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UTILIZATION OF NUTRIENTS BY BLACKGRAM (*PHASEOLUS MUNGO* L.) APPLIED WITH SULPHUR AND BIOFERTILIZERS

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ABSTRACT

A field experiment was conducted during rainy season of 2023 and 2024 to study the utilization of nutrients by blackgram (*Phaseolus mungo* L.) applied with sulphur and biofertilizers. The nutrient contents in grain and straw viz., N, P, K and S deviated significantly due to sulphur levels and biofertilizers as well as their interactions. The highest sulphur level (60 kg/ha) and dual biofertilizers (*Rhizobium* + PSB) resulted in almost significantly higher N, P, K and S contents and their uptake of blackgram cv. Pant Urad-31. The highest uptake of nutrients by blackgram producing a total biomass up to 31.60 q/ha with highest S level was 99.59 kg N, 11.72 kg P, 52.12 kg K and 5.43 kg S/ha. Similarly, under dual biofertilizers, the corresponding uptake values were 101.67 kg N, 10.68 kg P, 53.24 kg K and 5.60 kg S/ha. The findings suggest that due to heavy withdrawal of nutrients by blackgram cv. Pant Urad-31, the succeeding crop must be nourished properly based on nutrients status of the soil in Raisen region.

Key words : Biofertilizers, Blackgram, Sulphur, Nutrients.

Introduction

The deficiency of multi-nutrients in soil is posing a great threat towards sustainable productivity of blackgram. The heavy withdrawal of nutrients by high-yielding varieties, intensive cropping systems, imbalanced and insufficient use of manures and fertilizers and use of sulphur-free fertilizers aggravated the multi-nutrient deficiencies in the soil. The general tendency is that the total crop removal of nutrients is never replenished. That is why soil health and sustainable productivity of blackgram is becoming the burning problems. It is well known fact that blackgram, a nutritious crop, is highly responsive to the applied nutrients including sulphur. Due to fertility variations in different soil types, the response of a certain blackgram genotype to direct fertilizers application is highly inconsistent, location and even site specific (Saket *et al.*, 2014). The extensive use of biofertilizers *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 blackgram varieties in Raisen region of Madhya Pradesh. The present experiment was, taken up to generate relevant information for one of the most popular blackgram variety Pant urad-31.

Materials and Methods

The field experiment was conducted during rainy season of 2023 and 2024 at the Instructional Farm, RNT University, Raisen (M. P.), India. The soil of the experimental field was sandy-loam having pH 7.6-7.8, electrical conductivity 0.42-0.47 dS/m, organic carbon 8.8-9.3 g/kg, available N 259-268 kg/ha, available P_2O_5 14.8-15.8 kg/ha, available K_2O 210-226 kg/ ha and available S 7.70-8.19 ppm in both the years in 2024. The treatments. comprised five sulphur levels (0, 15, 30, 45 and 60 kg/ha) and four treatments of biofertilizers (no biofertilizer, *Rhizobium*+ phosphorus-solubilizing bacteria alone as well in combination). The 20 treatment combinations were laid out in the field in a factorial randomized block design with three replications. Blackgram var. Pant Urad-31 was sown @ 20 kg/ha in rows 30 cm apart between 16 to19 July in both the years. A uniform dose of 20 kg N and 50 kg P_2O_5/ha was applied through diammonium phosphate as basal in all the treatments. Sulphur levels were applied through elemental sulphur as basal. The seeds were inoculated with both the biofertilizers @ 20 g/kg seed mixed with FYM as per treatment. The crop was grown as per package of practices. The crop was harvested between 18 to 21 October in both the years. The percent N, P, K and S concentrations in seed and straw of blackgram were determined by following the standard analytical procedures (A.O.A.C., 1997). The nutrients uptake per hectare was calculated by multiplying the seed or straw yield with the percent N, P, K and S nutrient contents in seed or straw.

Results and Discussion

Growth parameters : Application of sulphur up to 60 kg/ha increased the plant height, branches/plant, significantly (Table 1). This might be owing to additional supply of sulphur nutrient which resulted in acceleration of cell elongation and cell division similar to that of nitrogen. Sulphur, being a fourth major nutrient, might have played an important physiological role by enhancing cell multiplication, elongation, expansion and chlorophyll biosynthesis which, in turn, increased the assimilate production. Dual inoculation (*Rhizobium*+PSB) brought about significantly higher all the growth parameters against the single inoculation of biofertilizers. This may be because of the increased proliferation of N- Fixing as well as P-solubilizing bacteria in the biosphere and the sufficient supply of N and P nutrients to them for their increased functions required for better plant growth and development. These results corroborate with those of also for Pandey *et al*. (2023), Singh *et al*. (2017), Singh and Singh (2017), Saket *et al.* (2017), Kumawat *et al.* (2014) and Das *et al*. (2017).

