RESEARCH PAPER International Journal of Agricultural Sciences, June to December, 2009, Vol. 5 Issue 2 : 453-458

Influence of weather parameters on safflower aphid, *Uroleucon compositae* (Theobald) and its management

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ABSTRACT

Aphid (*Uroleucon compositae* T.) is one of the serious pests of safflower, *Carthamus tinctorius* L. in India. Loss in yield caused by this pest in India ranged from 20 to 80 per cent. Field experiments were conducted during the *rabi* seasons of 2004-05, 2005-06, 2006-07 and 2007-08 to correlate weather parameters with the incidence of safflower aphid and also to evaluate the efficacy of newer insecticides from different groups for its effective management. The variety Bhima was sown in randomized block design with 9 treatments (including absolute control), 3 replications and plot size of 5.0 x 4.5 m^2 each. Two foliar sprays at 40-45 and 55-60 DAS were given. Among eight chemical treatments, Thiamethoxam 0.005 % and Acetamiprid 0.004% proved best by recording lowest aphid population and producing the highest seed yield of 1224 kg/ha and 1035 kg/ha, respectively. The B:C ratio was highest in Thiamethoxam (2.28) followed by Acetamiprid (1.86), Dimethoate (1.82), and Imidachloprid (1.69). The pest is active during December to January on pre-branching stage of safflower crop, but its appearance on crop totally depends upon prevailing climatic conditions. Low temperatures and high humidity with cloudy weather are conducive for the multiplication of this pest. However, the maximum and minimum temperatures ranged between 30 to 35 ^{0}C and 14 to 17 ^{0}C, respectively were found most favourable for the rapid development of aphid on safflower. The rise in temperatures and fall in humidity coupled with crop maturity at the end of January had the deleterious effect on it. Thus, for the effective and efficient control of safflower aphid and producing higher seed yield, two sprayings either of 0.005 % Thiamethoxam (Actra) 25 WG or 0.004 % Acetamiprid (Pride) 20 SP or one spray each alternatively first at ETL *i.e.* 40-45 DAS (46th MW, min. temp. below 20^{0}C) and second spray at 55-60 DAS (48th MW, min. temp. around 15^{0}C) is recommended particularly in the safflower growing scarcity zone of Maharashtra (India).

Key words : *Uroleucon compositae*, Weather parameters, Management

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of the important oilseed crops in the world. In India, it occupies an area of 3.77 lakh ha with a production of 2.40 lakh tones and productivity of 637 kg/ha (Anonymous, 2008a). India ranks first in area and second in production of safflower in the world. Maharashtra state of the country is largest producer of safflower having 2.63 lakh ha area and 1.58 tones production with the productivity of 604 kg/ha, which is considerably low.

Safflower crop is often affected by various insect-pests among which, the important and most devastating pest is aphid, *Uroleucon compositae* Theob (Akashe *et al.*,1999). Seed and oil content losses due to this pest to the extent of 20 to 80 per cent have been reported from different parts of country (Singh *et al.*, 2000). The aphids not only reduce yields of seed and oil content but also attack petals lowering the quality of the value added product of this part of the plant (Sastry, 1997). Control of safflower aphid has been achieved by using different insecticides (Neharkar *et al.*, 2003). This unilateral approach has provided an effective but short term remedy. The major limitations of this method are high cost of cash inputs and insecticidal hazards for plant protection. On the other hand, control of aphid is difficult due to its fast development rate and high reproductive potential irrespective of meteorological parameters. Efforts were, therefore, made during present investigation to evaluate the efficacy of some of the newly developed insecticides from different groups in comparison with earlier recommended insecticide dimethoate for the effective control of safflower aphid. Efforts were also taken to correlate aphid population with weather parameters so as to manipulate correct timing of pesticidal application.

MATERIALS AND METHODS

The effectiveness of some new insecticides *viz.*, Imidachloprid (Confidor 200 SL) 17.8 % @ 0.0045%, Acetamiprid (Pride) 20 SP @ 0.004%, Thiamethoxam (Actra) 25 WG @ 0.005%, Fipronil (Regent) 5 SC @ 0.01%, Abamectin (Vertimec) 1.8 EC @ 0.0009%, Difenthiuron (Polo) 50 WP @ 0.06% and Buprofexin (Applaud) 25 EC @ 0.04% in comparison with Dimethoate (Rogar) 30EC @ 0.03% were tested for their efficacy against safflower aphid during *rabi* 2004-05, 2005-06, 2006-07 and 2007-08 at AICRPO (Saff.), Solapur (M.S., India). The field experiments were conducted using cv. BHIMA in RBD with 9 treatments, 3 replications and

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plot size of 5.0 x 4.5 m^2 each. Two need based (46th and 48th MW) foliar sprayings were given at an interval of 15 days during each season. The observations on aphid count (5 cm apical twig/pl.) were recorded on three randomly selected plants in each treatment before and after sprays. Pre count was taken a day prior to the treatment. The data on surviving aphid per plant before and after treatment were subjected to pooled statistical analysis. Seed yield (kg/ha) of each treatment was also recorded at harvest during all the years. The benefit cost ratio was calculated to assess the economics of each treatment. The observations on aphid population recorded in promising treatments (Thiamethoxam and Acetamiprid) and in absolute control were correlated with maximum and minimum temperatures. The data on mean aphid population before and after the sprays are presented in Table 1 and 2. The average seed yield (kg/ha) and benefit:cost ratio obtained due to different treatments during all the four years are given in Table 3, whereas the observations on aphid population recorded in promising treatments (Thiamethoxam and Acetamiprid) and in absolute control along with its correlation are presented in Table 4 and 5, respectively.

