Content list available at http://epubs.icar.org.in, http://www.icarneh.ernet.in; ISSN: 0970-6429

Indian Journal of Hill Farming

Special Issue 2023, Volume 36, Pages 140-150

Effect of fertilizer dose and farm yard manure on soil meso-faunal population in maize (*Zea Mays* L.)

Ngangom Uma Devi[1,2]* • Kumar N.G.[1] • Basavaraj P.K.[3] • Sabyasachi Majumdar[2]

[1]Department of Agricultural Entomology, University of Agricultural Sciences, GKVK, Bangalore – 560065, Karnataka, India
[2]College of Agriculture, Central Agricultural University (Imphal), Kyrdemkulai – 793105, Ri-Bhoi, Meghalaya, India
[3]Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bangalore – 560065, Karnataka, India

ARTICLE INFO

Article history:
Received: 17 December, 2022
Revision: 13 July, 2023
Accepted: 04 August, 2023

Key words: *Maize, Organic manure, inorganic fertilizer, Soil mesofauna*

DOI: 10.56678/iahf-spl36.2023.19

ABSTRACT

Soil organisms are influenced by FYM and inorganic fertilizers in agricultural ecosystem. Organic manures known to increase the soil fertility, structure and influence the soil mesofaunal activity. With this background, an experiment was carried out to know the effect of higher NPK nutrient supplement through inorganic fertilizer alone (251.17:113.31:114.35 and 173.32:93.66:97.96 kg NPK/ha, with the target yield of 110 and 90 q/ha, respectively) and 50% through the organic manure on the population of the soil mesofauna. These were compared with the package of practices (POP) for maize cultivation and control. Soil mesofauna were collected in each treatment by collecting 400 g of soil at before application of treatments (BAT), 10 days interval up to 30 days after germination and 15 days interval from 30 days after germination (DAG) up to 300 DAG. The results indicated that higher soil mesofaunal population (26.88/400 g of soil) was observed in soil application of 123.74:48.91:55.59 kg NPK /ha +20.76 t of FYM/ha compared to the treatment with higher doses of inorganic fertilizer alone(13.81 mesofauna /400g soil) during cropping season.

1. 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 (Das et al. 2022). Conservation and efficient use of natural resources are the means to achieve long term sustainable yields, promote food and nutritional security and ensure environmental safety. In this regard, it will be essential to adopt farming practices that enrich soil fauna and promote soil processes. Soil is a natural habitat for large organisms' diversity on earth and consequently, 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) and without the soil fauna, soil would be a sterile medium that would not sustain crop production. Therefore, soil fauna is important for the long term sustainability of agricultural production. Agricultural inputs affect the abundance, activity and diversity of soil organisms. Studies revealed that the farm yard manure (FYM) application of two tonnes per ten acres of clay soils increased the mesofaunal population (Watanabe and Ogawa, 1990). Twenty-nine springtails and twenty-seven enchytrids were counted in one gram clod with largest biomass of collembolan occurred in oilseed crop – rapeseed green manure sandy soil, whereas individual numbers were greatest under sandy loam soil (Filser, 1995). Compost and recommended fertilizers application significantly increased the number of collembolan and acari in savanna soil (Chacon et al., 1997). In the soil, the soil faunal populations are important for the functioning of the ecosystem (Patra et al., 2005), both in direct interaction with plants and also with regard to nutrient recycling and organic matter recycling. These faunas are the driving force of most terrestrial ecosystem because of having their capacity to control the turnover and mineralization of organic substrates (Killham, 1994) and can perform important functions in the ecosystem (Giri et al., 2005). Manures and fertilizers change the inter-relationship among the organisms, so that some species get

*Corresponding author: ngangom.uma@gmail.com

benefitted, whereas others are adversely affected (Marshall, 1977). On one hand, studies have demonstrated that conventional chemical disrupt soil processes by disrupting the soil fauna (Bongers, 1990; Dick, 1992). While on the other hand, studies have shown that crops cultivated with organic fertilizers support greater abundance of soil fauna (Ayuke et al., 2011; Bengtsson et al., 2005; Calugar and Ivan, 2009; Dash and Saxena, 2012). However, the relationship between the types of inputs – organic and conventional – with soil fauna is influence by a variety of factors. These 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 fauna while keeping in some factors like soil type, seasons 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. Long-term and large number of soil inorganic fertilizer applications can affect negatively soil fertility, soil biodiversity and crop products quality (Gruzdeva et al., 2007). As a part, the interaction of inputs such as organic manures, fertilizers and other agrochemicals with the above and below ground arthropod population should be known because such relationship would be more useful in the utilization of organic manures and fertilizers as tools of integrated pest management as well as integrated soil fauna management. By keeping this in view, the present investigation was undertaken to know the effect of higher N, P and K nutrient supplement through inorganic fertilizer alone and 50% through the organic manure on the population of the soil mesofauna in rainfed maize ecosystem.

