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

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Abstract

A field experiment was conducted at the Research Farm, Department of Agronomy, AKS University, Satna (M.P.), during the *Kharif* season of 2024-25 to evaluate the effect of integrated nutrient management (INM) on the performance of green gram (*Vigna radiata* L.) in terms of growth, yield attributes, yield, quality, and economics. The experiment was laid out in a randomised block design (RBD) comprising nine treatments and three replications. The experiment was laid out in a Randomised Block Design (RBD) with nine treatments and three replications. The treatments were: T₁ - Control, T₂ - 100% RDF (20:40:30 kg N:P₂O₅:K₂O ha⁻¹), T₃ - 75% RDF + 5 t FYM ha⁻¹, T₄ - 50% RDF + 5 t FYM ha⁻¹, T₅ - 25% RDF + 5 t FYM ha⁻¹, T₆ - 75% RDF + 5 t vermicompost ha⁻¹, T₇ - 50% RDF + 5 t vermicompost ha⁻¹, T₈ - 25% RDF + 5 t vermicompost ha⁻¹, and T₉ - 5 t FYM ha⁻¹ + 5 t vermicompost ha⁻¹. The results revealed that the treatment T₆ (75% RDF + 5 t vermicompost ha⁻¹) recorded the highest plant height (47.43 cm at harvest), number of branches per plant (7.87 at harvest), root nodules (29.87 per plant at 40 DAS), number of pods per plant (28.40), seeds per pod (10.13), test weight (44.89 g), grain yield (1225 kg ha⁻¹), stover yield (2050 kg ha⁻¹), and protein content (25.9%). It also recorded the maximum net monetary return (₹47,375 ha⁻¹) and benefit: cost ratio (2.61). The lowest values for these parameters were observed in the control treatment (T₁). The study concludes that the integrated use of 75% RDF and 5 t ha⁻¹ vermicompost (T₆) is a superior and sustainable nutrient management strategy for enhancing productivity and profitability in green gram cultivation. The study concluded that the integrated application of 75% RDF with 5 t ha⁻¹ vermicompost is optimal for improving green gram productivity and profitability under the agro-climatic conditions of Satna.

Keywords: Green gram, integrated nutrient management, FYM, vermicompost, yield, protein, economics

Introduction

Green gram (*Vigna radiata* L.), commonly known as mung bean, is a vital pulse crop cultivated extensively across India due to its short duration, nitrogen-fixing ability, and high protein content (approximately 25%). It serves as an essential source of dietary protein and contributes significantly to soil fertility when integrated into cropping systems. Despite its importance, the productivity of green gram remains low, primarily due to cultivation on marginal lands with poor nutrient management (Saravanan *et al.*, 2013) ^[9]. India ranks first in global green gram production, cultivating it over an area of about 4.5 million hectares, with an annual production of 2.64 million tonnes and an average productivity of 548 kg/ha (Suddala *et al.*, 2024) ^[11].

In recent years, the concept of Integrated Nutrient Management (INM), which includes a combination of chemical fertilizers, organic manures, and biofertilizers, has gained prominence as a sustainable approach to improve crop productivity while preserving soil health. INM not only enhances nutrient availability and uptake but also improves microbial activity, organic matter content, and overall soil structure. The challenge with relying solely on chemical fertilizers lies in their rising cost, limited availability, and potential for adverse environmental impacts (Jat *et al.*, 2015) ^[4]. On the other hand, while organic manures like FYM and vermicompost improve soil physical properties and microbial biomass, their nutrient release is often slow. Therefore, integrating both nutrient sources under an INM strategy offers a promising solution. This study was designed to evaluate the effect of INM on the growth, yield, protein content, and economics of green gram under the agro-climatic conditions of Satna, Madhya Pradesh.

