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RESPONSE OF GREENGRAM (V*igna radiata* L.Wilczek) TO FOLIAR NUTRITION OF NANO UREA AND NANO DAP

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ABSTRACT

A field experiment entitled was conducted during *rabi* 2022-23 at Regional Agricultural Research Station, ANGRAU, Lam, Andhra Pradesh, to study the response of greengram (*Vigna radiata* L.Wilczek) with foliar nutrition of nano urea and nano DAP.The experiment comprised of nine treatments and three replications with RBD design.The results indicated that foliar spray of nano DAP and nano urea resulted in higher grain yield (929 kg ha^{-1}&900 kg ha^{-1}) with yield advantage over control (water spray) 739 kg ha^{-1}.The highest net returns and B:C ratios of Rs. 34056 /- & Rs. 31962/- and 0.92 & 0.86 were realized with foliar spray of nano DAP @1.25 ml/l and nano urea @ 2.5 ml/l at flowering initiation, respectively.

Keywords: Greengram, Nano urea, Nano DAP, Growth and Yield

INTRODUCTION

Greengram (*Vigna radiata* L.) is a major pulse crop in India that belongs to the Leguminosae family and contains significant amounts of proteins, minerals, nutrients, and essential amino acids. Greengram is cultivated approximately to an extent of 55.5 lakh hectares, yielding 36.8 lakh tonnes with a productivity of 663 kg ha^{-1} in India. In Andhra Pradesh, greengram is cultivated over an area of approximately 0.59 lakh hectares, with a total production of about 0.58 lakh tonnes and an average productivity of 973 kg ha^{-1} (IIPR, 2024). Nitrogen (N) is the most significant mineral nutrient required by crop plants and is essential for their vegetative growth because it is a component of numerous proteins and enzymes in addition to chlorophyll, while Phosphorus (P) is essential for all life and plays a major role in preserving and improving the fertility of natural soil. The increasing cost of P fertilizer is creating financial hardships, which is why there is an increasing interest in improving P use efficiency. Thus, it is necessary to produce fertilizers that can be taken up more readily by plants while posing no threat to soil and the environment. In this context, nanotechnology has a growing role in crop production with strong promise to alter the existing state of fertilizer use with environmental safety, ecological sustainability and economic stability (Nandhakumar *et al*., 2023).

Foliar nutrition refers to the application of nutrients to the vegetative part at specific concentrations and times so that the plant can

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absorb them through the stomata of leaves or through the cell walls and membranes to participate in vital plant physiological processes. This enhances the vegetative and qualitative aspects to prevent circumstances that restrict the availability of plant nutrients in the soil (Surender Kumar and Kuldeep, 2024). Nano DAP is an efficient source of available nitrogen (N) and phosphorus (P_2O_5) for all the crops. It corrects the nitrogen & phosphorus deficiencies in standing crops. Nutrient use efficiency is more than 90 percent under optimum field conditions. Now-a-days nano fertilizer technology is gaining importance for foliar application of nitrogen (N) through nano urea and phosphorus (P) through nano DAP with respect of growth and development, yield, quality and tolerance to abiotic stress in crops. With this background, the present study involving nano urea and nano DAP foliar application on performance of greengram crop was conducted.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* 2022-23 at Regional Agricultural Research Station (RARS), ANGRAU, Lam, AP located at a latitude of 16'18' North and longitude of 80'29' East with an elevation of 33 meters of above MSL with nine treatments and three replications of RBD design *viz*.T_1 Control (water spray),T_2 Urea 2% at flowering initiation (FI), T_3 nano Urea 2.5 ml/L at flowering initiation, T_4 nano urea 1.25 ml/L at flowering initiation, T_5 nano urea 1.25 ml/l at flowering initiation + 1.25 ml/ L at pod development (PD), T_6 DAP 2% at flowering initiation, T_7 nano DAP 2.5 ml/L at flowering initiation, T_8 nano DAP 1.25 ml/L at flowering initiation, and T_9 nano DAP 1.25 ml/L at flowering initiation +1.25 ml/L at pod development. The experimental soil was deep black clay loam in texture. The crop was sown during first fortnight of October with greengram variety LGG630 at 30 cm x10 cm spacing. The recommended dose of fertilizers was (20:50:00 NPK kg ha^{-1}) applied in the form of urea and Single Super Phosphate (SSP) at the time of sowing as basal. The nano formulation of nanourea (4% N w/v) andnano DAP (8:16:0) were utilized as the sources of nano nitrogen and nano phosphorous from IFFCO. Nano urea and nano phosphorous were sprayed at 30 and 45 days after sowing (DAS)using knapsack sprayer @500 lha^{-1}. Each treatment was accommodated in 4.8 m x 4.0 m plots and all the biometric data were recorded from five plants selected randomly at harvest but chlorophyll content was recorded at 35 DAS with SPAD meter. The data from each plot were tested for normality and analyzed using ANOVA with treatment means compared using CD at $P<0.05$ in JMP software.

