JOURNAL OF APPLIED BIOLOGY AND AGRICULTURE
Vol. 1 No. 2 (Dec 2024); PP 89-102
ISSN :3048-4588

Effect of Sulphur and Bio-inoculants on Yield, Quality and Uptake of Blackgram (*Vigna mungo)*

Bhagyaresha R. Gajbhiye and Shilpa D. Mane

Department of Soil Science and Agricultural Chemistry,

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

ABSTRACT

A field experiment was conducted on effect of sulphur and bio-inoculants on yield, quality and uptake of blackgram at College of Agriculture, Latur. The experiment was laid out in randomized block design with seven treatments and three replications.

The results of field study indicated that, yield, quality and uptake of blackgram was significantly influenced by application of RDF, different levels of sulphur and bio-inoculants. The yield attributes and yield of blackgram were influenced with application of RDF + 30kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus* . The yield contributing characters *viz;* seed yield, straw yield, biological yield and harvest index as well as quality parameters such as protein content and test weight were also increased with application of RDF + 30kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*. Uptake of nutrients *viz;* N, P, K, S, Fe, Mn, Zn and Cu at harvest stage of blackgram were increased with application of RDF + 30kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus* over RDF.

Thus, from the field experimentation, it can be concluded that, integrated use of RDF + 30 kg S ha $^{-1}$ with seed treatment of *Rhizobium*, PSB and *Thiobacillus* helps for significant improvement in yield and quality of blakgram with positive significant impact on the nutrient uptake .

(**Key words:** Blackgram, Yield, protein content, test weight, nutrient uptake)

INTRODUCTION

Blackgram is popularly known as “urd bean”. It is one of the important grain legumes in the rainfed farming and originated in the India. Blackgram belongs to the genus Vigna, family leguminaceae. It is an erect, sub erect or trailing densely hairy, annual herb. The tap root produces a branched root system with smooth, rounded nodules. The pods are narrow, cylindrical and up to 6 cm long.

Blackgram seeds are a good source of minerals and energy. It is rich in proteins (24 %), carbohydrates (60 %), fat (1-5 %), starch (40-45 %), amino acids, vitamins and minerals and much richer than most of grains used as concentrate. Blackgram bhusa when fed to calves provided positive balance for nitrogen, calcium and phosphorus. It has high nutritive value and consist high content of proteins, vitamins and minerals. Blackgram has highest fiber content (4.2%) and it is good source of phosphorus.

Sulphur is one of the essential plant nutrient classified as secondary nutrient. It is essential for all plants and is indispensible for the growth and metabolism. The concentration is found to be the highest in oilseeds (1.1-1.7 per cent), intermediate in pulses (0.24-0.32 per cent) and the lowest in cereals (0.12-0.20 per cent).Sulphur has number of oxidizing function in plant nutrition. It occurs in a variety of inorganic and organic pool is entirely caused by the activity, if the soil biota, particularly the soil microbial biomass, which has the greatest potential for mineralization and also for subsequent transformation of the oxidation state of sulphur.

Thiobacilli play an important role in sulphur oxidation in soil. Sulphur oxidation is the most important step of sulphur cycle, which improves soil fertility. *Rhizobium* is the oldest and most widely used biofertilizer. Different crops require different species of Rhizobia. *Rhizobium* can fix 50-200 kg nitrogen/hectare in leguminous crops. The use of phosphate solubilizing bacteria as inoculants simultaneously increases P uptake by the plant and crop yield. Strains from the genera *Pseudomonas* and *Bacillus* are among the most powerful phosphate solubilizers. The principle mechanism for mineral phosphate solubilization is the production of organic acids and acid phosphatases play a major role in the mineralization of organic phosphorous in soil. The importance of phosphorus application to blackgram has been recognized since long.

MATERIALS AND METHODS

The experiment was laid out in randomized block design with seven treatments and three replications.

For grain and straw yield, plot wise crop was harvested from net plot and pods were separated, separate weight of seeds and straw was recorded in kg and calculated on hectar basis. For biological yield, plot wise crop was harvested from net plot and pods were separated, separate weight of seeds and straw were recorded in kg and calculated on hectare basis by using formula given below,

Biological yield = seed yield + straw yield (kg ha $^{-1}$).

