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# Growth, Yield and Quality of Safflower Varieties as Influenced by Irrigation Schedules and Fertility Levels in Vertisols of Chhattisgarh Plains

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**Abstract**

The experiment was laid out in split-plot desigh with three replications. The main plot consisted of four levels of irrigation schedules i.e. $I_0$ -no irrigation, $I_1$-One irrigation at 40 DAS, $I_2$ -Two irrigations at 40 DAS and 80 DAS, $I_3$ -0.9 IW : CPE and two fertility levels i.e. high fertility level 120: 60: 60 kg NPK/ha and recommended fertility level 80:40:40 kg NPK/ha. The sub-plot treatment consisted of two varieties of safflower i.e. JSF-1 and JSI-7. The results revealed that the irrigation schedule at 0.9 IW: CPE produced maximum plant population, plant height, dry matter accumulation/plant, number of capitula/plant, number of seeds/capsule, 100-seed weight, seed and stover yield and harvest index.
**Key words : Safflower varieties, Yield, Irrigation schedules, Fertility levels.**

Oil is the chief constituent of human food diet. India has the dual distinction of having the highest acreage under oilseeds (19.0 million hectares). Most of the oilseed crops are cultivated in marginal and sub-marginal lands. Oilseeds are energy rich crops and need high energy inputs. Generally, farmers apply low input in terms of irrigation, fertilizer, pesticide and use local varieties. Oilseed production during the past 10 years has been stagnant around 10 meiric tonnes except for the year 1981-82, when it touched 11.3 metric tonnes. The per capita per day basic requirement of fat and oils have been recommended to be 34—38 g (1). Safflower (*Carthamus tinctorius* L.) is an important rabi oilseed crop in India, which is mostly cultivated in dry region. Besides India, it is also grown in Ethopia, China, Iran, South Europe and parts of USA. In general, safflower has 22—36% oil content which is rich in linoleic acid (75%). Person suffering from heart disorder can consume this oil and it does not build up cholesterol in the blood. The cake particularly from decorticated seed is used as concentrated cattle feed and some times used as manure. When oil is heated for two hours to 300 C and then poured into cold water it solidifies into gelationus glass cement and fixing stones used for ornamentals (2).

## Methods

The experiment was laid out in split-plot design with three replications. The main plot consisted of four levels of irrigation schedules i.e. $I_0$— No irrigation, $I_1$—One irrigation at 40 DAS, $I_2$— two irrigations at 40 DAS and 80 DAS, $I_3$—0.9 IW : CPE, and two fertility levels i.e. high fertility level 120 : 60 : 60 kg NPK/ha and recommended fertility level 80 : 40 : 40 kg NPK/ha. The sub-plot treatment consisted of two varieties of safflower i.e. JSF-1 and JSI-7, Safflower was sown on 27 November, 2003 with a seed rate of 10 kg/ha, row spacing of 40 cm and plant to plant spacing of 20 cm. The crop was harvested on 15 April 2004.

## Results and Discussion

The plant population of safflower was maximum under 0.9 IW : CPE, 120 : 60 kg NPK/ha and variety JSF-over their respective treatments. Plant height increased sharply from 30 to 60 DAS and later on rate of increase was slow. The taller plants were observed under 0.9 IW : CPE, 120 : 60 : 60 kg NPK/ha and variety JSF-1 at all the time intervals. Dry matter accumulation increased with the advancement of crop age. Dry matter accumulation followed the trend of plant height in response to irrigation schedules, fertility levels and varieties. Number of leaves/plant was maximum under 0.9 IW : CPE, higher level of 120 : 60: 60 kg NPK/ha and variety JSF-1 at all the time intervals (Table 1). Number of primary and secondary branches/plant

**Table 1.** Yield attributes and economics of safflower as influenced by irrigation schedules, fertility levels and varieties.

