E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(5): 451-455
Received: 17-03-2024
Accepted: 26-04-2024

Ummed Singh
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Victor Debbarma
Assistant Professor, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Meghna Choudhury
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Himanshu Saini
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Ummed Singh
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of biofertilizer and phosphorus on growth and yield of greengram [*Vigna radiata* (L.) Wilczek]

Ummed Singh, Victor Debbarma, Meghna Choudhury and Himanshu Saini

DOI: https://doi.org/10.33545/2618060X.2024.v7.i5f.747

Abstract
A field experiment was conducted during *kharif* season of 2023 at Crop Research Farm Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Sciences And Technology. To determine "Effect of biofertilizer and phosphorus on growth and yield of greengram [*Vigna radiata* (L.) Wilczek]". The results revealed that treatment 9 Rhizobium + Phosphorus 50 kg/ha recorded significantly higher plant height (40.40 cm), number of root nodules/plant (28.20), number of branches/plant (14.20), dry weight (16.80 g), number of pods/plant (28.00), number of seed/pod (11.27), seed yield (2.03t/ha), stover yield (3.10 t/ha), maximum gross return (INR 117024.00), net return (INR 72706.00) and B:C ratio (1.67) was recorded in treatment 9 Rhizobium + Phosphorus 50 kg/ha as compared to the other treatments was found to be productive as well as economically feasible.

Keywords: Biofertilizer, phosphorus, growth, yield, economics

Introduction
The mung bean, commonly known as greengram (*Vigna radiata* L.) is a significant conventional pulse crop grown in India. It is originated from India and central Asia. Because of its high nutrient content and ability to enrich soil with additional nitrogen, it is also known as the "Golden Bean". Because of its great nutritional value, it has an edge over other pulses. Protein (24.20%), fat (1.30%), and carbs (60.4%) are present in the seed, while calcium and phosphorus (340 mg and 118 mg/100 grams of seed, respectively) are also present. Soil physical properties are enhanced and atmospheric nitrogen is fixed by greengram. It has excellent quality tryptophan (60 mg/g), lysine (460 mg/g), riboflavin (021 mg/100 g), and minerals (3.84 mg/100 g) when ascorbic acid is noted. Globally an area about 150.05 lakh ha with a production of 158.72 lakh tonnes and productivity of 1058 kg/ha under (GOI, 2022) [6]. In India, greengram is grown over an area about 48.52lakh ha with a production of 26.48 lakh tonnes and productivity of 546 kg/ha (GOI, 2022) [6]. Total coverage under green gram in Uttar Pradesh 0.89 Lakh ha with a production 0.54 Lakh tonnes and the productivity 608 kg/ha".

According to Kunjammal and Sukumar (2019) [12] most greengram crops yield a lot of flowers, but very few of those blooms stay and turn into pods. Greengram is known for both flowering and pod shedding, which is mirrored in sink realization. The quality and quantity of greengram may be improved if there was a way to remove these possible obstacles to yield. In the current situation, when farmers would rather not use artificial fertilizers, concentrating on locally accessible sources of nutrients is a simple solution. At the moment, one of the biggest challenges facing agricultural experts is cutting back on the usage of costly chemical fertilizers, which have detrimental effects on both the environment and human health. Large-scale soil N replenishment is frequently achieved through the use of chemical fertilizers, which are expensive and seriously pollute the environment (Barakzai *et al*., 2019) [2].

Living microorganisms of bacterial, fungal, and algal origin are known as biofertilizers. They can be used separately or in combination and have different modes of action. Leguminous crop root nodules assist in fixing atmospheric nitrogen in the soil, which biofertilizers then make available to plants. Biofertilizers boost nutrient availability and boost yield by 10 to 25% when applied to seed or soil without negatively impacting the soil or environment (Chirumella *et al*., 2023) [4].

Vascular-Arbuscular Mycorrhiza (VAM) is essential to improve growth and yield by providing the host plant with a greater supply of phosphorus. It Allows plants to absorb nutrients that are attached to the soil or in unavailable forms. In neutral soil, several plant nutrients phosphorus in particular dissolve in water (Koshariya *et al*., 2023) [14].

