**Original Research Article**

**Impact of different nutrient management practices on *kharif* mung bean (*Vigna radiata* L*.*)**

**Abstract**

A field experiment on green gram was carried out at the Instruction Farm of Invertis University Bareilly, Uttar Pradesh, India during *kharif* season 2024. The soil of the experimental field was sandy loam in texture, low in organic carbon and available nitrogen, but medium in available phosphorus and available potassium having slightly alkali pH (7.83) with an electrical conductivity of 0.294. The experiment was arranged in a randomized complete block design having 10 treatments *viz;* T1- Control, T2- Farm practices (DAP) @ 100 kg/ha, T3- FYM @ 5 t/ha + DAP @ 100 kg/ha + *Rhizobium* @ 25 ml/kg seed, T4- FYM @ 5 t/ha + DAP @100 kg/ha + *Rhizobium* culture @ 25 ml/kg seed + 2 % foliar spray of nano urea at 40 and 50 DAS, T5 – FYM @ 5 t/ha + 100 kg/ha DAP + *Rhizobium* @ 25 ml/kg seed + N:P:K (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS, T6- FYM @5 t/ha + DAP (18:46) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed, T7- T6+ Foliar spray @ 1.5 % Nano DAP at 40 and 50 DAS, T8- FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed + NPK (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Biostimulant spray @ 625 ml/ha at 40 and 50 DAS, T9- T6 + foliar spray NPK (18:18:18) @ 0.5% at 40 and 50 DAS, T10- FYM @ 5 t/ha + NPK (12:32:16) @ 100 kg/ha + Seed treatment with PSB @ 625 ml/ha+ foliar Spray of @ 1.5% Nano DAP at 40 and 50 + Fe2So4 @ 0.5% at 40 and 50 DAS with three replication. The results noted that among the different nutrient management practices, application of FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed + NPK (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Biostimulant spray @ 625 ml/ha at 40 and 50 DAS had maximum plant height (61.10 cm), Number of branches/plants (6.16) and dry matter accumulation (18.23 g/plant) at harvest stage and significantly maximum pods/plant (14.5), pod length (8.3 cm), grains/pod (11.1), grain yield (13.5 q/ha), protein content (24.94 %) and protein yield (336.71 kg/ha) was recorded under the application. However maximum straw yield (25 q/ha), biological yield (38.1 q/ha) was recorded under the application of T10 ( FYM @ 5 t/ha + NPK (12:32:16) @ 100 kg/ha + Seed treatment with PSB @ 625 ml/ha+ foliar Spray of @ 1.5% Nano DAP @ 40 and 50 + Fe2So4 @ 0.5% at 40 and 50 DAS).

***Keywords***: Farm yard manure (FYM), *Rhizobium*, Nano urea, Nano DAP, NPK consortia, Biostimulant and Phosphorus solublizing bacteria (PSB)

