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INFLUENCE OF FYM AND NPK ON SOIL MESO-FAUNAL ABUNDANCE IN FODDER MAIZE ECOSYSTEM

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ABSTRACT

Soil organisms are known to be influenced by inputs like FYM and conventional fertilizers in agricultural ecosystems. However, their effects vary with the physiography, cultivation practices and the crop. Experiments were carried out to know theinfluence of different levels of FYM and NPK on soil meso-fauna in fodder maize crop cultivated in long term treatment plots (13 years under same set of treatments) under rainfed conditions in red sandy soils.There were ten treatments with varying combinations of FYM and conventional fertilizers, each administered to a specific plot over a period of 13 years. Results showed highest abundance of soil meso-fauna (mean abundance of 22.64 meso-fauna/400g soil) in plots that received 20 t of FYM/ha. The abundance of soil meso-fauna showed an overall increase along the cropping period (10.90, 12.43 and 27.70 per 400g soil. at 10, 45 and 90 days after germination, respectively). At harvest, plants that receivedFYM at the dose of 20 t/ha recorded 34.41% higher biomass (98.38 t/ha) than those that received conventional fertilizers alone (77.00 t/ha). Overall, long term application of FYM at the rate of 20 t/ha not only enhanced below-ground faunal diversity but also increased plant biomass.

KEY WORDS
Soil meso-fauna
Conventional fertilizers
Fodder maize
Glyricidia

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INTRODUCTION

Meeting the demand for food is a major challenge faced by the world today, because many of our soils are degraded due to indiscriminate use of chemicals. Conservation and efficient use of natural resources are the means to achieve long term sustainable yields, promote food, nutritional security and ensure environmental safety. In this regard, it would be essential to adopt farming practices that enrich soil biota and promote soil processes. Soil is a natural habitat for large organismal diversity on earth; soil fauna constitutes 23% of the total diversity of living organisms (Decaens *et al.,* 2006). Soil organisms make vital contributions to soil functions and soil processes (Brahmam *et al*., 2010); without the biota, soil would be a sterile medium that would not sustain crop production. Therefore, soil biota are important for the long term sustainability of agriculture. Agricultural inputs affect the abundance, activity and diversity of soil organisms. Fertilizers and manures change the inter-relationship among the organisms so that some species get benefited, whereas others are adversely affected (Marshall, 1977). On one hand, studies have demonstrated that conventional chemicals disrupt soil processes by disrupting the soil biota (Bongers, 1990; Dick, 1992), while on the other hand, studies have shown that crops cultivated with organic fertilization support greater abundance of fauna (Bengtsson, *et al.,*2005; Calugar and Ivan, 2009; Ayuke, *et al.,*2011; Dash *et al.,* 2012). However, the relationship between the types of inputs – organic and conventional – with soil biota is influenced by a variety of factors. They are affected by seasons (Maareg and Saleh, 1989), soil type (Chacon *et al.*, 1997), duration of soil treatment (Birkhofer, *et al.,*2008), soil moisture (Parwez and Sharma, 2014), crop species (Prashanthi, 2014), *etc*. Therefore, it is important to investigate the relationship between the nature of soil inputs and their influence on soil biota while keeping in view factors like soil type, season and crop species. Further, this should lead to a definite recommendation to farmers on the nature and extent of soil inputs that should be used under a defined set of conditions. Considering all these points, a long term study was carried out to determine the relationship between the nature of soil inputs and the abundance of soil biota in fodder maize ecosystem under rainfed conditions on red sandy soils.

MATERIALS AND METHODS

Studies were carried out at Gandhi Krishi Vignana Kendra campus of the University of Agricultural Sciences, Bengaluru, Karnataka, India during kharif season of 2014-15 under rainfed conditions. This was the long-term experiment initiated in August 2001 to know the effect of organic manure and chemical fertilizers on abundance of soil arthropods in cropping system. The same was continued during current year. The current field experiment was laid out in a randomized complete block design with the following treatments replicated thrice.

