International Journal of Agriculture and Food Science

ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating: 4.97
IJAFS 2025; 7(8): 71-76
www.agriculturaljournals.com
Received: 12-06-2025
Accepted: 14-07-2025

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Morphological and biochemical basis of tolerance mechanism in safflower against aphid

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DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i8b.594

Abstract
The present investigation entitled "Morphological and biochemical basis of tolerance mechanism in safflower against aphid" was conducted at Oilseeds Research Unit, Dr. PDKV, Akola during *Rabi* 2024- 25. The trial consisted of 29 genotypes replicated twice in Randomized Block Design. The research was performed to check out the reaction of different safflower genotypes against aphid. Among these GMU-7331, GMU-3205, AKS-325, AKS-322 and AKS/S-33 were found least Aphid Infestation Index (A.I.I.) with 2.0 and graded under tolerant category. Foliage drying due to aphids was observed in the range of 29.50 per cent to 87.25 per cent. Based on per cent foliage drying, foliage drying grade allotted to all tested genotypes. Genotypes GMU-7356, GMU-7331, GMU-3293, GMU-3205, AKS-325, AKS-322, AKS-207, GFD-3045, AKS/S-33 & A-1 alloted least grade i.e. 2. Morphological traits like pale green, shiny, thin and spiny leaves associated with tolerant mechanism against aphid. The genotypes having high total phenol, high total tannin and low chlorophyll content as compared to susceptible genotypes were recorded as tolerant genotypes.

Keywords: Screening, aphid, safflower genotypes, foliage, biochemical

Introduction
Safflower (*Carthamus tinctorius* L.) stands out as the key oilseed crop cultivated during the Safflower *Rabi* season. In India, it is referred to as "kardai" in the Marathi language, while in Hindi, it is called "kusum". This crop is primarily cultivated in arid conditions as an oilseed suitable for consumption (Akashe *et al.*, 2020) [1]. Among the vital oilseed varieties in India, safflower possesses enhanced value due to the nutritional and medicinal attributes found in its seed oil and flowers. Safflower oil is abundant in polyunsaturated fatty acids, particularly linoleic acid, which comprises 78%, marketed as saffola. This oil plays a crucial role in lowering blood cholesterol levels, exhibits favorable drying properties, therefore utilized in the production of paints, varnishes and linoleum (Rathod *et al.*, 2020) [21].

In India, safflower (*Carthamus tinctorius* L.) is known to be attacked by approximately 36 different insect pest species. Among the most economically damaging insect pests that infest the entire safflower plant are *Uroleucon compositae* (Theobald). Reports from different regions of India indicated yield losses in seed and oil content ranging from 20% to 30% due to these pests (Ghayal *et al.*, 2019) [8]. The adult aphids are black in color, while the nymphs appear reddish-brown. They initiate feeding from the early growth stages and continue through to flowering, significantly weakening the plant. These soft-bodied insects feed on phloem sap using piercing-sucking mouthparts, leading to wilting, leaf yellowing and overall decline in plant vigor due to excessive sap removal. Furthermore, aphids excrete a sugary substance known as honeydew, which promotes the development of sooty mold, thereby hampering photosynthetic efficiency (Chaithanya *et al.*, 2022) [5]. The loss in yield due to safflower aphid alone ranged from 34.05 to 45.80 per cent across varieties (Gurunath and Balikai, 2019) [11]. Insecticides have shown a great effect on population of safflower aphid, but synthetic insecticides have shown problems like toxic effects on humans as well as on the environment. Regular use of insecticides makes pests resistant against the chemical component that was previously used to kill the pest. To reduce the burden on environment, many bio pesticides have evolved and have shown good results against safflower aphids (Ghayal *et al.*, 2019) [8]. Mostly, the safflower crop is grown by small and marginal farmers

with low inputs and may not receive any plant protection measures, many times to avoid production cost. This often results in significant yield loss (Chaithanya *et al.*, 2019) [5].
The increasing awareness on deleterious effects of using chemical insecticides and the demand for insecticide free food has prompted to give emphasis on alternative management options (Gurunath and Balikai, 2018) [11]. Alternative to chemicals and biopesticides is to identify and develop the aphid tolerant varieties that reduces the cost of production and also safer to environment. Tolerance is distinctive in terms of the plant's ability to withstand or recover from herbivore injury through growth and compensatory physiological processes (Koch *et al.*, 2016) [14]. Identification of tolerant lines and biochemical basis of tolerance are important for the development of tolerance in host plant.

