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Screening of safflower germplasm accessions for resistance against safflower aphid (*Uroleucon compositae* Theobald)

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Abstract
Safflower (*Carthmus tinctorius* L.) is one of the most important traditional *rabi* (post-rainy season) oilseed crops in India. Safflower aphid (*Uroleucon compositae* Theobald) is the key pest of the crop which causes yield losses to the extent of 20 to 60 % with an average of 37 % throughout India. Use of resistant varieties / genotypes is a way of lowering the cost of pest protection as part of Integrated Pest Management in safflower. Thus, the present studies were made to evaluate safflower germplasm accessions for resistance against safflower aphids. The experiment was conducted during 2006-2007 at ICRISAT-DOR Farm, Directorate of Oilseeds Research, Hyderabad by growing a total of 2000 safflower germplasm accessions on 24th November, 2006 in an augmented design. The plots were single rows 4 m long and spaced 45 cm apart with 20 cm between plants within rows. The cultivars CO-1 was included as a susceptible infester check and A-1 as a resistant check in rows after every 10 accessions. In addition, CO-1 as the infester was planted all around the experimental field under late sown conditions so as to get maximum build up of the aphid population. Observations were recorded during peak aphid incidence on number of aphids/5 cm on the central twig/plant and % foliage drying of whole plants due to aphid infestation from five randomly selected plants of each accessions along with checks. Grade and category were made on a scale of 1 to 5 based up on the % foliage drying by observing visual symptoms of the whole plants. It was found that out of 2000 safflower germplasm accessions, 18 accessions recorded foliage drying of 0-15 % with aphid population of 11-34 aphids/5 cm on the central twig/plant and graded as highly tolerant to aphids. Of the 18 most promising safflower germplasm accessions, GMU No. 4474, 2902, 4585, 2866 and 3854, recorded zero per cent foliage drying with minimum aphid population of 11-15 aphids/5 cm on the central twig/plant and maximum seed yield of 3-3.3 g/plant, however, GMU-2866 was non-spiny type. Seven germplasm accessions, GMU No. 3714, 3725, 3764, 3936, 4176, 2609 and 2823, recorded 10 % foliage drying with 20-24 aphids/plant and seed yield of 2.8-3 g/plant and rest six germplasm accessions, GMU No. 2897, 2933, 3927, 3828, 3923 and 2596, recorded 15 % foliage drying with 29-34 aphids/plant and seed yield of 2.4-2.6 g/plant. Plant height, number of branches and capitulum had no correlation with susceptibility of aphids. In general, spiny genotypes with thin stems, pale green leaves were observed as tolerant / resistant to aphid infestation while non-spiny, late maturing and tall genotypes with succulent stems and green leathery leaves contributed for aphid susceptibility.

Introduction

Safflower (*Carthmus tinctorius* L.) is one of the most important traditional *rabi* (post-rainy season) oilseed crops in India especially grown in Maharashtra and Karnataka and to a limited extent in Andhra Pradesh, Gujarat, Orissa, Madhya Pradesh and Bihar which together occupies an area of 349.2 thousand ha with a production of 128.3 thousand tonnes and productivity of 367 kg/ha (2003-04). India is the highest safflower producer in the world. However, productivity per hectare of safflower is very low. One of the major reasons for the low productivity of safflower is infestation caused by insect pests. Out of over 80 species of insect, mite and nematode pests appearing throughout the world on safflower, as many as two dozen of them are of major economic importance in India and the safflower aphid (*Uroleucon compositae* Theobald) is the most destructive pest of safflower. Adults are black while nymphs are reddish dark brown in colour. Aphids are soft-bodied insects measuring 1.5 to 2 mm in length. Winged and wingless forms are abundantly seen from seedling stage till harvesting of the crop. The yield losses caused by aphids have been reported to the extent of 56 to 60 % in Kernataka (Basavanna *et al.,* 1981), 20 to 55 % in Maharashtra (Naragalkar and Shivpuje, 1990; Ghorpade, 1995) and an average of 37 % throughout India (Singh and Prasad, 2005). A

number of insecticides have been reported for the management of safflower aphids (Shetgar *et at.,* 1993; Makar *et al.,* 1994; Ghorpade *et al.,* 1994). However, the pesticide usage can lead to health hazards and high cost inputs. The use of resistant varieties / genotypes is a way to lowering the cost of pest protection as part of Integrated Pest Management in safflower. Thus, the present studies were made to evaluate safflower germplasm accessions for resistance against safflower aphids.