Materials and Methods

The experiment was conducted at the Research Farm, Department of Agronomy, AKS University, Satna (M.P.), during the Kharif season of 2024-25 on a sandy loam soil, which was neutral in pH (7.27) with medium organic carbon (0.62%) and available nitrogen (272.4 kg/ha), phosphorus (14.5 kg/ha), and potassium (298.2 kg/ha). It was laid out in a Randomized Block Design (RBD) with nine treatments and three replications, each plot measuring 4.5 m × 2.4 m. The treatments included control, varying levels of RDF (20:40:30 kg N: P₂O₅: K₂O ha⁻¹) alone or combined with FYM or vermicompost, and combinations of FYM and vermicompost. Green gram variety 'Virat' (IPM-205-7) was sown on 9th July 2024 at 30 × 10 cm spacing with a seed rate of 20 kg/ha, following recommended irrigation and plant protection practices, with fertilizers applied basally and organic manures incorporated three weeks before sowing. Observations were recorded on growth parameters (plant height, branches, leaves, nodules), yield attributes (pods, seeds, 1000-seed weight, grain and stover yield), protein content estimated via the Kjeldahl method, and economic returns including gross return, net return, and B:C ratio.

Results and Discussion

Growth Parameters

Treatment T₆ (75% RDF + 5 t vermicompost ha⁻¹) significantly outperformed all other treatments with respect to vegetative growth parameters, registering the highest plant height (50.57 cm), number of branches per plant (7.00), number of leaves per plant (14.07), and root nodules per plant (29.40). These growth enhancements can be attributed to the synergistic effects of organic and inorganic nutrient sources. The application of vermicompost alongside 75% of the recommended dose of fertilizers ensured a consistent and gradual nutrient release, which promoted robust root development, increased leaf area, and more effective canopy establishment.

The presence of humic substances, growth-promoting hormones (auxins, gibberellins), and enzymes in vermicompost likely contributed to enhanced cell division and elongation, thus promoting taller plants and increased branching (Masu *et al.*, 2019; Choudhary *et al.*, 2018) [5, 2]. The higher number of functional leaves also suggests increased photosynthetic surface, which would support vigorous growth and assimilate production (Rautaray *et al.*, 2003) [8]. Moreover, the improved root nodulation in T₆ reflects the favourable rhizosphere conditions fostered by vermicompost, which enhances microbial proliferation and nitrogen fixation. These observations align with the findings of Aulakh (2010) [1] and Meena *et al.* (2016) [6], who emphasized that the integration of organics with fertilizers improves soil physical properties, microbial activity, and nutrient use efficiency, thereby enhancing crop growth.

Yield Attributes and Yield

Significant improvements in yield-contributing parameters were observed due to the INM treatments. Among them, T₆ (75% RDF + 5 t vermicompost ha⁻¹) exhibited the highest number of pods per plant (29.67), seeds per pod (11.00), and 1000-seed weight (37.99 g), which ultimately translated into the maximum grain yield (1111.12 kg ha⁻¹) and stover yield (1526.55 kg ha⁻¹). The performance of T₂ (100%) was statistically at par with T₆, producing 27.60 pods per plant, 10.80 seeds per pod, 36.96 g test weight, and grain yield of 1060.50 kg ha⁻¹, indicating the efficiency of FYM in enhancing yield when integrated with recommended nutrients.

The remarkable yield improvement in T₆ can be attributed to

continuous and balanced nutrient supply throughout the crop growth period. Vermicompost not only improves physical properties of the soil, such as porosity and aeration, but also enhances biological activity and enzymatic processes crucial for effective nutrient cycling. These improvements facilitate better root proliferation and nutrient uptake, resulting in enhanced pod formation, seed setting, and ultimately higher productivity (Masu *et al.*, 2019; Rautaray *et al.*, 2003) [5, 8].

Moreover, the role of vermicompost in enhancing auxin and cytokinin levels might have contributed to better sink-source relationships, improving photosynthetic efficiency and dry matter partitioning towards reproductive structures (Choudhary *et al.*, 2018) [2]. The superior test weight under T₆ also indicates better seed filling, which is critical for overall seed quality and market value. The findings are in conformity with those of Singh *et al.* (2014) [10], who observed significant improvements in mungbean yield attributes and seed weight with integrated application of vermicompost and fertilizers.

