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Effect of Sulphur and Boron Nutrition on Chemical Properties of Soil after Harvest of Soybean

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A B S T R A C T

An experiment was carried out during *Kharif* 2014 and 2015 at Krishi Vigyana Kendra (KVK), Bidar, University of Agricultural Sciences, Raichur, Karnataka, India to assess the sulphur and born nutrition on chemical properties of soil after harvest of soybean under rainfed situation of Northern Karnataka. Results revealed that, among different rate of sulphur and boron application along with recommended dose of fertilizer was significantly not differed with respect to pH, electrical conductivity and organic carbon content in soil after harvest of soybean. Further, Application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha recorded significantly (p=0.05) higher available nitrogen (283.5 kg/ha), phosphorus (30.5 kg/ha), potassium (407.5 kg/ha), sulphur (22.82 kg/ha) and boron (0.44 ppm) in soil after harvest of soybean and which was on par with the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.5 kg Boron/ha (21.5 q/ha) compared to other treatments. It can be concluded that, Application of recommended dose of fertilizer (40:80:25 kg NPK/ha) + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha may increases the soil available nutrients status after harvest of soybean under Northern Karnataka.

Introduction

Recently Soybean [*Glycine max* (L.) Merrill] is being cultivated as an oilseed crop in India and it is recognized as "Golden Bean" due to its high nutritional value such as high quality protein (40-45 %), oil (18-20 %), mineral nutrients like calcium, iron and glycine. Apart from these, it is a good source of isoflavone which helps in preventing heart disease, cancer and HIVs. In India, the area under soybean cultivation was 10.18 m ha and the production was 12.28 m t with productivity level of 1.21t per ha, though the crop has potential productivity of nearly 2,500 – 3,000 kg per ha (Anon. 2016). Sulphur is involved in synthesis of fatty acid and also increased protein quality through the synthesis of certain sulphur containing amino acid such as cystine, cystein and methionine (Havlin *et al.*, 1999). Boron deficiency occurs in highly leached sandy soils, acidic soils and soils low in organic matter and it plays an important role in nodulation, flowering, pollen

germination, fruiting, seed setting and synthesis of protein and oil (Malewar *et al.*, 2001).

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 are the reasons for occurrence of sulphur and boron deficiency in the region which limits soil fertility and soybean yield. However, very meager information is available on response of soybean to sulphur and boron nutrition on chemical properties of soil after harvest of crop. Hence a field experiment was conducted to investigate the effect of sulphur and boron nutrition on chemical properties of soil after harvest of soybean in Northern Karnataka.

Materials and Methods

An experiment was carried out during *Kharif* 2014 and 2015 at Krishi Vigyana Kendra (KVK), Bidar, University of Agricultural Sciences, Raichur, Karnataka, India. The soil of the experimental field was clay loam, slightly saline (pH 8.32), high in organic carbon (0.53 %), available nitrogen (285.0 kg N/ha), phosphorus (30 kg P_2O_5/ha), potassium (416 kg K_2O/ha), sulphur (8.3 ppm) and boron (0.46 ppm).

The experiment was comprises of eight treatments *viz*., T_1: Absolute Control, T_2: RPP (40:85:25 kg NPK + 12 kg $ZnSO_4$+20 kg Sulphur/ha), T_3: RPP + 0.5 kg Boron/ha, T_4: RPP + 1.0 kg Boron/ha, T_5: RPP + 1.5 kg Boron/ha, T_6: RDF (40:85:25 kg NPK/ha) + 12 kg $ZnSO_4$/ha+30 kg Sulphur/ha + 0.5 kg Boron/ha, T_7: RDF + 12 kg $ZnSO_4$/ha+30 kg Sulphur/ha + 1.0 kg Boron/ha, T_8: RDF + 12 kg $ZnSO_4$/ha+30 kg Sulphur/ha + 1.5 kg Boron/ha.

The experiment was laid out in randomized complete block design with three 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:P_2O_5:K_2O per ha through urea, di-ammonium phosphate and muriate of potash, respectively. Sulphur and boron were applied as per treatment details through gypsum (18 % S) and borax (11 % B), respectively. Soybean seed were inoculated with *Bradyrhizobium japonicum* culture @ 5 g per kg seed. The rainfall received during *kharif* 2014 and 2015 was 800 mm and 950 mm, respectively. Other crop management practices were performed as per recommended package of practices. 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). The soil available sulphur was determined by turbidimetric method as outlined by Chesnin and Yien, 1950). The soil available boron was determined by Azomethine H method (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 on chemical properties of soil

The data on chemical properties of soil is presented in Table 1. Results revealed that, among different rate of sulphur and boron 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.

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 sulphur and boron level (Table 2 and 3). Maximum availability of nitrogen (283.5 kg/ha), phosphorus (30.5 kg/ha) and potassium (407.5 kg/ha) in soil after harvest of soybean was observed in the treatment with the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha (22.16 kg/ha) and which was onpar with the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +0.5 kg Boron/ha (281.5, 28.5 and 383.0 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).

Similarly, Sulphur availability in soil after harvest of crop was increased with increasing levels of sulphur application. Maximum available sulphur in soil (22.82 kg/ha) being associated with the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha and which was on par with the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.5 kg Boron/ha (17.67 kg/ha) compared to other treatments. The control treatment recorded the lowest soil available sulphur.

