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Research Article

POPULATION DYNAMICS OF EARTHWORM INFLUENCED BY USE OF DIFFERENT NUTRIENT SOURCES IN SOIL OF BALLIA, UTTAR PRADESH

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Abstract: The pot experiment was carried out on the population dynamics of earthworm (*E.fetida*) different doses of organic and inorganic source in soil of different soil depth. The experiment was conducted in 16 treatments with three replications of different amount of FYM, DAP, Urea, phorate and leaf litter at three depth of (0-15, 15-30, 30-45 cm) of soil along with inoculation of earthworms (*Esinia fetida*). Soil sample were draw for the number of earthworms and analyses of bulk density, organic carbon soil pH, EC, Available N,P,K,S and Fe, Cu, Zn and Mn on 110 DAT. The bulk density and pH were found decrease in all depth with treatment of FYM @ 60t/ha significantly, while EC of soil showed not much more significant difference among the treatments with no marked difference. Organic carbon content was significantly increased by all sources under the influence of earthworm, but earthworm alone treatment did not show any beneficial effect on enhancement of organic carbon, the application of FYM @ 60t/ha treatment significantly more effective. The earthworm and organic and inorganic materials a three depth were indicated greater available N and K in T7 at the30-45 cm depth than leaf litter treatment might be due to direct incorporation of nitrogen through FYM @60t/ha but highly effective was found 300 mg/kg urea application to the available N pool of the soil. Amount of available phosphorus and sulphur in all depth showed a gradual increase from depth 0-15 to 30- 45 showed greater amounts in T6 and further decreased up to 30-45cm depth with T12. Available Fe, Cu and Zn content were found gradual increased from upper to 30-45 cm depth on high dose of inorganic materials (DAP,urea and phorate) only. Greater available Mn content was found by the treatment of FYM @60 t/ha application in second depth in T3. So, that application of FYM @60t/ha was appeared to highly effective to count earthworm population at 0-15 cm soil depth where higher doses of phorate (>15kg/ha) cause the detrimental effect on earthworm.

Keywords: *Earthworm population, Organic sources, Chemical fertilizers, Micronutrients, Soil depths*

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Introduction

Many people have considered earthworms to be an indicator of soil quality because the responded to contribute to healthy soil. For earthworms to be abundant in a field must need several conditions that are also associated with soil quality and agricultural sustainability. Earthworm species vary in how they get food, in these inhabit different parts of the soil and have somewhat different offers on the soil environments. Epegeic (litter dwelling) earthworms live and feed in surface litter. They move horizontally though leaf litter or compost with litter ingestion of burrowing in to the soil. Both indogic and anecic species are important in contributing to these functions in agricultural systems. However, growth, reproduction and health of earthworms are being increasingly threatened by the excessive application of agrochemicals to soil and the agricultural activities or measures. Applied pesticides in different proportion affects the soil flora and fauna activities such microorganism and rest soil biota activities with consequent affect on soil health and resulted land degradation. Pesticides residence in soil is affected by many factors like soil pH, leaching, soil microbes, adsorption by clay, organic matter and soil water also [1]. Organic source such as manure, cow dung, leaf litters, crop residues and other agricultural wastes disposal in to soil for increase the fertility of soil, it depends on soil decomposer community which has develop biochemical soil environment. Decreasing animal population in India leads to decreasing the cow dung production and that's limits the supply FYM to arable land which is backbone of humus and organic carbon and biochemical phenomenon of soil. Gap of that vulnerable relationship between cow dung- FYM and organic carbon in soil buildup soil sickness. It is disturbed benefit-cast relationship and farmer get diminishing return from output.

The alternative sources such as leaf litter, crop residue, agricultural wastes and other organic substance are available in urban and rural farming community and they are able to ameliorate the soil sickness and act as soil conditioner to maintained soils health. But high cropping intensity, busy crop rotation and market-oriented cultivation practices and irresponsible land holding personality of farmers to want readymade materials to supply plant nutrients for more chemical returns, while those inorganic and chemical substances are capable to buildup soil ecological imbalance and degrade soil quality. Keeping this in view study was carried out in laboratory with pot experiment.

