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RESPONSE OF DATE OF SOWING ON YIELD AND YIELD ATTRIBUTES OF SAFFLOWER CULTIVARS

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ABSTRACT
In order to investigate the "Response of Date of Sowing on Yield and Yield Attributes of Safflower Cultivars" an experiment was conducted on a split plot design with 4 replications during the year 2013-14 at Indore (M.P.). The experiment consisted of 9 treatment combinations comprising 3 dates of sowing (1st November, 15th November, 30th November) as main plots and 3 cultivars (A-1, NARI-6, NARI-57) as subplots. The result showed that sowing of safflower on 1st November recorded significantly higher Yield and Yield attributing characters viz.; number of capitula/plant (26.21), weight of capitula (78.60 g plant^{-1}), number of seeds capitula^{-1} (22.21), 100 seed weight (6.20 g), higher seed yield (1701 kg ha^{-1}), straw yield (5683 kg ha^{-1}) and biological yield (7384 kg ha^{-1}) as compared to 15th November and 30th November respectively. Among the cultivars of safflower, A-1 had significantly higher yield and yield attributing characters viz., capitula/plant (27.21), weight of capitula (96.72 g plant^{-1}), and 100 seed weight (6.55 g), higher seed yield (1700 kg ha^{-1}), straw yield (5535 kg ha^{-1}) and biological yield (7235 kg ha^{-1}) over NARI-57 and NARI-6. From the study it can be concluded that combination of cultivar A-1 sown in 1st November performed best among all other treatment combinations.

INTRODUCTION

Safflower [*Carthamus tinctorius* (L.) Moench] is a very useful oilseed crop for rainfed or dryland areas. Generally it is known as *Kusum or Kardi*. Safflower is a member of the family Compositae and originally grown for the flowers that were used in making red and yellow dyes. In India the crop has traditionally been grown in the 'Rabi' or winter dry season. In Madhya Pradesh safflower average production is too low. In order to reduce deficiency in oil production and the level of oil and oilseed imported, oilseed crop production areas and oil yield should be increased or Alternative oil crops should be introduced (Nikabadi and Soleimani 2008). Safflower has a promising future as a salinity and drought resistant crop that has both spring and autumn types.

Planting date is very important in agricultural production management decisions, especially at region having environmental restrictions such as sooner or later coldness or serves (Emami *et al*., 2011). Cultivar selection is also a key management component in any cropping system even more critical in sowing date for crop production (Soleymani *et al*., 2011). All the varieties may not be suitable for timely as well as the late sowing. The differences in production of timely sown and late sown crops may be attributed to the unfavourable temperature prevailing at different growth stages, such as low temperature at the time of germination which may delay crop emergence. Low temperature may also slow down the growth and development of the crop, resulting in the accumulation of insufficient biomass and shortening of crop duration (Sooraj Chandra *et al*. 2015).

The field and quality properties of safflower are largely determined by ecological factors and cultivation techniques. It was reported that the sowing date and cultivars of safflower vary depending on ecological conditions (Daltalab *et al.,* 2013). Therefore, in order to obtain safflower with high yield and quality, it is essential to determine the suitable growth conditions and cultivation techniques. So the aim of this study was to evaluate the "Response of Date of Sowing on Yield and Yield Attributes of Safflower Cultivars".

MATERIALS AND METHODS

To evaluate the "Response of Date of Sowing on Yield and Yield Attributes of Safflower Cultivars" an experiment was conducted during the year 2013-14 at Field No. 4 under All India Coordinated Research Project on safflower, at RVSKVV, College of Agriculture, Indore (M.P.). A set of 9 treatment combinations comprising 3 dates of sowing (1st November, 15th November, 30th November) as main plots and 3 cultivars (A-1, NARI-6, NARI-57) as subplots laid out in split plot design with 4 replication.

