

Effect of Temperature Stress on Yield and Yield Attributing Traits of Safflower (*Carthamus tinctorius* L.)

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Received: 25 Apr 2026; Revised accepted: 30 June 2026

Abstract

In order to investigate the “effect of varying temperature on growth and yield attributes of safflower” a total of 75 accessions was sown through normal sowing (N) and late sowing (L) at ZARS farm, AICRP on Safflower, Solapur during the year 2024-2025. These lines were evaluated alongside three national checks viz. A-1, PBNS-12, ISF-764 with main objective to identify the accessions suitable for normal as well as late sowing with least variation in the yield. The results showed that some entries exhibited more than 50% yield reduction, some entries showed more than 20% yield reduction. A total of six accessions recorded stable seed yield, with yield decrease of 1.30% – 14.80 % due to delayed sowing (16/11/2024) as compared to normal sowing (9/10/2024) and remaining all other accessions showed more than 15% yield reduction. Whereas the best check (ISF-764) recorded 14% decrease in seed yield. The variability in other yield attributing traits viz. Days to 50% flowering, Days to maturity, Plant height (cm), No. of capitulum/plant, No. of seeds/capitulum, 100-seed weight (g), Seed yield/plot was also studied. At normal sowing following accessions such as GMU-7886 & GMU-7909 showed 50% flowering at 70 Days, GMU-7521 and GMU-7519 matured at 121 days, GMU-7514 recorded 33.33 number of capitulum/plant. GMU-7869 showed maximum number of seeds/capitulum, GMU-7914 showed 100-seed weight of 6.38 gram. At Late sowing following accessions such as GMU-7886 & GMU-7909 showed 50% flowering at 70 Days, GMU-7521 and GMU-7519 matured at 121 days, GMU-7514 recorded 33.33 number of capitulum/plant. GMU-7869 showed maximum number of seeds/capitulum, GMU-7914 showed 100-seed weight of 6.38 gram. At late sowing, the least days to 50% flowering was recorded by GMU-7879 (53 days), GMU-7553, GMU-7885 and GMU-7873 matured in 113 days. Also, the highest number of capitulum per plant was 31 produced by GMU-7553, the highest number of seeds per capitulum of 33.33 was produced by GMU-7867, and the highest 100 seed weight of 7.3 g was produced by GMU-7877. From the study it can be concluded that, six accessions performed best among all other accessions in both normal as well as late sowing. With further study it can be recommended for late sowing.

Key words: Safflower, *Carthamus tinctorius* L., Sowing date, Temperature stress, Yield

Safflower is a rabi season oilseed crop of 120-200 days duration. It is known by different names in India as Kusum in Hindi, Karadi in Marathi, Kusube in Kannada and Kusuma in Telugu. Safflower (*Carthamus tinctorius* L.) is an annual, thistle-like plant in the Asteraceae family, commonly cultivated for its oil-rich seeds and historically for dyes. The area under safflower in India was 0.65 lakh ha, with 0.50 lakh tons production and productivity of 786 kg/ha in 2024. It is mainly grown in Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Orissa and Bihar. It is mainly cultivated for its seed. With 54%, Asia is leader of safflower production followed by America (27%), Europe (15%) and Africa (3.53%). World's 90% safflower is produced from Kazakhstan (34.72%), Russia (14.80%), Mexico (13.29%), USA (10.27%), India (6.74%), China (5.12%), Argentina (3.46%) and Turkey (3.27%) [1]. Safflower is a member of the family Compositae and originally

grown for the flowers that were used in making red and yellow dyes and much valued oil. Safflower has a promising future as a salinity and drought resistant crop that has both spring and autumn types.

Sowing date is very important in agricultural production management decisions, especially at region having environmental restrictions such as sooner or later coldness or serves [2]. All the varieties may not be suitable for timely as well as late sowing. The differences in production of timely sown and late sown crops may be attributed to the unfavorable 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 [3]. The optimum temperature of 20-32°C is required for its cultivation.

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Citation: Rajput HJ, Dighule SB, Lachyan TS, Magar NM, Kamdi TS. 2026. Effect of temperature stress on yield and yield attributing traits of safflower (*Carthamus tinctorius* L.). *Res. Jr. Agril. Sci.* 17(4): 438-440.

