

Original Research Article

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Effect of Different Sources of Organic Manures and Decomposers on Physico-Chemical Properties of Soil under Chilli Cultivation

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ABSTRACT

Organic manures are known to be rich sources of both macro and micro nutrients of the crop. They also help in improving the physico-chemical status of the soil. In this experiment, the influences of different sources of organic manures and decomposers on the soil physical, chemical as well as biological properties of soil under chilli cultivation soils were investigated. A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming (RIOF), UAS, GKVK, Bengaluru during 2017-2018. Different sources of organic manures (FYM, vermicompost, poultry manure and sheep manure) on N equivalent basis were incorporated into the top 20 cm of soil in line sowing. To determine the effect of the organic sources, the soil samples were collected 1 month after addition of organic manures from depth of 20 cm. The soil physico-chemical properties *i.e.*, pH, EC, bulk density, water holding capacity and organic carbon content were determined. The results showed that application of organic manures and decomposers had significant effect on soil physical and chemical properties like EC, pH, organic carbon, bulk density and water holding capacity as compared to the control, soil treated with organic manures showed apparent increases of organic matter, EC, WHC and reduces bulk density. Irrespective of the decomposers treatments, application of vermicompost on N equivalent basis had recorded significantly higher physico-chemical properties *viz.*, water holding capacity (35.49 per cent), infiltration rate (7.48 cm hr⁻¹), electronic conductivity (0.21 dS m⁻¹) as compared to the other control.

Keywords

Organic manures,
Decomposers,
Organic carbon, pH,
EC and bulk density

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Introduction

Chilli (*Capsicum annuum* L.) is a popular vegetable crop, commonly known as bell pepper or sweet pepper or hot pepper or chilli. It was consumed as a spice, vegetable, pickle, condiment and sauce. Internationally, chillies are consumed as a spice and become an

ingredient in medicines and beverages (Daundkar and Bairagi, 2015, Velayutham and Damodaran, 2015). Green chillies provide proteins, minerals, vitamin A and C while dry chillies are known as a source of vitamin A and D (Patel, 2017). Organic matter plays an important and multi-faceted role in soil. Physically, organic matter influences soil

structure and all associated properties. Chemically, soil organic matter affects the cation exchange capacity and the capacity for buffering changes in soil pH. Biologically, organic matter acts as the nutrient and energy supply for microbial biomass and higher plants. A soil which is biologically and chemically fertile but which cannot physically support crop development will not fulfill its agronomic potential. Soil productivity is, therefore, determined by a combination of organic matter's influence on physical, chemical, and biological soil properties (Eilin and Kevin, 2012).

The soils physical condition directly influences environmental quality and crop production (Arshad *et al.*, 1996). Well-aggregated soils in good physical condition maintain the balance of air and water required to promote many other soil properties (Lowery *et al.*, 1996). Physical soil quality parameters include soil texture, bulk density, porosity, top soil depth, water holding capacity, soil temperature, and aggregate stability. Soil texture has considerable influence on moisture retention and hydraulic conductivity as well as bulk density (Arshad and Coen, 1992). Soils with a fine texture will have greater moisture retention and hydraulic conductivity and will exhibit a lower bulk density. Spain (1990) found a positive correlation between the soil texture and the amount of soil organic carbon. Soils with coarse (sand) textures tend to have a higher bulk density than soils with fine (clay) textures. Soil properties and processes such as moisture retention, water flow, root development, nutrient cycling, and the sustainability of micro and macro organisms are negatively influenced by high bulk density values (Arshad *et al.*, 1996, Arshad and Coen, 1992).

Chemical parameters of soil have shown profound interaction with biological properties and processes in soil. Chemical parameters of

soil quality include, organic carbon pH, and electrical conductivity. Total carbon and nitrogen correlate to the amount of SOM content. The organic C-organic matter conversion factors for surface soils have varied from 1.72 to 2.0 (Nelson and Sommers, 1996). Soil organic matter is often considered the key quality factor in soil and is highly correlated to numerous factors influencing productivity and environmental sustainability (Stott and Martin, 1990). Organic matter improves soil quality by improving other properties such as nutrient and water storage, buffering capacity and microbial activity/diversity (Arshad and Coen, 1992). The present study was undertaken to study the effect of different sources of organic manures and decomposers on physico-chemical properties of soils under chilli cultivation.