Harvest index is the ratio of seed yield to biological yield. It was computed by the formula.

$$\text{Harvest index (\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Test weight (g) was recorded by taking weight of 1000 seeds. Protein content in blackgram was estimated by multiplying the percentage of nitrogen in seeds sample by a constant factor 6.25 (A.O.A.C.,1975).

Total nitrogen in plant was measured by microkjeldha's methods (Waranke and Barber,1974). Phosphorus content in dry matter was determined on calorimeter by vanadomolybdate phosphoric acid yellow colour method as suggested by Jackson (1973). Total potassium content was estimated in plant samples on flame photometer as method described by Jackson (1973). Total sulphur content was determined on ultra violet spectrophotometer as method described by Tondon (1993).

Uptake of nutrients (N, P, K, S, Fe, Cu, Zn and Mn) on dry weight basis of plant was computed by multiplying the respective nutrient concentration by dry matter yield obtained.

RESULTS AND DISCUSSION

Yield attributes

The data pertaining to yield attributes *viz;* seed yield, straw yield, biological yield and harvest index are presented in table 1. The result regarding yield attributes showed significant influence by different treatments as regarded seed yield and biological yield but not reached to significant level for straw yield and harvest index.

Seed yield

The application of RDF + 30 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus* (T_7) recorded the highest seed yield (1250 kg ha^{-1}) which was at par with treatments T_3 (RDF + 20 kg S ha $^{-1}$+ *Rhizobium*), T_5 (RDF + 20 kg S ha^{-1} + *Thiobacillus*) and T_6 (RDF + 20 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*) and was found significantly superior over rest of the treatments. However, the lowest seed yield (900 kg ha $^{-1}$) was recorded with treatment T_1 (RDF). This might be due to enhanced activity of bacteria. Application of biofertilizers might have fixed more atmospheric nitrogen in the soil and more availability of phosphate resulted in increase in yield. These results are in agreement with findings of Ranware *et al.* (2007). Similarly, Kachhave *et al*.(2009) reported that the dual inoculation of *Rhizobium* and PSB with recommended dose of chemical fertilizer found beneficial in field experiment of blackgram over single use of biofertilizers. The biofertlilizers both *Rhizobium* and PSB exhibited spectacular performance in improving yield of blackgram.

Straw yield

The results indicated that straw yield of blackgram with application of different levels of sulphur and bio-fertilizers was found non significant. Application of RDF + 30 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus* (T_7) recorded higher straw yield (1453 kg ha^{-1}) and minimum straw yield (1226 kg ha^{-1}) was recorded with treatment T_1 (RDF). Increase in straw yield might be due to the important role of sulphur in energy transformation activity of enzymes and also in carbohydrate metabolites. Similar result observed by Nandan *et al.* (2012). Similarly, Singh and Singh (2004) observed that increasing dose of S significantly increased the straw yield. The similar findings were also reported by Rakesh Kumar *et al.* (2012) concluded that increasing doses of sulphur gradually increases straw yield.

Biological yield

Biological yield was influenced by different treatments of bio-fertilizers and sulphur significantly . The application of RDF + 30 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus* (T_7) noted the highest biological yield (2703 kg ha^{-1}) which was significantly superior than the other treatments and at par with treatments T_3(RDF + 20 kg S ha^{-1}+ *Rhizobium*), T_5 (RDF + 20 kg S ha^{-1} +*Thiobacillus*)and T_6 (RDF + 20 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*). However, the lowest biological yield (2126 kg ha $^{-1}$) was noted with application of RDF (T_1) in blackgram. Increased nitrogen concentration in plant increased the plant growth and thereby the photosynthesis, resulting in higher yield. These results are in conformity with the results of Patel and Kalyansunadaram (2002). Similarly, Ahmed *et al.* (2006) revealed that seed inoculation with *Rhizobium* and nitrogen fertilizer significantly increased biological yield as compared to control in greengram.

