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## Screening of safflower genotypes against the *Alternaria* leaf blight of safflower

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### Abstract

Safflower (*Carthamus tinctorius* L.) is an oilseed crop of the *Asteraceae* or *Compositae* family. In addition to Kusumbha in ancient Sanskrit, other names for it include kusum, karrad in Hindi, kusumpuli in Bengali, kusumbo in Gujarati, kardai, kurdi in Marathi, sendurakam in Tamil, kusuma in Telugu, and kusube in Kannada. Safflower crop is grown under hot and dry climate. However, its cultivation is significantly hampered by various plant diseases, notably leaf blight caused by *Alternaria carthami*. Safflower genotypes collected from Agriculture Research Station, Annigeri were screened against leaf blight of safflower, which were maintained at MARS, Dharwad, during rabi 2023-24. Consequently, an effort was made to screen 38 safflower genotypes to identify sources of resistance to *Alternaria* blight and reduce losses in farmers' fields. However, none of the screened genotypes exhibited immunity, resistance or high resistance to *Alternaria* blight of safflower. Only one genotype ANG 10-4 showed moderately resistant reaction. Most of the genotypes exhibited a highly susceptible reaction (19 genotypes), while 15 genotypes demonstrated a susceptible reaction and 3 genotypes (ANG 2020, ANG 7-7, ANG 9-14) showed moderately susceptible response to safflower *Alternaria* blight.

**Keywords:** Safflower, germplasm, *Alternaria* leaf blight and genotype

### Introduction

Safflower (*Carthamus tinctorius* L.) is an important oilseed crop belonging to *Asteraceae* family, thrives in semi arid regions across the globe. It is prized for its highly nutritious edible oil from seeds that contain 25-32 per cent oil and are particularly rich in polyunsaturated fatty acids, especially linoleic acid, which comprises 78 per cent of the oil. It is native to parts of Asia, the Middle East and Africa.

Safflower is cultivated in over 60 countries worldwide ranging between latitudes 50°N and 23°S (Gilbert *et al.*, 2008) [5]. Mexico is the largest producer, followed by India. In India, the primary safflower producing states are Maharashtra and Karnataka, which together account for (86%) of the country's total production with Maharashtra contributing (55%) and Karnataka 31 per cent. Globally, safflower is cultivated on 6.94 lakh hectares, producing 6.27 lakh tonnes annually, with an average yield of 903 kg per hectare (Anon., 2020). In India, safflower is grown on 0.79 lakh hectares, yielding 0.61 lakh tonnes annually, with an average yield of 777 kg per hectare. The crop is predominantly cultivated in the Indian states of Maharashtra, Karnataka, Andhra Pradesh, Telangana, and Madhya Pradesh. Karnataka alone accounts for 0.41 lakh hectares, producing 0.33 lakh tonnes, with an average yield of 810 kg per hectare. In Karnataka, safflower is primarily grown in the districts of Vijayapura, Kalaburagi, Bagalkot, Belagavi, Yadgiri, Raichur, Gadag and Dharwad (Anon., 2022).

Safflower is known for its tolerance to cold and drought (Majidi *et al.*, 2011) [11] and its ability to extract soil water that is inaccessible to most other dryland crops (Weiss, 2000) [22]. Despite its significant potential and adaptability to a wide range of agro-ecological conditions, safflower remains underutilized by farmers. This is due to several challenges, including its extended rosette stage, spiny nature, relatively low seed oil content (30-38%), late maturity and susceptibility to various diseases and pests (Sujatha *et al.*, 2008) [19]. The major biotic stresses affecting safflower production include leaf spot diseases caused by *Alternaria carthami* Chowdhury, *Cercospora carthami* Sundararaman and Ramakrishnan and *Ramularia carthami*

Zaprometov; wilts caused by *Fusarium oxysporum* Schlecht. f. sp. *carthami* and *Verticillium alboatrum*, Powdery mildew by *Erysiphe cichoracearum* f. sp. *Carthami* Milovtsova, Phytophthora root rot and insect pests such as aphids and the safflower fly (Kalpana Sastry and Chattopadhyay, 2005; Singh and Prasad, 2005) [9, 17].

Among the various diseases affecting safflower, *Alternaria* leaf blight and *Fusarium* wilt are considered the most significant biotic constraints on production. *Alternaria* leaf blight caused by *Alternaria carthami* leads to annual yield losses of 25-60 per cent (Singh and Prasad, 2005, Indi *et al.*, 1988) [17, 7] with substantial economic consequences for farmers in the Deccan Plateau of India (Rao *et al.*, 2014) [16]. The continuous practice of monocropping and the cultivation of susceptible conventional varieties are key factors contributing to the high incidence of these diseases with reduction in the seed size, seed volume as well as per cent oil content (Kalpana Sastry *et al.*, 1993) [10].