Materials and Methods

General description of the area

Experimental site

A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru which is situated in Eastern dry zone of Karnataka at a latitude of 12° 58' North, longitude of 75° 35' East and at an altitude of 930 m above mean sea level. The experiment was conducted to study the combined effect of different sources of organic manure, Jeevamrutha and decomposers on growth and yield of chilli during *kharif* - 2017 and 2018 under irrigated condition.

Climate and weather

The normal annual rainfall of the station was 920.5 and 919.65 mm in 2017 and 2018, respectively. The major portion of rainfall was

received during September (197 mm in 2017 and 195.21 mm in 2018). The maximum temperature was ranged from 26.2°C in December to 33.8°C in April during 2017. In 2018, it was ranged from 25.62°C in December to 33.05°C in April. The monthly relative humidity was ranged from 75.3 per cent in March to 89.0 per cent in August during 2017. In 2018, it was ranged from 73.9 per cent in March to 87.0 per cent in August. During 2017, bright sunshine hours was maximum during February (9.4 hrs.) and the lowest in July (4.3 hrs.), during 2018 maximum was recorded in February (9.1 hrs.) and lowest in the month July (4.2 hrs.) and the wind speed during 2017 was maximum in the month of June (12.8 km hr⁻¹) and minimum in October (5.5 km hr⁻¹), during 2018, it was maximum during June (12.4 km hr⁻¹) and the minimum in October (5.3 km hr⁻¹). The open pan evaporation was directly related to maximum and minimum temperature of the month and followed the same trend as that of maximum temperature with maximum in both year during April (7.7 and 7.3 mm day⁻¹) and December (4.5 and 4.4 mm day⁻¹) during 2017 and 2018, respectively.

Soil

Soil of the experimental site was red sandy loam with a pH of 6.93, EC (0.27 dSm⁻¹), low in organic carbon (0.44 %) and medium in available nitrogen (292 kg ha⁻¹), P₂O₅ (27 kg ha⁻¹) and K₂O (241 kg ha⁻¹).

Experimental details

The experiment was laid out on factorial Randomized Block Design with 12 treatments *viz.*, T₁: FYM x Jeevamrutha, T₂: FYM x Microbial consortia, T₃: FYM x Decomposer, T₄: Vermicompost x Jeevamrutha, T₅: Vermicompost x Microbial consortia, T₆: Vermicompost x Decomposer, T₇: Poultry manure x Jeevamrutha, T₈: Poultry manure x

Microbial consortia, T₉: Poultry manure x Decomposer, T₁₀: Sheep manure x Jeevamrutha, T₁₁: Sheep manure x Microbial consortia and T₁₂: Sheep manure x Decomposer and replicated thrice. Recommended dose of nutrients for chilli is 150:75:75 N:P₂O₅:K₂O kg ha⁻¹ and nutrients were supplied through FYM, vermicompost, poultry manures and sheep manures on the basis of nitrogen equivalent. Treatment combinations consisted of four different organic sources (M₁: FYM, M₂: Vermicompost, M₃: Poultry Manure and M₄: Sheep manures-100 % N equivalent basis), three decomposers (J₁: Jeevamrutha, C₂: Microbial consortia and N₃: decomposer developed by NCOF. All the different sources of organic manure were incorporated into the soil, three weeks prior to sowing.

Soil sampling

Surface (0-15cm) and subsurface (15-30cm) soil samples were collected before sowing and after the harvest of the three cropping sequences and were air dried and grinded in a wooden pestle and mortar to pass through 2 mm sieve and subsequently stored in polyethylene bags for determination of physical parameters.

Results and Discussion

Bulk density

Significantly lower bulk density was observed with vermicomposting application (1.33 g cc⁻¹ and 1.29 g cc⁻¹ during 2017 and 2018 respectively) and higher bulk density was observed in application of FYM (1.42 g cc⁻¹ and 1.35 g cc⁻¹ during 2017 and 2018 respectively). Soil application of jeevamrutha recorded significantly lower bulk density (1.24 g cc⁻¹ and 1.19 g cc⁻¹ during 2017 and 2018 respectively) and higher bulk density was observed in application of NCOF-

decomposers (1.48 g cc⁻¹ and 1.40 g cc⁻¹ during 2017 and 2018 respectively). Interaction effects of these two factors didn't differ significantly.

Maximum water holding capacity

Kharif, 2017

Significantly higher maximum water holding capacity was observed with vermicompost application (35.49 and 37.70 % during 2017 and 2018 respectively) as compared to FYM (31.67 and 33.46 % during 2017 and 2018 respectively) and it was on par with the application of poultry manure (33.63 and 35.64 % during 2017 and 2018 respectively).