**Introduction**

 Green gram (*Vigna radiata* L*.****)*** is also known as mung bean or golden bean, is a significant pulse crop in tropical and subtropical region. Mung bean is a short duration legume crop, cultivated during the *summer* season that belongs to the *Fabaceae* family. It is a valuable crop due to its high protein content, short duration and adaptability to various agro-climatic conditions [1]. It had 3rd rank among all pulses that are grown in India after chickpea and pigeon pea. Pulses are an important component of Indian diet being a good source of protein. It contains 24.5% protein with large amount of lysine (460 mg/g N) and tryptophan (60 mg/g N), it also contains quantity of ascorbic acid and riboflavin (0.21 mg/100 g). The presence of some antinutritional factors such as tannins (366.6 mg/100 mg), phytic acid (441.5 mg/100 g), trypsin inhibitors, hemagglutinin, proteinase inhibitors and polyphenols (462.5 mg/100 g) were reported in mung bean, which affect the digestion and bioavailability of full nutrition. In India, mung bean is cultivated an area about 55.72 lakh ha with the production of about 38.89 lakh tones and productivity 685 kg/ha other hand *kharif* mung bean shared cultivated an area about 33.91 lakh/ha with the production of about 17.47 lakh tones productivity 515 kg/ha [2]. The mung bean crop is increasingly adopted by farmers because of its short duration nature which makes it suitable for intensive crop rotation. Despite nutritional benefits, it helps in reducing soil erosion; enhance fertility of the soil through atmospheric nitrogen fixation[3]. Farmers use imbalanced chemical fertilizers for individual crop without considering integrated nutrient management approach. As a result, productivity and soil biodiversity has been affected. Recently, the growth and yield of mung bean has been affected by poor management and low soil fertility [4]. Farm yard manure, decomposed mixture of dung and urine of farm animals along with their litter and left over material from roughages or fodder fed to the cattle, supplies all major (N, P and K) and micro (Fe, Mn, Cu and Zn) nutrients necessary for plant growth. The entire amount of nutrients contained in FYM is not made available to the crop it has been applied and this depends upon rate of mineralization. Therefore, integrated use of both organic manures and inorganic fertilizers is the most effective method to maintain a healthy and sustainably productive soil [5]. Foliar nutrition recognized as an important method of fertilizer application since foliar nutrient usually penetrate the leaf cuticle or stomata and enter the cells facilitating easy and rapid utilization of nutrients leading no wastage and quick supply of food and thereby reduce the requirement of fertilizers. Foliar nutrition can hasten the growth of a crop suddenly [6]. Bio-fertilizers play an important role in increasing availability of nitrogen and phosphorus. Inoculation of seeds with *Rhizobium* culture is a low-cost method of nitrogen fertilization in legume and has been found beneficial to enhance the soil quality by providing more biological fixation of atmospheric nitrogen which may be helpful in boosting up. In this field experiment focused on mung bean production system in the Indo-Gangetic Plains, different agronomic practices were assessed for their impact on growth parameters, yield attributes and yield, protein content and protein yield. Further research is needed to determine the most effective combination of nutrient management strategies for maximizing mung bean yield and quality in Northwestern India for sustainable agriculture. [8]

**Material and method**

The field experiment was conducted at the Instruction Farm (at a latitude of 28° 29’ North and longitude of 79° 49’ East with an elevation of 252 m above mean sea level) of Invertis University Bareilly, Uttar Pradesh, India during *kharif* season 2024 on sandy loam soil. . Climatic conditions have a sub-tropical, semi-arid climate, which indicates that it is typically a hot dry summer (43°C) and very low temperature during winter (4.5°C). The soil of the experimental field was low in organic carbon (0.321 %) and available nitrogen (189.3 kg/ha), but medium in available phosphorus (18.5 kg/ha) and potassium (198.85.6 kg/ha) having slightly alkali pH (7.83) with an electric conductivity of 0.294. Experimental field was moist, well- drained with uniform topography. The experiment was arranged in a randomized complete block design having 10 treatments *viz;* T1- Control,T2- Farm practices (DAP) @ 100 kg/ha,T3- FYM @ 5 t/ha + DAP @ 100 kg/ha + Rhizobium @ 25 ml/Kg seed, T4- FYM @ 5 t/ha + DAP @ 100 Kg/ha + Rhizobium culture @ 25 ml/kg seed + 2 % foliar spray of nano urea at 40 and 50 DAS, T5 – FYM @ 5 t/ha + DAP @100 kg/ha + Rhizobium @ 25 ml/kg seed + N:P:K (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS, T6- FYM @ 5 t/ha + DAP (18:46) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed,T7- T6+ Foliar spray @ 1.5 % Nano DAP at 40 and 50 DAS,T8- FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK consortia @ 20 ml/kg seed + NPK(18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Bio stimulant spray @ 625 ml/ha at 40 and 50 DAS, T9- T6 + foliar spray NPK (18:18:18) @ 0.5% at 40 and 50 DAS, T10- FYM @ 5 t/ha + NPK (12:32:16) @ 100 kg/ha + Seed treatment with PSB @ 625 ml/ha+ foliar Spray of @ 1.5% Nano DAP at 40 and 50 + Fe2So4 of @ 0.5% at 40 and 50 DAS with three replication. The cultivar of mung bean “Pant Mung-5” was sown at proper soil moisture on 19 March 2024 by using seed @ 30 kg/ha at a depth of 4 cm with a hand drill with spacing 30 ×10 cm row to row and plant to plant was apparatus per layout design of the experiment.

