

Effect of phosphorus and sulphur on growth and yield of summer mungbean [*Vigna radiata* (L.) Wilczek]

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ABSTRACT

A field experiment was carried out during summer 2010 and 2011 on a sandy clay loam soil to investigate the effect of varying levels of P and K on summer mungbean [*Vigna radiata* (L.) Wilczek]. The study revealed that application of 60 kg P₂O₅/ha resulted in significantly higher LAI (2.47) and chlorophyll content (3.01 mg/g) in leaf at flower initiation and taller plants (36.6 cm), greater dry matter accumulation (8.84 g/plant), seeds/plant (130) and test weight (34.7 g) at harvest over any of the lower P levels (0, 20, 40 kg P₂O₅/ha). Seed and straw yields were also significantly improved with 60 kg P₂O₅/ha to the tune of 14.4 and 14.1% over control, respectively. Sulphur at 45 kg/ha produced significantly higher LAI (2.32) and chlorophyll content (2.94 mg/g) at flower initiation and more dry matter accumulation (8.54 g/plant), seeds/plant (128.5) and test weight (34.7 g) at harvest over any of the lower levels of sulphur (0, 15 and 30 kg/ha). Seed and straw yields were also significantly improved with 45 kg S/ha by 14.4 and 13.1% over the control, respectively. Interaction effect of 60 kg P₂O₅/ha and 45 kg S/ha was significant in respect of LAI and chlorophyll content at flower initiation and dry matter accumulation and test weight at harvest.

Key words: Mungbean, Phosphorus levels, Seed yield, Sulphur levels, Yield attributes

Mungbean, being the third most important pulse crop after chickpea and pigeonpea, is grown on 3.10 m ha area with annual production of 0.94 m t at an average productivity of 304 kg/ha. In Rajasthan, mungbean is cultivated on 1.06 m ha area with 0.41 m t production at an average yield of 390 kg/ha. Thus, both productivity and consumption have come down drastically over the years.

Mungbean is generally grown as a sole or mixed crop with cereals during *Kharif* in Rajasthan. Due to enhanced irrigation facility in southern Rajasthan, its acreage has been increased many-folds. In the canal command areas, the crop is grown during summer which has opened up new avenues for intensifying crop production in this mostly tribal dominated belt. It is also observed that judicious management of fertilizers plays a vital role for higher productivity in this crop. Besides N (taken care in part by BNF), appropriate P and K levels in this crop are also required which is the main objective of the present investigation.

MATERIALS AND METHODS

A field experiment was conducted on a sandy clay loam soil during summer 2010 and 2011 at Krishi Vigyan Kendra, Dungarpur (situated at 23.83°N latitude, 73.72°E longitude and an altitude of 579.5 m above msl) belonging to humid Southern Plain of Rajasthan. Sixteen treatments comprising of four levels of P (0, 20, 40 and 60 kg P₂O₅/ha) and four levels of S (0, 15, 30 and 45 kg S/ha) were tried in a factorial randomized block design with four replications. The mean annual rainfall of the tract is 760.2 mm. The soils was slightly alkaline in reaction, low in organic carbon (0.48 %), available N (247 kg/ha) and available sulphur (8.8 ppm SO₄⁻², medium in available P (17.9 kg P₂O₅/ha) and high in available K (282.4 kg K₂O/ha). The crop was sown in furrows at 25 cm apart at a depth of 3-4 cm and at a seed rate of 15 kg/ha in the same lay out/field during mid-March of 2010 and 2011. DAP-P and gypsum-S were applied manually at sowing in furrows at 5 cm below the seeding depth as per treatment. Urea-N was applied to make up the balance dose of N to 25 kg/ha in each treatment. Seeds of mungbean 'SML 668' was treated with both fungicide and appropriate *Rhizobium* culture (*Rhizobium phaseoli*). Weed control, irrigation and plant protection measures were followed as per normal package of practices recommended for the Zone. Plant observations viz., LAI and chlorophyll content at flower initiation stage and plant height, dry matter accumulation, seeds per plant, test weight, seed and straw yield at harvest along with harvest index were taken. The data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Cochran and Cox (1967). Bartlett's test was applied to test the homogeneity of variances and were found homogenous for both the years. Hence, pooled analysis was also carried out as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of P levels: Application of 60 kg P₂O₅/ha significantly increased leaf area index and chlorophyll content at flower initiation, plant height and dry matter accumulation at harvest over the other lower levels (0, 20 and 40 kg P₂O₅/ha) during both the years and on pooled basis with the exception of plant height which was at par with both 20 and 40 kg P₂O₅/ha during first year only (Table 1). Similar results were reported

