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EFFECT OF PHOSPHORUS AND SULPHUR ON YIELD ATTRIBUTES, YIELD AND NUTRIENT UPTAKE OF MUNGBEAN (*VIGNA RADIATA* L.) IN CENTRAL PLAIN ZONE OF PUNJAB, INDIA

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Abstract

A field experiment was conducted during summer season of 2015 at the Crop Research Centre of Department of Agriculture, Mata Gujri College, Sri Fatehgarh Sahib to study the response of phosphorus and sulphur on yield, yield attributes, Number of pods per plant, Number of grains per pod, Pod length (cm),100 grain weight (g),Grain yield q ha^{-1},Stover yield q ha^{-1},Biological yield q ha^{-1} and Harvest index (%) nutrient uptake, net returns and B:C ratio of summer mungbean. The results showed that application of 60 kg P_2O_5 ha^{-1} recorded the highest value of growth attributes *viz.* plant height and dry matter production, Number of pods per plant, Number of grains per pod, Pod length (cm), grain yield and nutrient uptake. Application of 60 kg P_2O_5 ha^{-1} and was superior over 40 kg P_2O_5 ha^{-1} and control were found to be significantly superior over phosphorus alone. Increasing levels of phosphorus up to 40 kg S ha^{-1} was found to be significantly superior over control. The application of 60 kg P_2O_5 ha^{-1} and was superior over 40kg P_2O_5 ha^{-1} significantly produced higher growth attributes, grain yield and nutrient uptake and economics which were significantly superior over. The maximum cost of cultivation (₹ 28930), net return (₹ 38210) and B: C (2.32) ratio was computed under $P_{60}S_{40}$ followed by all other treatment combinations.

Key words : Mungbean, phosphorus, sulphur, nutrient uptake and yield.

Introduction

The mungbean (*Vigna radiata* L.) is under cultivation since prehistoric time in India. It is also known as green gram and serve are a major source of dietary protein for the vast majority of people. In India these crops are cultivated in three different seasons, *viz*., *Kharif*, *Rabi* and summer. It is an important pulse crop in South and East Asia Keatinge *et al*. (2011). Pulses are one of the important segments of Indian agriculture after cereals in production. It is considered to be the hardiest of all pulse crops. It requires a hot climate and can tolerate drought also. The *kharif* season is the most prevalent and traditional mungbean growing period in India Singh and Sekhon (2005). Pulses, the leguminous crop possesses root nodules, which enhance soil fertility by fixing atmospheric nitrogen through symbiotic association with *Rhizobium*. At global level pulses are the third most important group of crops after cereals and oil grains. India ranks first in the world in area as well as production of mungbean. Mungbean is the third important pulse crop of India in terms of area cultivated and production, next to chickpea and pigeon pea. India is producing 18.43 mt of pulses from an area of 23.47 mha (Anonymous, 2015), which is one of largest pulses producing country in the world. In Punjab, during *kharif* season area and production of mungbean in 2014-15 was 3.7 thousand hectares and 3.1 thousand tonnes, respectively and average yield was 838 kg/ha (Anonymous, 2016). Phosphorus is known to have direct relation with root proliferation, straw strength, grain formation, crop maturation and crop quality. With the introduction of high yielding, nutrient responsive varieties, the present fertilizer recommendation for mungbean *i.e.* 12.5 kg N and 40 kg P_2O_5/ha. Among the macro nutrients, phosphorus application contributes immensively for increasing the yield of legumes. Phosphorus application not only increases the dry matter and grain yield of moong but also enhances the nitrogen and phosphorus content of the seed (bio-fortification).

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The significant effect of phosphorus in lentil on nodule development, plant height, branches/plant, pods/plant, grain yield and harvest index (HI) was well recognized (Togey *et al*., 2008). Like phosphorus, sulphur is also important for crop development. These amino acids are the building blocks of protein. Sulphur is also involved in the formation of chlorophyll, activation of enzymes etc (Mengel and Krikby, 1987). This is why adequate sulphur is so crucial for pulse crops. Sulphur is also a constituent of vitamins biotine and thiamine (B1) and also of iron sulphur proteins called ferrodoxins. Sulphur is associated with production of crops of superior nutritional and market quality. Sulphur deficiencies have been reported from over 70 countries worldwide including India. Deficiency of sulphur in Indian soils is on increase due to intensification of agriculture with high yielding varieties and multiple cropping coupled with the use of high analysis sulphur free fertilizers along with the restricted or no use of organic manures have accrued in depletion of the soil sulphur reserve. In West Bengal, 28 per cent of geographical area occupied by red and lateritic soils, which are mainly, sulphur deficient. In fact, the re lateritic soils of eastern India are often deficient in sulphur (Panda *et al*., 1991).