Phosphorus-solubilizing microorganisms (bacteria and fungi) make P available for plant uptake after solubilization. Soil bacteria like Bacillus and Pseudomonas, as well as fungi like Aspergillus and Penicillium, can convert insoluble soil phosphates into soluble forms by secreting organic acids like formic, acetic, propionic, lactic, glycolic, fumaric, and succinic. These acids reduce pH and dissolve bound phosphates (Venkatarao *et al.*, 2017) [20]. PSB play an important role in plant nutrition by increasing phosphorus availability through solubilization and mineralization of inorganic and organic soil P pools (Singh *et al*., 2021) [17]. *Rhizobium* is a group of motile Gram-negative aerobic rods with bipolar, subpolar, or peritrichous flagella. Cells contain β-hydroxybutyrate (40-50% of their dry weight). They do not generate spores. Rhizobium-mediated nitrogen fixation in legumes accounts for a significant portion of overall biological nitrogen fixation. Mung bean roots have nodules capable of fixing atmospheric nitrogen through symbiotic interaction with the bacteria Rhizobium (Mandale *et al*., 2021) [8].

Plants require phosphorus, in addition to nitrogen. Phosphorus availability in Indian soils ranges from poor to medium. Phosphorus application to legumes improves not just the current crop but also future non-legume crops. It has also increased crop quality and resilience to disease. It is a component of ADP, ATP, nucleic acid, thiamine phosphate, flavin nucleotides, phospholipids, and phosphorylated sugar, among others. It stores and transforms energy. It is also required for cell division, protein synthesis, root development, blooming, fruiting, and seed production. (Shalu *et al*., 2023) [18]. Keeping in view of the above fact, the experiment was conducted to find out “Effect of biofertilizer and phosphorus on growth and yield of greengram”.

Materials and Methods

The experiment was conducted during *kharif* season 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and zinc (2.32 mg/kg). The treatment consists of three levels of Phosphorus (30, 40, 50 kg/ha) and Biofertilizers (VAM, PSB, Rhizobium) . The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T1 - VAM + Phosphorus 30 kg/ha, T2 - VAM + Phosphorus 40 kg/ha, T3 - VAM + Phosphorus 50 kg/ha, T4 - PSB + Phosphorus 30 kg/ha, T5 - PSB + Phosphorus 40 kg/ha, T6 - PSB + Phosphorus 50 kg/ha, T7 - Rhizobium + Phosphorus 30 kg/ha, T8 - Rhizobium + Phosphorus 40 kg/ha, T9 - Rhizobium + Phosphorus 50 kg/ha, T10 - Control (N:P:K) 20:40:20 kg/ha. Data recorded on different aspects of crop, *viz.*, growth, weed management practices, yield attributes and yield were subjected to statistically analysed by analysis of variance method as described by (Gomez and Gomez, 1976) [5].

Result and Discussion

Growth Attributes

Plant height (cm)

The data revealed that significantly higher plant height (41.39cm) was recorded in the treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)] treatment 6 [PSB + Phosphorus (50 kg/ha)] and treatment 8 [Rhizobium + Phosphorus (40 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. Significant and higher plant height was observed with application of Rhizobium might be due to genetic characteristic and enhanced cell division and elongation. These results are in conformity with those of Nissa *et al*. (2017) [9]. Further, significant increase in plant height with the application of phosphorus may be due to the use of phosphorus levels, which facilitate the synthesis of new cells and the development of roots, this process makes all nutrients and water from deeper soil layers available for increased photosynthetic activity, may have encouraged vegetative growth, which raised the height of the plant. Similar results were also reported by Chirumella *et al*. (2023) [4].

Number of branches/plant

Significantly and maximum number of branches/plant (14.20) was obtained significant and maximum treatment-9 [Rhizobium + Phosphorus (50 kg/ha)]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)] and treatment 6 [PSB + Phosphorus (50 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. Significant and maximum number of branches/plant observed with the application of rhizobium might be it preserve a suitable ratio between the nutrients given to the plant for maximum growth along with chlorophyll production and elongation. These results were collaborated with Tripathi *et al.* (2021) [19]. Further, significantly increased in number of branches/plant was with the application of phosphorous maybe due to it improves root growth, enabling plants to absorb available nutrients and moisture from deeper layers, resulted in high number of branches/plant. Present findings are within the close proximity of Gadi *et al*. (2018) [7].

