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Growth response of blackgram (*Vigna mungo* L.) to nano DAP application

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Abstract

A field experiment entitled “Growth Response of Blackgram (*Vigna mungo* L.) to Nano DAP application” was conducted at the College Farm, Agricultural College, Polasa, Jagtial, during the *rabi* season of 2025–26. The experiment was laid out in Randomized block design with eight treatments and three replications. The results revealed that the treatment T₈ - 100% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 2 sprays of Nano DAP (3ml l⁻¹) at vegetative stage and flowering stage, recorded the maximum plant height of (24.4, 33.8 and 41.8 cm), number of branches plant⁻¹ (3.5, 5.4 and 7.5), dry matter production (359, 881 and 4183 kg ha⁻¹), leaf area index (0.71, 3.94 and 2.89) at 30, 45 DAS and at harvest respectively and SPAD meter readings of 40.9 and 46.6 at 30 and 45 DAS, respectively. At 30 and 45 DAS T₈ was on par with T₆ for all the above growth parameters. T₈ also recorded maximum dry weight of root nodules (88.67 mg plant⁻¹) at the flowering stage, which was on par with T₆, T₇ and T₂.

Keywords: Blackgram, RDF, nano DAP, seed treatment

Introduction

Blackgram (*Vigna mungo* L.) is an important grain legume of the family Fabaceae and is commonly known as urd bean in India. It is the third most important pulse crop in the country and is valued for its high nutritional content, containing 22.23% protein, 48.0% carbohydrates and appreciable amounts of minerals and vitamins (Asaduzzaman *et al.*, 2010) ^[1]. Being a leguminous crop, it forms a symbiotic association with *Rhizobium* bacteria, which fixes atmospheric nitrogen and contributes about 22.1 kg N ha⁻¹, saving nearly 59 thousand tonnes of urea annually (Jat *et al.*, 2017) ^[4]. Despite its importance, blackgram productivity remains low due to improper nutrient management. Excessive use of conventional fertilizers such as urea and DAP has resulted in poor nutrient use efficiency, soil degradation and environmental pollution, with substantial losses of applied nutrients (Raliya *et al.*, 2013) ^[9].

Nanofertilizers have emerged as an efficient alternative to conventional fertilizers because they enhance nutrient use efficiency through controlled nutrient release, improve crop growth and reduce nutrient losses and environmental hazards (Yadav *et al.*, 2023) ^[14]. Among these, IFFCO developed liquid Nano DAP containing 8% nitrogen and 16% phosphorus, which effectively supplies nitrogen and phosphorus through foliar application (Khemshetty *et al.*, 2024) ^[5]. Nano DAP improves nutrient availability, corrects nutrient deficiencies in standing crops and enhances crop productivity while minimizing adverse effects on the environment (Chundawat *et al.*, 2025) ^[2]. Keeping the above points into consideration, the present study was undertaken to evaluate the “Growth Response of Blackgram (*Vigna mungo* L.) to Nano DAP application.”

Materials and Methods

The field experiment was conducted during *rabi*, 2025-26 at the College Farm, Agricultural College, Polasa, Jagtial, Telangana, India, to evaluate the “Growth Response of Blackgram (*Vigna mungo* L.) to Nano DAP application.” The experiment comprised of eight treatments:- T₁ - Control, T₂ - 100% RDF (20:50:0 NPK), T₃ - 50% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 1 spray of Nano DAP (3ml l⁻¹) at vegetative stage, T₄ - 50% RDF+ seed treatment with Nano DAP (3ml kg⁻¹) + 1 spray of Nano DAP (3ml l⁻¹) at flowering stage, T₅ - 50% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 2 sprays of Nano DAP (3ml l⁻¹) at vegetative and flowering