RESULTS AND DISCUSSION

Effect of Nano Urea

Among the nano urea treatments, foliar application of nano urea @ 1.25 ml L^{-1} at flowering initiation followed by 1.25 ml L^{-1} at pod development (T_5) resulted in the maximum plant height (52.5 cm) and highest number of branches (2.1 $plant^{-1}$) (Table 1). This indicates improved vegetative growth due to sustained nitrogen availability during critical crop growth stages. However, the highest chlorophyll content (51.1 SPAD) was observed in T_3 (nano urea @ 2.5 ml L^{-1} at flowering initiation), followed closely by T_2 and T_5. All nano urea treatments showed significantly higher values compared to the control, though they remained statistically comparable with conventional urea spray. The improvement in growth parameters may be attributed to enhanced nitrogen uptake through foliar application, which increases leaf production and expands leaf area. This results in higher photosynthetic efficiency and greater

Table 1. Growth and yield attributes of greengram as influenced by nano urea and nano DAP

Treatments	Plant height at harvest (cm)	Bran-ches /plant	Chloro-phyll (SPAD)	Pods/ plant	Pod length (cm)	Seeds/ pod	Test wt. (g)
T_1 Control (water spray)	43.1	1.5	43.5	22.9	7.7	11.9	3.45
T_2 Urea 2% at flowering initiation(FI)	45.9	1.6	50.8	28.2	7.8	12.1	3.62
T_3 Nano Urea 2.5 ml l^{-1}at FI	46.6	1.8	51.1	29.3	7.9	12.1	3.65
T_4 Nano urea 1.25 ml l^{-1}at FI	48.0	1.6	46.3	25.3	7.8	12.4	3.84
T_5 Nano urea 1.25 ml l^{-1}at FI + 1.25 ml l^{-1} at pod development (PD)	52.5	2.1	49.7	26.7	7.9	12.1	3.54
T_6 DAP 2% at FI	43.5	1.6	46.8	27.1	7.8	12.5	3.87
T_7 Nano DAP 2.5 ml l^{-1}at FI	51.7	2.2	47.2	28.1	8.0	12.9	3.85
T_8 Nano DAP 1.25 ml l^{-1}at FI	49.6	1.9	50.7	25.1	7.9	12.3	3.75
T_9 Nano DAP 1.25 ml l^{-1}at FI +1.25 ml l^{-1}at PD	52.7	2.0	51.3	31.3	8.1	12.9	4.00
Sem+	1.846	0.042	1.752	1.084	0.149	0.163	0.059
CD (0.05)	5.5	0.1	3.8	3.3	NS	0.5	0.18
CV (%)	6.6	4.0	5.1	6.9	3.3	2.3	2.8

translocation of assimilates from source to sink, ultimately supporting branch development. Similar observations were reported by Marimuthu *et al*. (2024), who found increased branching with nitrogen supplementation.

Further, the combined effect of basal fertilizer and foliar nano nitrogen likely ensured continuous nitrogen availability, promoting active cell division and elongation. Comparable findings were reported by Arun Kumar *et al*. (2024). Alqader *et al*. (2020) also reported enhanced branching in pulse crops following nano nitrogen application. The small particle size of nano urea allows better absorption through leaf surfaces, improving nutrient use efficiency and enhancing photosynthate production. Yield attributes such as pods plant -¹, seeds pod-¹ and test weight were significantly improved under nano urea treatments (Table 1). The highest number of pods plant^{-1} (29.3) was recorded in T_3, while T_5 recorded stable improvement across all yield parameters. These improvements were significantly superior to the control.

