CHANGES IN THE CHEMICAL PROPERTIES OF SOIL DURING CONVERSION FROM CONVENTIONAL SYSTEM TO ORGANIC SYSTEM

H.C. Joshi[1*], P. Singh[3], S.K. Guru[1] and B.S. Mahapatra[2]

[1]Department of Plant Physiology, College of Basic Sciences and Humanities, G.B.P.U.A.&T. Pantnagar, U.S. Nagar, Uttarakhand, India
[2]Department of Agronomy, College of agriculture, G.B.P.U.A.&T. Pantnagar, U.S. Nagar, Uttarakhand, India
[3]Department of Biotechnology, Bhimtal Campus, Kumaun University, Nainital, Uttarakhand, India

*__Correspondence:__ hembiophysics12@gmail.com

ABSTRACT

The present study on soil, a field experiment was conducted during 2016-17 to assess the changes in soil quality and productivity in ongoing conventional / organic farming cropping system. Rice variety pant basmati 1 and wheat UP-2565 was used during the study. The soil samples were collected from each plot with a screw type auger from 0-15 cm and 15-30 cm depth after harvest of rice and wheat crops. After carrying out the observations, the pH of conventionally managed soil was more at 0-15 cm and 15-30 cm depth as compared to organically managed soil. Significant increase in carbon content was observed for organically managed soil at two depths as compared to conventionally managed soil. Available 'P' and 'K' content were higher for conventionally managed soil as compared to organic. Conventionally managed soil had more 'Ammonical Nitrogen' and 'Nitrate Nitrogen' content as compared to organically managed soil. Thus the Continuous cropping and combined use of organic / green manure improve chemical condition of soil.

Keywords: Organic farming, Conventional farming, Chemical properties, Soil fertility

INTRODUCTION

In the past five decades, the traditional knowledge and practices of organic farming have almost eroded from many parts of India due to influx of modern "green revolution" technologies. However, many communities particularly in the hill and mountain regions have sustained this knowledge. Hence, most of the cultivated area in north-western Himalayas of India has largely remained organic by default. In view of the renewed interest in organic farming and demand for organic products worldwide including India, these areas have vast potential to emerge as major suppliers of organic products. The world organic market is estimated at more than 30 billion Euros in 2006 (Yussefi *et al.*, 2007). This organic market expansion makes it possible for farmers to sell their products at high price premiums. India's National Program for Organic Production (NPOP) requires at least a two-year conversion period for annual crops before produce may be certified as organically grown. These two years pose many challenges, because the changes in the chemical, physical, and biological properties of the soil take time to reach an ecological balance. The transition from conventional to organic and low-input farming is accompanied by changes in an array of soil chemical properties and processes that affect soil fertility. Thus there is a need for better understanding of the various management options for transitioning from conventional to organic production. The purpose of this study was to evaluate the effects on the chemical properties of soil during conversion period.

EXPERIMENTAL SITES

The experimental site was located in the Organic Agriculture Technology Block-C at practical crop production centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Distt. Udham Singh Nagar, which is situated at an Altitude of 243.84 meters above mean sea level with the Latitude 29.5? N and Longitude 79.30? E. This region comes under Tarai and Bhabar agro climatic zone of Uttarakhand. The climate of this region varies from subtropical to temperate, with the rainfall ranging annually from 1000-2000 mm and temperature ranges between 32? C to 44? C during summer and minimum temperature ranges between 0-9? C in winter.

METHODOLOGY

Fertilizer Material: Urea (46% N), Diammonimum phosphate (DAP) (46% P_2O_5 and 18% N) and Potassium sulfate were used as inorganic fertilizers. FYM was used as an organic fertilizer.

Planting Material: A rice variety *Pant basmati 1* and wheat *variety-UP2565* was used as a test crop. These varieties matures in 135-145 days (medium), has a medium plant height. Rice transplanting/wheat sowing may be done immediately after incorporation of green manure/one day after. The incorporation of green manure crop could easily be done with the tractor drawn puddler. In case of Rice depending on duration of the variety, 25-30 day old seedling of rice should be transplanted. Before transplanting roots of seedlings may be dipped in suspension of *Pseudomonas fluorescens* (@5 g/l). Planting geometry of 20 × 15 cm. (row to row × hill to hill) to be maintained in organic rice cultivation so that 1 m^2area has about 50 hills. Square geometry has smothering effect on weeds.

Treatments and Experimental Design: The study was conducted during the main cropping seasons of 2016 and 2017. Treatments consisted of FYM and inorganic fertilizer (N fertilizer, P fertilizer and K fertilizer) the experiment was laid out in a randomized complete block design in a factorial arrangement and replicated three times per treatment. During kharif and Rabi seasons, rice and wheat were taken as test crop at a fixed site with the same layout plan. The rice (cv. *Pant basmati 1*) was sown every year during last week of June and harvested manually during last week of November. The subsequently wheat (cv. *UP 2565*) was sown in December and harvested during third week of May.