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stage, T₆ - 100% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 1 spray of Nano DAP (3 ml l⁻¹) at vegetative stage, T₇ - 100% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 1 spray of Nano DAP (3ml l⁻¹) at flowering stage, T₈ - 100% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 2 sprays of Nano DAP (3ml l⁻¹) at vegetative stage and flowering stage. These treatments were evaluated under a randomized block design (RBD) with three replications. The experiment field was characterized by well drained sandy clay loam soil with a composition of 62.8% sand, 6.5% silt and 29.85% clay. The initial soil chemical properties included a neutral pH of 7.86, electrical conductivity of 0.21 dS m⁻¹. The organic carbon content was moderate (0.50%). Prior to sowing, the soil was low in available nitrogen (198.7 kg ha⁻¹), medium in phosphorus (21.2 kg ha⁻¹) and available potassium (254.1 kg ha⁻¹). During the experimental period, the average maximum and minimum temperatures were 31.3°C and 13.3°C, respectively. The crop variety used was blackgram variety 'MBG-1070', which has a duration of 75-80 days. Sowing was done at a spacing of 30 cm × 10 cm using a seed rate of 20- 25 kg ha⁻¹ on 17th October, 2025. The recommended dose of fertilizers (20:50:0 kg ha⁻¹ of N, P₂O₅, and K₂O) was applied using urea and SSP as basal dose *i.e.*, at the time of sowing. Foliar application of Nano DAP was given by knapsack sprayer at 30 and 45 days after sowing. Data was recorded from five plants selected randomly from each treatment. Data on growth parameters such as plant height, number of branches, dry weight of root nodules, dry matter production, leaf area index and SPAD chlorophyll meter readings of blackgram were analysed statistically using ANOVA.

Results and Discussion

Effect of Nano DAP treatments on growth parameters of blackgram

1. Plant height (cm)

Plant height was significantly influenced by application of Nano DAP at 30, 45 DAS and at harvest in blackgram crop.

At all the growth stages, the maximum plant height was recorded in treatment T₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 2 sprays of Nano DAP (3 ml l⁻¹) at vegetative and flowering stages, recording 24.4, 33.8 and 41.8 cm at 30, 45 DAS and at harvest, respectively.

At 30 and 45 DAS, T₈ is on par with T₆ - 100% RDF + seed treatment with Nano DAP (3ml kg⁻¹) + 1 spray of Nano DAP (3ml l⁻¹) at vegetative stage, which recorded 23.6, 31.9 cm respectively. However, at harvest, T₈ was significantly superior to all other treatments.

The lowest plant height of 17.9, 24.4 and 31.9 cm at 30, 45 DAS and at harvest was recorded in T₁ (Control) respectively. The increased plant height under T₈ may be attributed to the combined effect of 100% RDF along with Nano DAP seed treatment and two foliar sprays at vegetative and flowering stages, which ensured a continuous supply of nutrients throughout the crop growth period. Adequate availability of nitrogen and phosphorus enhanced cell division, cell elongation, chlorophyll synthesis and photosynthetic efficiency, resulting in vigorous vegetative growth and taller plants. These results are in agreement with those reported by Girigoud *et al.* (2023) [3] and Shete *et al.* (2024) [11].

2. Number of branches plant⁻¹

The number of branches plant⁻¹ was significantly influenced by the different Nano DAP treatments at 30 DAS, 45 DAS and at harvest.

At all the growth stages treatment T₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 2 sprays of Nano DAP (3 ml l⁻¹) at vegetative and flowering stages, recorded maximum

number of branches plant⁻¹ of 3.5, 5.4 and 7.5 at 30, 45 DAS and harvest, respectively.

At 30 DAS and 45 DAS, treatment T₈ was on par with T₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 1 spray of Nano DAP (3 ml l⁻¹) at the vegetative stage, which recorded 3.2 and 5.2 branches plant⁻¹, respectively. At harvest, T₈ was significantly superior to all other treatments. The lowest number of branches plant⁻¹ was observed in T₁ *i.e.*, Control, with 2.4, 3.4 and 5.3 branches plant⁻¹ at 30, 45 DAS and harvest, respectively. The increase in number of branches may be due to foliar application of Nano DAP at vegetative and flowering stages improved nutrient use efficiency and photosynthetic activity, resulting in vigorous vegetative growth and increased branch formation. Results analogous to this have also been reported by Sruthy *et al.* (2023) [12] and Maurya *et al.* (2024) [7].