2. Material and method: The experiment was carried out at the field of Oilseeds Research Unit, Dr. PDKV, Akola, during Rabi 2024. The experiment was laid out in randomized block with 29 safflower entries with two replications. Each genotype was planted in a single row of 2 m length with 45 cm spacing in rows and 20 cm within plants. All the cultivation practices were followed as per recommendations for safflower cultivation. Infester rows of susceptible variety *viz.*, "CO-1" were sown one month before sowing of screening block. For maintaining uniform aphid population infester plants were uprooted and spread across the screening block uniformly when the main crop had attained age of 35-40 days. Necessary plant protection measures were undertaken to avoid wilt and Alternaria blight.
The aphid count on 5 cm top twig per plant was observed at stem elongation stage. Ten plants randomly selected from each entry was recorded and visually scoring in 1-5 scale.

Table 1: Screening of safflower germplasm against aphid based upon Foliage drying Grade

Visible symptoms	Drying of foliage (%)	Foliage drying grade
Healthy plant with normal capitula, seed yield equal to protected plant	0 to 20	1
Healthy plant but yellowing and drying of leaves on main stem and branches. Normal capitula.	21 to 40	2
Drying of 50% leaves on tender shoot of the plant, small to medium capitula with low seed setting.	41 to 60	3
Drying of leaves and tender shoots, whitening of branches, stunted growth less number of capitula with very poor seed setting	61 to 80	4
Death of plant before maturity and no seed yield	Above 80	5

Further the Aphid Infestation Index (AII) was computed by using following formula.

$$\text{Aphid Infestation Index} = \frac{1\times a+2\times b+3\times c+4\times d+5\times e}{a+b+c+d+e}$$

Where, a, b, c, d, e are the actual number of plants falling in each of the 5 corresponding foliage drying grade i.e. 1 - 5 scale.
The mean of A.I.I. was worked out and the entries were classified as follows:

A.I.I.	Reaction
Upto 1.0	Highly tolerant
1.1 to 2.0	Tolerant
2.1 to 3.0	Moderately tolerant
3.1 to 4.0	Susceptible
4.1 to 5.0	Highly susceptible

Biochemical parameters estimation
Collection of samples
The leaf samples were collected from sunflower genotypes. The collected leaves were oven dried. Each sample was analysed for total phenol, total tannin, chlorophyll, leaf nitrogen and protein content. The data were correlated with insect pest infesting for their significance.

Preparation of sample for analysis
The dried leaves were powered separately in morter and pestle, so as to pass through 60 mesh size. The powered material was used for total phenol, total tannin, chlorophyll, nitrogen and protein estimation. The analysis was undertaken separately by using the following methods.

- **Total phenol:** Phenol from sunflower leaves was determined by method suggested by Bray and Thorpe (1954) [3].
- **Total tannin:** Tannin from sunflower leaves was estimated by method of Sadashivam and Manickam (1992).
- **Chlorophyll:** chlorophyll was estimated by method of Sadashivam and Manickam (1992)

