

Original Research Article

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## Yield, Nutrient Uptake and Economics of Safflower as Influenced by INM under Irrigation and Rainfed Planting

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### ABSTRACT

A field experiment on “Yield, nutrient uptake and economics of safflower as influenced by INM under irrigation and rainfed planting” was conducted during *rabi*, 2013 at College Farm, Rajendranagar, Hyderabad. The experiment was laid out in a split plot design with two main treatments viz., M<sub>1</sub>: irrigation at rosette, branching and flowering, M<sub>2</sub>: rainfed planting; and seven sub treatments viz., S<sub>1</sub>: Control (no fertilizers), S<sub>2</sub>: RDF, S<sub>3</sub>: soil test based fertilizers, S<sub>4</sub>: RDF + FYM @ 5 t ha<sup>-1</sup>, S<sub>5</sub>: soil test based fertilizers + FYM @ 5 t ha<sup>-1</sup>, S<sub>6</sub>: RDF + vermicompost @ 2 t ha<sup>-1</sup> and S<sub>7</sub>: Soil test based fertilizers + vermicompost @ t ha<sup>-1</sup> and replicated thrice. With respect to irrigations at critical stages gives higher seed yield, stalk yield, nutrient uptake, gross returns, net returns and BC ratio were recorded with irrigation treatment and it was significantly higher than rainfed planting. With respect to organics and soil test based inorganic fertilizers gives higher seed yield, stalk yield, nutrient uptake, gross returns and net returns were recorded with S<sub>7</sub> (soil test based fertilizers + vermicompost @ 2 t ha<sup>-1</sup>) and it was significantly superior to S<sub>6</sub> (RDF + vermicompost @ 2 t ha<sup>-1</sup>) followed by S<sub>5</sub> (soil test based fertilizers + FYM @ 5 t ha<sup>-1</sup>), S<sub>4</sub> (RDF + FYM @ 5 t ha<sup>-1</sup>), S<sub>3</sub> (soil test based fertilizers) and S<sub>2</sub> (RDF). BC ratio recorded higher with S<sub>1</sub> (control) treatment. Interaction effect of seed yield, stalk yield, nutrient uptake and economics of safflower crop as influenced by main and sub treatments were found to be non-significant.

#### Keywords

Safflower, INM, Irrigation, Rainfed, Yield, Nutrient uptake and economics.

#### Article Info

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### Introduction

Safflower (*Carthamus tinctorius* L.) is an oldest oilseed crop cultivated in India, mainly for cooking oil and dyes. Besides, safflower is a multipurpose crop species used in preparation of medicines, cosmetics, salads and margarine production (Balasubramanian and Palaniappan, 2005). Safflower seed contains 28-34% of oil, flavourless and colourless, and nutritionally similar to sunflower oil, having enough amount of linoleic acid (78%), which is very useful for reducing blood cholesterol content (Kadu and

Ismail 2008). Safflower oil preferred for its higher poly unsaturated fatty acid (78% linoleic acid) which reduces blood cholesterol level (Belgin *et al.*, 2007).

But, the productivity of safflower is very low as the crop is cultivated under nutrient stress environment conditions. However there is ample scope to increase safflower yields and quality by adopting suitable water and fertilizer management. Major nutrients like N, P and K should be supplied in sufficient

quantity and in a balanced way to enhance productivity of the crop (Vishwanath *et al.*, 2006). Since fertilizer is major input for increasing productivity, but cost of fertilizer is increasing. Hence there is need for inherent soil fertility to be enhanced by inclusion of organic manures which not only minimizes the cost of inputs but also boost the production and sustains soil fertility (Raju *et al.*, 2013). Also dumping of chemical fertilizers by the farmers without information on soil fertility status and nutrient requirement by crop causes adverse effects on soil and crop regarding both toxicity and deficiency either by over use or inadequate use (Rajan Bhatt, 2013). Hence application of fertilizers based on soil testing is the mantra for sustainable agriculture which takes care of inherent soil fertility. Productivity of the safflower can also be substantially increased by adopting appropriate water management practices especially, scheduling irrigation at critical stages *i.e.*, rosette, branching and flowering. Therefore keeping in view of the said facts above, safflower crop yields can be enhanced through integrated nutrient management and adopting soil test based concept, for which the present investigation was initiated.

## Materials and Methods

An experiment was conducted at College farm, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad during *rabi* 2013-14. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen, and medium in available phosphorus and high in available potassium.

