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Response of Phosphorus and Vermicompost Application on Growth and Yield of Green Gram (*Vigna radiata* L.) under Rainfed Condition in Chitrakoot, Madhya Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted at Mahatma Gandhi Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) during the Kharif season of 2021–2022. The objective was to evaluate the response of green gram to phosphorus and vermicompost on growth parameters, yield attributes, and overall

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yield under the rainfed conditions of the Chitrakoot area. The experimental soil had a sandy loam texture with medium phosphorus availability. A randomized block design was employed with 12 treatment combinations and three replications. The PDM 139 variety of green gram was cultivated following recommended agronomic practices. Results indicated that applying 60 kg P ha^{-1} and 7.5 tons vermicompost ha^{-1} at 40 days after sowing (DAS) significantly enhanced growth parameters such as plant height, number of leaves, and number of branches. Yield attributes, including the number of pods per plant, number of seeds per pod, and 1000-seed weight, also showed significant improvement. Additionally, the application of 60 kg P ha^{-1} and 7.5 tons vermicompost ha^{-1} at 40 DAS markedly increased seed yield (q ha^{-1}) compared to the control.

Keywords: Sustainable agriculture; Green gram; PDM 139 variety; phosphorus application; rainfed conditions; sandy loam soil; growth parameters; yield attributes; seed yield.

1. INTRODUCTION

Green gram (*Vigna radiata* L.) is a significant pulse crop in India, known for its drought tolerance and suitability for light textured soils with poor water holding capacity and regions with low and erratic rainfall. It is cultivated for grain, green fodder, and green manuring. Green gram seeds and forage are rich in protein, fat, and minerals. The grain contains approximately 24.5% protein, which is highly digestible and of good quality. Sprouted seeds produce vitamin C and are also a good source of riboflavin and thiamine. The straw and husk serve as fodder for cattle. As a leguminous crop, green gram enhances soil fertility by fixing 30-40 kg of atmospheric nitrogen per hectare.

In India, pulses are cultivated on 29.83 million hectares, producing 25.72 million tons annually, with a productivity of 892 kg/ha (Anonymous 2020-21). Mungbam is grown on about 30.48 million hectares, yielding approximately 2.37 million tons with a productivity of 777.55 kg/ha (Anonymous 2020-21). In Madhya Pradesh, moonbeam covers 2.51 million hectares, with a total production of 1.16 million tons and a productivity of 464 kg/ha (Annual Report DPD 2016-17).

Indian soils are generally poor to medium in available phosphorus. Only about 30% of the applied phosphorus is available to crops, with the rest converting into insoluble forms. As the available phosphorus in the soil solution is typically insufficient for plant growth, continual supplementation from inorganic and organic sources is necessary. An extra dose of phosphorus in the recommended application increases nitrogen fixation and ultimately improves green gram productivity. Phosphorus plays a crucial role in major metabolic processes in plants, including photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis, and respiration. Phosphorus is an essential both as a part of several key plant structure compound and as catalysis in the conversion of key biochemical reaction in plant. Phosphorus is a vital component of ATP, the “energy unit” of plants. ATP forms during photosynthesis in its structure, and processes from the beginning of seedling growth through to the formation of grain and maturity (Aman Parashar et al., 2020).

Vermicompost enhances soil biodiversity by promoting beneficial microbes, which directly stimulate plant growth through the production of plant growth regulators (hormones and enzymes) and indirectly by controlling plant pathogens, nematodes, and other pests, thereby improving plant health and reducing yield loss (Pathama and Sakthivel, 2012). Vermicomposting offers an effective solution for recycling organic waste and reducing fertilizer use. The large-scale application of compost increases soil organic matter content, which is critical for long-term soil fertility. Furthermore, vermicompost is enriched with soil microbiota such as nitrogen-fixing and phosphorus-solubilizing organisms (Yatoo et al., 2020). Microbial inoculants are becoming increasingly popular due to their cost-effectiveness, ease of use, and lack of adverse effects. Phosphate-dissolving microorganisms render insoluble phosphate forms more available to plants. Additionally, soil microbes produce metabolic products like organic acids and humic substances, which form complexes with Fe and Al compounds, reducing further fixation and increasing the efficiency of applied phosphatic fertilizers.

