Indian Journal of Agriculture and Allied Sciences
A Refereed Research Journal

ISSN 2395-1109
Volume: 2, No.: 1, Year: 2016

Received: 08.03.2016, Accepted: 18.03.2016

EFFECT OF BORON AND SULPHUR ON YIELD AND QUALITY OF Mungbean (*Vigna radiata)* IN RED SOIL OF MIRZAPUR

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Abstract: *The present investigation was carried out during Kharif season of 2014 at the Agricultural Research Farm of Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur. The experiment was laid out in the factorial randomize block design with 3 levels of sulphur (0 kg ha^{-1}, 15 kg ha^{-1}, and 30 kg ha^{-1}) and 4 levels of boron (1.5 kg ha^{-1}, 1.0 kg ha^{-1}, 0.5 ha^{-1} and 0 kg ha^{-1}) of boron and was replicated thrice. The yield of mungbean was significantly influenced by the treatments of boron and sulphur levels ,highest grain yield, test weight (100 seed weight), Stover yield, biological yield and harvest index were obtained by application of 30 kg ha^{-1} sulphur and 1.5 kg ha^{-1} boron. The interaction of 1.5 kg ha^{-1} boron (B_3) with 30 kg sulphur per hectare (S_2) produced significantly highest value of yield attributes and yields over other treatments. Nutrient content (N, P, K, S, B content in the grain and straw), were also influenced significantly by different treatment of boron and sulphur levels. The application of 30 kg Sulphur ha^{-1} (S_2) gave better result over others. It was observed that application of 30 kg sulphur ha^{-1} with 1.5 kg ha^{-1} boron was found most suitable under rainfed condition for mungbean crop. Thus, the farmers of Vindhyan regions may be advised to apply 30 kg sulphur ha^{-1} with 1.5 kg ha^{-1} boron for getting higher yield of mungbean crop.*

Keywords*: Mungbean, Boron, Sulphur, Yield,Quality and red soil*

Introduction: Mungbean (*Vigna radiata)* is an important grain legume in India and is used as whole or split seeds as Dal (Soup) but in other countries sprouted seeds are widely used as vegetables. The importance of pulses is very much relevant for food and improving the farm family income in order to ensure food security, nutritional security and economic security. In India, the area of green gram was 2.30 m ha in 2011-12 and 1.16 m ha 2013-14 with production of 3.60 m tones and 1.80 m tones, respectively. Its average productivity was around 361 Kg ha^{-1} (2011-12) and 350 Kg ha^{-1} (2012-13) [1]. Sulphur is a component element of protein, sulpholipids, enzyme, vitamines etc. Sulphur deficiency in crops is gradually becoming widespread due to continuous use of sulphur free fertilizers, high yielding crop varieties, intensive multiple cropping systems coupled with higher productivity. Boron is one of the essential micronutrient for plant growth. The major causes of Boron deficiency of in Indian soils are coarse textured, low pH and low organic matter content. In Boron deficient soil, both yield and quality of pulses are poor. Thus Boron has become a key nutrient to increase productivity in B deficient light textured soil. Neglecting the B nutrient, will lead to a low yield, inferior crop quality and reduce efficiency of plant nutrient. The soil of Vindhyan plateau and hills of the district Mirzapur comes under rainfed, undulating topography, developing moisture stress condition due to excess runoff. Thus, soil falling under shallow depth, low infiltration and invariably poor fertility status. Red & lateritic soils comprise an area of about 70 million hectare covering around 28% of the total land area of the country. *Vindhyan* region is located in eastern Uttar Pradesh. The entire area of *Vindhyan* region is rainfed and about more than 50 percent, land is suitable for oil seeds and pulses cultivation in upland topography. Generally, farmers do not apply fertilizers in pulses due to lack of knowledge as a result productivity of the pulses in this region is quite low. At present, little scientific information is available on response of sulphur and boron application on mung bean in red soil .In view of above points, a field experiment was carried out to study the effect of sulphur and boron levels on yield and quality of Mung bean in red soil of Vindhya region.

