

INFLUENCE OF INTEGRATED APPLICATION OF FERTILIZERS AND NANO FERTILIZERS ON GROWTH AND SEED YIELD OF SESAME (*SESAMUM INDICUM* L)

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ABSTRACT

A field experiment was conducted during Kharif 2025–26 at the Research Farm, Project Coordinating Unit (Sesame and Niger), College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh. The experiment was designed to assess whether partial substitution of conventional fertilizers with nano fertilizers could sustain or improve crop growth and seed yield while reducing the requirement for soil-applied nutrients in sesame (*Sesamum indicum* L.). The study focused on crop growth, yield attributes, seed yield, oil content and economic returns. Nutrient management significantly influenced growth and productivity. The experiment comprised of fourteen treatments involving application of different levels and schedules of recommended doses of nitrogen, phosphorus and potassium fertilizers, their reduced doses, foliar application of nano urea, nano DAP and potassium chloride, and an absolute control. The recommended dose of fertilizer (RDF) was 60:40:20 kg N:P₂O₅:K₂O ha⁻¹. Nitrogen was applied either as basal and top-dressed as split applications at different crop growth stages. Nano fertilizers were applied as foliar sprays at 30 and 50 days after sowing (DAS) as per treatments in a Randomized Block Design with three replications using variety RT-372. The results revealed that treatment T13, comprising 125% RDF (75:50:25 kg N:P₂O₅:K₂O ha⁻¹) with 50% N as basal and the remaining N in two equal splits at 30 and 50 DAS, recorded the highest plant height at harvest (111.89 cm), branches plant⁻¹ (4.15), leaf area at 60 DAS (565.83 cm² plant⁻¹), LAI at 60 DAS (1.41), seed yield (758 kg ha⁻¹), oil content (46.60%) and oil yield (353.18 kg ha⁻¹). T13 also produced the highest gross monetary return (₹94,750 ha⁻¹), net monetary return (₹42,163 ha⁻¹) and B:C ratio (1.80) which was on par with treatment T3 & T12 involving RDF and reduced doses of nitrogen application in three equal splits. The findings proved that balanced fertilizer application with appropriate split application of nitrogen improved sesame growth, yield, oil productivity and economic efficiency under the conditions of the experiment and can help in saving of nutrients. Application of nano fertilizers though improve the crop yield, however could not attain the level of significance as compared to recommended doses of fertilizers and higher doses of 125% RDF.

KEYWORDS: Sesame, nutrient management, growth, seed yield, oil content, oil yield, economics, nano fertilizer

1. INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the important traditional oilseed crops cultivated in India. It belongs to the family Pedaliaceae. It is cultivated for its high-quality edible oil and nutritionally valuable seed. It is also called as “Poor man’s ghee” (Hegde, 2012). Sesame seed contains a considerable proportion of oil and protein, making it an important component of the food and oilseed sector. It is also known as the “seeds of immortality” due to presence of antioxidants such as sesamin, sesamolin, and sesamol. The productivity of sesame remains dependent on several agronomic factors, among which balanced and timely nutrient supply is particularly important. Plant nutrients play a fundamental role in regulating the growth and development of sesame from establishment to maturity. Adequate availability of major plant nutrients in balanced proportion is essential for promoting a vigorous crop canopy and achieving satisfactory yield. Split application of nitrogen and appropriate nitrogen scheduling along with balanced phosphorus and potassium application is an important component of efficient nutrient management in sesame. Recent advances in fertilizer technology have introduced nano-fertilizers as a supplementary source of plant nutrients. Nano fertilizers improve nutrient use efficiency by holding nutrients on their large surface area and releasing them slowly, reducing nutrient fixation and loss (Reddy, 2021). Nano Urea and Nano DAP can be applied as foliar sprays to complement soil-applied fertilizers during crop growth. Their integration with conventional fertilizers provides an opportunity to examine whether nutrient supply through

different routes can improve crop growth, yield formation and nutrient utilization. Nano fertilizers provide opportunity for improving nutrient use efficiency because of their potential for efficient nutrient delivery and better utilization by plants. However, the performance of such integrated approaches needs to be evaluated under specific agro-climatic and soil conditions before recommending them for wider adoption.

