International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 1591-1594

Received: 04-09-2018
Accepted: 05-10-2018

Jyoti Bangre
Department of Soil Science and Agricultural Chemistry
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya,
Gwalior, Madhya Pradesh, India

Bharat Singh
Department of Soil Science and Agricultural Chemistry
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya,
Gwalior, Madhya Pradesh, India

Correspondence
Jyoti Bangre
Department of Soil Science and Agricultural Chemistry
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya,
Gwalior, Madhya Pradesh, India

Effect of organic manures and inorganic fertilizers on physico-chemical properties of soil and yield of soybean grown in semi-arid vertisol

Jyoti Bangre and Bharat Singh

Abstract
The present investigation was carried out at the AICRPDA research farm of College of Agriculture, Indore during Kharif season of 2015, to the effect of organics and inorganics application on soil properties of soybean crop grown in semi-arid vertisol. The experiment was laid out in randomized block design with 3 replications. Treatment consisted of nine different levels of N and P, Kg ha^{-1} with FYM and Crop residue, $N_{20}P_{13}$, $N_{30}P_{20}$, $N_{40}P_{26}$, $N_{60}P_{35}$, FYM 6t + $N_{20}P_{13}$, Crop residue 5t+ $N_{20}P_{13}$, FYM 6t, Crop residue 5t ha^{-1} and one control (N_0P_0). The results revealed that the soil properties of soybean crop grown in semi-arid vertisol. The fertility the treatment combination (FYM+$N_{20}P_{13}$) enhanced the soil properties. Maximum value of organic carbon (0.87), available Nitrogen (289.67 kg ha-1), P (21.60 kg ha-1), K (646 kg ha-1), and S (18.39 kg ha-1) were recorded with treatment combination (FYM+$N_{20}P_{13}$) and minimum in control. The similar result was found in the treatment combination (FYM+$N_{20}P_{13}$) soil Microbial count of bacteria ($65x10^7$), fungi ($37x\ 10^4$) and actinomycetes ($33x10^4$) cfu g^{-1} soil. The treatment (FYM+$N_{20}P_{13}$) also increased seed and stover yields of soybean by 71.69% and 71.70% over the control (1025 and 2206 kg/ha), respectively. Thus, balanced use of organic & inorganic fertilizers are not only provided higher productivity but also sustained fertility of soil and improved microbial population in soil.

Keywords: Organic and inorganic fertilizer's, FYM, crop residue, productivity, fertility

Introduction
Soybean (*Glycine max* L.), a leguminous crop, is one of the most important and extensively grown crop. Since soybean is rich in oils (17-20%) and proteins (38-42%), it is suitable as food and feed for human and animals. Hence, the crop of soybean is one of the most economic legume crops of the world (Ibrahim and Kandil, 2007) [7]. In fact, soybean is estimated to fix 80% of its nitrogen (N) needs (Smaling *et al.*, 2008) [21] from atmosphere. The fixation of N by soybean as much as 300 kg of N ha-^{1} in addition to the release in the soil of 20-30 kg N ha-^{1} for the following crop had been estimated (Hungria *et al.*, 2006) [6].

Apart of N, phosphorus (P) is the second major plant growth-limiting nutrients in most agriculture soils. It plays an important role in the plant's energy transfer system since its deficiency retards growth (Shahid *et al.*, 2009) [22]. Symbiotic N_2 fixation needed high P as large amounts of energy being consumed during the process of photosynthesis and nodule development, production of protein, phospholipids and phytin in grains legume (Rahman *et al.*, 2008). Inadequate P restricts root growth, the process of photosynthesis, translocation of sugars and other such functions which directly influence N fixation by legume plants. Phosphorus supplementation can enhance plant growth by increasing the efficiency of biological N_2 fixation, enhancing the availability of other macronutrients in legumes (Makoi *et al.*, 2013) [10].