Materials and methods

Collection of earthworm and materials-Earthworm variety *Eisenia fetida* was collected from K.V.K, Lucknow, Uttar Pradesh. Before inoculation in pot, earthworms were, washed and weigh as per need of treatment combination. The organic sources such as FYM leaf litter and in organic sources as urea, DAP, and phorate were collected from locally available in Ballia city and nearby village.

Pot filling and incorporation of materials as per treatment combination

The surface soil (0-15 cm) samples were collected from agriculture farm of Shri Murli Manohar Town P.G. College, Ballia , Uttar Pradesh in September 2013 where no crop was standing in field and no rain fall occurred during the prior 48hrs. Collected soil were air dried in shade, powdered and made free from the plant roots gravels and stones etc before the pot filling. The 10kg air dried powered and sieved (through 2.0 mm, sieve) soil of 0-15 cm of agriculture farm

was field in earthen pots, soil was free from the any undesirable materials undecomposed organic residues pot, pieces, gravels, etc. soil was pulverized and powdered before mixing of treatment substances and filling of pots. Each pot was filled up with 10kg of well processed and powdered soil there after the amount al fertilizer N (as urea)@200mg/kg,300mg/kg, 400mg/kg DAP(as di ammonium phosphate) @100mg/kg, 200mg/kg, 300mg/kg, phorate (as phorate)@15kg/ha,25kg/ha and 35kg/ha and organic manure manure (as FYM) @ 20t/ha, 40t/ha,60t/ha dried leaf litter (as dry leaf) @20t/ha, 40t/ha and 60t/ha were mixed with different dose as per treatment combination. After filling the pots moisture was maintained 60% by adding of distilled water entire the experimental period. After filling of pot in three step 0-15, 15-30 and 30-45cm in a 45 cm deep plastic pot and the depth separation was made by using as plastic net, their pore size was smaller than earthworm. The treatment combinations were as T1-FYM@ 20t/ha, T2-FYM @40/ha, T3-FYM@60/ha, T4-DAP@100mg/kg, T5-DAP@200mg/kg, T6-DAP@300mg/kg, T7-Urea@200mg/kg T8-Urea@300mg/kg, T9-Urea@400mg/kg, T10-phorate@15kg/ha, T11-phorote@25kg/ha, T12-phorat @35kg/ha, T13-leaf litter@20t/ha, T14-leaf litter@40t/ha, T15- leaf letter@60t/ha, T16-Control. N was applied through urea, phorate 10% granule, DAP(N-18 and P2O5-46 %).The treated soil samples were drawing 110 days after treatment (DAT) for the analyses of bulk density pH, EC, organic carbon available N,P, K, S, micronutrients Fe, Cu, Zn and Mn and count earthworm population in each depth in a container.

Table-1 *Initial properties of experimental soil*

Parameters	Amounts
Bulk density (Mg m^{-3})	1.32
pH	7.65
EC (d Sm^{-1})	1.003
Organic carbon (%)	0.42
Available N(kg/ha)	288.53
Available P (kg/ha)	11.65
Available K (kg/ha)	157.18
Available S (mg/kg)	5.5
Available Fe (mg/kg)	5.721
Available Cu (mg/kg)	0.285
Available Zn (mg/kg)	0.726
Available Mn (mg/kg)	2.985

