

Original Research Article

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Effect of Plant Residues on Chemical Properties of Soil and Nutrient Uptake of Soybean

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ABSTRACT

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A field study was conducted during *Kharif* 2012 and 2013 at Krishi Vigyana Kendra, Janwada, Bidar, University of Agricultural Sciences, Raichur, Karnataka, India to study the effect of crop residues on chemical properties of soil and nutrient uptake of soybean in rainfed situation of Northern Karnataka. Results revealed that, application of RDF (40:80:25 NPK kg/ha + 12 kg ZnSO₄/ha+ 20 kg sulphur/ha) + plant residues at 3.0 tonnes/ha recorded significantly (p=0.05) higher uptake of nitrogen (225.7 kg/ha), phosphorus (17.0 kg/ha) and potassium (73.5 kg/ha) by soybean and which was on par with the application of RDF + plant residues at 2.25 tonnes/ha (157.8, 16.3 and 71.3 kg/ha, respectively). Further, Application of RDF + plant residues at 0.75, 1.5 and 2.25 tonnes/ha were at par with each other with respect to nitrogen, phosphorus and potassium uptake by the soybean. Application of RDF (40:80:25 NPK kg/ha + 12 kg ZnSO₄/ha+ 20 kg sulphur/ha) + plant residues at 3.0 tonnes/ha has been increased the soil available nutrients and improves the soil fertility.

Introduction

Soybean [*Glycine max* (L.) Merrill] in India is cultivated over an area of 9.4 million ha with production of 9.6 million tons and is known as “Golden Bean” of 20th century. Though soybean is a legume crop, yet it is widely used as an oilseed. It is now occupying first place among all the oilseed crops in India followed by rapeseed mustard and groundnut, respectively. It grows in varied agro-climatic conditions. Due to its world- wide popularity, the international trade of soybean has spread globally. Soybean possesses a very high nutritional value and is the richest, cheapest and easiest source of the best quality proteins

(40 %) and oil (20 %) having a vast multiplicity of uses as food and industrial products (Anon. 2016).

Producers have expressed concerns about production practices where high levels of crop residue are present on the soil surface. These concerns include wetter soil and lower soil temperatures delaying planting and retarding plant development during early vegetative growth, and less uniform germination and emergence using planting equipment that cannot operate adequately in the residue. By the reproductive growth stage, however,

vegetative growth of crops under no till management can catch up to the growth of crops under tilled management (Klocke *et al.*, 1985).

Another benefit of crop residue is that it reduces the energy of water droplets impacting the soil surface, thereby reducing the detachment of fine soil particles that tend to seal the surface and lead to crust formation. This sealing and crusting process can be enhanced by subsequent soil surface drying, and it reduces infiltration and promotes runoff because precipitation or irrigation rates may be greater than the rates at which the soil is able to absorb water.

Residue may increase surface storage of rain or irrigation water. In addition, it slows the velocity of runoff water across the soil surface, allowing more time for infiltration (Steiner, 1994).

Bidar District of Karnataka (India) is dominated by red lateritic and medium to deep black soils and these soils are poor in soil fertility due to deficiency of secondary and micronutrients. Soybean is one of the important oil seed crop and it is being grown in an area of 95,000 ha with a production of 33,250 thousand tonnes with an average productivity of 725 kg/ha. Since, the yields are low as compared to state average (950 Kg/ha).

Intensive cropping, indiscriminate use of fertilizers and limited use of organic matter and plant residues are the reasons for limits soybean yield. However, very meager information is available on effect of plant residues on chemical properties of soil and nutrient uptake of soybean. Hence a field experiment was conducted to investigate the effect of plant residues on chemical properties of soil and nutrient uptake of soybean in Northern Karnataka.