Table 1. Effect of phosphorus and sulphur on growth parameters of summer mungbean

Treatment	Plant height (cm)			Dry matter accumulation (g/plant)			Leaf area index			Chlorophyll content (mg/g)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
<i>Phosphorus (P₂O₅ kg/ha)</i>												
0	26.2	387.0	32.1	7.03	8.27	7.65	1.64	1.85	1.74	2.26	2.31	2.29
20	27.3	41.0	34.1	7.08	8.46	7.77	1.79	2.09	1.95	2.37	2.44	2.40
40	27.8	41.5	34.7	7.19	9.02	8.11	2.09	2.44	2.27	2.73	2.72	2.73
60	28.6	44.6	36.6	7.99	9.68	8.84	2.21	2.73	2.47	3.02	3.00	3.01
SEm (±)	0.6	0.7	0.4	0.09	0.12	0.06	0.03	0.05	0.01	0.02	0.04	0.01
CD (P=0.05)	1.7	2.0	1.1	0.26	0.34	0.18	0.10	0.13	0.02	0.07	0.12	0.03
<i>Sulphur (S kg/ha)</i>												
0	28.0	39.7	33.9	6.92	8.33	7.62	1.72	2.05	1.89	2.43	2.38	2.41
15	27.5	41.3	34.4	7.14	8.84	7.99	2.01	2.15	2.08	2.50	2.57	2.54
30	27.5	41.5	34.5	7.49	8.90	8.19	2.05	2.24	2.15	2.61	2.47	2.54
45	26.5	42.5	34.7	7.73	9.35	8.54	2.06	2.57	2.31	2.84	3.04	2.94
SEm±	0.6	0.7	0.4	0.09	0.12	0.06	0.03	0.05	0.01	0.02	0.04	0.01
CD (P=0.05)	NS	NS	NS	0.26	0.34	0.18	0.10	0.13	0.03	0.07	0.12	0.03

by Patil *et al.* (2011). In general, the overall increase in growth of summer mungbean with P application can be ascribed to its pivotal role in several physiological and biochemical processes necessary for crop growth and development. It is an established fact that among nutrients, P is the most important for exploiting genetic potentials of the crop/variety (Tisdale *et al.* 2003).

Application of 60 kg P₂O₅/ha also significantly increased yield attributes *viz.*, seeds/plant and test weight as compared to other lower levels (0, 20 and 40 kg P₂O₅/ha) across the years as well as on pooled basis (Table 2). Similarly, P application up to 60 kg P₂O₅/ha resulted in significantly higher seed and stalk yield of summer mungbean. On an average, application of 60 kg P₂O₅/ha produced 14.4 and 14.1% higher seed and stalk yield over the control, respectively (Table 2). Improvement in yield components and yield of summer mungbean due to P fertilization was also observed by Ali *et al.* (2010).

Effect of S levels: Application of S at 45 kg S/ha significantly increased leaf area index and chlorophyll content at flower initiation, dry matter accumulation at harvest over other levels (0, 15 and 30 kg S/ha) on pooled basis except that of dry matter accumulation which was at par with both 20 and 40 kg P₂O₅/ha during 2010. Varying sulphur levels could not influence plant height at harvest (Table 1). Similar results were reported by Patel *et al.* (2010). The role of S can be viewed from its participation in the primary and secondary metabolism as a constituent of various organic compounds that are vital for functioning of several plant processes. Sulphur in the form of sulphate, is best known for its role in synthesis of S

containing amino acids, namely methionine, cysteine and cystine (Lakkaneni and Abrol 1994).

