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Biochemical study on *Phaseolus mungo* L.

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Abstract
Black gram is one of the less-known legumes, mainly grown and consumed in India, Thailand, and other tropical parts of the world. A field experiment was conducted during rainy seasons of 2014 and 2015 to study the Biochemical study on *Phaseolus mungo* L. The nutrient contents in grain and straw viz., N, P, K and S deviated significantly due to sulphur levels and bio fertilizers as well as their interactions. The highest sulphur level (60 kg/ha) and dual bio fertilizers (Rhizobium + PSB) resulted in almost significantly higher N, P, K and S contents and their uptake of black gram. The highest uptake of nutrients by black gram producing a total biomass up to 31.36 q/ha with highest S level was 99.55 kg N, 11.696 kg P, 52.06 kg K and 5.413 kg S/ha. Similarly, under dual bio fertilizers, the corresponding uptake values were 101.63 kg N, 10.626 kg P, 53.19 kg K and 5.568 kg S/ha. Biological nitrogen fixation by symbiotic bacteria in root-nodule of legume plants, black gram is one of them, is quantitatively one of the most important ways in which atmospheric nitrogen enters the biosphere.

Keywords: Biochemical, *Phaseolus mungo*, nutrient contents

1. Introduction
Nutrients play an important role in boosting the crop production. Phosphorus (P) is an essential and pivotal plant nutrient next to nitrogen which is required in large quantity for better growth of legume plant types. Being a constituent of high energy phosphate bonds of ATP, Phosphorus is of prime importance in the formation and transiocation of carbohydrates, fatty acids and other compounds. Among the major plant nutrients, P requirement of legume crop plants is quite high as compared to nitrogen and potassium.

In recent years, sulphur deficiency has been aggravated in Indian soils due to increase in cropping intensity, use of high-yielding varieties and addition of sulphur-free fertilizers. Sulphur is now recognized as the fourth major nutrients after N, P and K. On an average, crops absorb sulphur as much as they absorb phosphorus. The increasing reports of sulphur deficiency suggest that S deserves greater attention than that it has received so far. According to Tandon (1995) [1], black gram yielding 8.90 q/ha removes 70 kg N, 5.6 kg P, 50.1 kg K and 5.1 kg S/ha from the soil. The extensive use of bio fertilizers viz., Rhizobium and phosphorus- solubilizing bacteria (PSB) in crop production is a major breakthrough as a pollution-free and low-cost input technology. The multi-nutrient deficiency in soils is the main reason of low productivity of black gram varieties in Kymore plateau of Madhya Pradesh.

2. Material and methods
The field experiment was conducted during rainy season of 2014 and 2015 at the Vindhya Science & Agricultural Research Institute, Raushar, Rewa (M. P.). The soil of the experimental field was silty clay-loam having pH 7.5-7.6, electrical conductivity 0.32- 0.34 dS/m, organic carbon 8.6-8.9 g/kg, available N 230-237 kg/ha, available P2O5 15.8-14.9 kg/ha, available K2O 372-380 kg/ha and available S 7.76-8.30 ppm in both the years. The total rainfall received during June to October was 716 mm in 2014 and 1134 mm in 2015. The treatments comprised five sulphur levels (0, 15, 30, 45 and 60 kg/ha) and four treatments of bio fertilizers (no bio fertilizer, Rhizobium + phosphorus - solubilizing bacteria alone as well in combination).

3. Result and discussion
Nutrient Contents
The percentage of N, P, K and S contents was found higher in black gram grain than in straw. The fact that seeds acted as a sink for photosynthates nitrogen and other nutrients has also been supported by Shah *et al*. (1994) [2] and Pandey *et al*. (2000) [3].