Soil sampling for analyses and population count of earthworm

After the completion of 110 days of inculcation at 60% moisture, each depth soil was spread on a plastic sheet and gently removed worm from soil side then count their number. 500 g soil sample were drawn from each treatment, process, dried, sieved for analyses of physical and chemical parameters. After that earthworm washed and weight on balance. Bulk density by RD bottle (Mg m^{-3}) method described by Kanwar and Chopra (1998) [2]. Soil pH was determined with glass electrode pH meter in 1:2.5 ratio of soil water suspension method described by piper (1966) [3]. Electrical conductivity (dSm^{-1}) of the supernatant liquid of the 1:2.5 ratio of soil water suspension was determined with Toshenwal conductivity meter method described by Kanwar and Chopra (1998). Organic carbon content of soil was determined by Walkley and Black (1934) [4] wet digestion method as described by Kanwar and Chopra (1998). Available N was determined by alkaline potassium permanganate method (Subbiah and Asija ,1956), Available P was estimated by using Olsen's method (1954) [5], available K by Ammonium acetate method described by Muhr *et. al*., (1965) [6], available sulphure content of soil was determined by Welliams and Steinbergs (1959) [7] described by Tandon (1999) [8]. Micronutrients as available (DTPA extractable) Fe, Cu, Zn, Mn [9] as given below in most widely used. The extraction of soil for Fe, Cu, Zn, and Mn analysis were done by the same extractants of DTPA measurement of AAS (Atomic Absorption Spectrophotometer). The statistical analysis on the data from different parameter was done by method described by Gomez and Gomez (1984) [10]. Using R.B.D. (Randomized Block Design) significance of the treatment mean was made with the help of critical difference calculated.

Result s and discussion

Bulk density (Mg m^{-3}), pH and Electrical conductivity (EC) dSm^{-1} of soil

The bulk density of soil was estimated by three depths (0-15cm, 15-30cm, 30-45 cm) soil [Table-1] found minimum value 1.22 Mgm^{-3} by treatment combination of phorate@25kg/ha as compared to FYM20 and 40 t/ha over the control. It was ranged from 1.22 to 1.33 Mg m^{-3} and observed seems that decreased by increasing soil depth of pot. The bulk density in the treatment combination with different organic materials were observed similar to the control value, while alone treatment showed significantly increased bulk density of soil. In fact, decrease in bulk density of soil in the treatment combination of FYM, Urea, DAP, Phorate and leaf litter with treatment due to increase organic carbon in surface soil [11] while alone earthworm application was increased the bulk density might by due to addition of minerals in the surface soil. Among the three soil depth, pH of 30-45cm depth soil had showed low pH than upper soil with all the treatment combination as compared to control. The organic source as manure (FYM)@60 t/ha was found to decreased in pH than other dose, while@ 40t/ha application of dry leaf letter got the similar response. The inorganic or chemical sources as fertilizers, DAP, Urea and Phorate were also to decrease the soil pH except phorate. Urea and DAP seems to gradual decreased soil pH due to developed soil acidity. The treatment combination of FYM and leaf litter were found to slightly higher pH value than chemical fertilizers due to might be presence of earthworm maintain the desirable soil pH. So, that rapid change in soil pH inorganic materials and plant materials applied pots were related to the concentration of excess cations and decomposition of the materials [12] and the application of leaf litter cause of acidification and slow down the soil pH.

