International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 2946-2949

Received: 17-03-2018
Accepted: 21-04-2018

Anil Nagwanshi
Ph.D. Scholar, Department of Soil Science and Agriculture Chemistry, JNKVV, Jabalpur, Madhya Pradesh, India

AK Dwivedi
Principle Scientist, Department of Soil Science and Agriculture Chemistry, JNKVV, Jabalpur, Madhya Pradesh, India

BS Dwivedi
Assistant Professor, Department of Soil Science and Agriculture Chemistry, JNKVV, Jabalpur, Madhya Pradesh, India

Anupama K
PhD Scholar, Department of Soil Science and Agriculture Chemistry, JNKVV, Jabalpur, Madhya Pradesh, India

Correspondence
Anil Nagwanshi
Ph.D. Scholar, Department of Soil Science and Agriculture Chemistry, JNKVV, Jabalpur, Madhya Pradesh, India

Effect of long term application of fertilizer and manure on soil properties of a vertisol in soybean-wheat cropping sequence

Anil Nagwanshi, AK Dwivedi, BS Dwivedi and Anupama K

Abstract
A field experiments was conducted under All India Co-ordinate Research Project on "Long term Fertilizer Experiment" during 2015-16 with soybean-wheat cropping sequence at the Research Farm Department of Soil Science and Agricultural Chemistry, J.N. Krishi Vishwa Vidyalaya, Jabalpur (M.P.), India to the present investigation was assess the chemical properties of a Vertisol. There were. Ten treatments were imposed with four replications in simple randomized block design in both soybean and wheat crops. The treatments were T1 (50% NPK), T2 (100% NPK, T3 (150% NPK), T4 (100% NPK+HW), T5 (100% NPK + Zn), T6 (100% NP), T7 (100% N), T8 (100% NPK+FYM), T9 (100% NPK-S) and T10 (Control). The results obtained from the present investigation clearly indicated that chemical properties changes in pH and EC in surface and sub-surface soils under different treatments were statistically non-significant. However, the treatments of long-term application of balanced nutrients with and without FYM have significant effect on organic carbon content, cation exchange capacity, calcium carbonate and microbial biomass carbon in surface and sub-surface soils under soybean-wheat cropping system.

Keywords: Soil properties, pH, EC, organic carbon, cation exchange capacity and calcium carbonate, soybean and wheat sequence and FYM

Introduction

Long Term Fertilizer Experiment (LTFE) play an important role in understanding the complex interactions involving plant, soil, climate, management practices and their effect on soil productivity over a long period of time [1]. Therefore, such experiments recognized as a valuable repertoires of information relating to the sustainability especially under intensified cultivation [2]. Initially, the aim was confined to demonstrate unequivocally, the attainable higher productivity potential with the use of chemical fertilizers as well as to identify and evaluate the impact of input management on sustainable soil fertility and subsequent productivity of crops [3]. In this connection, to study the impact of the continuous addition of fertilizer and organic manure for sustainability of high production farming, the ICAR initiated in 1972, the All India Coordinated Research Project (AICRP) on Long Term Fertilizer Experiments (LTFE) to study changes in soil quality, crop productivity and sustainability in the Soybean – Wheat cropping system on a Vertisol of Jabalpur.

Long-term experiments are conducted with the aim to monitor the impact of fertilizer input management on soil fertility and sustainability of a production system [4]. Assessment of nutrient status is one of the key parameters to evaluate the fertility status of a soil [5]. Correct estimate of nutrient will not only help in assessing the amount of fertilizer added to soil but will also help in evaluating the soil fertility status, to develop the strategies for sustainability of any crop production system [6]. Management of soil fertility has emerged as a key area of concern to realize the potential of soil recourses for sustainable crop production [7]. Increase organic matter in soil the clay humus complex become more active and provide more exchange sides thereby improve availability of nutrient further reported that decline in yield even with increase use of recommended NPK fertilizers the reduction in yield generally accounted to the result deficiency of secondary and micro nutrient as a result due to limited use of organic manure and less recycling of crop residue led to depletion of nutrient from soil reserves which directly deteriorates the fertility of soil [8].

