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Impact of biofertilizers and phosphorus on growth and yield of cowpea (*Vigna unguiculata* (L.) Walp.)

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Abstract

A field experiment was carried out during the summer season 2025. The experiment was conducted at the vegetable research farm of the Department of Horticulture, P.G. College, Ghaziipur on sandy loam soil to assess the effect of biofertilizers and phosphorus on growth and yield of cowpea cv. Kashi Kanchan. The experiment was laid out in Randomized Block Design with nine treatments and three replications. The observations were recorded at 45 days after sowing. Experimental results showed significant increase in growth parameters viz: plant height (87.38 cm), number of branches per plant (31.78) and number of nodules per plant (19.85) with treatment combinations T_6 , P_2O_5 @ 80 kg ha⁻¹ + Rhizobium. Number of leaves per plant (132.85) and number of pods per plant (32.91) were recorded with treatment combinations T_3 , P_2O_5 @ 80 kg ha⁻¹, and shoot biomass with treatment combinations T_9 , P_2O_5 @ 80 kg ha⁻¹ + PSB (7.09 g). Yield attributes and quality parameters showed significant increase in pod weight (12.48 g), grain weight per pod (2.650 g), shelling weight of pods (9.846 g), root biomass (0.71 g) and green pod yield (139.10 q/ha) with treatment combinations T_6 , P_2O_5 @ 80 kg ha⁻¹ + Rhizobium. Overall, the study suggests that the integration of biofertilizers with phosphorus application (particularly Rhizobium, P_2O_5 and PSB) is effective in improving cowpea productivity and quality.

Keywords: Cowpea, biofertilizers, phosphorus, Rhizobium, PSB, growth parameters and yield

Introduction

Cowpea (*Vigna unguiculata* (L.)) is commonly known as lobia in India, southern pea, and black-eyed pea. It is an important legume crop grown for multiple purposes such as vegetable, grain, fodder, and green manure. It is particularly valued for its short duration, high yield potential, and adaptability to drought-prone and marginal environments. The green tender pods are rich in moisture (84.6 g), protein (4.3 g), carbohydrates (8.0 g) per 100 g edible portion and are a significant source of affordable dietary protein, vitamins, and minerals, making cowpea a vital component of the human diet in many developing countries (1, 3). Globally, cowpea is cultivated on approximately 10.35 million hectares with a production of 19.77 million tonnes, contributing about 8.6% of the world vegetable production according to FAO (2024). Cowpea possesses the remarkable ability to fix atmospheric nitrogen, which is crucial for its early vegetative growth and development. Phosphorus (PSB) and nitrogen-fixing bacteria (*Rhizobium*) have been extensively employed to enhance soil fertility (4). Biofertilizers play a crucial role in plant metabolism and nutrient availability, facilitating nutrient uptake from the soil (5). The positive impact of phosphate biofertilizers produced with apatite plus sulphur inoculated with *Acidithiobacillus* on growth and yield of cowpea holds great promise for improving usage of these products as partial or total substitutes for soluble phosphate fertilizers due to low cost of production. While use of phosphate biofertilizers on low-P soils seems justified, caution must be exercised, since phosphate biofertilizers produced with phosphate rock plus elemental sulphur inoculated with *Acidithiobacillus*, when applied at higher levels, may decrease soil pH. Considering the need for sustainable nutrient management and improved cowpea productivity (2), the present investigation was undertaken to evaluate the effect of biofertilizers and phosphorus levels on the growth and yield of cowpea under field conditions (1, 6).

Materials and Methods

The field experiment was conducted during the said season, 2025, at the Vegetable Research Farm of the Department of Horticulture, Post Graduate College, Ghaziipur, to assess the effect of biofertilizers and phosphorus on growth and yield of cowpea.

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The trial was laid out in a Randomized Block Design with 9 treatments and 3 replications. Treatments included different combinations of biofertilizers, *Rhizobium* and Phosphate Solubilizing Bacteria (PSB), along with two levels of phosphorus: 40 and 80 kg/ha.

