Effect of organic cultivation on soil properties under different cropping systems: A Review

Abstract

Modern farming requires sustainable use of soil resources because soil quality can easily be deteriorated within a short period of time. For sustainable agricultural productivity, it is ~~utmost~~ important to improve and maintain soil physical, chemical and biological health. The micro biodiversity plays a crucial role in ensuring the availability of inherent and applied nutrients in the soil to the crop plants. The characterization of physical, chemical and microbiological properties of soil in relation to organic cultivation is important for recommending the nutrient and water input for optimum plant growth. The sustainability of World's agriculture is threatened by sharp declining factor productivity due to deteriorating soil quality, imbalanced use of fertilizers, mismatch between nutrient additions and removal and escalating cost of production. Despite the reduced potential of agro-ecosystems, organic cultivation can contribute to build up, or at least maintain, soil nutrient reserves whilst at the same time maximizing nutrient recycling and reducing external inputs. Organic farming is a system of crop production, which primarily aims to keep soil alive and in good health using organic based nutrient inputs like compost, farm yard manure, green manure, vermicompost, bone meal and crop residues *etc.*

Key words: Cropping system, organic cultivation, soil properties, FYM and compost

Introduction

"Organic cultivation leads to addition of organic matter, boosts beneficial microbial population and sustains soil productivity. Cropping system imply a specific pattern of crop succession, component crops and frequency with which all these interact and affect the entire production system" (Hedge, 1996). Cropping systems affect organic matter, soil health, nutrient supply and water uptake etc. The selection of cropping system and their residue management are vital under organic cultivation. Crops and cropping systems should be selected such that the residual nutrients left by one are efficiently used by subsequent crops (Panwar *et.al.*, 2010; Yadav *et al*., 2020).

"The organics like farm yard manure and crop residues are the source of energy to the soil, microflora and organic carbon content is considered to be an index of the soil health" (Chand, 2006; Yadav *et al*., 2023). "A better understanding of the Impact of organic manure on physical, chemical and biological soil properties is essential for the quantification of soil quality impacts and thereby

enhancing the cropping system sustainability" (Aparicio and Costa, 2007). "Thus, there is an urgent need to not only improve but also to sustain soil health for crop productivity. This requires an urgent shift from sole chemical to organic agriculture. In addition, it gives emphasis on crop rotation, biological pest and weed management and mixed cropping. Organic manures have thus, beneficial effects on soil quality than inorganic fertilizers thereby improving nutrient release and their availability to the plants" (Birkhofer *et al.*, 2008 and Ahlawat *et al.* 2023). However, the systematic information of organic cultivation with respect to inherent soil properties and their fertility status particularly under different cropping system is lacking. The impact of organic cultivation may be different under different cropping systems. Keeping in view the importance of these cropping systems under organic cultivation, the present investigation was taken to see the effect of organic cultivation on soil properties under different cropping systems.

Soil physical properties

"During the past several decades, a significant decline in soil health has been observed worldwide due to incongruous agricultural practices and different cropping systems" (Arshad and Martin, 2002). "This includes excessive and imbalanced chemical applications, inappropriate tillage and many anthropogenic activities" (Xiubin *et al.* 2002). "For the past few decades, conventional agricultural system has been adopted by using different synthetic chemical fertilizers and chemicals to increase productivity The intensive cropping coupled with the continuous use of chemicals as inputs has resulted in various issues including disturbance of soil physical environment with increasing appearance of multi-nutrient deficiencies. It is observed that continuous chemical nutrient management lower the fertility of soil especially the physical properties" (Vidyavathi *et al*., 2011). Effect of different cropping systems on soil properties and nutrient availability provides an opportunity to evaluate sustainability of agro ecosystem and thus the basic processes of soil degradation in relation to agricultural use.

Nancy *et al.* (2016) studied that "the impact of cropping systems on soil properties and nutrient availability in Shivalik hills of Himachal Pardesh. The four commonly occurring cropping systems namely vegetable, fruit, cereal crop and agroforestry were selected. The study indicated that the cropping systems in Shivalik hills varied significantly with respect to their impact on soil properties, nutrient availability and carbon sequestration potential". Similarly, Wang *et al.* (2016) studied "the effect of cropping system and fertilization on soil properties. They reported that the

lowest pH was observed in the continuous alfalfa cropping system, followed by the continuous wheat cropping and crop-legume rotation systems”.

