



Effect of nitrogen levels on growth and yield of different varieties of Safflower (*Carthamus tinctorius* L.)

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ARTICLE INFO	ABSTRACT
<p>Original Research Article Received on August 23, 2025 Revised on August 29, 2025 Accepted on September 27, 2025 Published on October 02, 2025</p> <p>Article Authors Usha Regar, N. S. Solanki, I. J. Mathur, Tarun Shreemali, Bhavna Singh Rathore, Vinod Kumar, T. S. Champawat, Manisha Rathore</p> <p>Corresponding Author Email usha01regar@gmail.com</p>	<p>A field experiment entitled “Effect of nitrogen levels on growth and yield of different varieties of Safflower (<i>Carthamus tinctorius</i> L.)” was conducted at School of Agricultural Sciences, JRN RVU, Dabok, Udaipur, Rajasthan during the <i>Rabi</i> season 2023-24. The experiment consisted of three varieties (RVSAF-18-1, JSF-99, JSF-97) and four nitrogen levels (0, 30, 45, and 60 kg ha⁻¹). The 12 treatment combinations were evaluated under a randomized block design with 3 replications. The results revealed that the highest yield of 2451 kg.ha⁻¹ was obtained with variety RVSAF-18-1 which was significantly higher over variety JSF-97 and JSF-99 by 28.3 and 173.5 per cent, respectively. Similar trends were observed with respect to stover and biological yield. The highest oil content and yield net return (₹ 116168/-) and B-C (4.3) was also noticed in variety RVSAF-18-1. The highest yield of 2074 kg.ha⁻¹ was obtained with the application of 60 kg N ha⁻¹ which was significantly higher over control and 30 kg N ha⁻¹ by 69.8 and 23.6 per cent, respectively but was at par with 45 kg N ha⁻¹ (2038 kg.ha⁻¹). Similar were the trends observed with respect to stover and biological yield. Application of 60 kg N ha⁻¹ also registered maximum oil content (33.4%), oil yield (722.5% kg.ha⁻¹), net return (₹ 92486 ha⁻¹) and B-C (3.61) which were at par with 45 kg N ha⁻¹.</p>
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Safflower (*Carthamus tinctorius* L.) is recognized as one of the oldest domesticated oilseed crops. This crop has been cultivated since ancient times for dual purposes: as a dye and as an oilseed, across a diverse array of geographical regions (Knowles, 1976). Safflower belongs to the family Compositae, also known as Asteraceae, within the genus *Carthamus*. Safflower is widely recognized as Kusum in India and Pakistan. The term originating from Sanskrit word Kusumbha (Minnie *et al.*, 2018).

The designation of this substance as a more economical alternative to saffron is reflected in its various names, including false saffron, bastard saffron, thistle saffron, and dyers saffron (Weiss, 2000). The oil is valued in the technology of alkyd resins. It can also be used in the preparation of paints, varnishes and surface coatings. It is used for preparing roghan meant for preservation of leather and the production of water proof cloth. Charred oil is used for healing sores and in rheumatism.

Safflower oil is also used in infant foods and liquid nutrition formulations. The oil is an effective non-allergenic dispersant for injectable medications. Dried red and orange flowers are sold as substitutes for saffron in Middle East and are used to colour foods and beverages. Carthamin, a red dye extracted from the flowers is used to colour cloth and foods. Flowers are also used in the preparation of cosmetics. Flowers are reported to have beneficial effects for problems of the circulatory system, for inflammation and muscular fatigue. Nitrogen is essential in plant processes such as photosynthesis thus; plants with sufficient nitrogen will experience high rates of photosynthesis and typically exhibit vigorous plant growth and development. Nitrogen (N) availability is an important factor in determining crop productivity, managing fertilizer rate can be a suitable strategy to improve crop growth and yield when crops need to enhance nutrient uptake (Patel *et al.*, 2022).