2. MATERIALS AND METHODS

2.1 Area and Location

The experiment was carried out at the research farm of Agriculture farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot Satna (M.P.) throughout July 2021 to Sept 2021 to observe the response of green gram to phosphorous and vermicompost below rainfed situation of Chitrakoot area. This lies in the semi-arid and sub-tropical region of Madhya Pradesh between 25.148° N latitude and 80.855° E longitude. The altitude of town is about 190-210 meter above mean sea level. Experimental site location is located in Bundelkhand sector of northern Madhya Pradesh and feature generally sub-tropical and semi-arid with monsoon starting off through the 1/3 week of June and with drawing through quit of September. Overall rainfall acquired throughout the crop growing duration became300 mm.

2.2 Edaphic Condition

"The experimental field is sandy loam in texture, neutral in pH 7.5, low in organic carbon (0.21%), available N (95.65 kg ha^{-1}), medium in available P (16.25 kg ha^{-1}), high in available K (308.95 kg ha^{-1}).

2.3 Study Design

The experiment was carried out in a randomized block design (RBD) assigning treatment combinations.

2.4 Treatment Details

The experiment was conducted with 4 levels of Phosphorus plant growth and 3 levels of Vermicompost of 12 treatment combination as indicated Table 1.

Table 1. Treatment details

A - Levels of Phosphorus	B - Levels of Vermicompost
1. P_0 - 0 kg ha^{-1}	1. V_0 - 0 tons ha^{-1}
2. P_1 - 40 kg ha^{-1}	2. V_1 - 5 tons ha^{-1}
3. P_2 - 50 kg ha^{-1}	3. V_2 - 7.5 tons ha^{-1}
4. P_3 - 60 kg ha^{-1}	

2.5 Application of Manures and Fertilizers

Phosphorus was applied at rates of 40 kg ha^{-1}, 50 kg ha^{-1}, and 60 kg ha^{-1}, and vermicompost was applied at rates of 7.5 t ha^{-1} and 5 t ha^{-1} as a basal dose. After laying out the experimental plots, the fertilizers were weighed, applied, and thoroughly mixed with the soil. The recommended doses of nitrogen, phosphorus, and potassium were applied to all control plots using urea and DAP (20:50:0 kg ha^{-1}).

2.6 Data Collection

2.6.1 Plant Growth parameters

Plant Height (cm): Heights of crop plants under different treatments were recorded at 20, 40, and 60 days after sowing (DAS). Five plants were randomly selected from each plot and tagged for observation. Plant height was measured from ground level up to the base of the last fully opened leaf of the main shoot.

Number of Leaves per Plant: The number of leaves per plant was recorded at 20, 40, and 60 DAS in the five tagged plants.

Number of Branches per Plant: The number of branches per plant was recorded at 20, 40, and 60 DAS in the five tagged plants.

Number of Nodules per Plant: The total number of nodules per plant in the five tagged plants was counted, and the average number of nodules per plant was calculated.

2.7 Yield Attributing Characters

Number of Pods per Plant: The number of pods per plant was counted from the five sample plants, and the average was calculated.

Number of Seeds per Pod: The number of seeds per pod was counted from the five sample plants, and the average was calculated.

Seed Index: The weight of 1000 seeds from the produce of each treatment was recorded and subjected to statistical computation.

Seed Yield (q ha^{-1}): The seed yield from the net plot area was recorded in kg plot^{-1} and converted into q ha^{-1}.

2.8 Statistical Analysis

Data recorded on various growth, yield, and quality attributes were subjected to statistical analysis following Fisher's method (1947) of analysis of variance (Panse and Sukhatme method, 1967). The significance of various treatments was judged by comparing the calculated "F" value with Fisher's "F" value at the 5% probability level against the appropriate degrees of freedom.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Plant Height: Data in Table 2 shows that plant height increased from 6.0 cm at 20 DAS to 9.63 cm, and from 37.13 cm at 40 DAS to 46.60 cm, with an increasing dose of 60 kg ha^{-1} phosphorus and 7.5 t ha^{-1} vermicompost, respectively. At 60 DAS, plant height ranged from 42.63 cm to 53.33 cm. The amounts of phosphorus and vermicompost at 20, 40, and 60 DAS resulted in statistically significant differences in plant height (Swami et al., 2020; Om Prakash Pandey et al., 2019).

