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Effect of organic manures on the growth of green gram under organic farming (*Vigna radiata* L.)

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Abstract
A field experiment was conducted during the Kharif season to evaluate the Effect of organic manures on the growth, yield and quality of green gram under organic farming (*Vignaradiata* L.) at Rama University. The experiment comprised 12 treatment combinations with four phosphorus levels (0, 20, 40, and 60 kg P_2O_5/ha) and three biofertilizer inoculations (PSB, *Rhizobium*, and PSB + *Rhizobium*) laid out in a randomized block design with four replications. Phosphorus was applied through single super phosphate, along with 20 kg N/ha (urea) and 20 kg K_2O/ha (MOP).The results revealed that application of 60 kg P_2O_5/ha significantly enhanced plant height, number of branches, dry matter, nodulation, and root traits. Yield attributes such as pods/plant, grains/pod, grain weight, and test weight improved significantly with increasing phosphorus levels. The maximum grain yield (11.40 q/ha), straw yield (26.50 q/ha), and biological yield (37.90 q/ha) were recorded at 60 kg P_2O_5/ha. Nutrient content and uptake (N, P, K) in seed and straw also peaked at this level. Among biofertilizers, PSB + *Rhizobium* seed inoculation outperformed others, resulting in significant improvements in growth parameters, yield components, nutrient content, and uptake. The combination of PSB + *Rhizobium* with 60 kg P_2O_5/ha produced the highest net return (₹100,287.80/ha) and benefit-cost ratio (2.85).

Keywords: Green gram, *Vigna radiata* L., organic manures, organic farming

Introduction
The pulses (A Pulse, Latin "puls" from Ancient Greek Poltos "porridge") are annual leguminous crops that hold a special place in Indian agriculture due to their innate ability to grow on marginal land and supply the nation's poor and vegetarians with a diet high in protein. In addition to being a great source of protein, pulses are essential to sustainable agriculture because they improve the physical, chemical, and biological characteristics of soil and function as little nitrogen factories. "Unique Jewels of Indian crop husbandry" is a fitting description of them (Swaminathan, 1981). Because they work effectively in a variety of crop rotations, pulses are an essential component of cropping systems.

With almost one-third of the world's land area and one-fourth of its pulse output, India is the world's largest producer of pulses. With an average productivity of 853 kg per hectare and a total area of 29.81 million hectares, India is now the world's greatest producer of pulses, contributing 25.42 million tons to the output (Anonymous, 2024) [3].

The most significant contribution to increasing N and P availability is made by biofertilizers like Rhizobium and phosphate solubilizing bacteria (PSB), which thrive in organic nitrogen fixation and provide the crop with more appropriate phosphorus availability, respectively.

By boosting nitrogen fixation, a Rhizobium may be added to a nitrogen-deficient soil to assist increase yield. By partly solubilizing insoluble phosphate and enhancing phosphorus usage performance and production, phosphorus-solubilizing microorganisms are inoculated into the root sector of crops.

Given the aforementioned situation, the current study was conducted to see how inexperienced greengram responded to high phosphorus levels and biofertilizers. Mineral nutrients are essential for maintaining the soil's long-term viability for agricultural output as well as for optimizing the crop's realizable potential. The need of emphasizing the dietary component may be crucial.

One of the most significant and potent agronomic components in the production process is fertilizer and how it is managed. Any plant nutrient that is supplied in excess or inadequately limits crop yield, and the fertility status of the soil determines the extent of crop response to fertilizer treatment (Pal *et al* 2023 &2024) [12, 13].

These days, phosphorus not only plays a vital role in root development and growth, but it also enhances nodulation and nitrogen fixation by supplying the roots with assimilates. It is the main component of ATP and ADP, co-enzymes that function as "strength currency" inside flowers. As a result, phosphorus promoted membrane shipping, cytoplasmic streaming, nucleic acid synthesis, protein and phospholipid biosynthesis, and photosynthesis.