 Plant height (cm) was recorded with the help of a meter scale, dry matter accumulation (g/plant) was recorded in each plot , two plants form the sample rows (second row from both north and west side of the plot) was cut from the ground surface with the help of sickle at all the stages of crop growth and sun dried for 2-3 days. After sun drying, these plants were dried at 65±50C temperature at until a constant weight was achieved and the average weight was expressed in gram per plant.

The yield attributes viz; Pods/plant, Pod length (cm) and Grains/pod were recorded according to standard procedure. After the harvesting of border rows the grain yield, stover yield and biological yield were recorded in kg/plot in each net plot and express as q/ha, protein content in grains was determined by modified- Kjeldahl method by using the formula a

Protein content (%) = Nitrogen content in grain (%) × 6.25 (correction factor)

 Protein yield of the grain was measured by multiplying the average protein content of grain with grain yield kg/ha and expressed as kg/ha. This gave the total protein yield/ha and as per given formula:[7]

Protein yield (kg/ha) = $\frac{Protein content in grain (\%) × grain yield (kg/ha)}{100}$

 The mean 7of data was analyzed through Analysis of Variance (ANOVA) techniques for randomized block design and presented at 5 % level of significance (<P = 0.05).

**Result and Discussion**

***Growth and developmental studies:***

The data is presenting table 1.indicated that growth parameter *viz*; Plant height(cm) number of branches/plant and dry matter accumulation (g/plant) at 25, 50 days after sowing (DAS) and at harvest stage varied significantly by various nutrient management practices. Among, the nutrient management practices, significantly maximum plant height of 29.5, 51.0 and 61.1 cm at 25, 50 days after sowing and maturity stages, respectively was obtained under the application of FYM @ 5 t/ha + N: P: K (12:32:16) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed + NPK (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Bio stimulant spray @ 625 ml/ha at 40 and 50 DAS, being *at par* with T7, T9 and T10 and significantly superior over rest of the nutrient management option during the studies. Moreover, the lowest plant height of 19.0, 30.8 and 35.1 cm noted under unfertilized plot (T1) at 25, 50 DAS and at harvest stage, respectively.

 Similarly, the result presented in table-1 showed that the number of branches/plants was significantly affected by different nutrient management practices. Number of branches/plant varied minimum to maximum from 2.01, 2.9 and 3.12 to 2.9, 5.1 and 6.16 at 25, 50 DAS and harvest was noted under control and T8 (FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK consortia @ 20 ml/kg seed + NPK(18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Bio stimulant spray @ 625 ml/ha at 40 and 50 DAS). The treatment T8 being statistically *at par* T10 at 25 DAS, harvesting, although. It was statistically *at par* T9 and T10  at 50 days after sowing (DAS).

The result presented in table 1 showed that the minimum to maximum dry matter accumulation (g/plant) varies from 1.72, 5.14 and 7.34 to 4.34, 11.48 and 18.23 (g/plant) was recorded under control and FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK onsortia @ 20 ml/kg seed + NPK(18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Bio stimulant spray @ 625 ml/ha at 40 and 50 DAS. The treatment T8 being statistically *at par* T10 at 25 DAS, 50 DAS. Although, at harvest it was *at par* with T7 and T10 . This might be due to application of NPK Consortia promoted nutrient solubilization and microbial activity in the rhizosphere, thereby enhancing root growth and nutrient uptake. While the spray of biostimulant further improved physiological functions and stress tolerance, leading to robust vegetative growth. The foliar application of NPK (18:18:18) during critical stages (40 and 50 DAS) met the crop’s immediate nutrient demand, contributing to healthy canopy development and better biomass accumulation. Similar results were also reported by [9], [10], [11]

***Yield attributes, yield and quality***

The data is presenting in table 2. Indicate that the various yield attributes *viz*., pods/plant, pod length, grains/pod, test weight (g) at harvest had significant difference by various nutrient management practices. Among, the nutrient management practices, significantly maximum number of pods/plant (14.5) and pod length (8.3cm) noted under T8, though it remained *at par* with T10 and statistically superior over other nutrient management practices. While, the minimum pods/plant (10.6) and Pod length (4.3 cm) was obtained under control.