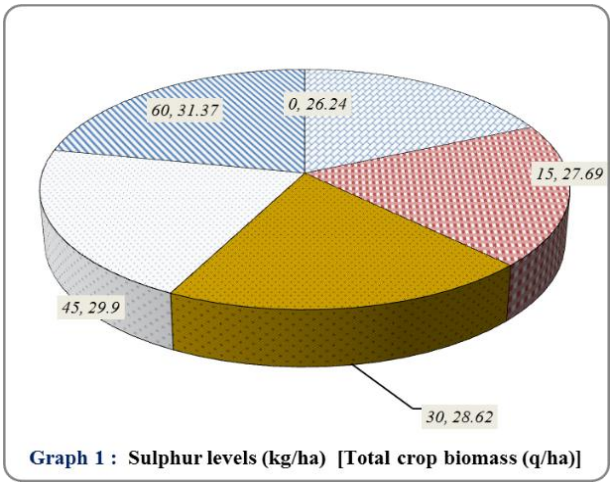
Application of sulphur up to 60 kg/ha augmented the N, P, K and S contents in grain and straw almost significantly over the lower doses (Table 1). This might be due to the fact that plants absorbed these nutrients proportionately in higher amounts because the pool of available nutrients was already increased in the soil by supplementing increased doses of applied sulphur. The present results agree with those of Singh *et al*. (2004) [4] and Singh *et al*. (2008) [5].

Among the bio fertilizer treatments, Rhizobium + PSB enhanced the N, P, K and S contents in grain and straw of black gram significantly. The highest level of sulphur with dual bio fertilizers further encouraged the nutrient contents. This might be due to stimulation of root growth, better root nodulation, increased microbial activities and chlorophyll content of leaves (Mishra and Tiwari, 2001 and Kumawat *et al*., 2009) [6-7].

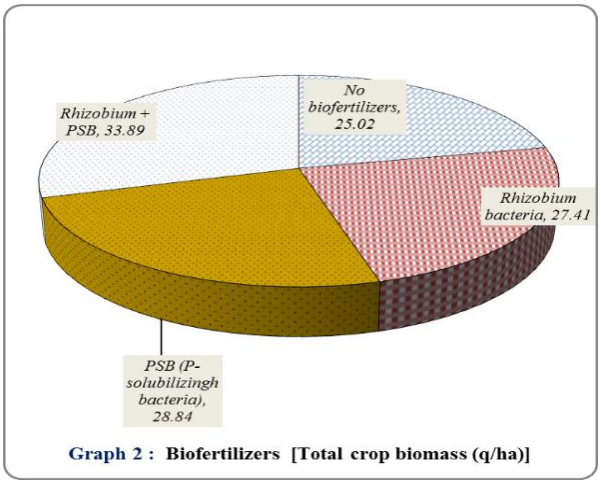
Table 1: Nutrient contents of black gram as influenced by sulphur levels and biofertilizer treatments (Mean of two years)

Treatment	N content (%)		P content (%)		K content (%)		S content (%)		Total crop biomass (q/ha)
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
Sulphur levels (kg/ha)									
0	3.24	2.28	0.263	0.182	1.49	1.18	0.176	0.126	26.24
15	3.44	2.41	0.326	0.203	1.56	1.26	0.181	0.135	27.69
30	3.62	2.55	0.391	0.228	1.67	1.32	1.83	0.140	28.62
45	3.72	2.65	0.427	0.266	1.72	1.46	0.191	0.147	29.90
60	3.82	2.76	0.446	0.320	1.82	1.56	0.196	0.158	31.37
C.D.(P=0.05)	0.23	0.026	0.010	0.026	0.024	0.025	0.004	0.0016	1.84
Bio fertilizers									
No bio fertilizers	3.48	2.46	0.341	0.211	1.56	1.28	0.178	0.135	25.02
Rhizobium bacteria	3.56	2.57	0.356	0.228	1.65	1.31	0.182	0.138	27.41
PSB (P- solubilizing bacteria)	3.56	2.50	0.376	0.242	1.65	1.36	0.185	0.140	28.84
Rhizobium + PSB	3.66	2.58	0.408	0.273	1.73	1.43	0.190	0.147	33.89
C.D.(P=0.05)	0.20	0.023	0.008	0.023	0.021	0.021	0.0034	0.0015	1.65
Interaction	*	*	*	*	*	*	*	*	*

* = Significant; NS = Not Significant



Graph 1 : Sulphur levels (kg/ha) [Total crop biomass (q/ha)]



Graph 2 : Biofertilizers [Total crop biomass (q/ha)]

Uptake of Nutrients

Application of higher levels of sulphur up to 60 kg/ha enhanced the N, P, K and S uptake by grain and straw significantly (Table 2). This might be attributed to increased grain and straw yields as well as nutrient contents in grain and straw at 60 kg S/ha. In contrast to the nutrient contents, the nutrients uptake was higher in straw than in grain. This was due to increased straw yields over grain yields. The present results corroborate with those of Shahi *et al*. (2003) [8], Singh *et al*. (2008) [5] and Marko *et al*. (2013) [11].