Soil application of jeevamrutha recorded significantly higher maximum water holding capacity (36.95 and 39.32 % during 2017 and 2018 respectively) as compared to application of decomposer (28.16 and 29.54 % during 2017 and 2018 respectively) and was on par with the application of microbial consortia (34.97 and 37.13 % during 2017 and 2018 respectively). Interaction effects of these two factors didn't differ significantly.

Infiltration rate

Significantly higher infiltration rate was observed with vermicompost application (7.48 cm hr⁻¹ and 8.28 cm hr⁻¹) as compared to FYM (6.68 cm hr⁻¹ and 7.34 cm hr⁻¹) and it was on par with the application of poultry manure (7.09 cm hr⁻¹ and 7.82 cm hr⁻¹). Soil application of jeevamrutha recorded higher infiltration rate was (7.79 cm hr⁻¹ and 8.63 cm hr⁻¹) as compared to application of decomposer (5.94 cm hr⁻¹ and 6.48 cm hr⁻¹) when was on par with the application of poultry manure (7.37 cm hr⁻¹ and 8.15 cm hr⁻¹). Interaction effects of these two factors didn't differ significantly.

Soil pH

Soil pH didn't differ significantly due to the application of different sources of application of FYM, vermicompost, poultry manure and sheep manure and also with the application of jeevamrutha, microbial consortia and decomposers. Numerically, lower soil pH (6.34 and 6.80 during both the season respectively) was observed with FYM at 100 per cent N equivalent and higher pH was observed with application of sheep manure (6.57 and 6.89 during both the season respectively). Interaction effects of these two factors didn't differ significantly.

Electrical conductivity

Electrical conductivity differed significantly due to the application of different sources of application of FYM, vermicompost, poultry manure and sheep manure and also with the application of jeevamrutha, microbial consortia and decomposers. Significantly higher electrical conductivity (0.21 dS m⁻¹ and 0.24dS m⁻¹ during both the season respectively) was observed with vermicompost application and lower electrical conductivity was observed with application of sheep manure (0.17 dS m⁻¹ and 0.21dS m⁻¹ during both the season). Interaction effects of these two factors didn't differ significantly.

Organic carbon

Organic carbon of soil differed significantly due to the application of different sources of application of FYM, vermicompost, poultry manure and sheep manure but it showed non-significant results with the application of jeevamrutha, microbial consortia and decomposers. Significantly higher organic carbon (0.49 and 0.50 % during both the season respectively) was observed with poultry manure application and lower organic carbon was observed with application of sheep

manure (0.45 and 0.47 % during both the season respectively). Interaction effects of these two factors didn't differ significantly.

Crop yield

Among the different organics treatment effect, application of vermicompost had recorded significantly higher green chill yield (20.47 t ha⁻¹ and 23.09t ha⁻¹ during both the season respectively) and was at par with the application of poultry manure (19.40 t ha⁻¹ and 21.85 t ha⁻¹ during both the season respectively) whereas; significantly lower green chilli yield (18.27 t ha⁻¹ and 20.54 t ha⁻¹ during both the season respectively) was noticed in FYM. Soil application of jeevamrutha recorded significantly higher green chilli yield (21.31 t ha⁻¹ and 24.06 t ha⁻¹ during both the season respectively) and it was on par with the application of microbial consortia (20.17 t ha⁻¹ and 22.74 t ha⁻¹ during both the season respectively) whereas; significantly lower green chilli yield (16.24 t ha⁻¹ and 18.20 t ha⁻¹ during both the season respectively) was observed in application of NCOF- decomposers. Interaction effects of these two factors didn't differ significantly.

Straw yield

Application of vermicompost had recorded significantly higher stalk yield (5.28 and 6.15 t ha⁻¹) as compared to FYM (4.74 and 5.50 t ha⁻¹) and it was on par with the application of poultry manure (5.01 and 5.83 t ha⁻¹). Soil application of jeevamrutha recorded significantly higher stalk yield (5.50 and 6.41 t ha⁻¹) as compared to application of decomposers (4.21 and 6.07 t ha⁻¹) and it was on par with the application of microbial consortia. Interaction effects of organic manures and decomposer didn't differ significantly.

Wormcasts are a resource that may be used in agriculture because of their effects on nutrient dynamic and the physical structure of soil may significantly enhance plant growth and conserve better soil status (Lee, 1985). Earthworm casts are usually considered to be responsible for a good soil structure and improve soil physical properties i.e. infiltration, water retention and resistance to erosion (Rose and Wood, 1980). Lee (1985) reported that the hydraulic conductivity increased by 80 per cent and water infiltration by six fold.

