

**RESEARCH ARTICLE :**

Effect of date of sowing on yield and disease intensity of *Alternaria* blight in safflower

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SUMMARY : The field experiment were carried out, during *Rabi*, 2013-14 and *Rabi*, 2014-15 at Research Farm, AICRP (Safflower) and Department of Agronomy, Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. *Alternaria* blight of safflower caused by a fungal pathogen, *Alternaria carthami* is an important disease. Investigations were made on the effect of sowing dates on disease intensity and yield of safflower crop. Highest disease intensity was recorded when crop was sown early during first fortnight of September was found to suffer severely with *Alternaria* blight disease with significant reduction in seed yield; however delayed sown crop from second fortnight of September onward the blight disease intensity was found to decrease drastically.

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KEY WORDS :

Alternaria carthami,
Carthamus tinctorius
L., Sowing dates

BACKGROUND AND OBJECTIVES

Safflower, (*Carthamus tinctorius* L.), is one of the world's oldest important oilseeds crop of the semi-arid regions belonging to the family Asteraceae (Compositae). The major safflower-producing countries of the world are: India, Mexico, USA, Argentina, Canada, China, Spain, Italy, Turkey, Iraq, Iran, Egypt, Ethiopia and Sudan. The area, production and productivity of safflower has been reported to be 14.64 and 2.96 lakh hectares, 13.21 and 1.80 lakh tons and 675.9 and 609 kg/ha, respectively, in the World and India (Anonymous, 2013). Major safflower growing states in India are: Maharashtra, Karnataka and part of Telangana and Andhra Pradesh,

Madhya Pradesh, Orissa and Bihar. The total area in Maharashtra and Marathwada region under safflower was 1.93 and 1.29 lakh hectares area, with production 1.14 and 0.96 lakh tones and productivity of 590 and 744 kg/ha, respectively (Anonymous, 2013). In Maharashtra it is mainly grown in Solapur, Pune, Ahmednagar, Latur, Osmanabad, Parbhani, Hingoli and Jalna districts (Das, 1997). In Maharashtra, popularly grown safflower varieties/cultivars are: Bhima (S4), Girna (JLSF-88), NARI-6, NARI-34, A-1, JSI-7, Sharda (BSF-168-4), PBNS-12, Nira (NRS-209), Nagpur-7, NARI-NH-1, N-62-8, Tara, Phule Kusum and N-630.

Among the major factors responsible for lower yields, diseases play an important role.

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Safflower is also affected by many biotic and abiotic stresses. Of the biotic agents, fungi cause major diseases, followed by bacteria, viruses and nematodes. Major safflower diseases caused by fungi are: Leaf spot / blight (*Alternaria carthami*), Wilt (*Fusarium oxysporum* f. sp. *carthami*), Root rot (*Rhizoctonia bataticola*), Powdery mildew (*Erysiphe cichoracearum* DC) and Anthracnose (*Colletotrichum capsici*); bacterial Leaf blight / spot (*Pseudomonas syringae* Van Hall); viral diseases such as Mosaic (Cucumber mosaic virus), Necrosis (Tobacco streak virus) and root knot (*Meloidogyne hapla*) nematode (Bhale *et al.*, 1998).

Alternaria blight caused by *A. carthami* (Chowdhury) is one of the most widely spread and destructive disease of safflower (*Carthamus tinctorius* L.). The pathogen induces damping-off, leaf blight and stem canker, which accounts for about 25 - 60 per cent seed yield losses. Though *Alternaria* blight disease in safflower and other crops can be managed by spraying chemicals / biological fungicides, but by adjusting sowing time one can avoid susceptible stage of the crop to *Alternaria* blight disease. The adjustment of sowing dates / seasons is an obviously best strategy, escaping the crops susceptible stage and also constitutes one of the components of integrated disease management (Singh *et al.*, 2009).