The electrical conductivity value [Table-2] revealed that there was no marked difference was found among the treatment combination of organic and inorganic materials in soil with earthworm than control. E.C. of soil under study was ranged from 1.001 to 1.007dSm^{-1}. It was observed that E.C. value of 0-15 cm depth was slight greater than 30-45 cm depth in all the treatment combination, it seems to might be accumulation of soluble salt in surface soil than control pot. There where incorporation of higher dose of FYM @ 60t/ha, DAP @ 300 mg/kg, Urea@400mg/kg, Phorate@35kg/ha, and leaf litter @60 t/ha were appeared to least accumulation of soluble salt in surface soil. The incorporated organic and inorganic materials in the presence of earthworm might be decrease the E.C. by electro chemical phenomenon [Table-4]. Organic carbon content was increased substantially due to incorporation of all organic and inorganic sources combination with earthworm except phorate treatments combination over the control [Table-4]. It was found significantly greater in FYM and leaf litter pots than among the treatment combination. Oxidizable soil organic carbon content 0.66% was maximized by application of FYM @ 40 and 60 t/ha treatment were significantly more than all other treatment combination. The addition effect of FYM in maintaining higher organic carbon level might be due to its less rapid decomposition under the prevented net temperate condition [13]. The application of leaf litters @ 40 and 60 t/ha was also appeared to increase the percent organic carbon (0.60 and 0.59%) due to easily decomposed by earthworm [14]. The application of phorate with their all three doses could not show to increase percent organic carbon while reduce the organic carbon might be inhibit the growth and activity of earthworm including other decomposers and microbes but it may increase the thermal activity of soil which reduce the organic carbon quantity [15]. Similarly, inorganic or chemical fertilizer as DAP @ 100 mg/kg and 200 mg/kg showed increasing the organic carbon content (0.62-0.64%) as compared to other chemical sources due to increase the decomposition of soil organic materials and other pool of carbon. In fact, inorganic fertilizers have positive effect on the earthworms and enhance the churning capacity including leaf litter also.

Population of earthworm

Earthworm population of soil [Table-4] was observed zero population counted by treatment combination of phorate @35 kg/ha as compared to DAP @300 mg/kg over the control, it was ranged from 0 to 62. It seems to decrease by increasing soil depth of pot. The higher doses of FYM@60t/ha and leaf litter@60t/ha application was significantly increasing the greater earthworm population in surface (0-15 cm) soil as well as lower depth. The population of earthworm was found decreasing along with increasing soil depth due to might be availability of oxygen and food materials as compared to inorganic substances [16].

Table-2 *Effect of different organic and inorganic source on Bulk density (Mg m^{-3}), pH and EC (dSm^{-1}) in three depth of soil*

Treatment combination with Earthworm	Soil Depth (cm)								
	0-15			15-30			30-45		
	Bd	pH	EC	Bd	pH	EC	Bd	pH	EC
T_1 FYM@20t/ha	1.32	7.63	1.007	1.31	7.59	1.005	1.26	7.73	1.004
T_2 FYM@40t/ha	1.32	7.53	1.004	1.3	7.57	1.005	1.28	7.5	1.003
T_3 FYM@60t/ha	1.28	7.65	1.004	1.28	7.66	1.004	1.26	7.4	1.002
T_4 DAP@100mg/kg	1.33	7.4	1.002	1.32	7.04	1.004	1.22	7.35	1.003
T_5 DAP@200mg/kg	1.3	7.51	1.004	1.28	7.52	1.005	1.23	7.42	1.004
T_6 DAP@300mg/kg	1.29	7.41	1.005	1.27	7.5	1.006	1.26	7.41	1.005
T_7 UREA@200mg/kg	1.25	7.59	1.001	1.25	7.56	1.001	1.22	7.46	1.004
T_8 UREA@300mg/kg	1.27	7.54	1.002	1.26	7.56	1.001	1.25	7.52	1.001
T_9 UREA@400mg/kg	1.25	7.51	1.003	1.27	7.58	1.002	1.25	7.46	1.003
T_{10} PHORATE@15kg/ha	1.24	8.01	1.004	1.25	7.89	1.001	1.23	7.84	1.002
T_{11}PHORATE@25kg/ha	1.22	7.92	1.005	1.22	7.89	1.003	1.24	7.8	1.002
T_{12} PHORATE@35kg/ha	1.28	7.88	1.002	1.24	7.69	1.004	1.24	7.7	1.004
T_{13} Leaf Litter@20t/ha	1.25	7.61	1.003	1.28	7.63	1.003	1.21	7.56	1.003
T_{14} Leaf Litter@40t/ha	1.27	7.54	1.003	1.25	7.61	1.004	1.26	7.65	1.002
T_{15} Leaf Litter@60t/ha	1.28	7.62	1.002	1.26	7.64	1.005	1.28	7.44	1.001
T_{16} Control	1.27	7.76	1.004	1.26	7.73	1.003	1.25	7.65	1.003
CD (P=0.05)	0.02	NS	NS	0.01	NS	NS	NS	0.02	NS