Number of nodules/plant

Significantly and maximum number of nodules/plant (28.20) was observed significant and maximum treatment-9 [Rhizobium + Phosphorus (50 kg/ha)]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)] and treatment 6 [PSB + Phosphorus (50 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. The significant and maximum number of nodules/plant was observed with the application of rhizobium might be due to larger capacity of microorganisms in nearby areas of roots, where microbial infection occurs and a well-developed root system yields more indications of infection, leading to a higher number of nodules. Similar results were observed by Tripathi *et al.* (2021) [19] in blackgram. Further, significantly increased in number of nodules/plant was with the application of phosphorus might be due it increases new cell proliferation, cellular elongation, plant vitality and foliar growth which resulted in better solar energy obtaining, improved nitrogen utilization which in turn produce high number of nodules/plant .The present findings are within the close proximity of Patel *et al*. (2020) [10].

Plant dry weight (g)

Results revealed that significantly higher plant dry weight (16.80g) was observed in treatment-9 [Rhizobium + Phosphorus (50 kg/ha)]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)], treatment 6 [PSB + Phosphorus (50 kg/ha)], and treatment 8 [Rhizobium + Phosphorus (40 kg/ha)] were found to be statistically at par with the treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. The significant and higher plant dry weight was with the application of Rhizobium inoculation might be due to by increasing nodulation and rate of nitrogen fixation might have promoted plant development through symbiotic methods Similar results were noticed by Kundu *et al*. (2013) [13]. Further significantly higher plant dry weight was with the application of phosphorous might be due to improved photosynthetic activity by improving light exposure, and increased nutritional availability to the plants. These findings were similar to Kumar and Debbarma (2023) [11].

Crop Growth Rate (g/m^2/day)

The data recorded during 60-80 DAS; Highest crop growth rate (19.20 g/m^2/day), was observed in treatment 9 [Rhizobium + Phosphorus (50 kg/ha)].

Relative Growth Rate (g/g/day)

The data revealed that During 60-80 DAS, treatment 2 [VAM + Phosphorus (40 kg/ha)] recorded significantly higher Relative Growth Rate (0.0429 g/g/day) , though there was no significant difference among the treatments.

Yield and Yield Parameters

Number of pods/plant

Treatment-9 [Rhizobium + Phosphorus (50kg/ha)] recorded significant and maximum number of pods/plant (28.00). However, treatment 3 [VAM + Phosphorus (50 kg/ha)] and treatment 6 [PSB + Phosphorus (50 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. The significant and maximum number of pods/plants was with the application of Rhizobium might be due the improved uptake of nutrients, absorption of solar radiation, and development of roots and shoots in addition of the relocation and build-up of photosynthates in economic sinks. These findings are in accordance with the findings of Ajaykumar *et al*. (2022) [1]. Further significantly increased in number of pods/plant with the application of phosphorous might be due to the involved in the formation of seeds and healthy fruiting. These results are in conformity with those of Gadi *et al.* (2018) [7].

Number of seeds/pod

Significantly higher number of seeds/pod (11.27) was recorded in treatment-9 [Rhizobium + Phosphorus (50 kg/ha)]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)] and treatment 6 [PSB + Phosphorus (50 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. The significant and higher number of seeds/pod with the application of Rhizobium is may be due to rise of bacteria as a result of artificial inoculation and plant has more leaves and branches, which allow it to create and transfer additional photosynthates and carbs to the lower regions. The result was in collaboration with Sajid *et al.* (2011) [16]. Further, increase in seeds/pod was obtained with the application of phosphorous may be due to greater rates of dry matter buildup and its transfer from sources to sinks in the plants were caused by phosphorus, resulted maximum number of seeds/pod . These results are in conformity with those of Singh *et al.* (2018) [15].

Test weight (g)

Statistically highest test weight (29.70g) was found in Treatment-8 [Rhizobium + Phosphorus (40kg/ha)], though there is no significant difference found among all the treatments.