Experiment was laid out in split plot design with two main treatments *viz.*, M<sub>1</sub>: irrigation at rosette, branching and flowering, M<sub>2</sub>: rainfed planting and seven sub treatments *viz.*, S<sub>1</sub>: Control (no fertilizers), S<sub>2</sub>: RDF, S<sub>3</sub>: RDF

based on soil test values, S<sub>4</sub>: RDF + FYM @ 5 t ha<sup>-1</sup>, S<sub>5</sub>: Soil test based fertilizers+ FYM @ 5 t ha<sup>-1</sup>, S<sub>6</sub>: RDF + vermicompost @ 2 t ha<sup>-1</sup> and S<sub>7</sub>: Soil test based fertilizers+ vermicompost @ 2 t ha<sup>-1</sup> and replicated thrice. Safflower variety Manjira was sown on 1-11-2013 at a spacing of 45 cm x 20 cm with one seed hill<sup>-1</sup>. RDF under irrigation is 60: 60: 30 kg ha<sup>-1</sup> and in rainfed is 30: 40: 20 kg ha<sup>-1</sup>. RDF as per soil test, under irrigation is 30: 39:15 kg and for rainfed is 20: 39: 10 kg NPK ha<sup>-1</sup>. P and K through SSP and muriate of potash applied as basal. While RDN as urea and through organics were applied as per the treatments. The organics were chemically analysed before sowing and N P and K content of FYM was 0.49, 0.74 and 0.92 per cent respectively, 1.64, 0.86 and 1.08 per cent in vermicompost respectively. About 98 mm rain fall received during the crop growing season in 8 rainy days.

## Results and Discussion

### Seed and stalk yield

The data pertaining to seed yield and stalk yield were presented in Table 1. Seed yield and stalk yield were significantly influenced by main treatments *i.e.*, irrigation and rainfed planting. Seed and stalk yield were significantly higher (1098 kg ha<sup>-1</sup>, 2666 kg ha<sup>-1</sup>) when the crop was irrigated at critical stages influencing the growth and yield parameters there by showing 20.21 % and 16.01% increase in the seed and stalk yield of rainfed safflower (876 kg ha<sup>-1</sup> and 2239 kg ha<sup>-1</sup>). Higher seed and stalk yield of safflower was obtained with irrigations at critical stages of crop growth, owing to availability of more nutrients for plant growth parameters and higher yield attributes like capitula per plant, seeds per plant and test weight. Similar results were reported by Singh *et al.*, (1995), Dashora and Sharma (2006) and Amoughin *et al.*, (2012).

Within the sub plots, the seed and stalk yield of 1295 and 3095 kg ha<sup>-1</sup> of safflower was significantly higher with S<sub>7</sub> (fertilizers based on soil testing + vermicompost @ 2 t ha<sup>-1</sup>) followed by S<sub>6</sub> *i.e.*, RDF + vermicompost @ 2 t ha<sup>-1</sup> (1148 and 2764 kg ha<sup>-1</sup>) followed by seed and stalk yield of 1062 and 2592 kg ha<sup>-1</sup> (S<sub>5</sub>), 982 and 2428 kg ha<sup>-1</sup> (S<sub>4</sub>), 907 and 2284 kg ha<sup>-1</sup> (S<sub>3</sub>) and 811 and 2093 kg ha<sup>-1</sup> (S<sub>2</sub>). The seed and stalk yield of safflower crop without fertilizers was found to be lower 705 and 1910 kg ha<sup>-1</sup> compared to rest of the treatments. Balanced supply of nutrients through balanced application of fertilizers (based on soil test), and organic matter in soil contributed by the application of organic manures significantly improved soil physico-chemical characters via modifying the soil environment to hold more moisture and

nutrients, better aeration and microbial activity influencing nutrient uptake and improving growth and yield components and ultimately yield of safflower. These results tend to support the results of Nalatwadmath *et al.*, (2003).

### Nutrient Uptake

The data pertaining to nutrient uptake of safflower was presented in Table 2. Significantly higher nitrogen (25.3, 16.0 kg ha<sup>-1</sup>), phosphorus (6.4, 8.1 kg ha<sup>-1</sup>) and potassium (24.9, 37.4 kg ha<sup>-1</sup>) uptake by grain and stalk of safflower was observed with irrigations at critical stages, while the lower nitrogen (18.8, 11.4 kg ha<sup>-1</sup>), phosphorus (4.5, 6.3 kg ha<sup>-1</sup>) and potassium (19.2, 30.3 kg ha<sup>-1</sup>) uptake was recorded in rainfed treatment.