Experimental procedures

Analysis of Soil Samples at Different Days: Soils from two different plots i.e. from conventional and organic were collected in different time intervals i.e. before ploughing, after transplantation, at maximum tillering stage, flowering stage and at maturity at two different depths i.e. 0-15 cm and 15-30 cm were analyzed. Soil analysis was done according to Horneck *et al.*, 2011 and summarized in (Table 1-2).

Soil pH

Before ploughing, the initial pH ranged from 8.0 to 8.5 for 15-30 and 0-15 cm depth which was mildly alkaline in nature, which remained stable for conventionally and organically managed soil after transplantation also. But, in the subsequent time intervals i.e. at 30, 60 and 90 Days after transplantation (DAT), it was seen that pH of conventionally managed soil was increased i.e. 8.5 to 9.0 at 0-15 cm and 15-30 cm depth conversely to organically managed soil, where it was decreased, ranging from 7.5 -8.5 at two different depths (0-15 and 15-30 cm).Initial alkaline pH of the field (i.e. before ploughing) might be explained by the fact that fertilizer residues of previous year crop rendered the soil slightly alkaline (Massey *et al.*, 2009). Later on, increase in pH of conventional field is explained by the combined effect of fertilizer application and rhizodeposits. Whereas, the decrease in pH of organically managed soil was attributed to the application of organic amendments like green manure, green leaf manure etc. Previously, it was also observed that the bacterial diversity remain highest in neutral soils (Dumbrell *et al.*, 2010) i.e. in organic soil.

Organic Carbon

Organic carbon is the most limiting factor in the soil. Most of the soil bacteria and the rhizobacterial species are organotrophs and therefore, their growth is greatly affected by the availability and accessibility of the available carbon (Mendes *et al.*, 2013). The total organic carbon (TOC) content in soil at 0-15 cm before ploughing (when plots were not divided into organic and conventional blocks) was “0.300-0.500 %” (medium low) and “0.1-0.3 %” (low) at 15-30 cm. After transplantation and at 30 DAT again in the organically managed soil, organic carbon content ranged from “0.300-0.500 %” (medium low) at 0-15cm depth whereas, for 15-30 cm, it was ranged from “0.1-0.3 %” (low). For conventionally managed soil, same trend was observed like before at both the depths 0-15 cm. Thereafter, at 60 DAT and 90 DAT, the organically managed soil at 0-15 cm depth, “OC” ranged from “0.500-0.750 %” (medium) whereas, for depth 15-30cm, it was ranged “0.300-0.500%” (medium low). Again, for the conventionally managed soil the trend remained the same for both the depths (0-15 cm and 15-30 cm) i.e. 0.300-0.500 % and 0.1-0.3 % respectively. This trend showed that initially organic carbon content of plot under study was low which remained stable after transplantation and at 30 DAT. Thereafter, a significant increase in carbon content was observed at 60 DAT for organically managed soil which become stable at 90 DAT at two depths as compared to conventionally managed soil.

Available Phosphorus and Potassium Content

In case of available phosphorus, before ploughing, the 'P' content of the soil was low i.e. < 22 kg ha^{-1} (medium) for both the depths. After transplantation, it was increased from 22-56 kg ha^{-1} for both organically and conventionally managed soil at considered depth of 0-15 cm and 15 -30 cm. Subsequently, at 30, 60 and 90 DAT it became low at 0-15 cm depth in organic soil and high for conventionally managed soil in subsequent stages (Table 3-5). Potassium content of the soil before ploughing and after transplantation was 112-280 kg ha^{-1} (medium) at 0-15 cm depth and <112 kg ha^{-1}, at 15-30 cm depth. Thereafter, its content was increased from 112 -280 kg ha^{-1} to 280 -392 kg ha^{-1} at 30, 60 DAT whereas, at 90 DAT its content varied from 112-280 kg ha^{-1} (Table 5). Therefore, the overall available 'K' content was higher for conventionally managed soil as compared to organically managed soil.

Nitrogen content

Nitrogen content of the soil was analyzed in two forms: “Ammonical Nitrogen (AN) and Nitrate Nitrogen (NN) content” (Lawlor 2002). Before ploughing, after transplantation and over all the subsequent stages(at 30,60 and 90 DAT) the 'AN' content of soil was low i.e. about 15 kg ha^{-1} at the depths of 0-15 cm and 15-30 cm for organically managed soil and in case conventionally managed soil it was about 73 kg ha^{-1} for the same time intervals and depths. However, 'AN' content of soil again became low at maturity for both the soils under study at 0-15 cm and 15 -30 cm. The overall results showed that the conventionally managed soil had more 'AN' content as compared to organically managed soil. Similarly, before ploughing and after transplantation the 'NN' content of the soil was very low i.e. about 4 kg ha^{-1}, no general trend was observed for subsequent time intervals of 30, 60 DAT for both the soils. However, at maturity 'NN'

