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Safflower Aphid, Uroleocon Compositae (Theobald) and its management: A review

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Abstract: *Safflower (Carthamus tinctorius L.) is one of the important oil producing crops cultivated in India. It has several importances in dye industry, pharmaceutical industry and food industry. Some biotic and abiotic stresses affect the production of safflower. Among all the biotic stress uroleocon compositae theobald is the main pest which reduces the crop yield. To control this pest many integrated pest management strategies have evolved. Plantation of host plants around the field, intercropping systems, introducing natural enemies, sowing patterns, insecticides and biopesticides can effectively control safflower aphid. This review gives the count on effectiveness of synthetic insecticides and botanical pesticides against safflower aphid Uroleocon compositae.*

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I. Introduction

Pests are the important biotic factor which reduces the crop yield on large scale. Among these pests "Aphids" of superfamily Aphidoidea, within the order Hemiptera are soft bodied insects which feed on phloem of plants. They are also called as plant sap sucking insects, plant lice or ant cows. Excessive sap removal can turn a plant into yellow and leaves can wilt. In addition to removal of sap, aphid secretes a sugar secretion that acts as a medium for the growth of sooty mould and adversely affects photosynthesis [1]. Various species of aphids are act as vectors for transmission of plant viruses. The world aphid fauna is of around total 5,000 species, of which 250 feed on different plants [2]. Different species of aphids attack on vegetable crops, cereal crops and oil seed crop. Among them 199 Indian species of aphids feed on almost 208 plants of family Asteraceae or Compositae [3]. Study reported the aphid attacks on Host plant species belonging to family Malvaceae (16%), Fabaceae (15%), Solanaceae (12%) and Asclepiadaceae (10%) in Vadodara, Gujrat [4]. Heavily infested plant with aphids can affect the crop yeild. Sometimes it was observed as the aphid count per plant (5 cm apical twig) crosses the economic threshold level i.e. 50-70 nymphs/ adult per plant (5 cm apical twig). Depending on the environmental factors aphid attacks can reduce the crop yield by 20-80%. Among oil seed crops several aphid species attack on Safflower crop.

Safflower (*Carthamus tinctorius L.)* is an oil producing plant that belongs to the family of Compositae or Asteraceae. Safflower is a multi-purpose plant that has been cultivated for multiple reasons for centuries in India and other parts of the world. Safflower in India is grown over a region of 2,749 lakh ha with an output of 1,777 lakh tons and an amount of an output of 636 kg/ha (2007-08 to 2011-12 average) [5]. Nearly two third of India's total 180,000 ton production is generated by the Maharashtra and Karnataka. Safflower is highly adaptive to low temperature. Many factors reduce the yield of safflower plant. Among them pest attacks affect plants more than other factors. Out of a dozen insect pests, the safflower aphid, *Uroleocon compositae* (Theobald) is a significant pest, resulting in weather-based yield losses of 30-80% [6]. Various chemical pesticides of organophosphate family showed lethal effects on safflower aphid. But as chemical pesticides have various adverse effects on environment pesticides derived from botanicals are in demand. The study focuses on management of safflower aphids by using pesticides.

II. Safflower (*Carthamus tinctorius L):* As a commercial crop

Safflower (*Carthamus tinctorius L.*), a multifunctional crop, has been cultivated in India for orange colour dye (Carthamine) obtained from its colored flowers and for its high quality oil rich in polyunsaturated acids (Linoleic acid, 78%) [7]. Dried flowers may be used to obtain Carthamine, a red textile dye that was commercially important at one time. India occupies an area of 3.77 lakh ha with a production of 2.40 lakh tones and productivity of 637 kg/ha [5]. Safflower is drought tolerant and highly adaptive to humid conditions [8].

Due to elevated adaptability of safflower to low humidity conditions, it is effectively cultivated under arid and semi arid areas. It grows on different soil types. But it gives better yield on well drained clay, sandy soils with neutral pH [9].