**Table.1** Yield (kg ha<sup>-1</sup>) and economics of safflower as influenced by integrated nutrient management under irrigation and rainfed planting

Treatments	Seed yield (kg ha <sup>-1</sup> )	Stalk yield (kg ha <sup>-1</sup> )	Gross returns	Net returns	B:C Ratio
<b>Main plots</b>					
M <sub>1</sub> : Irrigation	1098	2666	41760	24145	2.45
M <sub>2</sub> : Rainfed	876	2239	33289	18218	2.25
SEm±	11.5	16.0	437.5	437.5	0.02
CD (P=0.05)	71.0	98.9	2699.2	2699.2	0.09
<b>Sub plots</b>					
S <sub>1</sub> : Control (no fertilizers)	705	1910	26815	16250	2.53
S <sub>2</sub> : RDF (NPK)	811	2093	30830	17750	2.35
S <sub>3</sub> : Soil test based fertilizers	907	2284	34478	21614	2.68
S <sub>4</sub> :RDF + FYM @ 5 t ha <sup>-1</sup>	982	2428	37316	19235	2.06
S <sub>5</sub> : Soil test based fertilizers + FYM @ 5 t ha <sup>-1</sup>	1062	2592	40387	22523	2.25
S <sub>6</sub> : RDF + Vermicompost @2 t ha <sup>-1</sup>	1148	2764	43624	22543	2.07
S <sub>7</sub> : Soil test based fertilizers + Vermicompost @ 2 t ha <sup>-1</sup>	1295	3095	49222	28358	2.36
SEm±	22.1	45.4	859.2	859.2	0.06
CD (P=0.05)	66.0	132.6	2508.4	2508.4	0.16
<b>Interaction</b>					
<b>Sub treatment at same level of main treatment</b>					
SEm±	30.5	42.4	1157.5	1157.5	0.04
CD (P=0.05)	NS	NS	NS	NS	NS
<b>Main treatment at same or different level of sub treatment</b>					
SEm±	31.7	61.1	1207	1207	0.07
CD (P=0.05)	NS	NS	NS	NS	NS

**Table.2** Nutrient uptake (kg ha<sup>-1</sup>) of safflower as influenced by integrated nutrient management under irrigation and rainfed planting

Treatments	N uptake			P uptake			K uptake		
	Seed	Stalk	Total	Seed	Stalk	Total	Seed	Stalk	Total
<b>Main treatments</b>									
M <sub>1</sub> : Irrigation	25.3 (2.29)	16.0 (0.60)	41.3 (2.69)	6.4 (0.58)	8.1 (0.30)	14.5 (0.88)	24.9 (2.27)	37.4 (1.40)	62.3 (3.67)
M <sub>2</sub> : Rainfed	18.8 (2.13)	11.4 (0.50)	30.2 (2.63)	4.5 (0.50)	6.3 (0.27)	10.8 (0.77)	19.2 (2.19)	30.3 (1.35)	49.6 (3.54)
SEm±	0.38	0.23	0.61	0.09	0.06	0.15	0.09	0.18	0.27
CD (P=0.05)	2.34	1.42	3.76	0.58	0.37	0.95	0.57	1.11	1.6
<b>Sub treatments</b>									
S <sub>1</sub> : Control (no fertilizers)	14.6 (2.07)	8.5 (0.44)	23.2 (2.51)	3.2 (0.45)	5.0 (0.26)	8.2 (0.71)	14.9 (2.11)	24.7 (1.30)	39.6 (3.41)
S <sub>2</sub> : RDF (NPK)	17.6 (2.16)	10.3 (0.49)	27.9 (2.65)	3.9 (0.48)	5.7 (0.27)	9.6 (0.75)	17.5 (2.15)	27.7 (1.33)	44.2 (3.48)
S <sub>3</sub> : Soil test based fertilizers	19.9 (2.18)	12.0 (0.52)	31.9 (2.70)	4.6 (0.50)	6.4 (0.28)	11.1 (0.78)	19.9 (2.19)	30.9 (1.36)	50.9 (3.55)
S <sub>4</sub> :RDF + FYM @ 5 t ha <sup>-1</sup>	21.0 (2.24)	13.4 (0.55)	35.4 (2.79)	5.3 (0.54)	7.0 (0.28)	12.3 (0.82)	21.7 (2.23)	33.5 (1.38)	55.2 (3.61)
S <sub>5</sub> : Soil test based fertilizers + FYM @ 5 t ha <sup>-1</sup>	24.1 (2.26)	15.0 (0.58)	39.1 (2.84)	6.1 (0.57)	7.7 (0.30)	13.8 (0.87)	23.8 (2.27)	36.4 (1.40)	60.2 (3.67)
S <sub>6</sub> : RDF + Vermicompost @ 2 t ha <sup>-1</sup>	26.3 (2.28)	16.8 (0.61)	43.0 (2.89)	6.9 (0.60)	8.4 (0.31)	15.4 (0.91)	26.3 (2.29)	39.1 (1.42)	65.5 (3.71)
S <sub>7</sub> : Soil test based fertilizers + V.C.@ 2 t ha <sup>-1</sup>	29.9 (2.30)	19.9 (0.64)	49.8 (2.94)	8.2 (0.63)	10.0 (0.33)	18.1 (0.96)	30.4 (2.34)	44.4 (1.44)	74.8 (3.78)
SEm±	0.52	0.29	0.81	0.13	0.14	0.27	0.08	0.78	0.86
CD (P=0.05)	1.54	0.85	2.39	0.58	0.44	1.02	0.23	2.26	2.49
<b>Interaction</b>									
<b>Sub treatment at same level of main treatment</b>									
SEm±	1.06	0.61	1.67	0.25	0.16	0.41	0.87	0.47	1.34
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>Main treatment at same/different level of sub treatment</b>									
SEm±	0.79	0.44	1.21	0.20	0.20	0.40	0.75	0.86	1.61
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Irrigating the crop at different growth stages enhanced the root development and extraction of moisture and increasing nutrient uptake. The results reported by Singh and Singh (1980) and Katara and Bansal (1995).

