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Effect of Phosphorus, Sulphur and PSB on Growth Attributes and Yield of Mungbean (*Vigna radiata* L. Wilczek)

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ABSTRACT

A field experiment was conducted to find out the effect of phosphorus, sulphur and PSB on growth attributes and yield of *Vigna radiata*. The experiment consisted four levels of phosphorus (0, 20, 40 and 60 kg h^{-1}) and three levels of sulphur (0, 20, and 40 kg h^{-1}) and seed non-inoculated and inoculated with PSB. Increasing level of phosphorus up to 60 kg ha^{-1} and sulphur up to 40 kg ha^{-1} gradually increases the plant height and significantly increases the number of pod $plant^{-1}$, number of grain per pod^{-1}, grain yield h^{-1} and stover yield. Seed inoculated with PSB showed superior plant height, significantly increases the number of pod $plant^{-1}$, number of grain per pod^{-1}, grain yield h^{-1} and stover yield. In similar proportion net return also increased with increase in the level of phosphorus, sulphur and seed inoculation with PSB.

Keywords: Mungbean, Phosphorus, Sulphur, PSB

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is an important pulse crop having high nutritive value (Kumar *et al.*, 2012). It is one of the most important pulse crops of Asian origin and cultivated in many countries of Asia, Africa and Australian (Yang *et al.*, 2008). Mungbean is an important summer pulse crop of India, Pakistan and Thailand. It is a short duration highly productive crop and a rich source of protein. It has ability to fix atmospheric nitrogen through biological nitrogen fixation in the soil. In India, it is grown on 3.0 m ha area with production of 1.15 million tonnes and productivity of 3.83 kg ha^{-1}. Mungbean largely concentrated in Maharashtra, Andhra Pradesh, Rajasthan, Karnataka, Orissa and Uttar Pradesh. Phosphorus is one of the major nutrients essential for growth and development of plant. Being energy bond compound plays a vital role in the metabolism of plant in structural component of metabolically active compounds present in plant. It is needed by the leguminous crops for rapid and healthy root development. It hastens the maturity and increases the rate of nodulation and pod development. Sulphur is recognized as fourth major nutrient after nitrogen, phosphorus and potassium. It is essential for the growth and development of plants, besides it stimulates seed formation. Its deficiency has been reported from several states of India and importance of sulphur application of increasing crop yield and quality is being increasingly recognized. Sulphur is a vital plant nutrient and constituent of which result in serious human malnutrition. Phosphorus is an important nutrient especially for pulses but it cannot be used liberally on account of its high prices. Only about 15.20 per cent of the applied phosphorus is utilized by first crop. The availability of applied phosphorus can be increased by using phosphate solualizing bacteria (PSB). Thus a study was carried out to investigate the effect of phosphorus, sulphur and PSB on plant growth attributes and yield of mungbean.

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MATERIALS AND METHODS

A field experiment was conducted during summer 2008 and 2009 at instructional farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) lies between latitude 24.0^0-26.56 N and 82.12^0-83.98^0 last longitude. The soil texture of the experimental field was pH (1:2.5) 8.10, EC (1:2.5) 0.36, organic carbon 0.39% and available N, P, K and S was 260, 19.60, 276.0 and 12.20 kg h^{-1} respectively. A total 24 combinations of treatments consisting of four level of phosphorus (0, 20, 40 and 60 kg h^{-1}) and three levels of sulphur (0, 20, and 40kg h^{-1}) and with and without PSB seed inoculation was tested. The experiment was designed in factorial randomized block design with three replications. The nutrient was supplied through DAP and elemental sulphur and PSB was inoculated @ 25 g Kg^{-1} of seed and 2 hr. shed dried before sowing. Normal agronomical practices recommended was followed along with plant protection measures. In the present investigation the plants were selected randomly in each plot and tagged. Plant height was measured from the level of ground to the top. Five plants were randomly selected in each plot and numbers of pods were calculated. Similarly, from the same plants five pods from each plant were selected to count number of grains per pod. The grain and stover yield of each plot was calculated separately just after harvesting. The cost of cultivation and net return was also calculated.

RESULTS AND DISCUSSION

Effect of Phosphorus, Sulphur and PSB on plant height

The data presented in Table 1 revealed that plant height increased continuously with increasing level of phosphorus up to 60 kg P_2O_5 h^{-1} at all stages of crop growth. Maximum height was observed in maximum level of phosphorus 60 kg $P_2O_5 h^{-1}$ at harvesting. Application of sulphur increased height of plant non-significantly with increasing level of sulphur up to 40 kg S h^{-1} at all the crop growth stages in both the years.

Plant height also increases continuously in PSB inoculated crop. The effect of phosphorus was also observed in pod formulation. Number of pod plant^{-1} increased significantly with increasing phosphorus level up to 60 kg P_2O_5 kg ha^{-1} in both the yeas.