Typical symptoms of the disease are appearance of irregular necrotic lesions on leaves and stem. Dark necrotic lesions of 2-5 mm in diameter are firstly found on hypocotyls and cotyledons. In mature plant, small brown to dark brown concentric spots of

1-2 mm appear on leaves and brown discoloration appear on the stem. As the infection advances, these spots enlarge and coalesce, forming larger necrotic areas that may cover significant portions of the leaf surface. The lesions are frequently surrounded by a yellowish halo, indicating the spread of the pathogen (Mortensen and bergman, 1983; Wagh *et al.*, 2017) [13, 21]. Now a day the occurrence of safflower blight is the major threat for oilseed crop production so recent study conducted to evaluate different cultivars/varieties against test pathogen so as to minimize the problem and required cost for management of *Alternaria* blight disease.

## Materials and Methods

Safflower genotypes collected from Agriculture Research Station, Annigeri were screened against leaf blight of safflower, which were maintained at MARS, Dharwad, during *rabi* 2023-24. Totally 38 safflower genotypes (Table 2) were screened for leaf blight severity including the susceptible checks (Manjira, SSF and A-1). The disease severity was recorded by using 0-9 disease scale (Mayee and Datar, 1986) [12] given below (Table 1).

**Table 1:** Disease scoring scale for grading of disease severity of *Alternaria* leaf blight on different safflower genotypes

| Numerical ratings scales | Reaction               |
|--------------------------|------------------------|
| 0                        | Immune                 |
| 1                        | Resistant              |
| 3                        | Moderately resistant   |
| 5                        | Moderately susceptible |
| 7                        | Susceptible            |
| 9                        | Highly susceptible     |

**Table 2:** List of genotypes used for screening against *Alternaria* leaf blight of safflower

| Sl. No. | Genotypes | Sl. No. | Genotypes |
|---------|-----------|---------|-----------|
| 1.      | ANG 1-2   | 20      | ANG 3-4   |
| 2       | ANG 1-14  | 21      | ANG 3-8   |
| 3       | ANG 1-15  | 22      | ANG 4-4   |
| 4       | ANG 3-13  | 23      | ANG 7-7   |
| 5       | ANG 4-9   | 24      | ANG 7-12  |
| 6       | ANG 6-1   | 25      | ANG 8-01  |
| 7       | ANG 6-7   | 26      | ANG 8-22  |
| 8       | ANG 8-16  | 27      | ANG 8-24  |
| 9       | ANG 10-14 | 28      | ANG 8-25  |
| 10      | A 2020    | 29      | ANG 8-26  |
| 11      | ANG 18-01 | 30      | ANG 9-6   |
| 12      | DASF 1    | 31      | ANG 9-8   |
| 13      | A-1       | 32      | ANG 9-14  |
| 14      | PBNS – 12 | 33      | ANG 10-1  |
| 15      | RVS 18-1  | 34      | ANG 10-2  |
| 16      | ANG 1-1   | 35      | ANG 10-10 |
| 17      | ANG 1-9   | 36      | Manjira   |
| 18      | ANG 1-13  | 37      | SSF 658   |
| 19      | ANG 2-4   | 38      | A 1       |

## Results and Discussion

A total of 38 safflower genotypes were evaluated for resistance to *Alternaria* leaf blight under natural epiphytotic conditions during the *rabi* season of 2023-24. The results reveal that the genotypes were categorized into six response groups based on their reaction to leaf blight: immune (no infection), resistant (less than 1% leaf area affected), moderately resistant (1-10% leaf area affected), moderately susceptible (11-25% leaf area affected), susceptible (26-50% leaf area affected) and highly susceptible (more than 50% leaf area affected). Among the 38 genotypes tested, none of the genotypes exhibited immune or resistant. Only one genotype ANG 10-4 showed moderately resistant reaction. However, three genotypes found moderate susceptible to *Alternaria* blight of safflower with (11-25% of the leaf area affected) which includes A 2020, ANG 7-7 and ANG 9-14. (Table 3, Plate 13)

Additionally, 15 genotypes showed a susceptible reaction to *Alternaria* blight in safflowers, with severity ranging from (26% to 50%). The genotypes exhibiting this susceptibility include SSF 658, ANG 1-2, ANG 1-4, ANG 1-15, ANG 18-01, DSAF 1, PBNS 12, ANG 1-1, ANG 4-4, ANG 7-12, ANG 8-22, ANG 9-6, ANG 9-8 and ANG 10-1 (Table 4).

**Table 3:** Screening of safflower genotypes against *Alternaria* leaf blight

| Sl. No. | Genotypes | Disease grade | Reaction |
|---------|-----------|---------------|----------|
| 1       | Manjira   | 9             | HS       |
| 2       | SSF 658   | 7             | S        |
| 3       | A-1       | 9             | HS       |
| 4       | ANG 1-2   | 7             | S        |
| 5       | ANG 1-4   | 7             | S        |
| 6       | ANG 1-15  | 7             | S        |
| 7       | ANG 3-13  | 9             | HS       |
| 8       | ANG 4-9   | 9             | HS       |

