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Response of Biofertilizers and Kinetin on Growth and Yield Parameters of Summer Blackgram (*Vigna mungo* L.)

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ABSTRACT

The field experiment on blackgram was carried out in summer, 2022 at the Crop Research Farm in the Department of Agronomy. The treatment consisted of three levels of biofertilizer no seed inoculation, Phosphate solubilizing bacteria (20 g/kg seeds), *Rhizobium* (30 g/kg seeds), three levels of kinetin (20, 30 and 40 ppm) foliar spray and a control. The experiment was set up using a Randomized Block Design with ten treatments and three replications. The variety black gold of black gram was sown in *Zaid* 2022. The results of the experiment revealed that foliar application of 40 ppm kinetin along with biofertilizers recorded significantly increased growth parameters viz., plant height (33.94 cm), number of branches (8.13), number of nodules per plant (36.80), plant dry weight (4.47 g/plant), crop growth rate (8.23 g/m^2/day), relative growth rate (0.10 g/g/day). Same treatment also resulted in boosting yield and yield attributes viz., number of pods per plant (27.50), number of seeds per pod (8.07), test weight (40 g), seed yield (0.71 t/ha), stover yield (1.82 t/ha), harvesting index (28.09 %). In terms of gross returns (67450.00 INR/ha), net returns (44885.00 INR/ha), and the B:C (1.99), this treatment also demonstrated its favorable effects.

Keywords Black gram, Growth parameters, Kinetin, PSB, *Rhizobium* spp.

INTRODUCTION

Pulses are referred to as "poor man's meat" because they are cheaper source of protein. Pulses are "Marvel of Nature" they assist in fixing nitrogen from the atmosphere, through symbiosis. Black gram scientific name is *Vigna mungo* L., also known as Urad, Biri or mash in India. It belongs to the fabaceae family. It is from central Asia and India, where it was domesticated and spread throughout the world. As a fodder crop, it is grown in the USA and Australia (Masu *et al.* 2019). It serves primarily as nutrient-rich fodder for dairy animals. *Vigna mungo* has the following nutritional content per 100 g: 25 g protein, 138 g calcium, 7.57 g iron, 983 g potassium, 1.447 g niacin, 0.27 g thiamine, and 0.25 g riboflavin. Additionally, black gram contains a significant amount of folate (216 µg/100 g cooked, 628 µg/100 g raw) (Mugundha *et al.* 2022). With a national annual productivity of 533 kg per hectare, black gram production in

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2020–21 was 24.5 lakh tonnes from an area of 4.6 million hectares. It accounts for 10% of the nation's total pulse production and 13% of the total pulse area in India. In 2015 Uttar Pradesh got first rank in the production list (16.98%) and Madhya Pradesh comes in second (15.07%). The highest yield was in Bihar (898 kg/ha) (Directorate of economics and statistics, 2015). Plant growth regulators work by acting inside the plant cells to replenish the enzyme system, which helps to modify plant physiological processes and regulate plant metabolism. Although kinetin (Kn) is a well-known plant growth regulator, little is known regarding how it affects the interactions between phytohormones to improve plant growth and food quality. Due to its capacity to enhance cell division when auxin was present in the medium, it was given the name kinetin. The later shoot growth from lateral buds is stimulated by Kn application in pulses, and yield attributes, seed yield and population yield are all improved in turn (Sadak *et al.* 2013). Application of kinetin can control hormonal balance, which in turn controls nodule development and maintains plant senescence (Egamberdieva *et al.* 2017). Biofertilizers consists of living microorganisms which colonizes the inner portion of plant or the rhizosphere when applied to plants surface, soil and seeds and promotes the growth by regulating the amount or accessibility of essential nutrients to the plant host. Among all the rhizobacteria that promote plant growth, phosphorus-solubilizing bacteria (PSB) have proven to be the most effective bacteria for use as biofertilizers for plant growth and nutrient use efficiency (PGPR). The availability of phosphate to plant roots is impacted by the transformation of phosphate by soil microbes. The application of PSB results in an increase in morphological characters. *Rhizobium* spp. are soil microorganisms that help legumes use and "fix" atmospheric nitrogen for plant growth. Intensified nodulation and the morphological characteristics of the plant are both significantly influenced by *Rhizobium* spp. Due to their crucial role in soil N_2-fixation, it assumes a great significance. Through improved root growth and greater nutrient availability brought about by its inoculation, the root nodulation increases, which improves plant nutrient uptake and utilization overall. Identical results were also reported by Nawhal and Umesha (2022). The plant may acquire both N and P if *Rhizobium* spp. and phosphate solubilizing bacteria (PSB) are inoculated simultaneously. To increase the availability of native fixed phosphate and decrease the use of fertilizers, attention has been focused on the inoculation of seed with *Rhizobium* spp. and PSB (Jangir *et al.* 2016). Because of this, plants that have been applied kinetin along with biofertilizer inoculation (*Rhizobium* spp and phosphate-solubilizing bacteria) can easily avail nitrogen and phosphorus from their combined application. This also makes it simpler for nutrients and hormones to reach the site of food synthesis directly, leading to a rapid food production.