The soil of experimental field was a typical medium black soil (vertisol), soil pH 8.2, EC (0.432 dsm^{-1}), low in organic (0.36 %), medium in available Nitrogen (235 kg ha^{-1}) and available phosphorus (14.9 kg ha^{-1}) but high in available potash (411 kg ha^{-1}). For ensuring good germination, healthy and good quality seeds were used with 20 kg ha^{-1} With Planting geometry (R × P) 45 x 20 cm. The recommended dose of fertilizer (60 N + 40 P_2O_5 + 20 K_2O kg/ha) was applied in safflower. Full dose of P_2O_5, K_2O and half dose of N were applied at the time

of sowing in the furrow below the seed. Remaining half dose of N was applied at stage of crop at 45 DAS. Soil moisture was not sufficient for crop growth so one uniform irrigation was given to the crop at 50 DAS. Harvest operation done manually.

Studied attributes that selected using 5 plants randomized in each plot included yield (seed yield, straw yield and biological yield) and Yield attributing characters such as number of capitula/plant, weight of capitula, number of seeds/capitula and 100 seed weight was calculated. The data was analyzed by the method of "Analysis of Variance" as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Number of capitula plant^{-1}

Number of capitula per plant is important yield contributing character to judge the seed yield of safflower crop. The data on average number of capitula plant^{-1} were analyzed statistically**.** Data presented in Table 4, revealed that dates of sowing showed a significant variation on number of capitula plant^{-1}. The maximum capitula plant^{-1} (26.21) was recorded with 1st November sown crop, which was significantly superior over 15th November and 30th November sown crop. Similar result was found by Emami *et al*. (2011).

The maximum capitula plant^{-1} (27.21) was recorded in cultivar A-1 followed by NARI-57 (24.46) and minimum capitula was recorded in cultivar NARI-6 (19.25). These findings confirm those of (Anonymous 2012). The data revealed that combinations of sowing dates and safflower cultivar did not differ significantly for number of capitula plant^{-1} (Table 2).

Weight of capitula (g plant^{-1})

The data in Table 4, showed that the maximum weight of capitula plant^{-1} (78.60 g) was observed in the 1st November sown crop and minimum weight of capitula (58.83 g) was found at 30th November crop. Odivi *et al*. (2013) reported that delay in sowing resulted generally decrease in the yield attributes. Increase in different yield attributing characters in 1st November sowing might be due to more availability of favorable environmental condition at the vegetative and reproductive phase of the crop and might be due to better uptake of nutrients and translocation of photosynthates during the reproductive phase of the crop, thus increasing the size and weight of seeds.

A perusal of data indicated that the maximum weight of capitula (96.72 g) was recorded with A-1. Whereas minimum weight of capitula (52.48 g plant^{-1}) was found with safflower cultivar NARI-6. The data presented in Table 6, revealed that maximum weight of capitula plant^{-1} was given by cultivar A-1 (100.95 g) sown on 30th November as compared to other treatment combinations.

Number of seeds capitula^{-1}

As per Table 4, the highest number of seeds capitula^{-1} (22.21) was obtained by the 1st November sown crop. It was significantly superior over other sowing dates followed by 15th November sowing.

Among the cultivars of safflower, the highest number of seeds per capitula (21.92) was obtained under the NARI-6, which was significantly superior over NARI-57 and A-1. The variation in these yield attributing parameters of the cultivars might be related to inherent differences and high vigour in these cultivars.

The mean pertaining to number of seeds capitula^{-1} in different treatment combinations were subjected to statistically

analyzed, which revealed that there was no significant difference between combination of sowing dates and safflower cultivar (Table 2). These findings confirm those of Daltalab *et al*. (2013).

100 Seed weight (g)

Table 1 : Site conditions of experimental localities

Experimental site	Latitude	Longitude	Height above mean sea level (m)	Average annual precipitation sum (mm)	Soil texture
Indore, (M.P.)	22°43'N	75°56'E	555.7	46.8	Silty loam

Table 1: Cont.....