Methods and Materials

A field experiment was conducted during rabi season of 2024-25 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to To study the Effect of organic manures on the growth, yield and quality of green gram under organic farming (*Vigna radiata* L.).The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm-1, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha-1, respectively. The experiment comprised 12 treatment combinations with four phosphorus levels (0, 20, 40, and 60 kg P_2O_5/ha) and three biofertilizer inoculations (PSB, *Rhizobium*, and PSB + *Rhizobium*) laid out in a randomized block design with four replications weredata gathered on five plants chosen from each plot.

Results

Growth Characters

1. Plant height (cm)

Variable phosphorus levels and seed inoculation with biofertilizer affected plant height, which was assessed at 15, 30, 45, and 60 DAS as well as at harvest.

Generally speaking, plant height rose gradually from 15 to 60 days, although it decreased during the harvest phase of the experiment. The greatest growth in plant height, however, was noted between 15 and 30 days. After that, the rate of increase slowed between 30 and 60 days, and it slightly decreased during the harvest stage.

In every stage of crop growth, Table 4.1 demonstrates that P2O5 application at 60 kg per hectare greatly improved plant height in comparison to the control. Similar result reported by Ahirwar *et al*, (2016) [1], Bahadur *et al*, (2014) [4].

2. Number of branches per plant

The greatest number of branches per plant, however, was seen in the 15–30 day period. After that, the rate of growth slowed from 30–60 days and then somewhat decreased during the harvesting stage. Table 2 findings unequivocally demonstrate that, throughout all crop growth stages, spraying 60 kg P2O5 per hectare greatly enhanced the number of branches per plant compared to the control. At every stage of crop growth, however, the treatment of 60 kg P2O5 per hectare was equivalent to that of 40 kg P2O5.At every stage of crop growth, 60 kg P2O5 per ha application produced much more branches per plant than 20 kg P2O5 per ha application and control, even though the 60 kg P2O5 per ha treatment was equivalent to 40 kg P2O5 per ha. The number of branches per plant at every stage of crop growth was significantly impacted by biofertilizer inoculation throughout the experiment.

PSB + Rhizobium seed inoculation is comparable to Rhizobium seed inoculation at 60 DAS. At 15, 30, 45, and the harvest stage of crop growth, seed inoculation with PSB + Rhizobium produced noticeably more branches per plant than seed inoculation with Rhizobium plus PSB. Therefore, it can be concluded that PSB + Rhizobium-treated seeds are comparable to Rhizobium-treated seeds, although they are noticeably more numerous per plant than PSB-treated seeds. It was determined that there was no significant interaction between different phosphorus levels and seed inoculation with biofertilizers. Similar result reported by Amit *et al*, (2019) [2], Choudhary *et al*, (2011) [5].

3. Number of nodules per plant

Applying 60 kg of P2O5 per hectare clearly enhanced the number of nodules per plant compared to the control, as shown by the data in table 3. On the other hand, applying 60 kg of P2O5 per hectare was equivalent to applying 40 kg. Although 60 kg of P2O5 per hectare was determined to be equivalent to 40 kg of P2O5 per hectare, it resulted in much more nodules per plant than the control and 20 kg of P2O5 per hectare. The seeds that were infected with PSB + Rhizobium and were on par with Rhizobium had the greatest number of nodules per plant. Compared to seeds infected with Rhizobium and PSB, seeds treated with PSB + Rhizobium showed a much greater number of nodules per plant.

In, the number of nodules per plant was not significantly affected by the interaction between different phosphorus levels and seed inoculation with bio fertilizers. Similar result reported by Ghanshyam *et al*, (2010) [6], Gupta *et al*, (2016) [7].

4. Root dry weight(g)

The information in table 3 makes it clear that applying 60 kg of P2O5 per hectare increases the root dry weight over control. On the other hand, applying 60 kg of P2O5 per hectare was equivalent to applying 40 kg. The application of 60 kg P2O5 per hectare produced a much greater root dry weight than 20 kg P2O5 per hectare and the control, even if it was equivalent to that of 40 kg P2O5 per hectare. Compared to seeds inoculated with Rhizobium and PSB, seeds inoculated with PSB + Rhizobium showed a considerably larger root dry weight, and seeds inoculated with PSB + Rhizobium were determined to be comparable to Rhizobium. Root dry weight (g) was shown to be unaffected by the interplay between different phosphorus levels and seed inoculation with bio fertilizers. Similar result reported by Khan *et al*, (2019) [8], Kumari *et al*, (2015), [9] Mohammad *et al*, (2017) [11].

