Original Research Article

Effect of moisture conservation practices and fertility levels on *rabi* safflower (*Carthamus tinctorius* L.)

ABSTRACT

Aim: To determine the effect of moisture conservation practices and nutrient management practices on growth, yield and economics of safflower.

Study design: Split plot

Place and Duration of Study: Agriculture Research Station, Tandur, between Nov 2021 and March 2022.

Methodology: A field experiment was conducted at Agriculture Research Station, Tandur, Vikarabad (District) during *rabi* 2021-22 to assess the effect of moisture conservation practices and fertility levels on safflower (*Carthamus tinctorius*) under rainfed condition. The experiment was assigned in twenty treatments, laid out in split plot design with three replications. Treatments included were 4 treatments of moisture conservation practices (i) M_1 = Fallow in *kharif fb* safflower in *rabi* (ii) M_2 = Greengram in *kharif fb* safflower in *rabi* (iii) M_3 = Compartmental bunding in *kharif fb* safflower in *rabi* (iv) M_4 = Barnyard millet in *kharif fb* safflower in *rabi* and 5 fertility levels (i) N_1 = Control (No fertilizer) (ii) N_2 = 50% RDF (iii) N_3 = 75% RDF (iv) N_4 = 100% RDF (v) N_5 = 125% RDF randomly placed in sub plots of the main plot.

Results: Significantly higher grain yield (1402 kg ha^{-1}), stover yield (3130 kg ha^{-1}) was recorded under compartmental bunding in *kharif fb* safflower in *rabi* (M_3). Similarly maximum grain yield (1565 kg ha^{-1}), stover yield (3659 kg ha^{-1}) was observed in 125% RDF (N_5). The lower yield was recorded in M_4 in moisture conservation practices whereas it was N_1 (control) as in case of fertility levels. Exceptionally higher net returns was observed in M_3 (Rs.53401) and N_5 (Rs.61506).

Conclusion: Adoption of moisture conservation practices during *kharif* in semi arid regions impounds the rainwater effectively thereby providing more residual moisture for the upcoming *rabi* crop and enhances the crop yield.

1. INTRODUCTION

Safflower locally known as kusum, is an annual oilseed plant belongs to family asteraceae and botanically it is called *Carthamus tinctorius* L. In India safflower is grown in winter dry season in mixture with other *rabi* crops, such as wheat and sorghum. Safflower has been grown in India since ancient times not only for orange red dye extracted from florets but also for oil. The dye was largely used for coloring purposes in food and textile industry. Safflower produces oil rich in polyunsaturated fatty acids which play important role in reducing blood cholesterol level and is considered as good healthy cooking medium (Sudhakar et al., [12]). Safflower is an important oil seed crop of *rabi* season in India mainly grown in semi-arid regions for vegetable and industrial oil purpose, although elsewhere its seeds are used as bird feed, young plants as forage plant and florets for preparing textile dyes. Safflower seed contains around 28 to 34 per cent of oil with high levels of linoleic acid, which is known to reduce blood cholesterol content. Now-a-days the rainfall is erratic and undependable, causes excess or deficient moisture conditions during one or the other stage of crop growth. Therefore, the yield of crops is often low and erratic. The variability in yield has mostly been caused by a lack of even distribution of rainfall all through the *kharif* season, as well as a low infiltration rate of soil. Crop production in rainfed locations has become more problematic in recent years due to uncertainty in rainfall availability, as well as variations in monsoon commencement, continuation, and withdrawal patterns (Singh,[10]). In these circumstances, effective rainwater management measures provide crop insurance during periods of unusual rainfall. Drought stress is one of the most significant constraints to crop development and output. Rainwater conservation and effective recycling are vital in achieving a sustainable farming production system in a rainfed zone. Compartmental bunding, ridge and furrow, and broad bed furrow developed systems are among the several moisture conservation strategies that show promise in minimizing surface runoff, reducing soil loss through erosion, and enhancing infiltration.

2. MATERIAL AND METHODS

A field experiment was conducted during *rabi* season of 2021-22 at Agriculture Research Station, Tandur, Vikarabad (District) with twenty treatments, laid out in split plot design with three replications. The soil of experimental site was clayey in texture and slightly alkaline in reaction (pH 7.94), low in organic carbon (0.44%) and available nitrogen (220.5 kg ha^{-1}), high in available phosphorus (37.2 kg ha^{-1}) and potassium (381.37 kg ha^{-1}) with electrical conductivity of 0.3 ds m^{-1}. Treatments included were 4 treatments of moisture conservation practices (i) M_1 = Fallow in *kharif fb* safflower in *rabi* (ii) M_2 = Greengram in *kharif fb* safflower in *rabi* (iii) M_3 = Compartmental bunding in *kharif fb* safflower in *rabi* (iv) M_4 = Barnyard millet in *kharif fb* safflower in *rabi* and 5 fertility levels (i) N_1 = Control (No fertilizer) (ii) N_2 = 50% RDF (iii) N_3 = 75% RDF (iv) N_4 = 100% RDF (v) N_5 = 125% RDF randomly placed in sub plots of the main plot. Safflower variety 'ISF 764' was sown in the field with a seed rate of 10 kg ha^{-1}, maintaining 45 cm x 20 cm as spacing at a depth of 2-3 cm. The crop was fertilized with 40:20:00 kg (100% RDF) Nitrogen, Phosphorus and Potassium ha^{-1} in the form of Urea and DAP.