In Rajasthan, the challenges posed by erratic rainfall and nutrient-deficient soils frequently restrict crop productivity. Therefore, the optimization of nitrogen management is essential for enhancing yields. There is a lack of extensive research regarding the varietal responses to nitrogen fertilization within local conditions. This study seeks to address the existing knowledge gap by evaluating the responses of various safflower varieties to different nitrogen levels. The findings will contribute to improved agronomic practices and increased crop productivity in the challenging farming conditions of Agro climatic Zone of Rajasthan.

Materials and Methods

A field experiment entitled “Effect of nitrogen levels on growth and yield of different varieties of Safflower (*Carthamus tinctorius* L.)” was conducted during rabi 2023–24 at the Instructional Farm, School of Agricultural Sciences, Dabok, Udaipur (24°37' N, 73°53' E; 513 m AMSL) under agro-climatic zone IV. The soil was clay loam, neutral in reaction (pH 7.2), low in available N (275 kg ha⁻¹), medium in P₂O₅ (18 kg ha⁻¹) and high in K₂O (285 kg ha⁻¹) with 0.44% organic carbon. The climate is subtropical with 631 mm mean annual rainfall; during the crop season, 6.4 mm rainfall was received.

The experiment was laid out in Factorial Randomized Block Design with three replications, comprising twelve treatment combinations: three safflower varieties (RVSAF 18-1, JSF-99, JSF- 97) and four nitrogen levels (0, 30, 45, 60 kg N ha⁻¹). Sowing was done manually on 21st October 2023 with 10 kg seed ha⁻¹, maintaining 45 × 20 cm spacing. Phosphorus (40 kg P₂O₅ ha⁻¹) and half of nitrogen were applied at sowing, while the remaining nitrogen was top-dressed at 35 DAS. Crop management included gap filling (10 DAS), thinning (20 DAS), two hoeing's and weeding's (20 and 35 DAS), and three irrigations (at sowing, rosette, and pre-flowering stages). Imidacloprid 30.5% SC was sprayed at 60 DAS against aphids. Harvesting was done variety-wise at physiological maturity, followed by sun drying, threshing, and winnowing. Observations were recorded on growth, yield attributes, yield, oil content, and economics using standard procedures. Nitrogen content and uptake were determined by (Lindner's method, 1944), while oil content was estimated at IOR, Hyderabad. Data were analysed using ANOVA (Panse and Sukhatme, 1985), and treatment means were compared at 5% significance level.

Results and Discussion

Effect of Varieties

Yield

The analysis of seed yield, straw yield, biological yield and harvest index (table 1) across the three safflower varieties revealed significant differences, with RVSAF 18-1 showing the highest performance in all traits. RVSAF 18-1 produced the highest seed yield (2451 kg ha⁻¹), significantly outperforming both JSF-99 (896 kg ha⁻¹) and JSF-97 (1910 kg ha⁻¹), indicating its superior reproductive capacity. It also recorded the highest straw yield (4197 kg ha⁻¹), reflecting its robust vegetative growth, likely driven by efficient nitrogen uptake and resource allocation. Consequently, RVSAF 18-1 achieved the highest biological yield (6648 kg ha⁻¹), a combined result of its superior seed and straw yields. The harvest index of RVSAF 18-1 (36.8%) was also the highest, suggesting that it allocated a greater proportion of its total biomass towards seed production, thereby demonstrating efficient resource partitioning. In comparison, JSF-99 exhibited the lowest seed yield, straw yield, and biological yield, along with a similar harvest index (36.5%), highlighting its relatively lower productivity.

