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Yield and economics of safflower as influenced by different varieties and nitrogen levels under irrigated and rainfed conditions

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Abstract

A field experiment was carried out to study the Response of Safflower Varieties to Different Nitrogen Levels Under Irrigated and Rainfed Condition at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during *rabi* 2022-23. The experiment comprised with sixteen treatments consisting irrigation conditions (I_1-irrigated and I_2- rainfed) and four levels of nitrogen (N_1- 0 kg N ha^{-1}, N_2- 30 kg N ha^{-1}, N_3- 60 kg N ha^{-1} and N_4- 90 kg N ha^{-1}) as main plot treatment and two varieties (V_1-PBNS- 12 and V_2- PBNS-86) in sub-plot with three replications in a split-split plot design. The results revealed that the seed yield (1466 kg ha^{-1}), stover yield (3300 kg ha^{-1}), gross return (Rs 92971 ha^{-1}), net return (Rs 56116 ha^{-1}) and B:C ratio (2.52) recorded significantly superior under irrigated condition as compare to rainfed condition. Among the different levels of nitrogen application, the seed yield (1490 kg ha^{-1}), stover yield (3278 kg ha^{-1}), gross returns (Rs 94224 ha^{-1}) and net returns (Rs 57987 ha^{-1}) with benefit cost ratio of 2.60 was recorded significantly superior with the application of 90 kg N ha^{-1}. In case of variety, the seed yield (1302 kg ha^{-1}), stover yield (2972 kg ha^{-1}), gross returns (Rs 82779 ha^{-1}) and net returns (Rs 46962 ha^{-1}) with benefit cost ratio 2.31 were recorded significantly superior in variety PBNS-12 than PBNS-86.

Keywords: Seed yield, stover yield, net returns, irrigated and rainfed condition

Introduction

Safflower (*Carthamus tinctorius* L.), belonging to the Asteraceae family, is cultivated primarily for its seeds, which are used to produce edible oil and bird feed. Originating from the Middle East, safflower is considered one of humanity's oldest crops and is globally recognized as a minor oilseed crop compared to others. Its oil has a high ratio of polyunsaturated to saturated fatty acids, making it suitable for various culinary uses like cooking, mayonnaise, salad oil, and margarine. Safflower is typically grown in the winter season (*Rabi*) from October/November to March/April. Studies indicate that timely irrigation during critical growth stages can significantly enhance seed yield by up to 50%. Nitrogen is crucial for safflower production as it influences dry matter production, leaf area development, and photosynthetic efficiency. Nitrogen deficiency adversely affects growth, delays development stages, and reduces yield components such as capitula number, seed number per capitula and overall seed yield. Optimal nitrogen application varies, with studies suggesting different rates depending on soil conditions, cultivars, and irrigation levels (Haby *et al*., 1982). Cultivar selection is also vital, impacting safflower's response to irrigation and

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nitrogen fertilization. Adequate water supply is crucial for maximizing safflower growth and yield, particularly under irrigated conditions, where it can thrive given sufficient water availability (Ozturk *et al*., 2008).

Materials and Methods

A field experiment was conducted during *rabi* season of 2022-2023 at College farm, N. M College of Agriculture, N. A. U., Navsari, Gujarat. According to Agro-climatic conditions, Navsari falls under South Gujarat Heavy Rainfall Zone I (Agro-ecological situation - III). The soil of the experimental site clayey in texture, EC (0.36 dS m^{-1}) and pH was (7.9). The soil was low in available nitrogen (220.36 kg/ha), medium in available phosphorus (50.74 kg/ha) and high in available potassium (470.14 kg/ha). The experiment comprised with sixteen treatments consisting irrigation conditions (I_1-irrigated and I_2- rainfed) and four levels of nitrogen (N_1- 0 kg N ha^{-1}, N_2- 30 kg N ha^{-1}, N_3- 60 kg N ha^{-1} and N_4- 90 kg N ha^{-1}) as main plot treatment and two varieties (V_1-PBNS-12 and V_2- PBNS- 86) in sub-plot. These treatments replicated threetimes in a split-split plot design. The experimental field was prepared by one deep ploughing with tractor-drawn plough and followed by harrowing and planking to achieve loose and friable seedbed. After final levelling plots and irrigation channels were prepared. The seeds of different varieties were sown at the spacing of 45 cm X 15 cm. The recommended full dose of P_2O_5 fertilizer 30 kg ha^{-1}, 50 per cent dose of nitrogen was applied as a basal dose and remaining 50 per

Table 1. Seed yield (kg ha^{-1}), Straw yield (kg ha^{-1}) and biological yield (kg ha^{-1}) of safflower as influenced by different treatments

Treatments	Seed yield	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Main Plot :I. Irrigation condition (I)			
Irrigation (I1)	1466.12	3300.04	4766.18
Rainfed(I2)	931.54	2227.08	3158.62
S.Em. ±	9.67	30.36	78.94
C.D. at 5%	58.85	184.73	480.35
II. Nitrogen levels (N)			
N1 - 0 kg N ha^{-1}	783.91	1892.25	2676.02
N2 - 30 kg N ha^{-1}	1176.50	2789.17	3965.69
N3 - 60 kg N ha^{-1}	1344.16	3094.75	4438.93
N4 - 90 kg N ha^{-1}	1490.75	3278.08	4768.95
S.Em. ±	32.85	91.74	87.57
C.D. at 5%	101.21	282.68	269.84
Sub plot :Variety (V)			
V1- PBNS-12	1302.87	2972.54	4275.42
V2- PBNS-86	1094.79	2554.58	3649.38
S.Em. ±	24.94	56.82	77.96
C.D. at 5%	74.77	170.36	233.73
Interaction			
I x N			
S.Em. ±	46.45	129.74	123.84
C.D. at 5%	NS	NS	NS
I x V			
S.Em. ±	35.27	80.36	110.25
C.D. at 5%	NS	NS	NS
N x V			
S.Em. ±	49.87	113.64	155.92
C.D. at 5%	NS	NS	NS
I x N x V			
S.Em. ±	70.54	160.72	220.51
C.D. at 5%	NS	NS	NS
C.V %	10.19	10.07	9.67

cent nitrogen was applied at 30 days after sowing as per treatment. The observation on seed yield, stover yield, biological yield, harvest index. Also calculate gross return, net return and B:C ratio as per standard formula's.