The consistent and superior performance of INM treatments over control and inorganic treatments also suggests the importance of integrating organics in nutrient management for sustainable productivity. T₂ (100% RDF) and T₃ were found to be next best treatments with grain yields of 1060.50 kg ha⁻¹ and 1020.99 kg ha⁻¹ respectively, supporting the hypothesis that balanced fertilization with organics is superior to chemical-only applications. These results confirm earlier findings by Meena *et al.* (2016) [6] and Divyavani *et al.* (2020) [3], who emphasized the yield-enhancing potential of integrated systems in legumes under varying agro-ecological conditions.

Protein Content

Protein content of green gram grains was significantly influenced by the nutrient management strategies. The maximum protein content (25.39%) was observed in T₆ (75% RDF + 5 t Vermicompost ha⁻¹), which was at par with T₂ (100% RDF, 25.26%), T₃ (75% RDF + 5 t FYM ha⁻¹, 24.49%), and T₇ (50% RDF + 5 t Vermicompost ha⁻¹, 24.24%). The minimum protein content (19.46%) was recorded in T₁ (Control). The enhanced protein content in T₆ is directly associated with higher nitrogen availability and its efficient assimilation into proteins. Vermicompost not only supplies nitrogen but also enhances soil microbial activity and enzymatic processes responsible for amino acid synthesis. Moreover, it improves nitrogen retention and reduces losses. The integration with RDF provides the crop with an immediate and continuous supply of nitrogen, crucial during the grain filling stage. These combined effects lead to improved protein accumulation in the seed. Similar findings were reported by Raj *et al.* (2014) [7], Meena *et al.* (2016) [6] and Choudhary *et al.* (2018) [2].

Economics

The highest gross monetary return (₹97,993.70/ha) was recorded under T₆ (75% RDF + 5 t Vermicompost ha⁻¹), due to significantly higher yields. Though the cost of cultivation was relatively high (₹35,581/ha), the net return (₹62,412.70/ha) also surpassed all other treatments. This is because the improvement in growth and yield parameters more than compensated for the additional input cost. The added value from increased marketable produce and improved quality contributed significantly to profitability. T₂ (100% RDF) followed closely in terms of gross (₹93,572.99/ha) and net returns (₹62,272.99/ha), and recorded the highest B:C ratio (2.99), owing to its lower input cost compared to T₆. However, from an agronomic and sustainability perspective, T₆ proved more beneficial due to its

positive impact on soil health and crop quality. T₁ (Control) recorded the lowest gross (₹62,504.17/ha) and net return (₹34,079.17/ha), as expected due to minimal crop productivity.