Plant performance depends on day length and temperature. During long day length and high temperature (28°C-31°C), plants will be more branchy and high yield. Whereas short day length and low temperature lead to reduced branches and low yield. In order to obtain safflower with high yield and yield attributing traits it is essential to identify the safflower lines suitable to temperature variations.

MATERIALS AND METHODS

To evaluate the “Effect of temperature stress on yield and yield attributes of safflower genotypes”, an experiment was conducted during the year 2024-25 at All India Coordinated Research Project on safflower, at AICRP Solapur (Maharashtra). A total of lines were evaluated alongside three national checks viz. A-1, PBNS-12, ISF-764 for various yield and yield attributing parameters viz. days to 50% flowering, days to maturity, plant height (cm), No. of capitulum / plant, No. of seeds/capitulum, 100-seed weight (g), Seed yield/plot and biological yield (kg/ha). The soil of experimental field was a typical medium black soil (vertisol), for ensuring good germination, healthy and good quality seeds were used with planting geometry of 45 × 20 cm. The recommended dose of fertilizer (40 N + 20 P + 20 K kg/ha) was applied in safflower. Full dose of P and K and half dose of N were applied at the time

of sowing. Remaining half dose of N was applied at stage of crop at 30-35 DAS. The plants were thinned after complete emergence in the 4-6 leaf stage. The final harvest was performed at physiological maturity stage.

RESULTS AND DISCUSSION

Number of capitula per plant

Number of capitula per plant is important yield contributing character to judge the seed yield of safflower crop. Data recorded during experiment, revealed that sowing date showed a significant variation on number of capitula/plant. Most of the entries showed reduced no. of capitula/plant at late sowing than normal sowing date issue to temperature variation at crop growth stages as reported by Mirzakhani *et al.* [4], Emami *et al.* [5], Badri *et al.* [6]. Whereas many entries showed more number of capitula per plant at late sowing as compared to normal sowing date such as, GMU- 7872 (12.67 N & 23 L), GMU-7916 (15 & 22.67), GMU-7890 & GMU-7865 (15 N & 20.5 L), GMU-7911 (10.67N & 22.67 L), GMU-7971 (12.33 N & 27.67 L) GMU-7920 (16.33 N & 27 L). The maximum capitula per plant was recorded 33.33 (GMU-7514) when sown at normal sowing date and maximum capitula / plant was recorded 31.00 (GMU-7514) when sown late.

Table 1 Variability in germplasm at different sowing dates-Solapur

Traits	Range		Range	
	Normal Sowing		Delayed Sowing	
	Minimum	Maximum	Minimum	Maximum
Days to 50% flowering	70 (GMU-7886, GMU-7909)	85 (GMU-7989))	53 (GMU-7879)	70 (GMU-7906, GMU-7913 GMU-7893)
Days to maturity	121 (GMU-7521, GMU-7519)	128 (GMU-7186)	113 (GMU-7553, GMU-7885, GMU-7873)	123 (GMU-7913)
Plant height (cm)	24.67 (GMU-7516)	83.33 (GMU-7517)	42 (GMU-7897)	110.33 (GMU-7522)
No. of capitula / plant	10 (GMU-7523, GMU-7519)	33.33 (GMU-7514)	3.67 (GMU-7869)	31 (GMU-7553 & GMU-7514)
No. of seeds / capitula	10.7 (GMU-7870)	31.3 (GMU-7869)	6.33 (GMU-7523)	33.33 (GMU-7867)
100-seed weight (g)	2.12 (GMU-7883)	6.38 (GMU-7914)	1.28 (GMU-7890)	7.3 (GMU-7877)
Seed yield / plot	28 (GMU-5146)	218 (GMU-7514)	11 (GMU-7555)	226 (GMU-7971)
Biological yield (kg/ha)	26 (GMU-7892)	1054 (GMU-7574)	54 (GMU-7863)	585 (GMU-7920)

Number of seeds per capitula

Among all the entries highest number of seeds / capitula (31.3) was obtained by GMU-7869 at normal sowing which was superior over A-1 (28.3), PBNS-12 (23.7) and at par with ISF-764 (32.3). At late sowing the highest number of seeds / capitula (33.33) was obtained by GMU-7867 which was significantly superior over all the three checks A-1 (32.3), PBNS-12 (23.3) and ISF-764 (21.67). In contrast to other entries, there were some entries which were showing more number of seeds per capitula at late sowing than normal sowing such as GMU-7881 (15.7 N & 20.3 L), GMU- 7870 (10.7 N & 20.67 L), GMU-7877 (21 N & 26.66 L), GMU-7873 (16 N & 21.33 L), GMU-7886 (20 N & 28 L), GMU-7971 (14 N & 20 L) & GMU- 7867 (25.7 N & 33.33 L). On the other hand, some entries showed stable number of seeds per capitula even during the temperature stress caused due to change in sowing dates such as GMU-7863 (13.3

N & 13.3 L), GMU-7874 (17.3 N & 18 L) and GMU-7521 (21 N & 20 L).