Table-3 *Effect of different organic and inorganic source on Available N,P and K (kgha^{-1}) in three depth of soil*

Treatment combination with Earthworm	Soil Depth (cm)								
	0-15			15-30			30-45		
	Available S N	Available S P	Available S K	Available S N	Available S P	Available S K	Available S N	Available S.P	Available S K
T_1 FYM@20t/ha	345.4	18.4	248.01	355.5	16.5	249.09	342.8	17.48	246.05
T_2 FYM@40t/ha	365	18.65	259.81	365.5	18.9	258.96	366.7	16.76	258.76
T_3 FYM@60t/ha	370.8	19.5	269.19	385.6	18.95	268.58	379	17.65	249.09
T_4 DAP@100mg/kg	310.5	20.65	228.21	335.8	20.66	227.98	318.6	19.9	225.85
T_5 DAP@200mg/kg	300.6	24.56	227.76	298.6	24.98	228.98	268.5	21.9	227.19
T_6 DAP@300mg/kg	310.6	28.5	228.09	240.6	26.95	230.05	335.6	26.8	229.9
T_7 Urea@200mg/kg	398.6	16.86	204.68	420.6	15.1	204.09	406.5	15.65	204.07
T_8 Urea@300mg/kg	410.5	18.64	206.96	420.5	17.5	207.98	418.5	16.65	205.07
T_9 Urea@400mg/kg	408.5	17.5	208.89	415.6	16.16	206.9	416.8	16.8	204.91
T_{10} Phorate@15kg/ha	305.6	14.8	196.09	318.8	17.6	198.56	310.6	15.5	197.96
T_{11}phorate@25kg/ha	299.5	15.65	195.76	302.5	12.5	197.18	306.6	13.9	196.79
T_{12} Phorate@35kg/ha	299.8	11.65	196.96	304.5	10.85	198.78	305.6	10.65	196.8
T_{13} Leaf Litter@20t/ha	298.6	14.5	195.53	310.5	13.9	200.05	298.8	12.65	203.06
T_{14} Leaf Litter@40t/ha	300.5	15.65	204.66	299.5	16.9	210.56	300.6	13.65	218.19
T_{15} Leaf Litter@60t/ha	296.6	17.05	208.33	298.5	16.65	209.9	298.2	15.9	212.65
T_{16} Control	301.5	11.65	157.18	298.8	12.5	161.09	300.6	13.5	158.28
CD (P = 0.05)	25.4	2.69	16.88	40.9	3.12	14.69	30.6	2.8	18.06

The application of different doses of phorate was appeared to significantly greater decrease in population from upper to lower depth of soil. In fact, higher dose (15,25 and 35 kg/ha) of phorate cause poisonous effect and kill the inoculated worms. Inspite of the phorate dose inhibit the enzymes activity and detrimental effect on nervous system along with fertility of worm.

Available Sulphur (mg/kg)

The available sulphur content was gradual increased with depth of soil in all treatment combination [Table-4]. On 15-30 cm depth alone application of higher dose of treatment T14 showed significantly high value (6.66 mg/kg) than T3 and T13. The similar pattern was observed at all depth of experiment. The content was varied with the treatment depending upon soil pH and organic materials (FYM and leaf litter). A greater amount of available S was found in 15-30 cm depth and at par value of T14. The continuous release of greater extant of available sulphur by the alone application of earthworm in soil then FYM and leaf litter. Manure (FYM) and dry leaf litter might be due to prolong the sulphur solubilization, use of organic manure and sulphur containing fertilizer have led to increase sulphur content in those treatment, several soil factors influence the availability of sulphur and hance the status of different form of sulphur in soil varied widely with soil type [17].