Growth characteristics such as plant height, branching, leaf area, leaf area index and dry matter accumulation are important indicators of the crop's response to nutrient management. Improved vegetative growth can increase the photosynthetic surface and biomass available for reproductive development. Ultimately, the response of these growth processes is reflected in yield attributes, seed yield and quality. In sesame, oil content and oil yield are particularly important because the economic value of the crop depends substantially on the quantity and quality of seed produced. Keeping these considerations in view, the present investigation was undertaken to assess the influence of integrated application of fertilizers and nano fertilizers on growth, yield attributes, seed yield, oil content, oil yield and economics of sesame under the agro-climatic conditions of Jabalpur, Madhya Pradesh identifying a nutrient-management approach capable of improving crop performance and profitability under the experimental conditions.

2. MATERIALS AND METHODS

The experiment was conducted during Kharif 2025–26 at the Research Farm, ICAR- Project Coordinating Unit (Sesame and Niger), College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh. The soil of the experimental field was sandy loam in texture, neutral in reaction and medium in available nutrients. The experiment was laid out in Randomized Block Design with fourteen treatments and three replications. Sesame variety RT-372 was sown in the experimental field with nutrient application as treatments comprised of RDF (60:40:20) 50% N as basal and remaining N in 2 equal splits at 30 & 50 DAS (T1), 100% P₂O₅ & K₂O as basal & 75% RDN (50% basal & 50% at 30 DAS) (T2), 100% P₂O₅ and K₂O as basal & 75% RDN (top dressing in 3 equal splits at 15, 30, & 50 DAS) (T3), 100% P₂O₅ and K₂O & 50% RDN as basal (T4), 50% RDN, 50% P₂O₅ and 100% K₂O as basal (T5), 50% RDF (30:20:10) 50% N as basal & 50% at 30 DAS (T6), T4 + Nano Urea (4 ml/ liter water) spray at 30 and 50 DAS @ 300 & 400 L water/ ha (T7), T5 + Nano DAP (4 ml/ liter water) spray at 30 and 50 DAS @ 300 & 400 L water/ ha (T8), T6 + Nano DAP (4 ml/ liter water) + K (1% KCL) spray at 30 and 50 DAS @ 300 & 400 L water/ ha (T9), T6 + Nano Urea at 30 & Nano DAP at 50 DAS (4 ml/ liter water) + K (1% KCL) @ 300 & 400 L water/ ha (T10), T6 + spray of water at 30 and 50 DAS @ 300 & 400 L water/ha (T11), RDF (60:40:20) N in 3 equal splits at 15, 30 & 50 DAS, (T12), 125% (75:50:25) 50% N as basal and remaining N in 2 equal splits at 30 & 50 DAS (T13), Absolute control (T14) tested against recommended dose of fertilizer 60:40:20 kg N:P₂O₅:K₂O ha⁻¹ and absolute control. The crop was sown at a row spacing of 40 cm. Observations on growth and yield attributes were recorded viz. plant height, number of branches plant⁻¹, and dry matter accumulation were recorded at specified crop-growth stages. At maturity, number of capsules plant⁻¹, number of seeds capsule⁻¹ and test weight were recorded. After harvesting, biological yield was recorded from each net plot. Seed yield was obtained after drying, threshing and winnowing of the produce and expressed in kg ha⁻¹. Stover yield was calculated by subtracting seed yield from biological yield. Harvest index was calculated as the ratio of seed yield to biological yield and expressed as percentage. Oil yield was calculated from seed yield and oil content in the seed. The economics of different treatments were worked out by considering the prevailing prices of inputs and produce.