MATERIALS AND METHODS

A field trial on black gram was carried out at Crop Research Farm of Sam Higginbottom University of Agriculture, Technology and Sciences, UP, during the *Zaid* season of 2022. Experimental field soil is nearly neutral in nature (pH 7.4), with high levels of nitrogen (260.25 kg/ha), potassium (242.1 kg/ha), and phosphorus (22.6 kg/ha) and had sandy loam texture. There were ten treatment combinations set up using a Randomized Block Design viz., T_1: No inoculation and spray of 20 ppm kinetin, T_2: Inoculation of seeds with PSB and spray of 20 ppm kinetin, T_3: Inoculation of seeds with *Rhizobium* spp. and spray of 20 ppm kinetin, T_4: No inoculation and spray of 40 ppm kinetin, T_5: Inoculation of seeds with PSB and spray of 30 ppm kinetin, T_6: Inoculation of seeds with *Rhizobium* spp and spray of 30 ppm kinetin, T_7: No inoculation and spray of 40 ppm kinetin, T_8: Inoculation of seeds with PSB and spray of 40 ppm kinetin, T_9: Inoculation of seeds with *Rhizobium* spp. and spray of 40 ppm kinetin and T_{10}: Blanket application of 20-40-20 kg/ha of NPK (control). The field was thoroughly tilled, clods and stubbles were removed to achieve a fine tilth. Field was divided in 30 plots, each measuring 3.0 m × 3.0 m, seeds of black gold variety were sown at a spacing of 30 cm between rows and 10 cm between plants, through line sowing method. The growth parameters such as number of nodules, plant height (cm), dry weight (g/plant), number of branches per plant and yield attributes and yield such as number of pods per plant, seeds per pod, test weight, seed yield (0.71 t/ha) were recorded at an interval of 15 days and statistically analyzed by ANOVA (Gomez and Gomez 1984).

Table 1. Effect of biofertilizers and kinetin on growth attributes of blackgram.

	Treatments	At 45 DAS			At 45 DAS
		Plant height (cm)	Branches per plant (No.)	Dry weight (g/plant)	Nodules per plant (No.)
1	No inoculation + 20 ppm kinetin	23.57	6.13	0.59	27.00
2	PSB + 20 ppm kinetin	27.76	6.67	0.70	29.33
3	*Rhizobium* spp. + 20 ppm kinetin	25.05	6.20	0.65	31.66
4	No inoculation + 30 ppm kinetin	24.97	7.33	0.59	26.00
5	PSB + 30 ppm kinetin	30.81	5.60	0.67	28.86
6	*Rhizobium* spp. +30 ppm kinetin	26.42	7.50	0.62	33.20
7	No inoculation + 40 ppm kinetin	27.89	7.07	0.76	28.66
8	PSB + 40 ppm kinetin	33.94	7.73	0.72	32.60
9	*Rhizobium* spp. + 40 ppm kinetin	31.25	8.13	0.49	36.80
10	Control (20-40-20 kg NPK/ha)	24.68	5.33	0.49	24.80
SEm (±)		0.80	0.26	0.02	1.04
CD (5%)		2.39	0.78	0.06	3.10

Table 2. Effect of biofertilizers and kinetin on yield attributes and yield of blackgram.

	Treatments	Pods/ plant (No.)	Seeds/ pod (No.)	Test weight (g)	Seed yield (t/ha)
1	No inoculation + 20 ppm kinetin	17.55	4.77	30.33	0.50
2	PSB + 20 ppm kinetin	21.11	5.07	34.33	0.61
3	*Rhizobium* spp. + 20 ppm kinetin	20.33	6.97	34.00	0.64
4	No inoculation + 30 ppm kinetin	18.33	3.97	37.00	0.56
5	PSB + 30 ppm kinetin	24.55	5.20	39.00	0.66
6	*Rhizobium* spp.+ 30 ppm kinetin	22.10	5.30	38.00	0.67
7	No inoculation + 40 ppm kinetin	19.33	4.97	36.00	0.59
8	PSB + 40 ppm kinetin	27.50	8.07	40.00	0.69
9	*Rhizobium* spp.+ 40 ppm kinetin	25.73	5.97	37.00	0.71
10	Control (20-40-20 kg NPK/ha)	15.55	6.07	37.33	0.45
SEm (±)		0.30	0.66	1.46	0.02
CD (5%)		0.90	1.98	4.35	0.06