Xin *et al.* (2016) studied “the long term (23 years) effect of compost application on soil physical properties of an intensively cultivated sandy loam soil under maize-wheat cropping system in North China Plain. The experiment consisted of seven treatments: organic compost ; half organic compost plus half mineral fertilizer NPK; mineral fertilizer NPK; mineral fertilizer NP; mineral fertilizer PK; mineral fertilizer NK; and unfertilized control replicated with four times. They reported that manure application significantly reduced the soil bulk density and increased total porosity as compared to control plots”.

Nima *et al.* (2020) studied “the effect of long term organic farming on soil bulk density under four cropping systems: green manure-basmati rice-wheat, green manure-basmati rice-chickpea, summer moong-cluster bean-wheat and soybean-wheat at research farm of PAU, Ludhiana. They observed that bulk density was lowest in green manure-basmati rice-wheat (1.47 g/cm^3) followed by green manure-basmati rice-chickpea (1.50 g/cm^3) and summer moong-cluster bean-wheat (1.51 g/cm^3). However, highest bulk density was observed in soybean-wheat (1.57 g/cm^3) cropping system”.

Nabayi *et al.* (2021) studied “the long term effect cultivation and soil organic matter content on particle density, bulk density and porosity of soils of Sudan Savannah Entisols. The field experiment was laid in RCB design and replicated three times each at a depth and 50 m intervals from one spot to another. They observed that organic matter content of location greatly influenced the particle density, bulk density and porosity of the soils, the sampling site with higher organic matter shown to have lower particle density, bulk density and higher total porosity”.

Soil chemical properties

Uddin *et al.* (2016) conducted an experiment to study the impact of organic practices on soil available macronutrients (N, P, K and S) at Horticulture Research Center, Bangladesh. They reported that 54 %, 163 %, 34 % and 135 % increase in available N, P, K and S respectively in compost treated plots as compared to control under tomato- egg plant- cabbage / cauliflower cultivation. Simmlarly, Nagar *et al.* (2016) studied the effect of organic manure and crop residue management on soil available N, P and K and reported that available soil N, P and K was highest under FYM and pigeon pea stalk incorporation. Manjunatha *et al.* (2013) reported that available soil N, P and K was found to be increased from fifth to fifteenth year of organic farming practice.

Parmar *et al.* (2016) conducted a field experiment at Bajaura, Kullu (Himachal Pradesh) to evaluate the changes in soil properties under two vegetable production systems. They supplied with five nutrient sources: 100 % N via vermicompost, 100 % N supplemented with rock phosphate enriched FYM, 50 % N via farmyard manure and 50% N via vermicompost, 50 % N supplemented with farmyard manure enriched rock phosphate and 50 % N via vermicompost and control. They recorded higher soil organic carbon (0.5 %) in capsicum/cabbage-coriander-spinach/pea as compared to tomato-cauliflower- radish/pea cropping system.

Mahmood *et al.* (2017) studied the effect of organic manures {Sheep manure (SM) @ 15 t /ha, poultry manure (PM) @ 13 t/ha and farmyard manure (FYM) @ 16 t /ha} on soil pH in maize at research farm of University of Agriculture Faisalabad, Pakistan. They reported that organic manure additions reduced the pH of soil irrespective of its nature. Lowest soil pH (7.0) was observed in treatment having FYM @ 16 t/ha.

Sihi *et al.* (2017) studied the effect of organic farming on soil pH, EC and soil organic carbon in basmati rice at Kaithal district of Haryana. The soil samples were collected from each field with three replications. Three sampling events were carried out for evaluating the long-term effect (15 years) of organic vs. conventional farming systems. They reported that the soil pH and EC were 0.3 and 0.09 units lower respectively, and the soil organic carbon was 0.14 % higher in organic fields as compared to initial value under long term incorporation of neem cake, FYM and green manuring before transplanting basmati rice in sandy loam soil.

Głodowska *et al.* (2017) conducted an experiment to study heavy metals concentration in conventional and organic farming soils under vegetables in the western part of Poland. They reported that heavy metals Co (3.83 mg/kg), Cr (7.63 mg/kg) and Ni (4.25 mg/kg) were lower in organic farming as compared to conventional farming.

