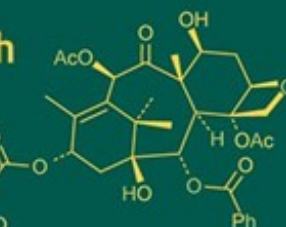
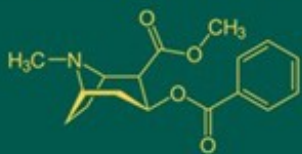


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Influence of nano urea foliar spray on growth, yield and economics of sunflower

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ABSTRACT

A field experiment was carried out during rabi season, 2024-25 at Agricultural Research Station, Tornala, PJTAU, Siddipet district, Telangana, to study the response of nano urea on growth and yield attributes and yield of sunflower. The experiment was laid out in Randomized Block Design (RBD) with eight treatments replicated thrice. The results revealed that the growth and yield attributes of sunflower influenced significantly due to the different treatments. Significantly higher seed yield of sunflower was recorded in treatment RDN through urea (basal + 45 DAS (1625 kg ha⁻¹) followed by treatment 50% RDN through urea as basal + nano urea @ 3 ml L⁻¹ at 45 DAS (1473 kg ha⁻¹) and on par with treatment 50% RDN through urea as basal + nano urea @ 2 ml L⁻¹ at 45 DAS (1454 kg ha⁻¹) when compared to other treatment. The same treatment exhibited higher gross returns (₹ 1,18,300 ha⁻¹), net return (₹ 60020 ha⁻¹) and B:C ratio (2.03).

Keywords: Sunflower, Nano urea, Foliar sprays, Growth and yield attributes, Seed yield

Introduction

Sunflower (*Helianthus annuus* L.) is an edible, short duration and photo insensitive oilseed crop in India which produces good quality oil (40–45%) and protein (16%) (Guhan *et al.*, 2026) [1]. It is cultivated on about 1.51 lakh hectares with a production of 1.73 lakh tonnes and a productivity of 1144 kg ha⁻¹ in India and 0.100 lakh hectares producing 0.283 lakh tonnes with an average productivity of 2833 kg ha⁻¹ in Telangana, demonstrating its potential under suitable conditions (Indiastat, 2023–2024). It is highly adaptable to different soils and agro-climatic conditions, tolerant to drought and suitable for diversified cropping systems due to its deep root system and high seed multiplication ratio. However, despite these advantages, productivity in India remains suboptimal due to factors such as moisture stress, climatic variability and inefficient nutrient management (Rath *et al.*, 2022) [2].

Among major nutrients, nitrogen is one of essential nutrient for plant growth and development. Nitrogen application increased vegetative growth of plant. Nutrients, when applied as a foliar spray, are taken up by the plants through its foliage and absorbed in the cell sap and circulated in the plant body. They activate several enzymes or biological reactions in plant tissue (Singh *et al.*, 2026) [3].

Nitrogen deficiency is probably the most important nutritional limitation to sunflower production worldwide. Conventional fertilizer practices are often associated with low nutrient use efficiency, with 40–70% of nitrogen lost through leaching, volatilization and fixation before plant uptake. These losses not only reduce crop yield and farm profitability but also contribute to environmental degradation (Reddy *et al.*, 2026) [4]. Foliar application of nutrients has emerged as an effective strategy to overcome soil-related nutrient losses and improve nutrient use efficiency.

In this context, nanotechnology has emerged as a promising approach in modern agriculture. Nanofertilizers are actually nutrient carriers of nano size which usually ranges from 30–40 nm. They are capable of holding nutrient ions because of their high surface area, sorption capacity, controlled-release kinetics to targeted sites, slow release ability, thus improving nutrient use efficiency and preventing the ions to get fixed or lost in the environment and have been considered as smart delivery system (Rameshaiah *et al.*, 2015; Solanki *et al.*, 2015; Reddy, 2021) [5, 6].

Nano urea is a liquid formulation consisting of nano-sized nitrogen particles, usually smaller than 20–30 nm, designed to enhance foliar absorption and systemic translocation within the plant system. Unlike conventional urea, which is susceptible to volatilization and leaching losses, nano urea adheres well to leaf surfaces and enters plant cells through stomatal openings or cuticular pathways, thereby improving nitrogen availability and reducing environmental losses (Adhikari *et al.*, 2023; Kumar *et al.*, 2021) [7, 8].

Studies have reported that nano urea can enhance photosynthetic efficiency, stomatal conductance and water use efficiency while potentially reducing overall nitrogen application by 25–50 per cent without compromising crop yields (Maheta *et al.*, 2023; Raliya *et al.*, 2017) [9, 10]. Considering the importance of nitrogen in sunflower production and the limitations associated with conventional fertilizers, the use of nano-based nu

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trient sources offers a promising alternative for improving crop productivity and sustainability. Therefore, the present investigation was undertaken to evaluate the effect of nano urea on the growth, yield attributes and productivity of sunflower.