2. Material and Methods

Experimental site

The studies on the influence of different approaches of nutrient application on soil fauna in maize cropping system were carried out at Gandhi Krishi Vignana Kendra campus of the University of Agricultural Sciences, Bangalore during *kharif* season of 2012-13 under rain fed condition. The experimental site is located at 13’’0’ N Latitude and 77’’35’ east longitude at an altitude of 930 m from mean sea level (msl). The soil belongs to Vijaya Pura series and is classified as Kandic Paleustalfs. According to FAO Classification, soil is Ferric Luvisol. In the present cropping season, the total rainfall of 361.7 mm was received. The experiment was laid out in the same plot where earlier three crops were taken *viz*. Ragi, Sunflower and Soybean with the same treatment to know impact of different approaches of nutrient application on the abundance and diversity of soil fauna. The same was continued in 2012-13 with maize crop.

Collection and preparation of soil samples

Soil samples were collected just before imposing the treatment, 45 days after germination (DAG) and at the time of harvesting to a depth of 15 cm, to compare the fertility status of each treatment. The collected samples were dried under shade. The samples were crushed into powder and passed through 2 mm sieve. Soil samples were preserved in polyethylene bags for analytical work in the laboratory.

Analysis of chemical properties of soil

Soil pH was determined by potentiometric method using a glass electrode (Systronics pH system 362, India) at a soil to solution ratio of 1:2.5 (Jackson, 1973). The particle size distribution for estimating the sand, silt and clay content was done by international pipette method (Jackson, 1973).The organic carbon content of the soil was estimated by following wet oxidation method (Walkley and Black, 1934).The available nitrogen in the soil was estimated by alkaline potassium permanganate method by taking 20g of soil sample and distilled (Subbaiah and Asija, 1956) and expressed in kg N/ha. The available phosphorus in the soil was estimated by taking 5 g of soil sample extracted with quantity used (10 ml) Bray’s I reagent. The extracted phosphorus was then estimated by ascorbic acid method. The intensity of the blue colour was read in spectrophotometer as described by Bray and Kurtz (Bray and Kurtz, 1945) and expressed in kg P_2O_5/ha. The available potassium in the soil was estimated by taking 5 g of soil sample extracted with neutral normal ammonium acetate solution using flame photometer (Schollenberger and Simon, 1945) and expressed in kg K_2O /ha. Calcium content of soil was estimated by Versenate titration method using sodium hydroxide and Eriochrome black-T (EBT) indicator after extraction with neutral normal ammonium acetate (Jackson, 1973). Microbial biomass C and N were estimated following fumigation and extraction method (Carter, 1991).

Initial soil properties and treatment details

The initial soil chemical properties are presented in Table 1. The soil was moderately acidic with low organic carbon content. The field experiment was laid out in a randomized complete block design with the seven treatments and replicated three times (Table 2). FYM was applied to the respective plots about one week before sowing. Chemical fertilizers N, P, K (Urea, SSP, MOP) were applied with recommended doses to particular treatments at the time of sowing in furrows. Seed treatment with fungicide (Bavistin @2g/kg seed) was done before sowing. The maize hybrid Hemawas sown with a spacing of 60×30 cm in 10.8 m ×3 m plot on 5th August 2012.

Estimation of the population of below ground arthropods

Sampling method

The soil samples were collected before application of treatments (BAT) and on 10, 20, 30, 45, 60, 75, 90 and 105 days after germination (DAG) in each treatment. The samples (400 g on dry weight basis) were collected using the circular core sampler measuring 12 cm diameter and 10 cm height. Such collected samples were immediately transferred to aluminium cans (15 cm height and 6 cm diameter) and labels were placed into each can and closed with lid.

Extraction technique

The fauna was extracted from the soil samples using Rothamsted modified MacFadyen high gradient funnel apparatus situated in the soil biology laboratory. Soil samples were placed carefully along with the labels in canisters. The electric 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 invertebrates passing through 2×2 mm sieve of the sample holder were collected in vials containing 70% ethyl alcohol fixed to the lower end of the funnel.

Sorting procedure

Soil faunal composition in terms of number and diversity was recorded for each sampling time. The extracted fauna was separated by using a fine camel hair brush under a stereo binocular microscope (35X magnification). The specimens were counted in each sample and separated out into different taxonomical units. For the apportionment of soil arthropods, Lewontin (1972) technique was adopted.

Preservation of mesofauna

Taxonomic groups encountered during the study period were preserved in vials containing 75% ethyl alcohol and labelled (date of collection, treatment *etc*) for further taxonomic identification.

Impact of different approaches of nutrient application on the growth parameters of maize:

The height of 10 plants were taken randomly from each treatment and expressed in centimeter. The cobs from randomly selected ten plants from each treatment were counted. Mean of ten plants was taken as the number of cobs per plant. Cob yield was recorded at the time of harvesting of cobs from the net plot area and expressed in quintal per hectare.

Statistical analysis

The data were transformed using arcsine and $\sqrt{X+0.5}$ transformations, wherever necessary and statistically analyzed by adopting analysis of variance (Sundararaj et al., 1972).

Abundance

The total number of individuals of all arthropods 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).

Diversity index

Simpson (1949) gave the probability of any two individuals drawn at random from an infinitely large community belonging to different species as $D=\sum pi^2$, Where pi=the proportion of individuals in the i^{th} species. As D increases, diversity decreases. Simpson's index therefore, usually expressed as 1-D.