Among the application of different organic manure, application of poultry manure through N equivalent recorded higher organic carbon content (0.49 and 0.50 %), higher pH with sheep manure (6.57 and 6.89), higher EC (0.21 and 0.24 dSm⁻¹), lower BD (1.20 and 1.26 g cm⁻³) and higher MWHC (35.49 and 37.70 %) with vermicompost as compared to rest other organic treatment (Table 2, 3, 4 and 5). These finding are in line with the Hangarge *et al.*, (2004) reported higher organic carbon content, higher pH and EC with the combined application of organics (vermicompost @ 5 t/ha) + liquid organics (cow dung slurry @ 1 l/m² and organic booster @ 1 l/m²) against initial values and after harvest of chilli.

During the process of decomposition many intermediate compounds, organic acids and humic substance will be produced. These substances will act as cementing for aggregation of soil particles resulting in improvement in soil structure. These results are similar to the findings of Martin (1991) reported that earthworm casts had increased the proportion of macro-aggregates significantly from 25.4 to 31.2 per cent. Kale *et al.*, (1992) found that the application of earthworm casts to fields can improve the physio-chemical and biological properties of the soil.

Table.1 Green chilli yield and stalk yield of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2017 and 2018

Manures	Green chilli yield (t ha ⁻¹)							
	2017				2018			
	Decomposers				Decomposers			
	J	C	N	Mean	J	C	N	Mean
FYM	20.66	19.30	14.85	18.27	23.30	21.73	16.59	20.54
VC	22.30	20.61	18.51	20.47	25.20	23.24	20.81	23.09
PM	21.38	20.59	16.22	19.40	24.14	23.23	18.17	21.85
SM	20.90	20.19	15.39	18.83	23.59	22.76	17.21	21.19
Mean	21.31	20.17	16.24		24.06	22.74	18.20	
	S.Em ±		CD (P = 0.05)		S.Em ±		CD (P = 0.05)	
M	0.510		1.496		0.596		1.749	
D	0.442		1.295		0.516		1.514	
M x D	0.883		NS		1.033		NS	
Manures	Stalk yield (t ha ⁻¹)							
	2017				2018			
	Decomposers				Decomposers			
	J	C	N	Mean	J	C	N	Mean
FYM	5.34	4.99	3.87	4.74	6.22	5.81	4.48	5.50
VC	5.75	5.32	4.78	5.28	6.71	6.20	5.56	6.15
PM	5.52	5.31	4.20	5.01	6.43	6.19	4.86	5.83
SM	5.39	5.21	3.98	4.86	6.29	6.07	4.61	5.65
Mean	5.50	5.21	4.21		6.41	6.07	4.88	
	S.Em ±		CD (P = 0.05)		S.Em ±		CD (P = 0.05)	
M	0.132		0.386		0.159		0.467	
D	0.114		0.335		0.138		0.404	
M x D	0.228		NS		0.276		NS	

CD at 5 % **NS** - Non-significant **DAT**- Days after Transplanting **M** - Manures
RDF: 125:75:63 kg N:P₂O₅:K₂O ha⁻¹ for N equivalent FYM application **D** - Decomposers
FYM - Farm yard manure **VC** - Vermicompost **PM** - Poultry manure **SM** - Sheep manure
J - Jeevamrutha **C** - Microbial Consortia **N** - Decomposer from NCOF

Table.2 Physical properties of soil at harvest of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2017

Manures	Physical properties							
	BD (g cc ⁻¹)				MWHC (%)			
	Decomposers				Decomposers			
	J	C	N	Mean	J	C	N	Mean
FYM	1.27	1.53	1.43	1.42	35.81	33.46	25.74	31.67
VC	1.22	1.23	1.55	1.33	38.66	35.72	32.08	35.49
PM	1.24	1.43	1.48	1.38	37.07	35.70	28.12	33.63
SM	1.23	1.40	1.45	1.36	36.24	35.00	26.88	32.64
Mean	1.24	1.40	1.48		36.95	34.97	28.16	
	S.Em ±		CD (P = 0.05)		S.Em ±		CD (P = 0.05)	
M	0.037		0.107		0.884		2.593	
D	0.032		0.093		0.766		2.246	
M x D	0.063		NS		1.531		NS	
Manures	Physical properties							
	Infiltration rate (cm hr ⁻¹)							
	Decomposers							
	J	C	N	Mean				
FYM	7.55	7.05	5.43	6.68				
VC	8.15	7.53	6.76	7.48				
PM	7.81	7.53	5.93	7.09				
SM	7.64	7.38	5.62	6.88				
Mean	7.79	7.37	5.94					
	S.Em ±		CD (P = 0.05)					
M	0.186		0.547					
D	0.161		0.473					
M x D	0.323		NS					