 Similarly, the maximum number of grain/pod (11.1) was noted under the application of FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed + NPK (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Biostimulant spray @ 625 ml/ha at 40 and 50 DAS), being statically *at par* with T3, T6, T9 and T10. In other hand the maximum test weight (33.4 g) noted with the application of FYM @5 t/ha + DAP @100 Kg/ha + *Rhizobium* culture @ 25 ml/kg seed + 2 % foliar spray of nano urea at 40 and 50 DAS (T4), which was significantly superior with T1, T3 and T6. The minimum test weight (27.7 g) noted under control.

Among, the nutrient management practices yield (grain, strow and biological) of mung bean was significantly affected. Application of FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK Consortia @ 20 ml/kg seed + NPK (18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Biostimulant spray @ 625 ml/ha at 40 and 50 DAS had significantly maximum grain yield of 13.5 q/ha than rest of the treatment, except T10 only. While minimum grain yield (6.2 q/ha) was found under control. Moreover, T8 had 53% more grain yield than the farm practices treatment (DAP @100 kg/ha)

 In other hand, significantly higher straw yield of 25 q/ha and biological yield of 38.1 q/ha was registered under combined application of FYM @ 5 t/ha + NPK (12:32:16) @ 100 kg/ha along with seed treatment by PSB @ 625 ml/ha+ foliar Spray of @ 1.5% Nano DAP at 40 and 50 + Fe2So4 @ 0.5% at 40 and 50 DAS), through it remained *at par* with T8 but significantly superior over remaining nutrient management strategies. The encriment in yield attributes cumulative positive effects on growth and nutrient availability. The organic input (FYM) improved soil structure and moisture retention, which facilitated better crop stand and reduced nutrient leaching losses. The NPK (12:32:16) supplied sufficient macronutrients at early stages, boosting flowering and branches. Seed treatment with NPK Consortia enhanced the availability and uptake of phosphorus and potassium, crucial for flowering and grain development. Foliar feeding of NPK ensured a quick nutrient supply during the reproductive phase, improving grain filling and test weight. The use of bio stimulants likely increased enzymatic activity and photosynthetic efficiency, which ultimately resulted in higher yield compared to other treatments.

The result presented in table 2. showed that the protein content in grains was significantly affected by different nutrient management practices. The minimum to maximum protein content (%) in grains from 19.69 to 24.94 under control and T8 (FYM @ 5 t/ha + N:P:K (12:32:16) @ 100 kg/ha + NPK consortia @ 20 ml/kg seed + NPK(18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Bio stimulant spray @ 625 ml/ha at 40 and 50 DAS). The treatment T8 being statistically *at par* T5, T6, T7, T9 and T10. T8 had 16 % more protein content than the farm practices treatment (DAP @100 kg/ha). Similarly, the minimum to maximum protein yield in grain from122.04 to 336.71 kg/ha was noted under control and T8. The treatment T8 being statistically *at par* with T10 only.[12], [13], [14].

* The protein content in grain and protein yield increased significantly with the enhanced availability of balanced nutrients throughout the crop growth stages facilitated better metabolite synthesis, especially proteins. The combination of FYM and biofertilizers supported microbial activity and improved nitrogen metabolism, resulting in higher protein content in grains. The bio stimulant applications may have influenced enzymatic and hormonal activities, leading to enhanced grain quality and nutritional value. Moreover, foliar application of NPK helped maintain nutrient levels during grain filling, reducing the chances of nutrient deficiencies that often degrade grain quality Similar results also reported by [15], [16]

**Conclusion**

On the basis of experiment, it may be concluded that with the application of FYM @5 t/ha + N:P:K (12:32:16) @100 kg/ha + NPK consortia @ 20 ml/kg seed + NPK(18:18:18) @ 0.5 % foliar spray at 40 and 50 DAS + Bio stimulant spray @ 625 ml/ha at 40 and 50 DAS, in mung bean seems to be best as they improved the growth, yield attributes, yield and quality of green gram andprovides a reliable, short- term and sustainable approach for increasing the yield in green gram.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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**Table 1:** Impact of different nutrient management practices on plant height (cm), number of branches/plant and dry matter accumulation (g/plant) of *kharif* mung bean at successive stage of crop growth.

