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EFFECT OF DIFFERENT BIOFERTILIZER FORMULATIONS AND FOLIAR SPRAYS ON GROWTH PARAMETERS OF BLACKGRAM

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ABSTRACT

A field experiment was conducted during *rabi* 2024–25 at the research farm, School of Agricultural Sciences, Malla Reddy University, Hyderabad, to study the effect of seed treatment with biofertilizers and foliar sprays on the growth parameters of blackgram (*Vigna mungo* L.). The experiment was laid out in a randomized block design with seven treatments replicated thrice using blackgram variety TBG-104. Results revealed that, significant differences among treatments for all observed parameters. The seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂ PO₄ 1 % (T₆) consistently recorded the highest plant height, leaf area index (LAI), dry matter production, and nodule count at all growth stages. No formulation + no foliar spray (T₇), recorded the lowest values across all parameters. The results suggest that integrated use of biofertilizers and KH₂ PO₄ enhances nutrient uptake and growth of blackgram, highlighting a promising approach for sustainable pulse production in rainfed systems.

Key words: Black gram, Biofertilizers, KH₂ PO₄, Foliar spray and Growth

Introduction

Pulses are leguminous, edible dry seeds that are rich in protein, minerals, and dietary fiber. They play a multifaceted role in agriculture as food crops, fodder, cash crops, and as valuable components in crop rotation and intercropping systems Mishra *et al.*, (2021). Achieving many of the Sustainable Development Goals (SDGs) by 2030 is unlikely without the integration of pulses into both production and consumption systems Rawal V. and Navarro D.K. (2019). India holds the distinction of being the world's largest producer, consumer, and importer of pulses. The major pulse-producing states include Madhya Pradesh (25%), Uttar Pradesh (13%), Maharashtra (12%), Rajasthan (11%), and Andhra Pradesh (9%), with the remaining 30% contributed by other states. The key pulse crops cultivated and consumed across India are chickpea, pigeon pea, lentil, black gram, green gram, and field pea.

Blackgram (*Vigna mungo* L.), commonly known as urad bean, is an important legume crop widely cultivated in South Asia, particularly in India. Valued for its high

protein content—approximately 24% per 100 grams—it serves as a crucial source of plant-based protein, especially in vegetarian diets Nitin (2023). Notably, 78–80% of its nitrogen is stored in the form of albumin and globulin. In addition to protein, blackgram is rich in essential nutrients such as potassium, calcium, iron, niacin, thiamine, and riboflavin, making it a well-balanced dietary component. Beyond its nutritional value, blackgram plays a significant role in sustainable agriculture. As a leguminous crop, it enhances soil fertility by fixing atmospheric nitrogen through symbiotic associations, thereby reducing dependence on synthetic nitrogen fertilizers. Its dry seeds are also an excellent source of phosphorus Singh *et al.*, (2022). These attributes not only improve soil health but also support the sustainability and productivity of cropping systems.

Proper and balanced nutrition is essential for successful crop production. Biofertilizers, containing beneficial microorganisms, colonize the rhizosphere—the soil region surrounding plant roots and enhance nutrient availability to plants David *et al.*, (2023), Vani *et al.*,

Table 1: Effect of different bio-fertilizer formulations and foliar sprays on plant height (cm) of blackgram at different growth stages.

Treatments	20 DAS	40 DAS	60 DAS	At Harvest
T ₁ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + water spray	10.47	18.41	20.72	23.02
T ₂ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KNO ₃ @ 0.5 %	12.08	26.30	30.26	32.74
T ₃ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KH ₂ PO ₄ @ 1 %	12.24	30.40	34.75	37.53
T ₄ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + water spray	15.49	22.23	25.40	27.94
T ₅ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KNO ₃ @ 0.5 %	17.18	34.61	39.16	42.38
T ₆ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KH ₂ PO ₄ @ 1 %	17.26	39.13	44.02	47.18
T ₇ : No formulation + no foliar spray	8.55	14.62	16.37	18.27
SEm±	0.601	1.287	1.470	1.564
CD (P=0.05)	1.77	3.78	4.32	4.60

(2020). These microorganisms facilitate nutrient transformation processes, such as nitrogen fixation and phosphorus solubilization, making essential nutrients more accessible Choudhary *et al.*, (2025). Additionally, certain biofertilizers secrete organic acids that solubilize bound phosphates in the soil, increasing phosphorus availability which is a critical nutrient often limited in agricultural soils Alori *et al.*, (2023).