Harvest index

The harvest index was found non-significant due to different treatments (table 9). It was observed from the result that the highest harvest index (46.92 %) was observed with treatment T_5 (RDF + 20 kg S ha^{-1} +*Thiobacillus*) and the lowest harvest index (42.32%) was observed at treatment T_1 (RDF). Increase in harvest index might be the result of co-ordinated inter play of growth and development characters. Under inoculated treatment, plant synthesis more photosynthates and better development in seed was observed by Shukla and Dixit (1994).

Quality Parameters

Protein content and protein yield

The results regarding protein content and protein yield are presented in table 2. Effect of different levels of sulphur and bio-inoculants was found non-significant for protein content but found significant in protein yield of blackgram seeds. The higher protein content (24.61%) and protein yield (308.13 kg ha $^{-1}$) were obtained through application of RDF + 30 kg S ha $^{-1}$+*Rhizobium*+ PSB + *Thiobacillus* (T_7). In case of protein yield, treatment T_7 was at par with treatment T_6 (RDF + 20 kg S ha^{-1} + *Rhizobium* + PSB+ *Thiobacillus*).While, the lowest protein content (22.67 %) and protein yield (203.37 kgha^{-1}) were obtained with application of RDF (T_1). It might be due to increased availability of sulphur and thus nitrogen availability was also increased. Sulphur is a constituent of many amino acids, *viz;* cystine, cysteine and methionine applied sulphur increased the amount of these amino acids and protein content. These results are in accordance with the findings of Patel *et al.* (2013) and Singh *et al.* (1998).

Test weight

It was observed (Table 2) that effect of sulphur and bio-fertilizers on test weight was not reach to significant level. The maximum (55.90 g) and minimum (53.67 g) test weight of blackgram seeds were recorded with treatments T_7 (RDF + 30 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*) and T_1(RDF), respectively.

Improvement of photosynthesis by bacteria may increase seed thousand weight moreover on increasing vegetative growth these results are in conformity with the results of Zarei *et al.* (2012). Similarly, Vairavan (2011) concluded that the number of 100 seed weight did not significantly influenced by the application of chemical, organic and bio-fertilizers.

Uptake of N, P, K, S, Fe, Mn, Zn and Cu

Total uptake of N, P, S, Fe and Zn significantly increased due to application of different levels of sulphur and bio-fertilizers but total uptake of K, Mn and Cu were affected non-significantly with various treatments. Significantly maximum uptake of N (186.38 kg ha $^{-1}$), P (28.95 kg ha $^{-1}$), S (25.66 kg ha $^{-1}$), Fe (18.98 kg ha $^{-1}$) and Zn (4.54 kg ha $^{-1}$) recorded with treatment T_7 (RDF+ 30 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*) than the other treatments followed by treatment T_6 (RDF+ 20 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*). Whereas, total uptake of N, P, S, Fe and Zn were recorded minimum with treatment only RDF.

The increase in N concentration in legume may be due to more fixation of molecular di-nitrogen by symbiotic bacteria. These results are in conformity with the results of Singh and Singh (2004) and Balachandran *et al.* (2005). PSB facilitate P supply to plant by solubilising insoluble soil P and resulted in more P uptake. PSB alone recorded significantly more P uptake than the control. These results are in agreement with the findings of Goud *et al.* (2010).Similarly, Singh and Singh (2004) revealed that, the application of S significantly increased the uptake of P. He also concluded that *Rhizobium* and PSB inoculation increase K uptake than the control. Santosh Kumar *et al.* (2010) reported that dual application of *Rhizobium*+ phosphate solubilizing bacteria as well as single inoculation with either *Rhizobium* or PSB increased the potassium content in seed and straw of mothbean over no inoculation.

Release of sulphate sulphur in soil by oxidation of insoluble elemental sulphur hence uptake of S increased. These results are in agreement with the results of Shinde *et al*. (1996). Plant growth promotion mechanism by bacteria is the changing of morphological and physiological changes in root hairs cause addition of root surface available for uptake of micronutrients. Similar findings were observed by Selvakumar *et al.* (2012) that bio-fertilizers increase uptake of micro-nutrients by improving root surface as compare to un-inoculation.