RESULTS

Growth parameters

Among various nutrient management treatments, significantly higher plant height, number of branches plant⁻¹ and dry weight plant⁻¹ T13 recorded (111.89 cm, 4.15 & 11.19 g respectively) which was statistically at par with T12 (109.67 cm, 4.02 & 10.90 g respectively), whereas significantly lower plant height (95.44 cm, 1.70 & 6.47 g respectively) was recorded under no fertilizer treatment (T14). These results were in close conformity with the findings of Mallik et al. (2003), Damdar et al. (2015) Rathod et al. (2021), Sharma et al. (2022), Sharma et al. (2020) and Tuli et al. (2022). The results of the experiment confirmed the importance of both nutrient dose and their application schedule in sesame production. Nitrogen is highly dynamic in the soil during the kharif season, and a single application may not coincide with crop demand throughout the growing period. Therefore, better growth with split application of nitrogen even under reduced doses proved to improve nitrogen availability and reduce nutrient losses at critical growth stages. The better growth under T13 can be attributed to the higher and balanced supply of N, P and K combined with split nitrogen application as in case of T12 & T3. Timely availability of nitrogen resulted in better leaf expansion, increased leaf area and LAI. Thus, improved the photosynthetic assimilatory surface, which resulted in increased branching and dry matter accumulation. and contributed to biomass production. Reduction in conventional fertilizer application can reduce nutrient input costs and potential nutrient losses, but excessive reduction may result in nutrient deficiency and lower productivity. The use of nano fertilizers as foliar supplements although improved the nutrient availability to the crop, however they could not entirely fulfill the requirement with doses corresponding to the reduced fertilizer treatment to the level of significance.

Yield attributes & yield

Different nutrient management treatments significantly influenced the mean number of capsules plant⁻¹, seeds capsule⁻¹, and test weight (g) as compared to control with no nutrient application (table 1). Among different treatments, treatment T13 recorded significantly higher number of capsules plant⁻¹, seeds capsule⁻¹, and test weight (g) (64.33, 70.22 & 3.63 g), while the control treatment (T14) recorded significantly lower (24.67, 53.11 & 3.20g) number of capsules plant⁻¹, seeds capsule⁻¹, and test weight (g) respectively. The sequential application of nano urea at 30 DAS and nano DAP at 50 DAS represents a stage-specific nutrient management strategy. This approach may be advantageous because nutrient demand and physiological priorities differ between vegetative and reproductive growth stages. The 125% RDF treatment provides a useful benchmark for assessing whether greater nutrient input necessarily produces proportionately greater seed yield. If an integrated nano fertilizer treatment produces comparable yield with reduced conventional fertilizer, it may offer a more efficient nutrient management strategy.

Table 1: Effect of different treatments on yield attributes of sesame				
Treatments		Number of capsules plant ⁻¹	Number of seeds capsule ⁻¹	1000 Seed weight (g)
T1	RDF (60:40:20) 50% N as basal and remaining N in 2 equal splits at 30 & 50 DAS	48.33	64.21	3.47
T2	100% P ₂ O ₅ & K ₂ O as basal & 75% RDN (50% basal & 50% at 30 DAS)	44.00	63.33	3.37
T3	100% P ₂ O ₅ and K ₂ O as basal & 75% RDN (top dressing in 3 equal splits at 15,30 & 50 DAS)	55.33	69.36	3.50
T4	100% P ₂ O ₅ and K ₂ O & 50% RDN as basal	35.33	60.11	3.33
T5	50% RDN, 50% P ₂ O ₅ and 100% K ₂ O as basal	32.89	56.22	3.27
T6	50% RDF (30:20:10) 50% N as basal & 50% at 30 DAS	35.00	56.00	3.23
T7	T4+Nano Urea (4 ml / liter water) spray at 30 and 50 DAS @ 300 & 400 L water/ha	49.00	59.11	3.33
T8	T5+Nano DAP (4 ml / liter water) spray at 30 and 50 DAS @ 300 & 400 L water/ha	44.67	60.00	3.40
T9	T6+Nano DAP (4 ml /liter water)+K(1% KCL) spray at 30 and 50 DAS @ 300 & 400 L water/ha	43.00	63.89	3.47
T10	T6+Nano Urea at 30 & Nano DAP at 50 DAS (4 ml/liter water)+K(1% KCL) @ 300 & 400 L water/ha	44.33	62.40	3.43
T11	T6+spray of water at 30 and 50 DAS @ 300 & 400 L water/ha.	33.00	58.44	3.30
T12	RDF (60:40:20) N in 3 equal splits at 15, 30 & 50 DAS	56.67	69.56	3.60
T13	125% (75:50:25) 50% N as basal and remaining N in 2 equal splits at 30 & 50 DAS	64.33	70.22	3.63
T14	No fertilizer	24.67	53.11	3.20
	SEm ±	1.71	2.59	0.16
	CD (p=0.05)	4.97	7.53	NS

