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Effect of plant growth promoting rhizobacteria on yield and yield attributes of blackgram (*Vigna mungo* L.)

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ABSTRACT

A field experiment entitled "Effect of Plant Growth Promoting Rhizobacteria on yield and yield attributes of blackgram (*Vigna mungo* L.)" was conducted during *Rabi*, 2024–25 at the Agricultural College Farm, Bapatla. The experiment was laid out in a randomized block design comprising of nine treatments and three replications. The treatments consisted of, seed treatment with *Rhizobium* @ 10 mL/ kg seed (T_1), seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed (T_2), seed treatment with Pink-Pigmented Facultative Methylotrophic bacteria (PPFM) @ 10 mL/ kg seed (T_3), foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_4), foliar spray of PPFM @ 5 mL/ litre (T_5), foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre + foliar spray of PPFM @ 5 mL/ litre (T_6), seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_7), seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre (T_8) and control (T_9). All foliar sprays were applied once at 40 DAS. Among all the treatments, blackgram seeds treated with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre recorded superior performance over control with respect to yield and yield attributes. The seed treatments and foliar sprays of PGPRs had positive effects on the yield and yield attributing traits *viz.,* number of pods per plant, pod weight, test weight and seed yield. Among all the treatments, seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre (T9) found to be the best, significantly increased yield and was consistent in the present study.

Keywords: *Bacterial leaf blight, Disease severity, Rice and Rice ecosystem*

Pulses are rich in proteins and found to be main source of protein to people of India. Pulses play an indispensable role in Indian agriculture as they restore soil fertility by fixing atmospheric nitrogen through their nodules. The stable increase in Indian population together with stagnant production of pulses over the past four decades compared to cereals has resulted in decreased per cent handiness of pulses. Therefore, much attention has been given to boost up pulse production in India (Shashikumar *et al*., 2013).
Blackgram is the fourth important pulse crop in India in terms of extent of cultivation. India is the world's largest producer as well as consumer of blackgram. Blackgram area accounts for about 29% of India's total pulse acreage and contributes 10.25% total pulse production. In *rabi* 2022-23, blackgram area was 19.21 lakh hectares which was decreased by 5.0% when compared to last year in India (www.agricoop.nic). In Andhra Pradesh, during *rabi* 2022-23, blackgram was grown in 3.13 lakh hectares with a production of 4.02 lakh tonnes and productivity of 1279 kg/ha (DES-AP). Blackgram contains 25-26% protein, 60% carbohydrate, 1.5% fat, minerals, aminoacids as well as vitamins (Jadhav *et al*., 2017) thereby increasing its nutritional quality.

Despite occupying a greater position both in respect of area and production, the productivity of blackgram is very low compared to its yield potential, because the crop is mainly grown in uplands and residual moisture conditions in rice fallows with poor management practices, and also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from genetic makeup, the physiological factors *viz*., insufficient partitioning of assimilates (or) reduced translocation of assimilates to the reproductive parts, poor pod setting due to flower abscission/flower drop, lack of nutrients during critical stages of crop growth play a major role in declined blackgram production (Marimuthu and Surendran, 2015).

Different agronomic practices and strategies such as genetic approaches and the use of beneficial microbes have been adopted to tackle the adverse effects of these severe conditions. PGPRs are a heterogeneous group of bacteria that can be found in the rhizosphere, at root surface and in association with roots, which can improve plant growth directly or indirectly (Kloepper *et al*., 1989).

During the last few decades PGPRs have been employed in agriculture to improve nutrient availability, stress tolerance and sustainability of production. A large number of plant growth promoting bacteria including *Rhizobium*, *Pseudomonas*, *Methylobacterium*, *Azotobacter*, *Azospirillum*, and *Bacillus* have been isolated and characterized in terms of their plant growth promotion abilities (Ramasamy *et al*., 2011). PGPRs influence a wide array of physiological and biochemical parameters like uptake of nutrients, increased mobilization of photo-assimilates, enhancing osmoregulation and release of antioxidants during stress conditions and thus increasing the crop yields. Therefore, this study was conducted to evaluate the influence of seed treatments and foliar sprays of PGPRs on yield and yield attributes of blackgram.