CONCLUSIONS

Integrated use of RDF + 30 kg S ha $^{-1}$ with *Rhizobium*, PSB and *Thiobacillus* helps for significant improvement in yield and quality of blakgram with positive significant impact on the nutrient uptake.

REFERENCES

A.O.A.C. (1975). Official Methods of Analysis. Ed. 12, Association of Official Analytical. Chemist, Washington, D. C.

Ahmed, Z. I., Anjum, M. S. and Rauf, A. (2006). Effect of Rhizobium inoculation on growth and nodule formation of green gram. International *J. Agric. and Bio*., 8 (2) : 235 - 237.

Balachandran, S., Deotale, R. D., Hatmade, C. N., Titare, P. S. and Thorat, W. A. (2005). Effect of biofertilizers (pressmud, *Rhizobium* and PSB) and nutrients (NPK) on morphological parameters of greengram. *J. Soils and Crop*., 15 (2): 442-447.

Goud, V. V., Kale, H. B., and Patil, A. N. (2010). Performance of organically grown mungbean nunder rainfed condition in Vertisols. *J. Food Legumes*., 23 (3 and 4) : 218-222.

Jackson, M. L. (1973). Soil Chemical Analysis, Prentice Hall of India Private Ltd , New Delhi.

Kachhave, K. G., Dhage, S. J. and Adsul, P. B. (2009). Associative effect of Rhizobium, PSB and fertilizers on nodulation and yields of blackgram (*Vigna mungo*) in Vertisols. *J. Maharashtra Agric. Univ*., 34 (2): 186-188.

Nandan, R., Kaleem, M. and Moinuddin (2012). Rhizobium inoculation, phosphorus and sulphur fertilization and their effect on greengram (*Vigna radiata). International Agronomy. Congresss*., Nov. 26-30.

Patel, B. T. and Kalyanasundaram, N. K. (2002). Inoculation of Rhizobium strains to chickpeas influenced by phosphorus and molybdenum application. *J. Indian Agril. Chem.,* 35 (3): 168-172.

Patel, H. R., Patel, H. F., Maheriya V. D., and Dodia, I. N. (2013). Response of Kharif greengram (*Vigna radiata L. Wilczek*) to sulphur and phosphorus fertilization with and without bio-fertilizers application. *International Quarterly J. Life Sci.,* 8 (1) :149-152.

Rakesh Kumar, Singh, Y. V., Singh, S., Latare, A. M., Mishra, P. K. and Supriya (2012). Effect of phosphorus and sulphur nutrition on yield attributes and yield of mungbean (*Vigna radiate L. Wilczek*). *J. Chemical and Pharmaceutical Res.,* 4 (5) : 2571-2573.

Ranaware,V. S. Shaikh, A. A. and Jawale, S. M. (2007). Yield contributing characters and yield in blackgram influenced by integrated nutrient management. *J. Maharashtra. Agric. Univ.,* 32 (3): 321-323 .

Santosh Kumar, Reager, M. L. and Pareek, B. L. (2010). Effect of phosphorus and biofertilizers on nutrient content and its uptake by mothbean , (*Vigna aconitifolia* (Jacq.) Marechal). *J. Progressive Agric*., 1 (1) : 68-70.

Selvakumar, G., Reetha, S. and Thamizhiniyan, P. (2012). Response of biofertilizer on growth, yield attributes and associated protein profiling changes of blackgram. *J. World Applied Sci*., 16 (10) : 1368-1374.

Shinde, D. B., Patil, P.L. and Khade, K.K. (1996). A study on sulphur biofertilization of greengram for yield and quality. *J. Maharashtra Agric. Univ*., 21 (3) : 356-367.

Singh, Y. P. and Singh, R. (2004). Interaction effect of sulphur and phosphorus on growth and nutrient conent of blackgram. *J. Indian Soc. Soil Sci.*, 52 (3)266- 269.

Singh, S. , Singh, K. P. , Singh, S. K , and Kumar, G. (1998). Response of blackgram to sulphur on acid Alfisols of Bihar plateau. *J. Indian Soc. Soil. Sci.,* 46 (2) : 257-260.

Tondon, H. L. S. (1993). Methods of Soil, Plants, Water and Fertilizers Analysis, FDCO, New Delhi., pp:190-205.