CD at 5 % **NS** - Non-significant **DAT**- Days after Transplanting **M** - Manures
RDF: 125:75:63 kg N:P₂O₅:K₂O ha⁻¹ for N equivalent FYM application **D** - Decomposers
FYM - Farm yard manure **VC** - Vermicompost **PM** - Poultry manure **SM** - Sheep manure
J - Jeevamrutha **C** - Microbial Consortia **N** - Decomposer from NCOF

Table.3 Physical properties of soil at harvest of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2018

Manures	Physical properties							
	BD (g cc ⁻¹)				MWHC (%)			
	Decomposers				Decomposers			
	J	C	N	Mean	J	C	N	Mean
FYM	1.22	1.46	1.36	1.35	38.06	35.44	26.86	33.46
VC	1.18	1.27	1.47	1.29	41.23	37.96	33.91	37.70
PM	1.20	1.36	1.41	1.32	39.46	37.94	29.51	35.64
SM	1.19	1.33	1.38	1.30	35.54	37.16	27.90	34.53
Mean	1.19	1.35	1.40		39.32	37.13	29.54	
	S.Em ±		CD (P = 0.05)		S.Em ±		CD (P = 0.05)	
M	0.034		0.099		0.972		2.851	
D	0.029		0.085		0.842		2.469	
M x D	0.058		NS		1.684		NS	
Manures	Physical properties							
	Infiltration rate (cm hr ⁻¹)							
	Decomposers							
	J	C	N	Mean				
FYM	8.36	7.78	5.90	7.34				
VC	9.05	8.33	7.44	8.28				
PM	8.66	8.33	6.48	7.82				
SM	8.46	8.16	6.12	7.58				
Mean	8.63	8.15	6.48					
	S.Em ±		CD (P = 0.05)					
M	0.213		0.626					
D	0.185		0.542					
M x D	0.370		NS					

CD at 5 % **NS** - Non-significant **DAT**- Days after Transplanting **M** - Manures
RDF: 125:75:63 kg N:P₂O₅:K₂O ha⁻¹ for N equivalent FYM application **D** - Decomposers
FYM - Farm yard manure **VC** - Vermicompost **PM** - Poultry manure **SM** - Sheep manure
J - Jeevamrutha **C** - Microbial Consortia **N** - Decomposer from NCOF

Table.4 Chemical properties of soil at harvest of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2017

Manures	Chemical properties							
	pH				EC (dSm ⁻¹)			
	Decomposers				Decomposers			
	J	C	N	Mean	J	C	N	Mean
FYM	6.36	6.35	6.30	6.34	0.18	0.20	0.21	0.19
VC	6.50	6.49	6.44	6.48	0.22	0.21	0.19	0.21
PM	6.41	6.40	6.38	6.40	0.17	0.20	0.19	0.18
SM	6.59	6.58	6.55	6.57	0.15	0.18	0.17	0.17
Mean	6.46	6.46	6.42		0.18	0.19	0.19	
	S.Em ±		CD (P = 0.05)		S.Em ±		CD (P = 0.05)	
M	0.287		NS		0.009		0.0018	
D	0.249		NS		0.008		NS	
M x D	0.497		NS		0.015		NS	
Manures	Chemical properties							
	OC (%)							
	Decomposers							
	J	C	N	Mean				
FYM	0.50	0.45	0.42	0.46				
VC	0.52	0.47	0.44	0.48				
PM	0.55	0.48	0.45	0.49				
SM	0.50	0.46	0.41	0.45				
Mean	0.52	0.47	0.44					
	S.Em ±		CD (P = 0.05)					
M	0.013		0.032					
D	0.011		NS					
M x D	0.022		NS					

CD at 5 % **NS** - Non-significant **DAT**- Days after Transplanting **M** - Manures
RDF: 125:75:63 kg N:P₂O₅:K₂O ha⁻¹ for N equivalent FYM application **D** - Decomposers
FYM - Farm yard manure **VC** - Vermicompost **PM** - Poultry manure **SM** - Sheep manure
J - Jeevamrutha **C** - Microbial Consortia **N** - Decomposer from NCOF