The experimental design consisted of nine treatment combinations, viz:

- T₁: Control
- T₂: P₂O₅ @ 40 kg/ha
- T₃: P₂O₅ @ 80 kg/ha
- T₄: Rhizobium
- T₅: P₂O₅ @ 40 kg/ha + Rhizobium
- T₆: P₂O₅ @ 80 kg/ha + Rhizobium
- T₇: PSB
- T₈: P₂O₅ @ 40 kg/ha + PSB
- T₉: P₂O₅ @ 80 kg/ha + PSB

The crop was sown in sandy loam soil following standard agronomic practices. Uniform cultural operations and plant care were provided to all plots. Observations were recorded on phenological traits such as plant height, number of leaves per plant, number of branches per plant, shoot biomass, number of nodules per plant, number of pods per plant, and yield parameters including pod weight, grain weight per pod, shelling weight of pods, root biomass, and green pod yield. The data collected were subjected to statistical analysis using Analysis of Variance (ANOVA) for RBD. Treatment means were compared using the Critical Difference (CD) at a 5% level of significance.

Results and Discussion

Plant Height at Maturity

The highest plant height at maturity (87.38 cm) was recorded with P₂O₅ @ 80 kg ha⁻¹ + Rhizobium, while the lowest (58.38 cm) was observed with T₁ (control). The increase in plant height with P₂O₅ and Rhizobium may be attributed to enhanced nutrient availability and improved growth (Khan *et al.*, 2017) [7].

Number of Leaves per Plant

The maximum number of leaves per plant (132.85) was observed with P₂O₅ @ 80 kg ha⁻¹, while the lowest (114.38) was recorded with PSB (Ayub, 2012). The increased number of leaves with P₂O₅ and PSB may be due to improved phosphorus availability, promoting leaf growth.

Number of Branches per Plant

The maximum number of branches per plant at maturity (31.78) was recorded with P₂O₅ @ 80 kg ha⁻¹ + Rhizobium at 45 days, while the lowest (24.00) was observed with Rhizobium alone (Patel, 2013) [9].

Shoot Biomass (g)

The maximum shoot biomass of cowpea (7.09 g) was recorded under P₂O₅ @ 80 kg ha⁻¹ + PSB, while the minimum (4.46 g) was observed under T₁ (control).

Number of Nodules per Plant

The maximum number of nodules per plant (19.85) was recorded with P₂O₅ @ 80 kg ha⁻¹ + Rhizobium, while the minimum (11.08) was recorded with PSB. Phosphorus level and Rhizobium enhanced nodule formation (Tiwari, Patel *et al.*, 2020) [12].

Number of Pods per Plant

Significant variation was observed in the number of pods per plant. The maximum number of pods per plant (32.91) at 45 days was recorded with P₂O₅ @ 80 kg ha⁻¹, while the minimum (24.78) was observed in T₁ (control) (Tomar, 2013) [14].

Pod Weight (g)

The maximum pod weight (12.48 g) was observed with application of P₂O₅ @ 80 kg ha⁻¹ + Rhizobium, while the minimum (8.31 g) was observed with treatment T₁ (control).

Grain Weight per Plant (g)

The maximum grain weight per plant (2.650 g) was recorded with application of P₂O₅ @ 80 kg ha⁻¹ + Rhizobium, while the minimum (2.165 g) was observed in treatment T₁.

Shelling Weight of Pods (g)

The highest shelling weight of pods (9.846 g) was observed with P₂O₅ @ 80 kg ha⁻¹ followed by Rhizobium at 45 days, while the lowest (6.161 g) was recorded in treatment T₁. The improvement with P₂O₅ + Rhizobium may be due to enhanced nutrient uptake and better translocation, resulting in improved shelling weight.

