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Research Article

SOIL PROPERTIES AND EARTHWORM POPULATION DYNAMICS INFLUNCED BY ORGANIC MANURE IN WINTER AND SPRING SEASONS AT RAMPUR, CHITWAN, NEPAL

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Abstract

Two experiments were carried out in a Randomized Complete Block Design with six treatments (0, 10, 20, 30, 40, 50 Mg FYM ha^{-1}) replicated four times at the horticultural farm, IAAS, Rampur, Chitwan, Nepal in winter (Oct-Jan) and spring (Feb-May) seasons to quantify optimum dose of organic manure (FYM) to maintain earthworm population and enhance soil properties. In each treatment 100 earthworms (*Eisenia fetida*) were inoculated within one square meter of each plot. Porosity in the first season was significantly higher than the control treatment (0 Mg FYM ha^{-1}). In the second season it remained unaffected but in increasing trend. In the second season the highest porosity (40.75 ± 1.57%) was obtained from 50 Mg FYM ha^{-1}. The highest bulk density (1.553 ± 0.017 Mg m^{-3}) in the second season was observed from the control treatment but it was in decreasing trend with increasing doses of FYM. There was no significant effect of FYM on pH in the either season. The highest OM (3.87 ± 0.22%) was observed from 50 Mg FYM ha^{-1} which was similar to 30 and 40 Mg FYM ha^{-1} in first season. Similarly, in the second season, increasing doses of FYM increased the OM and the highest OM (3.83 ± 0.19%) was from 50 Mg FYM ha^{-1} which did not differ from 40 Mg FYM ha^{-1}. As anticipated, the lowest OM 2.425 ± 0.224% and 2.275 ± 0.1968% were from control treatments of the first and second seasons, respectively. As the doses of FYM were increased, earthworm populations were also increased significantly in the both seasons. Earthworm numbers from 50 Mg FYM ha^{-1} were significantly higher than the 20, 30 and 40 Mg FYM ha^{-1} in both seasons. The highest numbers 887 ± 12.84 and 976 ± 20.30 of earthworm per square meter were recorded from 50 Mg FYM ha^{-1} in the both seasons, respectively. Thus, the application of 30 Mg FYM ha^{-1} is optimum for both the seasons to improve soil properties and to maintain earthworm population in the agricultural field. Also, this research indicated a possibility for earthworm inoculation in the field to enhance soil fertility for sustainable agriculture in the western Chitwan, Nepal.

Key words: Farm Yard Manure; Soil organic matter; Earthworm population.

Introduction

Organic manure is one of the best alternative sources of chemical fertilizer in the sustainable management of soil. Among different sources of organic manures, Nepalese farmers mostly rely on farmyard manure (FYM); an important component of livestock based farming system. More than 80% of the farmers (Adhikari, 2002) in Chitwan valley use FYM as a source of organic manures in their field.

Earthworms are considered as farmers' friends and also called the engineers of soil system (Hale *et al.*, 2005). The earthworm relation to the soil fertility is still not carried out in Nepalese context. Farmers also neglect the management aspect of field to conserve and multiply earthworm in their field. So, almost no work has been carried out in the earthworm in Nepal to explore its role in relation to soil fertility and soil sustainability. Earthworms are considered as the best indicator of soil quality (Doube and Schmidt, 1997). Presence of earthworm in the soil indicates higher soil organic matter content and microbes which are the best indicators of soil health (Blair *et al.*, 1996)

Higher rate of mineralization of FYM in the summer season (Gupta and Laik, 2002), causes fast depletion of organic matter from the soil which directly affects the soil physical and chemical properties. Earthworm life cycle in the agricultural field may last for one to two seasons (Edwards and Bohlen, 1996) because of wide range of predators. So, optimum quantification of the FYM to maintain soil properties and earthworm population in the farmers' field is a major thrust of Nepalese agriculture. Hence, this research was carried out to meet the following objectives:

1. To assess the effects of organic manure application on the selected soil physical properties
2. To assess the effects of organic manure application on the selected soil chemical properties.
3. To determine the earthworm population dynamics in winter and spring season as affected by organic manure.

