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Effect of foliar application of nano urea and nano-DAP on growth, yield, nutrient content and economics of green gram (*Vigna Radiata* L.)

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ABSTRACT

Background: Green gram (*Vigna radiata* L.) is an important pulse crop, but its productivity in the Marathwada region is constrained by inadequate nutrient management and predominantly rainfed cultivation. Nano-fertilizers have emerged as a potential approach for improving nutrient-use efficiency through foliar application.

Methods: A field experiment was conducted during Kharif 2025 at the Research Farm, Department of Soil Science, College of Agriculture, VNMKV, Parbhani. The experiment was laid out in a randomized block design with seven treatments and three replications. Treatments comprised 100% recommended dose of fertilizer (RDF), reduced RDF levels combined with foliar application of nano-urea and nano-DAP, and their combinations. Green gram variety BM-2003-2 was sown at 30 × 10 cm spacing. Growth, yield, nutrient content and economic parameters were recorded.

Results: The application of 100% RDF recorded the highest seed yield (1388 kg ha⁻¹), straw yield (3048 kg ha⁻¹), biological yield (4436 kg ha⁻¹) and gross monetary returns (₹120945 ha⁻¹). Treatment receiving 75% RDF with 0.4% nano-urea at 25 DAS and 0.4% nano-DAP at 45 DAS recorded seed yield of 1274 kg ha⁻¹ and the highest zinc concentration in grain (1.46 mg kg⁻¹) and straw (0.81 mg kg⁻¹).

Conclusion: Foliar application of nano-urea and nano-DAP with 75% RDF improved growth, yield attributes and nutrient accumulation compared with reduced RDF treatments. Under the conditions of the present experiment, 100% RDF remained superior for maximum seed productivity and economic returns.

Keywords: Green gram, Nano-DAP, Nano-fertilizer, Nano-urea, Nutrient uptake, *Vigna radiata*

1. Introduction

Green gram (*Vigna radiata* L.), commonly known as mung bean, is an important pulse crop cultivated during kharif, rabi and summer seasons. It is valued for its edible seeds, high protein content and nutritional quality. Pulses also contribute to soil fertility through biological nitrogen fixation and therefore play an important role in sustainable agricultural production.

In the Marathwada region of Maharashtra, green gram productivity is relatively low, primarily because a large proportion of the crop is cultivated under rainfed conditions, together with inadequate adoption of improved production technologies and nutrient-management practices. Balanced and efficient nutrient management is therefore essential for improving crop productivity while maintaining nutrient-use efficiency.

Nano-fertilizers have attracted considerable attention as an alternative or complementary nutrient-management technology. Their small particle size and large surface area may facilitate efficient nutrient delivery and improve nutrient-use efficiency when applied at appropriate crop growth stages. Nano-urea is a nano-formulation of nitrogen intended for foliar application, whereas nano-DAP supplies nitrogen and phosphorus.

Comparatively limited field information is available regarding the combined application of nano-urea and nano-DAP with reduced basal fertilizer levels in green gram under the agro-climatic conditions of Parbhani. Therefore, the present investigation was undertaken to evaluate their effect on growth, yield, nutrient accumulation and economics of green gram.

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2. Materials and Methods

2.1 Experimental site

The field experiment was conducted during Kharif 2025 at the Research Farm of the Department of Soil Science, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra.

2.2 Soil characteristics

Before initiation of the experiment, soil samples were collected from 0–30 cm depth from ten locations and a composite sample was prepared. The experimental soil was clayey in texture, slightly alkaline in reaction, medium in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium. Initial soil pH was 8.10, electrical conductivity 0.44 dS m^{-1} , organic carbon 0.56%, available nitrogen $179.08 \text{ kg ha}^{-1}$, available phosphorus 12.98 kg ha^{-1} and available potassium 469 kg ha^{-1} .

2.3 Experimental design and treatments

The experiment was conducted using a randomized block design with seven treatments and three replications. Gross plot size was $5.4 \times 4.5 \text{ m}$ and net plot size was $4.6 \times 3.3 \text{ m}$. Green gram variety BM-2003-2 was sown on 13 June 2025 at $30 \times 10 \text{ cm}$ spacing. The recommended dose of fertilizer was $25:50:25 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$.

Treatment	Treatment details
T_1	100% RDF ($25:50:25 \text{ kg NPK ha}^{-1}$)
T_2	75% RDF + 0.4% nano-urea at 25 and 40 DAS
T_3	75% RDF + 0.4% nano-DAP at 45 DAS
T_4	50% RDF + 0.4% nano-urea at 25 and 40 DAS
T_5	50% RDF + 0.4% nano-DAP at 45 DAS
T_6	75% RDF + 0.4% nano-urea at 25 DAS + 0.4% nano-DAP at 45 DAS
T_7	50% RDF + 0.4% nano-urea at 25 DAS + 0.4% nano-DAP at 45 DAS

2.4 Crop management

The crop was sown using $15 \text{ kg seed ha}^{-1}$ at approximately 5 cm depth. Chemical fertilizers were applied according to the respective treatments. Nano-urea was applied as foliar spray at the specified growth stages using a battery-operated sprayer, while nano-DAP was applied at 45 DAS. One hand weeding was carried out at 22 DAS.