Progressive increase in S levels up to 45 kg S/ha was also effective in increasing yield attributes *viz.*, seeds/plant and test weight significantly over other lower levels (control, 15 and 30 kg S/ha) on pooled basis (Table 2). Similarly, seed and stalk yield of mungbean increased progressively and significantly by increasing S levels from 0 to 45 kg/ha. Pooled data also showed that with application of 45 kg S/ha, both seed and stalk yields were raised by 14.4 and 13.1% over control, respectively (Table 2). The net result of increase in yield attributes was also reflected in increased seed yield of mungbean following S fertilization. Patel *et al.* (2010) also supported these findings.

Interaction effects: Pooled analysis also indicated that combined application of 60 kg P₂O₅/ha and 45 kg S/ha was superior over the rest of the combinations accounting 36.5 and 33.9% increase in dry matter accumulation at harvest over the control during 2010 and on pooled data, respectively (Table 3). However, the data on LAI at flower initiation indicated variable results with application of P and S in combination during both the years. Pooled analysis revealed that 60 kg P₂O₅/ha + 45 kg S/ha gave significantly higher LAI (2.65) which registered 75.5% higher over the unfertilized control (Table 4). On chlorophyll content in the leaves at flower initiation stage, pooled analysis indicated that application of 60 kg P₂O₅/ha + 45 kg S/ha gave significantly higher chlorophyll content than rest of the treatment combinations accounting 63.7% more than the unfertilized control (Table 5). On pooled basis, 60 kg P₂O₅/ha+45 kg S/ha also accounted

Table 2. Effect of phosphorus and sulphur on yield attributes, seed yield and harvest index of summer mungbean

Treatment	Seeds/plant			Test weight (g)			Seed yield (kg/ha)			Stover yield (kg/ha)			Harvest index (%)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
<i>Phosphorus (P₂O₅ kg/ha)</i>															
0	109.8	112.1	110.9	31.0	32.9	32.0	616	681	648	988	1194	1091	38.4	36.3	37.4
20	112.6	117.3	115.0	31.2	33.8	32.5	625	695	660	1003	1214	1109	38.4	36.5	37.4
40	122.5	123.8	123.2	32.6	33.9	33.2	665	741	703	1066	1317	1192	38.4	36.0	37.2
60	129.1	131.6	130.3	33.6	35.8	34.7	715	776	745	1139	1351	1245	38.4	36.5	37.5
SEm (±)	1.1	1.2	0.8	0.3	0.3	0.2	15	17	11	26	27	18	0.1	0.4	0.2
CD (P=0.05)	3.3	3.5	2.1	0.8	0.8	0.4	43	50	32	73	76	50	NS	NS	NS
<i>Sulphur (S kg/ha)</i>															
0	111.7	112.6	112.2	30.7	33.2	32.0	617	682	650	987.06	1181	1084	38.5	36.7	37.6
15	115.7	117.5	116.6	31.7	33.4	32.5	644	716	680	1022	1265	1143	38.5	36.2	37.3
30	120.6	123.8	122.2	32.9	34.3	33.6	666	718	692	1074	1292	1183	38.3	35.8	37.0
45	126.0	131.0	128.5	33.2	35.3	34.2	693	775	743	1113	1339	1226	38.7	36.7	37.5
SEm (±)	1.1	1.2	0.8	0.3	0.3	0.2	15	17	11	26	27	18	0.1	0.4	0.2
CD (P=0.05)	3.3	3.5	2.1	0.8	0.8	0.4	43	49	32	73	76	50	NS	NS	NS

