International Journal of Environment, Agriculture and Biotechnology
Vol-11, Issue-4; Jul-Aug, 2026
Peer-Reviewed International Journal
Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Effect of *Nano* DAP on Yield and Economics of Chickpea (*Cicer arietinum*)

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Received: 19 Jun 2026; Received in revised form: 13 Jul 2026; Accepted: 17 Jul 2026; Available online: 26 Jul 2026

Abstract*— A field experiment entitled "Effect of Nano DAP on Yield and Quality of Chickpea (Cicer arietinum L.)" was conducted during the rabi season of 2025–26 at the Instructional Farm, DFRS, Arjia, Bhilwara, Rajasthan, on a clay loam soil. The experiment was laid out in a Randomized Block Design (RBD) with three replications comprising different levels of recommended dose of fertilizers (RDF) and Nano DAP applied through seed treatment and foliar spray. The results revealed that Nano DAP significantly influenced the productivity and economics of chickpea. The highest seed yield, haulm yield, biological yield and net return were recorded under T_{10}, which was statistically at par with T_7, T_8 and T_9. However, the highest benefit-cost ratio was recorded under T_9, which remained statistically comparable with T_7. Considering the comparable yield performance and economic returns with lower fertilizer input, T_7 (75% RDF + Nano DAP seed treatment @ 5 ml kg^{-1} seed + foliar spray @ 4 ml L^{-1} water at 30 DAS) may be considered a more suitable and economical nutrient management practice for chickpea cultivation under the conditions of Southern Rajasthan.

***Keywords*— Nano DAP, Chickpea, RDF**

I. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important grain legumes belonging to the family Fabaceae and is widely cultivated in semi-arid and subtropical regions of the world. Owing to its high protein content (18–24%), carbohydrates, dietary fibre, vitamins and minerals. Chickpea plays a vital role in ensuring nutritional security and improving soil fertility through biological nitrogen fixation. It is also an important component of sustainable cropping systems because of its ability to improve soil health and reduce the dependence on synthetic nitrogen fertilizers (Jukanti *et al*., 2012; Merga and Haji, 2019).

Chickpea was cultivated over an area of 9.61 million hectares with a production of 11.34 million tonnes and an average productivity of 1180 kg ha^{-1}. Rajasthan ranks third in chickpea cultivation with an area of 1.74 million hectares and a production of 1.92 million tonnes, having an average productivity of 1081 kg ha^{-1} (Directorate of Economics and Statistics, 2024).

Phosphorus is one of the most essential macronutrients required for optimum plant growth and development. It plays a crucial role in energy transfer, root proliferation, nodulation, biological nitrogen fixation, flowering, seed formation and ultimately crop productivity. However, phosphorus use efficiency in agricultural soils is generally low because a considerable proportion of applied phosphorus becomes fixed in the soil, making it unavailable to plants. Consequently, improving phosphorus use efficiency has become an important objective for enhancing crop productivity while minimizing fertilizer losses (Singh and Sharma, 2011; Pang *et al*., 2018; Rana *et al*., 2025).

Recent advances in *Nano* technology have led to the development of *Nano*-fertilizers, which improve nutrient use efficiency through targeted and controlled nutrient release. *Nano* di-ammonium phosphate (*Nano* DAP) is an innovative liquid fertilizer containing approximately 8.0% nitrogen and 16.0% phosphorus (P_2O_5). Owing to its nanoscale particle size and higher surface area, *Nano* DAP facilitates efficient nutrient absorption, enhances root growth, improves phosphorus availability and increases nutrient use efficiency compared with conventional phosphorus fertilizers (Singh *et al*., 2021; Al-Khuzai et al., 2020; Baral *et al*., 2025).

II. MATERIALS AND METHODS

A field experiment was conducted during *rabi* season (2025-26) at the Instructional Farm, DFRS Arjia, Bhilwara on clay loam soil. The soil was slightly alkaline (7.85), medium in organic carbon (0.53 percent), EC (0.81dS m^{-1}), available nitrogen (221.50 kg ha^{-1}), available phosphorus (14.80 kg ha^{-1}) and available potassium (312.20 kg ha^{-1}). The experiment was laid out in a randomized block design with three replications. RDF and *Nano* DAP with seed treatment and foliar application assigned in among all the experimental field:T_1(Control), T_2(50% of RDF), T_3(75% of RDF), T_4(100%RDF), T_5(T_2 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml $litter^{-1}$ water at 30 DAS), T_6(T_2 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml $litter^{-1}$ water at 30 and 60 DAS), T_7(T_3 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml $litter^{-1}$ water at 30 DAS), T_8(T_3 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml $litter^{-1}$ water at 30 and 60 DAS), T_9(T_4 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml $litter^{-1}$ water at 30 DAS) and T_{10}(T_4 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml $litter^{-1}$ water at 30 and 60 DAS). Chickpea (GNG-2171) was sown at 30×10 cm spacing by using the behind the country plough. In this study yield and economics were recorded.