Table 2: Uptake of nutrients by black gram as influenced by sulphur levels and biofertilizer treatments (Mean of two years)

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)			S uptake (kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Sulphur levels (kg/ha)												
0	30.12	34.06	64.18	2.427	3.098	5.525	13.76	20.29	34.05	1.621	2.133	3.754
15	34.74	42.80	77.54	3.308	3.373	6.681	15.80	22.50	38.30	1.832	2.392	4.224
30	38.67	46.05	84.72	7.198	4.250	8.448	17.86	24.06	41.92	1.962	2.528	4.490
45	42.16	49.54	91.70	3.745	4.990	8.736	19.49	27.13	46.62	2.146	2.785	4.931
60	45.87	53.68	99.55	5.407	6.289	11.696	21.90	30.16	52.06	2.327	3.086	5.413
C.D.(P=0.05)	3.37	4.71	8.07	0.211	0.490	0.701	0.41	0.52	0.94	2.130	0.045	2.175
Bio fertilizers												
No bio fertilizers	32.97	38.68	71.65	3.044	3.312	6.356	14.86	20.09	34.95	1.692	2.115	3.807
Rhizobium bacteria	38.30	42.85	81.15	3.684	3.892	7.576	17.42	22.00	39.42	1.976	2.345	4.321
PSB (P- solubilizing bacteria)	36.81	46.36	83.17	3.732	4.578	8.310	17.17	25.61	42.78	1.920	2.626	4.546
Rhizobium + PSB	45.16	56.47	101.63	4.810	5.816	10.626	21.57	31.62	53.19	2.320	3.248	5.568
C.D.(P=0.05)	3.00	4.22	7.25	0.187	0.438	0.526	0.36	0.48	0.85	2.116	0.040	2.157
Interaction	*	*	*	*	*	*	*	*	*	*	*	*

* = Significant; NS = Not Significant

The total crop biomass which produced up to 31.36 q/ha at 60 kg S/ha removed almost significantly higher nutrients (99.55 kg N, 11.696 kg P, 52.06 kg K and 5.413 kg S/ha) over the preceding S levels.

Amongst the biofertilizer treatments, dual biofertilizer inoculation resulted in significantly higher nutrients uptake by grain and straw. The total biomass produced in this treatment was 33.89 q/ha which removed 101.63 kg N, 10.626 kg P, 53.19 kg K and 5.568 kg S/ha. This was followed by PSB and then Rhizobium inoculated individually. These results agree with those of Verma *et al*. (2000) [9], Pathak *et al*. (2003) [10] and Marko *et al*. (2013) [11].

The best treatment interaction was 60 kg S/ha with dual bio fertilizers which further augmented uptake of N, P, K and S nutrients synergistically. The positive influence of such interaction on the plant growth, grain yield and nutrient uptake might be due to its impact on the carbon cycle in plant i.e. higher CO2 fixation and their efficient translocation towards developing grains.

The maximum uptake of these nutrients in this treatment may be owing to the increased crop biomass as well as nutrient contents Kumawat *et al*., (2009) [7] and Marko *et al*. (2013) [11].

Root Nodulation

Biological nitrogen fixation by symbiotic bacteria in root-nodule of legume plants, black gram is one of them, is quantitatively one of the most important ways in which atmospheric nitrogen enters the biosphere. Biosphere is that prt of the earth's envelope in which living organisms exist in their natural state. It has been well established that the fast growing symbiotic bacteria (Rhizobium sp.) present in the legume root-nodules fix substantial amount of nitrogen under field conditions. Amongst the growth regulators, triacontanols i.e. Vipul, Tata, Miraculan and N-triacontanol (Grocel) and NAA performed the best in encouraging higher number of root-nodules/plant. Similar effects of IAA (Indole acetic acid) on greengram, and triacontanol (Vipul) on black gram have also been reported by Shah *et al*. (1994) [2].

4. Conclusion

The total nitrogen, phosphorus and potassium uptake per hectare by black gram grain plus straw was found highest due to the same PGR i.e. [triacontanol (Vipul)], followed by triacontanol (TATA) and N-triacontanol (Grocel).

5. Acknowledgement

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6. References

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