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Effect of biofertilizers and phosphorous on growth and yield of greengram (*Vigna radiata* L.)

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Abstract
The present field experiment was carried out during the rabi season of 2024-2025 (November to March) at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The primary objective of the study was to evaluate the effect of biofertilizers and phosphorus levels on the growth and yield performance of greengram (*Vigna radiata* L.), using the variety SAMRAT PDM-139.
The experiment comprised three levels of phosphorus application (30, 40, and 50 kg P_2O_5/ha) and three types of biofertilizers (Rhizobium, PSB, and VAM), each applied at 20 g/kg of seed. The treatments were arranged in a two-factor Randomized Block Design (RBD) with three replications.
The findings revealed significant differences among treatments for most growth and yield parameters. Application of 50 kg P_2O_5/ha produced the tallest plants, as well as the highest number of pods per plant, seeds per pod, and 1000-seed weight, compared to lower phosphorus levels. Among the biofertilizers, Rhizobium inoculation resulted in the highest seed yield (16.91 t/ha), along with maximum stover yield, biological yield, and harvest index. Conversely, treatments with only Rhizobium at 20 g/kg seed recorded the lowest values for most parameters.
The interaction between phosphorus levels and biofertilizers showed a significant effect on all growth and yield traits. The combination of 50 kg P_2O_5/ha with Rhizobium at 20 g/kg seed consistently produced superior results for all parameters, including seed yield, which peaked at 16.91 t/ha. The only exception was harvest index, which did not follow the same trend.

Keywords: INM, biofertilizers, rhizobium, PSB & VAM

Introduction

Green gram (*Vigna radiata* L.) is one of the most important pulse crops grown in India. Its grains, whether whole or split, are widely used as food in different forms. They are consumed as dal, ground into flour, or eaten whole after sprouting. The grains are also roasted, salted, mixed with sugar, or boiled with spices to make a variety of dishes. In addition, the straw and husk left after processing are used as nutritious fodder for cattle.

The major green gram producing states in India include Madhya Pradesh, Maharashtra, Uttar Pradesh, Punjab, Andhra Pradesh, Rajasthan, Karnataka, and Tamil Nadu. India is the largest producer of pulses in the world, and green gram is among the oldest and most extensively cultivated legume crops in the country. Pulses are an important part of the diet in tropical and subtropical regions because they are a rich source of protein.

Green gram provides high-quality protein and essential amino acids like lysine (4600 mg/g N) and tryptophan (60 mg/g N), making it a valuable part of a balanced diet. Its seeds are highly nutritious, containing about 24.7% protein, 57.6% carbohydrates, 0.5% fat, 0.9% fiber, and 3.7% ash (Choudhary *et al.*, 2010) [94]. Because it is easy to digest, it is especially preferred for patients and people recovering from illness.

In India, green gram is grown on about 34.4 lakh hectares, which accounts for 18% of the total pulse area and 11.48% of total pulse production (CMIE, 2014-15). However, the productivity of green gram is still lower than the world average. Rajasthan and Maharashtra are the leading producers, contributing around 26% and 20%, respectively, followed by Andhra Pradesh (10%) and Gujarat (7%) (Anon., 2018).

Green gram, also called mung, mung bean, or golden gram, plays an important role in improving soil fertility because its roots form nodules with Rhizobium bacteria, which fix about 35 kg of atmospheric nitrogen per hectare. This fixed nitrogen benefits not only the green gram crop but also the subsequent crops in rotation, making it an essential part of sustainable farming systems.

Pulses have some unique characteristics that make them essential and difficult to replace in agriculture. Firstly, they play a key role in maintaining soil productivity because of their ability to fix atmospheric nitrogen through a symbiotic association with Rhizobium bacteria. Each pulse plant acts like a natural mini-fertilizer factory, enriching the soil and promoting sustainability. Secondly, pulses have a deep root system that allows them to utilize limited moisture more efficiently than many other crops, such as cereals. These roots also loosen the soil, improving its structure and overall health. Thirdly, pulses are an important part of the human diet as a rich source of protein, containing 20-30% protein, which is almost three times higher than cereals.