Nutrient imbalance is one of the important factors affecting the productivity of soybean. Therefore, keeping the above points in view, the present study investigated the effects of farmyard manure, vermicompost and chemical fertilizer on the germination and growth of this important legume crop.

Keeping the above facts in view, the present investigation was carried out to study the effect of organic manure and inorganic fertilizer's on physico-chemical properties of soil and yield of soybean grown in semi-arid vertisol.

Materials and Methods

A field experiment was conducted at research field AICRPDA, College of Agriculture, Indore during Karif season of 2015 at Indore The area has almost uniform topography with light to medium black soils. Indore is situated in Malwa Plateau in western parts of Madhya Pradesh on 22.430N latitude and 75.660E longitudes with an altitude of 555.5 meters above the mean sea level. Indore is situated in central India in semi-arid (Hot moist) climatic of Malwa Plateau in M.P. (5.2). Summers are dry with the rising temperature up to 440C or even higher during April-May. The winters are normal with temperature descending up to 100C or even more during December and January. The average annual rainfall varies from 750 mm to 1000 mm and 90% of this is received during the last week of June, July, August, September and first week of October through South-West monsoon.

Fertilizer and Seed Sowing

Fertilizer sources for N, P & K (urea, single super phosphate, murate of potash) respectively. N, P and K were applied at the time of sowing. Soybean variety var. (JS-335) was sown in 2nd week of June and harvested in the 1st week of October 2015. All improved packages of practice were followed to raise the crop.

Soil Properties

The surface (0-15 cm) soil samples were collected from the experimental site before sowing of soybean crop and after harvest. The soil samples were air dried and crushed with wooden pestle and mortar and sieved through 2 mm sieve. The material passed through the sieve was used for determination of various characters. Soil pH was determined in 1:2.5 soils-water suspensions (Piper, 1950) [18] using Systronics pH meter and EC, (Piper, 1950) [18]. Determination of organic carbon was done by Walkley and Black's rapid titration method (1934) [26] as described by Piper (1950) [18]. A suitable quantity of the soil was digested with chromic acid and sulphuric acid making the use of heat of dilution of sulphuric acid. Excess of chromic acid left over unreduced by the organic matter of the soil was determined by a titration with Ferrous Ammonium Sulphate solution using diphenylamine indicator. Available N in soil was determined by using alkaline permanganate method (Subbiah and Asija, 1956) [23]. A known weight of soil is mixed with excess of alkaline permanganate and distilled. The phosphorus content of soil was estimated by extraction procedure as described by Olsen *et al.*, (1954). Soil available phosphorus was extracted using 0.5 M NaHCO3 (pH 8.5) and determination was done by ascorbic acid method as described by Miller and Keeney (1982) [14]. The available potassium was extracted by neutral 1N ammonium acetate and it was estimated using flame photometer K (Jackson, 1973) [8]. The microbial population of soil were analysed bacterial count (Allen 1957) [1], Fungi (Martin 1950) [12], and actinomycetes (Kuznetsov and Arjunarao, 1972) [9]. The data thus obtained were analysed statistically using analysis of variance technique for various parameters at 5% level of significance.

Bulk density

To determine the bulk density, soil cores were collected with manually operated core sampler 0-15 cm depth. The samples were dried in the oven at 105 ^{0}C for 24 hours and then dry weights were recorded. The bulk density was calculated by using the following relation (Richards *et al*., 1954) [20].

