



## **Effect of Phosphorus and Sulphur Application on Growth and Yield Attributes of Mungbean (*Vigna radiata* L)**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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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 Response of phosphorus and sulphur application on Growth and yield attributes of mungbean (*Vigna radiata* L). The number of plants in meter row length was recorded highest with the application of 40 kg /ha followed by 20 kg S/ha and control. The highest plant height was recorded with the application of 40 kg S/ha which was statistically at par with application of 20 kg S/ha it was significantly superior over the control during all observation stages of crop. However at 30 and 60 DAS, the number of branches per plant recorded maximum with the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha followed by 60 kg P<sub>2</sub>O<sub>5</sub>/ha and control. At harvest, the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha recorded highest number of branches per plant but was statistically at par with other levels of phosphorus. The maximum number of grains per pod was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>/ha. It was found that the pod length was maximum with the application of 40

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kg S/ha followed by 20 kg S/ha and control. The maximum grain yield was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was significantly superior to other treatments.

**Keywords:** Summer mungbean; Sulphur; phosphorus; growth; yield attributes and yield.

## 1. 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 [1] 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 [2] 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 [3] which is one of largest pulses producing country in the world. In Punjab, during *kharif* season area and production of mungbean in 2014-15 [4] was 3.7 thousand hectares and 3.1 thousand tonnes, respectively and average yield was 838 kg/ha [5].

Mungbean and urdbean are the second largest protein producing pulse crop of the world where as Soybean and groundnut rank first position. Since they contain 23-25% protein in their grain, they could provide an answer to the problem of protein deficiency as well as protein malnutrition. The nutritive value of mungbean lies in its high and easily digestible protein, and contains approximately 25-28% protein, 1.0% oil, 3.5-4.5% fiber, 4.5-5.5% ash and 62-65% carbohydrates on dry weight basis. Pulses, "A poor Man's Meat", have more importance in a country like India due to its large vegetarian population. Most of the protein needs of the vegetarian population of our country are met through pulses. The nutritive value of

mungbean *dal* (per 100 g) is as follows: energy 348 kcal., protein 24.5 g, fat 1.2 g, carbohydrates 59.9 g, calcium 75 mg, iron 3.9 mg, thiamine 0.47 mg, riboflavin 0.21 mg and mungbean whole grain contains energy 334 kcal., protein 24.0 g, fat 1.3 g, carbohydrates 56.7 g, calcium 124 g, iron 4.4 mg, thiamine 0.47 mg, riboflavin 0.27 mg [6]. It is consumed in different ways as *dal*, *halwa*, snacks etc. Ascorbic acid (vitamin C) is synthesized in sprouted grains of mungbean and the amount of riboflavin and thiamine is also increased, which is important from human diet point of view.

## 2. MATERIALS AND METHODS

The field experiment entitled was carried out at 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 altitude is 246 meter above mean sea level at 30° 27' and 30° 46' north latitude and 76° 04' and 76° 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 April to June 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 °C 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 °C. 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. Design Randomized block design (Factorial) Phosphorus levels three, Sulphur levels three.

### 3. RESULTS AND DISCUSSION

#### 3.1 Number of Plants in Meter row Length

Germination of any crop is an important factor which influences the plant stand and ultimately growth and yield. The data presented in (Table 1) revealed that the application of phosphorus did not affect significantly on the number of plants in meter row length. However, the maximum number of plants in meter row observed with the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha followed by other treatments. In case of sulphur, the application of sulphur has no significant effect on the number of plants in meter row length at different stages of crop growth. The number of plants in meter row length was recorded highest with the application of 40 kg S/ha followed by 20 kg S/ha and control. Similar trend was obtained at later growth stages. However, the interaction was non-significant [7]. reported that the application of 40 kg S/ha recorded maximum plant height (47.31 cm), number of leaves per plant (49.80), number of nodules per plant (25.58), haulm yield (28.80 q/ha), grain yield (7.92 q/ha) and phosphorus, sulphur and protein content (0.295 , 0.281 and 21.79%, respectively).

#### 3.2 Plant Height

Plant height is a useful growth index which influences the dry matter production and yield. Although, plant height is controlled genetically but it may be modified by different agronomic practices. The data depicted in (Table 2) revealed that plant height continued to increase with advancement in crop age. Plant height was significantly influenced due to application phosphorus. The plant height was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was statistically at par with the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha and was significantly superior over control at 30 and 60 DAS. At harvest stage, the highest plant height was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was significantly superior to other treatments. Similarly, application of sulphur also increased the plant height. The periodic data recorded at 30, 60 and at harvest. Data presented in (Table 2) revealed that plant height increased up to harvest time. The highest plant height was recorded with the application of 40 kg S/ha which was statistically at par with application of 20 kg S/ha it was significantly superior over the control during all observation stages of crop. The interaction effect of phosphorous and sulphur on

plant height at all growth stages was non-significant. Favorable effects of phosphorus on plant height have also been reported by [8,9].