RESOURCES AND METHODS

Effect of sowing dates and safflower cultivars :

The effects of sowing dates and safflower cultivars on the intensity of *Alternaria* blight (*A. carthami*) disease and its corresponding effect on seed yield were studied under field conditions, during *Rabi*, 2013-14 and *Rabi*, 2014-15 at Research Farm, AICRP (Safflower) and Department of Agronomy, Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani. A total of five sowing dates as main treatments (D₁ - 1st September, D₂ - 10th September, D₃ - 20th September, D₄ - 30th September and D₅ - 10th October) and three safflower cultivars *viz.*, V₁ - PBNS-12, V₂ - Sharada and V₃ - Manjira as sub-treatments were sown in 3.15 x 2.0 m² plot size at 10 days intervals with 45 x 20 cm spacing, starting from 1st Sept. to 10th Oct. in split plot design with three replications.

The crop was grown as per recommended package of practices. Except fungicidal application, plant protection measures for insect pest management were undertaken and protective irrigations to the crop were

given, whenever required during both the seasons. Observations on *Alternaria* blight disease intensity on the safflower crop sown at various dates were recorded, starting at first appearance of the disease, subsequent at 15 days interval and continued till 90 days.

For recording *Alternaria* blight disease intensity, ten safflower plants / plot / replication were randomly selected tagged and three leaves (bottom, middle and top) per plant were selected. The disease intensity was recorded at 15 days interval applying 0-9 grade disease rating scale (Mayee and Datar, 1986). Per cent disease intensity (PDI) was worked out by applying standard formula (McKinney, 1923).

$$PDI = \frac{\text{Summation of numerical ratings observed}}{\text{No. of leaves / plants observed} \times \text{maximum grade}} \times 100$$

Seed yield data :

The safflower crop cultivars sown at various dates during *Rabi*, 2013-14 and *Rabi*, 2014-15 were harvested manually at their maturity allowed to sun-dry, threshed manually, recorded the test weight and seed yield (kg / plot / replication) and cumulative seed yield data was presented (q/ha).

Pooled analysis

The data obtained on per cent blight disease intensity, seed test weight and seed yield in both the experiments (*Rabi* 2013-14 and 2014-15) were subjected to pooled analysis and interpreted the results thereof.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Effect of sowing dates and safflower cultivars on *Alternaria* blight intensity :

Pooled mean results (2013-14 and 2014-15) :

Effect of sowing dates :

The pooled mean data (Table 1) revealed that the *Alternaria* blight disease intensity on the safflower crop sown at various dates was increased with age of the crop and decreased steadily with subsequently delay in the sowing. The safflower sown early (D₁ : 1st September) exhibited significantly highest pooled overall average *Alternaria* blight intensity of 22.42, 33.46, 42.64, 46.51 and 48.96 per cent, respectively at 30, 45, 60, 75

and 90 DAS. This was followed by the crop sown on 10th September (D₂) with pooled overall average disease intensity of 19.13, 29.48, 38.65, 42.50 and 44.94 per cent; the crop sown on 20th September (D₃) with pooled overall average disease intensity of 14.27, 24.56, 33.01, 36.84 and 39.25 per cent and the crop sown on 30th September (D₄) with pooled overall average disease intensity of 9.48, 19.72, 27.84, 31.64 and 34.01 per cent, respectively at 30, 45, 60, 75 and 90 DAS. The crop sown late on 10th October (D₅) was found to suffer less with comparatively least pooled overall average disease intensity of 8.16, 16.35, 24.42, 28.20 and 30.56 per cent at 30, 45, 60, 75 and 90 (DAS), respectively. At 90 DAS, disease intensity among five sowing dates was at par as well as it was significantly higher in the crop sown early, which later decreased steadily in the crop sown on later subsequently

dates.

Effect of safflower cultivars :

The pooled mean results (Table 1) revealed that in all three safflower cultivars, *Alternaria* blight intensity varied significantly with the sowing dates as well as increased steadily with age of the crop.

