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# Effect of foliar application of nano urea and nano-dap on growth, yield attributes and yield of green gram (*Vigna radiata* L.)

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## Abstract
A field investigation was undertaken during *Kharif* 2024 at the Experimental Farm, Department of Agronomy, VNMKV, Parbhani to study the effect of foliar application of nano urea and nano-DAP on growth, yield attributes and yield of green gram (*Vigna radiata* L.). The experiment comprised of seven treatments and three replications and was set in randomized block design. The treatments comprised different combinations of RDF (Recommended Dose of Fertilizer) and foliar applications of nano urea and nano-DAP. The findings of investigation indicated that application of 75% RDF +0.4% foliar spray of nano urea at 25 & 40 DAS recorded significantly higher growth attributes of green gram and was at par with 25:50:25 NPK Kg $ha^{-1}$ (100% RDF), 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS and application of 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$). Whereas application of 25:50:25 NPK Kg $ha^{-1}$ (100% RDF) recorded higher yield attributes and yield of green gram and was comparable with 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS and 75% RDF + 0.4% spray of nano DAP at 45 DAS.

**Keywords:** Green gram, Nano urea, Nano DAP, Growth and Yield.

## Introduction
Green gram (*Vigna radiata* L.) is an important legume crop grown predominantly in South and Southeast Asia. It serves as a significant source of dietary protein and has a prominent role in improving soil fertility through biological nitrogen fixation. However, its productivity is constrained by several factors, with inadequate and inefficient nutrient management being one of the major limitations (Ali & Gupta, 2012) [1].

Conventional fertilizers, though widely used, often suffer from low nutrient use efficiency due to losses through leaching, volatilization, and fixation in the soil. In recent years, nanotechnology has emerged as a promising tool in modern agriculture, particularly in the development of nano fertilizers aimed at enhancing nutrient delivery and uptake efficiency (Solanki *et al*., 2015) [8]. Nano fertilizers are engineered materials with particle sizes in the nano meter range, designed to improve the bioavailability of nutrients and reduce environmental losses.

Nano urea (4% N) and nano diammonium phosphate (nano DAP; 8% N, 16% P) are recent innovations developed using nanotechnology. These formulations provide essential nutrients in a more soluble and reactive form, allowing for improved foliar absorption and translocation within the plant system (Ramesha *et al*., 2022) [7]. Foliar application of nano urea and nano DAP ensures rapid nutrient uptake, supports physiological processes such as photosynthesis and enzyme activation, and has been shown to enhance crop growth and yield (Kumar *et al*., 2021 and Yadav *et al*., 2023) [5, 9]. The growing emphasis on sustainable and resource-efficient agricultural practices, evaluating the potential of nano-based fertilizers in leguminous crops like green gram is of considerable interest. Therefore, the present investigation was undertaken to assess the effect of foliar application of nano urea and nano DAP on the growth, yield attributes and yield of green gram under field condition.

## Materials and Methods

A field trial was undertaken during *Kharif* 2024 at the Experimental Farm of Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, located at 19°16′ N latitude, 76°47′ E longitude, and an altitude of 409 meters above mean sea level. The soil of the experimental field was clayey in texture, slightly alkaline in reaction (pH 8.1), medium in organic carbon (0.56%) and phosphorus (12.98 kg $ha^{-1}$); low in available nitrogen (179.08 kg $ha^{-1}$) and high in potassium (469 kg $ha^{-1}$) content. Weather data recorded during the crop growth period showed that the field received 455.3 mm of rainfall in 31 rainy days, with mean maximum and minimum temperatures of 31.65°C and 23.36 °C, respectively.