Relative abundance

The number of organisms of a particular kind as a percentage of the total number of organisms of a given area or community and expressed in percentage.

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

3. Results And Discussion

Chemical properties of soil as influenced by different approaches of nutrient application:

Numerically higher soil pH was noticed in T_1 (6.74) at 45 days after treatment. However, it was on par with T_4 (6.33), T_3 (6.52) and T_2 (6.59). Significantly lower soil pH was recorded in T_7 (5.93) and was on par with T_5 (6.18), T_6 (6.20) and T_4 (6.33). Significantly higher soil pH was found in T_7 (6.10) after harvest (Table 3). The variation may be due to addition of organic manure with fertilizers since the past many years. Addition of manure that altered the release of organic acids during decomposition leads to lower soil pH. The present findings are in close agreement with findings of (Narasa Reddy, 2012; Singh et al., 1980; Satish, 2009; Virupaksha, 2011).

Exchangeable magnesium content of the soil was significantly higher in T_1 (4.60 meq/100g) compared to remaining treatments except T_5 (3.93), T_7 (4.03) and T_6 (4.06) at 45 DAG. Significantly least exchangeable magnesium content of the soil was noticed in T_4 (2.50 meq/100g) which was on par with T_3 (2.63meq/100g) and T_2 (3.26 meq/100g).Significantly higher exchangeable magnesium content of the soil after harvesting was noticed in T_5 (2.76 meq/100g) which was on par with the remaining treatments except T_2 and T_6(Table 3). This may be due to continuous application of manure and fertilizer. The release of magnesium during the mineralization of added organic manure might have contributed to higher magnesium. Increase in the exchangeable magnesium content of soil due to addition of FYM has been reported by (Arun Prasad Totey et al., 1991; Devaraja, 2005; Girish, 2006; Prasanna, 2006;

Singh et al., 1980; Satish, 2009; Virupaksha, 2011).

At 45 days after germination (DAG), T_2 recorded significantly higher exchangeable calcium content (7.20 meq/100g) of the soil which was on par with T_4 (6.76) (Table 3). Significantly higher exchangeable calcium content of soil after harvest was found in T_1 (5.23 meq/100g) which was on par with other treatments except T_7 and T_4. Similarly, higher exchangeable calcium in T_1 may be due to application of SSP which is having up to 12 per cent of calcium. The increased content of exchangeable calcium in FYM treated plots attributed to release of calcium during mineralization of added organic matter and also due to retention of calcium by added organic matter. Higher soil faunal activity also enhanced the base content of soil. The increase in the exchangeable calcium content of soil due to FYM application has been reported by several authors (Devaraja, 2005; Prasanna, 2006; Singh et al., 1980; Satish, 2009; Virupaksha, 2011).

There was significant difference in soil microbial biomass carbon among the treatments at BAT (Table 3). Significantly higher soil microbial biomass carbon was noticed in T_2 (2012.71 µg g^{-1} soil) than rest of the treatments. Significantly least soil microbial biomass carbon was noticed in T_1 (803.91 µg g^{-1} soil). Soil microbial biomass carbon content showed significant difference among the treatments at 45 DAG. Significantly higher soil microbial biomass C was recorded in T_2 (3547.11 µg g^{-1} soil). Significantly least soil microbial biomass C was recorded in T_1 (1565.77 µg g^{-1} soil). Significantly higher soil microbial biomass C was recorded in T_2 (2903.17 µg g^{-1} soil). It may be due to the more availability of the organic matter and other major nutrients as food source with good moisture retention capacity compared to other treatments. The present findings coincide with the findings of Shashi et al., (2007) who reported that addition of FYM @ 20.0 t/ ha increased the microbial population and improved soil properties compared to that of untreated plots. Significantly higher soil microbial biomass C recorded at 45 DAG as compared to before application of treatments and at harvest. Similarly, Asha (2003) reported that significantly higher soil microbial biomass C in wetland compared to dry land.The results are in accordance with the findings of several authors [Satish, 2009; Virupaksha, 2011; Narasa Reddy, 2012; Raj Kumar, 2010].

At 45 DAG, the available nitrogen content was highest in T_3 (173.32:93.66:97.96 kg N:P:K/ha) (Table 4). However, least available nitrogen content of soil was registered in plots treated with 20.76 t FYM + 123.74:48.91:55.59 kg N:P:K/ha at 45 DAG. These results revealed that incorporation of FYM reduced the available nitrogen content of soil compared to recommended fertilizer alone. The decrease in the available nitrogen content of soil may be attributed to organic acid produced during decomposition of FYM and with decrease in the quantity of FYM applied. The present result is in contrary with the results observed by numerous authors (Singh et al., 1980; Satish, 2009; Narasa Reddy, 2012; Prasanna, 2006; Girish, 2006; Mishra et al., 2006).

