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ISSN: 2455-6521 (Online)

Innovative Farming
-A Quarterly International Journal of Agriculture

Research Article

Article: SAAI/IF/402

Influence of Organic Amendments on Soil Health under Vegetable based Cropping Sequences at Mid-Hills Altitude of Meghalaya

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KEYWORDS:

Economics, Organic farming, Produce quality, Productivity, Soil fertility, Yield

ARTICLE INFO

Received on:
01.07.2020
Revised on:
12.01.2021
Published on:
21.01.2021

ABSTRACT

Field experiments were conducted during 2005 to 2015 at the ICAR Research Complex for NEH Region, Umiam, Meghalaya (950 m ASL) to study the effects of organic nutrient management practices on soil health under vegetable based cropping sequences. The organic sources used were farmyard manure (FYM), vermicompost (VC), and integrated nutrient sources (½ through FYM + ½ through VC) applied on N equivalent basis; phosphosporus requirement being compensated through rock phosphate. Three cropping sequences tested were maize + soybean - tomato, maize + soybean - potato and maize + soybean - French bean. For present study, the data on soil health parameters were recorded during 2015 after 10 cropping cycles. The soil organic carbon concentration improved significantly due to application of all the organic manures as nutrient sources than that under control. Maximum microbial population and soil microbial biomass carbon were recorded with integrated nutrient source. The soil properties like nutrient status and SOC were higher under maize + soybean - tomato than others. Thus, FYM + VC as source of nutrient supply under maize + soybean - tomato system was found to be effective for sustainable organic food production in NEH region of India.

How to Cite:

Kumar, M., Das, A., Ramkrushna, G.I., Layek, J., Babu, S., 2021. Influence of organic amendments on soil health under vegetable based cropping sequences at mid-hills altitude of Meghalaya. *Innovative Farming* 6(1), 01-05.

INTRODUCTION

Modern conventional agricultural production practices rely heavily on synthetic fertilizers and pesticides. Intensive inorganic fertilizer use in agriculture has caused multiple health and environmental problems. To reduce and eliminate adverse effects of synthetic fertilizers and pesticides on human health and environment new agricultural practices have been developed such as organic agriculture, ecological agriculture or sustainable agriculture (Chowdhury, 2004). Organic production systems have the potentiality to achieve sustainability of agricultural systems (van Diepeningen *et al.*, 2006). Many of the sustainability issues are related to the soil quality (Nannipeeri, 1994). Soil quality includes microbial activity and soil fertility, which are closely related because it is

through the biomass that the mineralization of the important organic elements occur (Frankenberger Jr. and Dick, 1983). Higher levels of total organic C, total N and soluble P were reported from organic soils (Clark *et al.*, 1998). Organic manure influence soil productivity through their effect on soil physical, chemical and biological properties (Ramesh *et al.*, 2009).

Farmers of North Eastern Hill (NEH) region rarely apply any fertilizer or manure to field crops. Whatever quantity of organic manure are available is applied to vegetable crops at the rate of 5-10 t ha^{-1} depending upon availability, either alone or rarely, in combination with chemical fertilizers (Das *et al.*, 2008). The manures are applied without considering the crop need, soil fertility, *etc*. There is limited research on the efficiency and effects of organic source of nutrients on growth, yield and quality of crops and soil properties. Hence, an experiment was undertaken in mid altitude of subtropical Meghalaya (950 m MSL) to evaluate the efficacy of various on- and off-farm produced organic amendments on performance of vegetables as well as soil physico-chemical properties and crop nutrient uptake. It is hypothesized that application of nutrients through various organic sources would influences crop performance and soil health depending upon their chemical composition, physical properties and nutrient release pattern.

MATERIALS AND METHODS

Field experiments were conducted during *pre-kharif*, *kharif* and *rabi* seasons of 2005 to 2015 at medium land, in research farm of ICAR-Research Complex for NEH Region, Umiam Meghalaya, India. The average rainfall received during 2013-15 was 1981.7 mm. The monthly average maximum and minimum temperature of three years ranged from 22.0 to 28.5 °C and 6.4 to 20.3 °C, respectively. The experimental soil had organic carbon 18.0 g kg^{-1}, available nitrogen 255.6 kg ha^{-1}, phosphorus 19.2 kg ha^{-1} and potassium 232.1 kg ha^{-1}. The soil was sandy loam in texture.

