International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 382-385

Received: 17-01-2018
Accepted: 19-02-2018

GV Venkataravana Nayaka
Department of Agronomy, Ph.D Scholar, S. V. Agricultural College, Tirupati, ANGRAU. A.P, India

G Somanagouda
Junior Agronomist, Department of Agronomy, ARS, Annigeri, Karnataka, India

Correspondence
GV Venkataravana Nayaka
Department of Agronomy, Ph.D Scholar, S. V. Agricultural College, Tirupati, ANGRAU. A.P, India

Effect of spacing and nitrogen levels on yield and oil content of *rabi* safflower (*Carthamus tinctorius*) in Vertisols of south India

GV Venkataravana Nayaka and G Somanagouda

Abstract
Safflower (*Carthamus tinctorius*) growth and productivity are influenced by many factors such as genotype, environment and agronomic practices. A field experiment was conducted at Agriculture Research Station, Annigeri, University of Agricultural Sciences, Dharwad during *kharif* and *rabi* seasons of 2014-15 under rainfed conditions to study the Effect of Spacing and Nitrogen levels on Yield and Oil content of *Rabi* Safflower (*Carthamus tinctorius*) in Vertisols of South India. The experiment was laid out in a split-split plot design and replicated thrice. Main plot consists of three treatments, greengram as a green manuring, greengram as a dual purpose crop grown during *kharif* and one fallow. Succeeding safflower was sown during *rabi* season with two sub treatments of spacings (45 cm x 20 cm and 60 cm x 30 cm) and three sub sub treatments of nitrogen levels (20, 30 and 40 kg N/ ha). In different spacing treatments, significantly higher oil yield was observed in 60 cm x 30 cm (360.64 kg/ha) than 45 cm x 20 cm (315.77 kg/ha). Among the different nitrogen levels, significantly higher oil yield was observed at 40 kg N/ha (409.30 kg/ha) over the 30 kg N/ha (318.17 kg/ha) and 20 kg N/ha (287.13 kg/ha).

Keywords: Safflower, Seed yield, oil yield, Spacing and Nitrogen levels

Introduction
Safflower (*Carthamus tinctorius*) (Asteraceae) is an oil-seed crop that originated from the eastern Mediterranean. It is mainly grown in semiarid regions for use as vegetable and industrial oil. Safflower is a crop species which is well adapted to dry and salty land conditions since it is a strongly tap-rooted annual plant which is resistant to saline conditions, drought stress and can reach the deep-lying water (Weiss, 2000) [9]. The importance of safflower as oilseed crop has increased in recent years, especially with the increasing interest in the production of biofuels. It is usually grown after cereals or fallow in crop rotation and can be adapted in organic production systems. Safflower growth as well as composition and quality of seeds are influenced by many factors like genotype, environment and agronomic practices. Fertilizing with nitrogen is one of the most important factors effects determining yield due to its multi-dimensional effects on the growth and development of safflower. Safflower has a higher need for nitrogen than other nutritional elements for its optimum vegetative and generative development and this need is generally met by nitrogen applications. Nitrogen increases seed yield primarily through its effect on the number of heads per plant and the increase is greater in tertiary and to a lesser extent in secondary heads. It is necessary to apply sufficient amount of nitrogen to achieve optimum yield and high-quality product. However over-Fertilization and insufficient fertilization applications lead to economic losses and discharge of excessive amount of nitrogen in the nitrate form through washing. Therefore Suggestions for fertilizers with nitrogen should be made so as to ensure a high-quality product, optimum yield, high profit and less environmental pollution risks. The other key point for optimizing safflower productivity in a given location is the choice of the appropriate spacing. Flowering is the most sensitive plant stage to water deficit. Moreover, various safflower diseases tend to spread and intensify towards and after flowering. Therefore, plants are subjected to several biotic and abiotic stresses during the seed filling period that diminish photosynthesis and crop nitrogen uptake limiting their production. The importance of carbohydrate and nitrogen storage in vegetative parts and their translocation to seeds to obtaining high yields under stress conditions has been widely recognized in many plant species.

Currently, sufficient data on safflower production management is lacking. Therefore, the key objectives of the present study were to determine the effect of nitrogen levels and spacing on *rabi* safflower needed to optimize cultivation criteria for the production of the safflower. This will enable more efficient use of nitrogen and determining the most proper spacing in the management of safflower crops.

