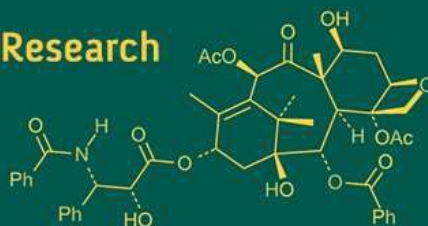


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Response of nano dap on postharvest nutrient status in soil and economics in chickpea (*Cicer kabulium*)

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Abstract

A field experiment was carried out during the *rabi*, 2023-24, on a clay loamy soil at the Agricultural College Farm, Bapatla, to study the effect of nano DAP on the growth and economics of chickpea. The experiment was laid out in a Randomised Block design with eleven treatments and three replications. The results of the investigation that the available N content increased from 176.3 kg ha⁻¹ in control (T₁) to 211.4 kg ha⁻¹ in treatment (T₉). Similarly amount of phosphorus in postharvest soil was affected by different levels of phosphorus fertilisers. The maximum available phosphorus content (34.8 kg ha⁻¹) was available in 100% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₉), and the lowest was recorded (17.5 kg ha⁻¹) in control (T₁). The maximum available K content was registered in (T₉) 100% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (319.1 kg ha⁻¹) and lowest in (T₁) control (292.2 kg ha⁻¹). Among Maximum gross returns (Rs. 145119 ha⁻¹) were registered with 100% P + seed treatment with nano-DAP @ 5 ml per kg seed + nano-DAP spray @ 2.5 ml L⁻¹ (T₉) before flowering which was on parity with T₁₀ i.e., 75% P+seed treatment with nano-DAP @ 5 ml per kg seed + nano-DAP spray @ 2.5 ml L⁻¹ before flowering (Rs. 138053 ha⁻¹). While significantly higher lower gross returns was observed in T₁-control in which no fertilisers were applied Among all the treatments, net returns and B:C ratio was highest in T₉ which was statistically on par with T₃.

Keywords: Dap, seed treatment, fertilisers and nutrient status

1. Introduction

Chickpea, a significant pulse crop, is hampered by water scarcity and nutritional deficiencies in semi-arid regions. Chickpea (*Cicer arietinum* L.), being a major *rabi* pulse crop of India, occupies 35.2% of total area under pulses, contributing to about 49.7% of total pulse production in 2021-22 (Anonymous, 2022) [1]. In Andhra Pradesh, it is grown in an area of 4.51 lakh hectares, producing 4.90 lakh tonnes with a productivity of 1105 kg ha⁻¹ (Anonymous, 2022a) [2]. The natural requirements for nitrogen and phosphorus fertilisers can affect the growth of the chickpea crop. Chickpea, being a leguminous crop, can fix atmospheric Nitrogen. When it comes to phosphorus, a greater amount applied was fixed in the soil (Attiwell and Adams, 1993; Frossard et. al., 2000) [3, 10]. A key plant nutrient that affects cell division, seed germination, blooming, fruiting, fat synthesis and starch is phosphorus. (Rotaru and Sinclair, 2009; Yadav et al., 2017) [21, 27]. Additionally, it participates in a number of biochemical processes, including the control of metabolic pathways and enzyme reactions (Malhotra et al., 2018) [15]. When applied properly, phosphoric fertiliser improves nodulation and facilitates biological nitrogen fixation, which boosts legume growth and yield (Dharwe et al., 2019) [9]. In addition, phosphorus enhances growth and productivity of legumes (Sudharani et al., 2018; Sahu et al., 2020) [26, 22]. Therefore, application of phosphorus is essential to meet the needs at flowering and pod filling. The nutrient source can be either a single fertiliser, a compound fertiliser, or a combination of both, especially for pulse crops. A wide range of agricultural inputs is being used extensively in agricultural techniques worldwide to increase food production. Fertilisers are crucial agricultural inputs that primarily improve crop yields and quality (Babu et al., 2021) [5]. Without the significant use of fertilisers, current agricultural systems are unable to supply the increasing demand for food. But plants are intrinsically incapable of efficiently absorbing and using nutrients. The use of conventional fertilisers has demonstrated a crucial role in maintaining adequate food supplies and cumulative crop yields during the past 60 years.