The experiment was laid out in a split plot design with treatment combinations of three cropping sequences in main plot, *viz*., maize + soybean (2:2 row ratio) - French bean - tomato (CS1), maize + soybean (2:2) - radish- potato (CS2) and maize + soybean (2:2) - French bean - carrot (CS3) along with four organic manures such as farmyard manure (FYM), vermicompost (VC), integrated nutrient source (½ FYM + ½ VC) and compared with control (no manure) in sub-plots. The levels of nutrients supplemented through organic manure were 80:60 kg ha^{-1} N and P for all the crops. Organic manures were applied on the basis of N-equivalent and phosphorus requirement was supplemented through rock phosphate. The combinations were replicated three times. Recommended package and practices of different crops were followed. The nutrient composition of FYM and VC were 0.73 - 0.29 - 0.61% and 1.50 - 0.65 - 0.86% of N, P and K, respectively. Neem cake was applied @ 150 kg ha^{-1} during last ploughing and mixed with the soil. Derisom (fractions of *Derris indica*) @ 2.5 ml l^{-1} was applied at flowering stage and 15 days after first spray to manage insect pests. Diseased leaves were stripped off manually whenever possible.

The post-harvest soil samples were collected from 0 to 20 cm depth for analyzing the available nutrient status at the end of 2015. Bulk density was determined following core method. Insect pest and diseases were controlled through organic means. Organic block was protected from all possible contaminations by giving proper drainage, buffer zone, bunds, *etc*. The analysis of variance method was followed to statistically analyze the various data by standard procedure.

RESULTS AND DISCUSSION

After 10 cropping cycles, maize + soybean - tomato cropping sequences resulted in the higher soil organic carbon (22.6 g kg^{-1}), available N (249.3 kg ha^{-1}), P (32.9 kg ha^{-1}) and K (232.5 kg ha^{-1}) content compared to other cropping sequences (Table 1). Among sources of nutrient supply, INS recorded maximum SOC (2.39%), available N (255.1 kg ha^{-1}) available P (34.3 kg ha^{-1}) and K (250.0 kg ha^{-1}) compared to other sources. Percentage increase in SOC, available N, P and K content under INS were 26.4, 21.5, 20.4 and 9.7%, respectively, compared to

that recorded under control. Maximum water holding capacity (MWHC) was observed under FYM while maximum SMBC was noted under INS as nutrient source. Minimum bulk density was recorded under FYM among all the sources of nutrient supply. Long term application of organic sources was reported to improve the SOC, available N, P and K in soil, thereby sustaining the soil health (Panwar *et al.*, 2010; Patel *et al.*, 2014; Das *et al.*, 2016).

Table 1: Soil parameters as influenced by various cropping systems and organic sources after 3 cropping cycle (2015)

Particulars	SOC (g kg^{-1})	Avg. N (kg ha^{-1})	Avg. P (kg ha^{-1})	Avg. K (kg ha^{-1})	Bulk Density (mg m^{-3})	MWHC (%)	SMBC (µg g^{-1} dry soil)
1. Cropping Systems							
Maize + soybean-tomato	22.3	249.3	32.9	226.5	1.15	49.4	178.7
Maize + soybean-potato	22.0	233.7	32.3	220.7	1.16	52.4	182.5
Maize + soybean-French bean	22.6	238.4	28.8	222.9	1.17	49.8	188.2
CD (P=0.05)	NS	12.4	3.15	4.87	NS	2.38	5.18
2. Nutrient Sources							
FYM	23.4	250.4	32.1	229.9	1.14	54.9	194.0
Vermicompost	23.0	246.4	31.7	218.5	1.15	49.7	186.4
FYM + VC	23.9	255.1	33.7	232.8	1.14	51.6	207.4
Control	18.9	209.9	28.0	212.2	1.17	45.9	146.2
Initial value	18.0	235.6	19.2	202.1	1.19	42.9	194.5
CD (P=0.05)	0.5	14.5	3.43	6.15	NS	3.86	21.4