2.5 Observations and laboratory analysis

Five plants were randomly selected from each net plot for biometric observations. Growth and yield attributes were recorded periodically and at harvest. Grain and straw samples were dried, powdered and subjected to acid digestion. Total nitrogen was determined by the micro-Kjeldahl method, phosphorus by the vanado-molybdate phosphoric acid yellow colour method and potassium using a flame photometer. Copper, manganese, iron and zinc were determined using atomic absorption spectrophotometry.

2.6 Statistical analysis

The experimental data were statistically analysed using analysis of variance following Panse *et al.* (1967) [1]. Critical difference values at the 5% probability level were calculated where the *F*-test was significant.

3. Results

3.1 Growth attributes

Treatment effects on crop growth varied with crop growth stage. Application of 100% RDF produced superior early vegetative growth, while foliar nano-urea and nano-DAP treatments showed comparatively strong performance at later stages. At harvest, plant height was 52.84 cm under T_1 , 53.45 cm under T_2 and 49.63 cm under T_6 . T_2 recorded 29.97 and 28.10 functional leaves plant^{-1} at 45 DAS and harvest, respectively. Dry matter accumulation at harvest was $34.60 \text{ g plant}^{-1}$ under T_1 , $33.44 \text{ g plant}^{-1}$ under T_2 and $32.29 \text{ g plant}^{-1}$ under T_6 .

3.2 Yield attributes

T_1 recorded the highest seed yield plant^{-1} (9.48 g), number of pods plant^{-1} (18.15), seeds pod^{-1} (11.65) and test weight (45.58 g). T_6 recorded $8.55 \text{ g seed yield plant}^{-1}$, $17.10 \text{ pods plant}^{-1}$ and $11.02 \text{ seeds pod}^{-1}$. Test weight was not significantly affected by the treatments.

3.3 Seed, straw and biological yield

The highest seed yield was obtained with 100% RDF (T_1), recording 1388 kg ha^{-1} . T_6 recorded 1274 kg ha^{-1} , followed by T_3 with 1264 kg ha^{-1} and T_2 with 1210 kg ha^{-1} . T_1 also recorded the highest straw yield (3048 kg ha^{-1}) and biological yield (4436 kg ha^{-1}), while T_6 produced 2790 kg ha^{-1} straw and 4064 kg ha^{-1} biological yield. Harvest index was 31.29% in T_1 and 31.34% in T_6 .

3.4 Nutrient accumulation

T_6 showed notable micronutrient accumulation. Zinc concentration reached 1.46 mg kg^{-1} in grain and 0.81 mg kg^{-1} in straw under T_6 , compared with 1.42 and 0.78 mg kg^{-1} , respectively, under T_1 . Manganese concentration under T_6 was 33.10 in grain and 30.50 in straw, while corresponding values under T_1 were 32.40 and 29.80, respectively.

3.5 Economics

Mean cost of cultivation was $\text{₹}41,118 \text{ ha}^{-1}$, while mean gross monetary return, net monetary return and benefit-cost ratio were $\text{₹}103,799 \text{ ha}^{-1}$, $\text{₹}62,681 \text{ ha}^{-1}$ and 2.53, respectively. T_1 recorded the highest gross monetary return ($\text{₹}120,945 \text{ ha}^{-1}$), net monetary return ($\text{₹}81,388 \text{ ha}^{-1}$) and benefit-cost ratio (3.05). T_6 recorded gross monetary return of $\text{₹}110,348 \text{ ha}^{-1}$, net monetary return of $\text{₹}67,498 \text{ ha}^{-1}$ and benefit-cost ratio of 2.58.

4. Discussion

The present investigation demonstrated that nutrient management influenced vegetative growth, yield formation and nutrient accumulation in green gram. The superior early growth observed under 100% RDF can be associated with immediate availability of nitrogen, phosphorus and potassium from basal fertilizer application.

The improved performance of nano-fertilizer treatments at later growth stages suggests that foliar nutrient supply can supplement basal fertilization during critical crop growth periods. The yield results indicate that nano-fertilizers could not completely compensate for a substantial reduction in basal fertilizer under the conditions of this experiment.

The enhanced zinc and manganese concentration under T_6 is of particular interest from a nutritional and biochemical perspective. This response may reflect improved plant nutritional status under balanced basal fertilization combined with targeted foliar nutrient supply. However, the present study does not establish a direct biochemical mechanism, and further biochemical investigations would be required.

From an economic perspective, full RDF produced the highest gross and net returns and benefit-cost ratio. The results therefore support an integrated nutrient-management approach in which nano-fertilizers are used as supplementary foliar sources rather than complete replacements for conventional fertilization.

5. Conclusion

The field experiment conducted during Kharif 2025 at VNMKV, Parbhani demonstrated that foliar application of nano-urea and nano-DAP influenced growth, yield attributes and nutrient accumulation of green gram. The application of 100% RDF produced the highest seed yield (1388 kg ha⁻¹), straw yield (3048 kg ha⁻¹), biological yield (4436 kg ha⁻¹), gross monetary return (₹120945 ha⁻¹), net monetary return (₹81388 ha⁻¹) and benefit-cost ratio (3.05).

The integrated treatment consisting of 75% RDF + 0.4% nano-urea at 25 DAS + 0.4% nano-DAP at 45 DAS maintained comparatively high growth and yield performance and recorded the highest zinc concentration in grain and straw. Its seed yield was 1274 kg ha⁻¹. Under the conditions of the present experiment, full RDF remained superior for maximum productivity and economic returns. Further multi-location and multi-season studies are recommended.

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