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By conserving fertiliser resources and boosting crop yields via appropriate nutrient management. Nano fertilisers are incredibly effective for precise nutrient administration in food production (Kumpawat, 2010) [14]. Nano-designed ingredients as fertiliser haulers or staggered proclamation vectors for the construction of "smart fertiliser" as new facilities to enhance nutrient use competence and lower costs of environmental safety (Solanki *et al.*, 2015) [24]. Nano fertilisers are disparagingly imperative for encouraging the advancement of eco-friendly and sustainable agriculture production by decreasing the burden on farmers (Rai *et al.*, 2012; Chhipa, 2017) [17, 6]. Therefore a study was conducted to evaluate the effect on nano DAP on post harvest nutrient status and economics in chickpea.

2. Materials and Methods

A field experiment was carried out, 2023-24, on a clay loamy soil at the Agricultural College Farm, Bapatla. The experimental site is situated at 80° 25' E longitude, 15° 54' N latitude, and at an altitude of 5.49 m and 7 km away from the Bay of Bengal. It is located in the upland coastal area of the Krishna Agro Climatic Zone of Andhra Pradesh. The experiment was laid out in a randomised block design concept and in three replications. The weekly mean maximum and minimum temperatures during the crop period range from 32.8 °C to 28.7 °C and 18.0 °C to 22.5

°C, respectively, while the average maximum and minimum temperatures during the crop growth period were 30.4 °C and 20.1 °C, respectively. The weekly mean relative humidity ranged between 85.73% to 71.73% with an average of 78.7%. A total rainfall of 326.6 mm was received in 5 days during the crop growth period. Composite soil samples from the experimental site were collected from 0-30 cm depth before experimentation. The soil samples were thoroughly mixed and then kept for air drying. A representative soil sample of about 1 kg was drawn by the quartering method. The soil sample was analysed for different physical and physicochemical properties. The soil of the experimental site was classified as clay loam in texture, neutral in reaction, E.C. was non-saline in nature and below the critical point, low in organic carbon, low in available nitrogen (190 kg ha⁻¹), and medium in available phosphorus (24.6 kg ha⁻¹) and high in potassium (305 kg ha⁻¹). The Recommended Dose of Fertilizer (RDF) for chickpea was 20:50:0 kg N: P₂O₅:K₂O ha⁻¹. N and P₂O₅ were applied in different doses by means of urea and diammonium phosphate, respectively. The recommended dosage of nano DAP used 500 ml acre⁻¹, applied as seed treatment and spraying before flowering. However, seed treatment and application of foliar sprays of nano DAP were given in selected treatments only. The following table shows the treatments in the experiment Treatments (Table-1).

Table 1: Treatments of the Experiment

S. No	Treatments
T ₁	Control
T ₂	100% P
T ₃	100% P+nano DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₄	75% P+nano DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₅	50% P+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₆	Nano-DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₇	Seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed
T ₈	Seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₉	100% P+seed treatment with nano-DAP @ 5 ml kg seed+ nano-DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₁₀	75% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+ nano-DAP spray @ 2.5 ml L ⁻¹ before flowering
T ₁₁	50% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+ nano-DAP spray @ 2.5 ml L ⁻¹ before flowering

Gross return (Rs) = Value of the product (seed + haulm)

Net return (Rs) = Gross income ha⁻¹ (Rs)-Cost of Cultivation (Rs)

$$\text{Benefit-cost ratio} = \frac{\text{Gross return (Rs)}}{\text{Cost of Cultivation (Rs)}}$$

3. Results and Discussion

3.1 Post-harvest soil N, P₂O₅, and K₂O status as influenced by application of Nano DAP

The data about post-harvest soil N, P₂O₅, and K₂O are shown in Table 2 *i.e.*, NPK availability (kg ha⁻¹) in soil after harvest of chickpea as influenced by the application of nano DAP. The available N content increased from 176.3 kg ha⁻¹ in control (T₁) to 211.4 kg ha⁻¹ in treatment (T₉), 100% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering. Similarly amount

of phosphorus in postharvest soil was affected by different levels of phosphorus fertilisers. The maximum available phosphorus content (34.8 kg ha⁻¹) was available in 100% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₉), and the lowest was recorded (17.5 kg ha⁻¹) in control (T₁). The maximum available K content was registered in (T₉) 100% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (319.1 kg ha⁻¹) and lowest in (T₁) control (292.2 kg ha⁻¹) might be due to foliar application of nano fertilisers plus soil application of traditional fertilisers might led to increased levels of accessible nutrients after the fulfilment of the crop's nutritional needs at various phases of development. These results are in close conformity to the findings of Choudhary *et al.* (2014) [8] and Hasaneen *et al.* (2016) [11] along with the results of Rajonee *et al.* (2017) [18].