Dry weight of root nodules (mg plant⁻¹)

The dry weight of root nodules at the flowering stage was significantly influenced by the different Nano DAP treatments.

Among the treatments, T₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 2 sprays of Nano DAP (3 ml l⁻¹) at vegetative and flowering stages, recorded the highest dry weight of root nodules (88.67 mg plant⁻¹). This treatment is on par with T₆ (87.00 mg plant⁻¹), T₇ (82.33 mg plant⁻¹), T₂ (81.20 mg plant⁻¹). The lowest dry weight of root nodules (60.60 mg plant⁻¹) was observed in T₁. The increased dry weight of root nodules under T₈ may be attributed to the synergistic effect of recommended fertilizer application along with Nano DAP seed treatment and foliar nutrition, which provided an adequate supply of phosphorus required for nodule initiation, development and functioning. Phosphorus plays a crucial role in energy transfer and metabolic activities associated with nitrogen fixation, thereby promoting the formation of larger and more active nodules. These findings are in close agreement with the reports of Kumar *et al.* (2022) [6].

Dry matter production (kg ha⁻¹)

The dry matter production was significantly influenced by the different Nano DAP treatments at 30 DAS, 45 DAS and at harvest.

At all growth stages, the highest dry matter production was recorded in T₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 2 sprays of Nano DAP (3 ml l⁻¹) at vegetative and flowering stages, recording 359, 881 and 4183 kg ha⁻¹ at 30 DAS, 45 DAS and at harvest, respectively.

At 30 DAS and 45 DAS, treatment T₈ was on par with T₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 1 spray of Nano DAP (3 ml l⁻¹) at the vegetative stage, which recorded 323 and 810 kg ha⁻¹, respectively. However, at harvest, T₈ recorded significantly higher dry matter production than all other treatments.

The lowest dry matter production was recorded in T₁ *i.e.*, Control, recording 201, 606 and 2480 kg ha⁻¹ at 30 DAS, 45 DAS and at harvest, respectively. The foliar application of Nano DAP at critical growth stages might have further improved nutrient-use efficiency and reduced nutrient losses, thereby enhancing biomass production. Concordant result was reported by Sarika *et al.* (2025) [10].

Leaf area index

Leaf area index was significantly influenced by the different Nano DAP treatments at 30 DAS, 45 DAS and at harvest.

At all growth stages, the highest leaf area index was recorded in T₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 2 sprays of Nano DAP (3 ml l⁻¹) at vegetative and flowering stages,

recording 0.71, 3.94 and 2.89 at 30 DAS, 45 DAS and harvest, respectively.

At 30 and 45 DAS, treatment T₈ was statistically on par with T₆, which recorded leaf area index values of 0.70 and 3.81, respectively. However, at harvest, T₈ registered a significantly higher leaf area index compared to all the other treatments.

The lowest leaf area index was recorded in T₁ (Control), with the values 0.37, 2.34 and 1.54 at 30 DAS, 45 DAS and harvest, respectively. The superior LAI under T₈ might be attributed to the combined effect of RDF, seed treatment and foliar application of nano DAP, which ensured adequate and continuous nutrient supply throughout the crop growth period. The increase of leaf area index in T₈ is due to enhanced availability of nitrogen and phosphorus which promoted vigorous vegetative growth, increased leaf initiation and expansion, higher chlorophyll synthesis and improved photosynthetic activity, leading to greater canopy development. Similar findings were recorded by Khemshetty *et al.* (2024) [5].

SPAD chlorophyll meter readings (SCMR)

SPAD chlorophyll meter readings were significantly influenced by the different Nano DAP treatments at 30 and 45 DAS.

The highest SPAD meter readings was recorded with T₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 2 sprays of Nano DAP (3 ml l⁻¹) at vegetative and flowering stages recording 40.9, 46.6 at 30 and 45 DAS respectively.

At 30 and 45 DAS, T₈ was on par with T₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg⁻¹) + 1 spray of Nano DAP (3 ml l⁻¹) at the vegetative stage, which recorded 39.2, 44.0 respectively.

