



Effect of Conjoint application of phosphorus and Nano DAP on growth and yield of Black gram (*Vigna mungo* L.)

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ARTICLE INFO	ABSTRACT
<p>Original Research Article Received on August 16, 2025 Revised on August 21, 2025 Accepted on September 14, 2025 Published on September 19, 2025</p> <p>Article Authors Diya Singh Chundawat, N. S. Solanki, I. J. Mathur, Bhavna Singh Rathore, Vinod Kumar, Sonia Jaiswani Chanchal Patel</p> <p>Corresponding Author Email diyachundawat270@gmail.com</p>	<p>A field experiment entitled “Effect of Conjoint application of phosphorus and Nano DAP on growth and yield of Black gram (<i>Vigna mungo</i> L.)” was conducted during <i>Kharif</i>, 2024 at Instructional Farm, School of Agricultural Sciences, Dabok, Udaipur, Rajasthan to find out the effect of nano DAP on growth and yield of black gram, to explore whether application of nano DAP can fulfill the recommended dose of phosphorus and to work out an economically viable treatment. The experiment consisted of 8 treatments including <i>viz.</i> T₁ (control), T₂ (100% RDP), T₃ (50% RDP), T₄ (75% RDP), T₅ (50% RDP + nano DAP 4ml l⁻¹ one spray), T₆ (50% RDP + nano DAP 4ml l⁻¹ two sprays) T₇ (75% RDP + nano DAP 4ml l⁻¹ one spray) and T₈ (75% RDP + nano DAP 4ml l⁻¹ two sprays) which were evaluated under randomized block design with 3 replications. Black gram variety PU 31 was used as test crop. The results revealed that maximum values of growth attributes <i>viz.</i>, dry matter accumulation at 30 DAS was recorded with T₇ (75% RDP + nano DAP 4ml l⁻¹ one spray) and T₈ (75% RDP + nano DAP 4ml l⁻¹ two sprays) but at 60 DAS and at harvest it was recorded with T₈ (75% RDP + nano DAP 4ml l⁻¹ two sprays) and T₇ (75% RDP + nano DAP 4ml l⁻¹ one spray), while maximum values of CGR between 30-60 DAS was recorded with T₂ (100% RDP) and between 60 DAS to harvest it was recorded highest with T₇ (75% RDP + nano DAP 4ml l⁻¹ one spray). Treatment T₈ (75% RDP + nano DAP 4 ml l⁻¹ two sprays) recorded significantly higher grain (588 kg ha⁻¹), haulm (1625 kg ha⁻¹) and biological (2213 kg ha⁻¹) over control and T₄ (75 % RDP) but at par with T₂ (100% RDP). However, T₂ (100% RDP) fetched highest net return (₹31048 ha⁻¹) and highest B-C ratio (0.89), which significantly superior over T₈ (75% RDP + nano DAP 4 ml l⁻¹ two spray).</p>
<p>PUBLICATION INFO International Journal of Agricultural Invention (IJAI) RNI: UPENG/2016/70091 ISSN: 2456-1797 (P) Vol.: 10, Issue: 2, Pages: 82-86 Journal Homepage URL http://agriinventionjournal.com/ DOI: 10.46492/IJAI/2025.10.2.15</p>	<p>KEYWORDS Phosphorus, Nano DAP, Growth, Yield, Black gram</p>

HOW TO CITE THIS ARTICLE

Chundawat, D. S., Solanki, N. S., Mathur, I. J., Rathore, B. S., Kumar, V., Jaiswani, S., Patel, C. (2025) Effect of conjoint application of phosphorus and Nano DAP on growth and yield of Black gram (*Vigna mungo* L.), *International Journal of Agricultural Invention*, 10(2): 82-86. DOI: 10.46492/IJAI/2025.10.2.15

Black gram (*Vigna mungo* L.) is popularly known as ‘Urdbean’ which belongs to the family Leguminosae. India is the largest grower and consumer of pulses in the world. About 70 percent of the world’s black gram production comes from India. It produces about 24.5 lakh tones of black gram annually from about 4.6 m ha area with an average productivity of 533 kg ha⁻¹, while the area and productivity of black gram in Rajasthan is 5.15

m ha and 3.37 lakh tones with average productivity of 654 kg ha⁻¹ (Government of Rajasthan, 2022). Phosphorus is the second most essential plant nutrient that influences plant growth by regulating key metabolic activities such as cell division and development, energy transfer (ATP and ADP), signal transduction, macromolecular biosynthesis, photosynthesis and respiration (Khan *et al.*, 2014).

Phosphorus nutrient in legumes promotes higher production and productivity by fostering robust root development and rhizobial activity, leading to more nodulation, which results in more nitrogen fixation (Chauhan and Raghav, 2017). Nano DAP is a nanotechnology based revolutionary input and a sustainable option for farmers towards smart agriculture. Nano DAP is an efficient source of available nitrogen and phosphorous for all crops and helps in correcting their deficiencies in standing crops.