Available N, P and K (kg ha^{-1})

The available nitrogen content in soil was found in gradual increase along with depth (0-15, 15-30 & 30-45 cm) at 110 days, from 296.5 to 420.5 kg/ha throughout the experiment [Table-3]. However available N content was found maximum in T7 (420.5kg/ha) where urea had incorporated and enhanced, the availability as compared to control pot. It might be due to direct incorporation of urea nitrogen through in soil in the presence of earthworm. The favorable soil condition under manuring might have helped the mineralization of soil N leading to buildup of higher available N [18]. The available nitrogen content was not increased by the application of high No. of earthworm alone due to low initial value of soil in respect of nitrogen mineralization. Although treatment combination with FYM found to increase greater available N might be due to mineralization. The treatment combination of dry leaf litter with earthworm showed low available nitrogen as compared to control treatment. It ranged from 296.6 to 310.5 kg/ha in 0-15, 15-30 and 30-45 cm depth of pot. In fact, application of 20, 40 and 60 t/ha dry leaf letter in soil get to release of low amount of available N due to mineralization and narrow C:N ratio of soil. Available phosphorus content was found small variation in all soil depth. A gradual increase was found that grater amount by 28.50 kg/ha in T6 and it was decreasing by 10.65 kg/ha in T12. The similar trend was observed T6 and T12. Phosphorus availability increased by T5 and T6 then control pot with continuous use of organic sources. A significantly build-up of available P was recovered with grade level of fertilizers and it was producing of organic acids during microbial decomposition of the dry leaf in soil and decreased in soil pH [19]. Increase in the available P might be attributed to the decomposition of organic matter accompanied by the release of abundant quantity of CO_2. CO_2 production play a dominant role in enhancing the phosphorus availability [20] organic matter forms a protective core on sesquioxider and this facilitates redirection in the phosphate fixing capacity of soil [21].

Table-4 *Effect of different organic and inorganic source on organic carbon (%), Available S (mgkg^{-1}) number of earthworms in three depth of soil*

Treatment combination with Earthworm	Soil Depth (cm)								
	0-15			15-30			30-45		
	O.C	Available S	Earth worm	O.C	Available S S	Earth worm	O.C	Available S S	Earthworm
T_1 FYM@20t/ha	0.65	5.65	40	0.63	5.59	24	0.61	5.55	11
T_2 FYM@40t/ha	0.64	5.66	56	0.66	5.67	36	0.6	5.65	29
T_3 FYM@60t/ha	0.64	5.64	62	0.64	5.68	41	0.62	5.63	35
T_4 DAP@100mg/kg	0.63	5.51	13	0.64	5.53	11	0.64	5.49	8
T_5 DAP@200mg/kg	0.6	5.48	6	0.63	5.52	5	0.61	5.51	6
T_6 DAP@300mg/kg	0.62	5.5	4	0.63	5.56	4	0.6	5.59	1
T_7 Urea@200mg/kg	0.52	5.49	19	0.54	5.54	12	0.53	5.57	18
T_8 Urea@300mg/kg	0.51	5.44	15	0.52	5.67	10	0.5	4.98	7
T_9 Urea@400mg/kg	0.49	4.8	15	0.5	4.81	12	0.47	4.81	12
T_{10} Phorate@15kg/ha	0.51	4.71	5	0.51	4.7	4	0.49	4.69	3
T_{11}phorate@25kg/ha	0.49	4.76	0	0.5	4.85	1	0.49	4.78	0
T_{12} Phorate@35kg/ha	0.48	4.68	0	0.52	4.7	0	0.48	4.69	0
T_{13} Leaf Litter@20t/ha	0.6	6.21	24	0.59	6.4	20	0.52	6.42	1
T_{14} Leaf Litter@40t/ha	0.59	6.38	41	0.61	6.46	27	0.63	6.45	17
T_{15} Leaf Litter@60t/ha	0.59	6.41	49	0.64	6.5	37	0.61	6.39	12
T_{16} Control	0.51	5.48	18	0.51	5.52	16	0.5	5.49	9
CD (P = 0.05)	0.12	0.68	7.81	0.16	0.48	6.42	0.11	0.38	4.82