Recommended fertilizers (100: 50: 25 KgNPK per ha) + Recommended FYM (10

tonnes per ha) + fungicide seed treatment (Carbendazim)

12.5 t of FYM/ha + 75 per cent NPK

15.0 t of FYM/ha + 50 per cent NPK

17.5 t of FYM/ha + 25 per cent NPK

20.0 t of FYM/ha

10.0 t of FYM/h.

10.0 t of FYM/ha (partially decomposed)

10.0 t of FYM/ha + mulching (glyricidia 2 tonnes per ha.)

Recommended fertilizer alone

5.0 t of FYM/ha

(Note: N, P, K- Nitrogen, Phosphorous, Potassium. FYM- Farm yard manure)

FYM was applied to the respective plots about one week before sowing. Chemical fertilizers N, P, K (Urea, DAP, MOP) were applied with recommended doses to particular treatments at the time of sowing in furrows. The fodder maize variety 'African tall' was sown with a spacing of 30×10 cm in 6×3.6 m sub plot on 9th August 2014. Crop was raised under rainfed conditions.The soil collected from the adjacent undisturbed natural grassland was applied to all the treatments at the rate of 1 kg/plot to introduce native soil fauna.

The soil samples were collected before imposition of treatments and on 10, 20, 30, 45, 60, 75, 90 and 105 days after germination in each treatment. The samples were also collected at 15 days interval during non-cropping season. The samples were collected using the circular core sampler measuring 12 cm diameter and 10 cm height (Jackson, 1986).The meso-fauna was extracted from the soil samples using Rothamsted modified MacFadyen high gradient funnel apparatus, where the electric bulbs (25 W) fixed at the top in the baffle board served as the source of light and heat energy (Macfadyen, 1953). The apparatus was run for 48 hours.The extracted fauna were separated by using a fine camel hair brush under a stereo binocular microscope (35 X magnification). The specimen were counted in each sample and separated out into different taxonomical units.

The total number of individuals of all invertebrate species, which appeared at the time of observation in each treatment, was recorded. The data were transformed using $\sqrt{X+0.5}$ transformations before statistical analysis (Sundararaj *et al*., 1972).The height of 10 plants were taken randomly from each treatment and expressed in centimeter later converted to meter.Fifty plant samples from each treatment were selected randomly at the time of harvest and the mean weight was expressed in tonnes/ha.

RESULTS

Abundance of soil meso-fauna

Significant difference in the abundance of soil meso-fauna was noticed among the treatments. Significantly higher soil meso-faunal abundance was recorded in 20 tonnes of FYM applied treatment (22.64 meso-fauna / 400 g of soil) compared to rest of the treatments. The next best treatment was T_8 (15.78) and was on par in soil meso-faunal population with T_6 (15.67). Soil application of 10 tonnes of partially decomposed FYM, recorded least soil meso-faunal abundance (9.69) and was on

Table 1: Impact of organic manure (FYM) and fertilizers (NPK) on the abundance of soil meso-fauna in fodder maize ecosystem during cropping

