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Effect of Graded Dose of Sulfur and Boron on Yield and Nutrient Uptake by Mungbean (*Vigna radiata)*

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ABSTRACT

A pot experiment was conducted during *kharif* 2017 to study the effect of sulfur and boron application on yield and uptake available nutrients N, P, K, S and B by mungbean. The yield of mungbean was increased with the increasing dose of sulfur significantly up to 30 kg/ ha. However increasing doses of boron were not found significant on yield. The maximum yield was found with T_4 -30 kg S ha^{-1} + 0 kg B ha^{-1} (12.171 mg/pot). Uptake of available nutrients N, P, K, S and B increased significantly up to 30 kg S ha^{-1}. Owing to boron application, similar trend in nutrient uptake was observed up to the level of 1 kg B ha^{-1}. Interaction effect between sulfur and boron synergistically improved the yield as well as total nutrient uptake of mungbean.

Keywords Sulfur, Boron, Yield, Nutrient uptake, Mungbean.

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INTRODUCTION

Pulses historically have been one of the most important constituent of the Indian cropping and consumption patterns. In a country where vegetarianism is promoted, pulses form the indispensable constituent of the daily dining plate of the poorest Indian. India is the largest producer and consumer of pulses in the world and grown in an area of 22-23 million hectares with an annual production of 13-18 million tons (MT). Chickpea, pigeon pea, lentil, mungbean, urad bean and field pea are major pulses grown and consumed in India.

Green gram is an excellent source of high quality protein (24-25%). It is also a good source of fat (1.3%), minerals (3.5%), fiber (4.1%), carbohydrates (56%), calcium (124 mg/100 g), phosphorus (326 mg/100 g), iron (7.3 mg/100 g), calorific value (334 kcal/100 g) and moisture content (10%). Mungbean is an annual, semi erect to erect or sometimes twining, deep-rooted herb, 25-100 cm tall. Leaves are alternate and trifoliate, or sometimes with five leaflets. In spite of having the largest area under mungbean in the country and state as well its productivity is not satisfactory which yet to see a major breakthrough low productivity of mungbean is due to abiotic and biotic factors. Amongst them, imbalance use of nutrients is one of the most important factor. Secondly in the past two three decades continuous use of major plant nutrients (N, P and K) through chemical fertilizers under irrigated cropping system has syphoned the secondary and micronutrients from soil. Among the secondary nutrients, sulfur and in the micronutrients, boron has become very important and their deficiency is now being very prevalent in different parts of the country (Takkar 1988, Tandon 1991).

Sulfur is an essential plant nutrient for higher pulse production and have been recognized as fourth major essential plant nutrient because of its widespread deficiency in many crops (Singh 2001). It is prevalent in crop plants in inorganic form and major part of the adsorbed sulfur is reduced in plant tissues and thus becomes a constituent of various organic compounds (protein, vitamins, enzymes). It is an integral part of sulfur containing amino acids visually cystine, cystein and methionine. Besides it involves in various metabolic and enzymatic process including photosynthesis respiration and legume rhizobium symbiotic nitrogen fixation (Rao et al. 2001).

Boron plays an important role in plant nutrition and recognized as major yield limiting factor in pulses (Ali et al. 2004). It helps in chlorophyll synthesis as well as involved in carbohydrates metabolism and response of field crops to boron application is generally greater than any other micronutrients. The most promising role of boron in moving is to activate the germination of pollen accelerates the growth of pollen tube and increases the number of flowers and fruits. Since meager information is available on the interaction between sulfur and boron in relation to response of pulse crops, the present investigation was undertaken to investigate the effect of interaction between sulfur and boron on the yield of and their uptake pattern in mungbean.