| Treatments | Plant height (cm) at harvest | Dry matter accumulation (g plant) At harvest | Number of leaves plant | Number of primary branches plant | Number of secondary branches plant | Capitula plant (No.) |
|---|---|---|---|---|---|---|
| **Irrigation Schedules** | | | | | | |
| No irrigation | 105.08 | 73.80 | 103.21 | 12.21 | 31.13 | 24.44 |
| One irrigation (40 DAS) | 109.14 | 75.38 | 109.43 | 12.19 | 33.83 | 27.20 |
| Two irrigations (40 & 80 DAS) | 111.55 | 77.09 | 114.38 | 13.27 | 35.44 | 29.45 |
| 0.9 IW : CPE | 114.54 | 78.07 | 118.03 | 14.47 | 35.88 | 31.79 |
| SE | 0.67 | 0.60 | 0.62 | 0.26 | 0.43 | 1.25 |
| CD ($P$ = 0.05) | 2.02 | 1.82 | 1.89 | 0.79 | 1.29 | 3.80 |
| **Fertility Levels (kg/ha)** | | | | | | |
| $N_{80} + P_{40} + K_{40}$ | 109.15 | 74.95 | 107.97 | 12.62 | 32.75 | 27.36 |
| $N_{120} + P_{60} + K_{60}$ | 111.01 | 77.22 | 114.55 | 13.40 | 35.38 | 29.08 |
| SE | 0.47 | 0.42 | 0.44 | 0.18 | 0.30 | 0.88 |
| CD ($P$ = 0.05) | 1.43 | 1.29 | 1.33 | 0.56 | 0.91 | NS |
| **Varieties** | | | | | | |
| JSF-1 | 111.11 | 76.74 | 114.15 | 13.60 | 35.52 | 29.02 |
| JSI-7 | 109.05 | 75.43 | 108.37 | 12.66 | 32.61 | 27.42 |
| SE | 0.64 | 0.31 | 0.34 | 0.14 | 0.25 | 0.66 |
| CD ($P$ = 0.05) | 1.92 | 0.96 | 1.01 | 0.42 | 0.76 | NS |

**Table 1.** Continued.

| Treatments | Seeds capsule (No.) | 100-seed weight (g) | Seed yield (kg/ha$^{-1}$) | Stover yield (kg/ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|
| **Irrigation Schedules** | | | | | |
| No irrigation | 12.97 | 4.40 | 1147.76 | 4703.67 | 19.60 |
| One irrigation (40 DAS) | 13.66 | 4.44 | 1288.67 | 5191.67 | 19.79 |
| Two irrigations (40 & 80 DAS) | 13.85 | 4.46 | 1375.75 | 5310.08 | 20.51 |
| 0.9 IW : CPE | 14.17 | 4.49 | 1446.91 | 5453.75 | 20.94 |
| SE | 0.43 | 0.07 | 9.35 | 41.10 | 0.12 |
| CD ($P$ = 0.05) | NS | NS | 28.37 | 124.68 | 0.36 |
| **Fertility Levels (kg/ha)** | | | | | |
| $N_{80} + P_{40} + K_{40}$ | 12.31 | 4.24 | 1277.50 | 5065.75 | 20.08 |
| $N_{120} + P_{60} + K_{60}$ | 15.01 | 4.65 | 1351.54 | 5263.83 | 20.35 |
| SE | 0.30 | 0.49 | 6.61 | 29.06 | 0.08 |
| CD ($P$ = 0.05) | 0.93 | NS | 20.06 | 88.16 | 0.25 |
| **Varieties** | | | | | |
| JSF-1 | 13.34 | 5.51 | 1335.14 | 5240.03 | 20.23 |
| JSI-7 | 19.99 | 3.38 | 1293.90 | 5089.21 | 20.20 |
| SE | 0.23 | 0.53 | 19.56 | 42.20 | 0.21 |
| CD (P = 0.05) | 0.69 | NS | NS | 126.53 | NS |

**Table 2.** Oil, protein content protein yield and economics as influenced by irrigation schedules, fertility levels and varieties.

| Treatments | Oil content (%) | Oil yield (kg/ha) | Protein content (%) | Protein yield (kg/ha) | Water use efficiency (kg/ha-cm) | Cost of cultiva-vation (Rs/ha) | Gross return (Rs/ha) | Net return (Rs/ha) | Benefit : Cost ratio |
|---|---|---|---|---|---|---|---|---|---|
| **Irrigation Schedules** | | | | | | | | | |
| No irrigation | 30.37 | 348.17 | 14.65 | 168.08 | 39.70 | 16068.50 | 16068.50 | 9648.00 | 1.50 |
| One irrigation (40 DAS) | 30.48 | 392.76 | 15.04 | 193.90 | 36.92 | 18041.38 | 18041.38 | 11170.88 | 1.62 |
| Two irrigations (40 & 80 DAS) | 30.84 | 424.33 | 15.34 | 212.04 | 33.63 | 19260.50 | 19260.50 | 11940.00 | 1.63 |
| 0.9 IW : CPE | 31.03 | 448.73 | 15.77 | 228.18 | 22.33 | 20256.74 | 20256.74 | 11586.24 | 1.33 |
| SE | 0.18 | 4.05 | 0.01 | 1.37 | 0.62 | | | | |
| CD ($P$ = 0.05) | NS | 12.28 | 0.03 | 4.16 | 1.89 | | | | |
| **Fertility Levels (kg/ha)** | | | | | | | | | |
| $N_{80} + P_{40} + K_{40}$ | 30.35 | 387.79 | 15.06 | 192.72 | 31.65 | 6870.50 | 17885.00 | 11014.50 | 1.60 |
| $N_{120} + P_{60} + K_{60}$ | 31.01 | 419.20 | 15.35 | 207.83 | 34.65 | 7770.50 | 18921.56 | 11151.06 | 1.43 |
| SE | 0.13 | 2.86 | 0.007 | 0.97 | 0.44 | | | | |
| CD (P = 0.05) | 0.38 | 8.68 | 0.022 | 2.94 | 1.33 | | | | |
| **Varieties** | | | | | | | | | |
| JSF-1 | 29.89 | 399.31 | 15.36 | 205.54 | 33.97 | 7325.50 | 18691.96 | 11366.46 | 1.55 |
| JSI-7 | 31.46 | 407.68 | 15.04 | 195.01 | 32.37 | 7315.50 | 18114.60 | 10789.10 | 1.47 |
| SE | 0.11 | 6.21 | 0.01 | 3.05 | 0.48 | | | | |
| CD ($P$ = 0.05) | 0.33 | NS | 0.03 | 9.14 | 1.42 | | | | |