The experiment was laid out in a Randomized Block Design (RBD) with three replications and seven treatments i.e. $T_1$ - 100% RDF; $T_2$ - 75% RDF + 0.4% nano urea spray at 25 and 40 DAS; $T_3$ - 75% RDF + 0.4% nano DAP spray at 45 DAS; $T_4$ - 50% RDF + 0.4% nano urea spray at 25 and 40 DAS; $T_5$ - 50% RDF + 0.4% nano DAP spray at 45 DAS; $T_6$ - 75% RDF + 0.4% nano urea spray at 25 DAS + 0.4% nano DAP spray at 45 DAS; and $T_7$ - 50% RDF + 0.4% nano urea spray at 25 DAS + 0.4% nano DAP spray at 45 DAS. The gross plot size was 5.4 × 4.5 m, and the net plot size was 4.6 × 3.3 m. The test crop was green gram (*Vigna radiata* L.), variety BM-2003-2, sown on 22nd June 2024 by dibbling at a spacing of 30 × 10 cm. A uniform Recommended Dose of Fertilizer (25:50:25 NPK kg $ha^{-1}$) was applied through urea, SSP, and MOP. All recommended agronomic and plant protection measures were followed uniformly across treatments. Observations in respect of growth attributes like plant height, no. of leaves per plant, leaf area per plant, no. of branches per plant and dry matter accumulation per plant were recorded at periodical interval of fifteen days. Whereas observation in respect of yield attributes and yield was recorded at harvest. The data was statistically analyzed using the Analysis of Variance (ANOVA) method as described by Panse and Sukhatme (1967) [6], and treatment means were compared using the Critical Difference (CD) at a 5% probability level.

### Plant height (cm), Number of branches plant per plant and dry matter accumulation per plant

The application of 25:50:25 NPK Kg $ha^{-1}$(100% RDF) ($T_1$) recorded significantly higher plant height of green gram over rest of the treatments at 30 DAS, however it was at par with 75% RDF +0.4% spray of nano urea at 25 & 40 DAS ($T_2$), 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$) and 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4%spray of nano DAP at 45 DAS ($T_6$). Whereas at 45 DAS and at harvest significantly higher plant height was observed in 75% RDF +0.4% spray of nano urea at 25 & 40 DAS ($T_2$) and it was at par with 25:50:25 NPK Kg $ha^{-1}$(100% RDF) ($T_1$), 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4%spray of nano DAP at 45 DAS ($T_6$) and 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$).The significantly higher plant height observed in 25:50:25 NPK Kg $ha^{-1}$(100% RDF) ($T_1$) at 30 DAS might be due to the beneficial effect of complete dose of NPK supplied at the time of sowing which promoted rapid early vegetative growth due to enhanced cell elongation and division, particularly driven by readily available nitrogen. These findings are in agreement with the earlier findings reported by Daware *et al*. (2024) [4].

However, at 45 DAS and at harvest, application of 75% RDF +0.4% spray of nano urea at 25 & 40 DAS ($T_2$) exhibited superior performance in plant height. This might be due to synergistic effect of foliar application of nano urea at 25 and 40 DAS, which likely provided a continuous and efficient nutrient supply during the critical periods of branching and flowering. Nano urea, due to its ultra-fine particle size and higher surface area, enhances nutrient absorption through leaves and supports sustained physiological activities like photosynthesis, protein synthesis, and hormonal balance over time. This sustained nutrition positively impacted plant growth during later stages, resulting in increased plant height at 45 DAS and at harvest.

Similar trend was observed in respect of number of leaves plant per plant, Leaf area plant- per plant, Number of branches plant per plant and dry matter accumulation per plant. These findings are parallel with earlier findings reported by Chhipa (2017) [3], Yadav *et al.* (2021) [10] and Chavan *et al*. (2024) [2] in respect of above growth attributes

### Seed yield plant$^{-1}$ (g)

Data furnished in Table 4 evinced that significantly higher seed yield plant$^{-1}$ was found in treatment application of 25:50:25 NPK Kg $ha^{-1}$(100% RDF) ($T_1$), however it was at par with 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4%spray of nano DAP at 45 DAS ($T_6$) and 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$), whereas lower seed yield plant$^{-1}$ was recorded in 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS ($T_4$).

### Seed yield (kg ha$^{-1}$)

Data presented in Table 4 revealed that seed yield of green gram was significantly influenced due to different treatments. It is clear from the data that application of 25:50:25 NPK kg $ha^{-1}$(100% RDF) ($T_1$) significantly recorded higher seed yield, however it was comparable with application of 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4%spray of nano DAP at 45 DAS ($T_6$) and 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$). These results indicate that foliar application of nano fertilizers can partially substitute RDF, the complete dose of conventional fertilizers remains necessary for achieving maximum productivity in green gram.