Treat	Number of soil meso-fauna/400g of soil at BAT/ DAG												
ment	60BAT	45BAT	30BAT	15BAT	10	20	30	45	60	75	90	105	MEAN
T1	6	4	4.33	2	7.67	13.67	4.33	13.33	17.33	19.67	23	8.33	10.31
	-2.32	-2.09	-1.95	-1.47	-2.83	-3.74	-2.16	-3.69	-3.78	-4.25	-4.74	-2.88	(2.99)^{c}
T2	10.67	1.67	5	2.33	12.33	22	10	14.67	22.33	19	22	9.33	12.61
	-3.25	-1.44	-2.16	-1.49	-3.47	-4.71	-3.24	-3.88	-4.69	-4.38	-4.62	-3.01	(3.36)^{bc}
T3	10.67	3.33	9.33	3.67	8.33	25	8.67	10.33	22.33	16.67	26	6.33	12.56
	-3.14	-1.77	-2.62	-1.97	-2.9	-4.94	-2.99	-3.23	-4.78	-4.14	-4.82	-2.49	(3.32)^{bc}
T4	9	5.33	3	2.67	6.67	12.33	15	7.33	17.33	21.67	23	16.33	11.64
	-3.01	-2.29	-1.84	-1.72	-2.67	-3.4	-3.89	-2.79	-4.17	-4.69	-4.79	-4.04	(3.27)^{bc}
T5	25	7.33	7.67	7.67	22.33	22	22	22.67	36	35.33	39.33	24.33	22.64
	-5.04	-2.78	-2.84	-2.86	-4.77	-4.64	-4.73	-4.79	-6.03	-5.98	-6.31	-4.98	(4.65)^{a}
T6	21	3	6	1.33	13.33	22	11	11	32.67	20	40.66	6	15.67
	-4.57	-1.81	-2.52	-1.34	-3.59	-4.67	-3.37	-3.19	-5.71	-4.45	-6.41	-2.37	(3.67)^{b}
T7	13.67	4.33	3.67	2.67	14	14.33	5.67	4.67	10.33	15.33	14	13.67	9.69
	-3.19	-2.18	-2.03	-1.76	-3.49	-3.71	-2.34	-2.23	-3.21	-3.78	-3.76	-3.76	(2.95)^{c}
T8	16	3.33	9	2	8.67	15.33	7.67	20.33	40	19.67	36.33	11	15.78
	-4.03	-1.93	-2.98	-1.47	-2.95	-3.91	-2.69	-4.52	-6.22	-4.39	-5.76	-3.84	(3.69)^{b}
T9	13.33	5.33	4	1	4.33	9.67	3.67	8.33	23	12	29.67	7.67	10.17
	-3.58	-2.33	-2.06	-1.22	-2.12	-3.11	-2.04	-2.93	-4.83	-3.52	-4.96	-2.61	(2.94)^{c}
T10	9.67	2.33	7	4.67	11.33	17	8	11.67	16.67	9	23	8.33	10.72
	-3.19	-1.68	-2.67	-2.21	-3.42	-4.16	-2.91	-3.43	-4.12	-3.08	-4.74	-2.92	(3.21)^{c}
Mean	13.5	4	5.9	3	10.9	17.33	9.6	12.43	23.8	18.83	27.7	11.13	
	-3.53	-2.03	-2.37	-1.75	-3.22	-4.09	-3.04	-3.47	-4.75	-4.27	-5.09	-3.24	
											CV %	S.Em±	CD@5%
Treatment											28.1	0.16	0.45
Duration												0.18	0.49
Interaction												-	NS

Note: Figures in the parentheses are $\sqrt{X+0.5}$ transformed values, BAT = Before application of treatment, DAG = Days after germination

Table 2 : Impact of organic manure and fertilizers on growth and yield parameters of fodder maize

Treatment	Mean plant height(m)	Biomass (Kg/50plant)	PlantBiomass (t /ha)%	increase overT1	% increase over T9
T1	2.15	30.16	86.02	-	17.52
T2	2.40	28.66	81.74	-4.97	11.68
T3	2.31	30.66	87.45	1.67	19.48
T4	2.26	26.00	74.14	-13.79	1.29
T5	2.24	34.50	98.38	14.37	34.41
T6	2.10	28.83	82.23	-4.41	12.34
T7	2.13	26.16	74.62	-13.25	1.95
T8	2.24	27.66	78.90	-8.28	7.79
T9	2.16	25.66	73.19	-14.91	-
T10	2.04	27.00	77.00	-10.49	5.19
S.Em ±	0.07	-	-		
CD@5%	0.21	NS	NS		
CV %	5.57	18.34	18.34		