Significantly higher available phosphorus content of soil was found in T_1 (79.24 kg/ha) compared to other treatments except T_3 (78.35) at 45 days after germination (DAG) (Table 4). The higher inorganic phosphorus fertilizer application enhanced the available phosphorus. These results indicated that incorporation of FYM increases the available phosphorus content of soil compared to recommended fertilizer alone. The decrease in the available phosphorus content of soil may be attributed to organic acid produced during decomposition of FYM, preventing the conversion of soluble form of phosphorus to insoluble form of phosphorus and enhanced the solubilization of native phosphorus in the soil. Similar changes were observed by several authors (Devaraja, 2005; Prasanna, 2006; Singh et al., 1980; Satish, 2009; Virupaksha, 2011; Mathur et al., 1998).

Significantly higher available potassium content of soil was noticed in T_2 (95.26 kg/ha) compared to rest of the treatments at BAT (Table 4). Available potassium content of the soil was least in T_3 (50.4 kg/ha) which was on par with T_7 (53.2).At 45 days after germination, significantly higher available potassium content of soil was observed in T_6 (412.66 kg/ha) which was on par with the remaining treatments except T_7 and T_3. The available potassium content increased due to the addition of FYM in combination with fertilizer. This may be due to addition of potassium through FYM and also minimizes potassium loss due to leaching by retaining potassium at exchange site and thereby increasing the availability. This results coincides with the findings of Ben et al. (2007) who showed that continuous application of NPK + 10 t FYM annually to maize resulted in buildup of available K. Similar results were observed by (Satish, 2009; Virupaksha, 2011; Narasa Reddy, 2012; Prasanna, 2006; Girish, 2006; Mathur et al., 1998; Bansal, 1992).

Impact of different approaches of nutrient application on the abundance of soil mesofauna during cropping season

Significant difference in abundance of soil mesofauna was noticed among the treatments (Table 5). Significantly higher soil mesofauna abundance was recorded in T_2 (26.88 mesofauna / 400 g of soil) followed by T_4 (23.22). Further, the latter treatment was on par with T_5 (20.74). Soil application of fertilizer alone T_1 (13.81 mesofauna /400 g of soil) recorded least soil mesofauna abundance which was on par with T_3 (15.81).The abundance of soil mesofauna in maize crop differed significantly at different times of crop growth period. It varied from 5.95 (BAT) to 31.85 at 105 DAG. The soil mesofauna population was relatively high at 105 DAG compared to rest of the sampling periods except 90 DAG (29.57). Gradual increase in population of mesofauna was noticed from BAT up to 105 DAG. The abundance of soil mesofauna was significantly higher in T_2 (22.33) and was on par with other remaining treatments except T_1 (10.66) which recorded least number of mesofauna at 20 DAG. Soil mesofauna abundance was significantly high in T_2 (27.00) and was on par with other treatments except T_1 and T_3 at 45 DAG.

In this study, fluctuation and the gradual increase in the abundance of the soil mesofauna from BAT was noticed in maize ecosystem. Highest population was noticed at 105 DAG. The peak population occurred when there was sufficient food availability with optimum moisture in food, soil moisture, lower soil temperature, crop shade, less disturbance and settlement of soil particles due to rainfall after inter-cultivation. The abundance of soil mesofauna was higher in cropping season and lower during non-cropping season. This may be due to higher soil and atmospheric temperature, no cover crop and lower moisture level both in the soil and food. The present findings are in close agreement with the observations of (Satish, 2009; Virupaksha, 2011; Narasa Reddy, 2012; Girish, 2006; Srinivas Reddy, 2002) who reported peak population of the soil fauna during the post monsoon period (September-October) and lower population in pre-monsoon period (May-June) in soybean ecosystem.

Impact of different approaches of nutrient application on the diversity of soil mesofauna during cropping season:

Diversity of soil mesofauna in maize crop differed significantly among the intervals. It varied from 0.59 (45 DAG) to 0.93 (BAT) (Table 6). Soil mesofauna diversity was significantly high at BAT which was on par with 10 DAG (0.92). Least diversity was observed at 45 DAG (0.59) and was on par with 105 (0.64), 90 (0.65) and 30 DAG (0.65).Significantly higher diversity of soil mesofauna was noticed in recommended fertilizer (251.17:113.31:114.35 kg N:P:K/ha) alone treated plot followed by 20.76 t of FYM/ha + 50 % fertilizer (123.74:48.91:55.59 kg N:P:K/ha) applied plots. It may be due to sufficient food availability, varied feeding habit with optimum moisture in food, soil moisture, lower soil temperature, crop shade, less disturbance and high amount of available phosphorous, as it gives good plant growth. Several earlier soil biologists have reported that single formulations particularly of nitrogen and calcium, increased number of the species and individuals (Ghilarov, 1971). Significantly higher diversity of soil mesofauna was noticed at BAT which may be due to rainfall in the previous fortnights which also increased the soil and food moisture and improved the emergence of mesofauna and the other soil invertebrates after the rainfall. Narasa Reddy (2012) also noticed higher diversity of mesofauna in 20 t of FYM treated plots of soybean.