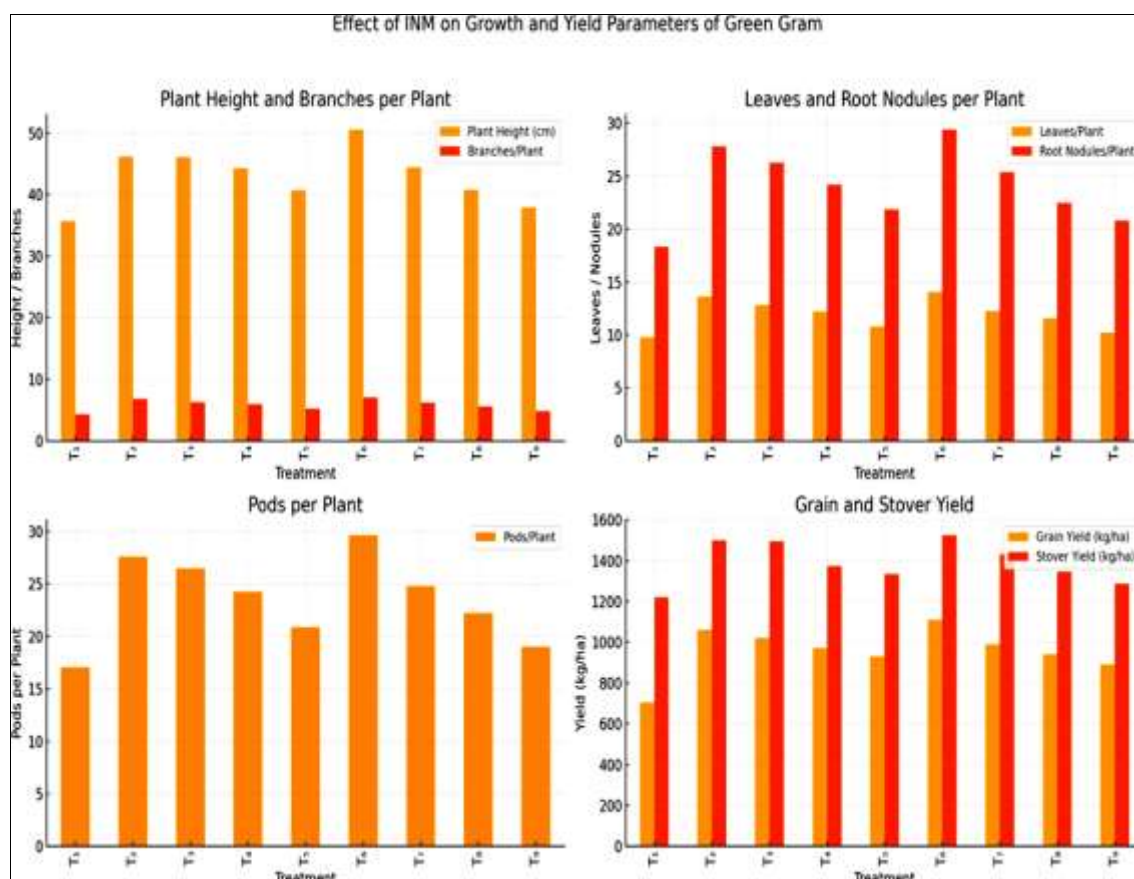
Similar results were also obtained by Raj *et al.* (2014)^[7], Meena *et al.* (2016)^[6] and Choudhary *et al.* (2018)^[2].

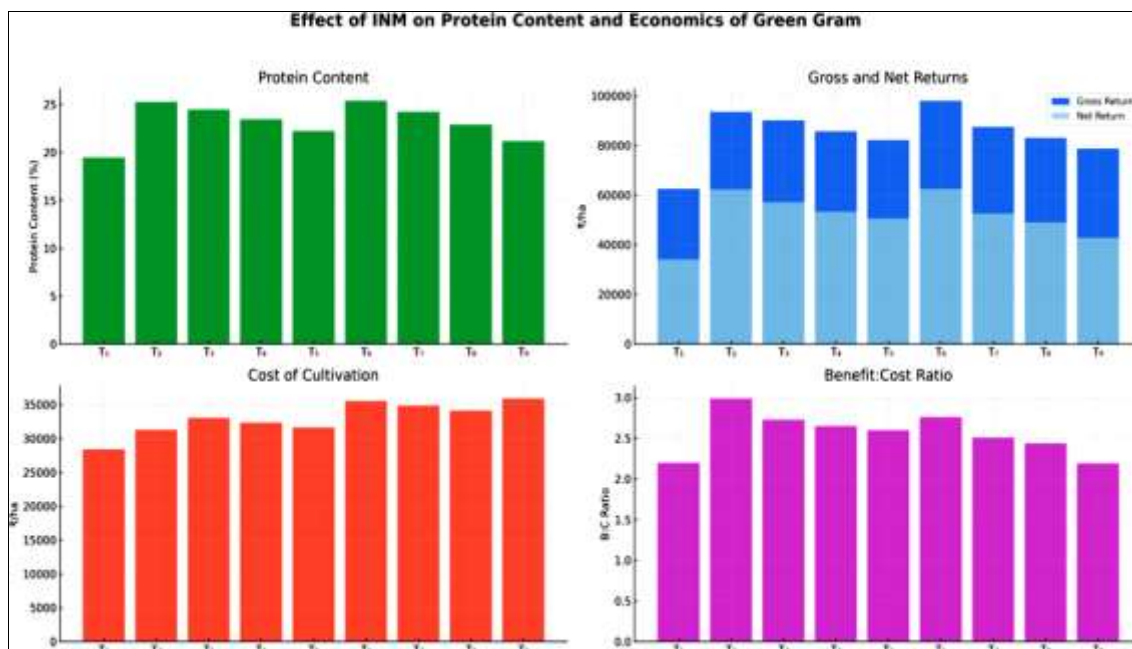
Table 1: Effect of INM on Growth and Yield Parameters of Green Gram