The lowest SPAD chlorophyll meter readings were recorded in T₁ (Control) with values of 31.4 and 36.4 at 30 and 45 DAS respectively. Foliar application of Nano DAP at critical growth stages could have facilitated rapid nutrient absorption and utilization, thereby maintaining higher chlorophyll content in leaves. Similar findings were observed by Venkatarao *et al.* (2025) [13].

Table 1: Plant height (cm) of blackgram as influenced by application of Nano DAP at different stages of crop growth.

Treatments	Plant height (cm)		
	30 DAS	45 DAS	Harvest
T ₁ - Control	17.9	24.4	31.9
T ₂ - 100% RDF	21.9	29.7	35.8
T ₃ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	20.7	29.2	36.9
T ₄ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	19.9	28.8	36.4
T ₅ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	21.7	29.6	37.8
T ₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	23.6	31.9	37.5
T ₇ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	21.8	30.1	36.7
T ₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	24.4	33.8	41.8
S.Em ±	0.78	1.07	1.20
CD (P=0.05)	2.36	3.24	3.64

Table 2: Number of branches plant⁻¹ of blackgram as influenced by application of Nano DAP at different stages of crop growth

Treatments	No. of branches plant ⁻¹		
	30DAS	45DAS	Harvest
T ₁ - Control	2.4	3.4	5.3
T ₂ - 100% RDF	3.1	4.8	5.8
T ₃ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	3.0	4.6	6.3
T ₄ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	2.9	3.9	6.0
T ₅ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	3.0	4.7	6.8
T ₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	3.2	5.2	6.7
T ₇ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	3.1	4.8	6.5
T ₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	3.5	5.4	7.5
S.Em ±	0.12	0.16	0.22
CD (P=0.05)	0.35	0.50	0.67

Table 3: Dry weight (mg) of root nodules plant⁻¹ of blackgram as influenced by application of Nano DAP at different stages of crop growth

Treatments	Dry weight of root nodules (mg plant ⁻¹)
T ₁ - Control	60.60
T ₂ - 100% RDF	81.20
T ₃ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	75.63
T ₄ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	71.50
T ₅ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	77.97
T ₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	87.00
T ₇ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	82.33
T ₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	88.67
S.Em ±	2.76
CD (P=0.05)	8.36

Table 4: Dry matter production (kg ha⁻¹) of blackgram crop as influenced by application of Nano DAP at different stages of crop growth

Treatments	Dry matter production (kg ha ⁻¹)		
	30 DAS	45 DAS	Harvest
T ₁ - Control	201	606	2480
T ₂ - 100% RDF	313	770	3003
T ₃ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	273	682	3487
T ₄ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	220	648	3400
T ₅ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	310	711	3802
T ₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	323	810	3703
T ₇ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	312	788	3572
T ₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	359	881	4183
S.Em ±	15.13	28.45	122.73
CD (P=0.05)	45.90	86.30	372.26

Table 5: Leaf area index of blackgram crop as influenced by application of Nano DAP at different stages of crop growth

Treatments	Leaf area index		
	30DAS	45DAS	Harvest
T ₁ - Control	0.37	2.34	1.54
T ₂ - 100% RDF	0.61	3.44	1.97
T ₃ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	0.59	3.47	2.40
T ₄ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	0.52	2.63	2.29
T ₅ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	0.60	3.49	2.57
T ₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	0.70	3.81	2.62
T ₇ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	0.60	3.53	2.44
T ₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	0.71	3.94	2.89
S.Em ±	0.03	0.12	0.08
CD (P=0.05)	0.09	0.36	0.25

Table 6: SPAD chlorophyll meter reading of blackgram crop as influenced by application of Nano DAP at different stages of crop growth

Treatments	SPAD chlorophyll meter readings	
	30 DAS	45 DAS
T ₁ - Control	31.4	36.4
T ₂ - 100% RDF	36.0	41.2
T ₃ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	35.7	40.9
T ₄ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	34.1	39.1
T ₅ - 50% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	35.6	41.8
T ₆ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Vegetative stage.	39.2	44.0
T ₇ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 1 spray Nano DAP (3 ml l ⁻¹) at Flowering stage.	35.3	42.1
T ₈ - 100% RDF + seed treatment with Nano DAP (3 ml kg ⁻¹) + 2 sprays Nano DAP (3 ml l ⁻¹) at Vegetative and Flowering stage.	40.9	46.6
S.Em ±	1.37	1.49
CD (P=0.05)	4.15	4.51