Result and Discussion
The data presented in the table 3 revealed that, out of 29 genotypes screened, 6 genotypes *viz.* GMU-7331, GMU-3205, AKS-325, AKS-322, AKS/S-33, A-1 were found tolerant with A.I.I. 2.0. The susceptible check, CO-1 and tolerant check, A-1 were recorded with A.I.I of 4.7 and 2.0 respectively. Foliage drying due to aphids was observed in the range of 29.50 per cent to 87.25 per cent. Lowest foliage drying 29.50 per cent was observed on AKS-322 followed by GMU-3205 (30%), A-1 (31.25%), AKS-325 (32%) and GMU-7331(32.30%). Based on per cent foliage drying, foliage drying grade allotted to all tested genotypes. Genotypes GMU-7356, GMU-7331, GMU-3293, GMU-3205, AKS-325, AKS-322, AKS-207, GFD-3045, AKS/S-33 & A-1 alloted least grade i.e. 2. Ghorpade and Thakur (1996), Balikai (2000), Dayalu Patil (2008), Kamal Anand (2009), Murumkar *et al.*, (2009), Rajput *et al.*, (2013), Mutkule *et al.*, (2018), Chaithanya *et al.*, (2019) [5] and Akashe *et al.*, (2020) [1, 9, 17, 18, 20] evaluated safflower genotypes against aphids & used foliage drying grade and A.I.I. for categorizing the safflower genotypes.
According to (table 4) morphological characters like pale green leaf colour, shiny leaf, thin leaves with many spines per leaf were associated with aphid tolerant safflower genotypes as compared to susceptible genotypes. The susceptible genotypes have dark green leaf, matty leaf, thick leaves with few spines. Kadam *et al.*, (2024) [12] safflower genotypes with a greater number of spines, green, thin and waxy leaves hosted fewer aphids compared to non-spiny types, thick and leathery leaves.

Safflower genotypes showing tolerance to aphid infestation had significantly higher phenol content (ranging from 3.42 mg/g to 2.83 mg/g). Genotype A-1 had the highest phenol content (3.42 mg/g) followed by AKS-322, AKS/S-33, AKS-325, GMU-3205 and GMU-7331. In contrast, the susceptible genotype CO-1 had the lowest phenol content (0.87 mg/g). This might be due to the fact that, the phenol acts as antifeedant to insect herbivores (Singh *et al.*, 2021). The findings of Divya *et al.*, (2017) [7, 23] indicated that aphid infestation led to an increase in total phenols, condensed tannins and enzymatic activities. Sunitha *et al.* (2008) [24] revealed that, phenol content was associated with resistance levels to Maruca vitrata in pigeonpea. The higher phenol concentrations in flowers (6.5%) and pods (9.3%) in ICPL 98003 were linked to resistance against insect pests. The report of Kumar *et al.*, (2010) [15] found that, lower occurrences of the mustard aphid were associated with higher levels of phenols (B 85 Glossy and RWH 1).

Safflower genotypes tolerant to aphid infestation showed higher tannin content, ranging from 3.91 mg/g to 4.02 mg/g. The highest tannin level was observed in AKS/S-33 (4.02 mg/g) followed by A-1, AKS-322, GMU-7331, AKS-325 and GMU-3205. However, the susceptible genotype CO-1 had a significantly lower tannin content of 1.88 mg/g. Tannin acts as feeding deterrent (Barbehenn & Constabel, 2011) [2]. The findings of (Kaura *et al.*, 2017) [13] stated that, the increase in tannin content after aphid infestation indicates protective role in plants. Safflower genotypes tolerant to aphid infestation exhibited lower total chlorophyll content, ranging from 28.71 mg/g to 29.82 mg/g. GMU-3205 showed the lowest level (28.71 mg/g) followed by AKS/S-33, AKS-322, GMU-7331, A-1 and AKS-325. In contrast, the susceptible genotype CO-1 had a significantly higher chlorophyll content of 40.19 mg/g. These findings indicated that, tolerant genotypes generally possess lower total chlorophyll content compared to susceptible check. It was observed that genotypes susceptible to pest attack contains higher total chlorophyll, chlorophyll - a and chlorophyll - b contents compared to resistant genotypes (Prabhakar *et al.*, 2013) [19]. These results are in agreement with the findings of (Ghosh *et al.*, 2009) [10] who indicated that pest susceptible genotypes posseses high chlorophyll content compared to resistant genotypes. Incidence of insect herbivores proportionately varies with the leaf chlorophyll content. Higher the content of leaf chlorophyll, greater was the incidence of the insect herbivores (Datta *et al.*, 2018) [6].