$$BD = \frac{\text{Weight of oven dry soil}}{\text{Total volume of soil}}$$

Results and Discussion

Physico-Chemical Properties of Soil

To evaluate the effect of various treatments on soil bulk density and soil porosity, surface soil samples were analyzed and data are presented in Table 1 revealed that addition of organic along with chemical fertilizer and alone reduced the bulk density. The lowest bulk density of 1.15 Mg m-^{3} was obtained in case of FYM 6t ha-^{1}+ $N_{20}P_{13}$ treatment followed by T_7, T_8, and T_9. Due to reduced bulk density the porosity of soil has also increased in organic amendments treated plots. The porosity ranged from 44.53 to 56.98% in different treatments and was highest in the treatment FYM 6t ha-^{1}+ $N_{20}P_{13}$ and lowest in case of control. Similar trend was observed at the harvest of crop. Prasad *et al*. (1983) [19] reported that an increasing trend of bulk density had been observed with increasing dose of inorganic fertilizers (50 to 150% NPK). Whereas, FYM incorporation with 100% NPK lowered the bulk density of soil as compared to 100% NPK application and control. Continuous application of ammonium sulphate alone raised the bulk density of soil.

pH and EC

Apersual of the data (table1) showed that, in soil were not affected significantly with application of nutrients Table-1 presents the data on soil pH and pH, and EC in soil at harvest. Soil reactions (soil pH) and EC were statistically unaffected due to application different levels of N and P, *Kg ha^{-1}* with FYM and Crop residue, $N_{20}P_{13}$, $N_{30}P_{20}$, $N_{40}P_{26}$, $N_{60}P_{35}$, FYM 6t + $N_{20}P_{13}$, Crop residue 5t+ $N_{20}P_{13}$, FYM 6t, Crop residue 5t ha^{-1} and one control control (N_0P_0). Gattani *et al.,* (1976) [3, 6] similar result was noticed reported that there was no noticeable change in soil pH due to continuous use of chemical fertilizer and bio fertilizer.

Organic Carbon

Table-1 presents the data different nutrient management options showed substantial impact on organic carbon in surface layer. There was a buildup of organic carbon in the organics along with inorganics treatment combination FYM+$N_{20}P_{13}$. Highest depletion of organic carbon was obtained in control plots followed by inorganic treatments. Control plots showed higher negative carbon sequestration rate followed by inorganic treatments at lower rate of application. Application of higher dose of N, P application of N, P along with organic manure enhanced organic carbon sequestration rate in soil. Hati *et al*. (2005) [5] also found that the application of 10t FYM and recommended NPK (NPK + FYM) to soybean for three consecutive years improved the organic carbon of the surface (0-15cm).

Available N, P and K

The data regarding available N, P and K content in soil (0-15 cm) after harvest of the crop are presented in table 2. Available N in soil varied from 183 to 307 kg N ha^{-1}. Treatment combination Residues 5t+ $N_{20}P_{13}$ significantly increased the available N content in soil over the control plot. Among all the treatments, Residues 5t+ $N_{20}P_{13}$ responded the best by 37.45% increase, followed by FYM+$N_{20}P_{13}$ 37.15%, FYM 6t36.87% increase, respectively over control (182 kg N ha^{-1}).

The data regarding available P content in soil (0-15 cm) after harvest of the crop are presented in table 2. Available P in soil

varied from 8.07 to 13.53 kgP ha^{-1}. Treatment combination FYM+$N_{20}P_{13}$ significantly increased the available P content in soil over the control plot. Among all the treatments, FYM+$N_{20}P_{13}$ responded the best by 58.79% increase, followed by FYM+$N_{20}P_{13}$ 51.63%, FYM 6t 44.025% increase, respectively over control (8.07 kg Pha^{-1}).

The data regarding available K content in soil (0-15 cm) after harvest of the crop are presented in table 2. Available K in soil varied from 460 to 708 kg K ha^{-1}. Treatment combination FYM+$N_{20}P_{13}$ significantly increased the available K content in soil over the control plot. Among all the treatments, FYM+$N_{20}P_{13}$ responded the best by 27.08% increase, followed by Residues 5t+ $N_{20}P_{13}$ 26.05%, FYM6t 22.53%increase, respectively over control (460 kg K ha^{-1}). Integrated use of chemical fertilizer with organics could ameliorate the soil and improve the productivity of a soybean wheat cropping sequence resulting in eco-friendly farming system.

