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Effect of integrated phosphorus management on growth, yield and economics of green gram (*Vigna radiata* L.)

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Abstract
The field experiment took place in the Department of Agriculture's Crop Research Farm, SHUATS, Allahabad, during the Kharif season of 2021. (U.P). The soil in the experimental plot has a sandy loam texture, a pH of 7.1, low organic carbon (0.36 percent), available N (171.48 kg/ha), available P (15.2 kg/ha), and available K (232.5 kg/ha), and is low in organic carbon (0.36 percent). FYM (5t/ha), vermicompost (2.5t/ha), phosphorous (20, 30, and 40kg/ha), and PSB (with PSB) and (without PSB), i.e. (var. SAMRAT). A randomized block design was adopted in the trial, with 12 treatments replicated three times. Maximum plant height (37.11 cm), number of branches (4.66), dry weight of plants (4.59 g / plant), nuts per plant (26.05), seeds per pod (9.08), and test weight were all shown to be significant (43.39 g). The application of FYM (5t/ha) + phosphorus 40 kg/ha + PSB had a substantial impact on seed yield (1.88 t/ha), store yield (3.74 kg/ha), and crop index (33.49 percent). Control yielded the highest crop growth rate (6.90g / m2 / day). RGR, on the other hand, is widely acknowledged as critical. With FYM (5t / ha) + phosphorus 40 kg / ha application in treatment + PSB, the maximum gross return (Rs. 1,78,600 / ha), net return (Rs. 1,32,946 / ha), and BC ratio (2.91) were obtained. As a result, it can be concluded that the application of FYM (5t/ha) + phosphorus 40 kg/ha + PSB is effective.

Keywords: Phosphorus, PSB, FYM, vermicompost

Introduction
In Indian agriculture, pulses play an important role. Grain legumes are high-value, low-input crops that contribute to crop diversity. Pulses have a special place in Indian agriculture due to their increased protein content and ability to stabilize nitrogen from the atmosphere. Green gram [*Vigna radiata* L. Wilczek. 2n = 22] is a commercially important legume crop grown worldwide in tropical and subtropical regions, and is one of the most important legume crops in India. The advantages are high protein content (25-28%) and lower fat than other pulses, as well as wide adaptation, minimum agricultural input requirements, and the ability to increase soil fertility. Sprouts and green gram are high in vitamins and minerals, making them a good and economical source of nutritious protein for low-income people.

Phosphorus (P) is one of the most important components in the creation of legumes. Although it is not required on a large scale, phosphorus is essential for the production of green gram due to its many nutritional effects. All growing plants need large amounts of phosphorus for growth and development. The importance of phosphorus in root structure, nodule number, and yield is well understood. In the opinion of many researchers, the application of phosphorus affects the number of other nutrients in the leaves and seeds. Phosphorus deficiency is severe in some soils in the northern dry zone of Karnataka and plant growth stops as soon as the phosphorus supply in the soil decreases. Due to its multiple effects on plant nutrition, phosphorus fertilizer is recommended to improve yield (20 - 60 kg ha-1) (not just nodulation).

In India's sustainable agricultural system, bio-fertilizers, which are part of integrated nutrient management, are bulk, low-cost plant-enhancing fertilizers that are cost-effective, environmentally friendly, and renewable. As a result, in the current climate of the high cost of chemical fertilizers, bio-fertilizers play a particularly important role. Phosphorus solubilizers are placed in the pulses to increase their number and place them more significantly in the rhizosphere.

Materials and Methods
During the 2020 *Kharif* season, the experiment was carried out at latitude 250 30'42 'N and