Materials and Methods

The present investigation was carried out at the Agricultural Research Farm of the Rajeev Gandhi South Campus, Banaras Hindu University, Barkachha, and Mirzapur (U.P.) during *Kharif* season of 2014-15. The experiment was laid in fairly uniform topography and well drained soil which had invariably poor fertility status. The soil of the experimental field was sandy loam in texture with low drainage. It was acidic in reaction, poor in nitrogen as well as phosphorus and moderate in potash. Considering the convenience and efficiency of agricultural operation, Factorial- RBD design was selected for experimentation Three levels of sulphur viz. 0 kg, 15 kg, and 30 kg ha-^{1} and four levels of Boron viz. 0 kg, 0.5 kg, 1.0 kg and 1.5 kg^{-1} were designed with three replications. Each replication was divided into 12 equal plots and treatments were randomly allocated within the block for each replication, fresh steps of randomization were followed. The greengram variety Samrat was selected which was a promising and recommended variety for the cultivation of during summer and *Kharif* both the seasons. This variety is shining green colour seeds and test weight of 30-35g and generally mature in 65-70 days. The variety has almost uniform maturity and may be harvested at only one picking.

Height of randomly selected and marked plants from each plot was measured from base of the plants up to growing tip of main stem. Plants from the net plot area were harvested, bundled and weighed after sun drying. Thereafter, the material was transferred to threshing floor, threshed, cleaned and grain yield (kg plot^{-1}) was recorded. The difference of the bundle weight and the grain yield gave the straw yield of crops. Yield obtained in kg plot^{-1} were converted to yield in kg ha^{-1} by multiplying with appropriate conversion factor.

Results and Discussion

Grain Yield (q ha^{-1}): Grain yield ranged from 8.43 to 9.70 q ha^{-1},lowest grain yield was recorded (8.43 q ha^{-1}) in treatment S_0B_0 and a highest grain yield (9.70 q ha^{-1}) was recorded in S_2B_3 at harvest stage.(Table1)The treatment S_2B_3 have shown about 14% increased over control. Application of sulphur (S_2) and boron (B_3) increase the grain yield significantly. The yield increased progressively and significantly with each successive doses of sulphur application. In S_0 level of sulphur, the seed yield was 16.83 as against 18.33, 19.33 and 18.87 q ha-1 recorded in S_{20}, S_{40} and S_{60} levels of sulphur, respectively. Thus, the difference in yield resulting from S application was significant from biofertilizer. Reported that uptake of N, K and S both in grain and Stover increased significantly with increasing levels of sulphur but phosphorus uptake was at par with 25 and 50 kg S ha^{-1} [2].

Table-1: Effect of sulphur and boron levels on yield

Treatment	Grain yield (q ha^{-1})
S_0B_0	8.43
S_0B_1	8.56
S_0B_2	9.27
S_0B_3	8.62
S_1B_0	8.70
S_1B_1	9.56
S_1B_2	8.95
S_1B_3	8.81
S_2B_0	9.69
S_2B_1	9.37
S_2B_2	9.09
S_2B_3	9.70
SEm±	**0.04**
CD (P=0.05)	**0.12**

Test Weight (1000 Seed Weight): Data regarding effect of sulphur and boron levels on test weight was shown in table 2. Test weight ranged from 38.22 to 39.48 g. lowest test weight was recorded (38.22 g) in treatment S_0B_0 and highest test weight (39.48 g) was recorded in S_2B_3 at harvest stage. The treatment S_2B_3 have shown about 4% increased over control.

Straw Yield (q ha^{-1}): Straw yield ranged from 22.09 to 23.60 q ha^{-1}. Lowest straw yield was recorded (22.09 q ha^{-1}) in treatment S_0B_0 and a highest straw yield (23.60 q ha^{-1}) was recorded in S_2B_3 at harvest stage (Table 2). The treatment

S_2B_3 have shown about 6% increase over control. Application of 15 kg ha^{-1} sulphur (S_2) and 1.5 kg ha^{-1} boron (B_3) increased the straw yield significantly. Application of 30 kg S ha^{-1} gave the maximum plant height, dry matter, pods $plant^{-1}$, 1000-grain weight, grain and straw yield of summer greengram [3].

Table 2: Effect of sulphur and boron levels on yield and harvest index

Treatment	Yield and Yield attributes		
	1000-grain weight (g)	**Straw yield (q ha^{-1})**	**Harvest index**
S_0B_0	38.22	22.09	23.09
S_0B_1	38.37	22.24	23.23
S_0B_2	38.68	22.40	23.26
S_0B_3	38.30	22.19	23.19
S_1B_0	38.62	22.33	23.33
S_1B_1	38.82	22.78	23.72
S_1B_2	38.41	22.53	23.53
S_1B_3	38.72	22.65	23.65
S_2B_0	39.07	23.34	24.31
S_2B_1	38.55	22.66	23.64
S_2B_2	38.92	23.18	24.15
S_2B_3	39.48	23.60	24.60
SEm±	**0.29**	**0.03**	**0.31**
CD (P=0.05)	**0.10**	**0.1**	**0.1**