Impact of different approaches of nutrient application on growth and grain yield of maize:

There was no significant difference in plant height among the treatments (Table 7). No significant difference in cobs/plant was noticed among the treatments (Table 7). Significantly higher yield was recorded in T_3 (47.35 q/ha) and was on par with T_6 (43.9) and T_4 (44.1)(Table 7). Lowest yield was recorded in T_7 (34.43).Plot treated with higher fertilizer (251.17:113.31:114.35 kg N:P:K/ ha) recorded more number of cobs per plant and more plant height than other treatments. The maximum grain yield was obtained in the plot receiving 173.32:93.66:97.96 kg N:P:K/ha fertilizer. The increase in grain yield may be due to the higher availability of available nitrogen, available phosphorus, available potassium, exchangeable calcium and exchangeable magnesium to the crop. The present findings are in contrary with the findings of (Satish, 2009; Virupaksha, 2011; Narasa Reddy, 2012; Devaraja, 2005; Girish, 2006) where they got higher soybean grain yield in plots treated with 20 t of FYM/ha. The variation may be due to reduced level of soil moisture at critical stage of crop especially due to drought year during the experiment.

4. Conclusion

This study indicated that soil application of 123.74:48.91:55.59 kg N:P:K/ha + 20.76 tonnes of FYM ha^{-1} harbored significantly higher soil mesofauna (26.88) compared to other treatments during the cropping and non-cropping season. Least abundance of soil mesofauna was observed in the plot treated with recommended fertilizer alone (251.17:113.31:114.35 kg N:P:K/ha) (13.81) in cropping seasons. The lowest and highest population of total soil mesofauna was noticed at before application of treatments (5.95) and 105 DAG (31.85) respectively, in cropping season. Abundance of mesofauna was highest in 123.74:48.91:55.59 kg N:P:K/ha + 20.76 t FYM/ha treated plots. However, the highest diversity was recorded in 251.17:113.31:114.35 kg N:P:K/ha applied plots (0.76).

5. References

Arun prasad Totey, N. G., Khatri, P. K. and Bhowmick., (1991). Effect of added tree leaves on the composition of humus and availability of nutrients in soil. Journal of Indian Society of Soil Science 39: 428-483

Asha, N.N., (2003). Effect of incorporation of *Chromolaena odorata* in soil microbial biomass and transformation of N and P in soils of Southern Karnataka. M.Sc.(Agri) Thesis, University of Agricultural Sciences, Banglore. p.136

Ayuke, F.O., Brussaard, L., Vanlauwe, B., Six, J., Lelei D.K., Kibunja, C.N., Pulleman, M.M., (2011). Soil fertility management: impacts on soil macro-fauna, soil aggregation and soil organic matter allocation. Applied Soil Ecology 48(1): 53-62

Bansal, K.N., (1992). Potassium balance in multiple cropping systems in vertisol at Jabalpur. Journal of Potassium Research 85: 52-58

Bengtsson, J., Ahnstrom, J., Weibull, A.C., (2005). The effects of organic agriculture on biodiversity and abundance: a meta-analysis. Journal of Applied Ecology 42: 61-269

Ben, L.M., Lydia, B., Dirk, R., Maurice, M., Stefaan, D.N., (2007). The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: Effects on soil fauna and yield. European Journal of Soil Biology 43: 91-100

Birkhofer, K., Bezemer, T.M., Bloem, J., Bonkowski, M., Christensen, S., Dubois, D., Ekelund, F., FlieBbach, A., Gunst, L., Hedlund, K., Mader, P., Mikola, J., Robin, C., Setala, H., Tatin-Froux, F., Vander Putten, W.H., Scheu, S., (2008). Long-term organic farming fosters below and aboveground biota: Implications for soil quality, biological control and productivity. Soil Biology and Biochemistry 40: 2297-2308

Bongers, T., (1990). The maturity index: an ecological measure of environmental disturbance based on nematode species composition. Oecologia 83(1): 14-19

Brahmam, P., Sravanthy, C., Laxman, P., Samatha, C., Sammaiah, C., (2010). Biodiversity of soil arthropods in Bt-cotton fields of Warangal, Andhra Pradesh, India. Bioscan 5: 159-160

Bray, R.H., and Kurtz, L.T., (1945). Determination of total, organic and available forms of phosphorus in soil. Soil Sci 59(1): 39-46.

Calugar, A., Ivan, O., (2009). Diversity and structure of edaphic mesofauna in relation of culture system. Ion-Ionescu de la Brad lasi, SeriaAgronomie 52(1): 306-312

Carter, M.R., (1991). Ninhydrin reactive N released by fumigation extraction method as a measure of microbial biomass under field conditions. Soil Biol. Biochem., 23:139-143

Chacon, P., Nazoa, S., Hemandez, L.Y.D., (1997). Effect of organic fertilization on arthropods abundance ia a savanna soil. Acta BiologicaVenezuelica 17(2): 77-83

Das, B. S., Wani, S. P., Benbi, D. K., Muddu, S., Bhattacharyya,T., Mandal, B., Santra, P., Chakraborty, D., Bhattacharyya, R., Basak N., Reddy, N. N., (2022). Soil health and its relationship with food security and human health to meet the sustainable development goals in India. Soil Security 8, 100071, ISSN 2667-0062. https://doi.org/10.1016/j.soisec.2022.100071.