Table-5 *Effect of different organic and inorganic source on DTPA extractable Fe, Cu, Mn and Zn (mgkg^{-1}) in three depth of soil*

Treatment combination with Earthworm	Soil Depth (cm)											
	0-15				15-30				30-45			
	Fe	Cu	Mn	Zn	Fe	Cu	Mn	Zn	Fe	Cu	Mn	Zn
T_1 FYM@20t/ha	6.981	0.356	3.486	0.979	6.99	0.335	4.88	0.981	6.989	0.358	3.475	0.985
T_2 FYM@40t/ha	6.895	0.349	3.488	0.981	6.899	0.35	3.489	0.98	6.9	0.35	3.487	0.988
T_3 FYM@60t/ha	6.889	0.352	3.495	0.985	6.891	0.352	3.498	0.989	6.89	0.355	3.496	0.995
T_4 DAP@100mg/kg	7.021	0.332	3.279	0.884	7.03	0.331	3.284	0.885	6.048	0.335	3.274	0.888
T_5 DAP@200mg/kg	7.019	0.334	3.285	0.879	7.021	0.335	3.288	0.88	7.025	0.33	3.282	0.882
T_6 DAP@300mg/kg	7.02	0.331	3.269	0.881	7.019	0.333	3.299	0.882	7.022	0.33	3.295	0.885
T_7 Urea@200mg/kg	6.805	0.309	3.188	0.865	6.185	0.311	3.195	0.869	6.82	0.309	3.186	0.865
T_8 Urea@300mg/kg	6.789	0.312	3.179	0.856	6.788	0.31	3.187	0.858	6.79	0.315	3.181	0.86
T_9 Urea@400mg/kg	6.801	0.31	3.189	0.859	6.819	0.312	3.198	0.86	6.821	0.318	3.19	0.862
T_{10} Phorate@15kg/ha	5.841	0.298	3.886	0.764	5.84	0.295	3.288	0.764	5.845	0.291	2.879	0.768
T_{11}phorate@25kg/ha	5.672	0.289	2.79	0.759	5.67	0.288	2.805	0.76	5.675	0.292	2.788	0.762
T_{12} Phorate@35kg/ha	5.791	0.291	2.68	0.762	5.789	0.292	2.654	0.765	5.795	0.295	2.589	0.763
T_{13} Leaf Litter@20t/ha	6.553	0.304	3.249	0.788	6.555	0.306	3.255	0.799	6.56	0.31	3.248	0.793
T_{14} Leaf Litter@40t/ha	6.498	0.296	3.251	0.789	6.495	0.295	3.259	0.786	6.5	0.298	3.25	0.796
T_{15} Leaf Litter@60t/ha	6.523	0.303	3.259	0.783	6.525	0.305	3.265	0.785	6.53	0.308	3.255	0.788
T_{16} Control	5.721	0.285	2.986	0.726	5.725	0.289	2.985	0.73	5.728	0.29	2.981	0.787
CD (P = 0.05)	0.92	0.091	0.24	0.064	0.62	0.082	0.34	0.062	0.52	0.081	0.28	0.072

A larger build up in available P with dry leaf might be attributed to the enhance of FYM in increasing the P in soil through complication of cations like Ca^{2+} and Mg^{2+} which are manually responsible for the fixation of P in alkaline soil. Available potassium content in different treatment combination was decreased with increasing in all treatment combination; the maximum increased by available K was 269.19 kg/ha measured at T1 at 0-15 cm depth with within @60 t/ha FYM. Similarly, at all depth of experiment, showed amount of available Potassium by application of high dose of FYM with earthworm incorporated (T1). Inorganic chemical sources, as phorate application leads to significantly decreased the available K status. A positive effect of earthworm addition on potassium content of soil was also reported by Lal *et. al*., (1996), increase in available K due to dry leaf and FYM application might be attributed to the direct addition of potassium to the available pool of the soil K, beneficial effect of leaf manuring on might be attributed to the reduction of organic matter with clay, besides the direct condition to the available K pool of the soil [22]. Among, the chemical sources with earthworm treatment combination, phorate doses were appeared to minimize the K availability might be due to enhanced potassium fixation by alternate wetting and drying of incubated pot soil.