Table 2: Reaction of safflower genotypes to aphid infestation

Entry No.	Genotype	Aphids/5 cm twig	Foliage Drying (%)	Foliage drying Grade	A.I.I.	Reaction
1	GMU-3829	52.8	46.5	3	2.7	Moderately Tolerant
2	GMU-7356	52.6	37.5	2	2.3	Moderately Tolerant
3	GMU-3923	52.1	47.25	3	2.9	Moderately Tolerant
4	GMU-972	55.4	54.5	3	3.2	Susceptible
5	GMU-7359	48.4	41.00	3	2.4	Moderately Tolerant
6	GMU-7331	44.6	32.30	2	2.0	Tolerant
7	GMU-3863	44.3	42.25	3	2.5	Moderately Tolerant
8	GMU-3293	49.6	38.25	2	2.5	Moderately Tolerant
9	GMU-3933	47.0	46.50	3	2.7	Moderately Tolerant
10	GMU-5389	44.4	46.25	3	2.6	Moderately Tolerant
11	GMU-3205	53.1	30.00	2	2.0	Tolerant
12	GMU-884	42.5	42.00	3	2.5	Moderately Tolerant
13	GMU-1735	47.0	41.00	3	2.5	Moderately Tolerant
14	S-42	46.6	41.25	3	2.6	Moderately Tolerant
15	AKS-325	42.9	32.00	2	2.0	Tolerant
16	AKS-322	40.1	29.50	2	2.0	Tolerant
17	AKS-207	46.4	39.50	2	2.4	Moderately Tolerant
18	AKS-359	54.9	47.25	3	2.9	Moderately Tolerant
19	AKS-357	64.0	53.50	3	3.1	Susceptible
20	AKS-356	62.2	51.00	3	3.1	Susceptible
21	GFD-3114	45.5	48.25	3	2.9	Moderately Tolerant
22	GFD-3045	44.1	33.25	2	2.2	Moderately Tolerant
23	EC-337251	60.7	70.00	4	4.0	Susceptible
24	EC-661173	55.6	86.00	5	5.0	Highly Susceptible
25	EC-478401	56.2	87.25	5	4.5	Highly Susceptible
26	IC-337833	46.6	84.50	5	4.4	Highly Susceptible
27	AKS/S-33	42.1	40.25	2	2.0	Tolerant
28	CO-1 (Susceptible check)	58.1	83.75	5	4.7	Highly Susceptible
29	A-1 (Tolerant check)	42.5	31.25	2	2.0	Tolerant
	'F' test	NS	-	-	-	-
	SE(m)±	0.262	-	-	-	-
	CD at 5%	0.779	-	-	-	-
	CV (%)	5.27	-	-	-	-

Table 3: Categorization of safflower genotype based on A.I.I.

Reaction	A.I.I.	Genotype
Tolerant	2.0	GMU-7331, GMU-3205, AKS-325, AKS-322, AKS/S-33, A-1
Moderately Tolerant	2.2 - 2.9	GMU-3829, GMU-7356, GMU-3923, GMU-7359, GMU-3863, GMU-3293, GMU-3933, GMU-5389 GMU-884, GMU-1735, S-42, AKS-207, AKS-359 GFD-3114, GFD-3045
Susceptible	3.1-4.0	GMU-972, AKS-357, AKS-356, EC-337251
Highly Susceptible	4.4 - 5.0	EC-661173, EC-478401, IC-337833, CO-1

Table 4: Morphological characters of safflower genotype associated with aphid tolerance

Entry No.	Genotype	Leaf colour	Leaf appearance	Leaf thickness	Spines/leaf	Category
1	GMU-3829	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
2	GMU-7356	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
3	GMU-3923	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
4	GMU-972	Dark Green	Matty	Thick	Few	Susceptible
5	GMU- 359	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
6	GMU-7331	Pale Green	Shiny	Thin	Many	Tolerant
7	GMU-3863	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
8	GMU-3293	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
9	GMU-3933	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
10	GMU-5389	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
11	GMU-3205	Pale Green	Shiny	Thin	Many	Tolerant
12	GMU-884	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
13	GMU-1735	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
14	S-42	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
15	AKS-325	Pale Green	Shiny	Thin	Many	Tolerant
16	AKS-322	Pale Green	Shiny	Thin	Many	Tolerant
17	AKS-207	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
18	AKS-359	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
19	AKS-357	Dark Green	Matty	Thick	Few	Susceptible
20	AKS-356	Dark Green	Matty	Thick	Few	Susceptible
21	GFD-3114	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
22	GFD-3045	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
23	EC-337251	Dark Green	Matty	Thick	Few	Susceptible
24	EC-661173	Dark Green	Matty	Thick	Few	Highly Susceptible
25	EC-478401	Dark Green	Matty	Thick	Few	Highly Susceptible
26	IC-337833	Dark Green	Matty	Thick	Few	Highly Susceptible
27	AKS/S-33	Pale Green	Shiny	Thin	Many	Tolerant
28	CO-1	Dark Green	Matty	Thick	Absent	Highly Susceptible
29	A-1	Pale Green	Shiny	Thin	Many	Tolerant