Materials and Methods

Experimental details

Two experiments were conducted in Randomized Complete Block Design at the horticultural farm of the Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal in winter and spring seasons. Six treatments (0, 10, 20, 30, 40, 50 Mg FYM ha^{-1}) replicated four times. In the winter season Broccoli (*Brassica oleracea* var, italica) and in the spring season Mung Bean (*Vigna radiata*) crops were planted. One hundred earthworms (*Eisenea fetida*) were incorporated in the plot of all treatments within one square meter of plot (Earthworm Inoculation Unit). There were 24 plots (six treatments replicated four times) and area of each plot was 4.5 × 3 m^2 (13.5 m^2). Between two blocks and plots, 1 m distance was maintained to create a physical barrier for earthworm movement from the adjacent plot.

Earthworm counting

Earthworm population was manually counted after harvesting of both crops. One meter square area of the plot at the center that overlaps the Earthworm Inoculation Unit was selected. Sufficient moisture was provided within that area on the previous day. Next day earthworms were counted manually by digging the field to 20 cm depth. There is no record of native earthworm up to this depth. Counted earthworms were then released back to the field within that one square meter area in the first count which is then assessed in second count.

Statistical Analysis

All the data were subjected to two ways Analysis of Variance (ANOVA) for single factorial Randomized Complete Design. MSTAT-C (1990) was used to test ANOVA at 5% level of significance. Means were separated with Duncan's Multiple Range Test (DMRT). Microsoft Excel (2007) was also used for data manipulation.

Result and Discussions

Effects of FYM on soil chemical properties

Soil pH and organic matter

pH is not significantly affected by the levels of FYM. Slight decrease in pH was reported by Tisdale *et al.* (1985) with the application FYM due to formation of humic and carbonic acids in soil. pH was decreased with the increasing levels of FYM (Fig. 1).

Table 1. pH and Soil Organic Matter affected by levels of FYM at Rampur, Chitwan, Nepal, 2012/013

Treatments (Mg FYM ha^{-1})	pH		Soil organic Matter (%)	
	Winter season	winter season	winter season	spring season
0	5.937	2.42^{b}	2.42^{b}	2.27^{d}
10	5.620	2.77^{b}	2.77^{b}	2.70^{cd}
20	5.952	2.95^{b}	2.95^{b}	2.75^{cd}
30	5.930	3.65^{a}	3.65^{a}	3.15^{bc}
40	5.705	3.77^{a}	3.77^{a}	3.52^{ab}
50	5.617	3.87^{a}	3.87^{a}	3.83^{a}
LSD	ns	0.6774**	0.6774**	0.5934**
CV (%)	4.83	13.60	13.60	12.88
SEM	0.1157	0.224	0.224	0.1968
Probability	0.107	0.0004	0.0004	0.0003

Means followed by the same letter(s) in the column are not significantly different at 5% level of significance as determined by DMRT. ** indicates the 1% significance level. LSD = Least Significance Difference; ns = non-significant; CV = Coefficient of Variation; SEM = Standard Error of Mean; Mg = Mega gram.