MATERIALS AND METHODS

The experiment was carried out during *kharif* season of 2017-18 at the green house of Dept of soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu UniversityVaranasi, Uttar Pradesh, India. The experimental site is located at 25.18, North latitude and 80.36, East latitude and at an altitude of 80.71 m above mean sea level in the Gangetic plain of Eastern Uttar Pradesh. The experimental soil developed on Gangetic alluvial have predominance of illite, quartz and feldspar minerals. The experiment was laid out in a factorial CRD having 12 treatment combinations with four levels of sulfur (0,10, 20 and 30 kg ha^{-1}) and three levels of boron (0,1 and 2 kg ha^{-1}) replicated thrice viz., T_1-(S_0B_0) Control, T_2- (S_1B_0) 10 kg S ha^{-1} + 0 kg B ha^{-1}, T_3- (S_2B_0) 20 kg S ha^{-1} + 0 kg B ha^{-1},T_4- (S_3B_0) 30 kg S ha^{-1} + 0 kg B ha^{-1}, T_5- (S_0B_1) 0 kg S ha^{-1} +1 kg B ha^{-1}, T_6- (S_0B_2) 0 kg S ha^{-1} + 2 kg B ha^{-1}, T_7 - (S_3B_1) 30 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_8- (S_3B_2) 30 kg S ha^{-1} + 2.0 kg B ha^{-1}, T_9-(S_1B_1) 10 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_{10}-(S_1B_2) 10 kg S ha^{-1} + 2 kg B ha^{-1} , T_{11}- (S_2B_1) 20 kg S ha^{-1} + 1 kg B ha^{-1} and T_{12}-(S_2B_2) 20 kg S ha^{-1} + 2 kg B ha^{-1}. Fertilizer application was done at the time of sowing in accordance with treatment details. The nutrient sources used were gypsum and borax for sulfur and boron respectively. Nitrogen, phosphorus and potassium were applied basally through urea, di-ammonium phosphate and muriate of potash, respectively. Mungbean variety HUM-16 was sown as test crop in each polythene lined 10 kg earther pot. Total numbers of pods were collected from plants and their pods were weighed for pod weight pot^{-1}. Seed and straw samples were analyzed for N content by Kjeldahl's method as described by Piper (1966). Phosphorus by colorimetric method as described by Jackson (1967), potassium by flame photometer as described by Jackson (1967), sulfur by turbidimetric method as described by Chesnin and Yien (1950) and boron by Jackson (1967). Nutrient content (%) in seed and straw was multiplied with respective seed and straw yield to obtain uptake by seed and straw,

Table 1. Effect of sulfur and boron levels on no. of pods per plant, no. of seeds per pod and seed yield of mungbean. T_1-(S_0B_0) Control T_2- (S_1B_0)10 kg S ha^{-1} + 0 kg B ha^{-1} , T_3-(S_2B_0) 20 kg S ha^{-1} + 0 kg B ha^{-1}, T_4-(S_3B_0) 30 kg S ha^{-1} + 0 kg B ha^{-1} , T_5- (S_0B_1) 0 kg S ha^{-1} + 1 kg B ha^{-1}, T_6-(S_0B_2) 0 kg S ha^{-1} + 2 kg B ha^{-1} , T_7 -(S_3B_1) 30 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_8-(S_3B_2) 30 kg S ha^{-1} + 2.0 kg B ha^{-1}, T_9- (S_1B_1) 10 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_{10} - (S_1B_2) 10 kg S ha^{-1} + 2 kg B ha^{-1}, T_{11}-(S_2B_1) 20 kg S ha^{-1} + 1 kg B ha^{-1} and T_{12}-(S_2B_2) 20 kg S ha^{-1} + 2kg B ha^{-1}.

Treatments	No. of pods/plant	No. of seeds/pod	Seed yield (g/pot)
Sulfur levels (kg/ha)			
S_0	10.367	6.342	10.865
S_1	9.600	6.256	11.471
S_2	11.778	7.114	11.280
S_3	10.844	6.653	12.171
SEm (±)	0.296	0.091	0.206
CD (p=0.05)	0.868	0.267	0.604
Boron levels (kg/ha)			
B_0	10.925	6.749	11.289
B_1	1080	6.621	11.583
B_2	10.217	6.404	11.428
SEm (±)	0.256	0.219	0.178
CD (p=0.05)	NS	NS	NS

respectively. The data were statistically analyzed by standard method (Panse and Sukhatme1985).

RESULTS AND DISCUSSION

Yield attributes and seed yield

Yield attributes viz., number of pods/plant, no. of seeds/pod and seed yield was influenced significantly by different graded doses of sulfur (Table 1). It may explained due to more absorption of sulfur in appreciable quantity by crop plants at 30 kg S/ha which had a beneficial effect on seed setting and number of pods per plant. Results also confirmed by the findings of Shivran et al. (1996), Ramamoorthy et al. (1997), Duary and Mondal (2006), Islam et al. (2012).

The interaction effect between B and S significantly and synergistically influenced the no. of pods/plant and no. of seeds per pod of mungbean which was observed to be the highest at 2 kg/ha of applied B in conjunction with 40 kg/ha of S.

Nutrient uptake

Uptake of N, P, K, S and B by mungbean is presented which (Tables 2—4) shows that the graded doses of sulfur and boron caused significant variation in nutrient uptake. Total Nutrient uptake viz., N, P, K S, B increased significantly up to the level of 30 kg S ha^{-1}. Application of sulfur results in increased N fixation (Scherer and Lange 1996) which might have promoted production of higher amounts of above ground dry matter that could have led to higher acquisition of nutrients ultimately resulted in higher nutrient content in grain and straw. Boron application up to the level 1.0 kg ha^{-1} was found to increase nutrient uptake by seed and straw and their total nutrient uptake in mungbean over control. Earlier workers reported positive effect of boron on chlorophyll content which may be responsible for the increase in the nutrient content and uptake by plant with the higher growth characters. Yakuba et al. (2010) also reported about the beneficial effect of boron in nitrogen uptake in legumes. S and B fertilization have a pivotal role in enhancing yield attributing characters and nutrient uptake performance in mungbean. Application of 40 kg ha^{-1} of S and 2.0 kg B ha^{-1} proved to increase yield attributes and nutrient uptake by mungbean.