Number of Leaves per Plant: Table 2 indicates that the number of leaves per plant increased from 28.20 to 32.80 at 20 DAS, from 28.40 to 33.00 at 40 DAS, and from 28.10 to 33.20 at 60 DAS with increasing doses of phosphorus (control, 40 kg, 50 kg, 60 kg ha^{-1}) and vermicompost (control, 5 t, 7.5 t ha^{-1}). The increase in the number of leaves was statistically significant (Sanjay Kumar Shahi et al., 2019).

Number of Branches per Plant: Table 2 shows that the number of branches per plant increased from 3.40 to 5.37 at 20 DAS, from 5.07 to 10.00 at 40 DAS, and from 7.20 to 15.00 at 60 DAS with increasing doses of phosphorus (control, 40 kg, 50 kg, 60 kg ha^{-1}) and vermicompost (control, 5 t, 7.5 t ha^{-1}). The increase in the number of branches was statistically significant (Rajesh Kumar Sahu and DP Chaturvedi 2022).

3.2 Yield Components and Yield

Number of Pods per Plant: Table 3 shows that the number of pods per plant ranged from 8.40 to 12.13 under different levels of phosphorus and vermicompost. The maximum number of pods was observed with the T12 (P60 kg, V7.5 t ha^{-1}) application, which was higher than other treatments but statistically at par with T11 (P60 kg, V5 t ha^{-1}) (P.K. TYAGI AND A.K. UPADHYAY (2015).

Number of Seeds per Pod: Table 3 shows that the number of seeds per pod increased with different levels of phosphorus and vermicompost, ranging from 8.40 to 12.13. The T12 (P60 kg, V7.5 t ha^{-1}) application significantly increased the number of seeds per pod compared to the control (Ashish Masih et al., 2020).

1000 Seed Weight (gm): Table 3 shows that the T1 control (P0, V0) recorded a lower test weight of 27.10 g, while the highest test weight of 31.53 g was observed with the T12 (P60 kg, V7.5 t ha^{-1}) treatment. This increase was statistically significant (Sumit Kumar Mishra et al., 2022).

Table 2. Effect of different level of phosphorus and vermicompost on growth parameters of green gram

Treatments	Plant height (cm)			No. of leaves $plant^{-1}$			No. of branches		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
P_0 0Kg, V_0 0t. ha^{-1}	6.00	37.13	42.63	28.2	28.4	28.1	2.70	5.07	7.20
P_0 0Kg, V_1 5t. ha^{-1}	7.30	37.17	43.30	28.8	28.6	28.5	3.40	5.30	7.70
P_0 0Kg, V_2 7.5t. ha^{-1}	7.17	38.13	43.80	30.2	30.5	29.8	3.63	5.60	8.60
P_1 40Kg, V_0 0t. ha^{-1}	7.10	39.57	47.13	30.2	29.2	29.7	3.93	6.47	8.87
P_1 40Kg, V_1 5t. ha^{-1}	7.50	41.73	48.13	30.4	29.8	30	3.60	6.63	9.47
P_1 40Kg, V_2 7.5t. ha^{-1}	7.53	42.30	48.53	30.8	31	30.9	4.20	7.60	10.20
P_2 50Kg, V_0 0t. ha^{-1}	7.80	42.70	49.57	31	31.4	31.6	4.30	7.83	10.57
P_2 50Kg, V_1 5t. ha^{-1}	8.13	43.40	50.00	31.2	31.5	31.7	4.40	8.00	10.83
P_2 50Kg, V_2 7.5t. ha^{-1}	8.33	44.83	51.77	31.8	32	32.8	4.67	8.60	12.20
P_3 60Kg, V_0 0t. ha^{-1}	8.47	45.93	52.73	31.1	32.5	32.7	4.80	8.63	13.80
P_3 60Kg, V_1 5t. ha^{-1}	8.57	45.90	53.13	32.7	32.8	32.9	5.03	9.60	14.53
P_3 60Kg, V_2 7.5t. ha^{-1}	9.63	46.60	53.33	32.8	33	33.2	5.37	10.00	15.00
S.E. (m) ±	**0.097**	**0.277**	**0.223**	**0.218**	**0.221**	**0.178**	**0.117**	**0.113**	**0.108**
C.D. (5%)	**0.287**	**0.818**	**0.660**	**NA**	**0.651**	**0.525**	**0.345**	**0.333**	**0.318**