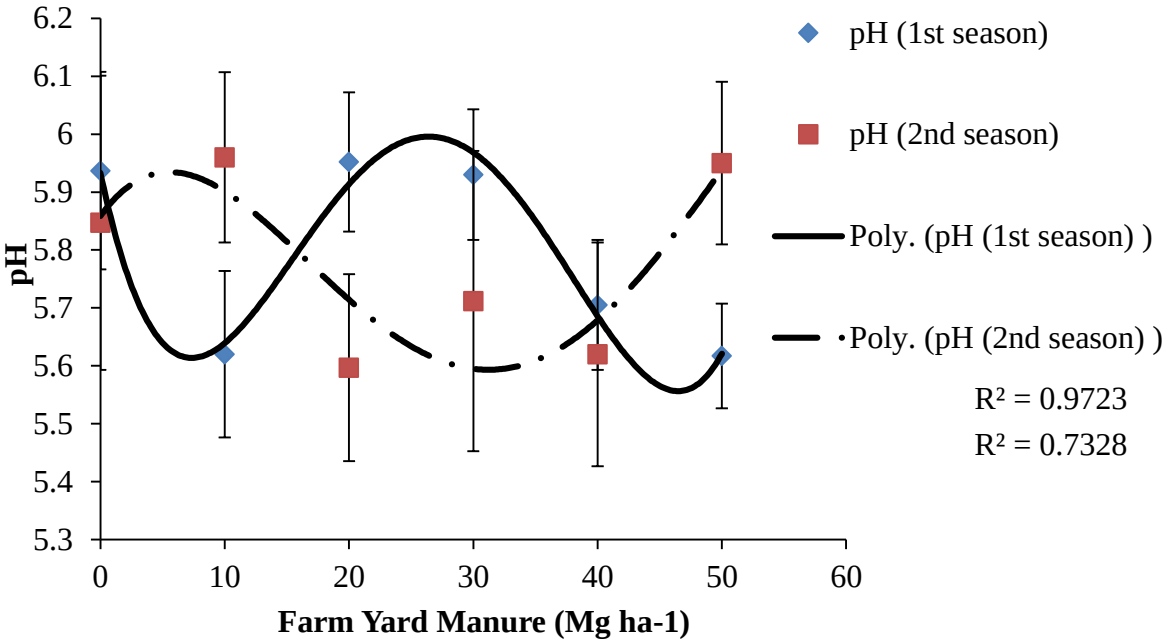

Fig. 1: Variations in pH with the levels of FYM used at Rampur, Chitwan, Nepal, 2012/2013. Solid bars in the figure represent the error bar diagram with standard error. 1st season and 2nd season in the figure represents the winter and spring seasons, respectively.

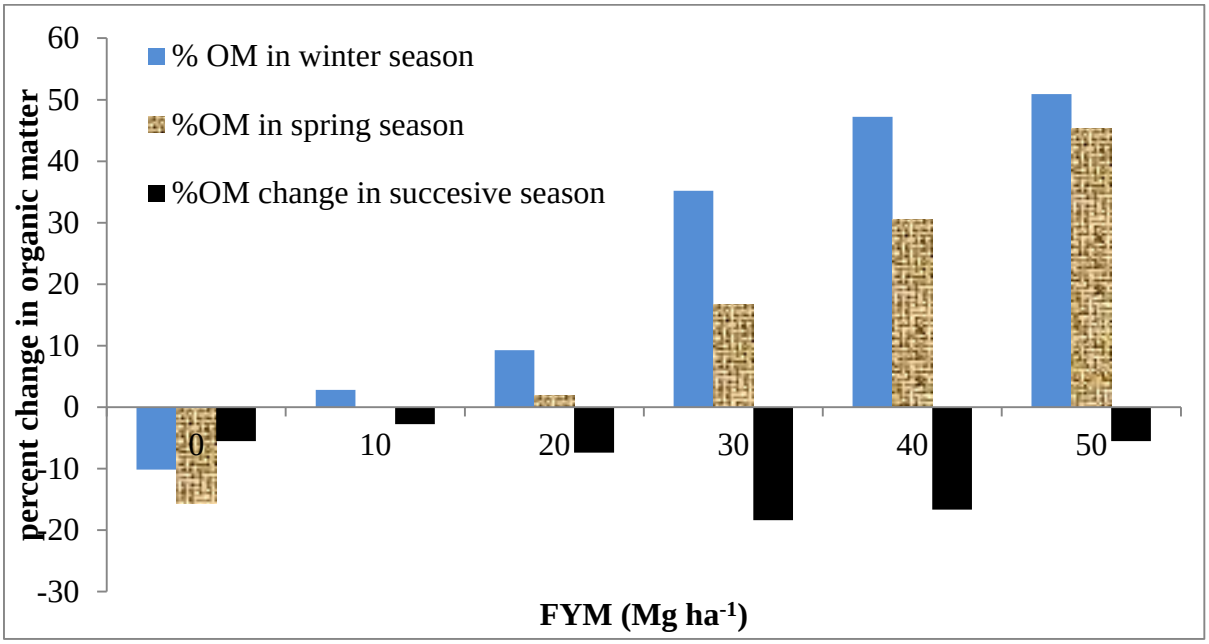

Fig. 2: Percent organic matter changes in winter and spring seasons with respect to initial organic matter at Rampur, Chitwan, Nepal 2012/2013.

Parvathi *et al.* (2013) noted that Soil pH did not significantly differ with the application FYM and other source of organic manures during first year of experiment. Release of organic acids during the mineralization of FYM helped to decrease soil pH (Srikanth *et al.*, 2000; Gupta *et al.*, 2008). Soil pH was found non-significant among the treatments because FYM might have enhanced the buffering capacity of soil (Brady and Weil, 2008).