Materials and Methods

The field experiment entitled "Effect of phosphorus and sulphur on growth and yield of mungbean (*Vigna radiata* L.)" was carried out at Students' Research Farm of the Department of Agriculture, Mata Gujri College, Sri Fatehgarh Sahib during *Kharif* season of 2015. It is situated in South from Chandigarh at distance of 42.0 km and it is in North from Patiala city at distance 35.0 km. Its attitude is 246 meter above mean sea level at 30^o 27' and 30^o 46' north latitude and 76^o 04' and 76^o 38' east longitude. The climate of experimental area is designated as sub-tropical and semi-arid climate, which is further described as winter coldness and hot-dry summers. Summer season extend from ApriltoJune where as winter season encountered from December to January, and in between these two seasons hot and humid monsoon period July to September. The weather showed a wide range of fluctuation during both season. The temperature starts decreasing sharply after November and continues till January, temperature recorded lowest during this period may be 1 or 2^0C accompanied by frost or foggy conditions. While contrary to this in summer the temperature starts rising at the end of February and continue to June that may go as high as up to 45^0C. The average annual rainfall lies between 500-750 mm. Most of the season's rainfall receives from southwest monsoon, which becomes active during July to September. The meteorological data recorded at the meteorological observatory of the Krishi Vigyan Kendra (KVK), Fatehgarh Sahib during the crop growing season (August to November, 2015).

Results and Discussion

The plant height increased at a faster rate between 30,60 DAS as affected significantly by different nutrient treatments. Number of plants in meter row length, Dry matter accumulation (g/plant) was significantly affected at 30, 60 DAS and at harvest in different treatments (table 2). The with application of phosphorus 60 kg P_2O_5 ha^{-1} which was significantly more than control and was statistically at par with 40 kg P_2O_5 ha^{-1} at harvest. Better height of the crop with phosphorus application may be due to impact of phosphorus on root proliferation, hastens cell division and multiplication and ultimately the growth and development of the plants. It is also help in nutrient movement within plant. It is favorable for plant height of crop. Favorable effects of phosphorus on plant height have also been reported by Tariq *et al*. (2001).

Yield attributes

Significantly higher number of pods/plant, number of grains/pod, pod length and 100-grain weight (table 3) recorded with the application of phosphorus 60 kg P_2O_5 ha^{-1}, which was significantly more than control and was statistically at par with 40 kg P_2O_5 ha^{-1} at harvest. The phosphorus application may mobilize the photosynthesis from growing organs to grains, consequently increasing their number and size. The similar results have been well documented by other researchers (Rasheed *et al*., 2010). The increase in these yield attributing characters might be due to the important role in sulphur in energy transformation, activation of number of enzymes and also in carbohydrate metabolism. An inadequate supply of P can reduce seed size, seed number, and viability. This attribute is also observed by Malik *et al*. (2003).

Yield (q ha^{-1})

Data pertaining to grain yield stover yield q ha^{-1} harvest indexare presented in (table 1). A significant variation in grain yield was recorded due to difference in treatment. The application of 40 kg Sha^{-1} gave significantly more grain yield than control and was statistically at par with 20 kg Sha^{-1}. However, the grain yield was significantly higher with the use of 20 kg S/ha than control. The application of 40 kg Sha^{-1} reported maximum stover yield, which was statistically at par with 20 kg S ha^{-1}, but significantly differed from control. However, Stover yield was also significantly differed with the application of 20 kg S ha^{-1} than control. However, the interaction was non-significant. The increase in yield

Table 1 : Influence of phosphorus and sulphur levels on pods per plant, number of grains per pod grain, Stover yield, biological yield and harvest index of mungbean.

Treatment	No. of pods per plant	No. of grains per pod	Pod length (cm)	100 grain weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
Phosphorus levels (kg/ha)								
P_0	19.82	9.63	6.8	2.74	9.84	22.52	32.36	30.37
P_{40}	21.49	10.56	7.2	2.89	11.18	24.03	35.21	31.74
P_{60}	22.35	11.22	7.5	2.93	12.44	25.08	37.52	33.12
LSD (p= 0.05)	2.01	1.18	NS	NS	1.10	1.77	2.40	1.13
Sulphur levels (kg/ha)								
S_0	19.71	9.59	7.0	2.70	9.55	21.13	30.68	31.12
S_{20}	21.28	10.62	7.2	2.91	11.87	24.99	36.86	32.16
S_{40}	22.68	11.20	7.3	2.92	12.03	25.51	37.54	31.96
LSD (p= 0.05)	2.01	1.18	NS	NS	1.10	1.77	2.40	NS

Table 2 : Influence of phosphorus and sulphur levels on number of plants in meter row length, plant height and dry matter of mungbean.