were recorded maximum under 0.9 IW : CPE, higher level of 120 : 60 : 60 kg NPK/ha and variety JSF-1 (Table 1). Similar result have been also reported by Abal (3) and Raghu and Sharma (4).

The yield attributes like number of capitula/plant, number of seeds/capsule and 100-seed weight were significantly the highest under 0.9 IW : CPE, 120 : 60 : 60 kg NPK/ha and variety JSF-1, but number of seeds/capsule was the highest under JSI-7 (Table 1). Whereas, the lowest yield attributes were recorded under no irrigation, 80:40:40 kg NPK/ha and variety JSI-7 except seeds/capsule. The seed stover yield and harvest index were maximum under 0.9 IW:CPE, 120 : 60 : 60 kg NPK/ha and variety JSF-1 (Table 1). These parameters were the lowest under no irrigation, 80 : 40 : 40 kg NPK/ha and variety JSI-7. The higher oil yield was obtained under 0.9 IW : CPE compared to no, one and two irrigations (Table 2). Similar results have been also reported by Singh and Rathore (5).

Application of 120 : 60 : 60 kg NPK/ha produced the highest oil yield which was significantly superior over 80 : 40 : 40 kg NPK/ha. Among varieties, significantly higher oil yield was obtained in variety JSI-7. The protein content was significantly influenced due to various irrigation schedules, fertility levels and varieties. Irrigation schedule having 0.9 IW : CPE recorded the higher protein content as compared to no, one and two irrigations.

With regard to fertility levels, application of 120 : 60 : 60 kg NPK/ha resulted the highest protein content. Similarly, variety JSF-1 had higher protein content over JSI-7.

Maximum net return and benefit : cost ratio was found under two irrigations, followed by one, no and 0.9 IW : CPE irrigation schedules. The higher cost of cultivation (Rs 8,670.5/ha) and gross return (Rs 20,256.74/ha) were found under 0.9 IW : CPE over no, one and two irrigations. However, net return (Rs 11,940/ha) and benefit : cost ratio (1.63) were found to

be highest under two irrigations.

The maximum cost of cultivation (Rs 7,770.5/ha), gross return (Rs 18,921.56/ha), net return (Rs 11,151.06/ha) were noted under higher dose of 120 : 60 : 60 kg NPK/ha but benefit : cost ratio (1.60) was the highest under 80 : 40 : 40 kg NPK/ha. A similar trend was found under JSF-1 variety of safflower. Similar results have been also reported by Rajput et al. (6).

Protein yield was also significantly affected due to irrigation schedules, fertility levels and varieties. The higher protein yield was noted under 0.9 IW : CPE in comparison to no, one and two irrigations. Similarly, higher dose of 120 : 60 : 60 kg NPK/ha and variety JSF-1 recorded the highest protein yield. Application of higher fertility level of 120 : 60 : 60 kg NPK/ha resulted in higher water use efficiency than recommended level of 80 : 40 : 40 kg NPK/ha. The safflower variety JSF-1 showed maximum water use efficiency.

Water use efficiency was significantly influenced due to all treatments viz. irrigation schedules, fertility levels and varieties (Table 2). It was recorded to be highest under no irrigation treatment.

Application of higher fertility level of 120 : 60 : 60 : kg NPK/ha resulted in higher water use efficiency than recommended level of 80 : 40 : 40 kg NPK/ha. The safflower variety JSF-1 had maximum water use efficiency. The interaction among irrigation schedules, fertility levels and varieties were proved to be non-significant. Benefit : cost ratio was highest under 80 : 40 : 40 kg NPK/ha. Similarly, these values were the highest in variety JSF-1 (Table 2).

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