Materials and Methods

An experiment was taken during *Kharif* 2012 and 2013 at Krishi Vigyana Kendra (KVK), Janwada, Bidar, University of Agricultural Sciences, Raichur, Karnataka, India. The soil of the experimental field was clay loam, slightly saline (pH 8.36), high in organic carbon (0.53 %), available nitrogen (268.0 kg N/ha), phosphorus (30.6 kg P₂O₅/ha) and potassium (423 kg K₂O/ha). The experiment was comprises of six treatments *viz.*, T₁: Absolute Control, T₂: RDF (40:85:25 kg NPK + 12 kg ZnSO₄+20 kg Sulphur/ha), T₃: RDF + Plant residue at 0.75 tonnes/ha, T₄: RDF + Plant residue at 1.50 tonnes/ha, T₅: RDF + Plant residue at 2.25 tonnes/ha and T₆: RDF + Plant residue at 3.0 tonnes/ha. The experiment was laid out in randomized complete block design with four replications. Soybean variety JS 335 was grown at a row spacing of 45 cm. Crop received recommended dose of nutrients @ 40:80:25: kg N: P₂O₅: K₂O per ha through urea, di-ammonium phosphate and muriate of potash, respectively. Sulphur and Zinc sulphate were applied as per treatment details through gypsum (18 % S) and Zinc sulphate, respectively. Soybean seed were inoculated with *Bradyrhizobium japonicum* culture @ 5 g per kg seed. The crop residues were applied as per the treatment after the germination of crop. The rainfall received during *kharif* 2012 and 2013 was 850 mm and 940 mm, respectively. Other crop management practices were performed as per recommended package of practices. The plant samples were collected for recording dry matter production and estimation of nutrient concentration. The plant samples used for recording dry matter production at harvest were used for analyzing nutrients present in the plant. After recording the dry weight from each treatment the samples were powdered in a micro Willey mill. The samples were analyzed for concentration of different nutrients (N, P and K) present in the plant

parts. Nitrogen Phosphorus and potassium content of stover was estimated by modified micro-Kjeldhal's method, Vanadomolybdo phosphoric acid yellow colour method and absorbance of the solution was recorded at 430 nm using spectrophotometer and flame photometer method, respectively (Jackson, 1967).

Available nitrogen in soil was determined by alkaline permanganate method as outlined by Subbiah and Asija (1959). Available phosphorus in soil was determined by Bray's method as outlined by Jackson (1967). Available potassium in soil was determined by neutral normal ammonium acetate solution using flame photometer as outlined by Jackson (1967). MSTAT was used for statistical analysis of data and means were separated using critical difference (CD) at $p=0.05$. The data on weeds were transformed by square root transformation before being subjected to ANOVA (Gomez and Gomez, 1984).

Results and Discussion

Effect of plant residues on yield and yield parameters of soybean

Results revealed that, Application of RDF (40:80:25 NPK kg/ha + 12 kg ZnSO₄/ha+ 20 kg sulphur/ha) + plant residues at 3.0 tonnes/ha recorded significantly ($p=0.05$) higher haulm and seed yield (3007 and 2269 kg/ha, respectively) and which was on par with the application of RDF + plant residues at 2.25 tonnes/ha (2839 and 2136 kg/ha, respectively).

Further, Application of RDF + plant residues at 0.75, 1.5 and 2.25 tonnes/ha were at par with each other with respect to haulm and seed yield (Table 1). This might be due to the favourable role of nutrients and moisture storage due to mulching with plant residues in

nodulation and seed formation process. The results are in consistent with the findings of Saxena and Nainwal (2010) who reported that seed and haulm yield increased significantly with incremental dose of sulphur and boron application.

Application of crop residues on soil may conserve the soil moisture content and reduces the weed population. Therefore, the yield of soybean has been drastically increased. Plant residues acts as a mulching so that, it favours the plant growth.

Effect of plant residues on nutrients uptake of soybean

Nitrogen, phosphorus and potassium uptake by soybean was significantly ($p=0.05$) increased with different rate of application of plant residues along with RDF (Table 1). Maximum uptake of nitrogen (225.7 kg/ha), phosphorus (17.0 kg/ha) and potassium (73.5 kg/ha) by soybean was observed in the treatment with the application of RDF + Plant residues at 3.0 tonnes/ha and which was on par with the application of RDF + plant residues at 2.25 tonnes/ha (157.8, 16.3 and 71.3 kg/ha, respectively) compared to other treatments. The control treatment recorded the lowest uptake of nitrogen, phosphorus and potassium. Similar findings are also reported by Ganeshamurthy (1996) who reported that application of sulphur significantly increased the sulphur uptake in soybean.

Effect on chemical properties of soil

The data on chemical properties of soil is presented in Table 2. Results revealed that, among different rate of plant residue application along with recommended dose of fertilizer was significantly not differed with respect to pH, electrical conductivity (EC) and organic carbon (OC) content in soil after harvest of soybean.