III. RESULTS AND DISCUSSION

Effect of Nano DAP on Seed Yield, Haulm Yield and Economics

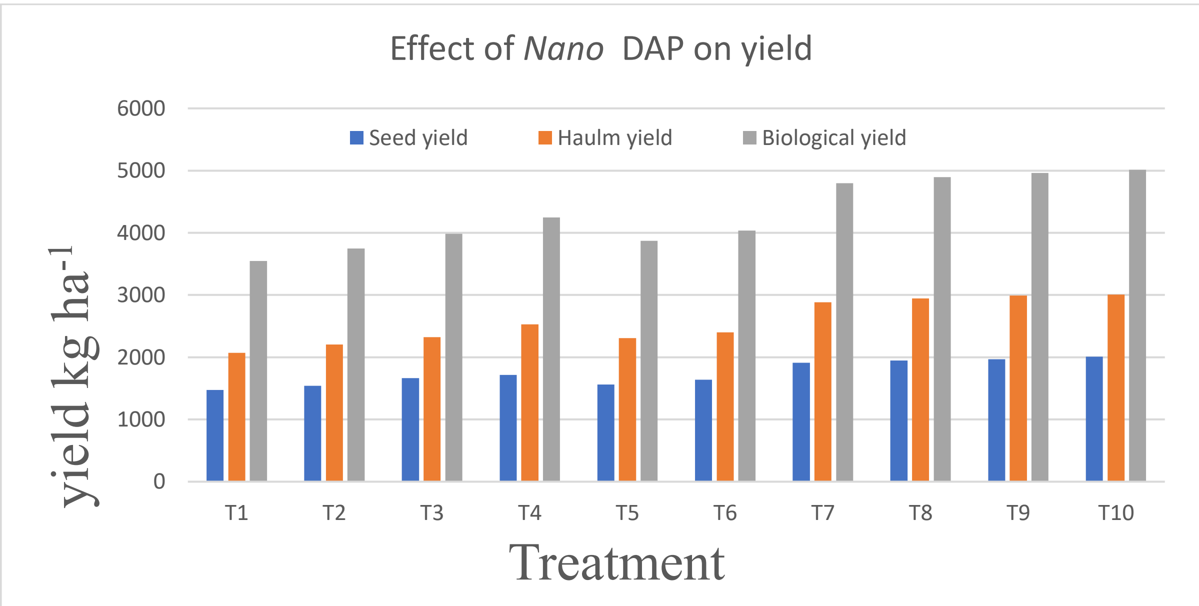
Nano DAP application significantly improved the seed yield, haulm yield and economics of chickpea over the control. The highest seed yield (2009.45 kg ha^{-1}), haulm yield (3005.33 kg ha^{-1}) and biological yield (5014.77 kg ha^{-1}) were recorded under T_{10} (100% RDF + *Nano* DAP seed treatment @ 5 ml kg^{-1} seed + foliar spray @ 4 ml L^{-1} at 30 and 60 DAS). However, T_{10} remained statistically at par with T_7 (1912.99 kg ha^{-1} seed yield and 2881.80 kg ha^{-1} haulm yield), T_8 (1947.99 kg ha^{-1} seed yield and 2944.82 kg ha^{-1} haulm yield) and T_9 (1969.79 kg ha^{-1} seed yield and 2993.24 kg ha^{-1} haulm yield). Among these statistically comparable treatments, T_7 emerged as the most efficient nutrient management practice because it achieved seed and haulm yields comparable to T_8, T_9 and T_{10} with only 75% RDF and a single foliar application of *Nano* DAP, indicating that 25% of the recommended fertilizer dose could be saved without any significant reduction in productivity. The improvement in yield may be attributed to enhanced phosphorus availability, improved nutrient uptake, better root growth, higher photosynthetic efficiency and greater translocation of assimilates towards reproductive organs. Similar findings were reported by Khemshetty *et al*. (2024), Pandao *et al*. (2025), Reddy *et al*. (2025) and Malaviya *et al*. (2025). Economic analysis further revealed that the maximum net return (₹103,735 ha^{-1}) was recorded under T_{10}, whereas the highest benefit-cost ratio (3.30) was observed under T_9 and was statistically comparable with T_7 (3.25). Therefore, considering comparable yield, lower fertilizer requirement, reduced cost of cultivation and higher economic efficiency, T_7 may be recommended as the most practical, economical and sustainable nutrient management practice for chickpea cultivation under the agro-climatic conditions of Southern Rajasthan. Similar findings were reported by Khemshetty *et al*. (2024), Pandao *et al*. (2025), Sarika *et al*. (2025), Abisankar *et al*. (2024) and Pandao *et al*. (2025), who also reported that *Nano* DAP improved phosphorus use efficiency, crop productivity and profitability while reducing the requirement for conventional phosphorus fertilizers.

