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Effect of organic and inorganic fertilizer on physico-chemical properties, macro nutrient and soybean productivity in a *Vertisol*

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Abstract
The present experiment entitled **"**Effect of organic and inorganic fertilizer on physico-chemical properties, macro nutrient and soybean productivity in a *Vertisol***"** was carried out at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *kharif*2016.The experiment was laid out in randomized block design (RBD) with three replications and seven treatments. The soybean crop cultivar JS-9752 was grown with recommended dose of fertilizers (30:60:30 kg ha^{-1}N, P_2O_5 and K_2O) respectively. The treatments consisted of organic and inorganic combination of T_1 (Control), T_2 (100% N RDF through organic source), T_3 (75% N RDF through organic source), T_4 (50% N RDF through inorganic +50% N RDF through organic), T_5 (75% N RDF through organic + 25% N through inorganic), T_6 (100% N RDF through inorganic) and T_7 (100% N RDF through inorganic + 5t FYM ha^{-1}). The available N, P and K were significantly higher in treatment T_3 **(**75% N RDF through organic source) at both surface (0-15 cm) and subsurface (15- 30 cm) soil depth and minimum was recorded in T_1(control) at surface and subsurface soil depthat harvest.

Keywords: Soil properties, nutrient, soybean productivity

Introduction
Soybean [*Glycine max* (L.) Merrill] known as a "Miracle Crop" because it contains about 40-42 per cent high quality protein, 20-22 percent edible oil, 20-30 percent carbohydrates, 4.5 percent minerals, 3.7 percent fiber, 8.1 per cent water, high level of amino acids such as lysine (5%),Lucien, lecithin and vitamins which is helpful for brain development and most of the cereals have deficient respectively.

In India, soybean occupies an area of 9.95 million ha with the production of 12.57 million tonnes and average productivity of 1264 kg ha^{-1}. In Chhattisgarh, soybean occupies 0.15 million ha area with the annual production of 0.153 million tonnes and average productivity of 1025 kg ha^{-1} (www.sopa.org/REK2011.pdf, 2012) [15]. In Chhattisgarh, maximum area and production of soybean comes under Rajnandgaon followed by Durg, Kabirdham and Bemetara districts.

The use of organic manures alone or in combination of chemical fertilizers helps to improve physico-chemical properties of the soils. Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties. One such strategy to maintain soil fertility for sustainable production of soybean is through the judicious use of fertilizers (Bobde *et al*., 1998)

Materials and Methods
The present experiment entitled "Effect of organic and inorganic fertilizer on physico-chemical properties, macro nutrient and soybean productivity in a *Vertisol*" was carried out at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *kharif* 2016.The experiment was laid out in randomized block design (RBD) with three replications and seven treatments. The soybean crop cultivar JS-9752 was grown with recommended dose of fertilizers (30:60:30 kg ha^{-1}N, P_2O_5 and K_2O) respectively. The treatments consisted of organic and inorganic combination of T_1 (Control), T_2 (100% N RDF through organic source), T_3 (75% N RDF through organic source), T_4 (50% N RDF through inorganic + 50% N RDF through organic), T_5 (75% N RDF through organic + 25% N through inorganic), T_6 (100% N RDF through inorganic) and T_7 (100% N RDF through inorganic + 5t FYM ha^{-1}).The experimental field soil pH (7.5), EC 0.27 (dSm^{-1} at 25^0C), bulk density 1.34 ($Mg\ m^{-3}$), soil organic carbon 6.0 ($g\ kg^{-1}$), nitrogen 234.69 ($kg\ ha^{-1}$), phosphorus 15.22($kg\ ha^{-1}$) and potassium 388.65 ($kg\ ha^{-1}$) respectively.

Soil analysis

The selected samples were analyzed for soil pH (1:2.5) soil: water suspension after stirring for 30 minutes by glass electrode pH meter as suggested by Piper (1967) [9], EC measurement using Conductivity Bridge as described by (Jackson, 1967) [6], organic carbon as referred by Walkley and Black rapid titration method (1934) [14], bulk density was measured as Core Sampler method given by Black (1965) [4], available nitrogen was determined by alkaline potassium permanganate method as described by Subbiah and Asija (1965) [12], available phosphorus was determined using 0.5*M* $NaHCO_3$ (pH 8.5) solution (Olsen extractant). Darco-G-60 used to make filtrate colourless for colorimetric analysis (Olsen and Watanabe 1965) andavailable potassium was extracted by shaking with neutral normal ammonium acetate for 5 minute (Hanway and Heidel, 1952) [5].

