Original Research Article

Effect of bio fertilizers and micro nutrients on growth and yield of black gram

ABSTRACT

The field experiment was conducted during ZAID season, 2023 at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India to study the effect of bio fertilizers and micro nutrients on growth and yield of black gram. The treatments consisted of three levels of bio fertilizers viz., VAM – 25 g/kg seeds, Pseudomonas - 10 g/kg seed, Rhizobium – 20g/ kg seedsand three different micro nutrients viz Zinc - 0.5 %, Iron - 0.5 %, Molybdenum - 0.4%.There were 10 treatments each replicated thrice. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.9), available nitrogen (138.00 kg/ha), available phosphorus (17.5 kg/ha) and available potassium (157.9 kg/ha). Results revealed that ~~s~~Significantly and higher plant height (44.40cm), plant dry weight (5.78 g), number of nodules/ plant (27.20), no of branches (18.43), number of pods (10.07), number of seeds/pod (9.67), seed index (39 g), grain yield (1213.33 kg/ha), stover yield (2233.33kg/ha) were recorded in treatment 8 (Rhizobium – 20g/kg seed + Iron - 0.5 %). Maximum gross return (INR 63,350.00), net return (INR 41,900.00) and B:C ratio (1.95) were also recorded in treatment 8 (Rhizobium – 20g/kg seed + Iron - 0.5 %).

Keywords:*Pseudomonas, Rhizobium, Zinc, Iron, Molybednum*

INTRODUCTION

Black gram (*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.Black gram is widely grown grain legume and belongs to the family "Leguminosae" and genus "*Vigna*" and assumes considerable importance from the point of food and nutritional security in the world. It is also known as urdbean, Urad dal, urad dal or

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urad. It also acts as cover crop and its deep root system protects the soil from erosion. The crop also improves soil fertility by symbiotic fixation of atmospheric nitrogen in root nodules(Sasidhar *et al*.,2022)

Biofertilizers are selected strains of beneficial soil microorganisms cultured in the laboratory and packaged in an appropriate carrier. They help to fix~~es~~ solubilizing different nutrients in soilessential nutrients like nitrogen and phosphorus through their activities in the soil or rhizosphere and gradually make them available to plants. *Rhizobium* culture to different legumes is common agronomic practice for enhanceproduction. *Rhizobium* inoculation is essential for all the pulse crops to increase the yield of pulses. It is a biofertilizer which increases symbiotic nitrogen fixation and ultimately it increases the yield.VAM (*vesicular-arbuscular mycorrhizae*) is a beneficial fungus that plays an important role in soil nutrient dynamics and improving soil physical, chemical and biological properties. VAM involving multistep colonization process, soil phosphorus dynamics in the rhizosphere and mycorrhizal mechanism and pathways involved in phosphorus availability and uptake.*Pseudomonas* belong to plant Growth Promoting Rhizobacteria (PGPR), the important group of bacteria that play a major role in the plant growth promotion, induced systemic resistance, biological control of pathogens etc. Many strains of *Pseudomonas fluorescens* are known to enhance plant growth promotion and reduce severity of various diseases. The efficacy of bacterial antagonists in controlling fungal diseases was often better as alone, and sometimes in combination with fungicides (Lalitha *et al*.,2018), Ganeshan and Kumar (2006), (Sasidhar *et al*.,2022).

Micronutrients are required in lower concentration, for crop plants, nevertheless are vital for ~~to~~ growth and productivity of many crops. Among the micronutrients, in plants, zinc is key constituent of many enzymes and proteins. It is essential in the formation of auxins, which help with growth regulation and stem elongation. Growth parameters were increased by zinc application regardless to its concentration and application method. Iron plays a significant role in various physiological and biochemical pathway in plants. In plants, iron is involved in the synthesis of chlorophyll and it is essential for the maintenance of chloroplast structure and function. Molybdenum is regarded as a critical micronutrient because it's lack causes low seed yield in pulses. It is a structural component of nitrogenase and nitrate reductase enzymes which brings about oxidation- reduction reaction in plant cells~~.~~Anand *et al.*,2022Soni and Kushwaha, (2020).

