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Research Paper

Growth, Yield and Nutrient Uptake of Safflower as Influenced by Inm Under Irrigation and Rainfed Planting

Agronomy

KEYWORDS : Safflower, INM, irrigation, rainfed, growth, yield, nutrient uptake.

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ABSTRACT

A field experiment on "Growth, yield and nutrient uptake 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., M1: irrigation at rosette, branching and flowering, M2 : rainfed planting; and seven sub treatments viz., S1 : Control (no fertilizers), S2: RDF, S3: soil test based fertilizers, S4: RDF + FYM @ 5 tons/ha, S5 : soil test based fertilizers + FYM @ 5 tons/ha, S6: RDF + vermicompost @ 2 tons/ha and S7: Soil test based fertilizers + vermicompost @ 2 tons/ha and replicated thrice. With respect to irrigations at critical stages gives higher plant height, dry matter production per plant, seed yield, stalk yield and nutrient uptake 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 plant height, dry matter production per plant, seed yield, stalk yield and nutrient uptake were recorded with S7 (soil test based fertilizers + vermicompost @ 2 tons/ha) and it was significantly superior to S6 (RDF + vermicompost @ 2 tons ha-1) followed by S5 (soil test based fertilizers + FYM @ 5 tons/ha), S4 (RDF + FYM @ 5 tons/ha), S3 (soil test based fertilizers) and S2 (RDF). Interaction effect of plant height, dry matter production, seed and stalk yield and nutrient uptake of safflower crop as influenced by main and sub treatments were found to be non-significant.

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). Across the world, safflower is grown in 7.52 lakh ha with a total production of 6.46 lakh tons. India ranks first in area (41%) and production (29%) of the safflower grown across the world. In India, safflower is grown in 3 lakh ha and production is 1.89 lakh tons (*http://www.theindhu businessline.com, January, 2011*). In A.P. safflower is grown in 14,000 hactares with a production of about 20,000 tons, with a productivity of 435 kg ha^{-1}(Vyavasayapanchangam, 2014-15).

Safflower is an important *rabi* oil seed crop mainly grown in semi-arid regions for use as vegetable and industrial oil, bird feed, forage plant, medicinal purpose and for its colourful petals used as food coloring, flavouring agent and preparing textile dyes (Dordas and Sioulos, 2008). Importance of safflower as oilseed crop has increased in recent years, especially with increasing interest in production of biofuels (Essendal, 2001) and its well adaptation to saline and drought stress conditions due to its strong tap root (Bitarfan *et al*., 2011).

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_1: irrigation at rosette, branching and flowering, M_2: rainfed planting and seven sub treatments *viz., S_1: Control (no fertilizers), S_2: RDF, S_3: RDF based on soil test values, S_4: RDF + FYM @ 5 tons ha^{-1}, S_5: Soil test based fertilizers+ FYM @ 5 tons ha^{-1}, S_6 : RDF + vermicompost @ 2 tons ha^{-1} and S_7: Soil test based fertilizers+ vermicompost @ 2 tons ha^{-1} and replicated thrice.* Safflower variety Manjira was sown on 1-11-2013 at a spacing of 45 cm x 20 cm with one seed $hill^{-1}$. RDF under irrigation is 60: 60: 30 kg ha^{-1} and in rainfed is 30: 40: 20 kg ha^{-1}. RDF as per soil test, under irrigation is 30: 39:15 kg and for rainfed is 20 : 39 : 10 kg NPK ha^{-1}. P and K through SSP and muriate of

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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

Growth attributes:

The data pertaining to growth attributes is presented in Table 1. Growth attributes viz., Plant height and dry matter production of safflower were significantly influenced by main treatments and sub-treatments at harvest stage. The data revealed that the plant height and dry matter production per plant of safflower increased significantly under irrigated and rainfed planting. However, plant height (74 cm) and dry matter production (55.6 g plant^{-1}) of safflower was found to be maximum under irrigation compared to rainfed planting (70 cm and 50.4 g plant^{-1}) at harvest. Rapid increase in growth attributes of safflower under irrigation might be due to optimum soil moisture availability coupled with higher water potential and turgidity of plant cells and leaf expansion which ultimately lead to higher assimilation compared to rainfed safflower. Similar findings were also reported by Katole and Meena (1988), Singh and Singh (1989) and Patel and Patel (1993).