Dash, M.C., Saxena, K.G., (2012). Earthworms in the Himalaya and Western ghats region of India: a review. The Bioscan 7(1): 1-8

Decaens, T., Jimenez, J.J, Gioia, C., Measey, G., Lavelle, P., (2006). The values of soil animals for conservation biology. Europian Journal of Soil Biology 42: 23-38

Devaraja, C., (2005). Impact of agro-chemicals and soil fertility levels on the abundance and diversity of soybean insect pests. M.Sc. (Agri) Thesis, University of Agricultural Sciences. Bangalore. p. 165

Dick, R.P., (1992). A review: long-term effects of agricultural systems on soil biochemical and microbial parameters. Agriculture, Ecosystems and Environment 40:25-36

Filser, J., (1995). Semi-field studies on the effects of insecticide endosulfan on Collembola. Verhandlungen Der Gesellschaft fur Okologia 19(2):302-309

Giri, B., Giang, P.H., Kumari, R., Prasad, R., Varma, A.,(2005). Microbial density in soils. In. Microorganisms in soils: roles in genesis and functions: Buscot F, Varma S, eds Heidelberg, Germany: Springer-Verlag 195-212

Ghilarov, M.S., (1971). Invertebrates, which destroy the forest litter and ways to increase their activity. In: Productivity of forest ecosystems. (ed P Durigneaud) UNESCO, Paris pp. 433-442

Girish, R., (2006). Effect of organic manure and chemical fertilizers on the soil fertility, abundance and diversity of arthropods (above and below ground) in soybean ecosystem. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bangalore, p. 185

Gruzdeva, L.I., Matveeva, E.M., Kovalenko, T.E., (2007). Changes in soil nematode communities under the impact of fertilizers. Eurasian Soil Science 40**:** 681 – 693

Jackson, M.L., (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 82-205

Killham, K., (1994). Soil Ecology. Cambridge University Press, New Work

Lewontin, R.C., (1972). The apportionment of human diversity. Evolutionary Biology **6:** 381-398

Maareg, M.F., Saleh, R.S., (1989). Seasonal occurrence of mites and other invertebrates fauna of chicken manure in Egypt. In: Progress in Acarology (Ed. Channabasavanna GP, Viraktamath CA) 2:301-303

Marshall, V.G., (1977). Effects of manures and fertilizers on soil fauna: A Review. CAB special publication No. 3 pp 79

Mathur, A.K., Sharma, S.N., Swamy, B.N., Singh, N., (1998). Direct and residual effect of FYM and phosphorous and zinc on major nutrients availability in wheat-pearl millet cropping sequence. CropResearch.16: 296-299

Mishra, B., Sharma, A., Singh, S.K., Prasad, J., Singh, B.P., (2008). Influence of continuous application of amendments to maize-wheat cropping system on dynamics of soil microbial biomass in alfisol of Jharkhand. Journal of Indian Society of Soil Science56(1): 71-75

Narasa Reddy, G., (2012). Studies on the inter-relationship between soil mesofauna and nematodes in organic farming system. M.Sc.(Agri) Thesis, University of Agricultural Sciences., Bangalore, p. 160

Parwez, H., Sharma, N., (2014). Effect of Edaphic Factors on the Population Density of Soil Microarthropods in Agro Forestry Habitat. Journal of Agroecology and Natural Resource Management. 1(3): 187-190

Patra, D.D., Bhandari, S.C., Misra, A., (2005). Effect of plant residues on the size of microbial biomass and nitrogen mineralization in soil. Soil Science and Plant Nutrition 38(1):1-6

Prasanna, P.M., (2006). Effect of organic manure and fertilizer on the abundance and diversity (above and below ground) of arthropods in soybean cropping system. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bangalore, p. 224

Prashanthi, G., (2014). Impact of crop rotation on soil fauna in organic farming ecosystem. M.Sc.(Agri) Thesis, University of Agricultural Sciences, Bangalore, p 154

Rajkumar, (2010). Anthropogenic effect on the soil fauna in agro-ecosystem. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bangalore, p. 191

Satish, (2009). Impact of different doses of organic manures on below ground biodiversity. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bangalore, p. 191

Schollenberger, C.J., and Simon, R.H., (1945). Determination of exchanged capacity and exchangeable bases in soil ammonium acetate method. Soil Sci. 59: 13-24.

Shashi, D.K., Nisha, K., Sarkar, A.K., (2007). Effect of pesticides and FYM on soil biological environment. Journal Res., 19(1): 1-2

Simpson, E.H., (1949). Measurement of diversity. *Nature*, 163: 688

Singh, L., Verma, R.N.S., Lohia, S.S., (1980). Effect of continuous application of FYM and chemical fertilizers on some soil properties. Journal of Indian Society of Soil Science 28: 170-172

Srinivas Reddy, K.M.,(2002). Impact of agro-chemicals and cropping systems on the abundance and diversity of soil invertebrates. Ph.D. Thesis, University of Agricultural Sciences, Bangalore, p. 174

Subbaiah, B.V., Asija, G.K., (1956). Available nitrogen by alkaline permanganate method. Current Science 25: 259-260

Sundararaj, N., Nagaraj, S., Venkataramu, M.N., Jagannath, M.K., (1972). Design and analysis of field experiments. UAS, Misc. Series, No. 22, Bangalore

Virupaksha, (2011). Development of conservation practices for below ground biodiversity in soybean ecosystem. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bangalore, p. 191

Walkley, A.J., Black, C.A., (1934). An examination method for determination soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci 37:29–38.

