Plant Archives Vol. 15 No. 1, 2015 pp. 143-147 ***ISSN 0972-5210***

LONG TERM APPLICATION OF FERTILIZER AND MANURES ON PHYSICO-CHEMICAL PROPERTIES AND N, P AND K UPTAKE IN SOYBEAN-WHEAT CROPPING SYSTEM

Lokesh Dubey, A. K. Dwivedi and Megha Dubey[1]*

Department of Soil Science and Agriculture Chemistry, J. N. K. V., Jabalpur- 482 004 (Madhya Pradesh), India.
[1]Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur- 482 004 (Madhya Pradesh), India.

Abstract

Field experiments was conducted under All India Co-ordinated Research Project on "Long term Fertilizer Experiment" since 1972, but the present work was conducted during 2009 with soybean-wheat cropping sequence at the Research Farm of Department of Soil Science and Agricultural Chemistry, J.N. Krishi Vishwa Vidyalaya, Jabalpur (M.P.), India to study the response of long term application of fertilizer and manures on physico-chemical properties and N, P and K uptake in soybean-wheat cropping system. The treatment were applied in eight treatment combinations comprising of different doses of fertilizers *viz*., 50, 100 and 150% NPK, 100% NP, 100% N, 100% NPK + FYM, 100% NPK-S and control. The results revealed that the application of 100% NPK and FYM has significantly increased the status of pH (7.70), organic carbon (8.58 g kg^{-1}) and calcium carbonate (60.00 g kg^{-1}). Further, the available N, P and K were markedly increased by the application of 100% NPK along with FYM as compared to NPK alone. Thus, the present studies indicated that the application of 100% NPK with FYM in soybean-wheat cropping system enhanced the physico-chemical properties and nutrient availability at the depth of 0-20 cm in soil.

Key words : Nutrient uptake, soybean-wheat cropping sequence, farmyard manure, electrical conductivity, organic carbon.

Introduction

Soybean-wheat is one of the most important cropping system used by farmers now a days. Although, being a leguminous crop its nutrient requirement is less. But wheat require higher amount of chemical fertilizers. It is observed that continuous use of inorganic fertilizers leads to deterioration in soil chemical, physical, and biological properties and soil health (Mahajan *et al.,* 2008). The negative impacts of chemical fertilizers, coupled with escalating prices, have led to growing interests in the use of organic fertilizers as a source of nutrients (Satyanarayana *et al.,* 2002). FYM supplies all major nutrients (N, P, K, Ca, Mg, S,) necessary for plant growth, as well as micronutrients (Fe, Mn, Cu and Zn). Hence, it acts as a mixed fertilizer (Dejene and Lamlam, 2012). FYM improves soil physical, chemical and biological properties. Improvement in the soil structure due to FYM application leads to a better environment for root development (Prasad *et al*., 2000). The use of FYM alone as a substitute to inorganic fertilizer is not be enough to maintain the present levels of crop productivity of high yielding varieties (Efthimiadou *et al*., 2010). Therefore, integrated nutrient management in which both organic manures and inorganic fertilizers are used simultaneously is the most effective method to maintain a healthy and sustainably productive soil. Emerging evidence indicated that integrated soil fertility management involving the judicious use of combined organic and inorganic resources is a feasible approach to overcome soil fertility constraints. The experiment was conducted to study the effect of long term application of fertilizers and manures on physico-chemical properties of soil and nutrients availability.

****Author for correspondence:*** E-mail : meghadubey33@yahoo.com

Materials and Methods

The present investigation is a part of an ongoing All India Co-ordinated Research Project on "Long Term Fertilizer Experiment", with soybean-wheat cropping sequence during the years 2009, at the Research Farm of the Department of Soil Science and Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. The experimental sites (23º10" N latitude and 79º57" E longitude) have a semi-arid and sub-tropical climate with a characteristic feature of dry summer and cold winter. In winter season *i.e.* from November to February the temperature ranges from 4 to 33^{0}C and the relative humidity varies from 70 to 90%. Dry and warm weather usually persists during the month of March to June. The temperature may rise as high as 44^{0}C during these summer months. Monsoon season extends from mid June to mid September. The temperature during this period varies between 25^{0}C and 35^{0}C and the relative humidity ranges from 70 to 80%. The total annual rainfall varies from 1200 to 1500 mm. The soil of the experimental sites falls under Vertisol and belongs to Kheri-series of fine montmorillonite, Hyperthermic family of *Typic Haplusterts* popularly known as "medium black soil". The textural class of soil is clayey, neutral in reaction, non-saline, non-calcareous, medium in organic carbon content, low in available N, medium in available P and K.