longitude 810 60'56' E at Crop Research Farm, Department of Agricultural Sciences, Naini Agricultural Institute, SHUATS, Prayagraj (UP). On average, the elevation is 98 meters above sea level. The soil structure of the sandy loam of the experimental plot is almost neutral in soil reaction (pH 7.1), low organic carbon (0.44%), available N (171.48 kg/ha), available P (27.0 kg/ha), and available K (291.2). kg/ha), and is almost neutral in soil action (pH 7.1). (pH 7.1). On June 30, 2021, the crop will be sown with the Nidhi Samrat variety. T1: FYM (5t / ha) + Phosphorus 20 kg / ha + PSB, T2: FYM (5t / ha) + Phosphorus 20 kg / ha + PSB, T3: FYM (5t / ha) + Phosphorus 20 kg / ha + PSB, T4: FYM (5t / ha) + Phosphorus 20 kg / ha + PSB, T5: Vermicompost (2.5 t / ha) + Phosphorus 30 kg / ha + PSB, T6: Vermicompost (2.5 t / ha) + Phosphorus (40 kg / ha) + PSB T7: FYM + phosphorus 20kg / ha, T8: FYM + phosphorus 30kg / ha, T9: FYM + phosphorus 40kg / ha T9: FYM4kphog0 ha, T10: vermicompost + phosphorus 20kg / ha, T11: vermicompost 30kg / ha + And T12: vermicompost + phosphorus 40 kg / ha. All fertilizers were applied to the soil using urea, single superphosphate (SSP), and potash muriate (MOP). The total dose of Nand K was used in all experiments. The prescribed amount in each plot is added to FYM, vermicompost, and phosphorus treatments. PSB is applied to the seedlings 24 hours before sowing. During the 15, 30, 45, 45, and 60 DAS intervals, five randomly selected plant growth symptoms were assessed in each treatment. The mean was compared with a 5% chance of significant results and statistical analysis was performed.

Results and Discussions

The effect of integrated phosphorus management on green gram growth parameters is indicated in Table 1.

Growth parameters

Plant height (cm)

Treatment with FYM (5t / ha) + phosphorus 40 kg / ha + PSB had the highest plant height (37.11cm), while FYM (5t / ha) + phosphorus had the lowest (28.27cm) with 20 kg / ha + PSB. Prasad and Sanoria (1984) [12], Dotania (2012) [6], Dotania, *et al.*, (2013) [7], Saad and Sharma (2003) [15], and Menaria *et al.*, (2003) [11] all showed similar results in green gram.

Number of branches plant^{-1}

There was a significant difference between the treatments, with the highest number of branches per plant (4.66) being observed with FYM (5t/ha) + Phosphorus 40 kg/ha + PSB, and the lowest number of branches (3.09) being recorded with FYM (5t/ha) + Phosphorus 30 kg/ha + PSB. On green gram, Prasad and Sanoria (1984) [12], Dotaniya (2012) [6], Dotaniya *et al.*, (2013) [7], Saad and Sharma (2003) [15], and Menaria *et al.*, (2003) [11] all reported similar results.

Dry weight (g plant^{-1})

Maximum The applications of FYM (5t/ha) + Phosphorus 40 kg/ha + PSB produced the highest dry weight (g) plant-1 (4.59), whereas the treatment Vermicompost (2.5t/ha) + Phosphorus 40 kg/ha + PSB produced the lowest value (3.35). There is no statistically significant difference in the treatments.

This is attributed to improved P consumption in the context of a larger P dosage. Phosphorus is known to help legumes grow by encouraging broad root development and nodulation, which increases the availability of nutrients to the plant's developing components, resulting in the greater photosynthetic area and dry matter build-up. These findings are consistent with those of Dhewa *et al.*, (2015) [5] and Das *et al.*, (2015) [4]. This could be because inorganic P, when added to soil, is changed into a variety of reaction products, the majority of which are sparingly soluble orthophosphates. When combined with vermicompost and PSB, however, fixed P is dislodged, resulting in increased P availability for the plants (Kadam *et al.*, 2014) [9]. These findings corroborate those of Tak *et al.*, (2013) [16] and Jat *et al.*, (2012) [8].

Yield and yield attributes

The effect of integrated phosphorus management on green gram yield attributes is shown in Table 2.

Number of pods plant^{-1}

The results revealed that there was a significant difference between the treatments, with the application of FYM (5t/ha) + Phosphorus 40 kg/ha + PSB resulting in the highest number of pods plant-1 (25.10 plant-1), and the application of FYM (5t/ha) + Phosphorus 20 kg/ha + PSB resulting in the lowest number of pods plant^{-1} (17.73).