Watanabe, J., Ogawa, K., (1990). Influence of organic matter application on soil mesofauna in clay soils. Research Bulletin, Hokkaido Agricultural Experiment Station, Japan 154: 83-91

Table 1. Initial soil properties of the experimental site

Soil properties	Value
pH (1:2.5)	5.5
Coarse sand (%)	36.50
Fine sand (%)	34.60
Silt (%)	11.50
Clay (%)	17.40
Organic carbon (%)	0.35
Available nitrogen (kg ha^{-1})	360.64
Available phosphorus (kg ha^{-1})	103.20
Available potassium (kg ha^{-1})	171.60
Exchangeable Ca (meq 100 g^{-1})	6.8
Exchangeable Mg (meq 100 g^{-1})	46.96

Table 2. Treatment details used in this experiment

Treatments	Details
T1	STCR approach (target yield of 110q/ha) fertilizer alone (251.17:113.31:114.35 kgN:P_2O_5:K_2O / ha)
T2	STCR approach (target yield of 110q/ha) 50% through fertiliser (123.74: 48.91: 55.59 kg N:P_2O_5:K_2O / ha) + 50% through FYM (20.76 tonnes FYM/ ha)
T3	STCR approach (target yield of 90q/ha) fertilizer alone (173.32: 93.66: 97.96 kg N:P_2O_5:K_2O/ha)
T4	STCR approach (target yield of 90q/ha) 50% through fertilizer (85.34:45.28:48.45 kg N:P_2O_5:K_2O/ha) + 50% through FYM (14.65 tonnes FYM/ ha)
T5	Package of practice (150:75:40 kg N:P_2O_5:K_2O/ha) + 10 tonnes FYM/ha
T6	LMH approach (150: 75: 50 kg N:P_2O_5:K_2O/ha) + 10 tonnes FYM/ha
T7	Control (absolute untreated)

Table 3. Impact of different approaches of nutrient application on soil pH, exchangeable calcium and magnesium,and soil microbial biomass carbon

Treatments	Soil pH			Exchangeable Magnesium (meq/100g)			Exchangeable Calcium (meq/100g)			Microbial biomass carbon(µg /g soil)		
	BAT	45DAG	At harvest	BAT	45DAG	At harvest	BAT	45DAG	At harvest	BAT	45DAG	At harvest
T1	5.64	6.74^{a}	5.52^{b}	1.90	4.60^{a}	1.93^{ab}	4.20	6.20^{c}	5.23^{a}	803.91^{g}	1565.77^{g}	978.27^{g}
T2	5.45	6.59^{a}	5.48^{b}	1.60	3.26^{b}	1.43^{b}	4.26	7.20^{a}	4.76^{a}	2012.71^{a}	3547.11^{a}	2903.17^{a}
T3	5.46	6.52^{a}	5.33^{b}	2.93	2.63^{b}	2.36^{a}	4.16	6.10^{c}	4.16^{ab}	894.53^{f}	1765.57^{f}	987.82^{f}
T4	5.41	6.33^{ab}	5.29^{b}	1.16	2.50^{b}	2.03^{ab}	4.20	6.76^{b}	4.30^{b}	1704.29^{b}	2856.95^{b}	2863.33^{b}
T5	5.42	6.18^{b}	5.56^{b}	1.46	3.93^{a}	2.76^{a}	4.40	6.56^{bc}	4.90^{a}	1550.71^{c}	2697.92^{c}	1987.11^{d}
T6	5.47	6.20^{b}	5.58^{b}	1.60	4.06^{a}	1.50^{b}	4.73	6.43^{bc}	4.93^{a}	1224.53^{d}	2583.12^{d}	2002.80^{c}
T7	5.74	5.93^{b}	6.10^{a}	1.66	4.03^{a}	2.26^{ab}	4.03	6.23^{bc}	3.96^{b}	1058.41^{e}	2352.73^{e}	1765.82^{e}
SEM±	0.12	0.14	0.09	0.43	0.35	0.28	0.31	0.17	0.23	1.67	1.20	1.53
CD at 5%	NS	0.45	0.29	NS	1.10	0.86	NS	0.53	0.73	5.16	3.72	4.73

Table 4. Impact of different approaches of nutrient application on soil available nitrogen, phosphorus and potassium

Treatments	Available Nitrogen (kg/ha)			Available Phosphorous (kg/ha)			Available Potassium (kg/ha)		
	BAT	45DAG	At harvest	BAT	45DAG	At harvest	BAT	45DAG	At harvest
T1	409.37	539.88^{a}	358.68	50.16	79.24^{a}	28.02	83.73^{b}	333.66^{a}	283.66^{a}
T2	346.03	348.99^{b}	282.80	52.60	65.59^{c}	38.53	95.26^{a}	401.33^{a}	354.66^{a}
T3	403.91	512.78^{a}	347.76	44.22	78.35^{a}	52.41	50.40^{e}	275.00^{b}	264.66^{b}
T4	387.61	356.39^{b}	322.22	45.09	67.45^{c}	44.61	75.46^{c}	324.66^{a}	283.66^{a}
T5	385.01	518.59^{a}	330.38	31.79	71.93^{b}	34.42	65.13^{d}	318.00^{a}	247.00^{bc}
T6	386.26	393.02^{b}	331.76	35.53	69.49^{b}	35.86	65.70^{d}	412.66^{a}	323.33^{a}
T7	408.17	398.57^{b}	332.18	35.48	72.27^{b}	45.55	53.20^{e}	183.00^{b}	179.66^{c}
SEM±	27.91	20.59	19.29	7.25	0.88	1.43	2.30	34.25	25.68
CD at 5%	NS	63.45	NS	NS	2.71	NS	7.10	105.54	79.13