Malewar and Hasnabade (1995) [11] also observed that combined use of organic manures and fertilizers in the proportion of 50:50 for longer time, buildup of organic carbon was more than two times over its initial value. Tiwari *et al*. (2002) [24] revealed that the application of recommended dose of N, P and K with manure @ 15t ha-1improved the organic carbon status and available N, P, K and S in soil there by sustaining the soil health. Imbalance nutrition is one of the important constraints of soybean productivity in the North Indian plains (Chandel, 1998; Tiwari, 2001) [2, 25].

Soil microbial population

The data on soil microbial population are presented in Table 3. Results revealed that the highest soil microbial population were recorded in treatment of FYM6t + $N_{20}P_{13}$ and lowest in case of control treatment (N0P0), whereas the soil samples under chemical fertilizer use showed the lower level of soil microbial population as compared to amended treatments. From the above results on the microbial population it is analyzed that the highest microbial count was observed in the treatment were the FYM is implemented with the inorganic fertilizer. Inorganic fertilizer maintain the Nutrient availability at the initial stage (few days after sowing) but later on depending physicochemical parameters of the soil nutrient availability declines due to formation of metal complexes, but the addition of FYM Maintains the soil organic carbon pool & which helps In maintenance of soil biological activities. Addition of inorganic fertilizer in conjunction with the organic fertilizer is the appropriate rescue system for maintenance of soil quality & productivity in long term use. Meena *et al*. (2015) [13] examined the soil microbial population, dehydrogenase activity and chemical properties of soil under different doses of farmyard manure (FYM), leaf compost and vermicompostat the research farm of the Indian Agriculture Research Institute (IARI), New Delhi, India during 2008-09 and 2009-10. Results indicated the higher value of microbial population, dehydrogenase activity; organic carbon, available nitrogen (N), phosphorus (P), potassium (K) and lower bulk density were observed in farmyard manure applied equivalent to 120 kg N ha^{-1} followed by vermicompost equivalent to 120 kg N ha^{-1}. Grain yield of popcorn was significantly higher in the treatments of recommended dose of fertilizers and vermicompost equivalent to 120 kg N ha^{-1}.

Yield of soybean

The data on the impact of different treatments on yield of soybean as influenced by different treatments have been presented in Table 2. The highest seed yield of (1367 kg ha-1was recorded due to treatment FYM6t + $N_{20}P_{13}$ over the control. Perusal of the data presented in the Table 2 indicated that there was no significant difference between the treatments in increasing the stover yield of soybean. However, the application of different treatments numerically increased the stover yield over control. The highest (3774.0 kg ha^{-1}) Stover yield of soybean was found with application of FYM6t + $N_{20}P_{13}$ over the control. Patil *et al*. (1995) [17] observed that the highest grain yield of sorghum and wheat was recorded due to application of 50 percent N through FYM + 50% recommended dose of NPK to wheat over only application of chemical fertilizers. Seed and straw yields of soybean were higher with organics and 50% inorganics. Wheat grown after the soybean in soybean- wheat sequence were produced the higher seed and straw yield with inorganic fertilizer than organic manure (More and Waghmare, 1995) [15].

Table 1: Effect of various treatments on Physicochemical properties of soilafter harvesting of crop

S. No	Treatment combination	After harvesting of Crop				
		Bulk density (Mg m-3)	Porosity (%)	pH	EC	OC
T_1	N_0P_0	1.49	43.77	7.5	0.20	0.27
T_2	$N_{20}P_{13}$	1.47	44.53	7.6	0.20	0.37
T_3	$N_{30}P_{20}$	1.43	46.04	7.7	0.22	0.43
T_4	$N_{40}P_{26}$	1.38	47.92	7.6	0.22	0.52
T_5	N60P35	1.39	47.55	7.7	0.23	0.55
T_6	FYM6t + $N_{20}P_{13}$	1.14	56.98	7.6	0.22	0.87
T_7	Residues ‘5t+ $N_{20}P_{13}$	1.16	56.23	7.9	0.18	0.83
T_8	FYM 6t	1.17	35.85	7.7	0.22	0.81
T_9	Crop residues 5t	1.29	51.32	7.8	0.20	0.66