|    |           |   |    |
|----|-----------|---|----|
| 9  | ANG 6-1   | 9 | HS |
| 10 | ANG 6-7   | 9 | HS |
| 11 | ANG 8-16  | 7 | S  |
| 12 | ANG 10-4  | 3 | MR |
| 13 | A 2020    | 5 | MS |
| 14 | ANG 18-01 | 7 | S  |
| 15 | DSAF 1    | 7 | S  |
| 16 | A 1(C)    | 9 | HS |
| 17 | PBNS 12   | 7 | S  |
| 18 | RVS 18-1  | 9 | HS |
| 19 | ANG 1-1   | 7 | S  |
| 20 | ANG 1-9   | 9 | HS |
| 21 | ANG 1-13  | 9 | HS |
| 22 | ANG 2-4   | 9 | HS |
| 23 | ANG 3-4   | 9 | HS |
| 24 | ANG 3-8   | 9 | HS |
| 25 | ANG 4-4   | 7 | S  |
| 26 | ANG 7-7   | 5 | MS |
| 27 | ANG 7-12  | 7 | S  |
| 28 | ANG 8-01  | 9 | HS |
| 29 | ANG 8-22  | 7 | S  |
| 30 | ANG 8-24  | 9 | HS |
| 31 | ANG 8-25  | 9 | HS |
| 32 | ANG 8-26  | 9 | HS |
| 33 | ANG 9-6   | 7 | S  |
| 34 | ANG 9-8   | 7 | S  |
| 35 | ANG 9-14  | 5 | MS |
| 36 | ANG 10-1  | 7 | S  |
| 37 | ANG 10-2  | 9 | HS |
| 38 | ANG 10-10 | 9 | HS |



**Plate 13:** Disease Rating scale (0-9) for *Alternaria* leaf blight of safflower

**Table 4:** Grouping of genotypes against *Alternaria* leaf blight of safflower under field conditions

| Disease score | Disease severity | Disease reaction       | Genotypes                                                                                                                                                                         | Total no. of genotypes |
|---------------|------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| 0             | 0 (%) blight     | Immune                 | -                                                                                                                                                                                 | -                      |
| 1             | 1 (%) blight     | Resistant              | -                                                                                                                                                                                 | -                      |
| 3             | 1-10 (%) blight  | Moderately Resistant   | ANG 10-4                                                                                                                                                                          | 1                      |
| 5             | 10-25 (%) blight | Moderately susceptible | A 2020, ANG 7-7, ANG 9-14,                                                                                                                                                        | 3                      |
| 7             | 25-50 (%) blight | Susceptible            | SSF 658, ANG 1-2, ANG 1-4, ANG 1-15, ANG 18-01, DSAF 1, PBNS 12 (C), ANG 1-1, ANG 4-4, ANG 7-12, ANG 8-22, ANG 9-6, ANG 9-8 and ANG 10-1                                          | 15                     |
| 9             | > 50 (%) blight  | Highly susceptible     | ANG 3-13, ANG 4-9, ANG 6-1, ANG 6-7, A 1, RVS 18-1, ANG 1-9, ANG 1-13, ANG 2-4, A 1(C), ANG 3-4, ANG 3-8, ANG 8-01, ANG 8-24, ANG 8-25, ANG 8-26, ANG 10-2, ANG 10-10 and Manjira | 19                     |

Furthermore, the majority of the screened genotypes exhibited a highly susceptible reaction, with severity levels exceeding 50 per cent. The genotypes showing this reaction include ANG 3-13, ANG 4-9, ANG 6-1, ANG 6-7, A 1(C), RVS 18-1, ANG 1-9, ANG 1-13, A1, manjira, ANG 2-4, ANG 3-4, ANG 3-8, ANG 8-01, ANG 8-24, ANG 8-25, ANG 8-26, ANG 10-2 and ANG

10-10 (Table 4, Plate 14).

The screening of genotypes identified genotypes with varying levels of reactions against *Alternaria* leaf blight of safflower, where only one moderately resistant (ANG 10-4) genotype identified along with three moderately susceptible genotypes (A 2020, ANG 7-7 and ANG 9-14), fifteen susceptible genotypes

and remaining nineteen genotypes (out of 38 genotypes evaluated) demonstrated highly susceptible reaction. The highest number of genotypes, 19 in total, fell into the highly susceptible category (disease severity >50%). Genotypes such as ANG 3-13, ANG 6-1 and A 1 demonstrated extreme vulnerability to *Alternaria* blight. This high level of susceptibility, particularly in genotypes with high disease scores, highlights the risk these genotypes pose for safflower cultivation in areas prone to the disease. According to Sivakumar *et al.* (2020) <sup>[18]</sup>, highly susceptible genotypes are likely to suffer from severe yield losses and should be avoided in areas with favourable conditions for *Alternaria* development.

These results are in conformity most of the entries/varieties with the findings of those reported earlier by several workers against, *Alternaria carthami* of safflower (Indi *et al.*, 2004; Harishbabu *et al.*, 2005; Murumkar *et al.*, 2009; Balode *et al.*, 2012; Pawar *et al.*, 2013; Gholve *et al.*, 2015) <sup>[8, 6, 14, 3, 15, 4]</sup>.

## Conclusion

While field screening of safflower genotypes revealed varying responses to leaf blight, it is crucial to further validate these findings by evaluating the genotypes in multiple hotspot areas for leaf blight. This will help determine their effectiveness as pre-breeding lines.

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