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Nitrogen management in sesame (Sesamum Indicum) through Nano-Urea supplementation

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Abstract
A field experiment entitled "Nitrogen Management in Sesame (*Sesamum indicum*) through Nano-Urea Supplementation" was conducted at School of Agricultural Sciences, JRNRVU, Dabok, Udaipur during *kharif* season 2025. The experiment consisted of fifteen treatment combination comprising three nitrogen levels *viz.* N_1; control, N_2; 75% RDN, N_3; 100% RDN and five levels of foliar nitrogen supplementation *viz.* F_1; water spray, F_2; one foliar spray of nano urea 4 ml L^{-1}, F_3; two foliar sprays of nano urea 4 ml L^{-1}, F_4; one foliar spray of nano urea 8 ml L^{-1} and F_5; two foliar sprays of nano urea 8 ml L^{-1}. Combinations of these treatments were evaluated under split plot design with four replications. Sesame variety RT-372 was used as a test crop. On the basis of results, it is recommended that sesame should be fertilized with 30 kg N ha^{-1} along with one foliar spray of nano urea @ 8 ml L^{-1} for achieving higher productivity and better economic profitability under the agro climatic zone IV-A (Sub Humid Southern Plain and Aravali Hills of Rajasthan).

Keywords: Sesame, rdn, foliar spray, nano urea, growth, yield

Introduction
Sesame (*Sesamum indicum*), locally known as *Til*, is one of the most important oil purpose non-legume, *kharif* crop grown for oilseeds production because of its excellent growth characters and economic source of dietary energy. Sesame is also known as poor man's substitute for ghee. It is a self-pollinated crop having chromosome number 2n=26. Sesame exhibits drought resistant and can reach height of 3-5 feet or even taller, featuring white and occasionally pink blossom. The yield potential of sesame crop for seed production makes it a highly priced crop. In India, it is mainly grown in Gujarat, West Bengal, Rajasthan, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Telangana, Maharashtra, Tamil Nadu and Karnataka where favorable climatic conditions are available. Its popularity among the farmers as an oilseed crop in the agro-climatic zone IV A 'Sub Humid Southern Plain' and Aravali Hills of Rajasthan is increasing because of excellent growth habit. It provides good quality oilseeds production during October-November. Sesame seed cakes are used as livestock feed. Sesame contains about 10-12% protein, 50-52% edible oil, 14-16% sugar, 5-7% essential mineral, such as calcium, phosphorus, iron, zinc, magnesium and supply abundant quantity of vitamin A, B_1, B_2 and E, dietary fiber. Sesame provides 6355 kcal energy kg^{-1} seeds. Sesame is now preferred as a functional food rich source of antioxidants, such as niacin, methionine, sesamol, sesamolin, sesamin, sesaminol, linolic acid having anti-aging properties and controls blood cholesterol level. The importance of sesame in the biochemical and cosmetic industry is also on the rise.
According to Indian Institute of Oilseed Research, sesame crop in the year 2021 occupies 3.05 lakh hectare area with a production of 12.59 MT and average seed yield of 412 kg ha^{-1} in Rajasthan. In the same year, sesame occupies an area of 20 lakh hectare with a production of 80 MT and the average yield of 413 kg ha^{-1} in India. IIOR (2023).
Nitrogenous fertilizer is the most important factor which influences both productivity and quality in sesame crop. It improves the quality by increasing the protein content in oilseed crops and governs to a considerable degree, the utilization of phosphorus, potassium and other essential nutrient elements (Goswami *et al.*, 2025) [4]. Since nitrogen is constituent of amino acid and deficiency of nitrogen in oilseed crops may cause severe diseases in sesame crop (Reddy *et al.*, 2021) [16]. Use of recently invented liquid fertilizer called "nano urea" in

place of more conventional nitrogen fertilizers *i.e.* urea can be economically viable for the farmers. Nano urea is a liquid fertilizer sprayed at critical crop growth stages when crop canopy is suitably developed for proper intake of foliar nutrients (Sruthi *et al.* 2022) [22]. Considering the above facts, an investigation is planned.