Treatment	Number of plants in meter row length			Plant height (cm)			Dry matter accumulation (g/plant)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Phosphorus levels (kg/ha)									
P_0	10.22	10.33	10.11	17.87	33.77	53.97	2.73	7.68	11.90
P_{40}	10.89	10.78	10.89	21.31	36.30	57.33	3.08	8.61	12.42
P_{60}	10.67	10.44	10.56	21.71	38.28	60.47	3.06	8.80	13.17
LSD (p= 0.05)	NS	NS	NS	1.04	2.49	2.49	0.27	0.64	0.88
Sulphur levels (kg/ha)									
S_0	10.00	10.00	10.00	17.83	33.93	52.27	2.53	7.88	11.60
S_{20}	10.56	10.67	10.78	21.13	36.53	58.13	3.12	8.59	12.74
S_{40}	11.22	10.89	10.78	21.92	37.88	61.37	3.23	8.62	13.16
LSD (p= 0.05)	NS	NS	NS	1.04	2.49	2.49	0.27	0.64	0.88

Interaction effect : P × S = NS

Table 3 : Influence of phosphorus and sulphur levels on total nitrogen, phosphorus and potassium uptake by crop and grain of mungbean.

Treatment	Total nutrient uptake by straw (kg/ha)			Nutrient uptake by grain (kg/ha)		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
Phosphorus levels(kg/ha)						
P_0	30.03	3.53	15.57	26.49	7.98	16.40
P_{40}	32.11	3.74	17.90	31.24	9.22	18.79
P_{60}	34.17	4.13	19.37	34.46	10.71	21.06
LSD (p= 0.05)	2.52	0.28	1.51	3.05	1.06	1.29
Sulphur levels (kg/ha)						
S_0	28.32	3.39	15.15	26.04	7.92	15.99
S_{20}	33.69	3.91	18.49	32.53	9.87	20.02
S_{40}	34.31	4.20	19.19	33.62	10.11	20.24
LSD (p= 0.05)	2.52	0.28	1.51	3.05	1.06	1.29

Interaction effect : P × S = NS

Table 4 : Cost of cultivation, gross return, net return and benefit : cost ratio treatment wise.

Treatment	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
$T_1 – P_0S_0$	27010	42793	15783	1.58
$T_2 – P_0S_{20}$	27344	49519	22175	1.81
$T_3 – P_0K_{40}$	27578	50828	23250	1.84
$T_4 – P_{40}S_0$	27978	46835	18857	1.67
$T_5 – P_{40}S_{20}$	28212	58637	30425	2.08
$T_6 – P_{40}S_{40}$	28496	57133	28637	2.00
$T_7 – P_{60}S_0$	28412	49341	20929	1.74
$T_8 – P_{60}S_{20}$	28696	64505	35809	2.25
$T_9 – P_{60}S_{40}$	28930	67140	38210	2.32
Treatment	**Cost of cultivation (₹/ha)**	**Gross return (₹/ha)**	**Net return (₹/ha)**	**B:C ratio**
Phosphorus levels (kg/ha)				
P_0	27311	47724	20413	1.75
P_{40}	28229	54223	25994	1.92
P_{60}	28679	60334	31655	2.10
Sulphur levels (kg/ha)				
S_0	27800	46318	18518	1.67
S_{20}	28084	57570	29486	2.05
S_{40}	28335	60334	31999	2.13

attributing characters might be due supply of sulphur in adequate and appropriate amount helps in flower primordial initiation for its reproductive part, which govern number of pods per plant, length of pod, number of seeds per pod (Dey and Basu, 2004; Singh and Yadav, 2007. Niraj and Parkash (2015) revealed that the percent increase in grain yield due to sulphur was 60.06%, whereas the straw yield was increased 32.82%.

Nutrient uptake straw and grain

Nutrient uptake grain and straw under different treatments is given in table 4. The application of 60 kg P_2O_5 ha^{-1} than other treatments. However, the use of 40 kg S/ha recorded highest nitrogen uptake by straw and grain significantly better than control, but was statistically at par with 20 kg S ha^{-1}. The interaction effect of phosphorus and sulphur on nitrogen, phosphorus and potassium uptake by grain and straw was non-significant. Like phosphorus, sulphur is also important for crop development. Now a day, sulphur is considered as 4th major essential plant nutrient after nitrogen, phosphorus and potassium. Sulphur is essential for protein synthesis. The quality of grain increases with increase in protein and oil percentage. Sulphur also promotes nodulation in legumes by fixing atmospheric nitrogen. It plays vital role in chlorophyll formation. It acts as biological agent in the chain of fatty acids (Patil*et al*., 2011). Kumar *et al.* (2012) revealed that the maximum grain and straw nitrogen uptake phosphorusuptake,sulphuruptake and quality parameters like protein and methionine in comparison to sulphur @ 15 kg/ha reported.

Economics

The economics different treatments are given in table 4. The highest cost of cultivation 37374 and 38675 Rs ha^{-1} was found in $\mathbf{T_{11}}$ where 75% NPK with vermicompost @ 2.5 t ha^{-1}+PSB + *Azotobacter* was applied, which was minimum cost of cultivation than the rest of the treatments Rs. 24558 and Rs. 24558 Rs. ha^{-1}during 2013-14 and 2014-15, respectively was found recorded control.

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