Pulses are a major source of plant-based protein in India, where they hold great significance in both diet and farming systems. Greengram (*Vigna radiata* L.) is one of the most important pulse crops, cultivated for grain, fodder, and green manure. However, due to the increasing population, the demand for pulses is rising, but production has not kept pace. Therefore, to meet the growing need, it is necessary to increase the area under pulse cultivation and improve productivity per unit area.

Greengram is mainly grown during kharif and zaid seasons, but in recent years, it is also being cultivated during the rabi season in some states. Rabi cultivation has shown higher yields compared to kharif because of reduced biotic and abiotic stress. Green gram seeds are consumed in various forms, including soups, porridge, snacks, flour, noodles, bread, and ice creams. Split seeds are processed into dal, while sprouted seeds are eaten raw or cooked. Green gram is also used for making starch noodles, vermicelli, and soap.

Biofertilizers are living microorganisms of bacterial, fungal, or algal origin that improve soil fertility and crop yield. They fix atmospheric nitrogen, solubilize insoluble phosphates like tricalcium phosphate and iron/aluminum phosphates, and release plant growth hormones that enhance root development. Biofertilizers also decompose organic matter and promote nutrient cycling, thereby increasing crop yield by 10-25% without harming the environment.

Rhizobium and Phosphate Solubilizing Bacteria (PSB) play a vital role in enhancing nitrogen and phosphorus availability. Studies have shown that inoculating mung bean seeds with PSB significantly increases yield attributes such as number of pods, seed weight, and seed yield (Khan *et al.*, 2004; Gajera *et al.*, 2014) [95, 96].

Similarly, Vesicular Arbuscular Mycorrhiza (VAM) fungi, such as Glomus fasciculatum and Glomus mosseae, improve phosphorus uptake, which leads to better nodulation and nitrogen fixation in legumes (Manjunath *et al.*, 1984) [97]. Many tropical legumes are highly dependent on VAM fungi for optimal growth (Adholeya *et al.*, 1988) [98].

Phosphorus is one of the most important nutrients for pulses, as it is essential for vegetative growth, root and nodule development, energy transfer, and seed formation. Adequate phosphorus availability accelerates crop maturity, stimulates early growth, and directly contributes to higher yields in mung bean (Singh *et al.*, 2017) [81].

Materials and Methods

This chapter describes the materials and methods used in the study titled, "Effect of Bio-fertilizers and Phosphorus on the Growth and Yield of Green Gram (*Vigna radiata* L.)", which was conducted during the Zaid season of 2025 at the Crop Research Farm, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. It provides a detailed account of the experimental site, soil properties, sampling methods, climatic conditions, cropping history, crop management practices, and statistical analysis employed.

Experimental site

The field experiment was carried out at the Crop Research Farm under the Department of Agronomy. The farm is located at 25.40° N latitude and 81.85° E longitude, with an altitude of 98 meters above mean sea level, situated on the right bank of the Yamuna River, opposite the city of Prayagraj. The site is well-equipped with all the facilities necessary for conducting crop cultivation experiments.

3.1 Soil of experimental field

The soil at the experimental site is part of the central Gangetic alluvial plains, characterized as neutral in reaction and deep in profile. Before laying out the experiment, soil samples were collected randomly from five different locations within the experimental field at a depth of 0-15 cm using a hand augur. These individual samples were combined to form a homogeneous composite sample, representing the entire field.

The composite sample was then analyzed to determine the physico-chemical properties of the soil, including texture, pH, organic carbon content, nutrient availability, and other relevant parameters. Standard methods were followed for each analysis to ensure accuracy and reliability. The results of the soil analysis, along with the procedures used for their determination, are described in the subsequent sections of this chapter.

Mechanical analysis of soil

The Mechanical analysis of soil (0-15 cm depth) is represented in Table 3.2.1

3.1.1 Chemical analysis of soil

The Chemical analysis of soil (0-15 cm depth) is presented in Table 3.1.2.