Grain yield (Table 2) followed a similar trend . The maximum yield of 900 kg ha^{-1} was obtained with T_5, which was significantly higher than the control (739 kg ha^{-1}). However, differences among nano urea treatments and conventional urea were statistically at par. The increased yield can be attributed to improved yield components, especially higher pod number and grain weight. Similar improvements due to nano urea application were reported by Islam *et al*.,2023 and Kunwar and Victor (2023) in blackgram. Economic analysis showed that nano urea treatments recorded higher profitability. The average net returns and B:C ratio of nano urea treatments

Table 2. Yield and economics of Greengram as influenced by nano urea and nano DAP

Treatments	Yield (kg/ha)	COC (Rs.)	Gross Returns (Rs.)	Net Returns (Rs.)	B:C ratio
T_1 Control (water spray)	739	36230	57309	21079	0.58
T_2 Urea 2% at flowering initiation(FI)	836	36289	64832	28543	0.79
T_3 Nano Urea 2.5 mll^{-1}at FI	889	36980	68942	31962	0.86
T_4 Nano urea 1.25 mll^{-1}at FI	846	36605	65607	29002	0.79
T_5 Nano urea 1.25 mll^{-1}at FI + 1.25 mll^{-1} at pod development (PD)	900	37730	69795	32065	0.85
T_6 DAP 2% at FI	862	36500	66848	30348	0.83
T_7 Nano DAP 2.5 mll^{-1}at FI	894	37730	69330	31600	0.84
T_8 Nano DAP 1.25 mll^{-1}at FI	916	36980	71036	34056	0.92
T_9 Nano DAP 1.25 mll^{-1}at FI +1.25 mll^{-1} at PD	929	38480	72044	33564	0.87
Sem+	33.229				
CD (0.05)	100				
CV (%)	6.6				

Note: Nano urea: Rs.250/- per 500 ml; Nano DAP: Rs.600/- per 500 ml, urea: Rs.5.92/- per kg, DAP: Rs.27/- per kg & produce (seed): Rs.7755/-per quintal

(T_3, T_4 and T_5) were Rs.31,010 ha^{-1} and 0.83, respectively, which were higher than conventional urea and control. Enhanced returns may be due to better photosynthetic efficiency and efficient partitioning of assimilates towards grain development, supported by sustained nitrogen availability. These findings are in agreement with Islam *et al.,*2023.

Effect of Nano DAP

Among nano DAP treatments, T_9 (nano DAP @1.25 ml L^{-1} at flowering initiation + 1.25 ml L^{-1} at pod development) recorded the highest plant height (52.7 cm) and maximum chlorophyll content (51.3 SPAD) (Table 1). Branch number was also higher under nano DAP treatments. Nano DAP treatments were comparable with conventional DAP for plant height but significantly superior for chlorophyll content. Improved growth under nano DAP application may be attributed to increased phosphorus availability, which plays a vital role in energy transfer, root development and cell division. Enhanced nutrient absorption through foliar application improves overall plant vigor. Similar findings were reported by Wu *et al*. (2024).

Yield attributes such as pods $plant^{-1}$ (31.3), seeds pod^{-1} (12.9) and test weight (4.00 g) were maximum in T_9 (Table 1). Consequently, the highest grain yield (929 kg ha^{-1}) was also recorded in this treatment, which was significantly superior to the control (739 kg ha^{-1}) (Table 2). However, yields among nano DAP and conventional DAP treatments were statistically comparable. Economic evaluation indicated that T_8 (nano DAP @1.25 ml L^{-1} at flowering initiation) recorded the highest net returns (Rs. 34,056 ha^{-1}) and B:C ratio (0.92),

making it the most cost-effective treatment. This suggests that a single spray at flowering stage is sufficient to achieve higher profitability.

The superior performance of nano DAP can be attributed to its controlled nutrient release, ensuring continuous phosphorus supply during reproductive stages. Enhanced enzymatic activity associated with phosphorus metabolism improves carbohydrate translocation and grain filling. Similar results were reported by Yadav *et al*. (2023) in chickpea and Henarani *et al*. (2022) in rice.

CONCLUSION

The study concluded that foliar application of nano fertilizers significantly enhanced greengram productivity and profitability. The highest grain yield (929 kg ha^{-1}) was recorded with nano DAP @1.25 ml L^{-1} applied twice, registering a 23.5% yield increase over control, while nano urea applied twice produced 900 kg ha^{-1}, showed an 18.8% yield advantage. The highest net returns (¹ 34,056 ha^{-1}) and B:C ratio (0.92) were obtained with nano DAP @1.25 ml L^{-1} at flowering initiation, whereas nano urea @2.5 ml L^{-1} recorded Rs.31,962 ha^{-1} net returns and 0.86 B:C ratio. Thus, foliar application of nano DAP @1.25 ml L^{-1} at flowering initiation can be recommended as an efficient and economically viable nutrient management strategy for greengram cultivation.

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