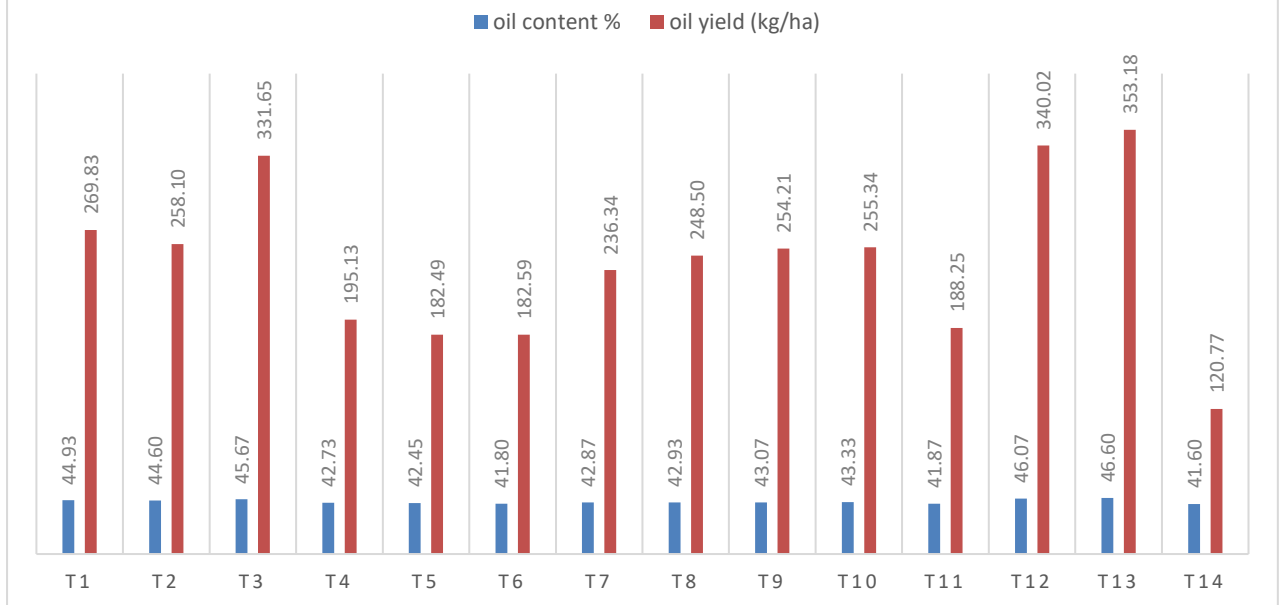
The results revealed that significantly higher seed yield (758 kg ha⁻¹) was recorded under T13 which was at par with T12 (738 kg ha⁻¹) and T3 (726 kg ha⁻¹), while significantly lower seed yield (290 kg ha⁻¹) was recorded under control treatment (T14) (table 2). Similarly, treatment T13 was recorded significantly higher stalk yield and biological yield (2815 kg ha⁻¹ and 3573 kg ha⁻¹, respectively) which was statistically at par with T12 (2758 kg ha⁻¹ and 3496 kg ha⁻¹, respectively) & treatment T3 (2722 kg ha⁻¹ and 3449 kg ha⁻¹, respectively). The control (T14) recorded significantly lower (1690 kg ha⁻¹ and 1980 kg ha⁻¹) stalk yield and biological yield, respectively. Similar findings were observed by Kamravaie and Shokohfar (2015) Kale et al. (2021), Kumar et al. (2014) and Parmar et al. (2022). The harvest index varied from 14.64% to 21.22% among different nutrient management treatments. The treatment T13 recorded maximum harvest index (21.22%), whereas the minimum harvest index (14.64%) was recorded in T14 control treatment. The improvement in yield under T13 was closely associated with better vegetative growth and reproductive development. Adequate nutrient availability throughout the crop cycle likely improved nutrient uptake and assimilate translocation towards developing capsules and seeds. The higher oil content and oil yield further indicate a favourable response of seed quality to balanced nutrient supply.