Table.1 Effect of plant residues on yield and nutrients uptake of soybean

Treatments	Seed yield (kg/ha)			Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1: Control	925	961	943	119.47	122.53	121.0	10.40	11.93	11.2	53.05	54.81	53.9
T2: RDF	1875	1893	1884	131.80	138.21	135.0	13.50	14.50	14.0	64.58	66.29	65.4
T3: RDF + Plant residue at 0.75 tonnes/ha	1963	1990	1977	138.78	142.57	140.7	14.90	14.98	14.9	66.38	68.98	67.7
T4: RDF + Plant residue at 1.50 tonnes/ha	2041	2102	2072	145.20	147.63	146.4	15.28	15.81	15.5	68.88	71.80	70.3
T5: RDF + Plant residue at 2.25 tonnes/ha	2125	2148	2136	156.30	159.20	157.8	16.10	16.45	16.3	70.53	72.10	71.3
T6: RDF + Plant residue at 3.0 tonnes/ha	2259	2279	2269	151.18	153.81	225.7	16.87	17.13	17.0	73.13	73.91	73.5
C.D.(P=0.05)	281.8	264.5	273.1	14.35	14.23	14.3	2.38	1.49	1.94	8.94	7.87	8.41

RDF: 40:80:25 NPK kg/ha + 12 kg ZnSO₄+ 20 kg sulphur

Table.2 Effect of plant residues on chemical properties of soil after harvest of soybean

Treatments	pH			EC (dS/m)			OC (%)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1: Control	8.35	8.36	8.35	0.24	0.28	0.26	0.51	0.50	0.51
T2: RDF	8.36	8.38	8.37	0.27	0.31	0.29	0.53	0.53	0.53
T3: RDF + Plant residue at 0.75 tonnes/ha	8.37	8.39	8.38	0.29	0.33	0.31	0.54	0.54	0.54
T4: RDF + Plant residue at 1.50 tonnes/ha	8.37	8.40	8.38	0.31	0.35	0.33	0.55	0.56	0.56
T5: RDF + Plant residue at 2.25 tonnes/ha	8.39	8.41	8.40	0.33	0.37	0.35	0.55	0.56	0.56
T6: RDF + Plant residue at 3.0 tonnes/ha	8.39	8.41	8.40	0.33	0.37	0.35	0.56	0.57	0.57
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

RDF: 40:80:25 NPK kg/ha + 12 kg ZnSO₄+ 20 kg sulphur

Table.3 Effect of plant residues on soil available nutrients after harvest of soybean

Treatments	Nitrogen (kg/ha)			P ₂ O ₅ (kg/ha)			K ₂ O (kg/ha)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1: Control	232	236	234	24.0	25.0	24.5	493	341	417
T2: RDF	273	278	276	27.2	29.1	28.2	518	373	445
T3: RDF + Plant residue at 0.75 tonnes/ha	280	285	283	31.4	33.2	32.3	530	385	457
T4: RDF + Plant residue at 1.50 tonnes/ha	287	290	289	36.6	38.1	37.4	534	391	463
T5: RDF + Plant residue at 2.25 tonnes/ha	291	296	293	43.7	44.9	44.3	548	402	475
T6: RDF + Plant residue at 3.0 tonnes/ha	299	304	302	49.6	52.2	50.9	550	405	478
C.D.(P=0.05)	26.5	22.9	24.9	3.25	5.41	4.33	NS	NS	NS

RDF: 40:80:25 NPK kg/ha + 12 kg ZnSO₄+ 20 kg sulphur

Effect on soil available nutrients after harvest of soybean

Available nitrogen, phosphorus and potassium in soil was significantly ($p=0.05$) increased with different rate of application of plant residues level (Table 3). Maximum availability of nitrogen (302 kg/ha), phosphorus (50.9 kg/ha) and potassium (478.0 kg/ha) in soil after harvest of soybean was observed in the treatment with the application of RDF + plant residues at 3.0 tonnes/ha and which was on par with the application of RDF + plant residues at 2.25 tonnes/ha (293.0, 44.3 and 475 kg/ha, respectively) compared to other treatments. The control treatment recorded significantly lower available nutrients in soil. These results are conformity with the findings of Meena *et al.*, (2011).

Results indicated that, application of RDF (40:80:25 NPK kg/ha + 12 kg ZnSO₄/ha+ 20 kg sulphur/ha) + plant residues at 2.25 or 3.0 tonnes/ha was improved the soil nutrient status and increased the seed yield of soybean.

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