3. RESULTS AND DISCUSSIONS

3.1 Growth parameters

The data presented in the (Table 1) shows the moisture conservation practices had not showed any significant difference among growth parameters of safflower. The M_3 treatment recorded higher plant height (77.95 cm), no. of branches (17.2), Leaf area index (3.58) and dry matter production (6311 kg ha^{-1}). The fertility levels recorded significantly higher plant height and other crop growth parameters. The 125% RDF (N_5) had recorded significantly higher plant height (99.77), no. of branches (21.5), leaf area index (3.85) and dry matter production (7351 kg ha^{-1}) followed by 100% RDF. The control treatment recorded lowest growth attributes due to non availability of nutrients. Instant and adequate availability of N, P and K under N_5 treatment resulted in higher plant height compared to other treatments. The low amount of nutrient availability might be the reason for slight response in the concerned treatments (N_1, N_2 and N_3). Similar results were reported by Rajput et al. [8], Kannan et al. [1] and Vijayaprabhakar et al. [13]. Residual soil moisture in the compartmental bunding treatment found to be beneficial to enhance the plant growth resulting in production of more number of branches per plant. Application of 125% RDF significantly increased the production of more branches due to availability of nutrients, and their absorption and utilization by the crop. Similar views were also expressed by Kubsad et al. [2] and Rajput [7].

3.2 Yield attributes and yield

The moisture conservation practices recorded significantly higher seed yield and stalk yield (Table 2). The M_3 treatment showed significantly higher seed yield (1402 kg ha^{-1}) and stalk yield (3130 kg ha^{-1}). The maximum no. of capitula $plant^{-1}$ (19.2), no. of seeds $capitulum^{-1}$ (18.3), weight of capitula $plant^{-1}$ (35.6 g $plant^{-1}$) was observed in M_3 followed by M_1. Among fertility levels 125% RDF recorded significantly higher yield attributes and yield (seed and stalk). Significantly higher no. of capitula $plant^{-1}$(20.0), weight of capitula $plant^{-1}$(42.5 g $plant^{-1}$), no. of seeds $capitulum^{-1}$(21.4), seed yield (1556 kg ha^{-1}) and stalk yield (3659 kg ha^{-1}). This was followed by 100% RDF (N_4) and 75% RDF (N_3). Increased seed yield of safflower was due to increase in yield attributes like number of capitula $plant^{-1}$, number of seeds $capitulum^{-1}$, weight of the capitula $plant^{-1}$ and 100 seed weight as observed in the present investigation. Increased NP availability due to adequacy of instant $N0^{-}_{3}$ ions from the fertilizers during seedling and vegetative stage might have increased dry matter production and its better partitioning resulted in improvement of yield attributing characters, culminating in higher seed yield and stalk yield which was clearly observed in case of N_5. Similar findings were also reported by Ramesh and Devasenapathy [9], Singh and Singh [11], Kumar et al. [3], Mesharam et al. [4].

3.3 Harvest index

The data presented in (Table 2) visualize that the moisture conservation practices did not have conspicuous effect on harvest index but harvest index was influenced significantly by fertility levels. The higher harvest index was noted with M_3 and lower harvest index with M_1. The significantly higher harvest index was observed in case of 125% RDF (N_5) followed by 100% RDF (N_4) whereas the lowest with control (N_1).

3.4 Economics

Compartmental bunding in *kharif fb* Safflower in *rabi* (M_3) registered higher net returns and B:C ratio (Table 2) among the moisture conservation practices. This was followed by Fallow in *kharif fb* Safflower in *rabi* (M_1). On the flip, least net returns and B:C ratio was observed with M_4. Among sub plots significantly higher net returns, B:C ratio was observed with 125% RDF (N_5) followed by 100% RDF (N_4). The least net returns was observed in N_1 (control) due to lower yields. Safflower under compartmental bunding coupled with 125% RDF recorded significantly higher gross returns, net returns and BC ratio due to vigorous plant growth, higher nutrient uptake improving translocation of photosynthates for elevated yield components production and higher seed yields resulting in higher monetary returns and BC ratio. These results tend to support the results of Patil et al. [6] and Narayana et al. [5].

Table 1. Growth parameters branches of safflower as influenced by moisture conservation practices and fertility levels.