Table 1: Effect of Phosphorus, Sulphur and PSB on plant height of mung bean at various growth stages

Treatments	30 DAS			60 DAS			At harvest		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
A. Phosphorus levels (P_2O_5 kg ha^{-1})									
P0 0	15.05	13.51	14.28	53.77	48.39	51.08	55.41	53.18	54.29
P1 20	15.51	13.87	14.69	54.49	49.04	51.76	56.01	53.77	54.89
P2 40	15.92	15.34	15.63	54.89	49.40	52.14	57.47	55.17	56.32
P3 60	16.08	15.46	15.77	55.61	50.05	52.83	57.75	55.44	56.59
SEm±	0.37	0.33		1.29	1.16		0.97	0.93	
CD (P=0.05)	NS	NS		NS	NS		NS	NS	
Sulphur levels (kg ha^{-1})									
S0 0	15.38	13.84	14.61	54.47	49.02	51.74	56.28	54.03	55.15
S1 20	15.65	14.09	14.87	54.75	49.28	52.02	56.44	54.18	55.31
S2 40	15.87	14.28	15.07	54.84	49.35	52.09	57.27	54.98	65.12
SEm±	0.32	0.29		1.12	1.00		0.87	0.80	
CD (P=0.05)	NS	NS		NS	NS		NS	NS	
PSB									
PSB$^-$	15.57	14.01	14.79	54.60	49.14	51.78	56.46	54.20	55.33
PSB$^+$	15.70	14.13	14.91	54.77	49.29	52.03	56.87	54.59	55.73
SEm±	0.26	0.24		0.92	0.82		0.69	0.66	
CD (P=0.05)	NS	NS		NS	NS		NS	NS	

Table 2: Effect of phosphorus, sulphur and PSB on yield attributes of Mung bean

Treatments	Pods plant^{-1}			No. of grains pod^{-1}			Grain yield (q ha^{-1})			Stover yield (q ha^{-1})		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Phosphorus level kg h^{-1}												
0	23.28	22.17	22.73	7.87	7.49	7.86	7.51	6.75	7.14	15.12	13.78	14.45
20	25.20	24.00	24.6	8.44	8.04	8.24	10.78	9.65	10.22	21.95	19.79	20.87
40	26.95	25.68	26.32	8.87	8.45	8.66	14.55	13.09	13.82	29.66	26.98	28.32
60	28.13	26.78	27.45	9.25	8.81	9.03	14.76	13.29	14.03	30.99	28.14	29.57
SEm±	0.46	0.43	-	0.15	0.16	-	0.21	0.20	-	0.48	0.43	-
CD (P =0.05)	1.32	1.21	-	0.43	0.45	-	0.60	0.56	-	1.36	1.24	-
Sulphur levels (kg ha^{-1})												
0	23.53	22.41	22.97	8.05	7.67	7.86	11.14	10.03	10.59	22.98	20.91	21.94
20	26.55	25.28	25.92	8.78	8.37	8.58	12.03	10.80	11.42	24.85	22.15	23.50
40	27.60	26.28	26.94	8.99	8.56	8.72	12.53	11.26	11.89	25.46	23.60	24.53
SEm±	0.40	0.37	-	0.15	0.14	-	0.18	0.17	-	0.41	0.38	-
CD (P =0.05)	1.14	1.05	-	0.42	0.39	-	0.52	0.49	-	1.18	1.07	-
PSB (Seed inoculation)												
PSB	24.71	23.53	23.85	8.29	7.90	8.09	11.69	10.48	1108	23.94	21.79	22.86
PSB+	27.07	25.78	26.42	8.95	8.50	4.36	12.12	10.91	11.52	24.92	22.64	23.76
SEm±	0.33	0.30	-	0.11	0.11	-	0.15	0.14	-	0.34	0.31	-
CD (P =0.05)	0.93	1.05	-	0.31	0.32	-	0.42	0.40	-	0.96	0.88	-

Effect of Phosphorus, Sulphur and PSB on growth and yield

It is found that number of pod plant^{-1}, significantly increases with increase sulphur level up to 40 kg S h^{-1}. Number of pod per plant was also increases significantly with the inoculation of PSB to the crop. Observation of number of grain per pod reveled that (Table2) increasing level of phosphorus significantly increases the number of grain pod^{-1} up to 60 kg P_2O_5 ha^{-1}. The highest number of grains was found in maximum phosphorus level 60 kg P_2O_5 ha^{-1}. Number of grain plant^{-1} also increases with increasing level of sulphur up to 40 kg S h^{-1}. Similarly, number of grain was significantly increased with inoculation of PSB (Table 2).

Effect on grain yield was observed and it is found that grain yield significantly increased with increasing level of phosphorus up to 60 kg P_2O_5ha^{-1}in both the years. The maximum (14.03 Q/h) grain yield obtained in level 60 kg P_2O_5ha^{-1}. Grain yield was also affected by sulphur supply and it is found that increasing level of sulphur up to 40 kg S ha^{-1} significantly increases the grain yield in both the years and maximum grain yield 8.72 Q/h (mean) was obtained in 40 kg S ha^{-1}. Similarly, grain yield was significantly increased with PSB inoculation (Table 2).

