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Influence of INM on Growth and Yield of Green Gram (*Vigna radiata* L.) NEPZ

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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

At the United University's Agricultural Research Farm in Rawatpur, Jhalwa, Prayagraj (U.P.), India, during the Kharif season of 2022, a research on green gram (*Vigna radiata* L.) was carried out to examine the effects of integrated nutrient management on growth, yield, and economics. On green gram (*Vigna radiata* L), the experiment was conducted using a randomized bock design with three replications in all allowable combinations of inorganic fertilizers, *Rhizobium*, and PSB together with FYM. This study showed that plant height (91.99 cm), dry weight (105.45 g), and number of root nodules (111.33) were all significantly enhanced by 100% RDF + 5.0 tonnes FYM ha^{-1} + *Rhizobium* and PSB seed inoculation. In terms of increasing yield and yield-related indicators, such as number of pods $plant^{-1}$ (31.43), number of seeds pod^{-1} (12.46), test weight (37.26 g), and harvest index (34.90%), the same treatment combination likewise showed the best results. As a result, adding

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farm yard manure at a rate of 5 tonnes per hectare coupled with *Rhizobium* and PSB increased yield compared to the control. But using 100% RDF, bio fertilizer, and FYM @ 5.0 tonnes ha^{-1} greatly boosts gross returns (₹ 104,120.00), net returns (₹ 76,017.00), and benefit: cost ratio (2.70). These results showed that the addition of organic matter, inorganic fertilizers, and bio-fertilizers all combined to boost yield while using various nutrition sources.

Keywords: Green gram; yield characteristics; INM; growth; and yield.

1. INTRODUCTION

"Green gram (*Vigna radiata* L.) is one of the most important and extensively cultivated pulse crops. India shares about 35- 37 % and 27 % of the total area and production of pulses, respectively in the world. Green gram commonly knows as "mung" or "mung bean" is the most important crop of the South-East Asia and particularly the India sub-continent" (Ranpariya et al. 2017). "This popular and ancient crop is especially recognized as an excellent source of protein. It also plays an important role in maintaining and improving the fertility of soil through its ability to fix atmospheric nitrogen in the soil by root nodules. Green gram contains about 24.3 % protein and a good source of riboflavin" [1]. "India is the world's top producer of green gram, and it is cultivated in practically every State. It is farmed on roughly 4.5 million hectares, producing 2.5 million tonnes at a productivity of 548 kg per hectare, making up 10% of the world's production of pulses" (Anonymous, 2021). The primary states in India that produce pulses include Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Bihar, and Karnataka.

"Rhizobia bacteria that live in symbiotic relationships with green gramme roots aid in fixing atmospheric nitrogen into the soil" [2]. A beginning dosage of nitrogen is necessary to boost green gram growth and production. The production of protein, chlorophyll, and plant enzymes in legumes depends heavily on nitrogen. The soil and environment are endangered by the massive use of chemical fertilizers. The soil has become choked with excessive amounts of macronutrients found in synthetic fertilizers, which have negative effects on crops, livestock, and people [3]. The utilization of organic sources of nutrients for crop growth should be prioritised for sustainable agriculture [4]. "In addition to improving soil fertility, soil porosity, infiltration rate, total carbon, water holding capacity, cation exchange capacity, reducing bulk density, stopping soil erosion, and increasing the availability of plant nutrients through mineralization process, organic manures contain both macro and micronutrients. Combining chemical fertilizers with organic nutrient sources can assist to improve the physical-chemical characteristics of the soils and the effective use of applied fertilizers for enhancing seed quality and quantity. Organic sources maintain a favorable nutritional balance and the physical characteristics of the soil while also acting as an excellent substrate for the growth of microorganisms. It is acknowledged that using a combination of organic manures, bio-fertilizers, and chemical fertilizers may significantly increase soil production. Manure from farms is recognized to have significant" [5]. The rising price of inorganic fertiliser, rising environmental concerns, and the energy crisis have generated a great deal of interest in the more affordable alternatives to inorganic fertilizer. Taking into account the aforementioned information, the current study was conducted to evaluate the productivity and profitability of green gram production using an integrated method of organic manures, bio-fertilizers, and inorganic fertilizers.

2. MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season 2022 at Agricultural Research Farm of United University, Rawatpur, Jhalwa, Prayagraj (U.P.), India which is situated at 25.39^0 N latitude, 81.75^0 E longitude with an altitude of 113 meters above mean sea level. To investigate the effects of integrated nutrient management on the development, production, and economics of green gram (*Vigna radiata* L.) under integrated nutrient management. The experiment was laid out in randomized block design with three replication. The experiment was comprised of eleven treatment *viz*., T_1 100% RDF, T_2 100% RDF + Seed treatment (*Rhizobium* and PSB), T_3 100% RDF plus seed treatment (*Rhizobium* and PSB) plus 2.5 t FYM ha^{-1}, T_4 100% RDF plus seed treatment (*Rhizobium* and PSB) plus 5.0 t FYM ha^{-1}, T_5 80% RDF plus seed treatment (*Rhizobium* and PSB), T_6 80% RDF plus seed treatment (*Rhizobium* and PSB) plus 2.5 t FYM ha^{-1}, T_7 80% RDF + *Rhizobium* and PSB seed treatment + 5.0 t FYM ha^{-1}, T_8 60% RDF + *Rhizobium* and PSB seed treatment, T_9: 60% RDF + *Rhizobium* and PSB seed treatment + 2.5 t FYM ha^{-1}, T_{10} 60% RDF + *Rhizobium* and PSB seed treatment + 5.0 t FYM $ha^{-1}$and T_{11} Control. After pre-sowing irrigation, the green gram variety "PDM-139 (Samrat)" was seeded using a 15 kg ha^{-1} seed rate. As suggested, a baseline dosage of 20 kg N and 50 kg P_2O_5 was administered per acre. Before sowing, FYM was administered to the field according to the treatment instructions and blended with the soil. As a result, *Rhizobium* and PSB were injected into the seeds. The "analysis of variance" method was used to do statistical analysis on the data gathered for each character. According to Cochran and Cox [6] the "F" test of significance was used to evaluate overall differences at a 5 percent level of significance. For comparing treatments, critical differences at a 5% level of probability were determined.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth Parameters

The plant height (91.99 cm) was maximal T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) according to the 60 DAS data. T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (86.44 cm) and T7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha-1) (90.74 cm) respectively, are the two other treatments. Additionally, T_3 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}) (82.12 cm) was discovered to be statistically comparable to T_4 in terms of height.

A maximum T_4 branch count of 7.46 was noted in the 60 DAS (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}). T_4 was shown to be statistically equivalent to T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (7.13) and T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (7.00).

It was noted that the plant's dry matter accumulation at 60 DAS (105.45) was at its highest T_4 level (100% RDF plus seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha_{-1}). T_4 was shown to be statistically comparable to T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (101.91) and T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (101.21) [7].

“Nitrogen is so vital because it is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide (*i.e*., photosynthesis). It is also a major component of amino acids, the building blocks of proteins” [8]. “Phosphorus is a vital component of ATP, the "energy unit" of plants. ATP forms during photosynthesis, has phosphorus in its structure, and processes from the beginning of seedling growth. Thus, phosphorus is essential for the general health and vigor of all plants” [9]. The application of *rhizobium* inoculum in green gram plants can increase the root nodules, which function to fix nitrogen for plants [10]. “Phosphate solubilizing bacteria (PSB) are the main contributors of plant nutrition in agriculture and could play a pivotal role in making soluble phosphorus available to plants” [11]. “Application of Farmyard Manure (FYM) is known to keep soil productivity longer than inorganic fertilizers. FYM contains all the macro- and micronutrients required for plant growth, but its main effect is due to nitrogen, phosphorus, and potassium” [12].

3.2 Effect on Yield Attributes and Yield

Application of T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) resulted in the highest (31.43) number of pods $plant^{-1}$. T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) and T10 (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) on the other hand, were statistically equal.