Table 5: Biochemical constituents present in different safflower genotypes associated with aphid tolerance

Entry No.	Genotype	Total phenol content (mg/g)	Total tannin content (mg/g)	Chlorophyll content (mg/g)			Category
				Chl 'a'	Chl 'b'	total	
1	GMU-3829	1.90	2.30	49.94	37.81	38.17	Moderately Tolerant
2	GMU-7356	1.94	2.37	49.98	37.94	38.29	Moderately Tolerant
3	GMU-3923	1.82	2.30	50.03	39.63	39.79	Moderately Tolerant
4	GMU-972	1.27	1.97	40.39	40.15	39.33	Susceptible
5	GMU-7359	2.01	2.23	50.17	38.05	38.41	Moderately Tolerant
6	GMU-7331	2.83	3.92	29.47	30.41	29.68	Tolerant
7	GMU-3863	2.04	2.18	50.10	38.14	38.48	Moderately Tolerant
8	GMU-3293	2.07	2.34	48.69	39.07	39.02	Moderately Tolerant
9	GMU-3933	2.04	2.22	50.00	38.08	38.42	Moderately Tolerant
10	GMU-5389	2.09	2.19	49.04	37.88	38.15	Moderately Tolerant
11	GMU-3205	2.96	3.89	29.53	29.31	28.71	Tolerant
12	GMU-884	2.13	2.21	50.05	38.14	38.48	Moderately Tolerant
13	GMU-1735	2.20	2.18	50.12	37.80	38.18	Moderately Tolerant
14	S-42	2.04	2.35	49.95	37.78	38.15	Moderately Tolerant
15	AKS-325	3.03	3.91	29.52	30.57	29.82	Tolerant
16	AKS-322	3.22	3.93	29.45	30.32	29.60	Tolerant
17	AKS-207	2.05	2.49	49.92	37.35	37.76	Moderately Tolerant
18	AKS-359	2.26	2.34	49.78	38.31	38.60	Moderately Tolerant
19	AKS-357	1.32	2.00	40.33	39.99	39.18	Susceptible
20	AKS-356	1.37	2.01	40.37	39.92	39.12	Susceptible
21	GFD-3114	2.20	2.49	49.78	39.69	39.82	Moderately Tolerant
22	GFD-3045	2.15	2.38	49.66	38.09	38.39	Moderately Tolerant
23	EC-337251	1.57	2.01	40.34	40.06	39.24	Susceptible

24	EC-661173	0.76	1.89	46.44	40.73	40.41	Highly Susceptible
25	EC-478401	0.79	1.83	46.38	40.80	40.47	Highly Susceptible
26	IC-337833	0.90	1.84	46.35	40.59	40.29	Highly Susceptible
27	AKS/S-33	3.20	4.02	29.39	30.25	29.53	Tolerant
28	CO-1	0.87	1.88	46.41	40.48	40.19	Highly Susceptible
29	A-1	3.42	3.98	29.61	30.52	29.79	Tolerant

Table 6: Biochemical parameters & Morphological traits associated with safflower genotypes