Seed yield per plot

Seed yield is the most economical character for evaluating the superiority of the treatment over the other. The highest seed yield (218 gm / plot) was obtained under normal sowing from GMU-7514, which was significantly superior over all the three checks and highest seed yield of about 226 gm/plot was obtained from GMU-7971 under late sowing. This increase in seed yield might be due to more yield attributes viz.; number of capitula per plant and number of seeds per capitula. Pasban Eslam [7] reported that there is a positive and significant correlation between number of seeds per head and seed yield. A total of 11 entries were found to give more seeds yield at late sowing than normal sowing whereas 4 entries showed almost same seed yield (gm / plot) at normal as well as late sowing,

such as GMU-7465 (66 N & 58 L), GMU-7891 (97 N & 84 L), GMU-7867 (72 N & 80 L) and GMU 7865 (58 N & 62 L). In 60-65 entries seed yield was decreased due to delayed sowing and this finding is in close conformity with findings of Abel [8].

Variability in the seed yield due to change in temperature at the crop growth stages at the two dates of sowing is presented in (Table 2). A total of six accessions recorded decrease of 1.30% – 14.80% due to delayed sowing whereas the best check (ISF-764) recorded 14% decrease in seed yield. GMU-7886 (77.00 and 76.00 g/plot), GMU-7891 (97 and 84 g/plot), GMU-7165 (66 and 58 g/plot), GMU- 7901 (41 and 34 g/plot) and GMU-7913 (129 and 110 g/plot) recorded stable seed yield in two dates of sowing. GMU-7886 gave 77.00 g/plot (N) and 76.00 g/plot (L) with 1.3% decrease in yield, GMU-7891 yielded 97.00 g/plot (N) and 84 g/plot (L) with 7.22% decrease in yield, GMU-7165 gave 66 g/plot (N) and 58 g/plot (L) with

12.20% decrease in yield, GMU- 7901 showed 41 g/plot (N) and 34 g/plot (L) with 12.20% decrease in yield and GMU-7913 yielded 129 g/plot (N) and 110 g/plot (L) with 14.80% decrease in yield [9].

Biological yield (kg /ha)

Data depicted in (Table 1) indicated that the highest biological yield (1054 kg/ha) was obtained under normal sown crop which was superior over late sown crop (725 kg/ha). Heidari Zadeh [10] 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 reduce the total plant dry weight. Two entries such as GMU-7553 & GMU-7872 produced approximately same amount of biological yield.

Table 2 Promising accession identified based on yield at two sowing dates

S. No.	Accession	Seed yield (g) (Normal sowing)	Seed yield (g) (Delayed sowing)	Decrease in seed yield (%)
1.	GMU-7165	66	58	12.20
2.	GMU-7913	129	110	14.80
3.	GMU-7891	97	84	7.22
4.	GMU-7914	152	133	12.50
5.	GMU-7886	77	76	1.30
6.	GMU-7901	41	34	12.20
7.	ISF-764 (Check)	50	43	14
8.	PBNS-12	64	58	12.80

CONCLUSION

According to our results, GMU-7514 and GMU-7895 produced the highest seed yield in comparison to other cultivars when sowing in an appropriate date. But in delayed sowing GMU-7971 and GMU-7905 produced higher seed yield. As concerned to stable yield in both the condition (normal and delayed sowing), these six entries viz., GMU-7886, GMU-7891, GMU-7165, GMU-7914, GMU-7901 and GMU-7913

produced approximately same seed yield in comparison to all the remaining entries. Therefore, with further studies, these entries can be recommended for delayed sowing in safflower growing regions.

Acknowledgement

We gratefully thank the Indian Institute of Oilseed Research, Hyderabad, Mahatma Pule Krishi Vidyapeeth, Rahuri and ADR, ZARS, Solapur for their invaluable support in completing this research project.

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