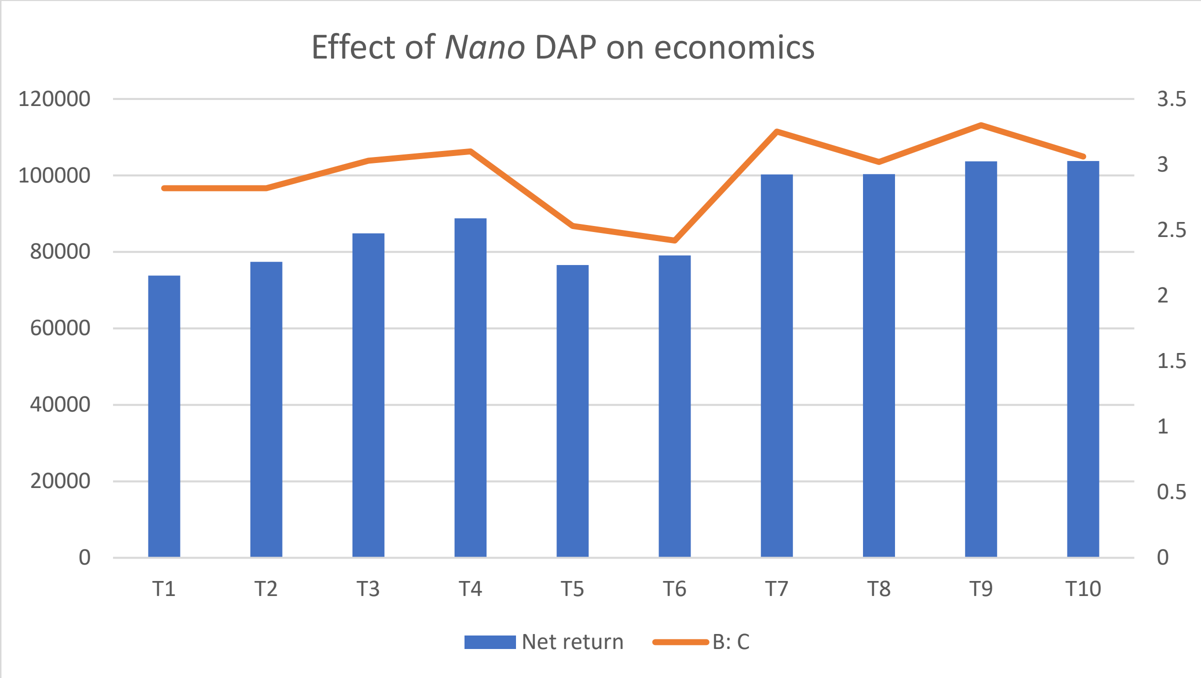
IV. CONCLUSION

The present study demonstrated that *Nano* DAP application significantly improved the seed yield, haulm yield and economic returns of chickpea compared with conventional nutrient management. Although the highest yield and net returns were recorded under T_{10}, treatments T_7, T_8 and T_9 were statistically at par with T_{10}. Among these treatments, T_7 (75% RDF + *Nano* DAP seed treatment @ 5 ml kg^{-1} seed + one foliar spray @ 4 ml L^{-1} at 30 DAS) may be considered the most suitable nutrient management practice, as it achieved comparable productivity with reduced fertilizer input and lower cost of cultivation. Therefore, T_7 can be recommended as an economical, resource-efficient and sustainable nutrient management strategy for chickpea cultivation under the agro-climatic conditions of Southern Rajasthan.

Table 1 Effect of Nano DAP on yield and economics

Treatment		Yield (kg ha^{-1})		Economics	
	Seed	Haulm	Biological	Net Return	B:C
T_1 Control	1472.55	2072.46	3545.01	73783	2.82
T_2 50 % of RDF	1539.16	2207.06	3746.22	77369	2.82
T_3 75 % of RDF	1663.46	2321.46	3984.91	84814	3.03
T_4 100 % RDF	1717.82	2530.78	4248.60	88767	3.10
T_5 T_2 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml litter^{-1} water at 30 DAS	1562.32	2307.29	3869.60	76531	2.53
T_6 T_2 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml liter^{-1} water at 30 and 60 DAS	1636.70	2399.32	4036.03	79100	2.42
T_7 T_3 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml liter^{-1} water at 30 and 60 DAS	1912.99	2881.80	4794.79	100266	3.25
T_8 T_3 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml liter^{-1} water at 30 and 60 DAS	1947.99	2944.82	4892.81	100332	3.02
T_9 T_4 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed treatment foliar spray of *Nano* DAP@ 4 ml liter^{-1} water at 30 DAS	1969.79	2993.24	4963.03	103726	3.30
T_{10} T_4 + Seed treatment with *Nano* DAP@ 5 ml kg^{-1} seed + foliar spray of *Nano* DAP@ 4 ml liter^{-1} water at 30 and 60 DAS	2009.45	3005.33	5014.77	103735	3.06
S.Em. ±	**36.43**	**50.56**	**58.04**	**2119.49**	**0.07**
CD at 5%	**108.24**	**150.21**	**172.46**	**6297.32**	**0.21**





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