Table 3. Effect of different level of phosphorus and vermicompost on yield components of green gram

Treatments		**Yield attribute character's**	
No. of pod plant-1		**No. of seeds pod-1**	**1000 seed weight (g)**
P_0 0Kg, V_0 0t. ha^{-1}	9.90	8.40	27.10
P_0 0Kg, V_1 5t. ha^{-1}	10.07	8.60	27.43
P_0 0Kg, V_2 7.5t. ha^{-1}	10.73	8.93	27.93
P_1 40Kg, V_0 0t. ha^{-1}	11.17	9.33	27.70
P_1 40Kg, V_1 5t. ha^{-1}	11.53	10.40	28.17
P_1 40Kg, V_2 7.5t. ha^{-1}	11.83	10.67	28.20
P_2 50Kg, V_0 0t. ha^{-1}	12.40	11.07	28.23
P_2 50Kg, V_1 5t. ha^{-1}	12.53	11.20	29.67
P_2 50Kg, V_2 7.5t. ha^{-1}	13.50	11.33	29.77
P_3 60Kg, V_0 0t. ha^{-1}	14.10	11.73	30.30
P_3 60Kg, V_1 5t. ha^{-1}	14.27	12.07	31.37
P_3 60Kg, V_2 7.5t. ha^{-1}	14.37	12.13	31.53
S.E. (m) ±	**0.106**	**0.118**	**0.171**
C.D. (5%)	**0.314**	**0.348**	**0.504**

Table 4. Effect of different level of phosphorus and vermicompost on productivity of green gram

Treatments	**Yield (q ha^{-1})**
P_0 0Kg, V_0 0t. ha^{-1}	5.0
P_0 0Kg, V_1 5t. ha^{-1}	5.3
P_0 0Kg, V_2 7.5t. ha^{-1}	6.0
P_1 40Kg, V_0 0t. ha^{-1}	6.4
P_1 40Kg, $V_1$5t.ha^{-1}	7.5
P_1 40Kg, V_2 7.5t. ha^{-1}	7.9
P_2 50Kg, V_0 0t. ha^{-1}	8.6
P_2 50Kg, V_1 5t. ha^{-1}	9.3
P_2 50Kg, V_2 7.5t. ha^{-1}	10.1
P_3 60Kg, V_0 0t. ha^{-1}	11.1
P_3 60Kg, V_1 5t. ha^{-1}	12.0
P_3 60Kg, V_2 7.5t. ha^{-1}	12.2
S.E. (m) ±	**10.17**
C.D. (5%)	**30.03**

Seed Yield (kg ha^{-1}): Table 4 indicates that the seed yield of mung bean increased with higher levels of phosphorus (40, 50, 60 kg ha^{-1}) and vermicompost (5 t, 7.5 t ha^{-1}). The highest yield of 12.2 q ha^{-1} was observed with the T12 (P60 kg, V7.5 t ha^{-1}) treatment, while the lowest yield was observed with the control (P0, V0). The yield increase was statistically significant (PK Singh et al., 2019).

4. CONCLUSION

The research conducted on the application of phosphorus and vermicompost in green gram (*Vigna radiata* L.) cultivation under rainfed conditions in Chitrakoot has demonstrated significant improvements in both growth parameters and yield attributes. The study found that the combined application of 60 kg P ha^{-1} and 7.5 tons vermicompost ha^{-1} led to marked enhancements in plant height, number of leaves, and number of branches per plant. This combination also significantly increased yield components such as the number of pods per plant, number of seeds per pod, and 1000-seed weight.