Table 2: NPK availability (kg ha⁻¹) in soil after harvest of chickpea as influenced by the application of nano DAP

Treatments	Available N (kg ha ⁻¹)	Available P ₂ O ₅ (kg ha ⁻¹)	Available K ₂ O (kg ha ⁻¹)
T ₁ : Control	176.3	17.5	292.2
T ₂ : 100% P	200.2	27.4	316.7
T ₃ : 100% P+nano DAP spray @ 2.5 ml L ⁻¹ before flowering	205.5	30.4	318.0
T ₄ : 75% P+nano DAP spray @ 2.5 ml L ⁻¹ before flowering	201.1	29.0	312.3
T ₅ : 50% P+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	195.1	23.2	306.7
T ₆ : Nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	186.3	20.2	301.3
T ₇ : Seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed	184.2	20.8	302.3
T ₈ : Seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	192.3	21.5	306.2
T ₉ :100% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	211.4	34.8	319.1
T ₁₀ :75% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	206.7	32.2	317.3
T ₁₁ :50% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	197.4	25.6	309.7
SEm (±)	9.0	1.2	15.05
CD (P = 0.05)	NS	3.5	NS
CV (%)	7.9	8.1	8.4

3.2 Economics

3.2.1 Gross returns (Rs ha⁻¹)

Maximum gross returns (Rs. 145119 ha⁻¹) were registered with 100% P+seed treatment with nano-DAP @ 5 ml per kg seed+nano-DAP spray @ 2.5 ml L⁻¹ (T₉) before flowering, which was on parity with T₁₀, i.e., 75% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (Rs.138053 ha⁻¹). The next best treatments, which recorded higher gross returns, were 100% P+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₃), which was, however, comparable with 75% P+nano DAP spray @ 2.5 ml L⁻¹ before flowering (T₄). While significantly lower gross returns (Rs 42088 ha⁻¹) were observed in the (T₁) control, in which no fertilisers were applied, this was significantly lower than all the treatments. The significant increase in gross returns might be due to higher seed yield and haulm yield in the treatments in which nano DAP performed well. The increase in yield attributes such as number of branches per plant, pods per branch, and number of seeds per plant resulted in a higher yield that in turn increased gross returns. Increased yields immediately result in higher overall gross monetary rewards are significantly influenced by output. By improving nitrogen absorption efficiency, foliar spray can reduce total fertiliser inputs without compromising production. This efficiency has a beneficial impact on gross monetary returns by lowering the cost per unit of yield. The results are in conformity with Rawat (2017) [20]. Similar observations were recorded by Jadhav *et al.* (2021) [12].

3.2.2 Net returns (Rs ha⁻¹)

Net returns were the actual profit that could be attained

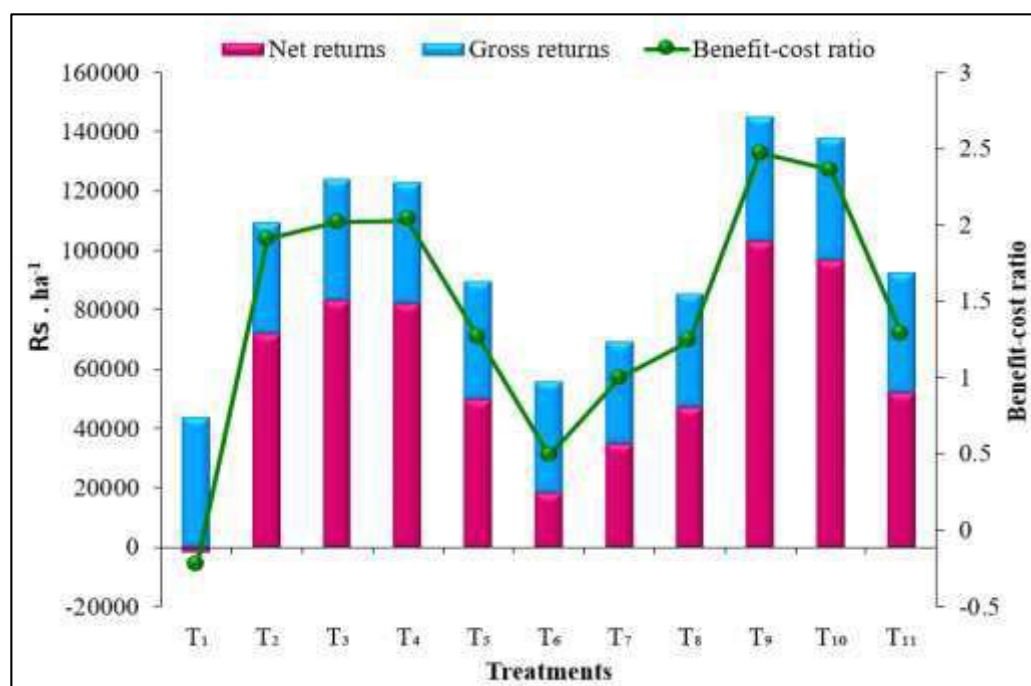
under particular treatments. The data depicted in Table 3 i.e., Gross returns (Rs ha⁻¹), net returns (Rs ha⁻¹) and B-C ratio of chickpea as influenced by the application of nano DAP and Figure 1. As regards, significantly higher net returns (Rs 103344 ha⁻¹) were realised with 100% P + seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₉), which was on par with 75% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before (T₁₀). Significantly lower net returns (Rs-1782 ha⁻¹) were recorded in control (T₁) due to lower yields.