BAT = Before application of treatments DAG = Days after germination

Table 5. Impact of different approaches of nutrient application on the abundance of soil mesofauna in maize ecosystem during cropping season

Treatments		Number of Mesofauna / 400g of soil at days after germination							
	BAT	**10**	**20**	**30**	**45**	**60**	**75**	**90**	**105**	**Mean**
T_1	3.66(2.01)	5.66 (2.46)	10.66 (3.32)	10.33(3.26)	13.33(3.63)	15.66(3.93)	18.66 (4.32)	22.33(4.75)	24.00(4.88)	13.81(3.62)^{e}
T_2	9.00 (3.07)	12.66(3.60)	22.33 (4.64)	25.00(4.94)	27.00(5.21)	30.00(5.47)	35.00 (5.89)	39.00(6.26)	42.00(6.48)	26.88(5.06)^{a}
T_3	5.33 (2.37)	6.66(2.66)	12.33 (3.53)	12.33(3.52)	15.66(4.00)	17.66(4.20)	21.33 (4.67)	24.66(4.93)	26.33(5.12)	15.81(3.89)^{de}
T_4	6.66 (2.66)	11.00(3.36)	17.00 (4.11)	20.33(4.52)	24.66(5.00)	27.00(5.19)	29.66 (5.47)	34.66(5.89)	38.00(6.09)	23.22(4.70)^{ab}
T_5	6.00 (2.52)	9.66 (3.15)	15.66 (3.94)	18.66(4.36)	21.66(4.68)	24.00(4.92)	27.00 (5.23)	30.33(5.50)	33.66(5.74)	20.74(4.45)^{bc}
T_6	5.66 (2.46)	9.33 (3.13)	15.00 (3.90)	16.33(4.09)	20.00(4.39)	22.33(4.77)	25.00 (5.00)	29.00(5.35)	30.33(5.44)	19.22 (4.28)^{c}
T_7	5.33 (2.41)	7.66 (2.84)	13.33 (3.71)	14.66(3.88)	17.66(4.25)	19.33(4.39)	23.00 (4.61)	27.00(5.17)	28.66(5.37)	17.40(4.07)^{cd}
Mean	5.95(2.50)^{g}	8.95 (3.03)^{g}	15.19(3.88)^{f}	16.80(4.08)^{ef}	20.00(4.45)^{de}	22.28(4.70)^{cd}	25.66(5.03)^{bc}	29.57(5.41)^{ab}	31.85(5.59)^{a}	
									S.Em±	CD@5%
Treatment									0.13	0.38
Days									0.15	0.43
Interaction									0.40	1.14

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

Table 6. Impact of different approaches of nutrient application on the diversity of soil mesofauna during cropping season

Treatments	Simpson diversity indices								
	BAT	**10**	**20**	**30**	**45**	**60**	**75**	**90**	**105**	**Mean**
T1	0.94	0.94	0.77	0.78	0.65	0.80	0.67	0.61	0.71	0.76
T2	0.92	0.92	0.74	0.66	0.60	0.72	0.76	0.70	0.71	0.75
T3	0.94	0.92	0.76	0.72	0.59	0.70	0.69	0.69	0.70	0.75
T4	0.92	0.91	0.75	0.64	0.56	0.68	0.77	0.63	0.62	0.72
T5	0.94	0.93	0.79	0.59	0.54	0.69	0.66	0.62	0.59	0.70
T6	0.97	0.89	0.75	0.54	0.59	0.67	0.75	0.66	0.61	0.71
T7	0.91	0.90	0.77	0.64	0.63	0.68	0.69	0.68	0.54	0.71
Mean	0.93^{a}	0.92^{a}	0.76^{b}	0.65^{de}	0.59^{e}	0.71^{bcd}	0.71^{bc}	0.65^{cde}	0.64^{de}	
									S.Em±	CD@5%
Treatment									0.02	NS
Days									0.02	0.06
Interaction									0.06	NS

Table 7. Impact of different approaches of nutrient application on the growth and grain yield of maize

Treatments	Plant height (cm)	No. of cobs/plant	Grain yield (q/ha)
T1	121.63	1.26	42.05[ab]
T2	119.70	1.10	41.19[b]
T3	116.50	1.03	47.35[a]
T4	120.96	1.20	44.10[ab]
T5	118.10	1.06	39.60[b]
T6	115.83	1.13	43.90[ab]
T7	111.23	1.00	34.43[c]
SEM±	3.37	0.07	1.63
CD at 5%	NS	NS	5.02