With the application of T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}), the maximum number of seeds pod^{-1} (12.46) was achieved. T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) and T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (11.93), in contrast, were statistically equal.

The application of T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) produced the highest (37.267 g) test weight (g), which was superior to the other treatments. T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) and T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (36.36 g) on the other hand, were statistically equal.

Table 1. Green gram development and integrated nutrition management

Tr. No.	Treatment combination	At harvest		
		Plant height (cm) at harvest	**Number branches plant^{-1}at harvest**	**Dry matter accumulation (gm^{-2})**
T_1	100% RDF	76.46	6.20	88.53
T_2	100% RDF + Seed treatment (*Rhizobium* and PSB)	78.17	6.30	88.93
T_3	100% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}	82.12	6.73	98.86
T_4	100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}	91.99	7.46	105.45
T_5	80% RDF + Seed treatment (*Rhizobium* and PSB)	70.99	6.06	78.71
T_6	80% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}	82.20	6.93	99.80
T_7	80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}	90.74	7.13	101.91
T_8	60% RDF + Seed treatment (*Rhizobium* and PSB)	68.78	5.80	78.56
T_9	60% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}	71.41	6.13	80.16
T_{10}	60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}	86.44	7.00	101.20
T_{11}	Control	54.86	5.40	75.00
	SEm±	5.68	0.40	38.72
	CD (p=0.05)	16.89	1.19	115.05

Table 2. Impact of integrated nutrition management on green gram yield characteristics

Tr. No.	Treatment	Number of pods plant $^{-1}$	Number of seeds pod $^{-1}$	Test weigh (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
T_1	100% RDF	26.70	11.26	32.86	0.97	1.60	37.24
T_2	100% RDF + Seed treatment (*Rhizobium* and PSB)	27.46	11.73	33.56	1.00	1.84	34.82
T_3	100% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}	28.33	11.76	34.70	1.11	1.32	33.68
T_4	100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}	31.43	12.46	37.26	1.33	2.49	34.90
T_5	80% RDF + Seed treatment (*Rhizobium* and PSB)	25.23	10.13	30.06	0.98	1.80	35.13
T_6	80% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}	29.73	11.86	35.86	1.01	1.90	35.86
T_7	80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}	30.20	12.26	36.36	1.31	2.44	35.00
T_8	60% RDF + Seed treatment (*Rhizobium* and PSB)	24.70	9.76	29.96	0.97	1.64	36.93
T_9	60% RDF + Seed treatment (*Rhizobium* and PSB) + 2.5 t FYM ha^{-1}	25.86	10.36	31.40	1.00	1.89	35.56
T_{10}	60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}	29.76	11.93	36.30	1.30	2.39	35.26
T_{11}	Control	23.80	9.70	28.70	0.66	2.19	33.33
	SEm±	1.15	0.34	1.67	40.76	70.28	0.76
	CD (p=0.05)	3.43	1.01	4.97	121.10	208.81	-

The application of T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) resulted in the highest seed production (1.33 t ha^{-1}). Statistically speaking, T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (1.31) and T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) (1.30) were comparable.

The application T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) had the highest steady yield (2.49 t ha^{-1}). T_7 (80% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) and T_{10} (60% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) were statistically equal.

T_1 100% RDF was used to get the highest harvest index (37.24%). While using T_4 (100% RDF + Seed treatment (*Rhizobium* and PSB) + 5.0 t FYM ha^{-1}) yielded the lowest harvest index (33.68%).

4. CONCLUSIONS

Thus, it can be inferred from the experiment that the integrated application of 100% of the recommended fertilizers dose along with farmyard manure @ 5 t ha^{-1} and *Rhizobium* and phosphate solubilizing bacteria (PSB) was found to be the best treatment for increasing productivity and obtaining higher net returns and benefit: cost ratios in the cultivation of green gram.

5. FUTURE SCOPE

As that conclusion are based on research conducted over a single season in Allahabad's agro-ecological environments, more experiment may be necessary before it could be considered a recommendation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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