



Response of blackgram (*Phaseolus mungo* L.) to applied sulphur and biofertilizers

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Abstract

A field experiment was conducted during rainy seasons of 2017 and 2018 to study the effect of sulphur and biofertilizers on growth, yield and quality of blackgram. Application of sulphur upto to 60 kg/ha to blackgram cv. Jawahar Urad-2 proved the most beneficial with respect to enhance all the growth and yield attributing characters, seed yield, seed quality and net income per hectare. The maximum seed yield was 12.34 q/ha, seed protein 23.83%, protein yield 294.6 kg/ha, seed carbohydrate 0.53%, net income Rs.45280/ha and B.C. ratio upto 2.47. Amongst the biofertilizer treatments, *Rhizobium* + PSB performed the best with respect to all these parameters. The treatment interactions were found to be non-significant in case of grain yield per hectare. The findings allude that 60 kg S/ha with dual biofertilizers may be applied to achieve maximum productivity and economical gain from blackgram cv. JU-2.

Keywords: Biofertilizers, blackgram, quality, sulphur, yield

Introduction

In addition to multi-nutrient deficiencies, sulphur deficiency has been also enhanced in Indian soils due to increase in cropping intensity, use of high yielding varieties and addition of sulphur-free fertilizers. The fact that crops require S and P in the comparable amounts suggests that S deserves greater attention than that it received so far. With the increase in yield, sulphur also improves crop quality by increasing synthesis of sulphur containing amino acids and protein percentage. Exploration of biofertilizers has opened the new possibilities to supplement chemical nitrogen and phosphatic fertilizers. Blackgram after seed inoculation with *Rhizobium leguminosarum* fixes 50-55 kg N/ha symbiotically (Motsara *et al.*, 1995) [12]. Similarly, phosphorus-solubilizing bacterial inoculation increased yield of rice 10-20%, wheat 10-40%, Bengal gram 10-20% and potato by 30-35% (Gand and Gaur, 1991) [2]. Increasing cost of chemical fertilizers and their scarcity in Indian market has insisted upon to search out the efficacious effect of dual biofertilizers on blackgram which are not only economical but also eco-friendly and pollution-free. In view of this fact, the present experiment was taken up.

Materials and methods

The field experiment was conducted during rainy season of 2017 and 2018 at the private Agriculture-cum-Research Farm, Beena-Semaria Road, 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 8.6-8.8 g/kg, available N 230-238 kg/ha, available P₂O₅ 13.8-14.3 kg/ha, available K₂O 372-381 kg/ha and available S 7.75-8.30 ppm in both the years. The total rainfall received during June to October was 1499 mm in 2017 and 760 mm

in 2018. The treatments comprised four sulphur levels (0, 20, 40 and 60 kg/ha) and four treatments of biofertilizers (no biofertilizers, *Azotobacter* or *Rhizobium* + phosphorus-solubilizing bacteria alone as well in combination). The 24 treatment combinations were laid out in the field in a factorial randomized block design with three replication. Blackgram var. JU-2 was sown @ 20 kg/ha in rows 30 cm apart between 9 to 15 July in both the years. An uniform dose of 20 kg N and 50 kg P₂O₅/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 10 to 19 October in both the years. Seed protein was estimated by multiplying % N-content with 6.25 (A.O.A.C., 1997) [1]. Carbohydrate content in seed was estimated by the acid hydrolysis process and titration with Fehling's solution (Sadasivam and Manickam, 1996) [15].

Results and discussion

Growth parameters

Application of sulphur up to 60 kg/ha increased the plant height, branches/plant, number and weight of root-nodules/plant and dry matter/plant almost significantly (Table 1 & Fig. 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 (Raj *et al.*, 2014) [14].

Table 1: Growth parameters and root nodulation of blackgram as influenced by sulphur levels and biofertilizers (mean of two years)

Treatments	Plant height (cm) at 90 DAS	Number of branches/ plant at 90 DAS	Weight of root-nodules/ plant (g)	Dry matter/ plant (g)	Leaves/ plant at 90 DAS	Pods/ plant	Seeds/ pod	1000-grain weight (g)	Seed weight/ plant (g)	Straw weight/ plant (g)
Sulphur levels (kg/ha)										
0	22.63	8.14	4.85	35.07	26.25	31.47	7.95	52.38	3.37	9.26
20	23.05	8.91	5.85	37.28	28.36	35.19	8.19	54.66	3.87	10.09
40	23.36	9.48	6.26	38.68	30.48	36.17	8.32	55.27	4.08	10.62
60	24.14	9.81	6.54	40.56	32.52	38.54	8.55	56.90	4.39	11.32
C.D. (P=0.05)	NS	1.45	0.72	2.33	2.10	2.37	NS	2.77	0.78	1.71
Biofertilizers										
No biofertilizer	21.40	7.53	4.70	26.87	25.38	29.77	7.22	51.96	3.44	8.14
<i>Rhizobium</i>	23.23	8.87	5.62	39.66	30.06	35.84	8.10	54.50	3.79	9.88
<i>Azotobacter</i>	23.04	8.82	5.45	38.23	28.06	34.30	8.01	52.86	3.72	9.76
PSB	22.28	8.04	5.18	37.23	28.48	33.83	8.39	54.55	3.64	9.58
Rhi.+PSB	25.00	10.66	7.23	43.79	32.90	40.04	8.96	58.16	4.53	12.34
Azoto.+PSB	24.83	10.59	7.06	41.59	31.54	38.28	8.85	56.81	4.45	12.21
CD (P=0.05)	2.63	1.78	0.88	2.85	2.57	2.90	1.55	3.38	0.96	2.09
Interaction	NS	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.