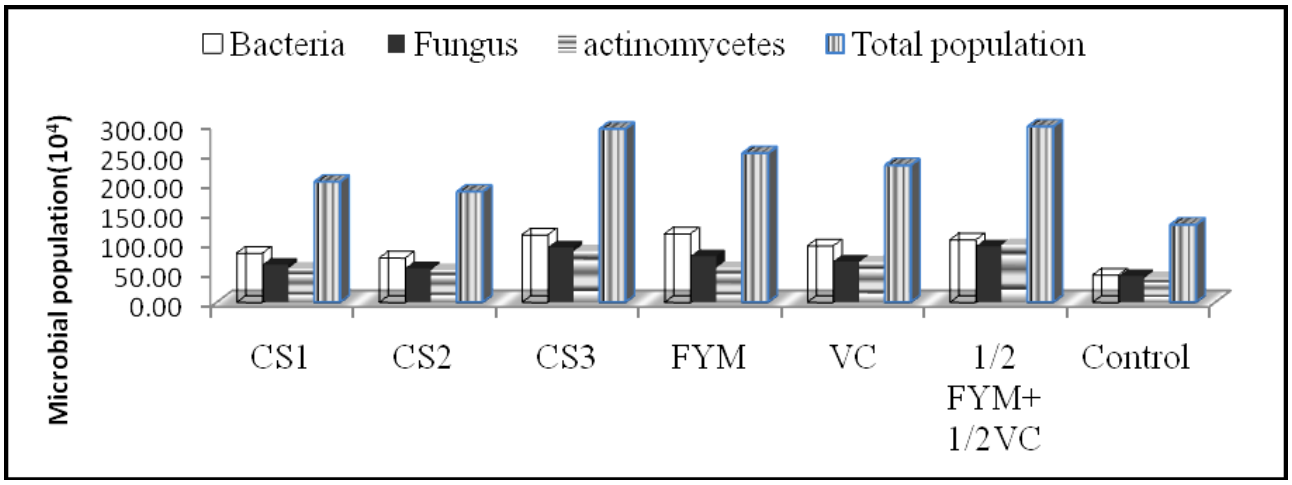

Figure 1: Microbial population (cfu g^{-1} dry soil) in soil as influenced by cropping systems and sources of nutrient supply

Population of bacteria (colony forming unit g^{-1} dry soil) was recorded maximum in FYM; whereas, fungus and actinomycetes were the highest under INS as nutrient sources. Maize + soybean (2:2) - French bean - carrot cropping sequence recorded the highest population of bacteria, fungi and actinomycetes and total microbial population compared to other cropping sequences (Figure 1). Total microbial population was recorded the highest under INS as source of nutrient supply followed by

FYM and VC. More microbial population indicates more biological activities in soil under INS than other nutrient sources, which helped in mineralizing the unavailable form of nutrients, thus, enhancing their availability in soil. Mader *et al.* (2002) also reported higher microbial activity and microbial biomass carbon in organic soils. However, some researchers found no differences in bacterial biodiversity (Lawlor *et al.*, 2000) or in fungal communities (Franke-Snyder *et al.*, 2001) between organically or conventionally managed soils.

CONCLUSION

Application of FYM + VC was found most effective in respect to residual health status at equivalent N-application rates followed by FYM. FYM + VC and FYM alone was found effective in improving soil fertility and biological parameters compared to VC along and control. Maize + soybean - tomato system registered maximum post-harvest soil fertility status than other systems. Thus, FYM + VC and FYM as organic amendment and maize + soybean - tomato system were found most effective for sustainable organic production of maize-vegetable systems.

Acknowledgement

The authors are thankful to the ICAR-Indian Institute of Farming System Research, Modipuram for providing financial support and guidance for conducting the study.

Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

Chowdhury, R., 2004. Effects of chemical fertilizers on the surrounding environment and the alternative to the chemical fertilizers. *IES - ENVIS Newsletters* 7(3), 4-5.

Clark, M.S., Horwath, W.R., Shennan, C., Scow, K.M., 1998. Changes in soil chemical properties resulting from organic and low input farming practices. *Agronomy Journal* 90(5), 662-671. DOI: https://doi.org/10.2134/agronj1998.00021962009000050016x.