MATERIAL AND METHODS

A field experiment was conducted in *rabi* during 2024-2025 at Agricultural College Farm, Bapatla, Andhra Pradesh. It is geographically located at 15°54" Northern latitude, and 80°25" Eastern longitude, with an altitude of 5.49 m above the mean sea level (MSL), which is about 8 km away from the Bay of Bengal in the Krishna Agro - Climatic Zone of Andhra Pradesh. The present study was laid out in a randomized block design with 9 treatments, replicated thrice and variety was LBG-884. The treatments used in the experiment were, seed treatment with *Rhizobium* @ 10 mL/ kg seed (T_1), seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed (T_2), seed treatment with Pink- pigmented facultative methylotrophic bacteria (PPFM) @ 10 mL/ kg seed (T_3), foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_4),foliar spray of PPFM @ 5 mL/ litre (T5), foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre + foliar spray of PPFM @ 5 mL/ litre (T_6), seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_7), seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre (T_8) and control (T_9).

Prior to sowing, blackgram seeds were subjected to seed treatments with *Rhizobium* @ 10 mL/ kg seed (T_1), *Pseudomonas fluorescence* @ 10 mL/ kg seed (T_2 and T_7), and pink-pigmented facultative methylotrophic bacteria (PPFM) @ 10 mL/ kg seed (T_3 and T_8). The treated seeds were uniformly coated with the respective microbial inoculants and allowed to dry in shade for 30 minutes to ensure proper adherence. All foliar sprays were applied once at 40 DAS to coincide with the active vegetative to early reproductive transition phase of blackgram, a critical stage for nutrient uptake and physiological activity.

At harvest, data on yield and yield attributes was recorded. Data on the number of pods per plant and pod weight were collected from five tagged plants per plot. Test weight was determined by counting and weighing 100 seeds from a representative sample. Seed yield per hectare was calculated by harvesting the net plot area, threshing and cleaning the seeds, and calculating the weight on a hectare basis.

The experimental data were statistically analyzed using the analysis of variance (ANOVA) technique for a Randomized Block Design (RBD). Treatment means were tested for significance using the F-test at 1 per cent and 5 per cent levels.

RESULTS AND DISCUSSION

Number of pods per plant

The data on number of pods per plant presented in Table 1. Among the treatments, the seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre (T_8) recorded the higher number of pods per plant (49.47) which was at par with seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_7-45.43). While, it was lower in control (T_9- 31.57) followed by seed treatment with *Rhizobium* @ 10 mL/ kg seed (T1-38.77).

The seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre (T_8) shown greater performance and increased the number of pods (49) in comparison to control (31). The significant increase in the number of pods per plant under T_8 (seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre) can be attributed to the enhanced cytokinin production by PPFMs, which promoted cell division and pod initiation. The present study was in consistent with the results of Ajay Kumar *et al*. (2023) and Krishnaveni *et al*. (2021).

Pod weight (g plant^{-1})

The data presented in Table 1 revealed that pod weight was significantly influenced by different seed treatments and foliar applications. Among all the treatments, T_8 (seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre) recorded the higher pod weight (21.32 g plant^{-1}), which was at par with seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_7- 19.64 g plant^{-1}). While, it was lower in control (T_9- 13.42 g plant^{-1}). Pod weight was improved by 58.8% and 46.3% in seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre and seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre, respectively, over control.

This notable increase in pod weight under T_8 as PPFMs produce phytohormones such as auxins and cytokinins, which not only improves plant vigor but also enhance assimilate transport toward developing pods. Additionally, the application of foliar sprays at a critical stage (40 DAS) might improved nutrient absorption and utilization efficiency, resulting in better grain filling and heavier pods. These results are supported by the findings of Madhaiyan *et al*. (2006).

Test weight (g)

The data furnished in the Table 1 and revealed that the test weight was significantly influenced by different seed treatments and foliar sprays by PGPRs. Higher test weight (4.83 g) was observed in T_8 (seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre), which was at par with (T_7- seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre) of 4.68 g. The lowesr test weight (3.10 g) was recorded in the control (T_9).