Materials and Methods

The experiment was conducted during 2006-2007 at ICRISAT-DOR Farm, Directorate of Oilseeds Research, Hyderabad. A total of 2000 safflower germplasm accessions were collected from Safflower Germplasm Maintenance Unit (GMU), Directorate of Oilseeds Research, Hyderabad and planted under field conditions on 24th November, 2006 in an augmented design. The plots were single rows 4 m long and spaced 45 cm apart with 20 cm between plants within rows. The cultivars CO-1 was included as a susceptible infester check and A-1 as a resistant check in rows after every 10 accessions. In addition, CO-1 as the infester was planted all around the experimental field under late sown conditions so as to get maximum build up of the aphid population. Maintenance of experiment was routine as per the package of practices for safflower in this area except for elimination of plant protection measures. Since aphids breed profusely, it is very difficult to precisely count the population of aphids on the plants. Therefore, % foliage drying due to aphid infestation was graded on a scale from 1 to 5. When the crop was 60 days old from planting, during the first week of February, peak aphid incidence occurred. Observations were recorded on number of aphids/5 cm on the central twig/plant along with % foliage drying of whole plants from five randomly selected plants of each accession. These measurements were also made on A-1 and CO-1 as the resistant and susceptible checks. Grade and category were made on a scale of 1 to 5 based up on the % foliage drying by observing visual symptoms of whole plants (Table 1). Observations were also recorded on plant height (cm), softness/succulency, spiny or non-spiny, branches/plant, capitulum/plant and seed yield (g/plant).

Table 1 Screening of safflower germplasm accessions against aphids based up on foliage drying

Grade	Category	% foliage drying	Visual symptoms
1	Highly Tolerant (HT)	0 to 20	Healthy plant with normal seed yield
2	Tolerant (T)	21 to 40	Healthy plant but yellowing and drying of leaves on main stem, branches and normal capitula
3	Moderately Tolerant (MT)	41 to 60	Drying of 50 leaves on tender shoots of the plant, small to medium capitula with low seed setting
4	Susceptible (S)	61 to 80	Drying of leaves and tender shoots, withering of branches, stunted growth and less number of capitula with very poor seed setting
5	Highly Susceptible (HS)	Above 80	Death of plant before maturity and no seed yield

Results and Discussions

This experiment was done under late sown crop conditions on 24th November so as to get maximum aphid infestation. Therefore, the load of aphid infestation initially on safflower in the field during the year was very heavy in general (>100 aphids/plant). It was found that none of the accessions of GMU was completely free from aphid infestation. Aphid infestation started from first week of January and reached its peak in the last weeks of January, continuing up to first week of March. In the prevailing heavy aphid infestation, it was indeed very interesting to note that out of 2000 safflower germplasm accessions screened, 18 accessions recorded foliage drying of 0-15 % with aphid population of 11-34 aphids/5 cm on the central twig/plant.

These accessions were graded as highly tolerant genotypes to safflower aphids (Table 2). The national resistant check (A-1) recorded 15 % of foliage drying with aphid population of 30 aphids/5 cm on the central twig/plant and seed yield of 2.6 g/plant and susceptible check (CO-1) recorded 82 % of foliage drying, aphid population of 94 aphids/5 cm on the central twig/plant and zero seed yield.