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^{-1}, 2666kg ha^{-1}) 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^{-1} and 2239 kg ha^{-1}). 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^{-1} of safflower was significantly higher with S_7 (fertilizers based on soil testing + vermicompost @ 2 t ha^{-1}) followed by S_6 *i.e.,* RDF + vermicompost @ 2 t ha^{-1}(1148 and 2764 kg ha^{-1}) followed by seed and stalk yield of 1062 and 2592 kg ha^{-1}(S_5), 982and 2428 kg ha^{-1} (S_4), 907 and 2284 kg ha^{-1} (S_3) and 811 and 2093 kg ha^{-1} (S_2). The seed and stalk yield of safflower crop without fertilizers was found to be lower 705 and 1910 kg ha^{-1} 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^{-1}), phosphorus (6.4, 8.1 kg ha^{-1}) and potassium (24.9, 37.4 kg ha^{-1}) uptake by grain and stalk of safflower was observed with irrigations at critical stages, while the lower nitrogen (18.8, 11.4 kg ha^{-1}), phosphorus (4.5, 6.3 kg ha^{-1}) and potassium (19.2, 30.3 kg ha^{-1}) uptake was recorded in rainfed treatment. 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^{-1}), phosphorus (8.2,10.0 kg ha^{-1}) and potassium (30.4, 44.4 kg ha^{-1}) uptake by grain and stalk was observed with application of *soil test based fertilizers + vermicompost @ 2 tons ha*$^{-1}$(S_7) 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^{-1} 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).

CONCLUSION:

The above results established that fertilizers based on soil testing + vermicompost @ 2 t/ha is the best INM practice that can be adopted for safflower crop, which was significantly superior over RDF + vermicompost @ 2 t/ ha, Soil test based fertilizers + FYM @ 5 tons/ha, RDF + FYM @ 5 tons/ha, RDF based on soil test values, RDF and control. The data led to conclude that soil testing +vermicompost @ 2 t/ha is best treatment for safflower crop compared to other treatment combinations and control.

Table 1. Growth and yield (kg ha^{-1}) of safflower as influenced by integrated nutrient management under irrigation and rainfed planting

Treatments	Plant height (cm)	Dry matter production (g plant^{-1})	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
Main plots				
M_1 : Irrigation	74	55.6	1098	2666
M_2 : Rainfed	70	50.4	876	2239
SEm±	0.1	0.4	11.5	16.0
CD (P=0.05)	0.4	2.6	71.0	98.9
Sub plots				
S_1: Control (no fertilizers)	65	39.8	705	1910
S_2: RDF (NPK)	69	47.9	811	2093
S_3: Soil test based fertilizers	71	50.7	907	2284
S_4 :RDF + FYM @ 5 t ha^{-1}	72	53.9	982	2428
S_5: Soil test based fertilizers + FYM @ 5 t ha^{-1}	73	56.4	1062	2592
S_6: RDF + Vermicompost @2 t ha^{-1}	75	59.9	1148	2764
S_7: Soil test based fertilizers + Vermicompost @ 2 t ha^{-1}	80	62.4	1295	3095
SEm±	0.35	0.7	22.1	45.4
CD (P=0.05)	1.46	2.1	66.0	132.6
Interaction				
Sub treatment at same level of main treatment				
SEm±	0.2	1.1	30.5	42.4
CD (P=0.05)	NS	NS	NS	NS
Main treatment at same or different level of sub treatment				
SEm±	0.7	1.1	31.7	61.1
CD (P=0.05)	NS	NS	NS	NS

Table 2. Nutrient uptake (kg ha^{-1}) 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
Main treatments									
M_1 : 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_2 : 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
Sub treatments									
S_1: 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_2: 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_3: 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_4 :RDF + FYM @ 5 t ha^{-1}	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_5: Soil test based fertilizers + FYM @ 5 t ha^{-1}	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_6: RDF + Vermicompost @ 2 t ha^{-1}	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_7: Soil test based fertilizers + V.C.@ 2 t ha^{-1}	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
Interaction									
Sub treatment at same level of main treatment									
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
Main treatment at same/different level of sub treatment									
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

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