Material and Methods: The field study was conducted during *kharif* and *rabi* seasons of 2014-15 under rainfed conditions at the Agricultural Research Station, Annigeri, Dharwad. The experiment was laid out in a split-split plot design and replicated thrice. Main plot consist of three treatments, greengram as a green manuring (GM_1) and greengram as a dual purpose (GM_2) grown during *kharif* and one fallow (GM_3). Succeeding safflower was sown during *rabi* season. Two sub treatments spacings (S_1: 45 cm x 20 cm and S_2: 60 cm x 30 cm) and nitrogen levels (N_1: 20, N_2: 30 and N_3: 40 kg N/ha) were applied to succeeding safflower.

The greengram crop was sown with the onset of monsoon (12th June 2014) at row spacing of 30 cm with seed rate of 12.5 kg/ha. Greengram crop was given a common dose of fertilizer of 25:50:25 kg N: P_2O_5: K_2O/ha at the time of sowing. Green manure GM_1 *i.e.* incorporation of greengram as a green manure at full bloom stage (45-50 DAS) in field was done on 1st August 2014. And GM_2 greengram as a dual purpose *i.e.* incorporation after picking of pods was carried out on (20.08.2014). The rainfall received in the month of August (170.4 mm) and September (130.2 mm) ensured proper decomposition of green manure. The average annual rainfall of the year April 2014 to May 2015 (841.7 mm) with 52 rainy days. During *rabi* season, the safflower crop was sown on 20th October 2014. The safflower was harvested at 130 days after sowing. The rainfall received in the month of October (128.4 mm), November (23.6 mm) and December (18.6 mm) ensured adequate moisture in the soil which in turns helped for proper growth and development of crop.

Results and Discussion

Effect of nitrogen on Yield and Oil Content of rabi Safflower: Nitrogen fertilization positively affected seed yield. Seed yield showed significant increase with increase in levels of nitrogen. Among the different nitrogen levels, significantly the highest seed yield was observed at 40 kg N/ha (14.42 q/ha) over the 30 kg N/ha (11.31 q/ha) and 20 kg N/ha (10.32 q/ha). And this was 39.72 per cent at 40 kg N/ha and 9.6 per cent at 30 kg N/ha higher compared to 20 kg N/ha (Table 1 and Fig 1). These results conformed to the following findings of Vishwanath *et al.*, 2006 [8]. Differences in seed yield of safflower were mainly due to differences in yield contributing characters. The improvement in seed yield with application of 40 kg nitrogen per ha was due to increase in yield attributing characters of safflower such number of capsules per plant, number seeds per capsules, seed weight per plant and test weight. All these yield components recorded significantly higher value at 40 kg nitrogen per ha than the 20 kg nitrogen per ha. Similar increases in yield attributes with increasing levels of nitrogen were reported in safflower by Golzarfar *et al.*, 2011 [3]; Zareie *et al.*, 2011 [11]; and Mohamed *et al.*, 2012 [5].

Effect of spacings on growth and yield of safflower: The performance of safflower was significantly influenced by adopting two different spacings. Between the spacings treatments, significantly higher seed yield was observed in 60 cm x 30 cm (12.77 q/ha) than the 45 cm x 20 cm (11.26 q/ha), which was 13.41 per cent higher in 60 cm x 30 cm compared to 45 cm x 20 cm (Table 1 and Fig 1). Wide spacing produced the highest number of capsules per plant, number of seeds per capsules, test weight and seed weight per plant as compared with narrow one. Due to the better environmental conditions in wide spacing and less competition between plants as well as increased light penetration within plant canopy which increased assimilation rate and oil formation. These results are in line with those obtained by Babak *et al.* (2011) [1] and Roqiyeh *et al.* (2012) [7].

Increased plant height with wider spacing (low density) may be due to increased light and decreased shadow, which permit auxin hormone to work together with gibberellin hormone to elongate the internal and this result in increasing stem growth. On the other hand, closer spacing (high density) leads to decreased light penetration to the vegetative parts of plant and cause photo destruction to oxygen which result in decreased plant height. With decreasing row spacing, seed yield per capsule generally tended to decrease. The yield per capsule reductions in safflower crop at high density can be explained by lower number of seeds per capsule, seed weight per plant and test weight Seed yield per capsule decreased with decrease row spacing, while total seed yield increased, this may be due to increase plant density which results in increased total seed yield as compared with seed yield per capsule, as shown in this reduction in seed yield per capsule by increasing plant density (decreasing row spacing) has been verified in some studies Ozel *et al.*, 2004. [6]

Quality parameters

Green manuring, spacing and different levels of nitrogen with their interactions effects did not show any significant influence on oil content of succeeding safflower but the oil yield of safflower at harvest, differed significant. Among the different nitrogen levels, significantly higher oil yield was observed at 40 kg N/ha (409.30 kg/ha) over the 30 kg N/ha (318.17 kg/ha) and 20 kg N/ha (287.13 kg/ha) (Table 2). These results are in line with the findings of Hebbi (2000) [4] and Yogesh (2013) [10].