Table 1. Effect of nitrogen levels on seed yield, stover, biological yield and harvest index of different varieties

Treatments	Seed (kg ha ⁻¹)	Stover (kg ha ⁻¹)	Biological (kg ha ⁻¹)	Harvest Index (%)
Varieties (V)				
V1: RVSAF 18-1	2451	4197	6648	36.8
V2: JSF-99	896	1546	2443	36.5
V3: JSF-97	1910	3280	5190	36.8
Nitrogen Levels (N)				
N0: Control	1221	2123	3345	36.3
N30: 30 kg ha ⁻¹	1677	2992	4669	35.9
N45: 45 kg ha ⁻¹	2038	3402	5440	37.6
N60: 60 kg N ha ⁻¹	2074	3513	5587	37.1

These findings emphasize RVSAF 18-1's superior efficiency in both vegetative and reproductive growth, making it the most promising variety for safflower cultivation in terms of overall yield and biomass production. Sahu and Thakur (2016), Shinde (2017), Sahu *et al.* (2017) and Sofy *et al.* (2020), also found similar results while working on safflower.

Oil Content and Oil Yield

Regarding oil content and oil yield, RVSAF 18-1 demonstrated the highest oil content (37.3%) and oil yield (923.9 kg ha⁻¹), highlighting its exceptional capacity to convert absorbed nitrogen into oil. This superior oil production can be attributed to its efficient nitrogen uptake and its ability to allocate resources effectively towards seed development. On the other hand, JSF-99 recorded the lowest oil content (28.74%) and oil yield (253.47 kg ha⁻¹), indicating that its limited nitrogen uptake resulted in lower oil accumulation. These results underscore the importance of both nitrogen uptake efficiency and resource allocation for maximizing oil production in safflower, with RVSAF 18-1 being the most promising variety for oil yield. Bitarafan *et al.* (2011), de Lima Bueno *et al.* (2020), and Gayathri *et al.* (2023) also found similar results while working on safflower.

Economics

The net return (table 2) for RVSAF 18-1 was the highest at ₹16168 ha⁻¹, significantly outperforming both JSF-99 with a net return of ₹20263 ha⁻¹ and JSF-97 with ₹82836 ha⁻¹.

Table 2. Effect of nitrogen levels on net return and B-C ratio of different varieties of Safflower

Treatments	Net Return (₹ ha ⁻¹)	B-C Ratio
Varieties (V)		
V1: RVSAF 18-1	116168	4.30
V2: JSF-99	20263	1.57
V3: JSF-97	82836	3.36
Nitrogen Levels (N)		
N0: Control	40841	2.18
N30: 30 kg ha ⁻¹	68588	2.96
N45: 45 kg ha ⁻¹	90440	3.57
N60: 60 kg N ha ⁻¹	92487	3.61

This highlights that RVSAF 18-1 generates the highest returns after accounting for the cost of cultivation, making it the most economically viable variety. The Benefit-Cost Ratio (BCR) also reflected the superior profitability of RVSAF 18-1, with a BCR of 4.30. In comparison, JSF-99 had a BCR of 1.57, suggesting lower economic efficiency, while JSF-97 showed a BCR of 3.36, which was higher than JSF-99 but still lower than RVSAF 18-1. These results indicate that RVSAF 18-1 is the most profitable variety for safflower cultivation in terms of both net returns and cost efficiency. Rani *et al.* (2015), Shinde (2017), Puri (2017), Barla (2017) and Surve *et al.* (2022) also found similar results while working on safflower.

Effect of Nitrogen Levels Yield

The effect of nitrogen levels on seed, straw, biological yield and harvest index revealed significant differences, with higher nitrogen levels generally enhancing all these traits (table 3). Among the nitrogen levels, 60 kg N ha⁻¹ consistently resulted in the highest values for seed yield (2451 kg ha⁻¹), straw yield (4197 kg ha⁻¹) and biological yield (6648 kg ha⁻¹), indicating that increased nitrogen availability significantly promotes both vegetative and reproductive growth. The higher seed yield observed under 60 kg N ha⁻¹ can be attributed to the increased number of capitula and seeds capitula⁻¹, along with enhanced nutrient availability, which contributed to better overall seed yield. Narayana *et al.* (2020), Patel *et al.* (2022) and Gayathri *et al.* (2023) also reported increased yield attributes and seed yield due to application of nitrogen.