Among three safflower cultivars grown, PBNS-12 and Sharda (tolerant) recorded comparatively minimum pooled average disease intensity (22.36 and 22.98 %) in the crop sown early on 1st September (D₁), followed by the crop sown on 10th September (19.33 and 20.92 %), on 20th September (16.11 and 17.70 %), on 30th September (13.63 and 15.22 %) and late sown on 10th October (11.77 and 13.35 %); whereas, cv. MANJIRA (susceptible) recorded comparatively maximum pooled

Table 1 : Effect of sowing dates and safflower cultivars on pooled mean *Alternaria* blight intensity at various intervals (Rabi, 2013-14 and 2014-15)

Sowing dates	Cultivars	Pooled mean disease intensity *(%) at DAS					Pooled Av. (%)
		At 1 st Apr. 30 DAS	45	60	75	90	
D ₁ (1 st September)	PBNS – 12	15.91 (9.16)	19.49 (11.24)	22.87 (13.23)	25.80 (14.96)	27.73 (16.12)	22.36 (12.94)
	Sharda	16.09 (9.27)	19.98 (11.53)	23.65 (13.69)	26.61 (15.48)	28.55 (16.60)	22.98 (13.31)
	Manjira	35.27 (20.67)	60.91 (37.76)	81.39 (57.14)	87.12 (62.20)	90.59 (66.51)	71.06 (48.86)
	Overall Av.	22.42 (13.03)	33.46 (20.18)	42.64 (28.02)	46.51 (30.88)	48.96 (33.08)	--
D ₂ (10 th September)	PBNS – 12	12.97 (7.46)	16.47 (9.49)	19.84 (11.45)	22.74 (13.17)	24.65 (14.28)	19.33 (11.17)
	Sharda	14.12 (8.12)	17.93 (10.34)	21.59 (12.48)	24.52 (14.20)	26.44 (15.34)	20.92 (12.10)
	Manjira	30.29 (17.70)	54.04(32.85)	74.52 (48.29)	80.25 (54.07)	83.72 (59.86)	64.56 (42.55)
	Overall Av.	19.13 (11.09)	29.48 (17.56)	38.65 (24.07)	42.50 (27.15)	44.94 (29.83)	---
D ₃ (20 th September)	PBNS – 12	9.89 (5.68)	13.30 (7.65)	16.59 (9.56)	19.46 (11.23)	21.33 (12.32)	16.11 (9.29)
	Sharda	11.04 (6.34)	14.76 (8.49)	18.34 (10.58)	21.24 (12.27)	23.12 (13.38)	17.70 (10.21)
	Manjira	21.88 (12.65)	45.63 (27.18)	64.10 (40.41)	69.83 (44.59)	73.30 (47.52)	54.95 (34.47)
	Overall Av.	14.27 (8.22)	24.56 (14.44)	33.01 (20.18)	36.84 (22.70)	39.25 (24.41)	--
D ₄ (30 th September)	PBNS – 12	7.49 (4.30)	10.83 (6.22)	14.12 (8.12)	16.95 (9.76)	18.76 (10.82)	13.63 (7.84)
	Sharda	8.64 (4.96)	12.29 (7.06)	15.87 (9.14)	18.73 (10.80)	20.55 (11.87)	15.22 (8.77)
	Manjira	12.30 (7.07)	36.05 (21.15)	53.52 (32.40)	59.25 (36.48)	62.72 (39.02)	44.77 (27.22)
	Overall Av.	9.48 (5.44)	19.72 (11.48)	27.84 (16.55)	31.64 (19.01)	34.01 (20.57)	--
D ₅ (10 th October)	PBNS – 12	6.28 (3.60)	8.87 (5.09)	12.10 (6.95)	14.89 (8.57)	16.69 (9.52)	11.77 (6.75)
	Sharda	7.43 (4.26)	10.33 (5.93)	13.85 (7.97)	16.67 (9.60)	18.48 (10.66)	13.35 (7.68)
	Manjira	10.78 (6.19)	29.85 (17.42)	47.32 (28.29)	53.05 (32.15)	56.52 (34.57)	39.50 (23.72)
	Overall Av.	8.16 (4.68)	16.35 (9.48)	24.42 (14.40)	28.20 (16.77)	30.56 (18.25)	--
S.E. ±	D	0.68	0.88	2.00	2.15	2.31	--
	V	0.55	7.50	1.42	1.28	1.50	--
	D x V	1.22	1.68	3.17	2.85	3.36	--
C.D. (P = 0.05)	D	2.00	2.58	5.90	6.32	6.82	--
	V	1.61	2.21	4.18	3.76	4.42	--
	D x V	3.60	4.94	9.34	8.41	9.88	--
C. V.		14.93	14.86	16.62	11.22	13.91	--