Number of seeds pod^{-1}

The results revealed that there was a significant difference between the treatments, with the highest number of seeds pod-1 (9.08) observed in the FYM (5t/ha) + Phosphorus 40 kg/ha + PSB treatment, and the lowest number of seeds pod-1 (5.48) in the Vermicompost (2.5t/ha) + Phosphorus 40 kg/ha + PSB treatment.

Test weight (g)

The results revealed that there was a significant difference between the treatments, with the application of FYM(5t/ha) + Phosphorus 40 kg/ha + PSB recorded the highest maximum test weight (43.39g), while the treatments with Vermicompost (2.5t/ha) + Phosphorus 30kg/ha + PSB recorded (40.09) and FYM + Phosphorus 20kg/ha recorded (38.57) were statistically at par to the treatment application of FYM (5t/ha) + Phosphorus 40 kg/ha + PSB.

Grain yield (t ha^{-1})

The results revealed that there was a significant difference between the treatments, with the treatment using FYM (5t/ha) + Phosphorus 40 kg/ha + PSB producing the highest Grain yield (1.88 t/ha), while the treatment using Vermicompost (2.5 t/ha) + Phosphorus 40kg/ha and FYM + Phosphorus 30kg/ha produced the lowest Grain yield (t ha^{-1}) (1.08).

Stover yield (t ha^{-1})

The results demonstrated a significant difference between the treatments, with the largest Stover yield (3.74t/ha) observed when FYM (5t/ha) + Phosphorus 40 kg/ha + PSB was applied, whereas the lesser Stover yield (3.09 t/ha) was recorded when FYM + Phosphorus 30kg/ha was applied.

Harvest Index (%)

The results revealed that there was a significant difference between the treatments, with the maximum Harvest index (33.49 percent) recorded by the application of FYM (5t/ha) + Phosphorus 40 kg/ha + PSB, and the Harvest index (31.26 percent) recorded by the application of FYM (5t/ha) +

Phosphorus 20 kg/ha + PSB, which was statistically at par with the treatment application of FYM (5t/ha) + Phosphorus 40 kg + PSB

Increased P availability and uptake led to profuse nodulation, resulting in more symbiotic nitrogen fixation, which in turn has a favorable influence on photosynthesis, and then on yield (Rani *et al.*,2016 and Kumar *et al.*,2014). Phosphorus is involved in cell division, enhances numerous metabolic processes, and causes cell enlargement, according to Rathour *et al.*, (2014). The use of phosphate solubilizing bacteria releases growth-promoting chemicals, which improves haulm production.

Economics

Table 3. shows the economic impact of Integrated Phosphorus Management on green gram. In treatment with FYM (5t/ha) + Phosphorus 40 kg/ha + PSB, the highest gross return (1,78,600 INR/ha), higher net returns (1,32,946 INR/ha), and maximum B:C ratio (2.91) were recorded

Table 1: Effect of Integrated Phosphorus Management on the number of Growth parameters of green gram

Treatment No.	Treatment Combination	Growth parameters at 45 DAS		
		Plant height (cm)	No. of Branches	Dry weight (g) plant^{-1}
1	FYM(5t/ha) + Phosphorus 20 kg/ha + PSB	28.27	3.60	3.37
2	FYM(5t/ha) + Phosphorus 30 kg/ha + PSB	32.47	3.09	3.79
3	FYM(5t/ha) + Phosphorus 40 kg/ha + PSB	37.11	4.66	4.59
4	Vermicompost (2.5t/ha) + Phosphorus 20kg/ha + PSB	29.94	3.19	3.44
5	Vermicompost (2.5t/ha) + Phosphorus 30kg/ha + PSB	34.24	3.33	3.40
6	Vermicompost (2.5t/ha) + Phosphorus 40kg/ha + PSB	29.56	3.89	3.35
7	FYM + Phosphorus 20kg/ha	35.39	4.08	4.14
8	FYM + Phosphorus 30kg/ha	30.25	3.11	3.98
9	FYM + Phosphorus 40kg/ha	33.01	3.37	4.56
10	Vermicompost + Phosphorus 20kg/ha	30.90	4.10	4.43
11	Vermicompost + Phosphorus 30kg/ha	34.50	3.85	3.56
12	Vermicompost + Phosphorus 40kg/ha	32.71	4.27	4.53
	F-Test	S	S	S
	CD at 0.5	2.942	0.370	0.830
	S.Ed(+)	1.419	0.178	0.400