Stover yield was significantly increased with increasing level of phosphorus up to 60 kg P_2O_5 ha^{-1} in both the years. The maximum stover yield 29.57Q h^{-1} (mean of both the years) obtained in level 60 kg P_2O_5ha^{-1}. Stover yield was also affected by sulphur supply and it is found that increasing level of sulphur up to 40 kg S ha^{-1}, significantly increases the grain yield in both the years. Similarly, stover yield significantly increased with PSB inoculation (Table 2).

The growth and yield attributes were increased significantly with addition of 60 kg P ha^{-1}, due to fulfill of required need of the crop, similarly Singh *et al.*(2008) reported that up to 50 kg P ha^{-1} supply significantly increases the growth and yield attributes.

These findings were supported by Nath *et al.* (2004). The findings of Kumar *et al,* (2012) showed that increasing level of phosphorus up to 45 kg P_2O_5 ha^{-1} supply, significantly increases the plant height, number of pod plant^{-1}, number of seed pod^{-1}, stover and grain yield (Table 2).

Due to sulphur deficiency of Indian soil (Srinivasarao *et al.,* 2004) the response of sulphur application was found very positive. Lover level of sulphur in the soil reduces the plant growth (Pacyna *et al.,* 2006) so that, additional supply of phosphorus significantly increase the crop growth and grain attributes. Similarly, the findings of Mishra and Tewari (2001) and Pathak *et al.* (2003) showed increase in yield attributes due to increasing level of phosphorus and sulphur. Application of sulphur 40 kg h^{-1} significantly increases plant height, grain yield, stover yield, number of pod plant^{-1}, number of grain plant^{-1}. Singh *et al.* (2008); Nath *et al.* (2004) also reported the similar results. The findings of Krishna (1995); Singh and Yadav (1997) and Kaisher *et al.* (2010) also supports the effect of sulphur significantly increases the number of pod plant^{-1} and ultimately crop grain yield. Tripathi *et al.* (2012).

Kumar *et al.* (2012) also reported increasing level of sulphur up to 30 kg h^{-1} increases the plant height, number of pod plant^{-1}, number of grains pod^{-1}, grain and straw yield h^{-1}. Singh *et a.,* (2008) reported supply of 40 kg S ha-^{1} significantly increases the plant height, number of pod plant^{-1}, number of grains pod^{-1}, grain and stover yield (Table 2).

Seed inoculation with PSB significantly increases the plant height, number of pod plant^{-1}, number of grain plant^{-1}, grain yield, stover yield and net return. Inoculation of PSB plays a vital role in uptake of various inorganic and organic phosphorus present in the soil. Similar findings were also reported by Tomar *et al.* (1996). (Tripathi *et al.,* 2012) reported growth characters of mung bean were showed significant higher due to rhizobial inculcation. Singh *et al.* (2008) also reported inoculation of seed with PSB significantly also increases the plant height, number of pod plant^{-1}, number of grains pod^{-1}, grain and stover yield (Nath *et al.,* 2004) found the similar result in faba bean. Gaur (1990) reported that production of organic acid by microorganisms appears to be major factor involved through other factors as protein extrusion mechanism production of humic acid substance H_2SO_4 H_2S, CO_2 and zymes are also play a vital role in the solubilization of inorganic phosphates.

Effect of Phosphorus, Sulphur and PSB on economics

Cost of cultivation was increased with increasing level of phosphorus due to increasing the cost of phosphorus. Maximum cost of cultivation was calculated Rs. 27302 ha^{-1} at level 60 kg P_2O_5 ha^{-1}. The cost of cultivation was found gradually increasing with increasing level of sulphur up to 40 kg S ha^{-1} due to increasing the cost of sulphur and Maximum cost of cultivation was increased Rs. 28884 ha^{-1} at level 40 kg S ha^{-1}. Similarly, cost of cultivation was slightly increases with PSB inoculation (Table 3).

Table 3: Effect of phosphorus, sulphur Mungbean production

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)
Phosphorus level kg h^{-1}			
0	26066	29122	3015
20	26478	41923	15445
40	26896	46696	29806
60	27302	57598	30296
Sulphur levels (kg ha^{-1})			
0	24484	43457	18973
20	26684	46855	20171
40	28884	48786	19902
PSB (Seed inoculation)			
PSB	26684	45463	18779
PSB+	26706	472687	20562

CONCLUSION

It is concluded that application of phosphorus up to 60 kg ha^{-1} and sulphur up to 40 kg ha^{-1}, not only improves growth and yield attributes but seed yield also. Similar and synergistic effects were also found with the seed inoculated with PSB.

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