Experimental details

The experiment was designed and conducted with 8 different doses of fertilizers along with FYM having four replications arranged in the randomized block design. Four blocks were separated with a gap of 2.0 m, whereas individual plots (17 m × 10.8 m) were separated with a distance of 1.0 m. At the inception of this experiment in 1972, pooled soil sample were drawn from the surface layers (0-20 cm). The pooled soil sample were analyzed for different soil characteristics of the surface soil (0-20cm, 20-40 cm and 40-60 cm) of the experiment. The treatment consist of $\mathbf{T_1}$–50% NPK, $\mathbf{T_2}$–100% NPK, $\mathbf{T_3}$ –150% NPK, $\mathbf{T_4}$–100% NP, $\mathbf{T_5}$-100% N, $\mathbf{T_6}$-100% NPK+ FYM, $\mathbf{T_7}$ -100% NPK – S and $\mathbf{T_8}$ – Control. The plot size is : 17 m. × 10.8 m. (183.6 m^2). The soil of the experimental field has pH (7.6), electrical conductivity (0.18), organic carbon (0.57%), calcium carbonate (4.60%), available N (193.0 kg ha^{-1}) available P (7.60 kg ha^{-1}) and available K (370 kg ha^{-1}). These crops were raised with recommended dose of fertilizer 20:80:20 in soybean and 120:80:40 (N:P:K in kgha^{-1}) in wheat. And all other recommended package of practices remained the same in both the crops.

Results and Discussion

The application of fertilizers and manures showed a positive response on soil physico-chemical properties. 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 36th years has resulted a slight changes in soil pH. The pH of the soil was 7.6 at the time of inception of experiment. In present investigation the values of pH ranged from 7.50 to 7.62 showing that continuous cropping and fertilizer use has no adverse effect on the pH of soil and might be due to high buffering capacity of soil (Dwivedi *et al*., 2007). It appeared that no substantial changes occurred due to treatments as reported earlier by Swarup *et al.* (2000), Santhy *et al*. (2001) and Singh *et al.* (2002). There was no appreciable change in pH of the soil with respect to depth as a result of continuous fertilizer additions and intensive cropping over 36th years. The high buffering capacity of the vertisols could be able to maintain pH of the soil. The EC measured also did not show any appreciable changes over the years due to continuous fertilizers application in almost all the treated plots. This could also be due to the peculiar characteristics of black soils that possessed inherent high buffering capacity which affected the slight alterations in EC of soil due to fertilizer addition as stated earlier by Sharma (1992). There were no considerable changes in EC of the soil with depth as a result of continuous fertilizer addition over the 36th years. These results are also in agreement with the finding of Tomar (2003). The response of long term manuring and fertilizer use is an intensive cropping over the last 36th years are illustrated in table (2). The data revealed that the lowest organic carbon content 5.73 g kg^{-1} was noted in control where no fertilizer was practised. However, the organic carbon values improved significantly with proportionate increment in fertilizer addition at sub optimal (6.23 g kg^{-1}), optimal (7.05 g kg^{-1}) and super optimal (7.23 g 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 Rawankar *et al*. (1998). 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 5.7 g kg^{-1}. Thus, FYM addition had a pronounced effect on organic carbon build up of the soil thereby integration of chemical fertilizer along with organic manure proved to be beneficial to sustaining the soil health and crop productivity (Vasanthi and Kumarswamy, 2000). 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. The calcium carbonate content at various

Table 1 : Effect of long term application of fertilizers and manure on distribution of soil pH,EC,organic carbon and calcium carbonate at various depths

Treatments	pH			EC (dSm^{-1})			Organic carbon (g kg^{-1})			Calcium Carbonate (g kg^{-1})		
	0-20 cm	20-40 cm	40-60 cm	0-20 cm	20-40 cm	40-60 cm	0-20 cm	20-40 cm	40-60 cm	0-20 cm	20-40 cm	40-60 cm
50% NPK	7.50	7.65	7.74	0.13	0.15	0.14	6.23	4.35	3.33	51.50	52.50	53.25
100% NPK	7.60	7.65	7.79	0.15	0.17	0.16	7.05	4.98	4.48	53.50	54.25	55.75
150% NPK	7.58	7.67	7.74	0.17	0.19	0.17	7.23	5.80	4.50	54.00	54.75	56.00
100% NP	7.60	7.61	7.64	0.18	0.19	0.18	6.33	4.53	3.68	52.50	53.50	53.75
100% N	7.62	7.69	7.75	0.18	0.19	0.18	6.10	4.03	3.55	47.00	48.75	49.00
100%NPK+FYM	7.58	7.63	7.70	0.17	0.17	0.15	8.58	6.53	5.75	58.75	59.50	60.00
100% NPK-S	7.60	7.70	7.75	0.17	0.18	0.17	6.81	4.90	3.68	57.75	58.00	59.75
Control	7.54	7.60	7.61	0.13	0.15	0.13	5.73	3.90	3.23	46.25	47.00	47.25
S.E.(m)±	0.35	0.40	0.41	0.01	0.01	0.01	0.40	0.29	0.19	3.04	2.64	2.90
C.D. (5%)	NS	NS	NS	NS	NS	NS	1.18	0.87	0.56	8.95	7.78	8.54
C.V.	9.19	10.44	10.71	12.01	10.21	16.25	11.87	12.06	9.43	11.56	9.88	10.68
Initial		7.60			0.18			5.70			46.00	

