Response of boron and biofertilizers on growth and yield of Summer Blackgram (*Vigna mungo* L.)

ABSTRACT

The Experiment was conducted in crop research farm in department of Agronomy during summer season of 2022. The treatments consisted of 3 levels of Boron (1.0, 1.5, and 2.0 kg/ha) as soil application and Rhizobium at (10 and 20 g/kg seed) along with PSB at (10 and 20 g/kg seed) applied as seed inoculation and a control. The experiment was layout in a RBD with 10 treatments and Replicated thrice. Application of 2.0 kg Boron with Rhizobium 10g/kg seed and PSB 10g/kg seed as seed inoculation recorded highest plant height, Maximum plant dry weight, CGR, RGR and the yield attributes namely more Number of pods per plant, seeds per pod, test weight and seed yield.

***Key words*: boron, bio-fertilizers, Yield.**

INTRODUCTION

Blackgram (*Vigna mungo* L.) is one of important pulse crop. The food legumes, particularly the grain or pulses are important food stuff in all tropical and subtropical countries. It is grown throughout India. Blackgram is widely grown grain legume and belongs to the family “leguminoseae” and genus “vigna” and assumes considerable importance from the point of food and nutritional security in the world. It is also known as urdbean, udad dal, urad dal or urad. It produces about 24.5 lakh tonnes of Urad annually from about 4.6 million hectares of area, with an average productivity of 533 Kg per hectare in 2020-21. Blackgram area accounts for about 19 per cent of India's total pulse acreage which contributes 23 per cent of total pulse production. India currently represents the largest producer of black gram accounting for more than 70% of the global production. India is followed by Myanmar and Pakistan. In India during kharif 2019-20, area covered under black gram is 37.52 lakh ha as against 38.18 lakh ha in last year. Tamil Nadu leads first in productivity with an average yield of 775 kg/ha. It contained 24.7% protein, 0.6% fat, 0.9% fibre and 3.7% ash as well as sufficient quantity of calcium, phosphorus and important vitamins. Due to cheaper protein source it is designated as “poor man’s meat”. Pulses are known as the poor man's meat because they are rich in nutrition and low in cost. Therefore, most low income populations can use this nutritious crop as their staple food. Sasidhar, P. (2022).

Boron plays a key role in sugar translocation, nodulation, nitrogen fixation, protein synthesis, sucrose synthesis, cell wall composition, membrane stability, K+ transport, viability of pollen, pollen germination and pollen tube growth and pollination and seed set. Boron deficiency commonly results in empty pollen grains, poor pollen vitality and a reduced number of flowers per plant besides stunted root growth as shown in the soybean and canola. It has been reported that boron deficiency limits reproductive growth. In wheat, B deficiency causes poor anther and pollen development; low grain set and stunted growth. Soils are quite variable in their B and clay forming minerals contents, and therefore have a fundamental effect on the availability of B. Its interaction both synergistic and antagonistic with most of the nutrients (N, P, K, Ca, Mg and Zn) may sometimes be influential in regulating B availability to plants in soil. (Naznin, F. 2020).

Biofertilizers are ready to use live formulations that contain living cells or latent cells of efficient strains of beneficial microorganisms which on application to seed, soil, or root surfaces mobilize the availability of nutrients by increasing biological activity in particular and colonizing the rhizosphere thereby helping in buildup of the micro-flora and in turn the soil health. Bio-fertilizers stimulates the activity of microorganisms that makes the plant to get the macro and micro-nutrients through enhanced biological processes, increase nutrient solubility, alter soil salinity, sodicity and pH, though, they contain relatively low concentrations of nutrients and handling them is labour intensive, there has been largely increase in their use over inorganic fertilizers as nutrient source. The long term manurial studies conducted at many places have revealed the superiority of integrated nutrient supply system in sustaining crop productivity at comparison to chemical fertilizer alone (Yadav, A, K. 2019).

Rhizobium culture to different legumes is common agronomic practice for enhance pulse production. Rhizobium inoculation is essential for all the pulse crops to increase the yield of pulses. It is a bio-fertilizer which increases symbiotic nitrogen fixation and ultimately it increases the yield. Thus, the response of nitrogen to legumes is more important than phosphorus as later is being fixed by the symbiosis. Increasing in the number of such microorganisms accelerates the microbial process to augment to the extent availability of nutrient in the form which can be easily assimilated by the plant. The techniques involving optimization of fertilizer inputs with aim to productivity. Sasidhar, P (2022). The phosphate solubilizing Bacteria (PSB), dissolving inter locked phosphates appear to have an important implication in Indian agriculture The role of microorganisms in solubilizing inorganic phosphates in soil and making them available to plants is well known these microorganisms bring about solubilization by the production of organic acid and phosphate enzyme activity. As regards phosphate only about 15-20 per cent of the applied phosphorous is utilized by first crop.