Materials and Methods

This zone possesses typical sub-tropical climatic conditions characterized by mild winters and moderate summers associated with high relative humidity during the months of June to September. The mean annual rainfall of Udaipur is 631 mm ± 184 mm received in 33 rainy days, most of which is contributed by south west monsoon from June to September. An analysis of weather data reveals that maximum and minimum temperature ranged between 28.8 to 31.9 ºC and 17.8 to 24.5 ºC during *kharif*-2025. Mean weekly maximum and minimum relative humidity ranged between 70.7 to 91.9 per cent and 58.6 to 80.9 per cent during *kharif*-2025. The mean wind speed ranges from 3.0 to 5.6 km h^{-1}. The lowest sunshine hours of 1.0 was recorded during SMW 34. The daily evaporation was ranged from 5.6 to 9.2 mm day^{-1}. Total rainfall of 112.6 mm in two rainy days was recorded in SMW 35 and 36, during crop season. The analytical results shows that soil of the experimental field was clay loam in texture, slightly alkaline in reaction (pH 7.6), low in organic carbon (0.47%), available nitrogen (174.0 kg ha^{-1}, while medium in available phosphorus (22.2 kg P_2O_5 ha^{-1}) and potassium (325.0 kg K_2O ha^{-1}). Sesame variety RT-372 was sown on 18th July, 2025 at a spacing of 30 cm x 10 cm. The calculated amount of nitrogen (40 kg ha^{-1}) as per treatment was applied through urea. Half dose of nitrogen applied in furrows at the time of sowing and remaining nitrogen was applied as top dressing at 30 DAS. Full dose of P_2O_5 (25 kg ha^{-1}) was applied at the time of sowing through single super phosphate. With respect to foliar spray of nano urea 4 ml and 8 ml L^{-1} was done at 30 DAS and 45 DAS. One prophylactic measure was taken by spraying of insecticide (Apache: Fipronil 15% + Flonicamid 15% WDG) + fungicide (Himil: Mencozeb 64 % + Metalaxyl 8% WP) at 56 DAS @ 500 ml ha^{-1} during capsule development stage. Harvesting of crop was performed on 14th October, 2025, followed by threshing and winnowing on 20th November, 2025.

Results and Discussion

The results of present investigation are presented with the help of tables and illustrations. The data recorded for important characters also have been graphically presented wherever; it was felt necessary for a well understanding of the important findings. The analysis of variance for all these data has been presented.

Growth attributes

Effect of nitrogen levels

The data in Table 1 revealed that application of 100% RDN significantly increased growth attributes of sesame. Application of 100% RDN resulted in maximum plant height at harvest (102.8 cm) which was significantly higher over control and 75% RDN. The highest dry matter accumulation at harvest (51.8 g $plant^{-1}$) was observed with application of 100% RDN which was remarkably higher over control and 75% RDN. The highest crop growth rate at 60 DAS- harvest (39.6 g m^{-2} day^{-1}) was recorded with 100% RDN which was significantly superior over control but at par with 75% RDN. The maximum number of branches $plant^{-1}$ at harvest (3.5) was observed with application of 100% RDN which was significantly superior over control and 75% RDN. It can be ascribed to increased nutrient availability in the root zone for crop development. The current study's findings are consistent with those of Ogundare *et al.* (2015) [12]. in sesame, who reported increased plant height, dry matter accumulation and number of branches $plant^{-1}$ as a result of increasing nitrogen dose to the recommended level. The significant and positive correlation existed between seed yield (kg ha^{-1}) and CGR at 60 DAS-harvest (r=0.982). Also, the significant and positive correlation was observed between stover yield (kg ha^{-1}) and plant height at harvest (r=0.931), Dry matter accumulation at harvest (r=0.959), number of branches $plant^{-1}$ (r=0.869), respectively. The results are in close agreement with the findings of Sarkar *et al.* (2010) [17], Reddy *et al.* (2021) [16]. and Kumar *et al.* (2022) [8]. in sesame.

Effect of Nano urea

The data (Table 1) showed the growth attributes of sesame *viz.* highest dry matter accumulation (45.5 g $plant^{-1}$) at harvest, crop growth rate (34.6 g $plant^{-1}$) at 60 DAS-harvest and number of branches (2.7 $plant^{-1}$) at harvest increased due to application of two foliar sprays of urea 8 ml L^{-1} which was remarkably higher over control but at par with one foliar spray of nano urea 8 ml L^{-1}. The foliar sprays of nano urea failed to increase plant height of sesame at several stages of growth period. The integration of the most effective application technique, foliar sprays and the provision of nutrients by single super phosphate, urea and nano urea fertilizers with the most effective nutrient delivery systems has led to an increase in the growth of the sesame. Nano urea applied topically to leaves that allow nitrogen to enter primarily through the stomata and cuticles. Rajpurohit *et al.* (2024) [14] at Udaipur concluded that highest plant height and dry matter accumulation at several growth stages of chickpea, number of nodules $plant^{-1}$ and secondary branches $plant^{-1}$ were significantly higher with the application of 75% RDF + nano DAP 4 ml L^{-1} + PSB as compared to other treatments. Sharma *et al.* (2022) [18]. reported ability of nano-particles to enter plant cells and leaves which accelerate growth and development in mustard. The importance of nitrogen in plants as a primary element of amino acids, proteins, vitamins, hormones and enzymes that immediately affect cell division and cell elongation, increase meristematic activity causes increase in internodal length and increase in plant height can be used to recognize the effect of nano nitrogen was clearly seen in growth and development of plants. Krantikumar *et al.* (2025) [7]. Reddy *et al.* (2021) [16]. reported that exogenous application of some nano-particles can significantly enhance plant growth and development of sesame. Foliar application of nano-urea resulted in highest plant height which may be attributed due to enhanced absorption or assistance in transport of plant nutrients that increases the cell division capacity and cell protein content. Combined use of conventional fertilizers with nano based fertilizers, stimulate the root and shoot development, which eventually reflect in enhanced plant height.