Foliar fertilization involves applying nutrients directly to plant leaves, enabling rapid absorption and effective utilization. Unlike soil fertilization, which has lower efficiency due to leaching, pH issues, or nutrient fixation, foliar feeding ensures up to 90–95% nutrient uptake. Nutrients can move within the plant at speeds of up to one foot per hour, allowing for swift correction of deficiencies. This method is especially useful during critical growth stages when plants require immediate nutrient support. Foliar feeding not only boosts yield by 15-25% but also improves drought tolerance and disease resistance Kushwah *et al.*, (2023). Though not a replacement for soil fertilization, it serves as a valuable supplement, particularly when quick nutrient delivery is essential for optimal plant growth and productivity Yanbo *et al.*, (2023).

Table 2: Effect of different bio-fertilizer formulations and foliar sprays on leaf area index of blackgram at different growth stages.

Treatments	20 DAS	40 DAS	60 DAS	At Harvest
T ₁ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + water spray	0.74	0.83	0.95	0.83
T ₂ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KNO ₃ @ 0.5 %	0.78	1.29	1.45	1.31
T ₃ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KH ₂ PO ₄ @ 1 %	0.81	1.52	1.70	1.55
T ₄ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + water spray	0.99	1.06	1.20	1.08
T ₅ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KNO ₃ @ 0.5 %	1.07	1.75	1.94	1.77
T ₆ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KH ₂ PO ₄ @ 1 %	1.21	2.02	2.33	2.15
T ₇ : No formulation + no foliar spray	0.55	0.61	0.72	0.61
SEm±	0.059	0.069	0.074	0.070
CD (P=0.05)	0.17	0.20	0.22	0.21

Materials and Method

The experiment was conducted during the *rabi* season of 2024–25 at the C-2 plot of the Research Farm, School of Agricultural Sciences, Malla Reddy University, Dulapally, Hyderabad, Telangana. The experimental site is geographically situated at 17°19'16.4" N latitude and 78°24'43" E longitude, at an altitude of 542.3 meters above mean sea level. The study was carried out using the blackgram variety TBG-104. A randomized block design (RBD) was employed, consisting of 7 treatments replicated three times. The details of the treatments used in the experiment are listed below.

T₁: Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha⁻¹ + water spray

T₂: Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha⁻¹ + KNO₃ @ 0.5%

T₃: Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha⁻¹ + KH₂PO₄ @ 1%

T₄: Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + water spray

T₅: Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KNO₃ @ 0.5%

Table 3: Effect of different bio-fertilizer formulations and foliar sprays on dry matter production (kg ha^{-1}) of blackgram at different growth stages.

Treatments	20 DAS	40 DAS	60 DAS	At Harvest
T ₁ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + water spray	50.0	374	1174	1948
T ₂ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KNO ₃ @ 0.5 %	53.6	554	1735	2688
T ₃ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KH ₂ PO ₄ @ 1 %	57.5	641	1999	3054
T ₄ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + water spray	78.3	469	1447	2309
T ₅ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KNO ₃ @ 0.5 %	80.2	728	2298	3410
T ₆ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KH ₂ PO ₄ @ 1 %	88.1	816	2619	3979
T ₇ : No formulation + no foliar spray	38.2	283	906	1601
SEm±	3.61	28.6	88.9	117.8
CD (P=0.05)	10.6	84	261	346

T₆: Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂PO₄ @ 1%

T₇: No formulation + no foliar spray

The data recorded on various parameters (plant height (cm), leaf area index, dry matter production (kg ha^{-1}) and nodule count (No.) of crop during the course of investigation in the field experiment was statistically analyzed by following the analysis of variance for randomized block design. Statistical significance was tested with 'F' test at 5 per cent level of probability and compared the treatment means with critical difference.

Results and Discussion

The plant height of blackgram was significantly influenced by various biofertilizer treatments and foliar sprays, measured at 20, 40, 60 days after sowing (DAS), and at harvest. A progressive increase in plant height was observed throughout the growth stages. The treatment T₆ (seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂PO₄ @ 1%) consistently recorded the highest plant height across all stages (17.26 cm at 20 DAS to 47.18 cm at harvest). The lowest plant height was noted in T₇ (no formulation + no spray). The enhanced plant growth under foliar treatments is attributed to the quick availability of

phosphorus, promoting better vegetative growth Sushil *et al.*, 2021) The synergistic effect of biofertilizers and foliar application ensured a steady nutrient supply. Similar findings were reported by Kumar *et al.*, (2023), and vani *et al.*, (2021) highlighting the effectiveness of KH₂PO₄ foliar spray during flowering and pod initiation stages.