Results and Discussion

The effect of organic and inorganic fertilizer on physico-chemical properties of soil in soybean was presented in Table.1 and effect of different treatment on available nutrients (kg ha^{-1}) in soil at harvest of soybean was depicted in Table.2.

Soil pH

The soil pH did not show significanttrend in all the treatments. It may be due to continuous use of organic manure and inorganic fertilizers and their combinations. However, pH values increased with increasing depth (0-15 cm to 15-30 cm). The pH value was recorded numerically higher in treatment T_1 (Control) at both surface soil (7.20) and subsurface soil (7.36), respectively. However, minimum pH was observed in treatment T_2 (100% N RDF through organic source).The soil pH values remained unaffected even due to the use of fertilizers applied to crops even for more than decades and the inherent buffering capacity of the soil would also resist small changes in soil pH (Kide *et al.*, 2014) [7].

Electrical conductivity (dSm^{-1})

Electrical conductivity (dS m^{-1}) did not show significant trend in all the treatments. Numerically maximum electrical conductivity was recorded in T_1 (Control) at both the surface and subsurface soil (0.141dSm^{-1}) and (0.127 dSm^{-1}), respectively. While, minimum EC value was recorded in T_2**(**100% N RDF through organic source) (0.126 dSm^{-1}). The electrical conductivity of soil increased due to use of organic manure either alone or in conjunction with inorganic fertilizer. The similar findings were also reported by Robinson *et al.* (2001) [10].

Bulk density (Mg m^{-3})

The bulk density was not differed significantly in all the treatments at both surface and subsurface soil depth. However, higher bulk density was found in treatment T_1 (Control) as compared to other treatments at both surface (1.3 Mg m^{-3}) and subsurface soil (1.47 Mg m^{-3}). Minimum value of bulk density at surface (1.30) and sub-surface (1.43) was recorded under **(**100% N RDF through organic source). Tiarks *et al.* (1974) [13] reported that the decrease in the bulk density might be due to higher soil organic carbon content for better aggregation and increased root growth and bio pores in the fertilizer and manure treated plots.

Organic Carbon (g kg^{-1})

The organic carbon content was maximum in T_2**(**100% N RDF through organic source) (6.6 g kg^{-1}) and T_7 (100 % N RDF through inorganic + 5t Fym ha^{-1}) (6.6 g kg^{-1}) as compared to the control (6.0 g kg^{-1}) at surface soil. However, maximum organic carbon was recorded in T_2 **(**100% N RDF through organic source) (5.4 g kg^{-1}) and T_3 **(**75% N RDF through organic source) (5.3 g kg^{-1}) as compared to the control (4.7 g kg^{-1}) at subsurface soil.Soil organic carbon increased due to addition of organic matter through farmyard manure. It may enhance the crop growth with concomitantly higher root biomass production. It was also supported by (Acharya *et al.*, 1988 and Benbi *et al.*, 1998) [2].

Available Nitrogen (kg ha^{-1})

Available N was ranged between 189.83-247.26 kg ha^{-1}at 0-15cm depth and 158.96-208.17 kg ha^{-1} at 15-30 cm depth. The maximum available N was found in treatment T_3 **(**75% N RDF through organic source) at surface 0-15 cm (247.26 kg ha^{-1}) and subsurface (208.17 (kg ha^{-1}) soil depth. However, the minimum available N was recorded in T_1 (control) at surface (189.83 kg ha^{-1}) and subsurface soil (158.96 kg ha^{-1}). Bhattacharya *et al*. (2008) [3] reported that the available nitrogen (kg ha^{-1}) status of surface soils was higher as compared to subsurface soils. Singh *et al.* (2012) [1] also reported that the continuous addition of fertilizers could be one of the major factors responsible to build up the available N status in the soil.

Available Phosphorus (kg ha^{-1})

Available P was ranged between 11.54-15.22 kg ha^{-1} at 0-15 cm depth and 10.02-12.70 kg ha^{-1} at 15-30 cm depth. The maximum available P was recorded in treatment T_3 **(**75% N RDF through organic source) (15.22 kg ha^{-1})as compared to control (11.54 (kg ha^{-1}) at 0- 15 cm depth. Similarly, treatment T_2 **(**100% N RDF through organic source) (12.70 kg ha^{-1}) and T_3 **(**75% N RDF through organic source) (12.70 kg ha^{-1}) were recorded maximum soil available P while, minimum was recorded in T_1 (control) (10.02 kg ha^{-1}) at 15-30 cm depth.Phosphorus through organic source and their interaction increased available phosphorus significantly which may attribute to bringing the helps in improving the available phosphorus of soil. Similar result was also reported by Thakur *et al.* (2011).