Harvest Index (%): Harvest index (%) ranged from 23.09 to 24.60 %. lowest harvest index was recorded (12.09 %) in treatment S_0B_0 and a highest harvest index (24.60 %) was recorded in S_2B_3 at harvest stage (Table 2). The treatment S_2B_3 have shown about 6% increase over control. The data on harvest index suggest that early maturing genotypes had better harvest index (18.9 – 23.9%) in comparison to normal duration genotypes (12.8–16.7%) [4]. On an average/ harvest index of short duration genotypes was 21.6 percent as compared to 14.4 percent of normal duration genotypes. Among the genotypes, IC 39358 followed by IC 39535 recorded significantly higher harvest indexes (23.8 and 23.3%, respectively) while IC 39429 recorded significantly lower harvest index (12.6%) that rest of the genotypes. It thus, seems that the partitioning of photosynthetic towards seed was more efficient in the early maturing genotype even under sufficient moisture availability conditions.

Table 3: Nitrogen and phosphorus uptake in seed and straw of green gram crop as influenced by sulphur levels and different boron treatments.

Treatment	Nitrogen uptake (Kg ha^{-1})		Phosphorus uptake (Kg ha^{-1})	
	Grain	Straw	Grain	Straw
S_0B_0	29.3	38.33	3.24	5.23
S_0B_1	29.7	38.59	3.26	5.26
S_0B_2	30.3	39.32	3.33	5.51
S_0B_3	29.5	38.54	3.29	5.56
S_1B_0	30.3	38.89	3.30	5.68
S_1B_1	30.7	39.57	3.36	5.78
S_1B_2	29.7	38.73	3.31	5.61
S_1B_3	30.4	39.26	3.33	5.81
S_2B_0	30.8	39.79	3.39	5.91
S_2B_1	29.8	39.13	3.40	5.79
S_2B_2	30.5	39.64	3.54	5.92
S_2B_3	30.9	39.86	3.66	6.15
SEm±	**0.02**	**0.02**	**0.0**	**0.01**
CD (P=0.05)	**0.08**	**0.06**	**0.5**	**0.03**

Nitrogen Uptake in Grain and Straw (kg ha^{-1}): Data regarding effect of sulphur and boron levels on nitrogen uptake in. Nitrogen uptake in grain and straw ranged from 29.3 to 30.9 (grain) and 39.33 to 39.86 (straw). Lowest nitrogen uptake in grain (29.3) was recorded and straw (39.33) recorded in treatment S_0B_0 and highest nitrogen uptake in grain (30.9) and straw (39.86) was recorded in S_2B_3 at harvest stage.

Phosphorus Uptake in Grain and Straw (kg ha^{-1}): Phosphorus uptake in grain and straw ranged from 3.24 to 3.66 (grain) and 5.23 to 6.15 (straw). Lowest phosphorus uptake in grain (3.24) was recorded and straw (5.23) recorded in treatment S_0B_0 and highest phosphorus uptake in grain (3.66) and straw (6.15) was recorded in S_2B_3 at harvest stage (Table 3). Application of sulphur (S_2) and boron (B_3) increase the phosphorus uptake in grain and straw significantly.

Potassium Uptake in Grain and Straw (kg ha^{-1}): Potassium uptake in grain and straw ranged from 14.6 to 17.7 (grain) and 15.23 to 19.61 (straw). Lowest potassium uptake in grain (14.6) was recorded and straw (15.23) recorded in treatment S_0B_0 and highest potassium uptake in grain (17.7) and straw (19.61) was recorded in S_2B_3 at harvest stage (Table 4).

Sulphur Uptake in Grain and Straw (kg ha^{-1}): Sulphur uptake in grain and straw ranged from 2.5 to 3.4 (grain) and 1.5 to 2.0 (straw). Lowest sulphur uptake in grain (2.5) was recorded and straw (1.5) recorded in treatment S_0B_0 and highest sulphur uptake in grain (3.4) and straw (2.0) was recorded in S_2B_3 at harvest stage (Table 4).