Soil organic matter was significantly increased by the 30 Mg FYM ha^{-1} and above. But Organic matter didn't significantly increase with the application of 0, 10, 20 Mg FYM ha^{-1}. Decrease in organic matter content in successive season (Fig. 2) was observed because there is no additional FYM incorporated in second season. Gondek and Philipek-Majur (2006) also reported the increase in soil organic carbon from the application of FYM and composts each year Increase in soil organic matter might be due to increase in active pool of soil organic carbon as different levels of FYM was applied in the plots.

Table 2: Effects of Farm Yard Manure on bulk density, particle density and porosity at Rampur, Chitwan, Nepal 2012/2013

Treatments (FYM Mg ha^{-1})	Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})		Porosity (%)	
	Winter season	Spring season	Winter season	Spring season	Winter season	Spring season
0	1.447	1.553	2.675^{a}	2.530	45.75^{a}	38.50
10	1.444	1.510	2.500^{b}	2.512	42.00^{b}	40.00
20	1.451	1.542	2.548^{b}	2.505	43.00^{ab}	38.00
30	1.472	1.502	2.488^{b}	2.565	40.75^{b}	41.25
40	1.462	1.493	2.550^{b}	2.500	42.75^{ab}	40.25
50	1.489	1.490	2.495^{b}	2.517	40.00^{b}	40.75
LSD	ns	ns	0.1066*	ns	2.881*	ns
CV (%)	2.62	2.37	2.76	3.47	4.51	7.93
SEm (±)	0.0191	0.0179	0.0351	0.0437	0.9556	1.5783
Probability			0.0164		0.0109	

Means followed by the same letter(s) in the column are not significant at 5% level of significance as determined by DMRT.

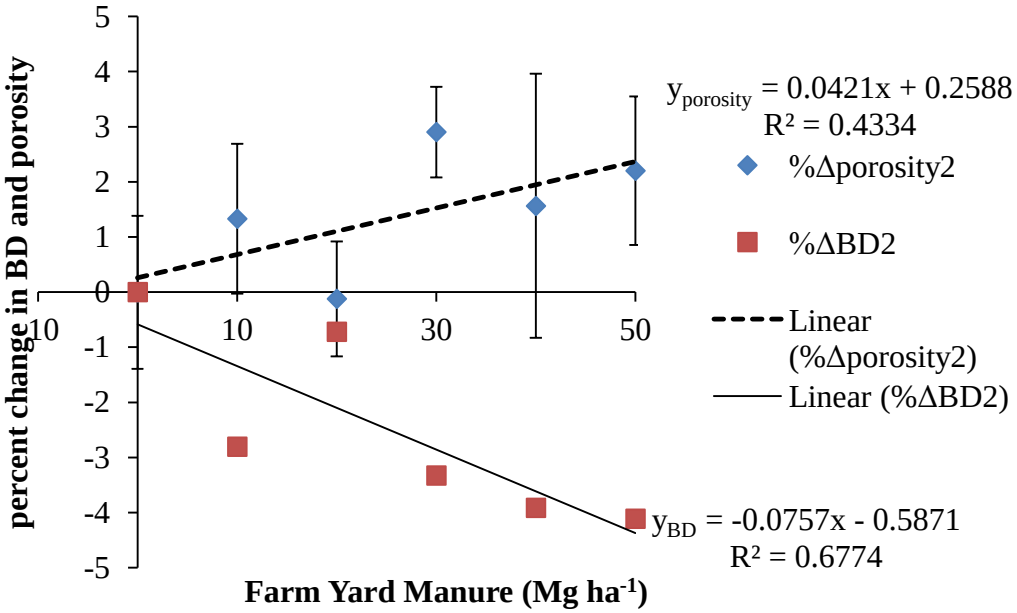

Fig. 3: Percent change in bulk density and porosity in spring season by the application of Farm Yard Manure at Rampur, Chitwan, Nepal, 2012/013. Numeric index 2 indicates the spring season. Length of solid bar in the figure represents the standard error.