Table 2: Effect of various treatments on available N, P K and Yield of soybean

S. No	Treatment combination	Available NPK (kg ha^{-1})			Yield (kg ha^{-1})	
		N	P	K	Seed yield	Stover yield
T_1	N_0P_0	182.0	8.9	471	387	1068
T_2	$N_{20}P_{13}$	240.0	10.8	521	645	1780
T_3	$N_{30}P_{20}$	214.3	12.5	543	550	1519
T_4	$N_{40}P_{26}$	208.0	13.3	552	903	2492
T_5	N60P35	217.6	14.5	584	628	1733
T_6	FYM6t + $N_{20}P_{13}$	289.6	21.6	646	1367	3774
T_7	Residues 5t+ $N_{20}P_1$	291.0	18.4	637	1041	3872

T_8	FYM 6t	288.3	15.9	608	688	1899
T_9	Crop residues 5t	249.0	14.5	605	783	2160
SE(m)±		-	-	-	33	90
CD at 5%		-	-	-	93	256

Table 3: Effect of different treatments on soil microbial population of rhizospheric soil of soybean

S. No	Treatment combination	Population (cfu g^{-1} soil)		
		Bacteria	Fungi	Actinomycetes
T_1	N_0P_0	$21x10^7$	$6x10^4$	$9x10^4$
T_2	$N_{20}P_{13}$	$24x10^7$	$10x10^4$	$13x10^4$
T_3	$N_{30}P_{20}$	$33x10^7$	$16x10^4$	$18x10^4$
T_4	$N_{40}P_{26}$	$53x10^7$	$25x10^4$	$14x10^4$
T_5	N60P35	$55x10^7$	$30x10^4$	$24x10^4$
T_6	FYM6t + $N_{20}P_{13}$	$65x10^7$	$37x10^4$	$33x10^4$
T_7	Residues 5t+ $N_{20}P_1$	$60x10^7$	$35x10^4$	$21x10^4$
T_8	FYM 6t	$59x10^7$	$25x10^4$	$18x10^4$
T_9	Crop residues 5t	$50x10^7$	$28x10^4$	$22x10^4$