Safflower is traditionally grown for dyes, animal feed and medicines. Safflower seed is used in the food industry because of oil and in pharmaceutical industry because of its medicinal properties as well as in the paint and lacquer sectors [10]. Safflower, like other plant is vulnerable to biotic and abiotic stress. Abiotic stresses like salinity and draught have shown negative effects on its growth. Biotic stresses include pests which affect safflower yield.

III. Safflower (*Carthamus tinctorius L)*and Safflower aphid *(Uroleucon compositae):*

There are many factors which affect the crop yield. Among them pest attack is the important biotic stress. In India, 36 pest species attack on safflower plant [11]. Pests can differ on the basis of parts of plants they feed on. Depending upon the insect type, they feed on inner or outer floral parts or other parts of the host plant. The most important pest insects feeding on the whole safflower plant are *Uroleucon compositae, Pleotrichophorus glandolosus, Brachycaudus helichrysi, Neoaliturus fenestratus, Euscelis alsius, Macrosteles laevis, Psammotettix striatus, Circulifer haematoceps, Thrips tabaci, Aeolothrips collaris, Haplothrips sp, Helicoverpa peltigera* [12, 13]. Losses in seed and oil content from separate areas of the nation have been recorded by 20-30% [14]. The aphids decrease seed and oil yields as well as attack petals which decrease the quality of this portion of the value added product of this plant [15].

The pests that feed on other parts of the plant are divided into two parts, Sucking pests and the insects that feed on the leaves and stem. Sucking insect includes aphids, thrips and some species of leaf hoppers. Among them Aphids affect the safflower plant most. Aphid, (family Aphididae, order Homoptera) is the soft body insect that is a phloem feeder and also sucks the plant sap by piercing the sucking mouthparts. It results into wilt and turning of leaves yellow because of excessive sap removal. In addition to this, aphid secrets a sugary liquid waste called "Honeydew" which acts as a medium for sooty mould development and adversely affects photosynthesis [5]. The world aphid fauna is of around total 5,000 species, of which 250 feed on different plants [2].

Species like *Dactynotus carthami (H.R.L.), Uroleucon compositae (Theobold), Dactynotus orientalis sp., Dactyonotus jaceae (Linn.), Macrosiphum sonchi (H.R.L.), Macrosiphum sonchi (Linn.), Macrosiphum compositae (Theobold), Macrosiphum spp. (jaceae), Myzus persicae (Sulz), Aphis fafia (Scop), Capitophorus eleagni (Del.Guer), Aphis gossypi , Aphis nerii, Pleotrichophorus glandolosus, Brachycaudus helichrysi* are recoreded to be fed on safflower [16, 6, 17] . In India, The Safflower aphid (*Uroleucon compositae*) is the major safflower pest because it can damage the crop entirely in high infestations [9].The yield losses for serious infestations range from 24.20-67.72%. [18]. In Karnataka it ranges from 56-60% and in Maharashtra it ranges from 20-55% [19].

Adults of this aphid are black while nymphs are reddish dark brown in colour. They suck the cell sap from initial stage to flowering stage of the plant, impairing the plant's vitality [20].

The severe infestation the entire plant is by safflower aphid is observed in November to December because Safflower aphid is highly adaptive to cool and cloudy conditions. The correlation with relative humidity, minimum temperature and cloudy weather was considerably positive [21].

IV. Management of safflower aphid (*Uroleucon compositae*):

There are many ways to manage safflower pest in IPM strategies. There are many factors to control population of *Uroleucon compositae.* By manipulating the sowing time of safflower, the yield loss caused by safflower aphid can be decreased. [6]. If the sowing period of safflower is changed and preponed in october (instead of December) it shows decrease in the number of occurrence of aphids [22].

Along with the sowing time, plantation of alternative host plants also reduces the effect of safflower aphid on safflower. It has been recorded that Sunflower, Niger, *Euphorbia geniculata*, Calendula, *Glyricidia maculata*, Ashwaghanda, Lactus sp. and *Parthenium hysterophorus* are the other hosts of safflower aphid in Karnataka [5, 23]. Among the various safflowers intercropping systems, minimum aphid population is recorded with musturd [24]. Also many natural enemies have been recorded for managing the safflower aphid *U. compositae.* The dipteran, *Pseudendaphis sp*. is known to cause up to 10% parasitisation of the aphid during first week of January in Karnataka, India [5].