Therefore the present study was undertaken to investigate the effect og long term application of fertilizer and manure impacts on soil properties in surface and subsurface under 46th years old soybean-wheat cropping sequence on a Vertisol.

Materials and Methods

Field experiments were conducted during *Kharif* and *Rabi* seasons of 2015-16 at the AICRP on LTFE research field of Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur, situated at 23.10' N latitude, 79.57' E longitudes and at elevation 393 meter above mean sea level in the South-Eastern part of the Madhya Pradesh**.** The experimental soil is medium black belonging to Kheri series of fine montmorillonitic hyperthermic family of T*ypic Haplustert* and known as medium deep black soil. Ten treatments were imposed with four replications in simple randomized block design in both soybean and wheat crops. The treatments were T1 (50% NPK), T2 (100% NPK, T3 (150% NPK), T4 (100% NPK+HW), T5 (100% NPK + Zn), T6 (100% NP), T7 (100% N), T8 (100% NPK+FYM), T9 (100% NPK-S) and T10 (Control). Where 100% NPK stands for 20:80:20 kg ha^{-1} and 120:80:40 kg ha^{-1} N: P_2O_5: K_2O. For the present study two sets of soil samples each for chemical analysis were collected with the help of core sampler from selected sites from each plot as per the treatments for surface (0-15 cm) and sub-surface (15-30 cm) soils after harvest of soybean and wheat crops grown during 2015-16. Soil pH was determined in a 1:2.5 soil-water suspension by glass electrode of Beckman pH meter (Piper, 1950). The soil suspension used for pH determination was allowed to settle down and conductivity of supernatant liquid was determined by using conductivity meter (Black, 1965). The results are expressed in dSm^{-1} at 25^0C. Organic carbon in soil was determined by Walkley and Black rapid titration method (1934). The CEC of soil sample was measured by leaching it with neutral 1N NH_4OAc solution which saturates the soil surface with NH_4^+ ions. The residual electrolytes were then removed by leaching with 99% isopropyl alcohol until the leachate was free of residual electrolytes. The NH_4^+ ions which was adsorbed by soil sample, finally, determined by Kjeldhal distillation method into 2% H_3BO_3. The boric acid containing ammonium borate was titrated by standard acid in the presence of mixed indicator to find out the meq. of exchangeable NH_4^+ adsorbed by soil sample (Amma, 1989). Analysis of soil calcium carbonate content was done using rapid titration method (Jackson, 1973) and microbial biomass carbon was done using soil fumigation method.

Result and discussion

Soil pH

The perusal of the data on soil reaction of the experimental soil indicated that intensive cropping with continuous use of fertilizer singly or in combination over 46th years has resulted a slight changes in soil pH. The pH of the soil was 7.6 at the time of inception of experiment. Data on pH of surface and sub-surface soils as influenced by long term application of fertilizer after harvest of soybean and wheat crops are given in Table 1. Data clearly indicated that pH of surface and sub-surface soils were not affected significantly by long-term application of integrated nutrient. It is also evident from data that pH of surface soil was lower than the sub-surface soil in all the treatments. Data further showed that pH of surface and sub-surface soils were slight decrease in soil pH was recorded in the treatments received FYM along with inorganic nutrients in both the soil depths, No significant change in soil pH under different treatments was might be due to higher buffering capacity of Vertisols. [9]. also reported that soil pH remained almost unchanged if balanced fertilizers were used along with organic manure (FYM) might be due to stabilizing effects of FYM. However, findings of [10, 11] indicated that pH of sub-surface soil increased under integrated treatments might be due to the moderating effect of organics over the years as it decreases the activity of exchangeable Al_3^+ in soil solution due to chelating effect of organic molecules.

