters'. In the present day, due to conventional farming practices and more pesticides application the diversity and population of soil mesofauna was declining and in future the soils may become unproductive. Hence, organic and natural farming practices are the only solutions which will enhance the multiplication of soil mesofauna. Finally the mesofauna will go to enhance the level of soil organic carbon, availability of nutrients that may contribute to the long term functional approach in an agro-ecosystem.

Acknowledgement

Authors are thankful to University of Agricultural Sciences, Bengaluru and Karnataka State Department of Agriculture for providing the necessary facilities, logistics, and financial support to carry out this study.

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