Table 2: Effect of different treatments on seed, stalk, biological yield and harvest index of sesame					
Treatments		Seed yield (kg/ha)	Stalk yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)
T1	RDF (60:40:20) 50% N as basal and remaining N in 2 equal splits at 30 & 50 DAS	600	2581	3181	18.89
T2	100% P ₂ O ₅ & K ₂ O as basal & 75% RDN (50% basal & 50% at 30 DAS)	580	2657	3237	17.90
T3	100% P ₂ O ₅ and K ₂ O as basal & 75% RDN (top dressing in 3 equal splits at 15,30 & 50 DAS)	726	2722	3449	21.06
T4	100% P ₂ O ₅ and K ₂ O & 50% RDN as basal	457	2313	2770	16.52
T5	50% RDN, 50% P ₂ O ₅ and 100% K ₂ O as basal	430	2311	2741	15.75
T6	50% RDF (30:20:10) 50% N as basal & 50% at 30 DAS	437	2210	2647	16.48
T7	T4+Nano Urea (4 ml / liter water) spray at 30 and 50 DAS @ 300 & 400 L water/ha	551	2392	2943	18.79
T8	T5+Nano DAP (4 ml / liter water) spray at 30 and 50 DAS @ 300 & 400 L water/ha	579	2407	2987	19.41
T9	T6+Nano DAP (4 ml /liter water)+K(1% KCL) spray at 30 and 50 DAS @ 300 & 400 L water/ha	591	2440	3031	19.48
T10	T6+Nano Urea at 30 & Nano DAP at 50 DAS (4 ml/liter water)+K(1% KCL) @ 300 & 400 L water/ha	590	2420	3010	19.61
T11	T6+spray of water at 30 and 50 DAS @ 300 & 400 L water/ha.	450	2253	2702	16.65
T12	RDF (60:40:20) N in 3 equal splits at 15, 30 & 50 DAS	738	2758	3496	21.11
T13	125% (75:50:25) 50% N as basal and remaining N in 2 equal splits at 30 & 50 DAS	758	2815	3573	21.22
T14	No fertilizer	290	1690	1980	14.64
SEm ±		27.32	47.90	36.94	
CD (p=0.05)		79.41	139.26	107.40	

Oil content and oil yield

Oil content ranged from 41.60 to 46.60%. T13 recorded the maximum oil content (46.60%) and oil yield (353.18 kg ha⁻¹), followed by T12 with 46.07% oil content and 340.02 kg ha⁻¹ oil yield. The control recorded 41.60% oil content and 120.77 kg ha⁻¹ oil yield. Among nano fertilizer treatments, comparable higher oil content (43.33%) and oil yield (255.34 kg ha⁻¹) were recorded under T10 (fig.1). These findings are in close agreement with the observations of Solanki et al. (2022), Gorlapalli et al. (2022), Indoria et al. (2024) and Kale et al. (2020). Balanced nutrient application not only increased the seed yield significantly but also resulted in improved oil content in the seeds and thus higher oil yield was also observed in treatments which ensured balanced availability of nutrients to the crop for a longer period of crop growth.