The leaf area index (LAI) of blackgram was significantly influenced by seed treatments and foliar sprays. LAI gradually increased up to 60 DAS and declined toward harvest due to natural leaf senescence during maturity. At 20 DAS, differences in LAI were statistically insignificant. However, the highest LAI was recorded with seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂PO₄ @ 1% (T₆). The lowest LAI was observed in the no formulation + no spray (T₇). At 40 and 60 DAS and at harvest, T₆ consistently recorded the highest LAI (2.02, 2.33, 2.15), followed by T₅ and T₃. This improvement can be attributed to the synergistic effect of biofertilizers and foliar-applied nutrients. Rhizobium and Phosphobacteria enhanced root-zone nutrient availability, while KH₂PO₄ provided a direct source of phosphorus and potassium, promoting leaf expansion and photosynthetic efficiency. These findings align with Ruiz *et al.*, (2023), and Choudary *et al.*, (2025) who reported increased LAI with

Table 4: Effect of different bio-fertilizer formulations and foliar sprays on nodule count (No.) of blackgram at different growth stages.

Treatments	20 DAS	40 DAS	60 DAS	At Harvest
T ₁ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + water spray	7.89	14.80	10.75	7.43
T ₂ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KNO ₃ @ 0.5 %	8.08	20.99	15.27	10.64
T ₃ : Seed treatment with Rhizobium & Phosphobacteria each @ 600 g ha ⁻¹ + KH ₂ PO ₄ @ 1 %	9.10	24.35	17.53	12.23
T ₄ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + water spray	10.54	17.89	13.01	9.07
T ₅ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KNO ₃ @ 0.5 %	11.78	27.99	19.87	13.85
T ₆ : Seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha ⁻¹ + KH ₂ PO ₄ @ 1 %	11.81	31.16	22.20	15.58
T ₇ : No formulation + no foliar spray	6.09	11.71	8.50	5.81
SEm±	0.464	1.045	0.755	0.523
CD (P=0.05)	NS	3.07	2.22	1.54

PSB and Rhizobium co-inoculation.

Dry matter production in blackgram steadily increased throughout the growth stages, showing significant variation due to different seed treatments and foliar spray applications. At 20 DAS, differences were statistically insignificant, though the highest dry matter was observed in T₆ (seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂ PO₄ @ 1 %), followed by T₅ and T₄. At later stages (40, 60 DAS, and harvest), T₆ consistently recorded the highest dry matter (816, 2619, and 3979 kg ha⁻¹ respectively), followed by T₅ and T₃. The lowest values were recorded in T₇ (no formulation + no foliar spray). The improved biomass accumulation in treated plots is attributed to enhanced nutrient availability, with Rhizobium and Phosphobacteria promoting nitrogen fixation and phosphorus solubilization. Foliar sprays of KH₂ PO₄ provided readily available nutrients, supporting early vegetative growth and sustained development. This treatment also promoted greater plant height and leaf area, increasing photosynthetic efficiency. Similar findings were reported by Rohit *et al.*, (2022) and Kumar *et al.*, (2023) in black gram.

Nodule count in blackgram increased significantly from 20 to 40 DAS, followed by a decline at 60 DAS and harvest, with notable variation among treatments. The highest nodule count at 20 DAS was recorded in T₆ (seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂ PO₄ @ 1 %) (11.81), statistically on par with T₅ and T₄. At later stages, T₆ consistently produced the highest number of nodules (31.16 at 40 DAS, 22.20 at 60 DAS, 15.58 at harvest), followed by T₅ and T₃. The lowest nodule count was observed with no formulation + no foliar spray (T₇). Enhanced nodulation in treated plots may be attributed to effective root colonization by Rhizobium and Phosphobacteria, improving nitrogen fixation. Foliar-applied phosphorus supported nodule development and energy transfer processes essential for nitrogen fixation. These results align with Gutte *et al.*, (2018) and Sushil *et al.*, (2021) who reported higher nodulation with seed inoculation and foliar nutrient sprays in legumes, reinforcing the synergistic benefit of integrated nutrient management.

Conclusion

The growth parameters of blackgram were significantly influenced by different formulations and foliar sprays. At 20 DAS, the highest plant height, leaf area index (LAI), dry matter production and nodule count were recorded in T₆ (seed treatment with Rhizobium & Phosphobacteria each @ 125 ml ha⁻¹ + KH₂ PO₄ @ 1 %), statistically on par with T₅ and T₄. T₆ consistently

recorded the highest values for plant height, LAI, dry matter accumulation, and nodule count at all stages compared to other treatments. The improvements can be attributed to enhanced nutrient uptake, photosynthetic activity, and symbiotic efficiency, highlighting the synergistic effect of liquid biofertilizers and KH₂ PO₄ foliar spray on black gram performance.

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