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MATERIALS AND METHODS

A field experiment was conducted duringzaidseason of2023 at the crop research farm, Department of agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj (U.P.) India. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 6.9)medium in available nitrogen, available phosphorus and available in potassium. The experiments was laid out in Randomized Block Design with 10 treatments each replicated thrice *viz.*, T1- VAM-25g/ kg seed+Zinc-0.5%, T2- VAM-25g/kg seed+Iron-0.5%,T3- VAM-25g/kg seed+Molybednum-0.4%,T4-*Pseudomonas*-10g/kg seed+Zinc-0.5%,T5 –*Pseudomonas*-10g/kg seed+Iron-0.5%, T6-*Pseudomonas*-10g/kg seed+Molybednum-0.4%, T7- *Rhizobium*-20g/kg seed+Zinc-0.5%, T8-*Rhizobium*-20g/kg seed+Iron-0.5%, T9- *Rhizobium*-20g/kg seed+Molybednum-0.4%,T10-Control (RDF)-NPK-20 – 40 - 20 kg/ha.The observations were recorded for plant height (cm), dry weight (g), number of nodules, number of branches, crop growth rate (g/m^2/day), relative growth rate (g/g/day), number of pods /plant (no.), no of seeds/pod, Seed index (g), seed yield (t/ha), stover yield (t/ha), harvest index(%). The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1976).

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RESULT AND DISCUSSION

GROWTH PARAMETERS

Plant height: At 60 DAS, significantly highest plant height (44.40 cm) was recorded with seed treatment of *Rhizobium*-20g/kg seed and foliar spray of Iron - 0.5%. However, the treatment T_4(*Pseudomonas* 10g/kg+ Zinc 0.5%) was found to be statistically at par with T_8. The better supplement of nutrients and increase in the availability of *Rhizobium* to plant might have stimulated the metabolic and enzymatic activities in crop and involved in the synthesis of chlorophyll and it is essential for the maintenance of chloroplast structure and function which helps in the increasing the growth of the plant.*Rhizobium* inoculation, which may maintain favourable balance between the applied nutrients in the plant for its optimum growth while elongation and chlorophyll biosynthesis in turn, improve the plant height. Similar findings were reported by (Kumar *et al.*,2020) in chickpea, (Subha *et al.*,2021) in black gram and (Boradkar*et al.*,2023) in green gram.

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Plant dry weight: At 60 DAS, significantly higher plant dry weight (5.78 g/plant)was recorded with the treatment *Rhizobium* – 20g/kg seed+Iron-0.5%. However, the $T_5$was found to be

statistically at par with $T_{8.}$ It might be due to *Rhizobium* and iron Dry matter accumulation was increased. *Rhizobium* inoculation, helps for its optimum growth, elongation and chlorophyll biosynthesis, which resulted in might be due to better growth of plants in terms of plant height and number of branches plant, ultimately resulted in higher dry matter accumulation. The increase in the availability of iron to plant might have stimulated the metabolic and enzymatic activities there by influenced the plant vigour through absorption of nutrients at critical stages that enhance the physiological activity of crop and increase the assimilation of photosynthates ultimately increasing the dry matter accumulation. similar Dobariya and Patel (2021), (Suman*et al*.,2021), (Kumar *et al*.,2021) in chickpea.

Number ofroot nodules:At 45 DAS, the significantly higher number of root nodules (27.20) was observed in treatment *Rhizobium* – 20g/kg seed + Iron - 0.5%. However, $T_{5,}$ $T_{6,}T_7$was statistically at par with $T_{8.}$The increase in nodule number was due to better compatibility and efficiency of inoculated *Rhizobium*it might have resulted due to more competitive ability of microbes near roots which is the site for microbial infection. Well-developed root system provides more evidence for infection resulting in greater number of nodules. Iron is important in nodule nitrogen fixation and is a component of key proteins such as nitrogenase, ~~leghemoglobin~~leghaemoglobin and ferredoxin. Similar findings were reported by (Geetanjali *et al*2020) (Kumar *et al*.,2020) in chickpea(S~~s~~ubha*et al*2021) in black gram.

Number ofbranches: At 60 DAS, the significantly higher number of branches (18.43) was observed in treatment *Rhizobium*-20g/kg seed+Iron-0.5% However,$T_{6,}$ T_5 was statistically at par with $T_{8.}$

This enhancement could be attributed to the promotional effects of iron on vegetative growth, ultimately leading to increased photosynthetic activity. Additionally, it may result from the availability of the required quantity of essential plant nutrients at various growth stages, accelerating plant metabolic processes and consequently leading to the production of more branches. (Rawat *et al*2023) in chickpea.