Test weight increased by 1.73 g and 1.58 g in seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre and seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre, respectively, over control.

Higher test weight generally signifies well

Table 1. Effect of PGPRs on the number of pods per plant, pod weight (g plant^{-1}), test weight (g) and seed yield (kg ha^{-1}) in blackgram

Treatments	Yield & Yield attributes			
	Number of pods plant^{-1}	Pod weight (g plant^{-1})	Test weight (g)	Seed yield (kg ha^{-1})
T_1 : Seed treatment with *Rhizobium* @ 10 mL/ kg seed	38.77	16.97	3.75	932.67
T_2 : Seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg	39.37	17.5	4.07	933.66
T_3 : Seed treatment with Pink-pigmented facultative Methylotrophic bacteria (PPFM) @10 mL/ kg seed	39.43	17.57	4.13	934.36
T_4 : Foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre	40	17.96	4.25	935.08
T_5 : Foliar spray of PPFM @ 5 mL/ litre	40.4	18.04	4.28	936.22
T_6 : Foliar spray of *Pseudomonas fluorescence* @ 5mL/ litre + Foliar spray of PPFM @ 5 mL/ litre	41.11	18.36	4.3	936.45
T_7 : Seed treatment with *Pseudomonas fluorescence* @ 10mL/ kg seed + Foliar spray of Pseudomonas fluorescence @ 5 mL/ litre	45.43	19.64	4.68	983.65
T_8 : Seed treatment with PPFM @ 10 mL/ kg seed + Foliar spray of PPFM @ 5 mL/ litre	49.47	21.32	4.83	1019.49
T_9 : Untreated (control)	31.57	13.42	3.1	850.9
SE.m±	2.57	0.57	0.17	27.27
CD (p=0.05)	7.7	1.71	0.52	81.75
CV (%)	10.95	5.06	7.24	5.02

Note: Foliar sprays are given at 40 DAS developed seeds with greater starch and protein accumulation, directly contributing to the final grain yield and market value as found by Balachandar *et al*. (2008). Our results are in corroboration with the findings of Krishnaveni *et al*. (2021).

Seed yield (kg ha^{-1})

The data pertaining to the seed yield (kg ha^{-1}) were presented in the Table 1 and which revealed that the seed yield of blackgram was significantly influenced by the application of PGPRs as seed treatment and foliar sprays. Seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre (T_8) significantly registered maximum seed yield (1091.49 kg ha^{-1}) and it was on a par with seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre (T_7- 983.65 kg ha^{-1}). The control (T_9) recorded 850.90 kg ha^{-1}. The higher seed yield was recorded in seed treatment with PPFM @ 10 mL/ kg + Foliar spray of PPFM @ 5 mL/ litre (1091.49 kg ha^{-1}), which exhibited superior performance and increased the seed yield by 19.8% over control, and the seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre at 40 DAS came in the second order by recording 15.6% increase in seed yield over control.

This significant increase in the seed yield under the influence of different seed treatments and foliar sprays at critical crop growth stages that enhanced nutrient uptake by effective translocation of nutrients from source to reproductive area of crop which in turn helped to increase plant height, number of pods per plant, number of seeds per pod, test weight (g) and ultimately the seed yield (kg ha^{-1}). These results were also in agreement with the results of Majeed *et al*. (2021) and Kumar *et al*. (2022).

CONCLUSION

Yield and yield attributes were significantly increased by the seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre at 40 DAS which recorded the highest seed yield of 19.8 % over the control, followed by the seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre at 40 DAS with 15.6 % over control.

Therefore, it could be concluded that the seed treatment with PPFM @ 10 mL/ kg seed + foliar spray of PPFM @ 5 mL/ litre at 40 DAS and also seed treatment with *Pseudomonas fluorescence* @ 10 mL/ kg seed + foliar spray of *Pseudomonas fluorescence* @ 5 mL/ litre at 40 DAS were found to be promising in enhancing the growth, physiology and productivity of blackgram (*var*. LBG- 884) by improving water use efficiency, stress tolerance and soil microbial activity in the rhizosphere.

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