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Plant Height (cm) at** | **Number of branches/plant at** | **Dry matter accumulation (g/plant) at** |
| **25 DAS** | **50 DAS** | **Harvest** | **25 DAS** | **50 DAS** | **Harvest** | **25 DAS** | **50 DAS** | **Harvest** |
| **T1** | 19.02  | 30.78  | 35.11  | 2.01  | 2.90  | 3.12  | 1.72  | 5.14  | 7.34  |
| **T2** | 21.57  | 39.67  | 46.55  | 2.22  | 3.60  | 4.42  | 2.80  | 6.22  | 9.67  |
| **T3** | 22.11  | 40.85  | 48.50  | 2.30  | 3.90  | 4.77  | 3.20  | 6.45  | 10.49  |
| **T4** | 23.32  | 42.27  | 50.49  | 2.41  | 4.21  | 5.10  | 3.31  | 7.38  | 12.89  |
| **T5** | 25.60 | 44.95  | 53.96  | 2.41  | 4.10  | 5.07  | 3.45  | 8.21  | 15.38  |
| **T6** | 24.87  | 43.88  | 52.63  | 2.60  | 4.50  | 5.44  | 3.84  | 6.95  | 13.44  |
| **T7** | 27.71  | 47.96  | 57.85  | 2.63  | 4.63  | 5.63  | 3.49  | 10.68  | 17.26  |
| **T8** | 29.54  | 51.00 | 61.10  | 2.90  | 5.10  | 6.16  | 4.34  | 11.48  | 18.23  |
| **T9** | 27.33  | 47.18  | 56.79  | 2.68  | 4.74  | 5.75  | 3.16  | 10.78  | 16.57  |
| **T10** | 28.72  | 49.17  | 59.18  | 2.77  | 4.92  | 5.96  | 4.18  | 11.13  | 17.83  |
| **SEm±** | 0.78  | 1.70  | 2.625  | 0.076  | 0.12  | 0.12  | 0.12  | 0.23  | 0.52  |
| **CD(P=0.05)** | 2.34  | 5.1  | 6.72  | 0.20  | 0.37  | 0.35  | 0.35  | 0.69  | 1.56  |

**Table 2**: Impact of different nutrient management practices on yield attributes, yield and quality of *kharif* mung bean

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Pods/plant** | **Pod length (cm)** | **Grains/pod** | **Test weight (g)** | **Grain yield (q/ha)** | **Straw yield (q/ha)** | **Biological yield (q/ha)** | **Protein content (%)** | **Protein yield (kg/ha)** |
| **T1** | 10.6  | 4.3  | 8.9  | 27.7  | 6.2 | 11.3 | 17.5 | 19.69 | 122.04 |
| **T2** | 11.6  | 4.8  | 9.3  | 31.0  | 8.8 | 16.1 | 24.9 | 21.50 | 189.81 |
| **T3** | 11.4  | 5.3  | 10.3  | 29.7  | 9.2 | 17.1 | 26.3 | 22.06 | 203.43 |
| **T4** | 11.1  | 5.8  | 9.7  | 33.4  | 9.4 | 17.6 | 27 | 22.75 | 213.48 |
| **T5** | 12.4  | 6.3  | 9.7  | 32.1  | 10.3 | 19.4 | 29.7 | 23.63 | 243.62 |
| **T6** | 13.1  | 5.7  | 10.4  | 27.2  | 9.8 | 18.2 | 28 | 23.31 | 228.46 |
| **T7** | 12.8  | 7.5  | 9.9  | 31.9  | 10.9 | 20.5 | 31.4 | 23.94 | 261.37 |
| **T8** | 14.5  | 8.3  | 11.1  | 31.0  | 13.5 | 24.5 | 38 | 24.94 | 336.71 |
| **T9** | 13.1  | 7.4  | 10.5  | 31.2  | 11.6 | 22.0 | 33.6 | 24.23 | 281.17 |
| **T10** | 13.9  | 7.9  | 10.8  | 32.2  | 13.1 | 25.0 | 38.1 | 24.56 | 321.66 |
| **SEm±** | 0.4  | 0.2  | 0.4  | 1.03  | 0.34  | 0.6 | 0.65 |  0.61 |  8.76 |
| **CD(P=0.05)** | 1.3  | 0.5  | 1.1  | 3.1  | 1.03  | 1.8  | 1.9 |  1.84 |  26.23 |

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