Available Nitrogen content (kg ha^{-1})	Available phosphorus content (kg ha^{-1})	Available potash content (kg ha^{-1})	OC (%)	EC (dsm^{-1})	Soil pH
235	14.9	411	0.36	0.432	8.2

Table 2: Analysis of variance for experimental characterstics

S.O.V.	df	Number of capitula plant^{-1}	Weight of capitula(g plant^{-1}	Number of seeds capitula^{-1}	100 seed weight (g)
Replication	3	0.42	67.35	0.24	0.03
Date of sowing (S)	2	88.72*	1173.39*	22.90*	3.07*
Error (a)	6	2.74	48.70	0.55	0.03
Cultivar (C)	2	196.05*	7039.08*	15.75*	9.30*
Interaction (S×C)	4	2.10	627.43*	0.24	0.14*
Error (b)	18	1.34	19.52	0.37	0.03
Total	35	* significant at 5 % level			

Table 3: Analysis of variance for experimental characterstics

S.O.V.	df	Seedyield(kgha^{-1})	Straw yield(kg ha^{-1})	Biological yield(kg ha^{-1})
Replication	3	1233.75	10957.28	15365.82
Date of sowing (S)	2	1320972.09*	6211730.06*	13254722.53*
Error (a)	6	1608.83	28288.69	22331.60
Cultivar (C)	2	1383230.16*	3850552.73*	9780615.76*
Interaction (S×C)	4	62974.75*	239467.74*	201222.88*
Error (b)	18	840.81	14329.43	14946.08
Total	35	* significant at 5 % level		

Table 4 :Mean comparision for experimental characterstics

Treatments		Number of capitula plant^{-1}	Weight of capitula (g plant^{-1})	Number of seeds capitula^{-1}	100 seed weight (g)
Dates of sowing	1 November	26.21	78.60	22.21	6.20
	15 November	23.92	69.27	20.25	5.49
	30 November	20.79	58.83	19.54	5.22
	SEm	0.48	2.01	0.21	0.05
	CD at 5 %	1.65	6.97	0.74	0.18
Cultivars	A-1	27.21	96.72	19.67	6.55
	NARI-6	19.25	52.48	21.92	4.80
	NARI-57	24.46	57.51	20.42	5.56
	SEm	0.33	1.28	0.18	0.05
	CD at 5 %	0.99	3.79	0.52	0.15

Table 5 : Mean comparision for experimental characterstics

Treatments		Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Dates of sowing	1 November	1701	5683	7384
	15 November	1314	4787	6101
	30 November	1041	4260	5301
	SEm	11.58	48.55	43.14
	CD at 5 %	40.07	168.02	149.28
Cultivars	A-1	1700	5535	7235
	NARI-6	1022	4429	5451
	NARI-57	1333	4767	6099
	SEm	8.37	34.56	35.29
	CD at 5 %	24.87	102.67	104.86

Table 6: Mean comparision of Interaction effects

Treatments	Number of capitula plant^{-1}	Weight of capitula (g plant^{-1})	Number of seeds capitula^{-1}	100 seed weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
S1C1	29.88	95.66	21.00	7.11	1941	6566	8507
S1C2	21.63	66.93	23.75	5.24	1505	4988	6493
S1C3	27.13	73.21	21.88	6.25	1656	5496	7153
S2C1	27.13	93.54	19.38	6.57	1766	5408	7174
S2C2	19.13	49.30	21.25	4.58	842	4279	5122
S2C3	25.50	64.98	20.13	5.31	1333	4674	6007
S3C1	24.63	100.95	18.63	5.98	1394	4630	6024
S3C2	17.00	41.21	20.75	4.57	719	4021	4740
S3C3	20.75	34.34	19.25	5.12	1009	4130	5139

Note : S1 - 1 November, S2 - 15 November, S3 - 30 November, C1 - A-1, C2 - NARI-6, C3 - NARI-57

The data (Table 4), showed maximum 100 Seed weight (6.20 g) was obtained under the 1st November sowing followed by 15th November sowing date. The cultivar A-1 registered the highest 100 Seed weight (6.55 g) which was significantly superior over cultivar NARI-6 and NARI-57. The analysis of data revealed that cultivar A-1 gave the maximum 100 seed weight (7.11 g) in 1st November sown crop as compared to other treatment combinations. (Table 6). Similar results were reported by Ali Reza Badri *et al.* (2011).