MATERIALS AND METHODS

The materials and methodology and techniques adopted in the present experiment entitled, Effect of boron and biofertilizers on growth and yield of varieties of black gram (*vigna mungo* L.) with a brief description regarding site of experiment, soil properties, sampling techniques, climatic conditions during crop growing period, cropping history, calendar operations and statistical analysis are presented in this chapter with following headings.

In order to study the three levels boron of and biofertilizers on the growth and yield characters of blackgram. The experiment was conducted at during *zaid* 2022 Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level (MSL). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.36%) and medium in available nitrogen (171.48 kg/ha), phosphorous (15.2 kg/ha) and low in potassium (232.5 kg/ha). The treatments consist three levels of boron (1, 1.5 and 2 kg/ha) and bio fertilizer (20g Rhizobium 20g/seed, PSB 20g/kg seed and Rhizobium 10g/kg seed + PSB 10g/ kg seed) respectively. The experiment was laid out in randomized block design with ten treatments each replicated thrice and control *i.e.,* recommended N, P and K (20:40:20 kg/ha) alone. The plots were prepared with dimension of 3× 3 m and seeds of variety Shekar-II were sown with a spacing of 30cm × 10 cm. At 4-5 leaf stage plants were thinned to appropriate density. Weeds were controlled manually at 5-leaf stage, stem elongation and flowering stage to maintain a uniform plant population. Growth characteristics plant height (cm), number of branches per plant, dry weight per plant (g), crop growth rate (g/m^{2}/day) and relative growth rate (g/g/day) were recorded, with following formulas (A & B). Irrigation were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was completely harvested at physiological maturity stage and their biometric observations such as number of capsules per plant, number of seeds per capsule, 1000 seed weight (g), seed yield (kg/ha), stalk yield (kg/ha) and were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by **Gomez**
(1984).

List 1 : List of treatment combinatioins for the study

TREATMENT No.	TREATMENT COMBINATION
1	Boron (1kg/ha) +Rhizobium (20g/kg seed)
2	Boron (1kg/ha) +PSB (20g/kg seed)
3	Boron (1kg/ha) +Rhizobium (10g/kg seed) + PSB (10g/kg seed)
4	Boron (1.5 kg/ha) +Rhizobium (20g/kg seed)
5	Boron (1.5 kg/ha) +PSB (20g/kg seed)
6	Boron (1.5 kg/ha) +Rhizobium (10g/kg seed) + PSB (10g/kg seed)
7	Boron (2 kg/ha) +Rhizobium (20g/kg seed)
8	Boron (2 kg/ha) +PSB (20g/kg seed)
9	Boron (2 kg/ha) +Rhizobium (10g/kg seed) + PSB (10g/kg seed)
10	20-40-20 NPK kg/ha (control)

RESULT

Growth parameters

Table.1pertaining that details of influence of boron and biofertilizers on blackgram growth attributes.

Plant height (cm)

At 75 DAS, maximum plant height (44.52 cm) was recorded with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed which was significantly superior over all the treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (43.91cm).

Number of branches for plant

At 75 DAS, maximum Branches (7.89) was recorded with application of Boron 2kg+Rhizobium 10g/kg seed + PSB 10g/kg seed. which was significantly superior over all the treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (7.11) and Boron 1.5 kg/ha + Rhizobium 20g/1kg seed (7.11).

Number of nodules for plant

At 45 DAS, maximum No of nodules (40.11) was recorded with application of Boron 2kg+ Rhizobium10g/kg seed + PSB 10g/kg seed which was significantly superior over all the treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (39.56).

Dry Weight (g/plant)

At 75 DAS, maximum Dry Weight (g) (11.08g) was recorded with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed which was significantly superior over all the treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (10.73g).

Crop growth rate (g/m^2/day)

At 45-60 DAS, crop growth rate(g/m^2/day) maximum (9.14 g/m^2/day) was recorded with application of Boron 1.5kg/ha + PSB 20g/1kg seed which was significantly superior over all the treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (7.62), Boron 2 kg/ha + Rhizobium 20g/kg seed (9.07) and Boron 2 kg/ha + PSB 20g/1kg seed (8.35) and Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (8.50).