Materials and Methods

The experiment entitled “Effect of nano urea on growth, yield and nutrient use efficiency of sunflower” was carried out at Agriculture Research Station, Tornala, Siddipet district, Telangana state, India during *rabi*, 2024-25. The experimental field is geographically located in a semi-arid zone with a sandy loam soil texture of *Alfisols*. The field is geographically located at a latitude of 18°07'07.04" N and a longitude of 78°44'32.50" E, with an altitude of 579.96 m above mean sea level. The initial experimental soil test analysis as per standard procedure revealed that the soil was low in available nitrogen (138 kg ha⁻¹) (Subbaiah *et al.*, 1956) [11], medium in phosphorus (68 kg ha⁻¹) (Olsen *et al.*, 1954) [12] and potassium (262 kg ha⁻¹) (Jackson, 1973) [13]. The experimental trial was laid out in randomized block design (RBD) with eight treatments and replicated thrice. The details of the treatment were as follows: T₁: 50% RDN through urea as basal + nano urea @ 1 ml L⁻¹ at 45 DAS, T₂: 50% RDN through urea as basal + nano urea @ 2 ml L⁻¹ at 45 DAS, T₃: 50% RDN through urea as basal + nano urea @ 3 ml L⁻¹ at 45 DAS, T₄: 50% RDN through urea as basal + nano urea @ 4 ml L⁻¹ at 45 DAS, T₅: 50% RDN through urea as basal + urea spray @ 2% at 45 DAS, T₆: RDN through urea (basal + 45 DAS), T₇: Nano urea @ 2 ml L⁻¹ at 15, 30 and 45 DAS and T₈: Nitrogen free control (*RDN : Recommended dose of nitrogen).

The sunflower hybrid (Tillhantech SUNH-1) was sown with a spacing of 60 cm x 30 cm. Land was prepared once with a disc plough (primary tillage), followed by cultivator and rotovator (secondary tillage). A uniform fertilizer dose of 90 kg phosphorus (P₂O₅) + 30 kg K₂O ha⁻¹ was applied across all treatment plots. The entire dose of P₂O₅ and half of the dose of K₂O were applied as basal dose and remaining half dose of potassium was top dressed at 55 DAS. Nitrogen was applied in form of urea as basal and foliar spray of nano urea as per treatment protocol. Weed management is carried by hoeing between the crop rows at 20 DAS and 40 DAS. All recommended agronomic practices and need based plant protection measures were followed to ensure a healthy crop. Other agronomic practices were followed according to the recommendations of Professor Jayashankar Telangana Agricultural University.

Five plants were randomly selected and tagged in each experimental plot for recording observations on phenological events following the methodology of Patel *et al.* (1987) [14].

Data pertaining to crop growth, growth parameters, yield attributes and yield were recorded from each treatment. Seed yield for each treatment was measured at harvest and expressed in kg ha⁻¹. The recorded data were systematically tabulated and statistically analysed following the procedures outlined by Panse *et al.* (1967) [15].

Results

Effect of nano urea foliar spray on growth attributes of sunflower

Significant difference in growth attributes was observed across the treatments and depicted in Table 1. The highest plant height was observed in T₄ - 50% RDN through urea as basal + nano urea @ 4 ml L⁻¹ (159.3 cm) and was comparable with T₁ (156.1 cm), T₂ (153 cm) and T₃ (152 cm). While nitrogen free control (T₈) treatment recorded lower plant height (140 cm) when compared with other treatments. Among the different treatments, application of 50% RDN through urea as basal + nano urea @ 3 ml L⁻¹ (T₃) exhibited highest stem girth (7.4 cm) and on par with T₂, T₄ and T₆ (7.2 cm each respectively). This might be due to enhanced nutrient uptake resulting stimulated chlorophyll biosynthesis, photosynthesis, enzymatic activity, and auxin metabolism, thereby promoting cell enlargement and elongation and ultimately increasing growth parameters *viz.*, plant height

and stem girth. These findings are consistent with the observations of Rajanikanthreddy *et al.* (2025) and Vyankatrao *et al.* (2024) [16].

Effect of nano urea foliar spray on yield parameters of sunflower

Results from Table 1 showed significant differences among yield parameters and yield of sunflower by different treatments. Among the different treatments, the maximum head diameter was recorded in T₇- Nano urea @ 2 ml L⁻¹ (12.1 cm) and comparable with T₁ (11.5 cm) and followed by T₅ (11.2 cm). Whereas, highest test weight was recorded with T₄ - 50% RDN through urea as basal + nano urea @ 4 ml L⁻¹ (6 g) and on par with all the other treatments except T₈- nitrogen free control (4.2 g). While, the treatments comprising of nitrogen basal application and nano urea foliar spray showed similar results in regards to volume weight of sunflower. Treatment T₁ - 50% RDN through urea as basal + nano urea @ 1 ml L⁻¹ exhibited maximum volume weight (43.2 g 100 ml⁻¹) and comparable with all other treatments except T₇ and T₈ (35.3 and 33.3 g 100 ml⁻¹) respectively. The improvement in yield attributes may be attributed to the balanced supply of essential nutrients, which likely enhanced photosynthetic efficiency and promoted the translocation of photosynthates towards developing seeds, thereby facilitating better seed filling. The application of nano-fertilizers may have further enhanced nutrient-use efficiency by improving nutrient availability and uptake, thereby supporting efficient seed development and contributing to the observed improvement in yield attributes. Similar observations were reported by Devi *et al.* (2024) [17], Roy *et al.* (2024) [18] and Bhakher *et al.* (2023) [19].