Yield attributes

Effect of nitrogen levels

The data presented in Table 1 revealed that yield attributes of sesame maximum number of capsule plant^{-1} (56.0), number of seeds capsule^{-1} (57.0) and seed yield plant^{-1} (1.463 g) were observed with the application of 100% RDN remarkably higher over control and 75% RDN. The highest 1000-seed weight (3.43 g) was noted with 100% RDN which was significantly higher over control but at par with 75% RDN. As seed and capsule production is predominantly determined by the cumulative influence of yield determining characters. These results are in close agreement with the findings of Shehu *et al.* (2010) [19], Barik *et al.* (2011) [2], Vani *et al.* (2017) [23]. and Sruthi *et al.* (2022) [22]. h in sesame. The significant and positive correlation between seed yield (kg ha^{-1}) and seed yield plant^{-1} (r=0.974), number of capsule plant^{-1} (r=0.850), 1000-seed weight (r=0.954), number of seeds capsule^{-1} (r=0.865) existed under present investigation.

Effect of nano urea

It is evident the results (Table 1) show that effect of two foliar sprays of nano urea 8 ml L^{-1} gave higher yield attributes of sesame *viz.* number of capsules plant^{-1} (41.5 plant^{-1}), number of seeds capsule^{-1} (49.7), 1000-seed weight (3.04 g) and seed yield plant^{-1} (1.248 g) superior over rest of the treatments. Nano nitrogen increased yield attributes of sesame as a result of nano size having high surface area to volume ratio which facilitates faster absorption of nutrients and reduces leaching losses which increase the use of efficiency of nitrogen in sesame (Meena *et al.*, 2017) [9]. The increase in yield attributes with nano-urea spray may be attributed that nano-urea promotes the overall plant growth and enhances nutrient uptake, improve photosynthesis rate and biological efficiency which reflected as improved contributing traits (Wang *et al.*, 2014) [24]. Acharya *et al.* (2024) [1]. at Udaipur observed that higher yield attributes *viz.* number of siliqua plant^{-1}, number of seed siliqua^{-1}, length of siliqua, 1000-seed weight of mustard were recorded under 75% RDN + nano urea 6 ml L^{-1} which was significantly superior over rest of the treatments. Myint *et al.* (2020) [11]. also reported that application of nano fertilizers as foliar sprays significantly increase the yield of sesame.

Table 1: Effect of nitrogen levels and nano urea on growth and yield attributes of sesame