Relative growth rate (g/g/day)

At 45-60 DAS, Relative growth rate (g/g/day) maximum (0.056 g/g/day) was recorded with application of Boron 1.5 kg/ha + Rhizobium 20g/1kg seed which was significantly superior over all the treatments and statistically at par with Boron 1.5kg/ha + PSB 20g/kg seed (0.054 g/g/day) and Boron 2 kg/ha + PSB 20g/kg seed (0.0049 g/g/day).

Yield attributes

Table.2 pertaining that details of influence of boron and biofertilizers on blackgram yield attributes.

Number of pods/plants

Treatment with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed was recorded maximum number of pods/plant (26.33) which was significantly superior over all other treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (22.44) and Boron 2 kg/ha + PSB 20g/kg seed (22.00).

Number of seeds/pod

Treatment with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed was recorded maximum number of pods/plant (4.77) which was significantly superior over all other treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (4.55).

Test weight(g)

Treatment with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed was recorded maximum number of pods/plant (34.42g) which was significantly superior over all other treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (34.23g) and Boron 2 kg/ha + PSB 20g/kg seed (33.49g).

Seed yield (t/ha)

Treatment with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed was recorded maximum number of pods/plant (1.24t/ha) which was significantly superior over all other treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (1.16t/ha).

Straw yield (t/ha)

Treatment with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed was recorded maximum number of pods/plant (2.03t/ha) which was significantly superior over all other treatments and statistically at par with treatment of Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (1.95t/ha).

Harvest index (%)

Treatment with application of Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed was recorded maximum harvest index (37.95%) which was significantly superior over all other treatments and statistically at par with treatment of Boron 1.5 kg/ha + PSB 20g/kg seed (35.21%), Boron1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed (37.39 %)

DISCUSSION

The increase in plant height and number of primary branches plant-1 may be due to favorable effects of boron on hormonal balance that helped proper growth and development of the soyabean plant. **(Das, S. 2022)**.

Seed inoculation with Rhizobium + PSB significantly increased plant height, leaf area index, stem girth, number of nodules per plant, number of branches per plant, total dry matter at harvesting stage of crops and green pods yield (176.47 g/plant and 110.09 q/ha) over single inoculation of Rhizobium and PSB. Overall improvement in the crop growth and yield parameters under the influence of microbial fertilization i.e.; Rhizobium, PSB and Rhizobium + PSB seems to be on account of their impact on nutritional environment and involvement in various physiological processes in the plant system which are considered to be pre-requisits for growth of the crop. Better nodulation in combined inoculation might be due to increased P availability through PSB and enhanced biological N2 fixation. **(Nadeem, M, A. 2017).**

Nodules :Rhizobium inoculation has a significant effect on plant nodulation. Different Rhizobium inoculation significantly influenced the number of nodule plant-1, nodule fresh weight plant-1, and nodule dryweight plant-1. Rhizobia strain significantly increases plant nodulation. Nodulation enhances the crop yield remarkably.The increased nodulation may due to effective symbiosis between legume and rhizobia strains inoculation significantly increased the nodulation that affected the yield. The result of the experiment indicates that Rhizobium inoculation influenced the inoculation significantly. That is showed the maximum nodulations**.(Islam, N, MD 2021).**

The rise in total dry matter production was attributable to improved source and sink capacity established as a result of improved dry matter production and accumulation in assimilatory surface area, as well as an improvement in photosynthetic efficiency, which resulted in enhanced production of photosynthates, which resulted in better growth and, ultimately, higher dry accumulation. **(Reddy, G, A 2022).**

Main effect of Zn and B were significantly influenced on RGR of blackgram at different growth stages. Data revealed that the application of B levels, B-1.5 kg ha–1 was more efficient to produced higher RGR and lowest RGR was recorded without B treated plants . (**Abu SayemMd.2018).**

This might be due to quick availability of boron to crop during the entire growing season. Boron plays an important role in tissue differentiation and carbohydrate metabolism. It is also a constituent of cell membrane and essential for cell division, maintenance of conducting tissue with regulatory effect on other element. It is also necessary for sugar translocation in plant and development of new cell in meristematic tissue. Similar trend observed that boron has significant effect on plant height, number of branches plant-1, number of pods plant-1, and seed yield of mung bean. **(Pathak, S, O. 2020).**

Highest seed yield was the resultant of cumulative performance by the yield components such as pods plant-1, seeds pod-1 and 1000-seed weight. This could have been due to some synergistic properties of combined use of sulphur and boron fertilization up to certain levels. (**Das, S 2022).**