Lower seed yield was recorded in 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS ($T_4$) which received only 50% RDF with foliar sprays of nano nutrients. The poor performance of these treatments suggests that nano fertilizers alone could not fully compensate for the reduced basal nutrition under rainfed conditions. These results indicate that foliar application of nano fertilizers can partially substitute RDF, the full dose of conventional fertilizers remains necessary for achieving maximum productivity in green gram. These findings are parallel with the earlier findings reported by Chavan *et al*. (2024) [2]. Similar trend was noticed in respect of biological yield.

### Harvest index

Data presented in Table 4 revealed that application of 25:50:25 NPK Kg $ha^{-1}$(100% RDF) ($T_1$) recorded higher harvest index followed by application of 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4%spray of nano DAP at 45 DAS ($T_6$) and 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$), whereas lower harvest index was observed in 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS ($T_4$).

**Table 1:** Mean Plant height (cm) of green gram as influenced by different treatments

| Treatments | 30 DAS | 45 DAS | At harvest |
|---|---|---|---|
| $T_1$: 100% RDF (25:50:25 NPK Kg ha$^{-1}$) | 26.35 | 46.12 | 52.98 |
| $T_2$: 75% RDF +0.4% spray of nano urea at 25 & 40 DAS | 23.99 | 46.47 | 53.99 |
| $T_3$: 75% RDF + 0.4% spray of nano DAP at 45 DAS | 23.54 | 40.11 | 46.51 |
| $T_4$: 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS | 20.81 | 37.22 | 43.66 |
| $T_5$: 50% RDF + 0.4% spray of nano DAP at 45 DAS | 20.22 | 34.66 | 40.55 |
| $T_6$: 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS | 24.11 | 43.45 | 50.19 |
| $T_7$: 50% RDF + 0.4% spray of nano urea at 25 DAS+0. 4% spray of nano DAP at 45 DAS | 20.55 | 36.86 | 42.81 |
| SE (m) ± | 1.49 | 2.69 | 3.12 |
| CD @ 5% | 4.59 | 8.28 | 9.63 |
| G.M. | 22.80 | 40.70 | 47.24 |

**Table 2:** Mean number of leaves plant$^{-1}$ and mean leaf area plant$^{-1}$ (dm$^2$) of green gram as influenced by different treatments

| Treatments | Number of leaves plant$^{-1}$ | | | Leaf area plant$^{-1}$ (dm$^2$) | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 45 DAS | At harvest | 30 DAS | 45 DAS | At harvest |
| $T_1$: 100% RDF (25:50:25 NPK Kg ha$^{-1}$) | 21.62 | 28.21 | 26.48 | 5.60 | 8.80 | 8.64 |
| $T_2$: 75% RDF +0.4% spray of nano urea at 25 & 40 DAS | 18.87 | 30.12 | 28.25 | 4.86 | 9.90 | 9.78 |
| $T_3$: 75% RDF + 0.4% spray of nano DAP at 45 DAS | 17.49 | 25.49 | 24.13 | 4.53 | 8.09 | 8.32 |
| $T_4$: 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS | 16.22 | 22.70 | 21.34 | 3.39 | 5.89 | 6.11 |
| $T_5$: 50% RDF + 0.4% spray of nano DAP at 45 DAS | 14.27 | 20.27 | 18.39 | 2.95 | 5.23 | 5.08 |
| $T_6$: 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS | 19.89 | 26.36 | 25.44 | 4.95 | 8.44 | 8.39 |
| $T_7$: 50% RDF + 0.4% spray of nano urea at 25 DAS+0. 4% spray of nano DAP at 45 DAS | 15.18 | 22.33 | 19.22 | 3.16 | 5.79 | 5.48 |
| SE (m) ± | 1.35 | 1.80 | 1.47 | 0.36 | 0.62 | 0.52 |
| CD @ 5% | 4.16 | 5.55 | 4.51 | 1.11 | 1.90 | 1.61 |
| G.M. | 17.65 | 25.07 | 23.32 | 4.21 | 7.45 | 7.40 |