Table 3.2.1 Mechanical analysis of the soil of experimental field:

Mineral Fraction	Value (Unit %)	Method (references)
Sand Silt	62.10 22.60	Bouyoucos hydrometer method (Bouyoucos, 1947)
Clay	13.80	
Textural class	Sandy loam	

Table 3.2.2: Chemical analysis of soil of experimental field:

Parameter	Value (unit)	Method	References
Available Nitrogen	70.6 kg ha^{-1}	Alkaline	Subbaiah & Asija,
		Permanganate	1956
Available Phosphorus	37.9 kg ha^{-1}	Olsen's Colorimetric	Olsen *et al.*, 1954
Available Potassium	214 kg ha^{-1}	NH4 Leaching	Jacson, 1973
Available Carbon	0.521	Walkley & Black	Walkley & Black,
			1947
pH	7.03	Digital pH Meter	Jacson,1973
EC	0.332 (dS m^{-1})	Digital EC Meter	Wilcox, 1950

3.11 Statistical analysis
The experimental data were subjected to analysis of variance (ANOVA) following the procedure outlined by Gamez and Gomez (2010) [99]. Where the 'F' test was found to be significant at the 5% level, Critical Difference (CD) values were calculated to determine the significance between treatment means.

Result and Discussion
4.1 Growth attributes
4.1.1 Plant height (cm)
The data of plant height (Table 1) shows that plant height was increased at faster rate up to 60 DAS, thereafter it slowdown at 80 DAS. The data for plant height was found to be significant at all recorded growth stages inoculation with Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control. However, plant height

At 20 DAS, significantly highest plant height (12.98 cm) has been recorded with co-(8.99 cm) with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control and plant height (11.87 cm) with inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed and plant height (11.70 cm) with inoculation by Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed and Rhizobium along with P found to be statistically on par with highest treatment.

At 40 DAS, significantly highest plant height (20.60 cm) has been recorded with co-(52.36 cm) with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control and plant height (20.40 cm) with inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed and plant height (20.28 cm) with inoculation by Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed and Rhizobium along with P found to be statistically on par with highest treatment.

At 60 DAS, significantly highest plant height (60.43 cm) has been recorded with co-(52.36 cm) with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control and plant height (59.66 cm) with inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed and plant height (59.29 cm) with inoculation by Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed and Rhizobium along with P found to be statistically on par with highest treatment.

At 80 DAS, significantly highest plant height (70.40 cm) has been recorded with co-(61.52 cm) with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control and plant height (59.66 cm) with inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed and plant height (59.29 cm) with inoculation by Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed and Rhizobium along with P found to be statistically on par with highest treatment.

Increase in the plant height was due to increasing levels of phosphorus, bio-fertilizers which helped in new cell formation and root development, leading to availability of all nutrients and water from the deeper soil layers for higher photosynthetic activity. Thereby promoted vegetative growth; consequently, increased the plant height. Similar findings were also reported by Roy and Rahaman (1992), Haque and Khan (2012), Rasool and Singh (2016) [100, 101, 102].

4.1.2 Dry weight (g)
A critical examination of data revealed in the (Table 1) plant dry weight had increased at slower pace up to 40 DAS, there after it was rapidly increasing up to 80 DAS (harvesting). The data for the dry weight was found to be significant at all the growth stages of the crop.

At 20 DAS, significantly higher dry weight (6.48 g plant-1) was recorded with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed had significantly increased the dry weight per plant over control, whereas inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed (5.46 g plant-1) found to be statistically on par with the maximum dry weight per plant.

At 40 DAS, inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed had significantly increased the dry weight per plant (8.16 g plant-1) over control, whereas inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed (7.71 g plant-1) found to be statistically on par with the maximum dry weight per plant.

At 60 DAS, significantly higher dry weight per plant (16.79 g plant-1) has been recorded with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control. However, dry matter with inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed (16.49 g plant-1) on par with inoculation by Rhizobium and P along with application of 50 kg P ha-1.

At 80 DAS, inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed showed significantly higher dry weight per plant (19.56 g plant-1) over control (RDF only), with Significant result.