RESULTS AND DISCUSSION

Growth attributes

Growth characteristics observations including plant height, number of branches, dry weight per plant and number of nodules are presented in the Table 1. Seed inoculation with PSB (20 g/kg) followed by foliar spray of kinetin 40 ppm was resulted in significantly highest plant height (33.94) which was found statistically at par with treatment 8 (31.25 cm). Number of branches (8.13) were increased significantly with seed inoculation with *Rhizobium* spp. followed by foliar spray of kinetin 40 ppm, while treatment 8 (7.73) and 9 (7.50) was found to be statistically at par with the highest. There was significant increase recorded in number of nodules (36.8) under the same treatment. These results might be due kinetin has an important function as a promoter of cell division and acts in the induction, development of meristematic tissues, retards different types of stresses thereby increasing the plant growth parameters and there would be better nutrient availabilities. The result is supported by Mazid (2014), Rasool and Singh (2016). The increased number of nodules could be a result of its balancing effect on apical dominance. As *Rhizobium* spp. affects plant growth and development through a variety of mechanisms, including optimised mineral uptake, the inhibition of plant diseases, boosts the microbial population in legume crops and produces more nodules per plant and maintenance of a favorable balance between the applied nutrients in the plant for its optimum growth while elongation, kinetin at high levels encourages the formation of lateral shoots from lateral buds and increases the number of shoots in pulses. Karaca and Uyanoz (2012) also reported the similar findings. In comparison to all other treatments, the foliar spray of 40 ppm kinetin without seed inoculation resulted in the highest plant dry weight (0.76). This might be due to sufficient application of kinetin which encouraged rate of photosynthetic activity, increased chlorophyll formation, and enabled

Table 3. Effect of biofertilizers and kinetin on economics of blackgram. Price of grain Rs 95/kg (MSP), Price of haulm: Rs 3/kg.

	Treatment details	Gross return (INR/ha)	Net return (INR/ha)	B:C
1	No inoculation + 20 ppm kinetin	47183.33	25708.33	1.20
2	PSB + 20 ppm kinetin	57950.00	36340.00	1.68
3	*Rhizobium* spp. + 20 ppm kinetin	60483.33	38948.33	1.81
4	No inoculation + 30 ppm kinetin	53200.00	31225.00	1.42
5	PSB + 30 ppm kinetin	62383.33	40273.33	1.82
6	Rhizobium spp.+ 30 ppm kinetin	63650.00	41585.00	1.88
7	No inoculation + 40 ppm kinetin	55575.00	33100.00	1.47
8	PSB + 40 ppm kinetin	65866.67	43256.67	1.91
9	*Rhizobium* spp.+ 40 ppm kinetin	67450.00	44885.00	1.99
10	Control (20-40-20 kg NPK/ha)	42750.00	22275.00	1.09

the plant tissue to expand. Similar results are also supported by Menaka *et al.* (2018).

Yield attributes and yield

Yield attributes and yield observations including number of seeds per pod, number of pods per plant, test weight and seed yield were presented in the Table 2. These attributes were notably highest in treatment 8 (seed inoculation with 20 g/kg PSB along with the foliar spray of 40 ppm kinetin), except seed yield which was highest in treatment 9 (seed inoculation with 30 g/kg *Rhizobium* spp. along with foliar spray of 40 ppm kinetin). If seeds were treated with both microorganisms and plant growth regulators, this increases carbohydrate accumulation and remobilization to the plants reproductive parts the nearest sink led to an increase in flowering, fruiting, as well as seed production. Increased pod production could be attributed to early vegetative growth that was more vigorus, accumulated more dry weight, produced a significant increase in the number of branches bearing pods. Similar results were noted by Singh *et al*. (2022).

Economics

Economics of blackgram were presented in Table 3. The inoculation of seeds with *Rhizobium* spp. (20 g/kg) along with the foliar spray of 40 ppm kinetin produced the highest gross return (67450.00 INR/ha), net return (44885.00 INR/ha) and B:C (1.99) ratio. This might be because *Rhizobium* spp. inoculation followed by spray of kinetin increased root nodulation through better root growth and increased nutrient availability, which led to vigorus plant growth and dry weight production, which improved flowering, fruiting and pod formation. As a result, there was a positive impact on seed yield, which in turn improved net return, gross return and the B:C ratio. Similar findings were reported by Kumawat *et al.* (2013).

CONCLUSION

On the basis of one season experimentation, it can be concluded that with the application of *Rhizobium* spp. 30 g/kg followed by foliar spray of kinetin 40 ppm (T_9) was found to be more desirable in terms of increasing yield and economics of summer black gram.

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