It might be due to the prospect further revealed that the inoculation of Rhizobium and PSB increase the test weight significantly improved the test weight of grain as comparison to rest of the treatment**. (Sasidhar, P. 2022).**

Increased growth parameters due to adequate sulphur application. Boron increases yield by increasing leaf area expansion, 1000 test weight, seed production, and biological yield. Boron regulates important cellular processes and metabolic activities and is essential for cell differentiation at all growing tips of plants. **(Deep, C, G. 2022).**

The highest yield under this treatment may be ascribed to either direct or cumulative effect of supplied macro-and micronutrients on metabolic processes of black gram. Availability of nutrients, especially the micronutrients at optimum level has direct impact on accelerated cell division and enlargement, root growth and plant vigour which resulted in higher grain and straw production. **(Singh, S, P. 2017).**

The most effective yield component that is most closely connected with seed yield is the number of pods per plant. Increased boron levels had a substantial impact on chickpea grain and stover yield. Which enhanced the survival and multiplication of microorganisms, improved nitrogen fixation, transport of sugars and better uptake and assimilation of available nutrients by the plants during the entire growth period**. (Reddy, G, A 2022).**

CONCLUSION

It is concluded that the treatment combination T9 (boron 2.0 kg/ha + Rhizobium-10g/kg seed + PSB-10g/kg seed) recorded significantly higher Plant height, number of nodules per plant, number of nodules per plant, number of branches per plant, dry weight, pods per plant, seeds per pod, seed yield, stalk yield.

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Table.1 Influence of boron and biofertilizers on growth of blackgram crop

Treatment	Plant height (cm)	Number of branches/plant	Number of nodules/plant	Dry weight (g)	Crop growth rate ($g/m^2/day$)	Relative growth rate (g/g/day)
Boron 1kg/ha + Rhizobium 20g/kg seed	38.09	6.44	34.89	8.25	5.16	0.039
Boron 1kg/ha + PSB 20g/kg seed	41.35	6.67	35.78	8.50	6.99	0.044
Boron 1kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed	40.55	6.56	36.11	9.61	5.87	0.037
Boron 1.5 kg/ha + Rhizobium 20g/kg seed	41.21	7.11	36.78	9.69	5.62	0.035
Boron 1.5kg/ha + PSB 20g/kg seed	42.76	6.67	36.67	10.27	9.14	0.054
Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed	43.91	7.11	39.56	10.73	7.62	0.041
Boron 2 kg/ha + Rhizobium 20g/kg seed	42.57	6.78	38.11	9.50	9.07	0.056
Boron 2 kg/ha + PSB 20g/kg seed	42.31	6.89	37.89	9.22	8.35	0.049
Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed	44.52	7.89	40.11	11.08	8.50	0.044
Control (20:40:20 NPK kg/ha)	37.03	5.67	34.44	7.70	5.14	0.039
F-Test	S	S	S	S	S	S
S.EM (±)	0.52	0.32	0.62	0.21	0.61	0.003
CD (p=0.05)	1.57	0.95	1.85	0.63	1.82	0.011

Table.2 Influence of boron and biofertilizers on yield and yield attributes of blackgram crop

Treatment	No.of pods/plant	No. of seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index(%)
Boron 1kg/ha + Rhizobium 20g/1kg seed	19.44	3.55	29.03	0.67	1.51	30.53
Boron 1kg/ha + PSB 20g/1kg seed	19.88	3.66	31.55	0.76	1.53	33.31
Boron 1kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed	20.33	3.55	30.81	0.74	1.65	30.97
Boron 1.5 kg/ha + Rhizobium 20g/1kg seed	21.22	3.77	30.19	0.80	1.78	31.11
Boron 1.5kg/ha + PSB 20g/1kg seed	21.77	4.22	32.54	1.00	1.83	35.21
Boron 1.5kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed	22.44	4.55	34.23	1.16	1.95	37.39
Boron 2 kg/ha + Rhizobium 20g/1kg seed	21.33	4.00	32.54	0.93	1.75	34.64
Boron 2 kg/ha + PSB 20g/1kg seed	22.00	4.11	33.49	1.00	1.90	34.55
Boron 2kg+ Rhizobium 10g/kg seed + PSB 10g/kg seed	22.66	4.77	34.42	1.24	2.03	37.95
Control (20:40:20 NPK kg/ha)	19.11	3.11	28.51	0.56	1.30	30.34
SEM (±)	0.22	0.15	0.62	0.02	0.04	0.95
CD (p=0.05)	0.68	0.44	1.85	0.08	0.12	2.84