#### 3.3 Number of Branches Per Plant

Number of branches per plant is an immediate index of growth and development of crop. Branching is an important growth character, which may affect the total number of pods and ultimately the grain yield. The number of branches per plant increased progressively with the advancement in the stage of crop growth. The data regarding the influence of different treatments on branches per plant given in (Table 3) revealed that the number of branches per plant increased up to maturity. The number of branches per plant recorded at 30, 60 DAS and at harvest were not influenced significantly with application of phosphorus and sulphur. However at 30 and 60 DAS, the number of branches per plant recorded maximum with the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha followed by 60 kg P<sub>2</sub>O<sub>5</sub>/ha and control. At harvest, the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha recorded highest number of branches per plant but was statistically at par with other levels of phosphorus. As perusal data presented in (Table 3) indicated that the number of branches per plant was not influenced by sulphur levels. It was found that the number of branches per plant at 30 DAS was maximum with the application of 40 kg S/ha which was statistically at par with lower levels of sulphur. Similar trend was obtained at 60 DAS and harvest. However, the interaction was non-significant.

#### 3.4 Number of Pods Per Plant

The productivity potential of mungbean is determined by number of pods per plant, an important yield attribute and has a key role to influence the grain yield. Application of phosphorus produced significantly higher number of pods per plant than the unfertilized control. Application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha produced maximum number of pods per plant which was significantly more than control, but was statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>/ha. A perusal of data presented in (Table 4) revealed that the number of pods per plant significantly influenced by sulphur levels. It was found that the application of 40 kg S/ha exhibited highest number of pods per plant which was significantly more than control, but was statistically at par with 20 kg S/ha.

**Table 1. Influence of phosphorus and sulphur levels on number of plants in meter row length of mungbean**

Treatment	Number of plants in meter row length		
	30 DAS	60 DAS	At harvest
<b>Phosphorus levels (kg/ha)</b>			
P <sub>0</sub>	10.22	10.33	10.11
P <sub>40</sub>	10.89	10.78	10.89
P <sub>60</sub>	10.67	10.44	10.56
LSD (p= 0.05)	NS	NS	NS
<b>Sulphur levels (kg/ha)</b>			
S <sub>0</sub>	10.00	10.00	10.00
S <sub>20</sub>	10.56	10.67	10.78
S <sub>40</sub>	11.22	10.89	10.78
LSD (p= 0.05)	NS	NS	NS
<b>Interaction effect</b>		<b>P x S = NS</b>	

**Table 2. Influence of phosphorus and sulphur levels on the periodic plant height of mungbean**

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At harvest
<b>Phosphorus levels (kg/ha)</b>			
P <sub>0</sub>	17.87	33.77	53.97
P <sub>40</sub>	21.31	36.30	57.33
P <sub>60</sub>	21.71	38.28	60.47
LSD (p= 0.05)	1.04	2.49	2.49
<b>Sulphur levels (kg/ha)</b>			
S <sub>0</sub>	17.83	33.93	52.27
S <sub>20</sub>	21.13	36.53	58.13
S <sub>40</sub>	21.92	37.88	61.37
LSD (p= 0.05)	1.04	2.49	2.49
<b>Interaction effect</b>		<b>P x S = NS</b>	

**Table 3. Influence of phosphorus and sulphur levels on number of branches per plant of mungbean**

Treatment	Number of branches per plant		
	30 DAS	60 DAS	At harvest
<b>Phosphorus levels (kg/ha)</b>			
P <sub>0</sub>	2.29	3.40	5.49
P <sub>40</sub>	2.46	3.51	5.48
P <sub>60</sub>	2.43	3.49	5.78
LSD (p= 0.05)	NS	NS	NS
<b>Sulphur levels (kg/ha)</b>			
S <sub>0</sub>	2.31	3.33	5.40
S <sub>20</sub>	2.39	3.47	5.54
S <sub>40</sub>	2.48	3.60	5.80
LSD (p= 0.05)	NS	NS	NS
<b>Interaction effect</b>		<b>P x S = NS</b>	

### 3.5 Number of Grains Per Pod

A perusal of data presented in (Table 4) exhibited that the application of 40 and 60 kg phosphorus per ha produced significantly higher number of grains per pod than unfertilized

control. The maximum number of grains per pod was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>/ha. The data revealed that the application of 40 kg S/ha recorded significantly higher number of grains per pod than control, but was

statistically at par with 20 kg S/ha. However, the interaction was non-significant.

### 3.6 Pod Length

The data of pod length presented in (Table 4) revealed that the pod length was significant more with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha than control and was statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>/ha. As perusal data presented in table 4.5 indicated that the pod length was not influenced by sulphur levels. It was found that the pod length was maximum with the application of 40 kg S/ha followed by 20 kg S/ha and control. However, the interaction was non-significant.