*: Mean of three replications, Av.: Average, DAS: Date after sowing,

Figures in parentheses are arcsine transformed values

average disease intensity of 71.06, 64.56, 54.95, 44.77 and 39.50 per cent in the crop sown on D₁, D₂, D₃, D₄ and D₅, respectively. In all the safflower cultivars, disease intensity from its first appearance was increased steadily with age of the crop and attained its peak at 90 DAS and the rate of increase in disease intensity was maximum in susceptible cv. MANJIRA that of tolerant cv. PBNS-12 and Sharda. Interaction effects (D x V) in respect of overall pooled average disease intensity at various intervals were found significant.

Effect on test weight and seed yield :

The results (Table 2) indicated that the pooled test weight and seed yield in all three cultivars of safflower were significantly influenced by the sowing dates and corresponding mean intensity of *Alternaria* blight disease. However, the crop sown on 20th September (D₃) recorded significantly highest pooled overall average test

weight (5.19 g) and highest overall average seed yield (15.32 q/ha), with moderate pooled overall average disease intensity (29.59 %). This was followed by the crop sown on 10th September (D₂) with pooled overall average test weight of 4.92 g, overall average seed yield of 13.65 q/ha and overall average disease intensity of 34.94 per cent; the crop sown on 30th September (D₄) with pooled overall average test weight of 4.72 g, pooled overall average seed yield of 12.40 q/ha and pooled overall average disease intensity of 24.54 per cent. The test weight and seed yield obtain in the crop sown on 10th September and 30th September were at par. The crop sown on 1st September recorded significantly minimum pooled overall average test weight (4.40 g) and seed yield (10.73 q/ha), followed by the crop sown on 10th October with overall average least test weight (3.98 g) and seed yield (8.94 q/ha).

Among the safflower varieties grown, PBNS-12

Table 2 : Effect of sowing dates, safflower cultivars and disease intensity on pooled mean test weight and seed yield (Rabi, 2013-14 and 2014-15)

Sowing dates	Cultivars	Intensity (%)	Test weight (g)	Seed yield (q/ha)
D ₁ (1 st September)	PBNS - 12	22.36	5.08	14.97
	Sharda	22.98	4.43	10.73
	Manjira	71.06	3.68	6.50
Overall Average		38.80	4.40	10.73
D ₂ (10 th September)	PBNS - 12	19.33	5.42	17.56
	Sharda	20.92	4.97	13.47
	Manjira	64.56	4.36	9.91
Overall Average		34.94	4.92	13.65
D ₃ (20 th September)	PBNS - 12	16.11	5.78	19.77
	Sharda	17.70	5.19	15.09
	Manjira	54.95	4.60	11.09
Overall Average		29.59	5.19	15.32
D ₄ (30 th September)	PBNS - 12	13.63	5.29	16.08
	Sharda	15.22	4.66	12.24
	Manjira	44.77	4.20	8.89
Overall Average		24.54	4.72	12.40
D ₅ (10 th October)	PBNS - 12	11.77	4.72	13.10
	Sharda	13.35	4.06	8.98
	Manjira	39.50	3.14	4.74
Overall Average		21.54	3.98	8.94
SE ±	D	--	0.04	0.46
	V	--	0.04	0.39
	D x V	--	0.08	0.88
C.D. (P = 0.05)	D	--	0.13	1.35
	V	--	0.11	1.15
	D x V	--	0.24	2.58
C. V.		--	5.03	12.45