Table 4.Potassium and Sulphur uptake in seed and straw of green gram crop as influenced by boron and sulphur levels treatments

Treatment	Potassium uptake (kg ha^{-1})		Sulphur uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw
S_0B_0	14.6	15.23	2.5	1.5
S_0B_1	15.2	16.21	2.5	1.5
S_0B_2	17.2	18.24	2.7	1.7
S_0B_3	14.6	15.43	2.5	1.5
S_1B_0	15.5	16.63	2.6	1.6
S_1B_1	17.3	18.80	3.1	1.8
S_1B_2	14.8	15.75	2.6	1.6
S_1B_3	15.7	17.68	2.7	1.7
S_2B_0	17.4	19.27	3.2	1.9
S_2B_1	15.0	16.14	2.7	1.7
S_2B_2	16.3	18.27	2.8	1.8
S_2B_3	17.7	19.61	3.4	2.0
SEm±	**0.11**	**0.4**	**0.01**	**0.01**
CD (P=0.05)	**0.33**	**0.14**	**0.05**	**0.03**
Interaction (Sulphur x Boron)	S	S	S	S

Boron Uptake in Grain and Straw (kg ha^{-1}): Data regarding effect of sulphur and boron levels on boron uptake in grain and straw was shown in table 5. Boron uptake in grain and straw ranged from 3.2 to 3.7 (grain) and 0.10 to 0.18 (straw). Lowest boron uptake in grain (3.2) was recorded and straw (0.10) recorded in treatment S_0B_0 and highest boron uptake in grain (3.7) and straw (0.18) was recorded in S_2B_3 at harvest stage. The interactions between boron and sulphur level for boron uptake in the grain and straw recorded significantly higher (3.4) grain and (0.18) straw at each level of treatment combinations over control.

Table 5. Boron uptake in seed and straw of green gram crop as influenced by boron and sulphur levels treatments.

Treatment	Boron uptake (Kg ha^{-1})	
	Grain	**Straw**
S_0B_0	3.2	0.10
S_0B_1	3.3	0.12
S_0B_2	3.3	0.13
S_0B_3	3.3	0.11
S_1B_0	3.3	0.13
S_1B_1	3.4	0.16
S_1B_2	3.3	0.13
S_1B_3	3.3	0.13
S_2B_0	3.4	0.16
S_2B_1	3.4	0.14
S_2B_2	3.5	0.15
S_2B_3	3.7	0.18
SEm±	**0.02**	**0.002**
CD (P=0.05)	**0.05**	**0.01**
Interaction (Sulphur x Boron)	S	S

Protein Content in the Grain and Straw (%): Protein content in grain and straw ranged from 21.3 to 23.2 (grain) and 11.27 to 12.21 (straw). Lowest protein content in grain (21.3) was recorded and straw (11.27) recorded in treatment S_0B_0 and highest protein content in grain (23.2) and straw (12.21) was recorded in S_2B_3 at harvest stage (Table 6). Application of sulphur (S_2) and boron (B_3) increased the protein content in grain and straw significantly. The interactions between boron and sulphur level for protein content in the grain and straw recorded significantly higher (23.2) grain and (12.2) straw at each level of treatment combinations Table 4 over control. Also reported that on mungbean the date pertaining to seed protein percentage as affected by varying levels of nitrogen and phosphorus applications are presented in the maximum grain protein content (25.6%) was obtained from the plot fertilized @ 25-75 kg NP ha^{-1} while the differences among T_1, T_2, T_3, T_4, and T8 treatments were also found to be non-significant [5]. Minimum seed protein content (23.1%) was recorded in control treatment.

Table 6: Effect of boron and Sulphur level on protein content (%) in seed and straw

Treatment	Protein content (%)	
	Grain	**Straw**
S_0B_0	21.3	11.27

S_0B_1	21.4	11.41
S_0B_2	21.3	11.60
S_0B_3	21.3	11.33
S_1B_0	21.7	11.71
S_1B_1	21.9	11.85
S_1B_2	21.4	11.40
S_1B_3	21.8	11.91
S_2B_0	21.7	11.88
S_2B_1	21.8	11.67
S_2B_2	22.4	12.40
S_2B_3	23.2	12.21
SEm±	**0.04**	**0.5**
CD (P=0.05)	**0.1**	**0.14**
Interaction (Sulphur x Boron)	S	S

Conclusion: On the basis of the results, it can be concluded that application of 30 kg sulphur ha^{-1} with 1.5 kg ha^{-1} boron was found most suitable under rainfed condition for mungbean crop. Since the experiment was conducted for one year only and needs further repetition of experiments to confirm the results in same condition. Thus, the farmers of Vindhyan regions are advised to apply 30 kg sulphur ha^{-1} with 1.5 kg ha^{-1} boron for getting higher yield of mungbean crop.

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