Table 2: Effect of Integrated Phosphorus Management on Yield and Yield Attributes of a Green gram

Treatment No.	Treatment Combination	Yield and yield attributes					
		No. of pods plant^{-1}	Seeds pod^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
1	FYM(5t/ha) + Phosphorus 20 kg/ha + PSB	17.73	8.08	36.484	1.44	3.18	31.26
2	FYM(5t/ha) + Phosphorus 30 kg/ha + PSB	19.54	7.41	34.1467	1.34	3.70	26.61
3	FYM(5t/ha) + Phosphorus 40 kg/ha + PSB	25.10	9.08	43.3933	1.88	3.74	33.49
4	Vermicompost (2.5t/ha) + Phosphorus 20kg/ha + PSB	26.05	5.98	34.7633	1.24	3.37	26.86
5	Vermicompost (2.5t/ha) + Phosphorus 30kg/ha + PSB	22.82	5.97	40.0933	1.31	3.60	26.61
6	Vermicompost (2.5t/ha) + Phosphorus 40kg/ha + PSB	23.35	5.48	37.0933	1.29	3.46	27.15
7	FYM + Phosphorus 20kg/ha	23.85	7.39	38.57	1.34	3.58	27.21
8	FYM + Phosphorus 30kg/ha	18.88	7.15	36.7267	1.08	3.09	25.88
9	FYM + Phosphorus 40kg/ha	20.28	6.82	34.7467	1.21	3.46	25.87
10	Vermicompost + Phosphorus 20kg/ha	21.14	8.60	32.8	1.25	3.58	25.91
11	Vermicompost + Phosphorus 30kg/ha	18.17	8.08	31.8467	1.22	3.23	27.26
12	Vermicompost + Phosphorus 40kg/ha	22.18	7.30	36.84	1.08	3.34	24.54
	F-Test	S	S	S	S	S	S
	CD at 0.5	5.015	1.855	5.502	0.208	0.336	3.591
	S.Ed(+)	2.418	0.895	2.653	0.100	0.162	1.732

Table 3: Effect of Integrated Phosphorus Management on Economics of green gram

Treatments No.	Treatment Details	Economics			
		Total cost of cultivation	Gross return	Net return	B:C ratio
1	FYM(5t/ha) + Phosphorus 20 kg/ha + PSB	42154	136800	94646	2.25
2	FYM(5t/ha) + Phosphorus 30 kg/ha + PSB	43904	127300	83396	1.90
3	FYM(5t/ha) + Phosphorus 40 kg/ha + PSB	45654	178600	132946	2.91
4	Vermicompost (2.5t/ha) + Phosphorus 20kg/ha + PSB	47154	117800	70646	1.50
5	Vermicompost (2.5t/ha) + Phosphorus 30kg/ha + PSB	48904	124450	75546	1.54
6	Vermicompost (2.5t/ha) + Phosphorus 40kg/ha + PSB	50654	122550	71896	1.42
7	FYM + Phosphorus 20kg/ha	42090	127300	85210	2.02
8	FYM + Phosphorus 30kg/ha	43840	102600	58760	1.34
9	FYM + Phosphorus 40kg/ha	45590	114950	69360	1.52
10	Vermicompost + Phosphorus 20kg/ha	47090	118750	71660	1.52
11	Vermicompost + Phosphorus 30kg/ha	48840	115900	67060	1.37
12	Vermicompost + Phosphorus 40kg/ha	50590	102600	52010	1.03

Conclusion

Based on the findings of the investigation it may be concluded of treatment FYM (5t/ha) + Phosphorus 40 kg/ha + PSB. performed exceptionally in obtaining the highest grain, net returns, and B:C ratio.

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