depths due to the effect of various treatments presented in table 1 indicating that impact of long term fertilizer experiment on content of calcium carbonate showed that there was a slight variation in its content due to fertilizer application. The lowest content was associated with control (46.25 g kg^{-1}) and 100% N (47.00 g kg^{-1}). There was also no appreciable alteration in its content was marked at lower depths. Identical finding were also reported by Choudhari *et al.* (2005).

Available N content as affected by various treatments illustrated in table (4.5) and fig. (5.5) which indicated that higher values of N content was obtained from surface soil could be due to the presence of residues after the harvest of crop as suggested by Dwivedi *et al.* (2014). Further lower content was found at control (179.63 kg ha^{-1}) attributed due to lack of fertilizers application which directly or indirectly affected normal biological activity. Similar results have been reported by Sharma *et al.* (2013). However, due to addition of fertilizer doses suboptimal, optimal and super optimal, N content was correspondingly improved indicating a impact of fertilizer application on enrichment of N pools. The highest N content was registered in 100% NPK+FYM (327.53 kg ha^{-1}) treatments followed by 150% NPK (301.35 kg ha^{-1}) could be resulted due to better biological activities in presence of FYM.

It has also been noted that higher status of N was obtained on the surface while progressively declined with depth but the rate of depletion was more apparent from surface to subsurface while, it was stabilize below 40 cm. Thus, could be attributed to higher root biomass in the rhizospheric upper soil layer and which declined with increasing soil depth. Continuous cropping and manuring remarkably improved the available P in almost all treatments receiving P annually as compared to application of fertilizer without P. The large difference in P content monitored from various fertility treatments receiving sub optimal, optimal and super optimal doses of nutrient indicating higher P build up respectively. The data also emphasized that lower content of P was confined even after 36th years comparatively lower than that received with treatments receiving P in a fertilizer schedule hence, progressive depletion could be resulted in considerable loss of fertility. Further more, the highest content was found when integrated application of fertilizer was practised with FYM (39.83 kg ha^{-1}) followed by 150% NPK (39.55 kg ha^{-1}) treatments indicating the beneficial effect of FYM on mineralization of P to a greater extent in soil (Garg and Milkha, 2010). The doses also emphasized that accumulation of P was higher at surface as compared to the lower depth. Such a behavior was

Table 2 : Effect of long term application of fertilizers and manure on distribution of available N, P and K (kg ha^{-1}) at various depths.

Treatments	N (kg ha^{-1})			P (kg ha^{-1})			K(kg ha^{-1})		
	0-20 cm	20-40 cm	40-60 cm	0-20 cm	20-40 cm	40-60 cm	0-20 cm	20-40 cm	40-60 cm
50% NPK	223.30	161.07	89.68	18.95	9.41	6.61	240	215	197
100% NPK	262.38	170.96	129.56	29.38	16.83	8.84	253	237	199
150% NPK	301.35	210.57	149.35	39.55	21.92	9.26	298	285	230
100% NP	245.93	198.02	124.61	28.75	15.87	8.05	246	236	172
100% N	197.36	116.65	71.78	9.66	5.27	4.77	209	191	156
100%NPK+FYM	327.53	212.94	160.57	39.83	22.11	10.27	305	292	251
100% NPK-S	258.66	165.45	113.73	27.25	14.74	7.84	235	217	164
Control	179.63	114.34	62.48	7.90	3.80	3.53	201	174	140
S.E.(m) ±	12.18	8.89	8.51	1.31	1.10	0.55	16.21	10.86	9.96
C.D. (5%)	35.82	25.27	25.02	3.84	3.23	1.63	47.69	31.94	29.29
C.V.	9.76	10.30	15.61	10.30	15.96	14.96	13.04	9.40	11.02
Initial	193.00			7.60			370.00		

attributed to the fixation of applied P with the soil and it's subsequent restricted movement within down profile thereby it leads to lower P content at 40 and 60 cm depth respectively. The changes in available K status as a result of continuous cropping and fertilizers application were illustrated in table 2. The data revealed that the application of optimal and super optimal doses resulted in depletion of available K leading to a negative balance and ultimately at reflects on consequent loss of K fertility in further successive years. Hence, the soil initially well supplied 370 kg ha^{-1} would decline to medium to low level of available K. A declining trend in available K status was found with depth and maximum content which gradually declined to lower depths.