Seed yield (t/ha)

Significantly maximum Seed Yield (2.56 t/ha) was recorded in treatment-9 [Rhizobium + Phosphorus 50 kg/ha]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)] and treatment 6 [PSB + Phosphorus (50 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. The significant and higher seed yield was obtained with the application of Rhizobium might be due to increased nodulation, which subsequently helped to increase nitrogen availability which is a very important factor that influenced seed yield. The similar results were obtained by Nissa *et al*., (2017) [9]. Further, significantly increased in seed yield with the application of Phosphorous may be due to fact that a larger seed production was eventually achieved by surplus assimilates being stored in the leaves and then translocated into seeds during senescence. These results are similar with those of Chirumella *et al.* (2023) [4].

Stover yield (t/ha)

Significant and higher haulm yield (3.10 t/ha), was observed in treatment-9 [Rhizobium + Phosphorus 50 kg/ha]. However, treatment 3 [VAM + Phosphorus (50 kg/ha)], treatment 4 [PSB + Phosphorus (30 kg/ha)], treatment 5 [PSB + Phosphorus (40 kg/ha)], treatment 6 [PSB + Phosphorus 50 kg/ha] and treatment 7 [Rhizobium + Phosphorus (30 kg/ha)] were found to be statistically at par with treatment 9 [Rhizobium + Phosphorus (50 kg/ha)]. The significant and higher stover yield was with the application of Rhizobium may be due to increase effect of other nutrients, improves nutrient uptake, and the movement of photosynthates from source to sink and it also raises the photosynthetic activity of leaves. These results were in similar with those of Tripathi (2021) [19]. Further significantly increased in stover yield was obtained with the application of Phosphorous may be due to the result of the plant's increased photosynthetic activity and a root system that allowed the plant to draw up more moisture and minerals from the ground. These results are in agreement with those of Kumar and Debbarma (2023) [11].

Harvest Index (%)

Statistically highest harvest index (40.81%) was recorded in Treatment-3 [VAM + Phosphorus (50 kg/ha)]. Though, there is no significant difference found among all the treatments.

Economics

The result showed that Maximum gross return (117024.00 INR/ha), higher net return (72706.00 INR/ha) and highest benefit cost ratio (1.67) was recorded in treatment 9 [Rhizobium + Phosphorus (50 kg/ha)] as compared to other treatments. Higher Gross returns, net returns, benefit cost ratio was recorded with application of PSB (20g/kg) seeds which might be due higher yield increases for grains and straw in comparison to the cost of cultivating at higher phosphorus levels. These results are in conformity with those of Singh *et al.* (2018) [15].

Table 1: Effect of bio-fertilizers and phosphorus on growth attributes of greengram.

S No	Treatments	Plant height (cm)	Number of Branches/Plant	Number of Nodules/plant	Plant dry weight (g)	CGR (g/m^2/day)	RGR (g/g/day)
1.	VAM + Phosphorus 30 kg/ha	32.77	12.13	16.80	13.30	16.89	0.0571
2.	VAM + Phosphorus 40 kg/ha	34.73	10.60	19.60	13.00	15.78	0.0535
3.	VAM + Phosphorus 50 kg/ha	37.70	13.23	22.80	14.70	17.41	0.0510
4.	PSB + Phosphorus 30 kg/ha	35.70	11.80	18.73	13.23	16.37	0.0540
5.	PSB + Phosphorus 40 kg/ha	36.33	11.67	21.60	13.67	16.96	0.0545
6.	PSB + Phosphorus 50 kg/ha	38.27	13.40	23.73	14.83	17.48	0.0513
7.	Rhizobium + Phosphorus 30 kg/ha	35.80	10.93	19.67	12.13	13.63	0.0471
8.	Rhizobium + Phosphorus 40 kg/ha	37.17	12.07	22.40	14.37	16.82	0.0500
9.	Rhizobium + Phosphorus 50 kg/ha	40.40	14.20	28.20	15.80	18.15	0.0487
10.	Control (N:P:K) 20:40:20 kg/ha	31.27	10.00	18.80	12.43	16.30	0.0593
	F-test	S	S	S	S	NS	NS
	SEm(±)	1.20	0.35	1.83	0.58	1.38	0.0049
	CD (P=0.05)	3.57	1.05	5.43	1.73	--	--

Table 2: Effect of bio-fertilizers and phosphorus on yield attributes and yield of greengram.