Table.5 Chemical properties of soil at harvest of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2018

Manures	Chemical properties							
	pH				EC (dSm ⁻¹)			
	Decomposers				Decomposers			
	J	C	N	Mean	J	C	N	Mean
FYM	6.90	6.80	6.70	6.80	0.23	0.21	0.23	0.22
VC	6.95	6.81	6.75	6.84	0.25	0.25	0.20	0.24
PM	6.98	6.84	6.76	6.86	0.21	0.25	0.23	0.23
SM	6.99	6.89	6.78	6.89	0.23	0.21	0.23	0.21
Mean	6.96	6.84	6.75		0.23	0.23	0.22	
	S.Em ±		CD (P = 0.05)		S.Em ±		CD (P = 0.05)	
M	0.191		NS		0.010		NS	
D	0.166		NS		0.008		NS	
M x D	0.331		NS		0.017		NS	
Manures	Chemical properties							
	OC (%)							
	Decomposers							
	J	C	N	Mean				
FYM	0.51	0.46	0.43	0.48				
VC	0.53	0.48	0.45	0.49				
PM	0.56	0.49	0.46	0.50				
SM	0.51	0.47	0.45	0.47				
Mean	0.53	0.48	0.45					
	S.Em ±		CD (P = 0.05)					
M	0.013		NS					
D	0.012		NS					
M x D	0.018		NS					

CD at 5 % NS - Non-significant DAT- Days after Transplanting M - Manures
 RDF: 125:75:63 kg N:P₂O₅:K₂O ha⁻¹ for N equivalent FYM application D - Decomposers
 FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
 J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

The infiltration capacity is said to increase upto 130 mm hr⁻¹ against 10 mm hr⁻¹ of a conventional farm. This ensures ground water retention and prevents soil erosion.

The subsequent decomposition of these materials might have resulted in enhanced organic carbon content of soil which resulted in increased water holding capacity and reduced bulk density due to humic substances penetrated the inter lamella space of clay minerals and influenced the interaction of clay with other soil constituents and ultimately increased water holding capacity of the soil (Singh *et al.*, 2006). An organic farming system trial conducted for 30 years at Rodale Institute, USA, involving organic compost equivalent to 190 kg N ha⁻¹ for maize and 120 kg ha⁻¹ for oats was applied and then rotated with legumes like soybean and alfalfa. Results clearly revealed that soil aggregation, water holding capacity, soil aeration were improved. The results of the present study are in accordance with Bhawalkar (1993) and Lanchnicht *et al.*, (1997). They reported that apart from raising the water table, the earthworm act as bio-pump by transporting moisture from lower layers to upper ones and increased macro pore formation due to earthworm burrows, which could increase preferential flow pathways, and movement of N through the soil profile.

Green chilli yield varied significantly due to application of different sources of FYM, vermicompost, poultry manure and sheep manure during *Kharif*, 2017 and 2018 seasons. Significantly higher green chilli yield (20.47 and 23.09 t ha⁻¹) was recorded with the application of vermicompost at 100 per cent N equivalent and it was 10.74 and 11.04 per cent higher yield over the application of 100 per cent N equivalent through FYM. Whereas, the application of vermicompost recorded 5.23 and 5.37 per cent higher yield over the 100 per cent N equivalent through poultry manure

(Table 1). Application of poultry manure recorded 5.82 and 5.99 per cent higher through FYM during both the seasons. These results are in conformity with findings of Husain *et al.*, (2014), Anand and Gupta (2018), Chandansingh and Azad husain (2015), Adekiya *et al.*, (2017). Lesser yield was observed with poultry manure, sheep manure and FYM might be due to higher C:N ratio which lead to less mineralization of nutrients in the soil as a result there will be less amount of available nutrient by the crop during growing season and in addition to this cumulative volatilization losses of NH₃-N during aerobic and anaerobic composting of poultry manure, sheep manure and FYM and there were only traces amount of NO₃⁻-N is available in these fresh manure which can be taken up by major crop for their metabolic activity (Stevan *et al.*, 1989). According to Anand and Gupta (2018), application of vermicompost increased the weight of fruits, number of fruits, stem diameter and dry matter yield of radish as compare to the application of cow dung where it recorded less weight of fruits, number of fruits, stem diameter and dry matter yield of radish. The increase in chilli yield might be due to significant increase in yield parameters such as higher number of fruits, fruit length and fruit weight during 2017 and 2018.

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