Root Biomass (g)

It was observed that the maximum root biomass (0.71 g) was recorded with P₂O₅ @ 80 kg ha⁻¹ + Rhizobium at 45 days, while the lowest (0.42 g) was observed with treatment T₁ (control) (Singh *et al.*, 2020) [11].

Green Pod Yield (q/ha)

The highest green pod yield (139.10 q/ha) was recorded with the application of P₂O₅ @ 80 kg ha⁻¹ + Rhizobium (Tomar, 2013) [14], while the lowest (90.60 q/ha) was observed in treatment T₁ (control). The improved yield at 80 kg/ha with biofertilizers is likely due to better nutrient uptake and enhanced rhizosphere activity.

Table 1: Effect of biofertilizers and phosphorus levels on yield attributes and yield parameters of cowpea

Treatment	Pod Weight (g)	Grain Weight per Pod (g)	Shelling Weight of Pods (g)	Root Biomass (g)	Green Pod Yield (q/ha)
T ₁ : Control	8.31	2.165	6.161	0.42	98.69
T ₂ : P ₂ O ₅ @ 40 kg/ha	9.15	2.465	6.701	0.55	105.25
T ₃ : P ₂ O ₅ @ 80 kg/ha	10.81	2.498	8.328	0.68	119.15
T ₄ : Rhizobium	8.58	2.229	6.367	0.59	102.56
T ₅ : P ₂ O ₅ @ 40 kg/ha + Rhizobium	10.78	2.565	8.231	0.62	120.36
T ₆ : P ₂ O ₅ @ 80 kg/ha + Rhizobium	12.48	2.650	9.846	0.71	139.10
T ₇ : PSB	8.78	2.310	6.486	0.44	99.27
T ₈ : P ₂ O ₅ @ 40 kg/ha + PSB	9.15	2.579	6.587	0.51	106.98
T ₉ : P ₂ O ₅ @ 80 kg/ha + PSB	10.81	2.611	8.215	0.65	120.44

Table 2: Effect of biofertilizers and phosphorus levels on growth and phenological parameters of cowpea

Treatment	Plant Height (cm)	No. of Leaves per Plant	No. of Branches per Plant	Shoot Biomass (g)	No. of Nodules per Plant	No. of Pods per Plant
T ₁ : Control	58.38	114.38	24.08	4.46	8.98	24.78
T ₂ : P ₂ O ₅ @40 kg/ha	70.98	123.65	27.71	5.31	11.28	30.58
T ₃ : P ₂ O ₅ @80 kg/ha	75.85	132.85	29.78	6.48	12.08	32.91
T ₄ : Rhizobium	64.51	118.25	24.58	4.76	11.31	26.65
T ₅ : P ₂ O ₅ @40 + kg/ha Rhizobium	86.31	127.18	29.58	6.01	14.65	28.85
T ₆ : P ₂ O ₅ @80 kg/ha + Rhizobium	87.38	132.71	31.78	6.42	19.85	32.91
T ₇ : PSB	58.78	114.51	24.85	4.45	11.88	24.89
T ₈ : P ₂ O ₅ @40 kg/ha + PSB	65.67	119.39	28.58	5.33	12.71	29.31
T ₉ : P ₂ O ₅ @80 kg/ha + PSB	79.38	129.71	29.71	7.09	13.18	30.71

Conclusion

The present study concluded that the integrated use of biofertilizers with an optimal dose of phosphorus significantly enhanced growth and yield of cowpea. All the growth characters observed in the experiment were greatly influenced by biofertilizers and various levels of phosphorus application. Application of P₂O₅, Rhizobium, and PSB up to the level of 80 kg P₂O₅/ha significantly increased plant height, number of leaves, number of branches, shoot biomass, number of nodules, number of pods, pod weight, grain weight, shelling weight, root biomass, and green pod yield. The experimental evidence suggests that this integrated nutrient management approach may be adopted for profitable cultivation of cowpea under existing agro-climatic conditions of Uttar Pradesh (Ghazipur region).

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