Safflower is also known to contain a moderate amount of polyphenolic compounds, including tannins, which may improve the nutritional value of this species, especially as far as the protein metabolization in ruminants (Grabber and Coblentz, 2009) [2].

Table 1: Effect of spacing and nitrogen levels on seed yield (q/ha) and stalk yield (q/ha) of safflower.

Treatment		Seed yield (q/ha)				Stalk yield (q/ha)			
		N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
GM_1	S_1	11.07	11.80	13.90	12.26	40.86	43.83	49.52	44.74
	S_2	11.73	13.27	15.73	13.58	47.98	51.06	59.80	52.95
	Mean	11.40	12.53	14.82	12.92	44.42	47.45	54.66	48.84
GM_2	S_1	9.76	10.17	13.50	11.14	33.83	42.36	49.96	42.05
	S_2	10.86	12.46	15.51	12.94	41.43	45.44	56.67	47.85
	Mean	10.31	11.31	14.51	12.04	37.63	43.90	53.31	44.95

	S_1	8.15	9.39	13.59	10.37	35.82	39.04	44.58	39.81
Fallow	S_2	10.37	10.75	14.27	11.80	38.69	45.86	56.05	46.87
	Mean	9.26	10.07	13.93	11.09	37.26	42.45	50.31	43.34
Mean of S	S_1	9.66	10.45	13.66	11.26	36.84	41.74	48.02	42.20
	S_2	10.99	12.16	15.17	12.77	42.70	47.46	57.51	49.22
Mean		10.32	11.31	14.42		39.77	44.60	52.76	
For comparison of means		S.Em+		CD (p=0.05)		S.Em+		CD (p=0.05)	
Green Manuring (GM)		0.24		0.95		0.97		3.79	
Spacing (S)		0.24		0.82		0.93		3.21	
Nitrogen (N)		0.29		0.85		0.97		2.83	
GM x S		0.41		NS		1.61		NS	
GM x N		0.51		NS		1.68		NS	
S x N		0.41		NS		1.37		NS	
GM x S x N		0.72		NS		2.38		NS	

GM_1: Green gram (green manuring) S_1: 45 cm x 20 cm N_1: 20 kg N/ha (50% RDN)
GM_2: Green gram (dual purpose) S_2: 60 cm x 30 cm N_2: 30 kg N/ha (75% RDN)
N_3: 40 kg N/ha (100% RDN

Table 2: Effect of spacing and nitrogen levels on oil content (%) and oil yield (kg/ha) of safflower.

Treatment		Oil content (%)				Oil yield (kg/ha)			
		N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
GM_1	S_1	28.05	28.32	28.63	28.33	310.58	334.27	398.00	347.62
	S_2	28.23	28.59	28.82	28.55	331.24	379.38	453.57	388.06
	Mean	28.14	28.45	28.73	28.44	320.91	356.83	425.78	367.84
GM_2	S_1	27.83	28.07	28.38	28.09	271.67	285.37	383.21	313.42
	S_2	27.98	28.34	28.57	28.30	303.76	353.31	443.30	366.79
	Mean	27.91	28.20	28.48	28.19	287.72	319.34	413.26	340.10
Fallow	S_1	27.83	27.71	28.08	27.87	221.56	258.39	378.84	286.26
	S_2	27.82	27.94	28.61	28.12	284.00	298.31	398.88	327.06
	Mean	27.83	27.83	28.34	28.00	252.78	278.35	388.86	306.66
Mean of S	S_1	27.91	28.03	28.36	28.10	267.94	292.68	386.68	315.77
	S_2	28.01	28.29	28.67	28.32	306.33	343.67	431.92	360.64
Mean		27.96	28.16	28.51		287.13	318.17	409.30	
For comparison of means		S.Em+		CD (p=0.05)		S.Em+		CD (p=0.05)	
Green Manuring (GM)		0.06		0.18		6.73		20.29	
Spacing (S)		0.02		0.10		6.67		20.20	
Nitrogen (N)		0.04		0.12		8.29		24.21	
GM x S		0.04		NS		11.56		NS	
GM x N		0.07		NS		14.37		NS	
S x N		0.06		NS		11.73		NS	
GM x S x N		0.10		NS		20.32		NS	

GM_1: Green gram (green manuring) S_1: 45 cm x 20 cm N_1: 20 kg N/ha (50% RDN)
GM_2: Green gram (dual purpose) S_2: 60 cm x 30 cm N_2: 30 kg N/ha (75% RDN)
N_3: 40 kg N/ha (100% RDN)