S No	Treatments	Number of pods/plant	Number of Seeds/Pod	Test Weight (g)	Seed Yield (t/ha)	Stover Yield (t/ha)	Harvest index (%)
1.	VAM + Phosphorus 30 kg/ha	20.67	9.40	22.50	1.17	2.09	35.86
2.	VAM + Phosphorus 40 kg/ha	21.07	9.00	24.83	1.32	2.33	38.82
3.	VAM + Phosphorus 50 kg/ha	25.93	10.30	24.60	1.72	2.49	40.81
4.	PSB + Phosphorus 30 kg/ha	20.47	8.53	27.10	1.40	2.66	34.46
5.	PSB + Phosphorus 40 kg/ha	21.80	9.27	27.73	1.24	2.50	32.47
6.	PSB + Phosphorus 50 kg/ha	25.97	11.00	28.03	1.87	2.79	40.09
7.	Rhizobium + Phosphorus 30 kg/ha	23.87	10.00	29.17	1.26	3.03	29.35
8.	Rhizobium + Phosphorus 40 kg/ha	21.20	10.20	29.70	1.37	2.12	40.57
9.	Rhizobium + Phosphorus 50 kg/ha	28.00	11.27	27.50	2.03	3.10	39.54
10.	Control (N:P:K) 20:40:20 kg/ha	20.13	9.93	22.40	0.95	1.98	32.36
	F-test	S	S	NS	S	S	NS
	SEm (±)	0.71	0.33	1.99	0.11	0.23	3.94
	CD (P=0.05)	2.10	0.97	--	0.32	0.69	--

Table 3: Effect of bio-fertilizers and phosphorus on economics of greengram.

S No	Treatments	Total cost of cultivation (INR)	Gross Returns	Net Returns	B:C ratio
1.	VAM + Phosphorus 30 kg/ha	30394.00	77772.00	37091.00	1.22
2.	VAM + Phosphorus 40 kg/ha	30394.00	83700.00	45701.00	1.50
3.	VAM + Phosphorus 50 kg/ha	42094.00	86328.00	56241.00	1.34
4.	PSB + Phosphorus 30 kg/ha	31144.00	93672.00	49846.00	1.60
5.	PSB + Phosphorus 40 kg/ha	31144.00	96120.00	40806.00	1.31
6.	PSB + Phosphorus 50 kg/ha	42844.00	97956.00	64191.00	1.50
7.	Rhizobium + Phosphorus 30 kg/ha	31894.00	101664.00	41951.00	1.32
8.	Rhizobium + Phosphorus 40 kg/ha	31894.00	111936.00	46636.00	1.46
9.	Rhizobium + Phosphorus 50 kg/ha	43594.00	117024.00	72706.00	1.67
10.	Control (N:P:K) 20:40:20 kg/ha	27244.00	80400.00	27976.00	1.03

Conclusion
From the results, it is concluded that in greengram (treatment 9), application of Rhizobium and Phosphorus (50 kg/ha) recorded highest grain yield and benefit cost ratio.

Acknowledgement
The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology and sciences, (U.P) India for providing necessary facilities to undertake the studies.

References
1. Ajaykumar R, Harishankar K, Sivasabari K, Rajeshkumar P, Saranraj T, Aravind J, *et al*. Effect of liquid *Rhizobium* with organic bio-stimulants on growth, yield attributes and yield of leguminous blackgram [*Vigna mungo* (L.) Hepper]. An International Journal of Legume Research. 2022;1-6.
2. Barakzai K, Rahman D, Shiva A, Khalili M, Rasooli, Jamal T. Effect of sources of nutrient and biofertilizers on growth and yield of mungbean (*Vigna radiata* L.). International Journal of Chemical Studies. 2020;8(1):555-559.
3. Choudhary SL, Sharma OP, Gora MK, Choudhary RR. Effect of organic manures and molybdenum on growth, yield and quality of groundnut. International Journal of Current Microbiology and Applied Sciences. 2017;6(6):736-742.
4. Chirumella J, Singh S, Nawhal A. Effect of bio-fertilizer and phosphorus on growth and yield of green gram (*Vigna radiata* L.). International Journal of Environment and Climate Change. 2023;13(10):310-317.
5. Gomez KA, Gomez AA. Three or more factor experiment. In: Statistical procedures for agricultural research. 2nd ed. New York: John Wiley & Sons; c1976. p. 139-141.
6. Government of India. Agricultural statistics at a glance: Ministry of Agriculture, Government of India. 2022. Available from: http://www.agricoop.nic.in