Electrical Conductivity

Data (Table 1) clearly showed that electrical conductivity (EC) of surface (0-15 cm) and sub-surface (15-30 cm) soils after harvest of soybean and wheat crops was not affected significantly by the treatments of long-term application of integrated nutrients. Electrical conductivity of sub-surface and surface soils was varied from 0.14-0.29 dSm^{-1} and 0.17-0.20 dSm^{-1} in soybean crop and from 0.16 to 0.19 dSm-1 and 0.18 to 0.21 dSm^{-1}in wheat crop respectively. Further it was observed that electrical conductivity of surface soil was lower than the sub-surface layer and lowest EC was obtained in control treatment at both the soil depths. The values of EC did not show remarkable alternation and this may be attributed to the low residual effect of applied inputs and high buffering capacity of soil. The findings are well supported by those reported by [12, 13].

Soil organic carbon

The response of long term manuring and fertilizer use is an intensive cropping over the last 46th years are illustrated in Table (1). The data revealed that the lowest organic carbon content 5.73 g kg^{-1} was note in control where no fertilizer was practiced. However, the organic carbon values improved significantly with proportionate increment in fertilizer addition at sub optimal (5.62 g kg^{-1}), optimal (7.59 g kg^{-1}) and super optimal (8.51g kg^{-1}) doses. This finding appeared to be due to enhanced root development of crop resulting higher residues as a result of intensive farming with continuous fertilizer applications. These results are also in agreement with the finding of [14, 15]. However, imbalance fertilizer application yielded low organic matter decomposition of plant residues but, addition of P with N resulted in abrupt increase of organic carbon and further addition of K *i.e.* 100% NPK as slightly improved while, appreciable improvement in organic carbon content was marked with 100% NPK+FYM which had comparatively higher in compared to its initial level reported [16, 77]. The higher organic carbon content was obtained at surface and declined progressively with depth. The magnitude of organic carbon was higher on surface and declined with depth could possibly due to the fact that cultivation enhanced and promote the decomposition of plant organic residues at surface level.

Calcium carbonate

The data pertaining to the effect of long-term application of integrated nutrients on calcium carbonate content in soil at 0-15 cm and 15-30 cm depths are given in Table 1. Data clearly indicated that calcium carbonate in soil at both the depths was significantly affected by different treatments of nutrient application. Data further revealed that calcium carbonate of surface and sub-surface soils was maximum under 150% NPK treatment while, it was lowest under control treatment. Higher value of $CaCO_3$ in surface and sub-surface soil after harvest of soybean and wheat crops was recorded in the treatments of balanced application of nutrients and lower values in imbalanced nutrient application treatments. It may be due to long term application of SSP which also contains calcium. Identical finding were also reported by [17, 4]. Further it was found that content of calcium carbonate in surface soil was lower than the sub-surface soil might be due to dissolution effect of organic acids produced during decomposition of organic matter in soil. The finding are well supported by those reported by [18, 19].

Soil microbial biomass carbon

Application of organics along with inorganic fertilizers recorded significantly higher level of SMBC as compared to other treatments during soybean-wheat crop (Table 1). The highest SMBC was recorded with the addition of 100% NPK + FYM followed by 150% NPK. The result illustrated the lowest value of SMBC in control. Among organics applied in kharif season, the highest residual effect on SMBC was noticed by 100% NPK+FYM. It might be due to the supply of additional mineralizable and readily hydrolyzable carbon due to organic manure application resulted in higher microbial activity and in turn higher microbial biomass carbon. These results are in conformity with [20, 21, 5].

Bulk density

Data clearly indicated that bulk density of soil at both the depths was no significantly affected by different treatments of nutrient application. Data further revealed that bulk density of surface and sub-surface soil was highest (1.35 and 1.39 Mgm^{-3}) under control (T_{10}) and lowest (1.30 and 1.33 Mg m^{-3}) under T_8 (100% NPK with FYM) followed by T_3 (150 % NPK) treatments. It was also evident from the data that bulk density of sub-surface soil layer was higher as compared to surface soil layer in all the treatments. The results clearly indicated that integration of organic source with inorganic nutrients decrease the bulk density of soil and also the bulk density increased with soil depth irrespective of the nutrients application treatments. It was might be because of addition of FYM and more root biomass in 100% NPK with FYM treatment which resulted in lower bulk density in both after harvest of soybean and wheat crops. The findings are in good agreement of those reported by [22, 23, 9].