Phosphorus encourages the formation of new cells, promote plant vigor and hastens leaf development, which helps in harvesting of more solar energy and better utilization of nitrogen. As the result growth attributes increased with increase in doses of phosphorus. Higher dry weight was may be due to the cumulative effect of increased plant height and number of branches which resulted in more dry matter production by plant. These findings were found relevant to Mashi *et al.* (2020) and Venkatarao *et al.* (2017) [103, 104].

4.1.3 Crop growth rate (g m² day)
The data of crop growth rate (Table 1) shows that effect of bio-fertilizers and Phosphorus on crop growth rate of green gram crop. The data was found non-significant at 20-40 DAS, and significant at 40-60 DAS and 60-80 DAS

During 20-40 DAS, maximum growth rate (4.83 g m² day) has been recorded with co- inoculation with Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed which was found to be statistically at per with all treatments.

During 40-60 DAS, inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed has significantly increases the crop growth rate (12.80 g m² day¹) over control (only RDF), whereas dual inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed and inoculation by Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed found to be statistically on par for crop growth rate (12.44 g m² day, 11.93 g m² day¹, respectively) with highest.

During 60-80 DAS, significantly higher crop growth rate (46.91 g m² day") has been recorded with inoculation by Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed over control (only RDF), whereas crop growth rate in inoculation by Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed (42.97 g m² day¹) found to be statistically on par with highest.

The inoculation of bio-fertilizers and basal application of 50 kg P ha-1 resulted in higher crop growth rate, this might be due to direct and higher availability and translocation of nutrients during development phase of crop growth, which enhances the physiological and metabolic activities of plant and put up more growth by assimilating the available nutrients at higher rate and facilitate more photosynthesis.

Relative Growth Rate (g m-1 day-1)

The data on relative growth rate (RGR) (Table 1) illustrate the effect of phosphorus and bio-fertilizers on the growth of green gram. The RGR showed both significant and non-significant differences among treatments at different growth stages.

During 20-40 days after sowing (DAS), the highest relative growth rate of 0.16 g g^{-1} day^{-1} was observed with the combined application of 50 kg P/ha + Rhizobium 20 g/kg seed, although this value was statistically at par with all other treatments.

In the period of 40-60 DAS, the combination of 50 kg P/ha + Rhizobium 20 g/kg seed significantly increased the RGR to 0.48 g g^{-1} day^{-1} compared to the control (RDF alone). Treatments with 40 kg P/ha + Rhizobium 20 g/kg seed, as well as 50 kg P/ha + Rhizobium 20 g/kg seed and 50 kg P/ha + PSB 20 g/kg seed, showed RGR values of 0.39 g g^{-1} day^{-1} and 0.38 g g^{-1} day^{-1}, respectively, and were statistically at par with the highest treatment.

During 60-80 DAS, the highest RGR of 2.17 g g^{-1} day^{-1} was recorded with 50 kg P/ha + Rhizobium 20 g/kg seed, significantly higher than the control. The treatment with 50 kg P/ha + Rhizobium 20 g/kg seed also exhibited a high RGR of 1.79 g g^{-1} day^{-1}, which was statistically comparable to the maximum value.

These results indicate that co-application of phosphorus and bio-fertilizers, especially 50 kg P/ha with Rhizobium, enhances the relative growth rate of green gram throughout the crop growth period, likely due to improved nutrient availability, efficient assimilation, and enhanced metabolic activity in the plants.

4.2.1 Number of nodules per plant

The data on number of nodules per plant (Table 1) demonstrate the effect of Rhizobium, VAM, and PSB in combination with phosphorus on nodulation in green gram. A significant difference in the number of nodules per plant was observed at 20, 40, 60, and 80 DAS.

At 20 DAS, the highest number of nodules (19.65 per plant) was recorded with 50 kg P/ha + Rhizobium 20 g/kg seed, which was significantly higher than the control (RDF alone). Treatments with 40 kg P/ha + Rhizobium 20 g/kg seed (18.83 nodules/plant) and 30 kg P/ha + Rhizobium 20 g/kg seed (15.65 nodules/plant) were statistically comparable to the highest treatment.