Insecticides have shown a great effect on population of safflower aphid. Chemical pesticides have shown lethal effects on safflower aphid.

Table 1: Chemical insecticides showing the good results in controlling safflower pest (*Uroleucon compositae*)

Chemical family	Mode of action	Insecticide	Efficacy	References
1. Organophosphates	Acetylcholinesterase inhibitors	1. Acephate 1 g/L of water at 40 days after Sowing (DAS)	Effective	(25)
		2. Dimethoate (0.05%)/ Malathion dust (5%) at 20 kg/ha, alternate use for 60 days	Best production and highest Benefit Ratio	(26)
		3. 0.05% Dimethoate at inetraval of 10 days starting from 40 DAS	Better plant height , better number of branches/plant	(27)
		4. 0.05% dimethoate	Highest yield and ICBR	(28)
		5. Dimethoate 0.05%	Effective results with a better yeild	(29)
		6. Dimethoate 0.05%, Malathion 0.05%	Lowest incident of aphids/ 5 cm shoot length, seed yield 15.55 q/ha	(30)
		7. One dusting of Parathion-methyl D (at 45 DAS)	Highest Incremental Cost Benefit Ratio (ICBR)	(31)
2. Neonicotinoid	Nicotin Acetyl Choline receptor (nAChR) Anagonists	1. 2 sprayings of Thimethoxam 0.05% and Acetamiprid 0.004%	Maximum percent decline in aphid population and yield 1087 kg/ha, 952 kg/ha respectively.	(32)
		2. Thiamethoxam 25 WG 0.005% 1,3,7 and 14 DAS		
		3. 2 sprays of Thiamethoxam 25% WG (at 45-55 DAS)	Highest yield 1025.1 kg/ha	(25)
		Clothianidin 50% WDG (at 60-65 DAS)	Highest seed yield of 15.409 g/ha and 2.94 B:C and highest seed yield of 15.23 g/ha and 2.64 B:C	(33)
		4. Thiamethoxam 0.005 % Acetamiprid 0.004%	97.2 % decline in aphid population and highest seed yield of 1393.3 kg/ha	(34)
		5. Thiomethoxam 0.05% Acetamiprid 0.005%	96.4% decline in aphid population	
		6. Imidacloprid 17.8 SL @ 0.035%	Found effective against *U. Compositae*	(35)
		Thiomethoxam 0.05% Acetamiprid 0.005%	highest seed yield of 1224 kg/ha B:C ratio 2.28	(32)
		7. Thiamethoxam 25 WG (0.0125%)	highest seed yield of 1035 kg/ha B:C ratio 1.86	
		Imidacloprid 70 WG (0.015%) Acetamiprid 20 SP (0.01%)	highest seed yield 16.04 q/ha, oil content 28.9% and B:C ratio >8.0	
		8. Thiomethoxam 25 g a. i./ha	1170.00 kg /ha seed yield and ICBR 1:14.12	(36)
		9. Dinotefuron 20SG @ 0.25 g/l	1026.00 kg/ha seed yield and ICBR 1:10.39	
		10. Dinotefuron 20 SG@ 0.25g/l	1104 kg/ha seed yield and ICBR 1:10.00	
			Maximum protection up to 92.84 %	(37)
			Aphid count of 14.61/ 5 cm apical shoot at 10 DAS, highest seed yield of 15.64 q/ha, B:C ratio	(38)
			Highest seed yield of 952kg/ha and B:C ratio 1.67	(39)
3. Pyrethroid	Sodium channel modulators	1. 2 sprayings of Fluvalinate (at 45 and 60 DAS),	Low aphid population and maximum seed yield	(31)