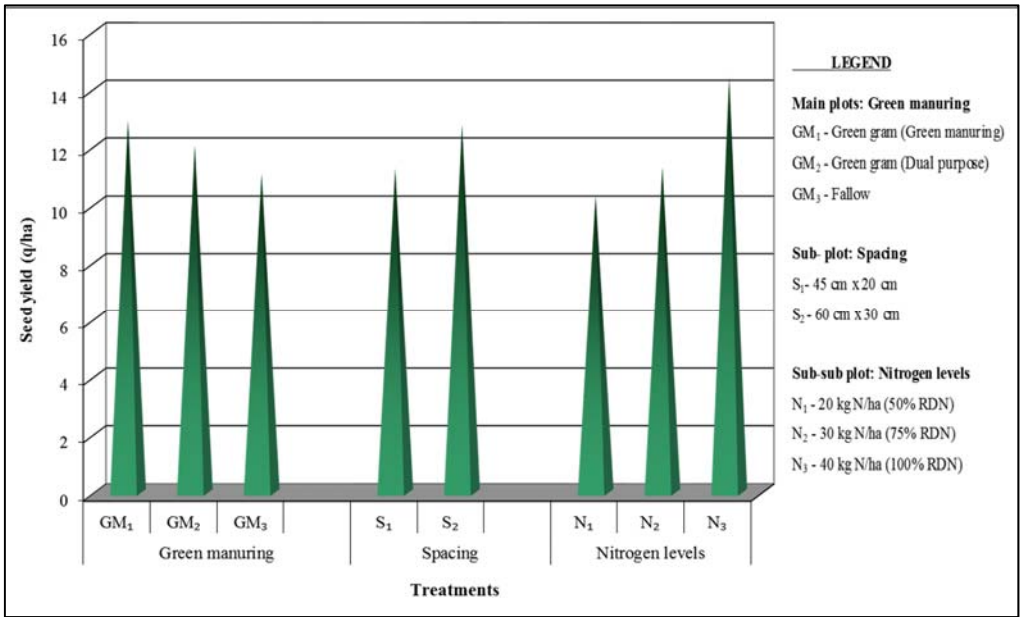

Fig 1: Effect of spacing and nitrogen levels on seed yield of safflower

References

1. Babak, Pasary, Ghorban, Noormohamadi, Evaluation of Growth Pattern, Seed and Flower Yield of Safflower Following Winter Crops. Intl. Conf. on Asia Argil and Animal. 13 IACSIT Press, Singapore. 2011, 96-100.
2. Grabber JH, Coblentz WK. Polyphenol, conditioning, and conservation effects on protein fractions and degradability in forage legumes. Crop. Sci., 2009; 49(4):1511-1522.
3. Golzarfar M, Shirani Rad AM, Delkhosh B. Nitrogen and phosphorus rates effect on yield and oil content of safflower in two growing season. Intl. J. Sci. Adv. Technol., 2011; 1(7):60-64.
4. Hebbi BS. Influence of *in situ* moisture conservation practices in sunnhemp green manururing and levels of nitrogen on *rabi* sorghum. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India)., 2000.
5. Mohamed SJ, Jellings AJ, Fuller MP. Effect of nitogen on safflower physiology and productivity. African Crop Sci. J., 2012; 20(4):225-237.
6. Ozel A, Demirbilek T, Gur MT. Copur effects of different sowing date and intrarow spacing on yield and some agronomic traits of safflower (*Carthamus tinctorius* L.) under Harran Plain's arid conditions. Turkish J. Agric. Forestry, 2004; 28:413-419.
7. Roqiyeh SA, Ahmad T, Shahzad JS. Effect of plant density on yied and yield components safflower under irrigation and no irrigation condition. Intl. J. Agric. Res. Rev., 2012; 2:1106-1116.
8. Vishwanath H, Pujari BT, Prakash SS, Ramesh babu, Deshmanya JB. Growth attributes, dry matter production and its partitioning and nutrient uptake studies in spainless safflower (*Cartamus tinctorious* L.) *var* NARI-6 as influenced by nitrogen and sulphur levels. Karnataka. J. Agric. Sci., 2006; 19(4):913-917.
9. Weiss EA. *Safflower*: Oilseed Crops, 93-129, Blackwell Sci. Ltd., Victoria, Australia, 2000, 606.
10. Yogesh TC. Effect of In-situ green manuring of legumes, NP levels and organic manures on growth, yield and quality of safflower. *Ph. D. Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India)., 2013.
11. Zareie S, Golkar P, Mohammadi NG. Effect of nitrogen and iron fertilizers on seed yield and yield components of safflower genotypes. African J. Agric. Res., 2011; 6(16):3924-3929.