Vairavan, K. (2011). Integrated nutrient management in rabi blackgram. *Madras Agric J*., 98 (10-12) : 267-369.

Waranke, D. D. and Barber, S.P. (1974). Root development and nutrient uptake by corn grown in solution culture. *J. Agron.,* 66 : 544.

Zarei, I., Sohrabi, Y., Heidari, G. R., Jalilian, A. and Mohammadi, K. (2012). Effects of biofertilizers on grain yield and protein content of two soybean (*Glycine max* L.) cultivars. *J. African Biotech.,* 11 (27): 7028-7037.

JOURNAL OF APPLIED BIOLOGY AND AGRICULTURE
Vol. 1 No. 2 (Dec 2024); PP 89-102
ISSN :3048-4588

Table 1: Seed yield, Straw yield, Biological yield and harvest index as influenced by various treatments

Treatments	Seed Yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T_1 - RDF	900	1226	2126	42.32
T_2 - RDF + 20 kg S ha^{-1}	1040	1287	2335	44.97

T_3- RDF+20 kg S ha^{-1} + *Rhizobium*	1131	1341	2472	45.73
T_4- RDF + 20 kg S ha^{-1} + PSB	1101	1309	2409	45.68
T_5- RDF + 20 kg S ha^{-1} + *Thiobacillus*	1193	1348	2541	46.92
T_6- RDF + 20 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*	1240	1435	2674	46.43
T_7- RDF + 30kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*	1250	1453	2704	46.29
SE ±	**44.00**	**58.58**	**87.76**	**0.93**
CD at 5%	**135.56**	**NS**	**270.41**	**NS**

Table 2: Protein content, protein yield and test weight as influenced by different treatments in blackgram

Treatments	**Protein content (%)**	**Protein yield (kg ha $^{-1}$)**	**Test weight (g)**

T_1 - RDF	22.67	203.37	53.67
T_2 - RDF + 20 kg S ha^{-1}	23.78	249.23	54.47
T_3- RDF+20 kg S ha^{-1} + *Rhizobium*	23.34	264.39	55.00
T_4- RDF + 20 kg S ha^{-1} + PSB	23.23	255.65	54.50
T_5- RDF + 20 kg S ha^{-1} + *Thiobacillus*	24.38	290.78	55.00
T_6- RDF + 20 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*	24.52	304.37	55.67
T_7- RDF + 30kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*	24.61	308.13	55.90
SE ±	**0.60**	**3.663**	**1.365**
CD at 5%	**NS**	**11.287**	**NS**

Table 3: Effect of sulphur and bio-inoculants on total N, P, K, S, Fe, Mn, Zn and Cu uptake (kg ha $^{-1}$) at harvest of blackgram

Treatments	N	P	K	S	Fe	Mn	Zn	Cu
T_1 - RDF	94.91	14.48	89.78	13.28	6.46	6.90	1.88	1.75
T_2 - RDF + 20 kg S ha^{-1}	100.99	15.43	94.68	15.05	7.68	8.25	2.11	1.92
T_3- RDF+20 kg S ha^{-1} + *Rhizobium*	144.43	20.77	118.15	19.27	11.98	12.51	2.86	2.92
T_4- RDF + 20 kg S ha^{-1} + PSB	138.22	23.10	113.04	18.68	11.82	10.17	3.42	2.52
T_5- RDF + 20 kg S ha^{-1} + *Thiobacillus*	135.36	22.21	123.88	21.49	15.49	11.71	3.37	2.78
T_6- RDF + 20 kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*	182.74	27.83	145.91	24.80	17.94	16.36	4.34	3.61
T_7- RDF + 30kg S ha^{-1} + *Rhizobium* + PSB + *Thiobacillus*	186.38	28.95	145.63	25.66	18.98	21.64	4.54	4.10
SE ±	**8.348**	**1.154**	**7.737**	**1.047**	**0.567**	**3.694**	**0.149**	**0.537**
CD at 5%	**25.722**	**3.556**	**NS**	**3.225**	**1.747**	**NS**	**0.461**	**NS**