Seed yield (kg ha^{-1})

Seed yield is the most economical character for evaluating the superiority of the treatment over the other. This increase in yield might be due to more yield attributes viz.; number of capitula plant^{-1}, weight of capitula plant^{-1} (g), number of seeds capitula^{-1}and 100 seed weight. The results are in close

association with findings of Emami *et al*. (2011). The data presented in Table 5, indicated that dates of sowing brought about significant variation in seed yield. The highest seed yield (1701 kg ha^{-1}) was obtained under 1st November sown crop, which was significantly higher over 15th November and 30th November sown crop. Similar result was noted by Odivi *et al*. (2013).

Among the cultivars maximum seed yield (1700 kg ha^{-1}) was recorded with A-1, Similar results were reported by Muralidharudu *et al*., 1989, Hulihalli *et al*., 1997, which was significantly higher over NARI-57 and NARI-57 also recoded significantly higher seed yield as compared to NARI-6 cultivar. (Table 5) Such close association of seed yield with different yield components was also observed by Mohankumar *et al*. (2005) and Anonymous (2012).

Among interaction of dates of sowing and cultivars of safflower, the data presented in Table - 6, indicated that cultivar A-1 recorded the highest seed yield (1941 kg ha^{-1}) with 1st November sown crop, which was followed by cultivar A-1 sown under 15th November (1766 kg ha^{-1}). All the cultivars performed significantly poorer seed yield on 30th November sowing over both the early dates. Planting season and cultivars and its interaction had significant effect on seed and biological yield. The findings are in close confirmity with Sheykhlou *et al*. (2012).

Straw yield (kg ha^{-1})

The data showed in Table 5, indicated that the highest straw yield (5683 kg ha^{-1}) was obtained under 1st November sown crop which was superior over 15th November and 30th November sown crop. In case of straw yield the cultivar A-1 was found superior over other cultivars due to taller plant. Cultivar A-1 registered highest straw yield (5535 kg ha^{-1}) over NARI-57 and NARI-6 during the investigation. The positive effect of date of sowing on straw and biological yield may be due to the pronounced growth during early stages of crop. It resulted that higher plant height and dry matter accumulation and ultimately tended in realization of higher straw and biological yields.

Among interaction of sowing dates and cultivars of safflower, the data presented in Table 6, indicated that cultivar A-1 recorded the highest straw yield (6566 kg ha^{-1}) under 1st November sown crop, which was followed by cultivar NARI-57 sown on 1st November (5496 kg ha^{-1}). On 30th November sowing all the cultivars performed significantly poorer over both the early dates. In case of straw yield cultivar A-1 with 1st November sowing was found superior over other combinations. This may due to taller plant. Similar result was found by Sheykhlou *et al*. (2012).

Biological yield (kg ha^{-1})

Table 5, indicated that the highest biological yield (7384 kg ha^{-1}) was obtained under 1st November sown crop which was superior over 15th November and 15th November sown crop also gave significantly highest biological yield over 30th November sown crop. Heidari Zadeh (2004) reported that postponing the sowing date in addition to temperature increase in developmental stages of germination to flowering which shortening this period cause to yield component production period encounter with high temperature and reduced the total plant dry weight although number of heads per plant, 100 seeds weight and seed yield more affected by it in comparison to biomass yield. The cultivar A-1 registered significantly higher biological yield (7235 kg ha^{-1}) over NARI-57 and NARI-57 also gave significantly highest biological yield over NARI-6 during the investigation.

Among interaction of dates of sowing and cultivars of safflower, the data presented in Table - 6, indicated that cultivar A-1 recorded the highest biological yield (8507 kg ha^{-1}) with 1st November sown crop, which was followed by cultivar A-1 sown on 15th November (7174 kg ha^{-1}). All the cultivars performed significantly poorer biological yield on 30th November sowing over both the early dates. Planting season and cultivars and its interaction had significant effect on seed and biological yield. The findings are in close confirmity with Sheykhlou *et al*. (2012).

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