7. Gadi Y, Sharma YK, Sharma SK, Bordoloi J. Influence of phosphorus and potassium on performance of green gram (*Vigna radiata* L.) in inceptisols of Nagaland. Annals of Plant and Soil Research. 2018;20(2):120-124.
8. Mandale AF, Prakash D, Patil SA, Jyostna T, Mane D, Dhanashree D. Effect of liquid formulations of *Rhizobium* inoculation on growth and yield of mung bean. Journal of Pharmacognosy and Phytochemistry. 2021;10(1):1276-1292.
9. Nissa S, Sabiya B, Dar SA, Jahangeer A, Baba SA, Hakeem RA, *et al*. Effect of *Rhizobium* and *PSB* in combination with phosphorus on the enrichment of soil fertility and its effect on yield of green gram (*Vigna radiata* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(11):3648-3652.
10. Patel BK, Patel HK, Makwana SN, Shiyal VN, Chotaliya RL. Effect of various sources of nitrogen and phosphorus on growth, yield and economics of summer green gram (*Vigna radiata* L. Wilczek). International Journal of Current Microbiology and Applied Sciences. 2020;11:745-752.
11. Kumar S, Debbarma V. Effects of phosphorus and boron on growth, yield and economics of green gram (*Vigna radiata* L.). International Journal of Plant & Soil Science. 2023;35(11):1-8.
12. Kunjammal P, Sukumar J. Effect of foliar application of nutrients and growth regulators on growth and yield of greengram (*Vigna radiata* L.). Madras Agricultural Journal. 2019;106(10):600-603.
13. Kundu R, Jajati M, Aparajita M. Growth and production potential of greengram (*Vigna radiata*) influenced by *Rhizobium* inoculation with different nutrient sources. International Journal of Agriculture, Environment & Biotechnology. 2013;6(3):344-350.
14. Koshariya AK, Sharma SK, Singampalli Y, Midhunlal V, Maloth S, Chinthada B, *et al*. Impact and potentials of vesicular-arbuscular mycorrhizae (*VAM*) fungi in plant nutrient and growth: a sustainable approach. International Journal of Plant & Soil Science. 2023;35(16):243-250.
15. Singh R, Singh VS, Prabhat, Yadav RA. Effect of phosphorus and *PSB* on yield attributes, quality and economics of summer greengram (*Vigna radiata* L.). Journal of Pharmacognosy and Phytochemistry. 2018;7(2):404-408.
16. Sajid M, Rab A, Fazal-I-Wahid, Syed N, Muhammad S, Ibadullah J, *et al*. Influence of *Rhizobium* inoculation on growth and yield of groundnut cultivars. Sarhad Journal of Agriculture. 2011;27(4).
17. Singh SR, Bhat MI, Wani JA, Naja GR. Role of *Rhizobium* and *VAM* fungi for improvement in fertility and yield of green gram under temperate conditions. Journal of the Indian Society of Soil Science. 2021;57(1):45-52.
18. Shalu, Rajhans V, Nisha, Santosh Y, Bharti Y. Effect of phosphorus and phosphate solubilizing microorganisms on soil fertility and yield of mungbean (*Vigna radiata* (L.) Wilczek). International Journal of Current Microbiology and Applied Sciences. 2023;12(3):5664-5667.
19. Tripathi S, Kumar S, Kumar M, Kumar A, Dhyani BP, Kumar Y. Effect of *Rhizobium* inoculation methods on growth, nodulation and yield of black gram (*Vigna mungo* L.). International Journal of Current Microbiology and Applied Sciences. 2021;10(01):1588-1598.
20. Venkatarao V, Naga SR, Yadav BL, Koli DK, Jagga RI. Effect of phosphorus and biofertilizers on growth and yield of mungbean (*Vigna radiata* (L.) Wilczek). International Journal of Current Microbiology and Applied Sciences. 2017;6(7):3992-3997.