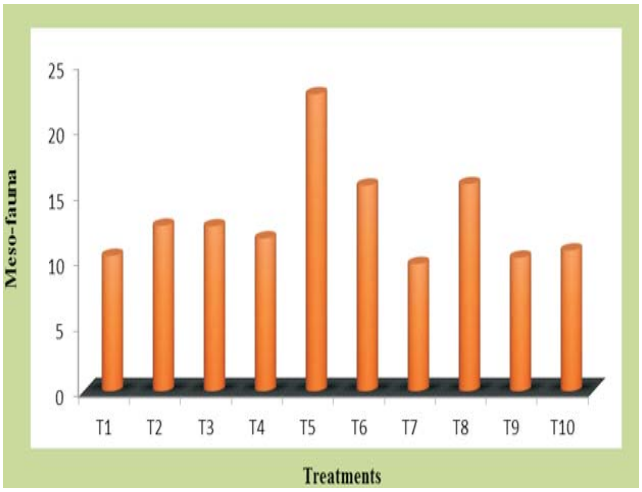

Figure1 : Impact of organic manure and fertilizers on the abundance of soil meso-fauna in fodder maize ecosystem during cropping season

par with recommended package of practices and other treatments except above mentioned treatments. The treatments with FYM recorded higher soil meso-fauna compared to recommended fertilizer alone (table 1).

The abundance of soil meso-fauna showed an overall increase along the cropping period (10.90, 12.43 and 27.70 per 400g soil. at 10, 45 and 90 days after germination, respectively).

Plant biomass

There was no significant difference in plant biomass among the treatments. Higher plant biomass was noticed in 20 tonnes of FYM/ha treated plot (98.38 tonnes/ha) compared to rest of the treatments except T9. Least plant biomass was observed in recommended dose of fertilizer alone (73.19 tonnes/ha). Significantly, all the treatments exhibited positive (1.29 to 34.41 %) yield over fertilizer alone treatment (T9). The plant height was more in the plot that received 12.5 tonnes of FYM/ ha + 75 per cent of recommended fertilizer among the treatments. The least plant height was recorded in the treatment that received 5 tonnes of FYM/ha (table 2).

DISCUSSION

Soil application of 20 t of FYM per hectare along with native soil fauna recorded significantly higher abundance of soil meso-fauna compared to other treatments (Fig 1). It may be due to abundant food supply (organic matter and microbial biomass), optimum moisture and temperature in the soil. The results are similar to the findings of Asif *et al*. (2016) who recorded positive correlation between the abundance of soil meso-fauna with organic matter and soil moisture content in the soils. Similarly, several earlier investigators *viz*., Ayuke *et al*., (2004), Girish (2006) and Ben *et al*. (2007) have recorded increase in all invertebrate group by adding organic amendments to the soil. The present investigation also supported by the findings of Narasa Reddy (2012) and Golive Prashanthi (2014) who recorded higher meso-faunal abundance in 20 t of FYM + native fauna treated plots compared to fertilizer alone and package of practices treatments. In the present study, there was a fluctuation of soil meso-faunal population in fodder maize ecosystem. Highest population was noticed at 90 days after germination of the crop. The peak population occurred when there was sufficient food availability with optimum moisture in the food as well as in soil, crop shade, less disturbance and settlement of soil particles due to rainfall after inter-cultivation.The abundance of soil meso-fauna was higher in cropping season and lower during non-cropping season. This may be due to low soil moisture content and increase in the soil temperature which might have reduced the abundance of fragile invertebrates. The present findings are more or less in accordance with the findings of Parwez and Sharma (2014) who reported that soil moisture, soil temperature and organic matter are responsible for the diversity and abundance of soil fauna.

Soil application of 20 t of FYM per hectare recorded higher plant biomass, this may be due to the higher availability of nitrogen, available phosphorus, available potassium (through high dose of FYM/ha), to the crop and it was supported by producing higher plant biomass. Similarly, investigators (Blumenthal *et al*., 2008; Keivanrad and Zandi, 2014) have recorded higher yields in response to the increased nitrogen levels.

Application of FYM in combination with fertilizers enhanced,soil meso-fauna and biomass production in the fodder maize ecosystem. Apart from maintaining soil sustainability, long term application of 20t of FYM/ha enhances below-ground diversity by providing congenial habitat with

good moisture holding capacity in red sandy soils under *rainfed* situation.

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