NS=Non-significant, Sig.= Significant

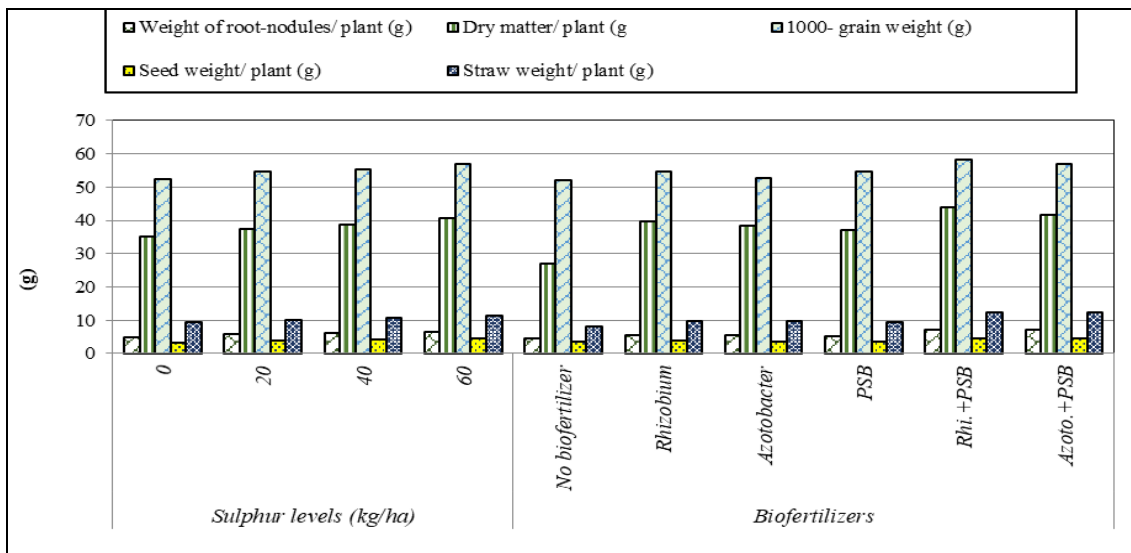


Fig 1: Graphics analysis of mean growth parameters and root nodulation of blackgram as influenced by sulphur levels and Biofertilizers

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 rhizosphere and the sufficient supply of N and P nutrient to them for their increased functions required for better plant growth and development. These results corroborate with those of Kumar *et al.* (2007) [8], Wam *et al.* (2007), Kumawat and Kumawat (2009) [9], Kanwar *et al.* (2013) [2] and Singh *et al.* (2015) [11].

Yield and yield components

The factors which are directly responsible for ultimate grain production viz. 38.54 pods/plant, 8.95 grains/pod, 56.90 g 1000-grain weight and 4.39 g seed weight/plant were increased almost significantly due to increased supply of sulphur upto 60 kg/ha (Table 2). The grain yield was 12.34 q/ha and harvest index 38.41%. This might be as a result of maximum plant growth associated with greater accumulation of carbohydrates, 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) [11] and Misra *et al.* (2011) [11].

Table 2: Productivity, economics and qualities of blackgram as influenced by sulphur levels and biofertilizers (mean of two years)

Treatments	Grain yield (q/ha)	Harvest index (%)	Net income (Rs./ha)	Difference over control (Rs./ha)	Benefit:cost ratio	Seed protein (%)	Protein yield (q/ha)	Carbohydrate content (%)
Sulphur levels (kg/ha)								
0	9.61	35.66	31484	--	2.13	20.26	195.6	0.356
20	10.95	37.38	38682	7198	2.34	22.47	246.4	0.460
40	11.54	37.81	41373	9889	2.39	23.26	269.1	0.500
60	12.34	38.41	45280	13796	2.47	23.83	294.6	0.528
C.D. (P=0.05)	1.83	2.44	--	--	--	2.51	55.0	0.078

Biofertilizers								
No biofertilizer	9.66	37.16	30244	--	2.03	21.67	210.4	0.383
<i>Rhizobium</i>	10.94	38.84	38038	7794	2.29	22.23	244.9	0.483
<i>Azotobacter</i>	10.77	38.77	36982	6740	2.26	22.00	238.5	0.478
PSB	10.45	35.44	35305	5061	2.20	22.64	238.3	0.379
Rhi.+PSB	12.62	37.09	48538	18294	2.65	23.21	294.4	0.524
Azoto.+PSB	12.22	36.59	46123	15879	2.57	22.98	282.0	0.520
CD (P=0.05)	2.23	2.98	--	--	--	NS	67.3	0.096
Interaction	Sig.	Sig.	--	--	--	NS	Sig.	Sig.

NS=Non-significant, Sig. = Significant

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 Kumar *et al.* (2004) [15], Tiwari *et al.* (2005) [19], Singh *et al.* (2008) [8], Kumar and Singh (2009 a), Marko *et al.* (2013) and Raj *et al.* (2014) [14].

Economics and grain quality

The highest level of sulphur (S₆₀) resulted in maximum net income upto Rs.45280/ha, seed protein 23.83%, 294.6 q/ha protein yield and seed carbohydrate 0.53%. Similar dual biofertilizers also recorded maximum economical gain as well as seed quality (Table 2). Dual biofertilizers with 60 kg S/ha further improved all these parameters. The maximum net income in these treatments was due to maximum crop productivity and its market value. The response of this 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, 2009 b). The present findings are in close conformity with those of Mishra and Tiwari (2001), Pathak *et al.* (2003) and Singh *et al.* (2005).

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