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EFFECT OF NANO-FERTILIZERS ON GROWTH, YIELD AND ECONOMIC VIABILITY OF SESAME

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ABSTRACT

An experiment was conducted during *kharif* season of 2023 and 2024 at Instruction Farm Dr. B.R. Choudhary Agricultural Research Station Mandor, Agriculture University, Jodhpur to study the effect of nano-fertilizers on growth, yield and economic viability of sesame. The treatments were arranged in a randomized block design with 3 replications. The 2-years pooled results showed that the treatment 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS (T_7) produced significantly higher values for plant height (163 cm), branches (3.17 $plant^{-1}$), capsules (76 $plant^{-1}$), test weight (3.32 g), seed yield (429 kg ha^{-1}) and net monetary returns (Rs. 21091 ha^{-1}). However, highest B: C ratio (2.21) was recorded under 100% RDF as basal + seed treatments with 5ml kg^{-1} nano DAP (T_5).Hence, on the basis of net monitory returns and B:C ratio treatment T_5 i.e. application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP and treatment T_7 i.e. application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS can be considered as an effective treatments in enhancing sesame yield in the arid western Rajasthan.

(Key words: Growth, nano-fertilizer, sesame and yield)

INTRODUCTION

Sesame (*Sesamum indicum* L.) also known as til and dubbed the "queen of oilseeds," is one of the earliest domesticated edible oilseed utilized by humans. It is a member of the Pedaliaceae family. It may be grown in a wide range of climates, from the semi-arid tropics and subtropics to temperate zones (Choudhary *et al*., 2022). India possesses first position in area and production of sesame in the world (Choudhary *et al*., 2021).

In India, the cultivation is mainly confined to Gujarat, Uttar Pradesh, Rajasthan and Madhya Pradesh. The total area, production and productivity in India were 14.81 lakh ha, 7.49 lakh tones and 502 kg ha^{-1}, respectively. In Rajasthan, it is cultivated in Jodhpur, Pali, Sirohi, Sawai Madhopur, Karauli, Bhilwara, Nagaur, Bikaner, Jalore and Ajmer districts. The total area under cultivation in Rajasthan was about 2.90 lakh ha with annual production of 77 thousand tonnes and average productivity of 266 kg ha^{-1} (Anonymous, 2022). Foliar feeding using nano fertilizers boosts chlorophyll production, and cellular activity, and regulates respiration. Indian agriculture is largely reliant on imported fertilizers which increases the cost of inputs as government of India is reducing the subsidies on imported fertilizers. The application of nitrogen, phosphorus and potassic fertilizers have been found to have lower fertilizer use efficiency which ranges from 20 to 50 per cent for nitrogen and 10-25 per cent for phosphorus and 70-80 per cent for potassium and high environmental impacts (Chinnamuthu and Boopathi, 2009). Foliar fertilization has been more popular in recent years due to the availability of soluble fertilizers, and it is especially important in the current climate change scenario (Borana *et al.,* 2024a and Ram *et al*., 2024). It also causes plants to respond to increase soil water and nutrient uptake. The goal of foliar spraying fertilizers using nano fertilizers is to keep leaves alive longer by replenishing nutrients that are promptly translocated to growing seeds (Agnihotri *et al*., 2023 and Borana *et al.,* 2024b). Nano fertilizers are gaining much importance in agriculture as they are required only in lower quantity which will help farmers to reduce the cost incurred for cultivation and improve the crop output (Sruthi *et al*., 2022 and Choudhary and Nehra, 2022). Keeping this in view, the present experiment entitled, "Effect of nano-fertilizers on growth, yield and economic viability of sesame" was carried out during *kharif* season of 2023 and 2024.

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MATERIALS AND METHODS

Study area, weather and climatic details

The field experiment was conducted at Dr. B.R. Choudhary Agricultural Research Station Mandor, Agriculture University, Jodhpur during *kharif* 2023 and 2024, which comes under agro-climatic zone Ia (Arid Western Plains Zone) of Rajasthan. Geographically, located at 26° 15' N to 26° 45' North latitude and 73° 00' E to latitude 73° 29' East longitude at an altitude of 231 meter above mean sea level. The daily meteorological data was recorded at meteorological observatory located at near the experimental site at Dr. B.R. Choudhary Agricultural Research Station Mandor. During both the crop seasons mean monthly maximum temperature lied between 29.2 to 40.4 °C and 32.6 to 37.5 °C during 2023 and 2024 respectively. Likewise range of minimum temperature during 2023 and 2024 was 19.8 to 29.6 °C and 20.5 to 29.0°C respectively. During 2023 and 2024, the morning time relative humidity was 52.5 to 61.2 % and 54.1 to 87.4 %, while in the afternoon it was 38.8 to 71.1 % and 36.9 to 72.6 % respectively. The total rainfall during the crop season was 672 mm during year 2023 and 248 mm during year 2024.