Table 2. Interaction effect of sulfur and boron levels no. of pods per plant, no. of seeds per pod and seed yield of mungbean.

	No. of pods/plant			No. of seeds/pod			Seed yield (g/pot)		
S × B	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
S_0	10.067	9.000	10.513	10.533	10.767	6.100	34.760	34.706	34.713
S_1	10.333	10.500	11.100	11.193	11.403	6.750	34.750	34.530	34.570
S_2	10.677	11.200	11.100	11.776	11.683	6.433	34.760	34.720	34.706
S_3	11.133	12.167	12.160	12.440	12.960	7.733	34.626	34.740	34.750
SEm (±)		0.512			0.158			0.356	
CD (p=0.05)		1.504			0.463			1.046	

Table 3. Effect of sulfur and boron levels on nutrient uptake. T_1- (S_0B_0) Control , T_2-(S_1B_0) 10 kg S ha^{-1} + 0 kg B ha^{-1}, T_3-(S_2B_0) 20 kg S ha^{-1} + 0 kg B ha^{-1}, T_4-(S_3B_0) 30 kg S ha^{-1} + 0 kg B ha^{-1} T_5 - (S_0B_1) 0 kg S ha^{-1} + 1kg B ha^{-1},T_6- (S_0B_2) 0 kg S ha^{-1} + 2 kg B ha^{-1} , T_7- (S_3B_1) 30 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_8-(S_3B_2) 30 kg S ha^{-1} + 2.0 kg B ha^{-1}, T_9 - (S_1B_1) 10 kg S ha^{-1} + 1.0 kg B ha^{-1}, T_{10} - (S_1B_2) 10 kg S ha^{-1} + 2 kg B ha^{-1}, T_{11}- (S_2B_1) 20 kg S ha^{-1} + 1 kg B ha^{-1} and T_{12} (S_2B_2) 20 kg S ha^{-1} + 2 kg B ha^{-1}.

Treatments	Total nitrogen uptake (mg/pot)	Total phosphorus uptake (mg/pot)	Total potassium uptake (mg/pot)	Total sulfur uptake (mg/pot)	Total boron uptake (mg/pot)
Sulfur levels (kg/ha)					
S_0	350	33.844	181.093	24.481	0.321
S_1	363	33.733	181.660	24.876	0.345
S_2	398	37.972	202.542	27.871	0.382
S_3	375	35.537	189.404	25.148	0.347
SEm (±)	0.005	0.547	1.946	0.424	0.011
CD (p=0.05)	0.015	1.607	5.7	1.244	0.004
Boron levels (kg/ha)					
B_0	375	36.199	191.820	26.355	0.349
B_1	378	35.695	191.184	25.710	0.361
B_2	362	33.920	183.024	24.737	0.337
SEm (±)	0.004	0.474	9.895	0.367	0.003
CD (p=0.05)	0.013	1.392	3.370	1.077	0.010

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Table 4. Interaction effect of sulfur and boron levels on nutrient uptake.

S × B	Total nitrogen uptake (mg/pot)			Total phosphorus uptake (mg/pot)			Total potassium uptake (mg/pot)		
	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
S_0	337.976	348.39	350.64	33.29	31.05	32.03	177.053	176.320	173.980
S_1	356.063	359.72	367.03	34.89	34.61	35.07	182.668	183.850	188.480
S_2	356.256	377.91	379.53	33.35	35.86	35.67	183.556	189.030	190.690
S_3	390.064	404.92	428.53	38.11	38.32	40.97	194.683	207.062	216.710
SEm (±)		0.009		0.948			3.370		
CD (p=0.05)		0.026		2.784			9.895		

Table 4. Continued.

S × B	Total sulfur uptake (mg/pot)			Total boron uptake (mg/pot)		
	B_0	B_1	B_2	B_0	B_1	B_2
S_0	23.756	22.858	24.084	0.308	0.334	0.341
S_1	24.757	24.719	25.158	0.327	0.330	0.339
S_2	24.93	25.071	25.215	0.327	0.352	0.350
S_3	27.68	28.741	30.152	0.360	0.388	0.429
SEm (±)	0.734			0.007		
CD (p=0.05)	2.155			0.019		

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