DTPA extractable Fe, Cu, Mn and Zn (mg/kg)

DTPA extractable available Fe content was a small variation in amount of available Fe in all depth [Table-5]. A gradual increase to decrease and decrease to increase in all treatment was found, the highest amount of Fe was observed in T4 (7.021 mg/kg) and lowest amount in T11 (5.721 mg/kg). The increased available Fe was observed with DAP doses than control pot as well as the other treatments. It might be increased due to already containing micro nutrients. Available Cu content was observed a gradual increase from 30-45cm soil depth (0.355 mg/kg) in T3 and it was decrease of 0.285 mg/kg at 0-15 cm depth [Table-5]. The increase in available Cu was observed with FYM dose of 60 t/ha than the control treatment. There was application of phorate as 15, 25 and 35 kg/ha appeared to low accumulation of DTPA extractable Cu as compared to leaf litter it might be increase the fixation of Cu with other minerals. Among the chemical sources phorate, DAP and Urea may contain a myriad of heavy metals including Cu which leads to accumulation in DAP treatments. The available DTPA extractable Zn content [Table-5] was showed that gradual increased with depth of pot of soil with different treatment combination. Application of FYM@ 60 t/ha at 0-15 to 30-45 cm depth were appeared to increase available Zn due to inherent capacity of manure. Application of DAP@100 mg/kg, 200 mg/kg and 300 mg/kg, were showed to increased greater content of available Zn. Similarly, Urea doses 200, 300 and 400 mg/kg along with earthworm treatment combination appeared to increase from 0.856 mg/kg in all depth of soil due to fertilizers already contain of heavy metals [1] from the manufacturing leads to increase the analyzed soil and water samples as compare to other source as leaf litter and phorate also. DTPA extractable Mn content in soil [Table-5] was found in gradual increase with depth of experiment from 2.788 to 4.88 mg/kg throughout the experiment and soil depth. However, content was found maximum in T1 at 15-30 cm of 4.88 mg/kg than FYM incorporated with earthworm. The application of higher dose of FYM and leaf litter@20, 40 and 60 t/ha were appeared to maximized the Mn content while

chemical source as DAP, Urea and Phorate were showed lower amount of Mn in soil to might be due to positive effect with earthworm at this dose as compare to alone earthworm application in soil.

Conclusion

Earthworm with FYM, DAP, Urea, Phorate and Leaf litter were showed as elastic change in the earthworm population and change in related soil properties due to habitats of organisms. Soil depth from 0-45 cm was appeared to responsible cause for earthworm might be supply of low oxygen. So, that surface soil (0-15 cm) as well as sub surface (15-30 cm) soil have been found suitable to harbinger of population and activities of earthworm *Esinia fetida*. Among the organic and inorganic sources, application of 60 t/ha FYM and their other lower doses were found suitable to increase the earthworm population and rest physical and chemical properties of soil. The leaf litter treatment combination @ 20, 40 & 60 t/ha with earthworm was also considerable task to increase the growth and development of *Esinia fetida*, which has economic as well as ecological benefits.

Application of research: To regulate the application of chemical fertilizers as per need of earthworm population and increase the doses of organic manure and organic sources of nutrients which are responsible for growth and movement of earthworm with depth of soil.

Research Category: Soil fertility and soil biology

Abbreviations: DAP- Di Ammonium Phosphate, FYM- Farm Yard Manure

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Study area / Sample Collection: Agriculture Farm, Ballia, 277001, Uttar Pradesh

Cultivar / Variety / Breed name: Nil

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