At 40 DAS, co-inoculation of 50 kg P/ha + Rhizobium 20 g/kg seed again produced the highest number of nodules (21.86 per plant), significantly exceeding the control. The treatment with 40 kg P/ha + Rhizobium 20 g/kg seed (20.27 nodules/plant) was statistically at par with the highest treatment, indicating that the combined application of bio-fertilizers and higher phosphorus effectively enhances nodulation during the crop growth period.

At 60 DAS, the highest number of nodules per plant (23.46) was recorded with co-inoculation of 50 kg P/ha + Rhizobium 20 g/kg seed, which was significantly higher than the control (RDF alone). The treatment with 40 kg P/ha + Rhizobium 20 g/kg seed (22.29 nodules/plant) was statistically comparable to the highest treatment.

At 80 DAS, the maximum nodulation (16.81 nodules/plant) was observed again with 50 kg P/ha + Rhizobium 20 g/kg seed, significantly higher than the control. The treatment with the same combination showed 15.87 nodules/plant, which was statistically at par with the highest treatment.

The increased nodulation can be attributed to the application of phosphorus, which enhanced nutrient utilization, promoted better canopy development, and improved the plant’s ability to absorb and use radiant energy efficiently. Rhizobium inoculation stimulated root nodule formation, enabling more atmospheric nitrogen fixation, thereby enriching soil fertility. Additionally, the interaction with VAM fungi had a synergistic effect on nodulation, further enhancing nodule formation. These findings are consistent with earlier reports by Masih *et al.* (2020) and Chaudhary (2019).

Yield attributes

4.2.2 Number of Pod per plant

The interaction between biofertilizer and phosphorus had a significant effect on the number of pods per plant (Table 2). The highest number of pods (19.21 per plant) was observed with the combined application of 50 kg P/ha + Rhizobium 20 g/kg seed. In contrast, the lowest number of pods (14.74 per plant) was recorded in the control, which was statistically comparable to the other treatments.

4.2.3 Number of seeds per Pod

A significant variation was observed among the different combinations of biofertilizer and phosphorus on the number of seeds per pod (Table 2). The highest number of seeds per pod (12.48) was recorded with the application of 50 kg P/ha + Rhizobium 20 g/kg seed, while the lowest (8.10 seeds per pod) was observed in the control plots. These values were statistically comparable to the other treatments.

Test weight

The combination of biofertilizer and phosphorus had a significant effect on the thousand-seed weight of greengram (Table 2). The highest thousand-seed weight (40.50 g) was recorded with 50 kg P/ha + Rhizobium 20 g/kg seed, while the lowest (32.10 g) was observed in the control plots (RDF 20:40:20 N:P:K kg/ha). These values were statistically comparable across treatments.

4.2.4 Seed yield (t ha-1)

A significant variation was observed among the different combinations of biofertilizer and phosphorus on the seed yield of greengram (Table 2). The highest seed yield (1.81 t/ha) was recorded with 50 kg P/ha + Rhizobium 20 g/kg seed, while the lowest (0.86 t/ha) was obtained from the control plots (RDF 20:40:20 N:P:K kg/ha). The increase in seed yield with biofertilizer and phosphorus application is attributed to their positive influence on growth parameters, leading to more vigorous plants with increased height, higher dry weight, and greater number of seeds per plant (Allen and Morgan, 2009) [5].

4.2.5 Stover yield (kg ha1)

The interaction between biofertilizer and phosphorus did not show a significant effect on stover yield in the present experiment. The highest stover yield (1.93 t/ha) was recorded with the combination of 50 kg P/ha + Rhizobium 20 g/kg seed, while the lowest (0.91 t/ha) was observed in the control plots (RDF 20:40:20 N:P:K kg/ha). These values were statistically comparable across treatments (Table 2).

Harvest index (%)

Non-significant interaction effect was also obtained between Biofertilizer and Phosphorus in consideration of harvest index under the present experiment (Table 2). The maximum harvest index (49.00) was recorded from the treatment combination Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed, while the minimum harvest index (41.44) was recorded from Control (RDF) 20:40:20 N:P:K kg/ha, which was found to be statistically on par with the highest and lowest treatment.