Treatments	Plant height (cm)	Dry matter accumulation (g plant^{-1})	Crop growth rate (g m^{-2} day^{-1})	Number of branches plant^{-1}	Number of capsule plant^{-1}	Number of seeds capsule^{-1}	1000-seed weight (g)	Seed yield plant^{-1} (g)
	At harvest	At harvest	60 DAS-harvest	At harvest	At harvest	At harvest	At harvest	At harvest
Nitrogen levels								
Control	61.1	26.4	19.8	1.5	26.0	38.1	1.72	0.684
75% RDN	93.5	45.2	35.4	2.3	33.8	44.2	3.42	1.318
100% RDN	102.8	51.8	39.6	3.5	56.0	57.0	3.43	1.463
S.Em.±	2.62	1.47	1.47	0.10	1.45	0.94	0.10	0.05
C.D.(P=0.05)	9.05	5.07	5.08	0.34	5.03	3.26	0.33	0.16
Nano urea foliar sprays								
Water spray	85.5	36.3	28.3	2.2	35.4	41.8	2.68	1.082
One spray of NU 4 ml L^{-1}	85.3	38.5	30.0	2.2	36.6	44.0	2.73	1.106
Two sprays of NU 4 ml L^{-1}	85.2	41.3	31.9	2.5	39.2	47.2	2.88	1.130
One spray of NU 8 ml L^{-1}	85.5	44.1	33.3	2.7	40.2	49.5	2.95	1.208
Two sprays of NU 8 ml L^{-1}	87.5	45.5	34.6	2.7	41.5	49.7	3.04	1.248
S.Em.±	0.82	0.63	0.80	0.08	0.55	0.78	3.04	0.02
C.D.(P=0.05)	NS	1.80	2.30	0.22	1.56	2.23	0.11	0.07
Treatments	**Plant height (cm)**	**Dry matter accumulation (g plant^{-1})**	**Crop growth rate (g m^{-2} day^{-1})**	**Number of branches plant^{-1}**	**Number of capsule plant^{-1}**	**Number of seeds capsule^{-1}**	**1000-seed weight (g)**	**Seed yield plant^{-1} (g)**
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One spray of NU 8 ml L^{-1}	85.5	44.1	33.3	2.7	40.2	49.5	2.95	1.208
Two sprays of NU 8 ml L^{-1}	87.5	45.5	34.6	2.7	41.5	49.7	3.04	1.248
S.Em.±	0.82	0.63	0.80	0.08	0.55	0.78	3.04	0.02
C.D.(P=0.05)	NS	1.80	2.30	0.22	1.56	2.23	0.11	0.07

Yield and harvest index

Effect of nitrogen levels

Data presented in Table 2 and Fig.1 revealed that highest seed yield (402 kg ha^{-1}) obtained with 100% RDN which was significantly superior over control but at par with 75% RDN. Application of 100% RDN produced the highest stover yield (1156 kg ha^{-1}), biological yield (1542 kg ha^{-1}) which was effectively higher over control and 75% RDN. Maximum harvest index (26.1%) observed with 100% RDN which was significantly superior over control but at par with 75% RDN. Increase in yield and harvest index provide strong evidence that an increased supply of N was available, resulting in increased seed and dry weight production and contributing to higher yield. The conclusion is supported further by a reduced percentage wise decrease with decreasing nitrogen levels. These findings are consisted with those of Ogundare *et al.* (2015) [12], Vani *et al.* (2017) [23]. and Meena *et al.* (2024) [10]. who obtained increased yield attributes, seed, stover and biological yields with nitrogen application to the optimum level.

Effect of nano urea

It is evident the results (Table 2 and Fig.1) that two foliar sprays of nano urea 8 ml L^{-1} obtained the highest seed yield (370 kg ha^{-1}), stover yield (1097 kg ha^{-1}), biological yield (1435 kg ha^{-1}) of sesame which was significantly higher over control but at par with one foliar spray of nano urea 8 ml L^{-1} and two foliar sprays of nano urea 4 ml L^{-1}. Being a primary element, nitrogen shows prominent effects by increasing the use of solar radiation in photosynthesis which tends to enhance vegetative growth and thus improve the biomass and seed yield. The foliar sprays of nano urea failed to brought a significant improvement in harvest index (%). Sheikh *et al.* (2024) [20]. at Udaipur observed that application of 90 kg N ha^{-1} + two sprays of nano urea 4 ml L^{-1} in oats gave the highest seed yield and green fodder yield which was significantly superior over lower dose of N + nano urea sprays but at par with 120 kg N ha^{-1}.

Table 2: Effect of nitrogen levels and nano urea on yield, harvest index and economics of sesame

Treatments	Seed yield (kg ha^{-1})	Stover yield(kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	Net return (₹ ha^{-1})	B:C ratio
Nitrogen levels						
Control	263	900	1164	22.5	19957	0.60
75% RDN	366	1078	1441	25.4	39599	1.18
100% RDN	402	1156	1542	26.1	46662	1.38
S.Em.±	12.5	25.90	31.06	0.60	1970	0.06
C.D.(P=0.05)	43.3	89.63	107.46	2.07	6818	0.20
Nano urea foliar sprays						
Water spray	319	986	1305	24.1	32736	1.03
One spray of NU 4 ml L^{-1}	337	1031	1369	24.5	34794	1.06
Two sprays of NU 4 ml L^{-1}	346	1056	1403	24.6	35250	1.04
One spray of NU 8 ml L^{-1}	347	1052	1400	24.7	35919	1.07
Two sprays of NU 8 ml L^{-1}	370	1097	1435	25.6	38331	1.07
S.Em.±	9.1	17.78	21.49	0.66	1004	0.03
C.D.(P=0.05)	26.2	51.00	61.64	NS	2881	NS