References

1. Allen ON. Experiments in soil bacteriology. Burgess Publication Co. Minneapolis. Minn. USA, 1957, 117.
2. Chandel NS, Maltepe E, Goldwasser E, Mathieu CE, Simon MC, Schumacker PT. Mitochondrial reactive oxygen species trigger hypoxia-induced transcription. Proceedings of the National Academy of Sciences. 1998; 95(20):11715-11720.
3. Gattani PD, Jain SV, Seth SP. Effect of Continuous Use of Chemical Fertilisers and Manures on Soil Physical and Chemical Properties. Journal of the Indian Society of Soil Science. 1976; 24(3):284-289.
4. Gattani PD, Jain SV, Seth SP. Effect of Continuous Use of Chemical Fertilisers and Manures on Soil Physical and Chemical Properties. Journal of the Indian Society of Soil Science. 1976; 24(3):284-289.
5. Hati KM, Swarup AK, Ghosh PK, Bandyopadhyay KK. Effect of inorganic fertilizer and manure on soil physical properties, root distribution and water use efficiency of soybean in Vertisols in Vertisols of central India. Bioresource Technol. 2005; 97(16):2182-2188.
6. Hungria M. Contribution of biological nitrogen fixation to the N nutrition of grain crops in the tropics: the success of soybean (*Glycine max* L. Merr.) in South America. Nitrogen nutrition in plant productivity, 2006, 43-93.
7. Ibrahim SA, Hala Kandil. Growth, Yield and Chemical Constituents of Corn (*Zea maize* L.) As Affected by Nitrogen and Phosphors Fertilization under Different Irrigation Intervals Journal of Applied Sciences Research. 2007; 3(10):1112-1120.
8. Jackson ML. Soil Chemical Analysis, Prentice Hall of India Private Limited, New Delhi, 1973, 187.
9. Kuznetson VD, Arjunarao V. Actinomycetes antagonistic to phytopatogenic fungi from south Indian soil. J Indian Phytopatho. 1972; 25(2):307-309.
10. Makoi JH, Bambara S, Ndakidemi PA. Rhizobium inoculation and the supply of molybdenum and lime affect the uptake of macroelements in common bean ('P. *Vulgaris* L.') plants. Australian Journal of Crop Science. 2013; 7(6):784.
11. Malewar GU, Hasnabade AR. Effects of long-term application of fertilizers and organic sources on some properties of Vertisol. Journal-maharashtra agricultural universities. 1995; 20:285-285.
12. Martin JP. Use of acid, Rose Bengal and Streptomycin in the Plate Method for Estimation of the Fungi. J Soil Sci. 1950; 69(3):215-232.
13. Meena BP, Kumar A, Lal B, Sinha NK, Tiwari PK, Dotaniya ML, Jat NK. Soil microbial, chemical properties and crop productivity as affected by organic manure application in popcorn (*Zea may* L. var. everta). African Journal of microbiology Res. 2015; 9(21):1402-1408.
14. Miller RH, Keeney DR. Methods of soil analysis. Part 2: chemical and microbiological properties, 2nd edn. American Society of Agronomy. Soil Science Society of America, Madison, 1982.
15. More SD, Waghmare SG. Nirogen management through organic and inorganic sources in soybean-wheat sequence. In Proc. Of State level seminar on Integrated Nutrient Management for Sustainable Agriculture held at MPKV, Rahuri on, 1995, 10.
16. Olsen SR, Cole CV, Watnabe PS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bi carbonate. U.S.D. Agr. Circ, 1954, 939.
17. Patil AD, Kumar NV, Kokke WC, Bean MF, Freyer AJ, Brosse CD, Carte B. Novel alkaloids from the sponge *Batzella* sp.: inhibitors of HIV gp120-human CD4 binding. The Journal of Organic Chemistry. 1995; 60(5):1182-1188.
18. Piper CS. Soil and Plant Analysis. Inter science publishers. Inc. New York, 1950.
19. Prasad B, Singh RP, Roy HK, Sinha H. Effect of fertilizer, lime and manure on some physical and chemical properties of a red loam soil under multiple cropping. J Indian Soc. Soil Sci. 1983; 31:601-603.
20. Richards LA. Diagnosis and improvement of saline and alkali soils. 1954; 78(2):154.
21. Smaling EMA. Roscoe R, Lesschen JP, Bouwman AF, Comunello E. From forest to waste: Assessment of the Brazilian soybean chain, using nitrogen as a marker. Agriculture, ecosystems & environment. 2008; 128(3):185-197.
22. Shahid M, Walker GB, Zorn SH, Wong EHF. Asenapine: a novel psychopharmacologic agent with a unique human receptor signature. Journal of psychopharmacology. 2009; 23(1):65-73.
23. Subbiah BV, Asija RM. A rapid procedure for estimation of available nitrogen in soils. Curr. Sci. 1956; 25:259-260.
24. Tiwari A, Diwedi AK, Dikshit PR. Long-term influence of organic and inorganic fertilization on soil fertility and productivity of system in soybean wheat Vertisols. J of the Indian Soc. of Soil Sci. 2002; 50(4):472-475.
25. Tiwari SB, Wang X J, Hagen G, Guilfoyle TJ. AUX/IAA proteins are active repressors, and their stability and activity are modulated by auxin. The Plant Cell. 2001; 13(12):2809-2822.
26. Walkley A, Black CA. An examination of the Degtozeff methods for determining the soil organic matter and nitrogen in the soil and a proposed modification of the chromic acid titration method. Soil Sci. 1934; 37:29-38.