		2.Ethofenprox 0.01% 3.Methyl demeton 0.05%	Lowest incident of aphids/ 5 cm shoot length, seed yield 15.55 q/ha Lowest aphid count	(30) (40)
4. Carbamates	Acetylcholinesterase inhibitors	1. 2 dusting of Carbaryl D (at 45and 60 DAS)	Low aphid population and maximum seed yeild	(31)
5. Flonicamid	Selective homopteran feeding blockers	1.Flonicamid 50 WG @ 0.1 g/l 2.Flonicamid 50WG @ 0.1 g/l	Highest seed yield of 1087 kg/ha and 1.89 B:C ratio Aphid count of 12.32 / 5 cm apical shoot at 10 DAS, highest seed yield of 15.40 q/ha, B:C ratio 2.94	(39) (38)
6. Cartap Hydrochloride	Nereistoxin analogues	1.Cartap hydrochloride 0.02%,	Lowest incident of aphids/ 5 cm shoot length, seed yield 15.55 q/ha	(30)
7. Cyclodiene organochlorines	GABA-gated chloride channel antagonists	1.Endosulfan 0.05%	Lowest aphid count	(40)

Study reviewed the detailed use of chemical insecticides used in early decades [6]. Various citations showed that chemical insecticides derived from organophosphate family are more effective than any other insecticidal family. Results of organophosphates are effective since 70's. Other than organophosphate insecticide primicarb 5% derived from family amminopyridine has shown high effectiveness against safflower aphid with a good crop yield [41]. Even the data from Table 1 show that use of insecticides derived from organophosphates are high in demand because of its affectivity against safflower aphid.

Chemical pesticides are unacceptable ecologically though they are very effective in showing rapid action against pest, availability, predictable level of control of easy handling. But these synthetic insecticides have shown problems like toxic effects on human as well as on environment. Regular use of insecticides make pests resistant against the chemical component that previously used to kill the pest. Pest resistivity against insecticides depends on pesticidal dose, number of treatments and genetic heterogeneity. Reappearance of the pest after application of insecticide i.e. resurgence of the pest is the main cause of intensive use of insecticides. To reduce the burden on environment many bio pesticides have evolved and have shown good results against safflower aphids. Following are some examples of bio pesticides which have shown great results against safflower aphid i.e. *U. compositae.*

Table 2: Bio-pesticides showing the good results in controlling safflower pest (*Uroleucon compositae*).

Bio pesticides	Efficiency	Authors
1. 2% leaf extract of *N. tabacum* and *I. carnea*	Equally effective in suppressing the aphid count and increasing the crop yield as endosulphan 0.05% and phosphamidon 0.02%	(42)
2. Tobacco decoction (2%) extracted in hot water	54.41 aphids per 10 cm terminal twig, higher flower yield 26.57 tonnes/ha and ICBR 1:44.38	(1)
Tobacco decoction (2%) extracted in cold water	58.79aphids per 10 cm terminal twig, higher flower yield 24.00 tonnes /ha and ICBR 1:33.88	
3. Oils fron Karanj (*pongamia pinata),*Neem *(Azadiracta indica*), Castor (*Racinus communis)*	Highest seed yield of 914.76 kg/ha, 776.48 kg/ha, 637.15 kg/ha respectively	(43)
4. NSKE 5% (Neem Seed Kernel Extract), Neem cake extract 5%, Neem oil 1%	NSKE 5% showed results as good as dimethoate 0.05% followed by neem cake extract and neem oil	(29)
5. Neem oil (0.5%) and NSKE (5%)	protected the crop against pest and resulted	(36)

6.	NSKE and Dashaparni extract	in higher yield protection up to the tune of 62.15 and 60.75 per cent respectively	[37]

[6] Reviewed the earlier work of [44] and [45], stated that safflower was controlled by botanical insecticides like Nicotine sulphate (0.05%) in 60's. Later the development of application of chemical insecticides lower the use of biopesticides. But after few years insecticides have become an environmental concern. Table 2 showed extracts of tobacco and neem have shown good effects on safflower aphid as good as dimothoate. Also early studies have stated that 2% of *Vinca rosea* is as effective as dimethoate [46]. Study stated the use of neem oil 0.5% is effective against safflower aphid [47].

Use of bio pesticide can depend on availability of the material, effectiveness of the insecticide, easy handling and cost. As to increase the yield and minimise the stress on environment, use of phyto originated insecticides can be used instead of chemical insecticides.

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