Conclusions

Our results showed that the chemical (OC, $CaCO_3$ and microbial biomass carbon) properties of surface and sub-surface soil after harvest of soybean and wheat crops were significantly altered by long-term application of integrated nutrients. However, treatments of long-term application of integrated nutrients did not affected pH, EC and bulk density of surface and sub-surface soils, significantly neither after harvest of soybean.

Table: Effect of continuous application of chemical fertilizers and manure on soil properties after harvest of soybean crop at 0-15 and 15-30cm

Treatment	pH		EC dSm^{-1}		OC g kg^{-1}		$CaCO_3$ %		MBC		BD Mg m^{-3}	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
50% NPK	7.56	7.58	0.14	0.16	5.62	4.38	5.54	6.25	248	222	1.34	1.37
100% NPK	7.63	7.68	0.18	0.18	7.59	5.49	5.75	6.37	285	245	1.32	1.36
150% NPK	7.64	7.69	0.17	0.19	8.51	6.20	6.42	6.59	353	303	1.31	1.36
100% NPK+ HW	7.57	7.64	0.17	0.17	7.54	5.32	5.75	6.41	280	243	1.32	1.34
100% NPK + Zn	7.65	7.65	0.18	0.18	7.62	5.33	5.74	6.40	286	241	1.32	1.35
100% NP	7.59	7.60	0.18	0.17	6.75	4.75	5.63	6.27	239	211	1.34	1.37
100% N	7.52	7.63	0.18	0.16	5.19	3.78	5.26	5.68	203	192	1.35	1.38
100% NPK+FYM	7.53	7.60	0.17	0.19	8.94	6.33	6.08	6.49	395	382	1.30	1.33
100% NPK-S	7.58	7.65	0.18	0.18	7.22	5.15	5.43	5.83	282	258	1.34	1.38
Control	7.54	7.57	0.14	0.15	4.21	3.58	5.08	5.20	201	186	1.35	1.39
S. Em. $\pm$	0.059	0.049	0.011	0.010	0.26	0.39	0.18	0.35	8.95	12.07	0.011	0.009
CD ($p=0.05$)	NS	NS	NS	NS	0.77	1.12	0.53	1.01	25.98	35.01	NS	NS

References

1. Gupta Anshita AK, Dwivedi Nagwanshi Anil, Dwivedi BS. Effect of Long Term Application of Chemical Fertilizers and Organic Manure Application on Crop Quality Parameters in Soybean Crop International Journal of Current Microbiology and Applied Sciences. 2018; 7:1403-1407.
2. Singh Muneshwar, Wanjari RH. Measures to Sustain and Restore Declined Productivity in Alfisols under Long-Term Fertiliser Experiments Indian Journal of Fertilizers. 2013; 9(2):24-32.
3. Dwivedi BS, Dwivedi AK, Sharma A. Effect of continuous fertilizer and manure application on productivity of soybean-wheat cropping sequence. International Conf. on sustainability of small holder agrian in developing countries changing climate Scenario, CSAUAT, Raipur held on Feb. 2018:156; 14-17.
4. Chouhan B, Rai HK, Suryawanshi A. Assessment of chemical properties of a Vertisol under long-term fertilizer experiment in soybean-wheat cropping system. International Journal of Chemical Studies. 2017; 5(6):2107-2111.
5. Sanyal SK, Majumdar K, Singh UK. Nutrient management in Indian Agriculture with special reference to nutrient mining -A Relook Journal of Indian Society of Soil Science. 2014; 62(4):307-325.
6. Tomar VS, Dwivedi AK. Long term effect of fertilizers and manure application on changes in soil health of vertisol in central India. Proc. National symposium on Soil Science Research: Restrospect and Prospect in the context of Environmental Quality and Food Security Kolkata during, 2007, 7-9.
7. Chandra R. Management of biological property for sustainable soil health Journal of Indian Society of Soil Science. 2013; 61:111-117.
8. Radulov Isidora, Adina Berbecea, Sala F, Crista F, Alina Lato. Mineral fertilization influence on soil ph, cationic exchange capacity and nutrient content. Research Journal of Agricultural Science. 2011; 43(3).
9. Dwivedi AK, Singh M, Kauraw DL, Wanjari RH, Chauhan SS. Research bulletin on impact of fertilizer and manure use for three decades on crop productivity and