$$BCR = \frac{\text{Gross returns (Rs/ha)}}{\text{Total Cost of Cultivation (Rs/ha)}}$$

Result and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

Impact of Irrigation Condition

Yield parameters

Among irrigation conditions significantly superior seed yield (1466 kgha^{-1}), stover yield (3300 kg ha^{-1}) and biological yield (4766 kg ha^{-1}) were observed under irrigated condition.

Post sowing irrigations of safflower enhanced moisture availability, resulted in extensive root development enabling the plant to extract water and increasing nutrient uptake from depths (Suryavanshi *et al.,* 2007). Which increases physiological aspects and lead to net assimilation of photosynthates from source to sink. Due to better translocation of photosynthates from source to sink, improve vigorous crop growth and dry matter production resulting in a higher number of flower heads with a greater number of seed per capitula. Which is directly enhance the yield parameters and yield of the crop (Singh *et al.,* 2016).

Economics

Gross return (Rs 92971 ha^{-1}), net returns (Rs 56116ha^{-1}) and benefit cost ratio (2.52) were superior under irrigated condition than rainfed condition.

Effect of Nitrogen

Yield parameters

Among different levels of nitrogen application, significantly superior in seed yield (1490 kg ha^{-1}), stover yield (3278 kg ha^{-1}) and biological yield (4768 kg ha^{-1}) were observed with application of nitrogen 90 kg N ha^{-1}.

Higher nitrogen levels enhance safflower growth, resulting in more primary and secondary branches and an increased number of capitulaper plant. The increase in seed yield per plant with higher nitrogen levels is attributed to the greater number of capitula and seeds per capitula, consistent with findings by Bagul (2011). Nitrogen positively affects growth parameters such as functional leaves and primary and secondary branches, as well as yield attributes like the number ofcapitula and seeds per capitulum, leading to higher seed yields, particularly at 90 kg N ha^{-1}. This is in line with and Bagul (2011), though Shahrokhnia and Sepaskhah (2016) reported different results. Increased nitrogen also boosts stover yield by improving plant height and branch numbers. Biological yield, which depends on seed and stover yield, increases with 90 kg N ha^{-1} by Zarei *et al*. (2011).

Table 2. Influence of different treatments on economics of safflower (Rs)

Treatments	Total fixed cost	Total variable cost	Cost of cultivation	Gross income	Net returns	B:C ratio
I. Irrigation condition (I)						
Irrigation (I_1)	35067	1788	36855	92971	56116	2.52
Rainfed(I_2)	35067	0	35067	59593	24526	1.69
II. Nitrogen levels (N)						
N_1 - 0 kg N ha^{-1}	35067	0	35067	50221	15154	1.43
N_2 - 30 kg N ha^{-1}	35067	390	35457	75170	39713	2.12
N_3 - 60 kg N ha^{-1}	35067	780	35847	85514	49667	2.38
N_4 - 90 kg N ha^{-1}	35067	1170	36237	94224	57987	2.60
Sub plot – Variety (V)						
V_1-PBNS-12	35067	750	35817	82779	46962	2.31
V_2-PBNS-86	35067	750	35817	69785	33968	1.94

Economics

Gross return (Rs 94224 ha^{-1}), net returns (Rs 57987 ha^{-1}) and benefit cost ratio (2.60) were superior with application of nitrogen 90 kg N ha^{-1} than application of 0 kg N ha^{-1}.

Effect of variety

Yield parameters

Among varieties significantly superior in seed yield (1302 kg ha^{-1}), stover yield (2972 kg ha^{-1}) and biological yield (4275 kg ha^{-1}) were observed in variety V_1 (PBNS-12).

Varietal differences in safflower, exemplified by PBNS-12 and PBNS-86, show significant impacts on yield attributes. PBNS-12 consistently displayed higher numbers of capitula per plant, attributed to its increased primary and secondary branches, as supported by Gite *et al*. (2007) and Kawale (2010). This variety also produced more seeds per capitulum, reflecting its genetic predisposition, in line with findings by Gite *et al*. (2007) and Satish *et al*. (2013). PBNS-12 further excelled in producing heavier capitula per plant due to both its increased capitula number and higher seed count per capitulum, consistent with Jadhao (2019). These genetic advantages translated into higher seed yield per plant compared to PBNS-86, supported by studies from Singh (2016) and Jadhao (2019). Varietal differences also influenced stover yield, influenced by plant height, leaf area, and branch numbers, as noted by Bina *et al*. (2014).

Economics

Variety V_1 (PBNS-12) were found superior in gross returns (Rs 82779 ha^{-1}), net returns (Rs 46962 ha^{-1}) and benefit cost ratio (2.31).

Conclusion

Based on the results of field experimentation it can be concluded that, irrigate the safflower crop soon after sowing, at the time of flowering and grain filling stage for increasing yield over rainfed condition. Apply 90 kg N ha^{-1} and grow variety PBNS-12 for getting higher seed yield, stover yield and net returns.

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