Yield attributes

Pods/plant: Significantly maximum pods/plant (10.07) was recorded with the treatment of *Rhizobium* – 20g/kg seed + Iron - 0.5%, which was found to be at par withT_5,T_7. These micronutrients and *R~~r~~hizobium* led to greater photosynthates production and vigorous growth. Further with efficient partitioning of accumulated photosynthates resulted in more bud initiation and flower initiation. which might have also responsible for efficient translocation

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of photosynthate from source to sink, this causes higher number of pod formation (Singh, 2017) and (Soni and Kushwaha 2020)

Seeds/pod: Significantly maximum seeds/pod (9.67) was recorded with the treatment of Rhizobium - 20 g/kg seed + Iron - 0.5%. However, T_2,T_4, T_7were found to be statistically at par with T_8. which might be due to greater availability of nutrients Iron and *Rhizobium* inoculation which was easily absorbed by the crop which significantly increase the rate of photosynthesis. The translocation and accumulation of photosynthates in the economic sinks resulted in increased seeds/ pod. Similar findings were reported by (Kumar *etal*.,2020) and (Veer *et al*.,2022).

Seed index: Significantly maximum seed index (39.00 g) was recorded with the treatment of *Rhizobium* - 20g/kg seed + Iron - 0.5%, VAM–25g seed/kg+Zinc-0.5%, VAM – 25g/kg seed+Iron-0.5%.HoweverT_5,T_6,T_9were found to be statistically at par withT_1,T_2,T_8.Increase in Seed index due to greater mobilization of photosynthesis to the developing seeds by application of iron might be the reason for increase in seed weight. Increase in this attributemight be due to the involvement of the iron.*Rhizobium*helps in enzyme activation, membrane integrity, chlorophyll formation, stomatal balance and starch utilization at early stages which enhanced accumulation of assimilate in the grains resulting in heavier grains. (Boradkar*et al*.,2023) and (Murali *et al*.,2018).

Seed yield: Significantly maximum seed yield (1213.33kg/ha) was recorded with thetreatment of *Rhizobium* - 20g/kg seed + Iron - 0.5%.In the process of tissue differentiation from somatic to reproductive, meristematic activity and development of floral primordial might have increased with *Rhizobium* inoculation methods resulting in more flowers and pods and ultimately the higher grain yield. demand of crop by higher assimilation and translocation of photosynthates from source to sink and better role of iron and rhizobium during reproductive phase of crop growth. However, combined effect of iron and *Rhizobium* provided sufficient nutrition to the plant and thereby more yield attributes and yield was recorded. Similar finding was reported by (Boradkar*et al*.(,2023) and (Tripathi *et al*.(,2021).

Stover yield: Significantly maximum stover yield (2233 kg/ha) was recorded with the treatment of *Rhizobium* - 20g/kg seed + Iron - 0.5%. *Rhizobium* inoculation photosynthetic activity increases of leaves, translocation of photosynthates from source to sink with consequent improvement, nutrients uptake and better metabolism and increase efficiency of

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other nutrients. Iron application also helped in better vegetative growth in plant, which helped in increase in the yield. (Subha *et al*.,2021)

Harvest index: Significantly maximum harvest index (34.91%) was recorded with the treatment of *Rhizobium* - 20g/kg seed +Iron-0.5%. However, the treatment ~~However,~~ T_1, T_2, T_5 were found to be statistically at par with T_8. Harvest index is directly correlated to the seed yield and haulm yield. Increased harvest index was due to better crop growth from early stages to at harvest. it might be due to less vegetative growth of plants which ultimate produce lower biological yield which increase the percentage of harvest index. Similar findings reported by (Kumar *et al.*, 2020)

Economic

Gross returns: Significantly higher gross return (63,350.00 INR/ha) was recorded with treatment Rhizobium-20 g/kg seed + Iron - 0.5%.

Net returns: Significantly higher net return (41.900.00INR/ha) was recorded under treatments Rhizobium - 20g/kg seed + Iron - 0.5%

Benefit-cost ratio: Significantly higher benefit-cost ratio (1.95) was recorded under treatment Rhizobium – 20g/kg seed + Iron - 0.5%.

CONCLUSION

It is concluded that the application of T_8(*Rhizobium* – 20g/kg seed+Iron-0.5%) recorded higher yield and benefit cost ratio in black gram.