Conclusion: The present study concluded that the application of 50 kg P/ha along with Rhizobium 20 g/kg seed was the most effective treatment for enhancing the growth, yield attributes, and productivity of green gram (*Vigna radiata* L.). This treatment consistently produced the highest plant height, number of pods and seeds per plant, thousand-seed weight, seed yield, stover yield, and harvest index compared to other combinations and the control. In addition, it provided the maximum economic benefits, including gross return, net return, and benefit-cost ratio, demonstrating its potential for improving both productivity and profitability. The results highlight the synergistic effect of biofertilizer and phosphorus, which improves nutrient availability, physiological activity, and overall plant performance. However, as these findings are based on one season of experimentation, further multi-season trials under varying agro-climatic conditions are recommended to validate the results before making final recommendations for large-scale cultivation to farmers.

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Table 1: Response of *Biofertilizer and Phosphorus* on growth attributes of Greengram

S. No.	Treatment Combination	Plant Height (cm)	Dry Weight (g)	Number of Nodules per Plant	Crop Growth Rate (g m^2 day^{-1}) (60-80 DAS)	Relative Growth Rate (g m^{-1} day^{-1}) (60-80 DAS)
1	Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed	69.74	17.63	15.71	39.74	1.17
2	Phosphorus 30 kg/ha + PSB 20 g/kg seed	66.06	16.08	15.10	38.82	1.04
3	Phosphorus 30 kg/ha + VAM 20 g/kg seed	64.85	15.80	14.10	32.23	0.97
4	Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed	69.84	17.97	15.87	42.97	1.79
5	Phosphorus 40 kg/ha + PSB 20 g/kg seed	64.10	16.85	14.94	39.34	1.30
6	Phosphorus 40 kg/ha + VAM 20 g/kg seed	66.76	15.28	13.87	41.86	1.41
7	Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed	70.40	19.56	16.81	46.91	2.17
8	Phosphorus 50 kg/ha + PSB 20 g/kg seed	58.62	16.01	15.34	32.12	1.42
9	Phosphorus 50 kg/ha + VAM 20 g/kg seed	65.86	15.78	15.46	29.18	1.33
10	Control N:P:K - 20:40:20 kg/ha (RDF)	61.52	15.03	13.67	19.12	0.88
F-Test		S	S	S	S	NS
S.Em (±)		48.05	1.60	0.23	6.12	0.19
CD (p = 0.05)		3.63	4.77	0.68	18.17	-

Table 2: Response of Biofertilizer and Phosphorus on Yield attributes of Greengram

S. No.	Treatment Combination	No. of Pods/Plant	No. of Seeds/Pod	Test Weight (g)	Seed Yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
1	Phosphorus 30 kg/ha + Rhizobium 20 g/kg seed	17.84	10.96	38.94	1.62	1.79	44.39
2	Phosphorus 30 kg/ha + PSB 20 g/kg seed	17.81	11.21	38.30	1.08	1.65	40.39
3	Phosphorus 30 kg/ha + VAM 20 g/kg seed	17.21	10.34	38.40	1.74	1.53	45.37
4	Phosphorus 40 kg/ha + Rhizobium 20 g/kg seed	18.21	11.46	39.70	1.66	1.84	46.24
5	Phosphorus 40 kg/ha + PSB 20 g/kg seed	17.14	10.88	38.10	1.06	1.79	43.52
6	Phosphorus 40 kg/ha + VAM 20 g/kg seed	17.88	10.41	38.70	1.57	1.71	47.44
7	Phosphorus 50 kg/ha + Rhizobium 20 g/kg seed	19.21	12.48	40.50	1.81	1.07	49.00
8	Phosphorus 50 kg/ha + PSB 20 g/kg seed	17.14	10.88	38.10	1.08	1.93	43.54
9	Phosphorus 50 kg/ha + VAM 20 g/kg seed	17.08	10.90	38.70	1.31	1.83	42.41
10	Control N:P:K - 20:40:20 kg/ha (RDF)	14.74	8.10	32.10	0.86	0.91	41.44
F-Test		S	S	NS	S	S	NS
S.Em (±)		0.13	0.17	0.38	13.79	32.25	1.40
CD (p = 0.05)		0.37	0.49	-	40.77	93.66	-

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