3.2.3 Benefit-cost ratio

The B-C ratio of chickpea shows a statistically detectable magnitude due to the application of nano DAP, depicted in Table 3 i.e., Gross returns (Rs ha⁻¹), net returns (Rs ha⁻¹) and B-C ratio of chickpea as influenced by the application of nano DAP and Figure 1. Significantly higher B-C (2.47) was registered with 100% P+seed treatment with nano DAP @ 5 ml kg⁻¹ seed + nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₉), which was, however, comparable with 75% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₁₀). The B-C ratio was negative (-0.23) and recorded a minimum in (T₁) Control. These findings are corroborative with the findings of Srivastava *et al.* (2017) [25] and Prakash *et al.* (2023) [16]. These are also supported by findings of Hence high yields and low cost contributed to increased B:C ratio for chickpea crop. Similar observations were recorded by Rajput *et al.* (2022) [19] and Sathyan *et al.* (2022) [23], Chinnappa *et al.* (2023) [7], Attri *et al.* (2023) [4] and Jagadeesh *et al.* (2024) [13].

Table 3. Gross returns (Rs ha⁻¹), net returns (Rs ha⁻¹) and B-C ratio of chickpea as influenced by the application of nano DAP

Treatments	Gross returns (Rs ha ⁻¹)	Net returns (Rs ha ⁻¹)	B-C Ratio
T ₁ : Control	42088	-1782	-0.23
T ₂ : 100% P	109746	71971	1.91
T ₃ : 100% P + nano DAP spray @ 2.5 ml L ⁻¹ before flowering	124359	83184	2.02
T ₄ : 75% P + nano DAP spray @ 2.5 ml L ⁻¹ before flowering	122877	82370	2.03
T ₅ : 50% P + nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	89865	50027	1.26
T ₆ : Nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	55929	18428	0.49
T ₇ : Seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed	69547	34846	1.00
T ₈ : Seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	85392	47291	1.24
T ₉ : 100% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	145119	103344	2.47
T ₁₀ : 75% P+seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	138053	96946	2.36
T ₁₁ : 50% P +seed treatment with nano-DAP @ 5 ml kg ⁻¹ seed+nano-DAP spray @ 2.5 ml L ⁻¹ before flowering	92664	52226	1.29
SEm (±)	4515	4515	0.12
CD (P = 0.05)	13244	13244	0.35
CV (%)	8.0	13.3	14.1

**Fig 1:** Gross returns, net returns, and B-C ratio of chickpea as influenced by application of nano DAP

4. Conclusion

Combined application of nano Dap and conventional Dap (T₉) 100% P+seed treatment with nano-DAP @ 5 ml kg⁻¹ seed+nano-DAP spray @ 2.5 ml L⁻¹ before flowering (T₉) recorded maximum available phosphorus content (34.8 kg ha⁻¹) and the lowest was recorded (17.5 kg ha⁻¹) in control (T₁). Maximum gross returns, net returns and B-C ratio were registered with 100% P + seed treatment with nano-DAP @ 5 ml per kg seed + nano-DAP spray @ 2.5 ml L⁻¹ (T₉) before flowering which was on parity with T₁₀.

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