sustainability and soil quality under Soybean-Wheat system on a Vertisol in Central India. IISS, 2007, 224-235.
10. Prasad RK, Kumar V, Prasad B, Singh AP. Long-term effect of crop residue and zinc fertilizer on crop yield, nutrient uptake and fertility built-up under rice-wheat cropping system in calciortents. Journal of the Indian Society of Soil Science. 2010; 58(2):205-211.
11. Lal Bahadur, Tiwari DD, Mishra J, Gupta BR. Effect of Integrated Nutrient Management on Yield, Microbial Population and Changes in Soil Properties under Rice-Wheat Cropping System in Sodic Soil. Journal of the Indian Society of Soil Science. 2012; 60(4):326-329.
12. Babu MVS, Reddy MC, Subramanyam A, Balaguravaih D. Effect of integrated use of organic and inorganic fertilizers on soil properties and yield of sugarcane. Journal of the Indian Society of Soil Science. 2007; 55(2):161-166.
13. Chauhan SS, Kumar V, Bhadauria UPS, Dwivedi AK. Effect of conjoint use of organic and inorganic fertilization on Soil Fertility and Productivity of Soybean-Wheat crop sequence. Ann. Pl. Soil Res. 2011; 13(1):47-50.
14. Rawankar H, Swarup PA, Tope RK, Rathod VB, Deshmukh PW. Productivity, nutrient availability and their uptake in sorghum-wheat sequence under long-term fertilizer in Vertisol. Agricultural Science Digestion. 2001; 21:141-144.
15. Santhy P, Velusamy MS, Muragappan V, Selvi D. Effect of inorganic fertilizers and fertilizer-manure combination on soil physico-chemical properties and dynamics of microbial biomass in an Incetisol. J Indian Soc. Soil Sci. 1999; 47:479-482.
16. Singh AK. Evaluation of soil quality under integrated nutrient management. Journal of the Indian Society of Soil Science. 2007; 55:58-61.
17. Choudhari SK, Singh K, Tripathi D, Bhandari AR. Morphology, genesis and classification of soils from two important land uses in outer Himalaya. Journal of the Indian Society of Soil Science. 2005; 53(3):394-398
18. Singh AK, Amgain LP, Sharma SK. Root characterization, soil physical properties and yield of rice as influenced by integrated nutrient management in rice-wheat system. Indian Journal of Agronomy. 2000; 45:217-222.
19. Choudhari SK, Singh K, Tripathi D, Bhandari AR. Morphology, genesis and classification of soils from two important land uses in outer Himalaya. Journal of the Indian Society of Soil Science. 2005; 53(3):394-398.
20. Satyavathi PLA. Influence of structural condition of vertisols on water relation characteristics Journal of the Indian Society of Soil Science. 1998; 46(1):129-132. Sangwan BS, Singh K. Vertical distribution of Zn, Mn, Cu and Fe in the semi-arid soils of Haryana and their relationship with soil chemical properties. Journal of Indian Society Soil Science. 1993; 41(3):463-467.
21. Dubey L, Dwivedi AK, Dubey M. Long term application of fertilizer and manures on physico-chemical properties and n, p and k uptake in soybean-wheat cropping system. 2015; 15(1):143-147.
22. Raghuwanshi C, Khamparia NK, Thakur RK, Sawarkar SD, Dwivedi BS. Effect of long-term application of fertilizers and manure on dry matter yield and nutrient content of soybean in a Vertisol. Green Farming. 2015; 7(2):392-396.
23. Chakraborty D, Garg RN, Tomar RK, Dwivedi BS, Aggarwal P, Singh R *et al*. soil physical quality as influenced by long-term application of fertilizers and manure under maize-wheat system. Journal of the Indian society Soil Science. 2010; 175:128-136.
24. Sharma MP, Bali SV, Gupta DK. Soil fertility and productivity of rice-wheat cropping system in an Inceptisol as influenced by integrated nutrient management. Indian Journal of Agricultural Sciences. 2001; 71:82-86.