Rai *et al.* (2018) reported "the DTPA extractable micronutrients (Zn, Fe, Cu and Mn) content under different cropping systems (Maize-oats, Rice-mustard, Moong-Berseem, Agri-horti system and Vegetable) of Jammu and Kashmir. They observed that DTPA extractable micronutrients Zn, Fe, Cu and Mn content were sufficient in all cropping systems and ranged from 5.37-23.36, 0.59-4.38, 0.74-2.08 and 4.59-21.08 mg/kg".

Sheoran *et al.* (2018) studied "the effect of organic and conventional farming on DTPA extractable micronutrient content in sandy to clay loam textured soils of Haryana. Surface soil samples were collected from different villages located at eleven districts of Haryana. They

concluded that the percent increase in Zn, Fe, Cu and Mn content in soil was 43.9, 21.3, 7.5 and 5.8 %, respectively, under organic farming as compared to conventional".

Jaggi *et al.* (2018) conducted a study to investigate the effect of organic amendment (*Sesbania rostrata*) and inorganic fertilizers for organic and conventional farming on soil pH and soil organic carbon at G.B. Pant University of Agriculture and Technology, Uttarakhand. They reported that soil pH was gradually decreased (0.5 unit) with the incorporation of green manuring crop (*Sesbania rostrata*). However, soil organic carbon increased (0.2 %) from initial value in green manure amended soil.

Patel *et al.* (2018) conducted an experiment to study the long-term effect of nutrient management on available N, P, K and S under soybean–wheat cropping system at Jabalpur, Madhya Pradesh. The treatments were FYM alone and along with chemical fertilizers with four replications. They reported that soil supplied with FYM @15 t/ha along with chemical fertilizer had highest available N (329 kg/ha), P (40.5 kg/ha), K (312 kg/ha) and S (48.6 kg/ha).

Soil biological properties

Heidari *et al.* (2016) conducted a study with different organic and inorganic treatments and they observed that the soil treated with a mixture of compost and farmyard manure had the maximum microbial biomass carbon (385.1 µg/g), dehydrogenase activity (85.7 µg TPF/g/h) and alkaline phosphatase activity (3183.6 µg PNP/g/h) compared to other treatments.

Jadhav *et al.* (2016) studied the effect of application of organic amendments (FYM, neem cake and vermicompost) in banana plantation at Rahuri, Maharastra. They reported that dehydrogenase and urease activity were higher in plot received nitrogen via organic manures compared to nitrogen via chemical fertilizers.

Bhavani *et al.* (2017) conducted a long term (16 years) experiment to study the effect of application organic manure on soil dehydrogenase and urease activity in rice – rice cropping system at Regional Agricultural Research Station, Jagtial (India). They reported that dehydrogenase, urease and alkaline phosphatase activities were 1.07 mg TPF/g/d, 25.54 µg PNP/g/h and 2.13 mg NH_4^+-N/g/hhigher in organic manured plot as compared to control plot.

Maharjan *et al.* (2017) studied the effect of organic and conventional management practices on microbial biomass in subtropical top and sub soils at Chitwan district of Nepal. They found that soil organic carbon and microbial biomass carbon were higher in the organic farming topsoil.

Sihi *et al.* (2017) studied the effect of organic farming on dehydrogenase and alkaline

phosphatase activity in basmati rice at Kaithal district of Haryana. The soil samples were collected from each field with three replications for evaluating the long-term effect (15 years) of organic vs. conventional farming systems on soil physical, properties. They reported that in long term application of FYM, neem cake and green manuring, the dehydrogenase and alkaline phosphatase activity were 8.88 µg TPF/g/d and 2.73 µg PNP/g/h in a sandy loam soil.

Jaggi *et al.* (2018) conducted a study to investigate the effect of organic amendment (*Sesbania rostrata*) on dehydrogenase activity at G.B.Pant University of Agriculture and Technology, Uttarakhand. They reported that dehydrogenase, alkaline phosphatase and urease activity increased 32.33 µg TPF/g soil/24h, 4.54 µg PNP/g soil/h and 23.97 mg NH_4^+-N/g/h from initial in green manure amended soil.

Conclusion

Organic cultivation is an environmentally viable approach to agriculture through its use of farm yard manures, compost and green manuring crops to provide nutrients and cultural practices to manage weeds, insects, and pathogens. The cropping system diversification under organic cultivation is necessary to get higher yield and economic profit as well as to maintain soil health, optimum utilization of available resources and meet daily requirement of human. Crop rotation with legumes has positive effect for sustaining soil fertility because of their nitrogen fixing ability. The study concluded that the soil properties were improved under organic cultivation in different cropping system.

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