Yield and yield components : The factors which are directly responsible for ultimate grain production viz., pods/plant, grains/pod, 1000-grain weight and seed weight/ plant were increased almost significantly due to increased supply of sulphur up to 60 kg/ha (Table 2). The grain yield was 12.05 q/ha and harvest index 38.37%. This might be as a result of maximum plant growth associated with greater accumulation of carbodydrates, protein and their translocation to the reproductive organs under increased supply of sulphur. These results are in close agreement with those of Kumar and Singh (2011) and Misra *et al*. (2011).

Seed inoculation with *Rhizobium* + PSB enhanced the yield and yield components significantly over the individual seed inoculation. Dual biofertilizers with 60 kg S/ha further increased all these parameters synergistically. Under this treatment interaction, blackgram plants synthesized more photosynthesis and the storage organ (grain) was better developed. These results agree with those of Singh *et al.* (2015), Nyekha *et al*. (2015), Saket *et al*. (2017), Singh and Singh (2017), Naragund *et al*. (2020).

Grain quality : The highest level of sulphur (S_{60}) resulted in maximum seed protein 23.91% and seed carbohydrate 0.51%. Similar dual biofertilizers also recorded maximum seed quality (Table 2). Dual biofertilizers parameters. The response of this

Table 1 : Productivity of blackgram as influenced by sulphur levels and biofertilizers (mean of two years).

Treatments	Gran yield (q/ha)	Straw yield (q/ha)	Total Biomass (q/ha)
Sulphur levels (kg/ha)			
0	9.32	17.16	26.48
15	10.18	17.78	27.96
30	10.78	18.09	28.87
45	11.35	18.80	30.15
60	12.05	19.55	31.60
C.D. (5%)	**0.68**	**1.20**	**1.38**
Biofertilizers			
No. biofertilizers	9.48	15.77	25.25
Rhizobium bacteria	10.81	16.83	27.64
PSB (P-solubilizing bacteria)	10.33	18.76	29.09
Rhizobium + PSB	12.32	21.81	34.13
CD (P=0.05)	**0.62**	**1.08**	**1.70**

Table 2 : Uptake of nutrients by blackgram as influenced by sulphur levels and biofertilizers (mean of two years).

Treatments	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	30.18	34.09	64.27	2.44	3.11	5.55	13.78	20.31	34.09	1.63	2.15	3.78
15	34.78	42.81	77.59	3.32	3.39	6.71	15.83	22.54	38.37	1.84	2.41	4.25
30	38.69	46.06	84.75	4.20	4.26	8.46	17.90	24.10	42.00	1.97	2.54	4.51
45	42.18	49.55	91.73	4.74	5.12	9.86	19.52	27.15	46.67	2.15	2.80	4.95
60	45.90	53.69	99.59	5.41	6.31	11.72	21.93	30.19	52.12	2.33	3.10	5.43
CD (P-0.05)	**3.38**	**4.74**	**8.12**	**0.22**	**0.51**	**0.73**	**0.44**	**0.55**	**1.00**	**0.14**	**0.048**	**0.19**
Biofertilizers												
No. biofertilizers	33.10	38.71	71.81	3.06	3.32	6.38	14.88	20.10	34.98	1.70	2.13	3.83
Rhizobium bacteria	38.36	42.86	81.22	3.69	3.91	7.60	17.45	22.13	39.58	1.98	2.36	4.34
PSB (P-solubilizing bacteria)	36.85	46.39	83.24	7.75	4.59	8.34	18.19	25.62	43.81	2.13	2.64	4.70
Rhizobium + PSB	45.19	56.48	101.67	4.83	5.85	10.68	21.60	31.64	53.24	2.34	3.29	5.60
CD (P=0.05)	**3.05**	**4.25**	**7.30**	**0.19**	**0.45**	**0.64**	**0.39**	**0.50**	**0.89**	**0.12**	**0.043**	**0.16**

combination in improving seed quality may be attributed to its significant role in regulating the photosynthesis, root enlargement and better microbial activities (Kumar and Singh, 2009b). The present findings are in close conformity with those of Kumar and Singh (2009), Marko *et al*. (2013), Raj *et al*. (2014), Saket *et al*, (2017) Singh *et al.* (2017) and Pandey *et al*. (2023).

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 P in grain and straw at 60 kg S/ha. In contrast to the nutrient contents, to the nutrient's 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 Kumar and Singh (2009), Kumawat *et al*. (2009), Patel *et al*. (2010), Marko *et al*. (2013) Saket *et al*. (2017), Pandey *et al*. (2023) and Saket *et al*. (2017).

The total crop biomass which produced up to 31.60 q/ha at 60 kg S/ha removed almost significantly higher nutrients (99.59 kg N, 11.72 kg P, 52.12 kg K and 5.43 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 34.13 q/ha which removed 101.67 kg N, 10.62 kg P, 53.24 kg K and 5.60 kg S/ha. This was followed by PSB and then *Rhizobium* inoculated individually. These results agree with those of Naragund *et al*. (2020), Pndey *et al*. (2023), Marko *et al*. (2013).

The best treatment interaction was 60 kg S/ha with dual biofertilizers 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 CO_2 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 (Kumar and Singh, 2009; Kumawat *et al*., 2009).

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