Table.1 Effect of sulphur and boron nutrition on chemical properties of soil after harvest of soybean

Treatments	pH			EC (dSm^{-1})			OC (%)		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
T_1: Absolute control	8.33	8.27	8.30	0.25	0.23	0.24	0.53	0.51	0.52
T_2: RPP (40:80:25 kg NPK/ha + 12 kg $ZnSO_4$/ha + 20 kg Sulphur/ha)	8.35	8.30	8.32	0.30	0.27	0.29	0.58	0.53	0.56
T_3: RPP + 0.5 kg Boron/ha	8.39	8.35	8.37	0.31	0.32	0.31	0.58	0.57	0.57
T_4: RPP + 1.0 kg Boron/ha	8.39	8.37	8.38	0.32	0.34	0.33	0.57	0.55	0.56
T_5: RPP + 1.5 kg Boron/ha	8.38	8.33	8.35	0.33	0.30	0.32	0.59	0.56	0.58
T_6: RDF (40:80:25 kg NPK/ha) + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha + 0.5 kg Boron/ha	8.38	8.38	8.38	0.33	0.35	0.34	0.56	0.57	0.57
T_7: RDF + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha	8.42	8.40	8.41	0.36	0.38	0.37	0.55	0.54	0.55
T_8: RDF + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.5 kg Boron/ha	8.39	8.38	8.39	0.35	0.36	0.36	0.56	0.58	0.57
C.D.(P=0.05)	**NS**	**NS**	**NS**	**0.02**	**0.03**	**0.03**	**NS**	**NS**	**NS**

Table.2 Effect of sulphur and boron nutrition on soil available nutrient status after harvest of soybean

Treatments	Nitrogen (kg/ha)			P_2O_5 (kg/ha)			K_2O (kg/ha)		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
T_1: Absolute control	229	244	226.5	20	21	20.5	358	351	354.5
T_2: RPP (40:80:25 kg NPK/ha + 12 kg $ZnSO_4$/ha + 20 kg Sulphur/ha)	242	238	240.0	26	24	25.0	365	367	366.0
T_3: RPP + 0.5 kg Boron/ha	265	254	259.5	22	21	21.5	370	371	370.5
T_4: RPP + 1.0 kg Boron/ha	274	263	268.5	25	26	25.5	376	373	374.5
T_5: RPP + 1.5 kg Boron/ha	271	263	267.0	23	25	24.0	381	370	375.5
T_6: RDF (40:80:25 kg NPK/ha) + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha + 0.5 kg Boron/ha	284	279	281.5	28	29	28.5	384	382	383.0
T_7: RDF + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha	288	279	283.5	30	31	30.5	405	410	407.5
T_8: RDF + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.5 kg Boron/ha	280	271	275.5	27	26	26.5	395	397	396.0
C.D.(P=0.05)	**13.44**	**18.44**	**15.94**	**2.30**	**3.25**	**2.77**	**10.73**	**13.87**	**12.30**

Table.3 Effect of sulphur and boron nutrition on soil available nutrient status after harvest of soybean

Treatments	Sulphur (kg/ha)			Boron (ppm)		
	2014	2015	Pooled	2014	2015	Pooled
T_1: Absolute control	8.15	8.10	8.13	0.39	0.37	0.38
T_2: RPP (40:80:25 kg NPK/ha + 12 kg $ZnSO_4$/ha + 20 kg Sulphur/ha)	10.66	10.13	10.40	0.45	0.44	0.44
T_3: RPP + 0.5 kg Boron/ha	10.19	10.00	10.09	0.39	0.38	0.39
T_4: RPP + 1.0 kg Boron/ha	14.23	14.54	14.38	0.40	0.41	0.41
T_5: RPP + 1.5 kg Boron/ha	16.15	17.30	16.72	0.44	0.42	0.43
T_6: RDF (40:80:25 kg NPK/ha) + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha + 0.5 kg Boron/ha	16.95	17.55	17.25	0.42	0.44	0.43
T_7: RDF + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha	22.50	23.15	22.82	0.43	0.45	0.44
T_8: RDF + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.5 kg Boron/ha	17.57	17.77	17.67	0.47	0.48	0.48
C.D.(P=0.05)	**2.25**	**2.73**	**2.49**	**0.02**	**0.03**	**0.02**

The above results revealed that sulphur doses increased sulphur availability in soil after harvest of soybean. Similar findings are also reported by Ganeshamurthy (1996) who reported that application of sulphur significantly increased the sulphur availability in soil after the harvest of soybean. The highest boron availability in soil was achieved by the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.5 kg Boron/ha (0.48 ppm) and which was closely followed by the application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg

Boron/ha (0.44 ppm) compared to other treatments. The lowest soil available boron was observed in control plot. Similar results are also reported by Saxena and Nainwal (2010) and Singh, *et al.*, (2013).

In conclusion, results indicated that, application of recommended dose of fertilizer + 12 kg $ZnSO_4$/ha + 30 kg Sulphur/ha +1.0 kg Boron/ha may enhances the soil available nutrient status and proved the improvement of soil fertility status in northern dry zone of Karnataka.

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