Nano DAP formulation contains 8.0 percent N_2 (w/v) and 16 percent P_2O_5 (w/v). Application of nano DAP leads to higher seed vigour, more chlorophyll, photosynthetic efficiency, better quality and increase in crop yield. Nano DAP fulfills the nutritional demand of crops without harming the environment. Nano-fertilizers outperform traditional fertilizers because they can triple nutrient efficacy, minimize the need for chemical fertilizers, make crops drought and disease resistant and are less harmful to the environment. It reduces the quantity of traditional fertilizer required by 50% or more (Panda *et al.*, 2020).

Materials and Methods

The field experiment was conducted during kharif, 2024 at Instructional Farm, School of Agricultural Sciences, Dabok, Udaipur, Rajasthan. The total rainfall received during the crop season was 575 mm. The soil of the experimental field was clay loam in texture, slightly alkaline (pH 7.5) in reaction, low in organic carbon (0.55%), nitrogen (250.3 kg ha^{-1}) and medium in available phosphorus (20.3 kg ha^{-1}) but high in potassium (349.3 kg ha^{-1}).

The experiment consisted of 8 treatment combinations including three with 50% RDP along with nano DAP 4 ml (one and two spray) in combination or alone with RDP, three with 75% RDP along with nano DAP 4 ml (one and two spray) in combination or alone with RDP, 100% RDP and control which were evaluated under randomized block design with three replications. Black gram variety Pant Urd 31 (PU 31) was used as test crop. The black gram crop was sown on 19th July 2024.

Results and Discussion

Growth Attributes

The results (table 1) showed that the application of nano DAP significantly influenced plant growth attributes, including dry matter accumulation and crop growth rate (CGR). Treatments involving nano DAP with varying doses of RDP showed notable improvements, with the significantly higher dry matter accumulation at 30 DAS and 60 DAS recorded with the application of T_8 (75% RDP + nano DAP 4 ml l^{-1} two sprays) as compared to other treatments except T_7 (75% RDP + nano DAP 4 ml l^{-1} one spray), T_6 (50% RDP + nano DAP 4 ml l^{-1} two sprays), T_5 (50% RDP + nano DAP 4 ml l^{-1} one spray) and T_2 (100% RDP).

The highest crop growth rate (CGR) were also obtained with the application of T_8 (75% RDP + nano DAP 4 ml l^{-1} two sprays) which was at par with T_7 (75% RDP + nano DAP 4 ml l^{-1} one spray) and (100% RDP). Phosphorous is known to induce cell division and cell enlargement in plants (Reyes *et al.*, 2002), therefore, the increase in plant growth might be attributed to enhance mobilization of added and natural soil phosphorous as a result of PSB application along with nano DAP. This enhancement can be attributed to the role of phosphorus, a primary component of nano DAP, in energy transfer, cell division, and root development, which are essential for robust plant growth (Shivay *et al.*, 2022).

Nano DAP's nano-sized particles increase the surface area, ensuring better nutrient availability and uptake by minimizing losses through volatilization and leaching (Prasad *et al.*, 2021). The slow and sustained release of nutrients from nano DAP maintains optimal nutrient availability during critical growth phases, reducing nutrient stress and improving biomass production (Kumari *et al.*, 2020). Moreover, the enhanced nutrient absorption facilitated by nano DAP likely improved photosynthetic activity, as phosphorus is critical for ATP synthesis and chlorophyll production, directly influencing CGR (Meena *et al.*, 2023). Treatments with nano DAP also promote microbial activity in the rhizosphere, aiding in the solubilization and mobilization of essential nutrients, further supporting plant growth (Goyal *et al.*, 2023).

Table 1. Effect of Nano DAP on dry matter accumulation and crop growth rate of black gram

Symbol Treatments		Dry Matter Accumulation (g Plant ⁻¹)			Crop Growth Rate (g/m ² /Day)	
		At 30 DAS	At 60 DAS	At Harvest	CGR between 30-60 DAS	CGR between 60 and Harvest
T ₁	Control	5.3	9.9	12.2	0.150	0.104
T ₂	100% RDP	6.1	10.9	13.5	0.189	0.114
T ₃	50% RDP	5.6	9.2	11.1	0.119	0.089
T ₄	75% RDP	6.0	9.1	11.2	0.121	0.095
T ₅	50% RDP + Nano DAP 4 ml l ⁻¹ one spray	7.4	12.8	15.7	0.173	0.134
T ₆	50% RDP + Nano DAP 4 ml l ⁻¹ two sprays	7.3	13.5	16.6	0.181	0.141
T ₇	75% RDP + Nano DAP 4 ml l ⁻¹ one spray	8.6	14.3	17.5	0.175	0.149
T ₈	75% RDP + Nano DAP 4 ml l ⁻¹ two sprays	8.6	14.4	17.2	0.177	0.126
S.Em±		0.31	0.61	0.68	0.0100	0.0100
C.D.(P=0.05)		0.93	1.87	2.07	0.0400	0.0300