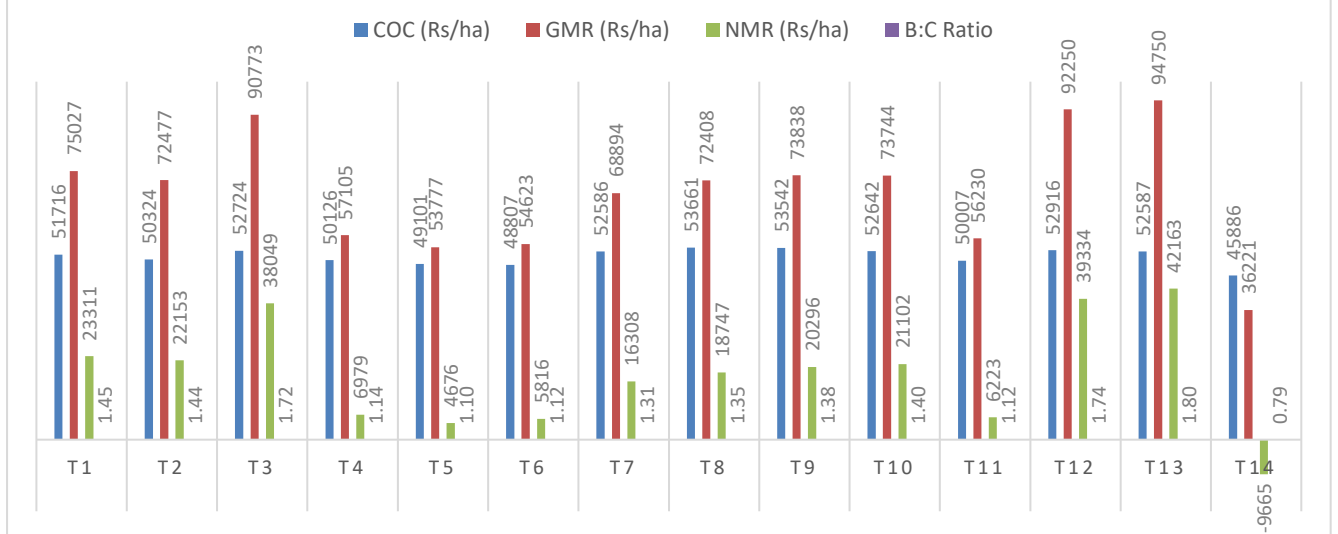
FIGURE 1: EFFECT OF NUTRIENT MANAGEMENT TREATMENTS ON QUALITY PARAMETER



Economics

The highest cost of cultivation (₹53661 ha⁻¹) was obtained under T8 closely followed by T9 (₹53542 ha⁻¹). While, the lower cost of cultivation (₹45886 ha⁻¹) was recorded under control treatment. T13 recorded the highest gross monetary return (₹94,750 ha⁻¹), net monetary return (₹42,163 ha⁻¹) and B:C ratio (1.80). The control recorded a negative net return of ₹9,665 ha⁻¹ and a B:C ratio of 0.79. These findings are in close agreement with the observations of Meena et al. (2024), Ghosh et al. (2017), Brajendra et al. (2012) and Caon et al. (2017). Balanced application of nutrients in appropriate quantity at critical stages has resulted in availability of plant nutrients in sufficient quantity when it is most required. This increased availability of nutrients has resulted in better growth of the crop and ultimately resulted in higher seed yield. The increased seed yield resulted in increased gross returns from the crop and thus recorded better B:C ratio was recorded in treatments which ensure better availability of nutrients to the crop for a longer period of time.

FIGURE 2: EFFECT OF NUTRIENT MANAGEMENT TREATMENTS ON ECONOMICS OF SESAME



CONCLUSION

Integrated nutrient management significantly improved sesame growth, yield, oil productivity and economics. T13, comprising 125% RDF (75:50:25 kg N:P₂O₅:K₂O ha⁻¹) with 50% N as basal and the remaining N in two equal splits at 30 and 50 DAS, was the most productive and profitable treatment, recording the highest seed yield

(758 kg ha⁻¹), oil content (46.60%), oil yield (353.18 kg ha⁻¹), net monetary return (₹42,163 ha⁻¹) and B:C ratio (1.80). Under the conditions of this experiment, T13 may be considered the most promising nutrient-management treatment for maximizing sesame productivity and profitability. However, T3 being statistically comparable with higher yielding treatments with relatively lower input requirement, may be considered a practical nutrient management option for sesame farmers.

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Conflict of interest

The author declares that there is no conflict of interest.

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