sown on 20th September gave significantly highest pooled average seed yield (19.77 q/ha), followed by the cv. SHARDA (15.09 q/ha) and Manjira (11.09 q/ha). In the crop sown on 10th September, the test safflower cultivars gave second highest yield pooled average seed yield. However average pooled seed yield obtained of the test safflower varieties sown on 1st September, 30th September and 10th October. The interaction effect between sowing dates and safflower varieties in respect of average test weight and average seed yield were significant.

Thus from the ongoing results, it can be concluded that the crop grown during *Rabi*, 2013 season was suffered more with *Alternaria* blight intensity than that of the crop grown during *Rabi*, 2014-15 season. This may be due to congenial weather parameters *viz.*, temperature (max. and min.), high relative humidity (morning and evening), adequate and widely spaced rainfall might etc. prevailed during this may have favored the *Alternaria* blight disease initiation, development and spread; whereas, these weather parameters were non-congenial. Further, the safflower crop sown early (1st September) exhibited maximum *Alternaria* blight intensity which was increased steadily with crop age. There was significant decrease in the disease intensity on the crop sown later 20th September. The crop sown early (1st September) gave minimum seed yield than that of sown on 10th and 20th September. Though, there was comparatively minimum blight intensity on the crop sown late (30th September and 10th October), but seed yield was reduced drastically.

Of the various cultural practices the adjustment of sowing / sowing dates is one of the promising and commonly followed practices, which also constitutes one of the components of integrated disease management. Adopting this practice one can avoid the coincidence of susceptible crop host stage with disease favorable environmental conditions, which is an obviously the best strategy of escaping the crop and obtaining better crop yields.

Similar effects of sowing time / dates and crop cultivars on ignition, development and intensity of *Alternaria* leaf spot / blight diseases caused by various *Alternaria* spp. in a wide range of crop hosts had been reported earlier by many workers. Singh and Singh (2003) reported that the linseed crop sown on 15th October suffered more from *Alternaria* blight (72.29-94.45 %) and gave minimum seed yield. There was gradual

decrease of blight disease intensity in the crop sown on 5th and 15th November, which also gave maximum seed yield. Hegde (2006) reported that the safflower crop sown 15th days prior to recommend time suffered heavily from *Alternaria* leaf spot disease (75.50 %) with reduced seed yield (1053 kg/ha); whereas, the crop sown during second fortnight of September exhibited moderate disease intensity (48.90 %) and gave highest maximum seed yield (1202 kg/ha) than the crop sown late at 15th and 30th days after recommended sowing time, with minimum disease intensity (38.40 and 31.50 %) as well as reduced seed yield (768 and 409 kg/ha), respectively. Kumar *et al.* (2008) reported that early sowing of mustard between 15th September to 5th October as optimum to minimize the intensity of *A. brassicae* disease and to get optimum seed yield. Mesta *et al.* (2009) reported that the sunflower crop sown during October and onwards suffered minimum with low *Alternaria* blight disease intensity and gave higher seed yield. This could be due to less congenial environmental conditions *viz.*, minimum rainfall, higher temperature and low humidity etc prevailed during October and onwards. Anonymous (2013) reported that in the safflower crop sown early during 1st fortnight of September to 1st fortnight of October, *Alternaria* blight disease development and its severity were very high (96.00 to 99.99 %), due to prevalence of intermittent rainfalls, minimum temperature and maximum relative humidity (RH-1 and RH-2).

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