Table 2. Effect of Nano DAP on yield and harvest index, net return and B: C of black gram

Symbol Treatments		Yield(kg ha ⁻¹)			Harvest Index (%)	Net Return (₹ ha ⁻¹)	B:C
		Grain	Haulm	Biological			
T ₁	Control	343	1158	1501	22.9	7537	0.23
T ₂	100% RDP	588	1625	2213	26.6	31048	0.89
T ₃	50% RDP	397	1299	1696	23.3	12326	0.37
T ₄	75% RDP	500	1412	1911	26.1	21953	0.64
T ₅	50% RDP + Nano DAP 4 ml l ⁻¹ one spray	449	1373	1822	24.6	14802	0.40
T ₆	50% RDP + Nano DAP 4 ml l ⁻¹ two spray	484	1548	2032	23.8	16552	0.42
T ₇	75% RDP + Nano DAP 4 ml l ⁻¹ one spray	547	1540	2086	26.2	24408	0.66
T ₈	75% RDP + Nano DAP 4 ml l ⁻¹ two spray	575	1571	2147	26.8	24419	0.61
S.Em±		22.85	46.03	59.92	0.85	2246.5	0.06
C.D.(P=0.05)		69.30	139.64	181.76	2.57	6814.7	0.19

These findings align with recent studies emphasizing the effectiveness of nano fertilizers in improving nutrient use efficiency and overall plant productivity under various agricultural conditions.

Yield and Harvest Index

The results (table 2) revealed that the application of nano DAP in black gram significantly influenced the yield. Grain yield, haulm yield, biological yield and harvest index, were significantly influenced with the application of nano DAP across treatment. Significantly higher grain yield (575 kg ha⁻¹), haulm yield (1571 kg ha⁻¹), biological yield (2147 kg ha⁻¹) and harvest index (26.8 %) were recorded with application of T₈ (75% RDP + nano DAP 4 ml l⁻¹ two sprays) as compared to other treatments except T₂ (100% RDP), T₇ (75% RDP + nano DAP 4 ml l⁻¹ one spray) and T₆ (50% RDP +

nano DAP 4 ml l⁻¹ two sprays), which also demonstrated remarkable yield improvements. The control treatment (T₁) exhibited the lowest values for all yield parameters, indicating the importance of phosphorus and nano DAP in improving crop productivity. The improved grain and haulm yields in nano DAP-treated plots can be attributed to better nutrient availability and uptake, particularly phosphorus, which is essential for energy transfer, root development and reproductive growth (Sharma *et al.*, 2023). Phosphorus also promotes better translocation of photosynthates to reproductive organs, enhancing grain filling and overall yield (Kumar *et al.*, 2023). The nano-sized formulation of DAP ensures a slow and sustained release of nutrients, minimizing losses and providing an uninterrupted nutrient supply throughout the growth stages (Prasad *et al.*, 2021).

Biological yield, which represents the total above-ground biomass, was significantly higher in treatments with nano DAP. This reflects improved photosynthetic efficiency and better partitioning of assimilates between vegetative and reproductive parts (Meena *et al.*, 2023). The harvest index, a measure of the efficiency of converting total biomass into economic yield, showed a marginal increase in treatments involving nano DAP, with T₈ (75% RDP + nano DAP 4 ml l⁻¹ two spray) recording the highest value (26.8%). This indicates that the application of nano DAP not only enhances biomass production but also improves the efficiency of resource allocation towards grain production.

Economics

The results (table 2) revealed that the application of T₈ (75% RDP + nano DAP 4 ml l⁻¹ two sprays) resulting in higher yield but at par with T₂ (100% RDP). Nano DAP is a value added product and generally more expensive per unit of nutrient delivered compared to traditional fertilizers. Even though it improves nutrient uptake, the cost per hectare might be higher due to product pricing or additional foliar application labour. Although, applying only 75% RDP reduces basal phosphatic fertilizer cost but this saving may be offset by the added cost of nano DAP and application labour, resulting in lower net return and B: C, in the present investigation the yield advantage is marginal, the additional returns from extra grain produced might not cover the added cost of the foliar nano DAP application. The higher net income in nano DAP treatments with 50% and 75% RDP as compared to 50% and 75% RDP alone can be attributed to the enhanced grain and haulm yields, which directly increase the total returns. The superior nutrient use efficiency of nano DAP ensures optimal growth and yield with lower fertilizer input costs compared to conventional fertilizers (Sharma *et al.*, 2023).

Conclusion

The application of 75% RDP with nano DAP 4 ml l⁻¹ gave significantly higher yield over 75 % RDP alone but at par with 100% RDP. However, net return and B:C were significantly reduced as compared to 100% RDP. Therefore, it may be recommended to continue using 100% RDP (40 kg P₂O₅ ha⁻¹) for better economic returns.

However, in areas with limited access to fertilizers or for environmentally focused farming, the 75% RDP (30 kg P₂O₅ ha⁻¹) + Nano DAP 4 ml l⁻¹ one spray strategy can be used to save resources while maintaining yield.

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