Effects on soil physical properties

Bulk density, Particle density and Porosity

Soil bulk density was not significantly differed from the rate of FYM application. There was a decreasing trend of the bulk density (Figure 3) with the increase in the FYM doses. Porosity was significantly differed among the treatments. The highest (45.75 ± 0.95%) porosity was obtained from 50 Mg FYM ha^{-1} and the lowest porosity (40 ± 0.95%) was obtained from control (0 Mg FYM ha^{-1}).

Decreasing trend of bulk density and increasing trend of porosity was found with the increase in the levels of FYM application (Fig. 3). Shirani *et al.* (2002) reported that bulk density was not significantly differed from the application of 0, 30 and 60 Mg FYM ha^{-1}. They also observed the decreasing trend of bulk density with increasing doses of FYM. Similar result was noted by Tairk *et al.* (1974); Soane, (1990); Felton and Ali (1992).

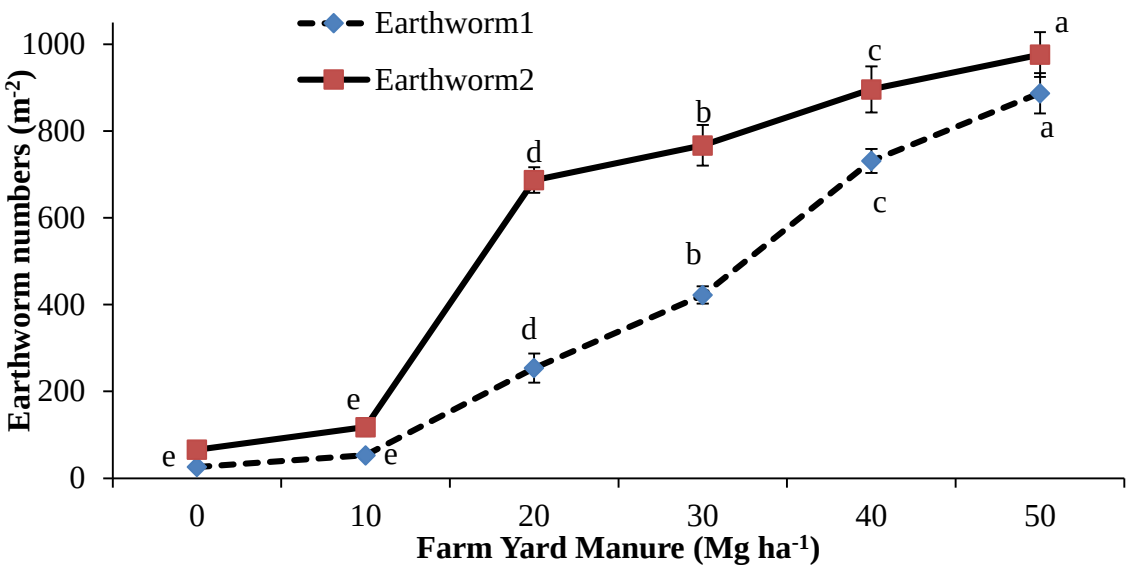

Fig. 4: Earthworm population variation by the levels of FYM in winter season and spring season at Rampur, Chitwan, Nepal, 2012/2013. Numeric indices 1 and 2 represent winter and spring seasons respectively. Length of solid bar in the bar diagram represents standard error. Means followed by the same letters in the line graph are not significantly different at 5% level of significance as determined by DMRT.

Effects on earthworm population performance

Earthworm numbers were significantly increased by the levels of FYM in the both seasons (Fig. 4). There was a significant increase in the population and biomass of the earthworm with the application of different doses of animal manures (Lofs-Holmin, 1983; Lowe and Butt, 2002). There was a significant increase in the earthworm population with the application of high-quality cattle manures (Curry, 1976; Cotton and curry, 1980; Edwards, 1983).

Higher the FYM dose, higher was the food availability (Edwards, 1983). Hence, the performance of the earthworm population was higher from increasing doses of FYM.

Conclusion

The soil physical and chemical properties like pH, organic matter content, Bulk density, particle density, and porosity were positively affected above the levels of 30 Mg FYM ha^{-1}. Earthworm population was also increased with the increasing doses of FYM. Hence, the annual application of 30 Mg FYM ha^{-1} may improve soil fertility and earthworm population under Chitwan condition. Further long-term research is necessary to quantify the doses of FYM at national level.

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