Table 2 Reaction of safflower germplasm accessions to aphids

No. of accessions	No. of aphids/pl	% foliage drying	Category	Grade
18	11-34	0-15	Highly Tolerant (HT)	1
5	41-69	32-40	Tolerant (T)	2
197	70-80	46-58	Moderately Tolerant (MT)	3
620	81-89	60-80	Susceptible (S)	4
1158	90-158	81-100	Highly Susceptible (HS)	5

Of the 18 most promising safflower germplasm accessions, GMU accession No. 4474, 2902, 4585, 2866 and 3854 recorded zero per cent of foliage drying with minimum aphid population of 11 to 15 aphids/5 cm on the central twig/plant and maximum seed yield of 3 to 3.3 g/plant, however, GMU-2866 was a non-spiny type. Seven germplasm accessions, GMU No. 3714, 3725, 3764, 3936, 4176, 2609 and 2823, recorded 10 % of foliage drying with aphid population of 20 to 24 aphids/5 cm on the central twig/plant and seed yield of 2.8 to 3 g/plant and rest six germplasm accessions showed 15 % of foliage drying with aphid population of 29 to 34 aphids/5 cm on the central twig/plant and seed yield of 2.4 to 2.6 g/plant (Table 3). However, plant height, number of branches and capitulum had no correlation on susceptibility of aphids.

Table 3 Reaction of most promising safflower germplasm accessions to aphid and their plant morphological characters

Accession No.	Aphids/ 5 cm central twig / plant	Foliage drying %	Grade	Cate-gory	Plant height (cm)	Plant soft-ness	Plant succu-lency	SP/ NSP	Branches (No./pl)	Capitulum (No./pl)	Seed yield (g/pl)
GMU-2596	34	15	1	HT	69	H	NSU	SP	16	23	2.5
GMU-2609	23	10	1	HT	67	H	NSU	SP	16	20	2.5
GMU-2823	24	10	1	HT	72	H	NSU	SP	20	29	2.9
GMU-2866	15	0	1	HT	66	H	NSU	NSP	16	20	3.5
GMU-2896	29	15	1	HT	71	H	NSU	SP	19	27	2.5
GMU-2902	13	0	1	HT	77	H	NSU	SP	18	25	3.1
GMU-2933	29	15	1	HT	72	H	NSU	SP	15	25	2.6
GMU-3714	20	10	1	HT	83	H	NSU	SP	18	27	2.8
GMU-3725	20	10	1	HT	89	H	NSU	SP	19	19	2.9
GMU-3764	20	10	1	HT	63	H	NSU	SP	10	16	3.0
GMU-3828	30	15	1	HT	72	H	NSU	SP	14	30	2.6
GMU-3854	15	0	1	HT	73	H	NSU	SP	16	18	3.3
GMU-3923	31	15	1	HT	71	H	NSU	SP	18	30	2.4
GMU-3927	29	15	1	HT	67	H	NSU	SP	17	32	2.4
GMU-3936	20	10	1	HT	75	H	NSU	SP	12	21	3.0
GMU-4176	21	10	1	HT	78	H	NSU	SP	18	33	2.8
GMU-4474	11	0	1	HT	72	H	NSU	SP	17	29	3.2
GMU-4585	14	0	1	HT	73	H	NSU	SP	18	45	3.3
A-1 (NC)	30	15	1	HT	69	H	NSU	SP	15	34	2.6
CO-1 (SC)	94	82	5	HS	95	S	SU	NSP	20	24	0.0

NC=National check, SC=Susceptible check, Gr=Grade, HT=Highly tolerant, HS= Highly susceptible, H=Hard, S=Soft, SU=Succulent, NSU=Non-succulent, SP=Spiny, NSP=Non-spiny, No./pl=Number/plant

These eighteen accessions were proved as resistant to safflower aphids under our conditions

and may be used as source of resistance by Safflower Breeders in their breeding programmes for developing high yielding and aphid resistant safflower cultivars. Earlier workers also found some germplasm accessions resistant to safflower aphids (Akashe *et al*., 1993; Akashe *et al*., 1996; Singh and Singh, 2007). In general, spiny genotypes with thin stems, pale green leaves were observed as tolerant / resistant to aphid infestation while non-spiny, late maturing and tall appearance with succulent stem and green leathery leaves of plants contributed for aphid susceptibility.

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