Entry No.	Genotype	Aphid population 5 cm / apical twig	Foliage drying grade	Aphid Infestation Index	Biochemical Parameters			Morphological traits				Category
					Total Phenol (mg/g)	Total Tannin	Total Chlorophyll	Leaf colour	Leaf appearance	Leaf thickness	Spines/ leaf	
1	GMU-3829	52.8	3	2.7	1.90	2.30	38.17	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
2	GMU-7356	52.6	2	2.3	1.94	2.37	38.29	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
3	GMU-3923	52.1	3	2.9	1.82	2.30	39.79	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
4	GMU-972	55.4	3	3.2	1.27	1.97	39.33	Dark Green	Matty	Thick	Few	Susceptible
5	GMU-7359	48.4	3	2.4	2.01	2.23	38.41	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
6	GMU-7331	44.6	2	2.0	2.83	3.92	29.68	Pale Green	Shiny	Thin	Many	Tolerant
7	GMU-3863	44.3	3	2.5	2.04	2.18	38.48	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
8	GMU-3293	49.6	2	2.5	2.07	2.34	41.02	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
9	GMU-3933	47.0	3	2.7	2.04	2.22	38.42	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
10	GMU-5389	44.4	3	2.6	2.09	2.19	38.15	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
11	GMU-3205	53.1	2	2.0	2.96	3.89	28.71	Pale Green	Shiny	Thin	Many	Tolerant
12	GMU-884	42.5	3	2.5	2.13	2.21	38.48	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
13	GMU-1735	47.0	3	2.5	2.20	2.18	38.18	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
14	S-42	46.6	3	2.6	2.04	2.35	38.15	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
15	AKS-325	42.9	2	2.0	3.03	3.91	29.82	Pale Green	Shiny	Thin	Many	Tolerant
16	AKS-322	40.1	2	2.9	3.22	3.93	29.60	Pale Green	Shiny	Thin	Many	Tolerant
17	AKS-207	46.4	2	2.4	2.05	2.49	37.76	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
18	AKS-359	54.9	3	2.9	2.26	2.34	38.60	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
19	AKS-357	64.0	3	3.1	1.32	2.00	39.18	Dark Green	Matty	Thick	Few	Susceptible
20	AKS-356	62.2	3	3.0	1.37	2.01	39.12	Dark Green	Matty	Thick	Few	Susceptible
21	GFD-3114	45.5	3	2.9	2.20	2.49	39.82	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
22	GFD-3045	44.1	2	2.2	2.15	2.38	38.39	Pale Green	Shiny	Thin	Medium	Moderately Tolerant
23	EC-337251	60.7	4	4.0	1.57	2.01	39.24	Dark Green	Matty	Thick	Few	Susceptible
24	EC-661173	55.6	5	5.0	0.76	1.89	40.41	Dark Green	Matty	Thick	Few	Highly Susceptible
25	EC-478401	56.2	5	4.5	0.79	1.83	40.47	Dark Green	Matty	Thick	Few	Highly Susceptible
26	IC-337833	46.6	5	4.4	0.90	1.84	40.29	Dark Green	Matty	Thick	Few	Highly Susceptible
27	AKS/S-33	42.1	2	2.0	3.20	4.02	29.53	Pale Green	Shiny	Thin	Many	Tolerant
28	CO-1	58.1	5	4.7	0.87	1.88	40.19	Dark Green	Matty	Thick	Absent	Highly Susceptible
29	A-1	42.5	2	2.0	3.42	3.98	29.79	Pale Green	Shiny	Thin	Many	Tolerant

Conclusion
The present study evaluated 29 safflower genotypes for tolerance against safflower aphid. Six genotypes, namely GMU-7331, GMU-3205, AKS- 325, AKS-322, AKS/S-33 and A-1 were identified as tolerant genotypes against safflower aphid. These genotypes having morphological traits like pale green, shiny, thin and spiny leaves are associated with the tolerance mechanism against aphid. These genotypes having high total phenol, high total tannin and low chlorophyll content as compare to susceptible genotypes were recorded as tolerant genotype. Genotypes exhibiting a higher level of tolerance to aphid infestation possess significant potential for incorporation into breeding programs focused on the development of safflower varieties tolerant to aphids.

Acknowledgement
I extend my sincere thanks to Prof. Dr. P. N. Mane (Major advisor) and to my advisory committee members for giving me proper guidance throughout the course of study.

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