	Plant height (cm)				Number of branches			Leaf area index (LAI)				Drymatter production (kg ha^{-1})			
Treatments	**30 DAS**	**60 DAS**	**90 DAS**	**Harvest**	**60 DAS**	**90 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**Harvest**
Moisture conservation practices															
M_1	9.79	53.55	70.53	74.20	6.5	14.8	17.0	0.37	2.93	3.88	3.57	864	2837	4760	5726
M_2	8.61	51.73	69.95	75.18	6.4	14.5	17.0	0.36	2.92	3.87	3.49	844	2742	4464	5689
M_3	10.09	58.00	71.01	77.95	7.0	15.7	17.2	0.37	2.95	3.96	3.58	922	2937	5128	6311
M_4	8.45	49.33	68.94	72.48	6.1	13.7	16.0	0.31	2.74	3.84	3.14	822	2666	4289	5488
SEm±	0.40	2.03	1.60	3.64	0.12	0.39	0.63	0.01	0.09	0.11	0.12	35.6	123.9	140.2	182.9
CD (P=0.05)	1.37	NS	NS	NS	0.40	NS	NS	0.05	NS	NS	NS	NS	NS	NS	NS
Fertility levels															
N_1	4.59	36.16	50.51	56.87	4.2	11.7	13.5	0.27	2.22	3.59	3.11	764	1846	3655	4361
N_2	5.58	46.89	58.42	61.02	5.1	12.5	14.5	0.32	2.64	3.62	3.36	809	2149	3996	4944
N_3	7.05	56.74	67.02	72.36	5.9	14.3	15.7	0.34	2.77	3.85	3.40	837	2388	4502	5834
N_4	13.01	60.24	81.76	84.75	7.8	16.2	18.8	0.39	3.16	4.03	3.51	915	3112	5181	6527
N_5	15.95	65.73	92.84	99.77	9.7	18.7	21.5	0.44	3.63	4.35	3.85	990	4476	5962	7351
SEm±	0.31	1.79	2.27	2.48	0.24	0.48	0.57	0.02	0.11	0.14	0.12	32.1	91.5	158.1	185.2
CD (P=0.05)	0.88	5.16	6.54	NS	0.70	1.39	1.65	0.06	0.32	0.41	0.35	92.4	263.7	455.4	533.6
Interaction															
Sub treatment at same level of main treatment															
SEm±	0.67	3.79	4.36	5.73	0.44	0.94	1.20	0.04	0.21	0.28	0.25	64.2	183.1	316.18	370.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment															
SEm±	0.61	3.58	4.54	4.95	0.48	0.96	1.14	0.04	0.22	0.29	0.24	67.6	205.4	315.68	378.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Yield attributes, yield and net returns of safflower as influenced by moisture conservation practices and fertility levels.

Treatments	No. of capitula plant $^{-1}$	No. of seeds capitulum^{-1}	Weight of capitula plant $^{-1}$(g)	100 seed weight (g)	Seed yield	Stalk yield	Harvest index (%)	Gross returns	Net returns	B:C ratio
Main treatments										
M_1	17.6	18.2	31.6	3.62	1251	2748	31.30	68090	46799	2.18
M_2	17.1	18.0	31.6	3.57	1207	2728	30.47	65691	43402	1.90
M_3	19.2	18.3	35.6	3.88	1402	3130	31.31	76292	53501	2.34
M_4	17.0	17.1	28.8	3.53	1116	2625	29.77	60737	38446	1.70
SEm±	0.76	0.75	1.21	0.12	38.74	77.92	1.11	2107.52	2107.66	0.09
CD (P=0.05)	NS	NS	4.19	NS	134.0	274.9	NS	7434.75	7435.25	0.34
Sub treatments										
N_1	15.6	15.7	22.0	3.48	947	2182	29.99	51538	30363	1.43
N_2	16.3	16.7	26.5	3.56	1070	2470	30.26	58200	36317	1.66
N_3	17.6	17.3	31.8	3.64	1225	2786	30.67	66683	44448	2.00
N_4	19.0	18.3	36.8	3.69	1426	2939	32.75	77588	54998	2.43
N_5	20.0	21.4	42.5	3.89	1565	3659	29.77	84504	61560	2.68
SEm±	0.59	0.61	1.04	0.12	36.9	77.9	0.91	2011.1	2011.1	0.09
CD (P=0.05)	1.71	1.74	2.99	NS	106.4	225.4	NS	5819.8	5819.8	0.26
Interaction										
Sub treatment at same level of main treatment										
SEm±	1.19	1.21	2.08	0.24	86.6	174.2	2.50	4712.5	4712.8	0.21
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment										
SEm±	1.30	1.31	2.21	0.24	76.6	159.6	1.98	4169.5	4169.6	0.18
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

4. CONCLUSION

Comparing compartmental bunding to other moisture conservation techniques, it can be said that compartmental bunding in the *kharif fb* safflower in *rabi* was more cost-effective in obtaining better seed yields and high net returns. Compartmental bunding during the *kharif* season ensures safflower production in areas where ongoing droughts and frequent crop failure are normal occurrences.

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