### 3.7 Grain Yield

Grain yield is the most important character regarding the economic value of crop, is influenced by different applied treatments as well as by agronomic practices and environment. The data presented in (Table 5) reported that the

phosphorus application gave significantly higher grain yield than unfertilized control. The maximum grain yield was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was significantly superior to other treatments.

The data presented in (Table 5) reported that the application of 40 kg S/ha gave significantly more grain yield than control and was statistically at par with 20 kg S/ha. However, the grain yield was significantly higher with the use of 20 kg S/ha than control. The plant height was not affected significantly with phosphorus application. Yield attributes like number of pods plant<sup>-1</sup> and seeds pod<sup>-1</sup> showed significant effect up to 40 kg P<sub>2</sub>O<sub>5</sub>/ha. Maximum seed (14.03 q/ha) and stover yield (29.57 q/ha) was obtained with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was 37.28, 41.69 and 96.77, 104.64 per cent more than 20 kg P<sub>2</sub>O<sub>5</sub>/ha and control, respectively [10,3]. These findings corroborate the results of [2,11] in green gram.

**Table 4. Influence of phosphorus and sulphur levels on number of pods per plant and number of grains per pod of mungbean**

Treatment	No. of pods per plant	No. of grains per pod	Pod length (cm)	100 grain weight (g)
<b>Phosphorus levels (kg/ha)</b>				
P <sub>0</sub>	19.82	9.63	6.8	2.74
P <sub>40</sub>	21.49	10.56	7.2	2.89
P <sub>60</sub>	22.35	11.22	7.5	2.93
LSD (p= 0.05)	2.01	1.18	0.3	NS
<b>Sulphur levels (kg/ha)</b>				
S <sub>0</sub>	19.71	9.59	7.0	2.70
S <sub>20</sub>	21.28	10.62	7.2	2.91
S <sub>40</sub>	22.68	11.20	7.3	2.92
LSD (p= 0.05)	2.01	1.18	NS	NS
<b>Interaction effect</b>	<b>P x S = NS</b>			

**Table 5. Influence of phosphorus and sulphur levels on grain, stover and biological yield and harvest index of mungbean**

Treatment	Grain yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
<b>Phosphorus levels (kg/ha)</b>				
P <sub>0</sub>	9.84	22.52	32.36	30.37
P <sub>40</sub>	11.18	24.03	35.21	31.74
P <sub>60</sub>	12.44	25.08	37.52	33.12
LSD (p= 0.05)	1.10	1.77	2.40	1.13
<b>Sulphur levels (kg/ha)</b>				
S <sub>0</sub>	9.55	21.13	30.68	31.12
S <sub>20</sub>	11.87	24.99	36.86	32.16
S <sub>40</sub>	12.03	25.51	37.54	31.96
LSD (p= 0.05)	1.10	1.77	2.40	NS
<b>Interaction effect</b>	<b>P x S = NS</b>			

### 3.8 Stover Yield

Stover yield is an important parameter of biological yield to evaluate its productivity index for judging the ultimate performance of a crop. Data presented in (Table 5) revealed that levels of phosphorus and sulphur exhibited significant effect on stover yield. The stover yield was recorded maximum with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha, which was significantly more than control but was statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>/ha. However, the stover yield was statistically at par with the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha and control. The application of 40 kg S/ha reported maximum stover yield, which was statistically at par with 20 kg S/ha but significantly differed from control. However, stover yield was also significantly differed with the application of 20 kg S/ha than control. However, the interaction was non-significant. [10,3] these findings corroborate the results of [5] in green gram.

### 3.9 Biological Yield

A perusal of data presented in (Table 5) exhibited that the application of different levels of phosphorus and sulphur has significant influenced on the biological yield of mungbean. It was found that the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha gave significantly higher biological yield than control and was statistically at par with use of 40 kg P<sub>2</sub>O<sub>5</sub>/ha. The biological yield varied significantly with the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha than control. The use of 40 kg S/ha reported highest biological yield, which was significantly more than control, but was at par with 20 kg S/ha. However, the interaction was non-significant.

### 3.10 Harvest Index

Harvest index is the physiological ability of a crop to convert the dry matter into economic yield. The data presented in (Table 5) revealed that the maximum harvest index was found with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was significantly more than other treatments. However, the sulphur did not influence the harvest index of mungbean. The highest harvest index was recorded with 40 kg S/ha followed by 20 kg S/ha and control. However, the interaction was non-significant.

## 4. CONCLUSION

The highest plant height was recorded with the application of 40 kg S/ha which was statistically

at par with application of 20 kg S/ha it was significantly superior over the control during all observation stages of crop. The maximum number of grains per pod was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>/ha. It was found that the pod length was maximum with the application of 40 kg S/ha followed by 20 kg S/ha and control. The maximum grain yield was recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub>/ha which was significantly superior to other treatments.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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