Soil type, crop management and treatment

Soil was sandy loam in texture, slightly alkaline in reaction (pH 8.2) and low in electrical conductivity (0.17 dS m^{-1}). The experimental soil was low in organic carbon (1.3 g kg^{-1}), available nitrogen (174 kg ha^{-1}), medium in phosphorus (22.2 kg P_2O_5 ha^{-1}) and available potassium (325 kg K_2O ha^{-1}).The experiment was laid out in randomized complete block design replicated thrice. The treatments comprised of 100% RDF (T_1), 100% RDF as basal + one foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 DAS (T_2), 100% RDF as basal + two foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 and 45-50 DAS (T_3), 50% RDF as basal + two foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 and 45-50 DAS (T_4), 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP (T_5), 50% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP (T_6), 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS (T_7), 50% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 DAS (T_8), 100% RDF as basal + one foliar spray of nano Zn (2 ml l^{-1} of water) at 30-35 DAS (T_9), 50% RDF as basal + one foliar spray of nano Zn (2 ml l^{-1} of water) at 30-35 DAS (T_{10}), 100% RDF as basal + one foliar spray of nano Cu (2 ml l^{-1} of water) at 30-35 DAS (T_{11}) and 50% RDF as basal + one foliar spray of nano Cu (2 ml l^{-1} of water) at 30-35 DAS (T_{12}). Remaining practices adopted as per package of practices developed by Agriculture University, Jodhpur. Nitrogen and phosphorus were given via urea and single super phosphate, respectively. The observation on plant stand (lac ha^{-1}), plant height (cm), branches $plant^{-1}$, capsules $plant^{-1}$, test weight (g) and seed yield (kg ha^{-1}) were calculated. Net monetary returns (Rs ha^{-1}) and B: C ratio was also calculated.

Statistical analysis:

Comprehensive statistical analysis (treatment mean, standard error mean, critical difference and range of variation) and significance test (F-test) were carried out for each quantitative and qualitative trait. For this, entire biometric data recorded during the course of investigation were compiled in proper tables and statistically analyzed by using the standard procedures of statistical analysis for split plot design suggest by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth parameters and yield attributes of sesame

The pooled data indicated that this application of various nano-fertilizers significantly influenced plant height, number of capsules and test weight except plant population and number of branches $plant^{-1}$ as compared to the rest of the treatments (Table 1). Pooled data showed significantly highest plant height (163 cm), capsules (76 $plant^{-1}$) and test weight (3.32 g) of sesame with application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS (T_7). But treatments 100% RDF (T_1), 100% RDF as basal + one foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 DAS (T_2), 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP, 100% RDF as basal + two foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 and 45-50 DAS (T_3), 100% RDF as basal + one foliar spray of nano Zn (2 ml l^{-1} of water) at 30-35 DAS (T_9) and 100% RDF as basal + one foliar spray of nano Cu (2 ml l^{-1} of water) at 30-35 DAS (T_{11}) were also found at par with treatment T_7in the pooled analysis. The increase in growth and yield was noted due to the application of nano-fertilisers when compared with 100 % RDF. Meena *et al*. (2024) reported that application of 100% RDN gave higher length (2.6 cm), width (0.84 cm), weight (20.08 g $plant^{-1}$) and number of capsules $plant^{-1}$ (32.2) and number of seeds $capsule^{-1}$ (49.2) in sesame.

Yield

The results revealed that the application of nano-fertilizers significantly influenced the yield of sesame. Application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS (T_7) resulted significantly higher seed yield (429 kg ha^{-1}) on pooled basis as compared to other treatments. The treatments 100% RDF, 100% RDF as basal + one foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 DAS, 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP, 100% RDF as basal + two foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 and 45-50 DAS, 100% RDF as basal + one foliar spray of nano Zn (2 ml l^{-1} of water) at 30-35 DAS and 100% RDF as basal + one foliar spray of nano Cu (2 ml l^{-1} of water) at 30-35 DAS were also found statistically at par with treatment T_7. The highest yield observed in these treatments can be attributed to the increased availability of nitrogen for crops. Nano fertilizers are very useful because it slowly released nutrients as and when required by the

plants ultimately it improves nutrients uptake and enhanced plant growth, yield attributes and yield. Meena *et al*. (2024) reported that application of 100% RDN gave higher seed yield (922 kg ha^{-1}), straw yield (2161 kg ha^{-1}) and biological yield (3026 kg ha^{-1}) over rest of the treatments.