Available potassium (kg ha^{-1})

Available K was ranged between 331.47-449.47 kg ha^{-1} at 0-15 cm depth and 226.38-301.27 kg ha^{-1} at 15-30 cm depth. The significantly maximum available K was recorded in treatment T_3 (75% N RDF through organic source) at 0-15 (cm) depth (449.47 kg ha^{-1}) and at 15- 30 cm depth (301.27 kg ha^{-1}) of the soil as compared to control. Whereas, the minimum soil available K was found in T_1 (control) at surface (331.47 kg ha^{-1}) and subsurface soil (226.38 kg ha^{-1}).An application of organic manure may have caused reduction in K fixation and consequently increased K content in soil due to interaction of organic matter with clay besides the direct addition to the soil. Yadhuvanshi and Swarup (2006) also revealed that the distribution pattern of K at various depths of soil profile indicated a major portion of applied K remained in the top 30 cm soil and moved in successively decreasing amounts down the profile to a depth of 60 cm in the plots receiving balanced fertilizer.

Conclusion

The soil pH and bulk density did not show significantdifference in all the treatments. Numerically higher pH and electrical conductivity value were recorded in treatment T_1 (Control) at both the surface soil (0-15 cm) and subsurface soil (15-30 cm). The organic carbon content was significantly maximum in T_2**(**100% N RDF through organic source) and T_7 (100 % N RDF through inorganic + 5t Fym ha^{-1}) at surface soil. Higher organic carbon was recorded in T_2 **(**100% N RDF through organic source) and T_3 **(**75% N RDF through organic source) at subsurface soil. The available N, P and K were significantly maximum in treatment T_3 **(**75% N RDF through organic source) at both surface and subsurface soil depth. However, the minimum was recorded in T_1 (control) at surface and subsurface soil at harvest.

Table 1: Effect of different organic and inorganic treatment on soil pH, EC, organic carbon and bulk density at harvestin soybean

Treatment	Surface soil (0-15 cm)				Subsurface soil (15-30 cm)			
	pH	EC (dSm^{-1})	OC (g kg^{-1})	BD (Mg m^{-3})	pH	EC (dSm^{-1})	O C (g kg^{-1})	BD (Mg m^{-3})
T_1-Control	7.20	0.141	6.0	1.34	7.36	0.127	4.7	1.47
T_2-100% N RDF through organic source	7.15	0.126	6.6	1.30	7.31	0.124	5.4	1.43
T_3-75% N RDF through organic source	7.16	0.132	6.4	1.31	7.35	0.124	5.3	1.46
T_4-50% N RDF through inorganic +50% N RDF through organic	7.18	0.137	6.5	1.33	7.34	0.125	4.9	1.45
T_5-75% N RDF through organic + 25% N through inorganic	7.15	0.132	6.5	1.33	7.32	0.123	5.0	1.46
T_6-100% N RDF through inorganic	7.17	0.136	6.4	1.32	7.35	0.121	4.9	1.45
T_7-100% N RDF through inorganic + 5t FYM ha$^{-1.}$	7.19	0.135	6.6	1.33	7.34	0.123	5.1	1.44
SEm ±	0.05	0.006	0.008	0.02	0.04	0.002	0.011	0.015
CD (P = 0.05)	NS	NS	0.025	NS	NS	NS	0.033	NS

Table 2: Effect of different treatment on available nutrients (kg ha^{-1}) in soil at harvest of soybean

Treatment	Available nutrients at surface soil (0-15 cm)			Available nutrients at sub surface (15-30 cm)		
	N	P	K	N	P	K
T_1- Control	189.83	11.54	331.47	158.96	10.02	226.38
T_2 - 100% N RDF through organic source	241.16	14.50	438.60	201.83	12.70	274.13
T_3 - 75% N RDF through organic source	247.26	15.22	449.47	208.17	12.70	301.27
T_4 –T_4 - 50% N RDF through inorganic +50% N RDF through organic	238.66	12.47	426.37	189.33	11.49	251.03
T_5 - 75% N RDF through organic + 25% N through inorganic	239.65	13.42	428.27	192.93	11.71	261.23
T_6 - 100% N RDF through inorganic	235.66	12.41	383.83	188.50	11.43	249.10
T_7 - 100% N RDF through inorganic + 5t FYM ha$^{-1.}$	239.93	14.30	429.93	200.17	12.38	272.77
SEm ±	2.70	0.70	22.32	5.83	0.48	12.04
CD (P = 0.05)	8.32	2.17	68.80	17.97	1.48	37.10

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