Effect of nano urea foliar spray on yield of sunflower

From the data of Table 1, it was evident that seed yield of sunflower was significantly maximum with T₆ - application of 100% conventional N fertilizer through urea (basal and 45 DAS) (1625 kg ha⁻¹) which was superior over the rest of the treatments. This was followed by 50% RDN through urea + nano urea @ 3 ml L⁻¹ at 45 DAS (1473 kg ha⁻¹) and 50% RDN through urea + nano urea @ 2 ml L⁻¹ at 45 DAS (1454 kg ha⁻¹). The lowest seed yield was obtained in the treatment T₈ - nitrogen free control (1115 kg ha⁻¹). Improved nitrogen availability resulting from the recommended dose of inorganic fertilizers during the seedling and grand vegetative stages might have stimulated vegetative growth and dry matter accumulation, with efficient partitioning of assimilates subsequently enhancing yield components and seed yield. Similar results have been observed by Mollashahi *et al.* (2013) [20] also reported that the application of RDF affects the development and growth of both source and sink.

Economics

The data pertaining to economics in terms of cost of cultivation, gross returns, net returns and benefit cost ratio as influenced by fertilizer treatments were presented in Table 1. Among different treatments, highest cost of cultivation was registered with T₇ - nano urea @ 2 ml L⁻¹ at various stages (15, 30 and 45 DAS) (₹ 59000 ha⁻¹). Maximum gross returns (₹ 1,18,300 ha⁻¹), net returns (₹ 60020 ha⁻¹) and benefit cost ratio (2.03) were observed T₆ - application of 100% conventional N fertilizer through urea (basal and 45 DAS) followed by T₃ - 50% RDN through urea + nano urea @ 3 ml L⁻¹ at 45 DAS (₹ 1,07,234 ha⁻¹, ₹ 48,594 ha⁻¹ and 1.83) respectively. The T₆ recorded higher seed yield which in turn resulted in higher monetary returns in term of gross and returns and benefit-cost ratio. Whereas, nitrogen free control treatment registered lower gross returns (₹ 81,172 ha⁻¹), net returns (₹ 23,732 ha⁻¹) and benefit cost ratio (1.41). The present results were in accordance with the findings of Dambale *et al.* (2018) [21].

Conclusion

From the present study, considering the overall growth, productivity (1625 kg ha⁻¹) and profitability (₹. 60020 ha⁻¹) conventional use of nitrogen fertilizer with urea 75 kg ha⁻¹ can be practiced in sunflower. However, during scarce supply of urea, 50% RDN through urea in

conjunction with 3 ml L⁻¹ nano urea spraying at 45 DAS can be practiced for higher productivity and profitability in sunflower.

Table 1. Effect of nano urea foliar spray on growth, yield attributes, yield and economic of *rabi* Sunflower

Treatments	Plant height (cm)	Stem girth (cm)	Head diameter (cm)	100 seed weight (g)	Volume weight (g 100 ml ⁻¹)	Seed yield (kg ha ⁻¹)	Cost of cultivation (₹. ha ⁻¹)	Gross returns (₹. ha ⁻¹)	Net returns (₹. ha ⁻¹)	B:C ratio
T ₁ : 50% RDN through urea as basal + nano urea @ 1 ml L ⁻¹ at 45 DAS	156.1	6.6	11.5	5.0	43.2	1306	58120	95077	36957	1.64
T ₂ : 50% RDN through urea as basal + nano urea @ 2 ml L ⁻¹ at 45 DAS	153.0	7.2	10.7	5.3	42.8	1454	58380	105851	47471	1.81
T ₃ : 50% RDN through urea as basal + nano urea @ 3 ml L ⁻¹ at 45 DAS	152.0	7.4	9.7	5.5	39.8	1473	58640	107234	48594	1.83
T ₄ : 50% RDN through urea as basal + nano urea @ 4 ml L ⁻¹ at 45 DAS	159.3	7.2	9.8	6.0	42.3	1389	58900	101119	42219	1.72
T ₅ : 50% RDN through urea as basal + urea spray @ 2% at 45 DAS	146.7	6.7	11.2	5.5	41.0	1368	57882	99590	41708	1.72
T ₆ : RDN through urea (basal + 45 DAS)	144.7	7.2	10.8	5.9	42.3	1625	58280	118300	60020	2.03
T ₇ : Nano urea @ 2 ml L ⁻¹ at 15, 30 and 45 DAS	145.3	6.5	12.1	5.8	35.3	1243	59000	90490	31490	1.53
T ₈ : Nitrogen free control	140.0	6.9	10.3	4.2	33.3	1115	57440	81172	23732	1.41
SEm (±)	2.4	0.1	0.2	0.3	1.7	27				
CD(p = 0.05)	7.5	0.4	0.7	0.9	5.4	82				

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