Table 3. Interaction effect of phosphorus and sulphur on dry matter accumulation and test weight at harvest in summer mungbean

Phosphorus (P ₂ O ₅ kg/ha)	Dry matter accumulation (g/plant)								Test weight (g)							
	2010				Pooled				2011				Pooled			
	Sulphur (kg/ha)				Sulphur (kg/ha)				Sulphur (kg/ha)				Sulphur (kg/ha)			
	0	15	30	45	0	15	30	45	0	15	30	45	0	15	30	45
0	6.42	6.82	7.61	7.25	7.13	7.49	7.98	7.97	31.78	32.1	33.8	34.0	30.5	31.3	33.3	32.8
20	6.80	6.99	7.22	7.29	7.53	7.65	7.76	8.13	32.03	33.2	33.8	36.0	31.5	31.9	32.4	34.3
40	7.08	6.89	7.18	7.64	7.73	8.06	8.13	8.50	34.55	33.3	33.6	34.0	32.8	32.8	33.7	33.7
60	7.38	7.87	7.98	8.76	8.11	8.77	8.92	9.55	34.63	35.1	36.2	37.2	33.1	34.2	35.2	36.3
SEm (±)		0.18				0.13			0.53				0.31			
CD (P=0.05)		0.52				0.36			1.49				0.88			

Table 4. Interaction effect of phosphorus and sulphur on LAI at flower initiation stage in summer mungbean

Phosphorus (P ₂ O ₅ kg/ha)	Leaf area index											
	2010				2011				Pooled			
	Sulphur (kg/ha)				Sulphur (kg/ha)				Sulphur (kg/ha)			
	0	15	30	45	0	15	30	45	0	15	30	45
0	1.23	1.56	1.75	2.00	1.79	1.57	2.05	2.00	1.51	1.57	1.89	2.00
20	1.35	1.99	1.72	2.12	2.00	1.80	2.22	2.36	1.68	1.89	1.97	2.24
40	2.29	2.20	2.00	1.87	2.01	2.41	2.44	2.90	2.15	2.31	2.22	2.39
60	2.02	2.47	2.08	2.26	2.41	2.62	2.85	3.04	2.22	2.55	2.47	2.65
SEm (±)		0.07				0.09			0.01			
CD (P=0.05)		0.19				0.27			0.04			

Table 5. Interaction effect of phosphorus and sulphur on chlorophyll content at flower initiation stage

Phosphorus (P ₂ O ₅ kg/ha)	Chlorophyll content (mg/g)											
	2010				2011				Pooled			
	Sulphur (kg/ha)				Sulphur (kg/ha)				Sulphur (kg/ha)			
	0	15	30	45	0	15	30	45	0	15	30	45
0	2.07	2.08	2.57	2.32	1.94	2.22	2.28	2.82	2.01	2.15	2.42	2.56
20	2.18	2.26	2.42	2.62	2.21	2.36	2.21	2.98	2.19	2.31	2.31	2.79
40	2.58	2.65	2.59	3.09	2.56	2.66	2.49	3.17	2.53	2.66	2.55	3.13
60	2.89	3.01	2.87	3.33	2.83	3.06	2.90	3.22	2.86	3.03	2.89	3.29
SEm (±)	0.05				0.08				0.02			
CD (P=0.05)	0.14				0.24				0.06			

for significantly higher test weight (36.3 g) over the rest of the treatment combinations representing 19.0% higher than the unfertilized control (Table 3). Researchers also reported that P x S interaction was synergistic at low to medium levels of P and antagonistic only at higher levels, usually at 60 kg P₂O₅/ha or more for field crops (Tandon 1991). In the present study with medium available P and low available S, a synergistic relationship between P and S in respect to growth and yield of summer mungbean was also evident. These results are in agreement with those of Aulakh *et al.* (1990) and Sharma and Singh (1997).

It was inferred from the above that 60 kg P₂O₅/ha and 45 kg S/ha were required for higher growth and yield of summer mungbean under the existing situation.

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