Table 1. Effect of IFFCO's nano-fertilizers on growth, yield and economic viability of sesame

Treatments	Plant stand (lac ha^{-1})	Plant height at harvest (cm)	Branches at harvest (plant^{-1})	Capsules plant^{-1}	Test weight (g)	Seed Yield (kg ha^{-1})			Net monetary returns (Rs.ha^{-1})	B:C Ratio
						2023	2024	Pooled		
T_1	2.42	153	2.79	69	2.98	405	349	377	18125	2.08
T_2	2.41	160	3.02	71	3.22	424	397	410	20038	2.11
T_3	2.43	162	3.08	75	3.23	426	400	413	19802	2.07
T_4	2.41	131	2.66	60	2.73	287	347	317	9292	1.46
T_5	2.42	161	2.95	71	3.22	419	392	406	20619	2.21
T_6	3.07	128	2.58	57	2.67	283	328	306	11352	1.67
T_7	2.43	163	3.17	76	3.32	438	419	429	21091	2.13
T_8	2.42	136	2.76	61	2.80	300	347	324	11361	1.61
T_9	2.42	160	2.92	70	3.17	416	369	392	17002	1.88
T_{10}	2.40	129	2.37	56	2.62	274	304	289	7410	1.38
T_{11}	2.42	156	2.85	70	3.06	409	364	386	16446	1.85
T_{12}	2.73	127	2.35	51	2.45	272	300	286	7148	1.37
SEm ±	**0.14**	**6.60**	**0.19**	**3.43**	**0.16**	**21.5**	**40.50**	**22.03**	-	-
CD at 5%	-	**19.36**	-	**10.07**	**0.47**	**63.0**	**118.78**	**64.62**	-	-
CV (%)	**9.97**	**7.78**	**12.08**	**9.07**	**9.31**	**10.2**	**19.50**	**10.57**	-	-

Note:- 100% RDF (T_1), 100% RDF as basal + one foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 DAS (T_2), 100% RDF as basal + two foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 and 45-50 DAS (T_3), 50% RDF as basal + two foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 and 45-50 DAS (T_4), 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP (T_5), 50% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP (T_6), 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS (T_7), 50% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano urea (2 ml l^{-1} of water) at 30-35 DAS (T_8), 100% RDF as basal + one foliar spray of nano Zn (2 ml l^{-1} of water) at 30-35 DAS (T_9), 50% RDF as basal + one foliar spray of nano Zn (2 ml^{-1} of water) at 30-35 DAS (T_{10}), 100% RDF as basal + one foliar spray of nano Cu (2 ml l^{-1} of water) at 30-35 DAS (T_{11}) and 50% RDF as basal + one foliar spray of nano Cu (2 ml l^{-1} of water) at 30-35 DAS (T_{12})

Economics

The study highlighted the economic impact of different nutrient application strategies on sesame cultivation. The highest net monetary return (Rs. 21091 ha^{-1}) was observed with the application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS(T_7). Similarly, the application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP (T_5) exhibited the highest benefit cost ratio of 2.21 for sesame. Differences in net returns and benefit cost ratios could be attributed to the effects of yield of sesame for each treatment. Singh *et al*. (2025) indicated a consensus in the agricultural community regarding the efficacy of this specific application of nano urea and nano DAP methods. Dhawne *et al*. (2024) reported that recommended dose of nano fertilizer in rice when combined with the recommended dose of fertilizer, contributed to enhanced net returns and benefit cost ratios.

Thus, it is concluded from the pooled data that the application of 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP (T_5) and 100% RDF as basal + seed treatment with 5ml kg^{-1} nano DAP + one foliar spray of nano DAP (2 ml l^{-1} of water) at 30-35 DAS (T_7) may be adopted to achieve the higher yield and productivity of sesame grown under Arid Western Plains Zone of Rajasthan. These findings highlight the potential of nano-fertilizer for fostering sustainable sesame cultivation practices in the region.

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