Conclusion

Plant height, number of branches, dry weight of root nodules, dry matter production, leaf area index, SPAD chlorophyll meter readings were significantly influenced by different Nano DAP treatments. Among the treatments T₈ recorded the highest values for all growth parameters and was found to be on par with T₆. This is due to improved phosphorus availability and sustained nutrient release through Nano DAP resulting in better vegetative growth, chlorophyll synthesis and overall crop development.

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References

- Asaduzzaman M, Sultana S, Roy TS, Masum SM. Weeding

and plant spacing effects on the growth and yield of blackgram. Bangladesh Research Publication Journal. 2010;4(1):62-68.

- Chundawat DS, Solanki NS, Mathur IJ, Rathore BS, Kumar V, Patel C. Effect of conjoint application of phosphorus and Nano DAP on growth and yield of blackgram (*Vigna mungo* L.). International Journal of Agricultural Invention. 2025;10(2):82-86.
- Girigoud A, Naik A, Siddaram BS, Bellakki MA. Effect of Nano-DAP on growth and yield of pigeon pea under rainfed condition. The Pharma Innovation Journal. 2023;12(12):1536-1539.
- Jat S, Dangi KL, Kumhar BL. Constraints in adoption of improved cultivation practices of blackgram. International Journal of Current Microbiology and Applied Sciences. 2017;6(5):1820-1824.
- Khemshetty A, Patil DH, Rathod PS, Patil AS, Basavaraj K.

- Studies on Nano DAP on growth, yield and quality of chickpeas under rainfed conditions of northeastern dry zone of Karnataka. *Journal of Experimental Agriculture International*. 2024;46(3):139-145.
6. Kumar N, Singh SK, Prasad SK, Tiwari S. Effect of efficient nutrient management on growth, yield and quality of lentil (*Lens culinaris* M.). *International Journal of Chemical Studies*. 2022;10(1):42-46.
 7. Maurya PK, Bahadur V, Shukla PK, Topno SE, Thakur G. Response of Nano NPK on growth, yield and quality of French bean (*Phaseolus vulgaris* L.). *Plant Archives*. 2024;24(2):931-935.
 8. Panse VC, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: Indian Council of Agricultural Research; 1978. p. 87-89.
 9. Raliya R, Tarafdar JC, Choudhary K, Saran RP. Scope of nanoscience and nanotechnology in agriculture. *Journal of Applied Biology and Biotechnology*. 2013;1(3):41-44.
 10. Sarika K, Ramesh G, Srinivasulu K, Latha M. Effect of Nano DAP on growth, yield attributes and yield of chickpea (*Cicer kabulinum*). *International Journal of Research in Agronomy*. 2025;8(4):20-25.
 11. Shete AD, Adsul PB, Sabale AP, Bobade JR. Impact of Nano DAP on growth and yield of black gram (*Vigna mungo* L.) in inceptisol soil. *International Journal of Research in Agronomy*. 2024;7(11):47-52.
 12. Sruthy H, Pillai PS, Shimi GJ, Bindhu JS, Sajeena A. Growth and yield of grain cowpea (*Vigna unguiculata* subsp. *cylindrica*) in response to foliar nutrition and graded levels of phosphorus and potassium. *International Journal of Environment and Climate Change*. 2023;13(11):4001-4014.
 13. Venkatarao P, Reddy AS, Ramana MV. Response of greengram (*Vigna radiata* L. Wilczek) to foliar nutrition of Nano Urea and Nano DAP. *Journal of Research ANGRAU*. 2025;53(5):70-75.
 14. Yadav A, Yadav K, Abd-Elsalam KA. Nanofertilizers: types, delivery and advantages in agricultural sustainability. *Agrochemicals*. 2023;2(2):296-336.