Table 3. Effect of nitrogen levels on oil content in seed and oil yield of different varieties of Safflower

Treatments	Oil Content (%)	Oil Yield (kg ha ⁻¹)
Varieties (V)		
V1: RVSAF 18-1	37.3	923.9
V2: JSF-99	28.7	259.2
V3: JSF-97	30.5	584.2
Nitrogen Levels (N)		
N0: Control	30.7	385.4
N30: 30 kg ha ⁻¹	32.0	559.3
N45: 45 kg ha ⁻¹	32.6	689.2
N60: 60 kg N ha ⁻¹	33.4	722.5

Oil Content and Oil Yield

The nitrogen levels also had a significant impact on oil content and oil yield. Application of 60 kg N ha⁻¹ resulted in the highest oil content (33.4%) and oil yield (722.5 kg ha⁻¹), demonstrating that increased nitrogen availability enhances oil production. 45 kg N ha⁻¹ also showed substantial oil content (32.6%) and oil yield (689.2 kg ha⁻¹), indicating that even at slightly lower nitrogen levels, oil production remains high. These findings clearly demonstrate the positive relationship between nitrogen availability and oil production, with higher nitrogen levels leading to increased oil yield, highlighting the importance of nitrogen management in maximizing safflower oil production. Mohtashami *et al.* (2018), Saisanthosh *et al.* (2018), Padmavathi *et al.* (2019) and Somanagouda *et al.* (2020) also found similar results while working on safflower.

Economics

The net returns (NR) increased with higher nitrogen levels, with 60 kg N ha⁻¹ recording the highest net returns of ₹92487 ha⁻¹, followed by 45 kg N ha⁻¹ at ₹90440 ha⁻¹ and 30 kg N ha⁻¹ at ₹68588 ha⁻¹. The control treatment had the lowest net returns of ₹59492.08 ha⁻¹, indicating that nitrogen application significantly improves economic returns from safflower cultivation by enhancing yield and overall productivity. The Benefit-Cost Ratio (BCR) also showed a positive trend with increasing nitrogen levels. 60 kg N ha⁻¹ achieved the highest BCR of 3.61. 45 kg N ha⁻¹ followed with a BCR of 3.57 and 30 kg N ha⁻¹ had a BCR of 3.80.

The control treatment had the lowest BCR of 2.96, which suggests that without nitrogen supplementation, the return on investment is significantly lower. Kawale (2010), Singh and Singh (2013), Narayana *et al.* (2020), Sravya *et al.* (2021) and Surve *et al.* (2022) also found similar results while working on safflower and indicated increase in benefit cost ratio due to increase in nitrogen application in soil.

Conclusion

From the results of the research entitled, “Effect of nitrogen levels on growth and yield of different varieties of Safflower (*Carthamus tinctorius* L.)” conducted during the Rabi season of 2023-24, it may be concluded that the application of nitrogen significantly influenced the growth and yield attributes of safflower varieties. Among the varieties, RVSAF 18-1 demonstrated superior performance in most growth parameters, and seed yield, compared to JSF-97 and JSF-99. Similarly, RVSAF 18-1 exhibited the highest net returns (₹116168 ha⁻¹) and benefit-cost ratio (4.30), making it the most economically viable option among the varieties studied. On the basis of nitrogen application, the treatment of 60 kg N ha⁻¹ resulted in the highest growth and yield attributes, including seed yield (2451 kg ha⁻¹), straw yield (4197 kg ha⁻¹), and oil yield (923.9 kg ha⁻¹). This nitrogen level also achieved the highest net returns (₹92487 ha⁻¹) and benefit-cost ratio (3.61). In conclusion, while 60 kg N ha⁻¹ is recommended for optimal growth and yield, RVSAF 18-1 stands out as the best variety for both yield and economic returns. This research provides valuable insights for improving safflower cultivation by optimizing nitrogen management to achieve maximum productivity.

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