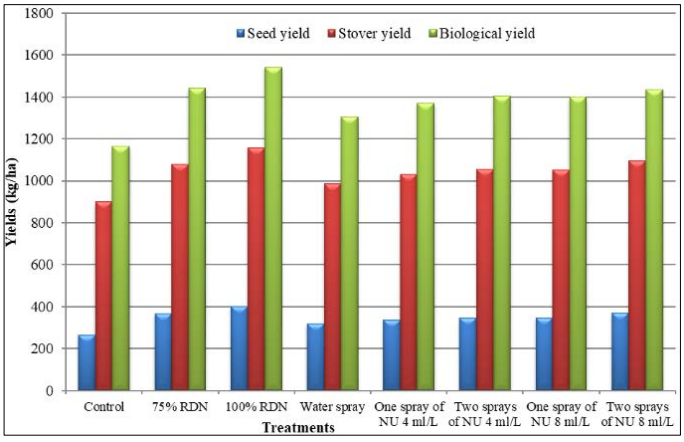

Fig 1: Effect of nitrogen levels and nano urea on seed, stover and biological yield of sesame

Net return and B:C ratio

Effect of nitrogen levels

It was evident from data (Table 2 and Fig.2) that different levels of RDN significantly enhanced the net return and B: C ratio. The highest net return (46,662 ha^{-1}) recorded with application of 100% RDN which was significantly higher as compared to rest of the treatments. The highest B:C ratio (1.38) recorded under 100% RDN was significantly higher over control but at par with 75% RDN. The cost involved under this treatment was comparatively lower than its additional income which led to significantly more returns.

Effect of nano urea

The results in Table 2 and Fig.2 revealed that foliar sprays of nano urea brought about significantly higher net return (33,098 ha^{-1}) but B:C ratio was not affected significantly. Highest net return (38,331 ha^{-1}) was obtained by the treatment F_5; two foliar sprays of nano urea 8 ml L^{-1} over control but at par with F_4; one foliar spray of nano urea 8 ml L^{-1}. This might be attributed to higher yield and better nitrogen use in sesame. These findings are in close agreement with Pujari *et al.* (2025) [13]. and Rathore *et al.* (2025) [15]. Foliar sprays of nano urea failed to get a significant raise in benefit-cost ratio of sesame. This trend in economic return is mainly due to the higher cost of cultivation and lower treatment effect on the seed and stover yield of sesame.

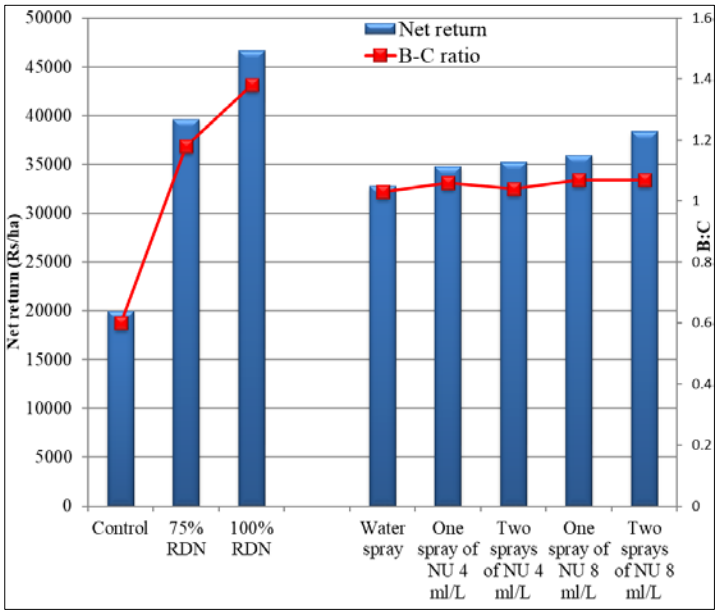

Fig 2: Effect of nitrogen levels and nano urea on net return and B:C ratio of sesame

Fig 3: Field layout of sesame

Fig 4: Sowing and basal application of fertilizer at 18/07/2025

Plate 1: General View of Experimental Trial

Conclusion

On the basis of result obtained from the present investigation entitled "Nitrogen Management in Sesame (*Sesamum indicum*) through Nano-Urea Supplementation" conducted during *kharif* 2025, it is recommended that sesame should be fertilized with 30 kg N ha^{-1} along with one foliar spray of nano urea @ 8 ml L^{-1} for achieving higher productivity and better economic profitability under the agro climatic zone IV-A (Sub Humid Southern Plain and Aravali Hills of Rajasthan).

Since the present study was conducted for only one season, further multi-year and multi-location experiments are required to validate these findings and for final recommendation.

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