Among sub plots, significantly higher nitrogen (29.9,19.9 kg ha<sup>-1</sup>), phosphorus (8.2,10.0 kg ha<sup>-1</sup>) and potassium (30.4, 44.4 kg ha<sup>-1</sup>) uptake by grain and stalk was observed with application of soil test based fertilizers + vermicompost @ 2 t ha<sup>-1</sup>(S<sub>7</sub>) superior to rest of the treatments. Interaction effect on nitrogen, phosphorus and potassium uptake was found to be non-significant.

Highest uptake of nitrogen with application of soil test based fertilizers + vermicompost @ 2 t ha<sup>-1</sup> might be due to improved nutrient availability pattern of soil, reflecting biological yield and ultimately nutrient content and uptake of nutrients. Similar results were also reported by Kadu and Ismail (2008) and Raju *et al.*, (2013).

### **Economics**

The data pertaining to gross returns, net returns and BC ratio of safflower was presented in Table 1. The gross returns, net returns and BC ratio were found to be significantly influenced by the main treatments *i.e.*, irrigation and rainfed planting condition. Highest gross returns (41760 ha<sup>-1</sup>), net returns (24145 ha<sup>-1</sup>) and BC ratio (2.45) was observed in safflower irrigated at critical stages of crop growth which were significantly superior to rainfed planting.

Among the sub treatments, gross returns and net returns were significantly higher (49222 ha<sup>-1</sup>, 28358 ha<sup>-1</sup>) with the soil test based fertilizers + vermicompost @ 2 t ha<sup>-1</sup> (S<sub>7</sub>) compared to other treatments. The gross returns and net returns (26815 ha<sup>-1</sup>, 16250 ha<sup>-1</sup>) were lowest in S<sub>1</sub> treatment. Significantly

higher benefit cost ratio of 2.53 was obtained with S<sub>1</sub> treatment (control) as the cost incurred on inputs was less and seed yields were also lower than the rest of the treatments.

Soil test based fertilizer treatment (S<sub>3</sub>) obtained the highest BC ratio of 2.68 due to higher targeted yields, compared to the conventional blanket application of RDF alone (S<sub>2</sub>). Soil test based fertilizer treatment integrated with organic manures like FYM (S<sub>5</sub>) and vermicompost (S<sub>7</sub>) enhanced the yields and also resulted in higher BC ratio of 2.25 and 2.36 though less compared to S<sub>1</sub> and S<sub>2</sub> due to additional costs incurred on organic manures.

Blanket application of RDF (S<sub>2</sub>) and integration with FYM (S<sub>4</sub>) and vermicompost (S<sub>6</sub>) recorded BC ratio of 2.06 and 2.07, respectively. Interaction effect on gross returns, net returns and BC ratio of safflower as influenced by main and sub treatments were found to be non-significant.

Safflower under irrigation conditions, application of soil test based fertilizers + vermicompost @ 2 t ha<sup>-1</sup> recorded significantly higher gross returns and net returns, due to vigorous plant growth, high nutrient uptake improving translocation of photosynthates for elevated yield components production and higher seed yields resulting in higher monetary returns and BC ratio. Similar results were reported by Milap-Chand *et al.*, (2006) and Arbad and Ismail (2011).

The above results established that fertilizers based on soil testing + vermicompost @ 2 t ha<sup>-1</sup> is the best INM practice that can be adopted for safflower crop, which was significantly superior over RDF + vermicompost @ 2 t ha<sup>-1</sup>, Soil test based fertilizers + FYM @ 5 t ha<sup>-1</sup>, RDF + FYM @ 5 t ha<sup>-1</sup>, RDF based on soil test values, RDF

and control. The data led to conclude that soil testing +vermicompost @ 2 t ha<sup>-1</sup> is best treatment for safflower crop compared to other treatment combinations and control.

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