Table 1. Soil physico-chemical properties at before ploughing[a]

Treatments	Soil pH	OC [b]					APH [c]				APT [d]				AN [e]			NN [f]				
Scale		L	ML	M	MH	H	L	M	MH	H	L	M	H	VH	L	M	H	VL	L	M	ML	H
(0-15 cm)	8.0-8.5																					
(15-30 cm)	8.0																					

Table 2. Soil physico-chemical properties after transplantation

Treatments	Soil pH	OC [b]					APH [c]				APT [d]				AN [e]			NN [f]				
Scale		L	ML	M	MH	H	L	M	MH	H	L	M	H	VH	L	M	H	VL	L	M	ML	H
Organic (0-15 cm)	8.5-9.0																					
Organic (15-30 cm)	8.5																					
Conventional (0-15 cm)	8.5																					
Conventional (15-30cm)	8.5																					

Table 3. Soil physico-chemical properties at 30 DAT[a]

Treatments	Soil pH	OC [b]					APH [c]				APT [d]				AN [e]			NN [f]				
Scale		L	ML	M	MH	H	L	M	MH	H	L	M	H	VH	L	M	H	VL	L	M	ML	H
Organic (0-15 cm)	8.5																					
Organic (15-30 cm)	7.5																					
Conventional (0-15 cm)	9.0																					
Conventional (15-30 cm)	8.5																					

Table 4. Soil physico-chemical properties at 60 dat[a]

Treatments	Soil pH	OC [b]					APH [c]				APT [d]				AN [e]			NN [f]				
Scale		L	ML	M	MH	H	L	M	MH	H	L	M	H	VH	L	M	H	VL	L	M	ML	H
Organic (0-15 cm)	7.5-8.5																					
Organic (15-30 cm)	7.0-7.5																					
Conventional (0-15 cm)	9.0 -9.5																					
Conventional (15-30cm)	8.5-9.0																					

Table 5. Soil physico-chemical properties at 90 dat

Treatments	Soil pH	OC [b]					APH [c]				APT [d]				AN [e]			NN [f]				
Scale		L	ML	M	MH	H	L	M	MH	H	L	M	H	VH	L	M	H	VL	L	M	ML	H
Organic (0-15 cm)	7.0-7.5																					
Organic (15-30 cm)	7.0																					
Conventional (0-15 cm)	8.5-9																					
Conventional (15-30 cm)	8.5																					

content of conventionally managed soil was higher as compared to organically managed soil. Results of soil analysis are summarized in (Table 3-5).

a : as per "K054 soil testing Kit; Himedia Laboratories Pvt Ltd India " Black boxes show respective test results and are a mean of three replicates.

b : OC, organic carbon (5 oxidizable organic carbon)

L : low (0.1- 0.3); ML: Medium low (0.300-0.500); M: Medium (0.500-0.750); MH: Medium High (0.750-1.00); H: High (1.00-1.50)

c : APH, Available phosphate as P_2O_5(Kgha^{-1})

B : Blank; L: Low (<22); M: Medium (22-56); MH: Medium High (56-73); H: High (<73)

d : APT, Available potassium as K_2O (Kgha^{-1})

L : Low (<112); M: Medium (112- 280); H: High (280-392); VH: Very High (<393)

e : AN, Ammonical nitrogen (Kgha^{-1})

L : Low (about 15); M: Medium (about 73); H: High (about 202)

f : NN, Nitrate nitrogen (Kgha^{-1})

VL: Very low (about 04); L: Low (about 10); M: Medium (about 20); H: High (about 50)

CONCLUSION

The pH of conventionally managed soil was more at 0-15 cm and 15-30 cm depth as compared to organically managed soil. The Significant increase in carbon content was observed for organically managed soil at two depths as compared to conventionally managed soil. The Available 'P' and 'K' content were higher for conventionally managed soil as compared to organic. The Conventionally managed soil had more 'Ammonical Nitrogen' and 'Nitrate Nitrogen' content as compared to organically managed soil.

REFERENCES

Dumbrell AJ, Nelson M, Helgason T, Dytham C, Fitter AH (2010). Relative roles of niche and neutral processes in structuring a soil microbial community. *The ISME Journal*, 4(3): 337.

Horneck DA, Sullivan DM, Owen JS, Hart JM (2011). Soil test interpretation guide. Oregon State University, *Extension Service*, 1-22.

Lawlor DW (2002). Carbon and nitrogen assimilation in relation to yield: mechanisms are the key to understanding production systems. *Journal of Experimental Botany*, 53(370):773-87.

Massey MS, Davis JG, Ippolito JA, Sheffield RE (2009). Effectiveness of recovered magnesium phosphates as fertilizers in neutral and slightly alkaline soils. *Agronomy Journal*, 101(2): 323-329.

Yussefi M, Willer H (2007). Organic farming worldwide, overview & main statistics. *In The world of organic agriculture-statistics and emerging trends*, 9-16.