The most notable result was the significant increase in seed yield, with the highest yield observed in the treatment with 60 kg P ha^{-1} and 7.5 tons vermicompost ha^{-1}, producing 12.2 q ha^{-1}. This yield was substantially higher than the control, highlighting the effectiveness of integrating phosphorus and vermicompost in green gram cultivation.

These findings suggest that farmers in the Bundelkhand region can benefit from the application of 60 kg ha^{-1} phosphorus and 7.5 tons ha^{-1} vermicompost, along with the recommended dose of NPK (20:50:0 kg ha^{-1}), to achieve maximum productivity in green gram crops. The use of vermicompost not only improves growth and yield but also contributes to long-term soil fertility by enhancing soil organic matter and promoting beneficial microbial activity.

Overall, this study underscores the importance of integrated nutrient management in optimizing green gram production under rainfed conditions, offering a sustainable and effective approach for improving crop yields and soil health in semi-arid regions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Anonymous. (2021). *Agricultural statistics at a glance 2020-21*. Government of India, Ministry of Agriculture and Farmers Welfare.

Directorate of Pulses Development (DPD). (2017). *Annual report 2016-17*. Directorate of Pulses Development, Bhopal, Madhya Pradesh.

Masih, A., Dawson, J., & Singh, R. E. (2020). Effect of levels of phosphorus and zinc on growth and yield of *green gram* (*Vigna radiata* L.). *International Journal of Current Microbiology and Applied Sciences, 9*(10), 3106-3112.

Mishra, S. K., & Chaturvedi, P. K. (2023). Effect of integrated nutrient management on growth and yield of *green gram* (*Vigna radiata* L.). *The Pharma Innovation Journal, 12*(1), 671-673.

Pandey, O. P., Shahi, S. K., Dubey, A. N., & Maurya, S. K. (2019). Effect of integrated nutrient management on growth and yield attributes of *green gram* (*Vigna radiata* L.). *Journal of Pharmacognosy and Phytochemistry, 8*(3), 2347-2352.

Parashar, A., Jain, M., & Nath, R. (2020). Effect of phosphorus and sulphur on the growth and yield of *green gram* (*Vigna radiata* L.). *Indian Journal of Pure and Applied Biosciences, 8*(5), 51-55.

Pathma, J., & Sakthivel, N. (2012). Microbial diversity of vermicompost bacteria that exhibit useful agricultural traits and waste management potential. *Springer Plus, 1*, 26. Available: http://www.springerplus.com/content/1/1/26

Sahu, R. K., & Chaturvedi, D. P. (2022). Growth, yield and quality response of *green gram* (*Vigna radiata* L.) to phosphorus levels and vermicompost. *The Pharma Innovation Journal, 11*(7), 1956-1958.

Shahi, S. K., Pandey, O. P., Dubey, A. N., & Maurya, S. K. (2019). Effect of integrated nutrient management on growth and yield attributes of *green gram* (*Vigna radiata* L.). *Journal of Pharmacognosy and Phytochemistry, 8*(2), 2347-2352.

Singh, P. K., Anees, M., Kumar, M., Yadav, K. G., Kumar, A., Kumar, M., Sharma, R., Singh, R. B., & Kumar, S. (2019). Effect of integrated nutrient management on growth, yield and quality of *moong bean* (*Vigna radiata* L.). *Journal of Pharmacognosy and Phytochemistry, SP2*, 1003-1006.

Swamy, B. M. V., Singh, V., Tiwari, D., & Thakur, I. (2020). Study of system of crop intensification (SCI) and phosphorus management on growth, yield and economics of *green gram* (*Vigna radiata* L.). *International Journal of Current Microbiology and Applied Sciences, 9*(8), 1950-1958.

Tyagi, P. K., & Upadhyay, A. K. (2015). Effect of integrated nutrient management on yield, quality, nutrient uptake and economics of summer *green gram*. *Annals of Plant and Soil Research, 17*(3), 242-247.

Yatoo, A. M., Rasool, S., Ali, S., Majid, S., Rehman, M. U., Ali, M., Eachkoti, R., Rasool, S., Rashid, S. M., & Farooq, S. (2020). Vermicomposting: An eco-friendly approach for recycling/ management of organic wastes. In *Bioremediation and Biotechnology* (pp. 167-187). Springer.

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