Treatment Notation	Plant Height (cm)	Branches Plant ⁻¹	Leaves Plant ⁻¹	Root Nodules Plant ⁻¹	Pods Plant ⁻¹	Seeds Pod ⁻¹	Test Weight (g)	Grain Yield (kg ha ⁻¹)	Stover Yield (kg ha ⁻¹)
T ₁	35.69	4.33	9.80	18.33	17.07	7.80	29.43	705.87	1220.83
T ₂	46.20	6.80	13.60	27.80	27.60	10.80	36.96	1060.50	1500.38
T ₃	46.06	6.27	12.80	26.27	26.47	10.20	36.64	1020.99	1494.63
T ₄	44.31	6.00	12.20	24.20	24.27	9.80	35.05	970.99	1374.40
T ₅	40.70	5.20	10.80	21.87	20.87	8.80	33.82	931.18	1336.03
T ₆	50.57	7.00	14.07	29.40	29.67	11.00	37.99	1111.12	1526.55
T ₇	44.40	6.17	12.27	25.40	24.80	10.00	35.74	990.75	1431.70
T ₈	40.82	5.60	11.60	22.47	22.20	9.40	34.24	941.06	1347.26
T ₉	37.87	4.87	10.20	20.80	19.00	8.20	33.26	891.05	1287.26
S.Em±	1.23	0.35	0.56	0.97	0.88	0.39	0.83	38.23	55.52
CD (P=0.05)	3.69	1.06	1.67	2.91	2.63	1.16	2.48	114.60	166.45

Table 2: Effect of INM on Protein Content and Economics of Green Gram

Treatment Notation	Protein Content (%)	Gross Return (₹ ha ⁻¹)	Cost of Cultivation (₹ ha ⁻¹)	Net Return (₹ ha ⁻¹)	B:C Ratio
T ₁	19.46	62504.17	28425.00	34079.17	2.20
T ₂	25.26	93572.99	31300.00	62272.99	2.99
T ₃	24.49	90136.98	33081.00	57055.98	2.73
T ₄	23.46	85675.76	32362.00	53313.76	2.65
T ₅	22.24	82181.07	31644.00	50537.07	2.60
T ₆	25.39	97993.70	35581.00	62412.70	2.76
T ₇	24.24	87448.32	34862.00	52586.32	2.51
T ₈	22.90	83049.80	34144.00	48905.80	2.44
T ₉	21.18	78648.51	35925.00	42723.51	2.19
S.Em±	0.58	3324.29	—	3324.29	0.10
CD (P=0.05)	1.74	9966.20	—	9966.20	0.31





Conclusion

The study clearly demonstrated that integrated nutrient management significantly influences growth, yield, protein content, and economic returns of green gram. The treatment T₆ (75% RDF + 5 t vermicompost ha⁻¹) proved to be the most effective combination, improving plant development and productivity while also offering superior economic benefits. Thus, the integration of vermicompost with reduced chemical fertilizers is recommended for sustainable and profitable green gram cultivation in the Satna region.

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