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Table 1. Effect of biofertilizers and micronutrients on yield of black gram

S.No	Treatment combinations	Plant height (cm)	Dry weight (g)	No of branches	No of Root nodules
1.	VAM-25g/kg seed+Zinc-0.5%	39.14	4.94	17.03	23.93
2.	VAM-25g/kg seed+Iron-0.5%	39.87	4.97	17.13	23.77
3.	VAM-25g/kg seed+Molybednum-0.4%	38.86	5.03	17.17	24.60
4.	*Pseudomonas*-10g/kg seed+Zinc-0.5%	41.00	5.13	17.10	24.60
5.	*Pseudomonas*-10g/kg seed+Iron-0.5%	40.53	5.39	18.13	25.50
6.	*Pseudomonas*-10g/kg seed+ Molybednum-0.4%	40.11	5.08	18.27	25.27
7.	Rhizobium-20g/kg seed+Zinc-0.5%	37.48	5.60	17.17	25.27
8.	Rhizobium-20g/seed+Iron-0.5%	44.40	5.78	18.43	27.20
9.	Rhizobium-20g/kg seed+Molybednum-0.4%	39.53	5.07	17.37	24.37
10.	Control (RDF)-20-40-20 NPK Kg/ha	35.93	4.46	16.13	21.13
	SFm(±)	1.33	0.21	0.35	0.75
	CD(p=0.05)	3.96	0.64	1.07	2.25

Table:2.Response of bio fertilizers and micro nutrients on yield attributes and yield of black gram

Treatments	At Harvest					
	Pods/plant	**Seed/ pod**	**Seed index (g)**	**Seed yield (Kg/ha)**	**Stover yield (kg/ha)**	**Harvest index (%)**
1. VAM-25g seed/kg+Zinc-0.5%	9.07	7.80	39.00	980.00	1836.67	34.74
2. VAM-25g/kg seed+Iron-0.5%	8.87	8.73	39.00	990.00	1933.33	33.88
3. VAM-25g/kg seed+Molybdenum-0.4%	9.47	8.33	38.00	970.00	2050.00	32.14
4. *Pseudomonas*-10g/kg seed+Zinc-0.5%	8.93	8.73	38.00	976.33	2123.33	31.48
5. *Pseudomonas*-10g/kg seed+Iron-0.5%	9.67	8.73	38.00	1150.00	2183.33	34.65
6. *Pseudomonas*-10g/kg seed+Molybdenum-0.4%	8.80	8.27	38.33	963.00	2126.67	31.14
7. Rhizobium-20g/kg seed+Zinc-0.5%	9.53	8.80	36.33	1016.67	2166.67	32.03
Rhizobium-20g/kg seed+Iron-0.5%	10.07	9.67	39.00	1213.33	2233.33	34.91
8. Rhizobium-20g/kg seed+Molybdenum-0.4%	9.27	7.80	38.67	976.67	2126.67	30.84
9. Control (RDF)- 20,40,20 N, P, KKg/ha	9.47	7.87	38.33	945.67	1996.67	31.18
S. Em (±)	0.18	0.37	0.50	28.92	83.77	1.05
CD (p = 0.05)	0.56	1.10	1.50	85.92	248.9	3.12

Table:3 Response of bio fertilizers and micro nutrients on economics of black gram

S.no	Treatment combination	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C
1.	VAM-25g seed/kg+Zinc-0.5%	20,730.00	51,605.00	30875.00	1.49
2.	VAM-25g/kg seed+Iron-0.5%	20,830.00	52,400.00	31570.00	1.52
3.	VAM-25g/kg seed+Molybdenum-0.4%	23,430.00	51,575.00	28145.00	1.20
4.	*Pseudomonas*-10g/kg seed+Zinc-0.5%	20,800.00	51,851.67	31051.67	1.49
5.	*Pseudomonas*-10g/kg seed+Iron-0.5%	20,900.00	59,916.67	39016.67	1.87
6.	*Pseudomonas*-10g/kgseed+Molybdenum-0.4%	23,500.00	51,190.00	27690.00	1.18
7.	*Rhizobium*-20g/kg seed+Zinc-0.5%	21,350.00	54,083.33	32733.33	1.53
8.	*Rhizobium*-20g/kg seed+Iron-0.5%	21,450.00	63,350.00	41900.00	1.95
9.	*Rhizobium*-20g/kg seed+Molybdenum-0.4%	24,050.00	50,523.33	26473.33	1.10
10.	Control (RDF)- 20-40-20 N, P, K Kg/ha	22,550.00	48,328.33	25778.33	1.14

*Data not subjected to statistical analysis

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