**Table 3:** Mean Number of branches plant$^{-1}$ and dry matter accumulation plant$^{-1}$ (g) of green gram as influenced by different treatments

| Treatments | Number of branches plant$^{-1}$ | | | Dry matter plant$^{-1}$ (g) | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 45 DAS | At harvest | 30 DAS | 45 DAS | At harvest |
| $T_1$: 100% RDF (25:50:25 NPK Kg ha$^{-1}$) | 6.09 | 7.27 | 7.37 | 5.32 | 24.34 | 35.11 |
| $T_2$: 75% RDF +0.4% spray of nano urea at 25 & 40 DAS | 5.33 | 7.67 | 7.77 | 4.73 | 24. 14 | 33.79 |
| $T_3$: 75% RDF + 0.4% spray of nano DAP at 45 DAS | 5.13 | 6.03 | 6.49 | 4.65 | 22.41 | 31.54 |
| $T_4$: 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS | 4.45 | 5.41 | 5.45 | 3.61 | 19.25 | 27.56 |
| $T_5$: 50% RDF + 0.4% spray of nano DAP at 45 DAS | 3.36 | 4.30 | 4.55 | 2.84 | 18.98 | 27.38 |
| $T_6$: 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS | 6.01 | 6.42 | 6.72 | 4.76 | 23.36 | 32.75 |
| $T_7$: 50% RDF + 0.4% spray of nano urea at 25 DAS+0. 4% spray of nano DAP at 45 DAS | 4.22 | 5.01 | 5.19 | 3.27 | 19.23 | 27.49 |
| S.E (m) ± | 0.32 | 0.70 | 0.42 | 0.22 | 1.45 | 2.21 |
| CD @ 5% | 0.98 | 2.15 | 1.29 | 0.68 | 4.48 | 6.80 |
| G.M. | 4.94 | 6.02 | 6.22 | 4.17 | 21.67 | 30.80 |

**Table 4:** Mean seed yield plant$^{-1}$ (g), seed yield (kg ha$^{-1}$), biological yield (kg ha$^{-1}$) and harvest index (%) of green gram as influenced by different treatments

| Treatments | Seed yield plant$^{-1}$ (g) | Seed yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|
| $T_1$: 100% RDF (25:50:25 NPK Kg ha$^{-1}$) | 9.54 | 1392 | 4444 | 31.33 |
| $T_2$: 75% RDF +0.4% spray of nano urea at 25 & 40 DAS | 6.46 | 1203 | 3889 | 30.93 |
| $T_3$: 75% RDF + 0.4% spray of nano DAP at 45 DAS | 8.32 | 1257 | 4032 | 31.18 |
| $T_4$: 50% RDF + 0.4% spray of nano urea at 25 & 40 DAS | 4.58 | 1017 | 3577 | 28.43 |
| $T_5$: 50% RDF + 0.4% spray of nano DAP at 45 DAS | 5.85 | 1193 | 3877 | 30.77 |
| $T_6$: 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4%spray of nano DAP at 45 DAS | 8.47 | 1269 | 4053 | 31.32 |
| $T_7$: 50% RDF + 0.4% spray of nano urea at 25 DAS+0. 4%spray of nano DAP at 45 DAS | 5.78 | 1033 | 3602 | 28.69 |
| SE (m) ± | 0.45 | 49.67 | 252.42 | - |
| CD @ 5% | 1.40 | 153.05 | 777.79 | - |
| G.M. | 7.00 | 1195 | 3925 | 30.38 |

## Conclusion

The application of 75% RDF +0.4% foliar spray of nano urea at 25 & 40 DAS) or application of 25:50:25 NPK Kg ha$^{-1}$ (100% RDF) or application of 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS and application of 75% RDF + 0.4% spray of nano DAP at 45 DAS ($T_3$) were found equally effective in achieving higher growth attributes of green gram, whereas application of 25:50:25 NPK Kg ha$^{-1}$ (100% RDF), application of 75% RDF + 0.4% spray of nano urea at 25 DAS +0.4% spray of nano DAP at 45 DAS and application of 75% RDF + 0.4% spray of nano DAP at 45 DAS were statistically similar in achieving higher yield attributes and yield of green gram.

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