Das, A., Patel, D.P., Munda, G.C., Hazarika, U.K., Bordiloi, J., 2008. Nutrient recycling potential in rice-vegetable cropping sequences under *in situ* residue management at mid-altitude subtropical Meghalaya. *Nutrient Cycling in Agroecosystems* 82, 251-258. DOI: https://doi.org/10.1007/s10705-008-9184-0.

Das, A., Patel, D.P., Lal, R., Kumar, M., Ramkrushna, G.I., Layek, J., Buragohain, J., Ngachan, S.V., Ghosh, P.K., Choudhury, B.U., Mohapatra, K.P., Shivakumar, B.G., 2016. Impact of fodder grasses and organic amendments on productivity and soil and crop quality in a subtropical region of eastern Himalayas, India. *Agriculture, Ecosystems and Environment* 216, 274-282. DOI: https://doi.org/10.1016/j.agee.2015.10.011.

Frankenberger Jr., W.T., Dick, W.A., 1983. Relationship between enzyme activities and microbial growth and activities in soil. *Soil Science Society of America Journal* 47(5), 945-951. DOI: https://doi.org/10.2136/sssaj1983.03615995004700050021x.

Franke-Snyder, M., Douds, D.D., Galvez, L., Phillips, J.G., Wagoner, P., Drinkwater, L., Morton, J.B., 2001. Diversity of communities of arbusculat mycorrhizal (AM) fungi present in conventional versus low-input agricultural sites in eastern Pennsylvania, USA. *Applied Soil Ecology* 16(1), 35-48. DOI: https://doi.org/10.1016/S0929-1393(00)00100-1.

Lawlor, K., Knight, B.P., Barbosa-Jefferson, V.L., Lane, P.W., Lilley, A.K., Paton, G.I., McGrath, S.P., O'flaherty, S., Hirsch, P.R., 2000. Comparison of methods to investigate microbial populations in soils under different agricultural management. *FEMS Microbiology Ecology* 33, 129-137. DOI: https://doi.org/10.1111/j.1574-6941.2000.tb00735.x.

Mader, P., Fliebbach, A., Dubois, D., Gunst, L., Fried, P., Niggli, U., 2002. Soil fertility and biodiversity in organic farming. *Science* 296(5573), 1694-1697. DOI: https://doi.org/10.1126/science.1071148.

Nannipeeri, P., 1994. The potential use of soil enzymes as indicators of productivity, sustainability and pollution. In: *Soil biota Management in Sustainable Farming Systems*. (Eds.) Pankhurst, C.E., Doube, B.M., Gupta, V.V.S.R. and Grace, P.R. CSIRO, East Melbourne. pp. 238-244.

Panwar, N.R., Ramesh, P., Singh, A.B., Ramana, S., 2010. Influences of organic, chemical and integrated management practices on soil organic carbon and soil nutrient status under semi-arid tropical conditions in central India. *Communications in Soil Science and Plant Analysis* 41(9), 1073-1083. DOI: https://doi.org/10.1080/00103621003687166.

Patel, D.P., Das, A., Kumar, M., Munda, G.C., Ngachan, S.V., Ramkrushna, G.I., Layek, J., Pongla, N., Buragohain, J., Somireddy, U., 2014. Continuous application of organic amendments enhances soil health, produce quality and system productivity of vegetable based cropping systems at subtropical eastern Himalayas. *Experimental Agriculture* 51(1), 85-106. DOI: https://doi.org/10.1017/S0014479714000167.

Ramesh, P., Panwar, N.R., Singh, A.B., Ramana, S., 2009. Effects of organic nutrient management practices on the production potential, nutrient uptake, soil quality, input-use efficiency and economics of mustard (*Brassica juncea*). *Indian Journal of Agricultural Sciences* 79(1), 40-44.

van Diepeningen, A.D., de Vos, O.J., Korthals, G.W., van Bruggen, A.H.C., 2006. Effects of organic versus conventional management on chemical and biological parameters in agricultural soils. *Applied Soil Ecology* 31(1-2), 120-135. DOI: https://doi.org/10.1016/j.apsoil.2005.03.003.

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