References

Choudhari, S. K., K. Singh, D. Tripathi and A.R. Bhandari (2005). Morphology, genesis and classification of soils from two important land uses in outer Himalaya. *J. Indian Soc. Soil Sci.,* **53(3)** : 394-398.

Dejene, M. and M. Lemlem (2012). "Integrated Agronomic Crop Managements to Improve Tef Productivity under Terminal Drought," In: I. Md. M. Rahman and H. Hasegawa, Eds., Water Stress, In *Tech Open Science*, pp. 235 – 254.

Dwivedi, A.K., M. Singh, D.L. Kauraw, R.H. Wanjari and S.S. Chauhan (2007). 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 (ICAR), Bhopal*.

Dwivedi,S.K., M.R. Meshram and N. Pandey (2014). Response of customized fertilizer on wheat under Chhattisgarh condition. *The Bioscan*., **9(4)** : 1590-1512.

Efthimiadou, A., D. Bilalis, A. Karkanis and B. Froud Williams (2010). "Combined Organic/Inorganic Fertilization Enhances Soil Quality and Increased Yield, Photosynthesis and Sustainability of Sweet Maize Crop." *Australian J. of Crop Sci*., **4(9)** : 722-729.

Garg, A. K. and S. A. Milkha (2010). Effect of long term fertilizer management and crop rotation on accumulation and downward movement of phosphorus in semi-arid subtropical irrigated soil. *Communication in Soil Sci. and Plant Ana*., **41** : 848-864.

Mahajan, A., R.M. Bhagat and R.G. Gupta (2008). "Integrated Nutrient Management in Sustainable Rice-Wheat Cropping System for Food Security in India," *SAARC J. of Agri*., **6(2)** : 29-32.

Prasad, B. and S.K. Sinha (2000). "Long-Term Effects of Fertilizers and Organic Manures on Crop Yields, Nutrient Balance, and Soil Properties in Rice-Wheat Cropping System in Bihar," In: I. P. Abrol, K. F. Bronson, J. M. Duxbury and R. K. Gupta, Eds., Long-Term Soil Fertility Experiments in Rice-Wheat Cropping Systems. Rice-Wheat Consortium Paper Series 6, Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi. pp. 105-119.

Ravankar, H. N., K.T. Naphase, R.B. Purnit and R.T. Patil (1998). Long term changes in soil fertility status under sorghum-wheat system on a vertisols. Proc. National Workship Long Term Fertility Management through Integrated Nutrient Supply System. *IISS,* Bhopal. pp. 221-225.

Santhy, P., P. Mathurvel and D. Selvi (2001). Status and impact of organic matter on yield, uptake and available nutrients in a long term fertilizer experiment. *J. Indian Soc. Soil Sci*., **49(2)** : 281-285.

Satyanarayana, V., P. V. Prasad, V. R. K. Murthy and K. J. Boote (2002). Influence of Integrated Use of Farmyard Manure and Inorganic Fertilizers on Yield and Yield Components of Irrigated Lowland Rice. *J. of Plant Nut*., **25(10)** : 2081-2090.

Sharma,G. D., R. Thakur, S. Raj, D. L. Kauraw and P. S. Kulhare (2013). Impact of Integrated Nutrient Management on yield,nutrient uptake,protein content of wheat and soil fertility in a typic haplustert. *The Bioscan.*, **8(4)** : 1159-1164.

Sharma, P. K. and B. R. Tripathi (1992). Fraction of phosphorus from some acid hill soil of Northwest India. *J. Indian Soc. Soil Sci*., **40** : 59-65.

Singh, R. (2002). Impact of continuous application of nutrients on soil physical environment and nutrient status. *M.Sc. (Ag.) Thesis,* J.N.K.V.V., Jabalpur, M.P.

Swarup, A. and N. P. S , Yaduvanshi (2000). Effect of integrated nutrient management on soil properties and yield of rice in alkali soil. *J. Indian Soc. Soil Sci*., **48(2)** : 279-282.

Tomar, V. K. (2003). Spatial distribution of inorganic and organic content of P and S as influenced by long term application of fertilizers and manure in Typic *Haplustert*. *M.Sc. Thesis* J. N. K. V. V. Jabalpur, M.P.

Vasanthi, D. and K. Kumarshwam (2000). Effect of manure and fertilizer schedule on the yield and uptake of nutrient by used fodder crops and on soil fertility. *J. Indian. Soc. Soil Sci.,* **48(2)** : 510-515.