Table no. 1: Plant height (cm) as affected by phosphorus levels and biofertilizer at successive stage of crop growth

S. N	Treatments	15 DAS	30 DAS	45 DAS	60 DAS	At harvest
a.	**Phosphorus levels (kg ha-1)**					
1	Control	9.90	20.50	26.20	30.80	38.33
2	20	11.90	26.40	33.90	39.90	45.17
3	40	12.50	30.30	38.40	46.40	49.14
4	60	12.90	32.00	41.50	47.30	51.76
	S.Em±	0.249	0.613	0.785	0.886	1.034
	C.D.(P=0.05)	0.716	1.764	2.258	2.549	2.976
b.	**Biofertilizer**					
1	PSB	10.50	22.90	29.00	38.40	43.41
2	*Rhizobium*	12.20	27.40	35.60	41.00	46.10
3	PSB + *Rhizobium*	12.70	31.60	40.40	43.90	48.79
	S.Em±	0.216	0.613	0.680	0.767	0.896
	C.D.(P=0.05)	0.620	1.764	1.956	2.207	2.578

Table 2: Number of branches per plant as affected by phosphorus levels and biofertilizers at successive stage of crop growth

S. N	Treatments	15	30	45	60	At harvest
a.	**Phosphorus levels (kg ha-1)**					
1	Control	2.20	4.67	6.40	8.00	8.40
2	20	2.50	5.71	8.00	9.90	10.20
3	40	2.78	6.67	9.20	11.17	11.60
4	60	2.92	6.95	9.60	11.73	12.20
	S.Em±	0.056	0.133	0.179	0.233	0.235
	C.D.(P=0.05)	0.161	0.382	0.515	0.671	0.676
b.	**Biofertilizer**					
1	PSB	2.30	5.52	7.10	9.10	9.20
2	*Rhizobium*	2.60	6.00	8.50	10.50	11.00
3	PSB + *Rhizobium*	2.90	6.48	9.30	11.00	11.60
	S.Em±	0.049	0.115	0.155	0.202	0.203
	C.D.(P=0.05)	0.140	0.331	0.446	0.581	0.585

Table 3: Root studies as affected by phosphorus levels and biofertilizers at successive stage of crop growth

S. N	Treatments	Root length (Cm)	No. of nodules $plant^{-1}$	Root dry weight (g)	Root volume (Cm^3)	Root spread (Cm^2)
a.	**Phosphorus levels (kg ha^{-1})**					
1	Control	13.90	37.60	0.35	1.78	1.65
2	20	14.20	40.80	0.38	1.84	1.67
3	40	15.10	43.20	0.43	2.00	1.70
4	60	15.60	45.00	0.44	2.10	1.74
	S.Em±	0.270	0.953	0.008	0.047	0.033
	C.D.(P=0.05)	0.776	2.742	0.022	0.136	0.094
b.	**Biofertilizer**					
1	PSB	14.00	38.15	0.36	1.80	1.64
2	*Rhizobium*	14.80	42.35	0.41	1.95	1.68
3	PSB + *Rhizobium*	15.30	44.45	0.43	2.04	1.75
	S.Em±	0.234	0.825	0.007	0.041	0.028
	C.D.(P=0.05)	0.672	2.375	0.019	0.118	0.081

Conclusion

Phosphorus application and seed inoculation with biofertilizers significantly influenced plant growth parameters. Plant height and the number of branches increased steadily until 60 DAS, peaking between 15–30 DAS before slightly declining at harvest. Application of 60 kg P_2O_5/ha consistently outperformed lower doses, though it was statistically on par with 40 kg/ha. Biofertilizer inoculation with PSB + Rhizobium notably improved plant height, branching, nodulation, and root dry weight, performing better than PSB or Rhizobium alone. However, no significant interaction was observed between phosphorus levels and seed inoculation. Thus, 60 kg P_2O_5/ha and PSB + Rhizobium inoculation are optimal for enhancing plant growth traits.

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