RESULTS AND DISCUSSION

The analyzed results reveled the significant differences for the treatments studied in respect of both aphid population after each spray and seed yield during four years. However, aphid population recorded in all

Table 1: Efficacy of newer insecticides for the control of safflower aphid (2004-05, 2005-06, 2006-07 and 2007-08)

Treatments	I st Spray : Av. aphids/5 cm twig/plant									
	Before spray					After spray				
	04-05	05-06	06-07	07-08	Mean	04-05	05-06	06-07	07-08	Mean
Imidachloprid @ 0.0045%	53.66	74.67	45.33	45.89	54.92	05.00	25.89	10.33	10.50	12.93
Acetamiprid @ 0.004%	56.33	71.00	43.33	45.50	54.08	01.67	23.11	07.50	5.17	9.36*
Thiamethoxa-m @ 0.005%	59.33	72.67	41.00	46.11	54.75	00.33	19.33	06.67	3.17	7.38*
Fipronil @ 0.01%	57.00	73.33	46.00	44.66	55.17	27.33	53.89	18.00	26.67	31.48
Abamectin @ 0.0009%	53.66	75.00	44.67	45.11	54.58	37.67	50.78	13.33	29.17	32.73
Difenthiuron @ 0.06%	51.66	75.67	45.33	45.00	54.42	29.50	61.67	24.17	27.50	35.71
Buprofexin @ 0.04%	59.00	72.67	44.67	44.89	54.83	40.67	64.22	25.00	37.83	41.93
Dimethoate @ 0.03%	58.33	77.67	44.00	45.56	56.42	07.17	34.45	08.67	13.83	16.03
Absolute control	56.00	75.00	45.67	45.67	55.58	59.00	93.67	61.33	57.17	67.79
S.E. ±	01.38	01.53	00.77	0.66	0.93	01.77	01.76	01.13	01.32	0.97
C.D. (P=0.05)	NS	NS	NS	NS	NS	06.67	06.55	03.38	3.95	2.73
CV %	04.79	06.32	03.20	2.52	5.86	15.29	08.58	07.84	9.74	11.79

NS-Non significant

Table 2: Efficacy of newer insecticides for the control of safflower aphid (2004-05, 2005-06, 2006-07 and 2007-08)

Treatments	After II nd Spray :Av. aphids/5 cm twig/plant(15 days after first spray)				
	04-05	05-06	06-07	07-08	Mean
Imidachloprid @ 0.0045%	03.33	07.50	07.17	05.67	5.92
Acetamiprid@ 0.004%	01.33	06.50	02.67	02.00	3.13*
Thiamethoxam @ 0.005%	02.33	05.50	01.83	01.17	2.71*
Fipronil @ 0.01%	12.33	27.17	16.50	16.33	18.08
Abamectin @ 0.0009%	26.00	31.00	16.17	26.33	24.88
Difenthiuron @ 0.06%	10.33	38.33	18.83	20.50	22.00
Buprofexin@ 0.04%	35.00	41.83	20.00	22.50	29.83
Dimethoate@ 0.03%	04.00	15.00	11.17	10.00	10.04
Absolute control	61.33	83.83	71.33	74.67	72.79
S.E. ±	01.93	01.68	01.40	1.85	0.93
C.D. (P=0.05)	07.90	06.01	04.20	5.54	2.64
CV %	21.86	11.24	10.42	16.08	15.38

treatments before first spray were statistically non significant which indicated the uniformity in pest population. The data on pooled mean (Table 1 and 2) of aphid population built up after both the sprays during all four seasons reveled that all the treatments were significantly superior to the absolute control (67.79 and 72.79 aphids/plant) in respect of reduction in aphid population. Amongst the chemical treatments, thiamethoxam @ 0.005% (7.38 and 2.71), acetamiprid @ 0.004% (9.36 and 3.13) and imidachloprid @ 0.0045%

Table 3 : Average seed yield and economics of safflower under various aphid control treatments (2004-05, 2005-06, 2006 – 07 and 2007-08)

Treatments	Grain yield (kg/ha)					Benefit Cost Ratio				
	04-05	05-06	06-07	07-08	Mean	04-05	05-06	06-07	07-08	Mean
Imidachloprid @ 0.0045%	461.72	1078.92	0896.34	1139.4	836	1.12	1.73	1.54	2.38	1.69
Acetamiprid @ 0.004%	575.91	1203.71	1076.90	1283.4	1035*	1.29	1.83	1.74	2.56	1.86*
Thiamethoxam @ 0.005%	701.62	1413.05	1145.34	1682.1	1224*	1.58	2.19	1.91	3.43	2.28*
Fipronil @ 0.01%	364.03	0529.39	0241.35	1072.5	552	0.84	0.81	0.40	2.16	1.05
Abamectin @ 0.0009%	307.11	0565.63	0608.30	913.1	598	0.49	0.69	0.79	1.52	0.87
Difenthiuron @ 0.06%	318.38	0394.53	0635.27	887.4	559	0.45	0.44	0.76	1.37	0.76
Buprofexin @ 0.04%	284.77	0408.62	0417.28	925.9	509	0.59	0.62	0.68	1.85	0.94
Dimethoate @ 0.03%	546.50	1125.21	0706.12	1244.9	866	1.31	1.92	1.33	2.73	1.82
Absolute control	132.13	0181.16	0185.19	563.0	265	0.33	0.32	0.35	1.10	0.53
S.E. $\pm$	075.70	0168.16	0063.134	137.09	50.31	-	-	-	-	-
C.D. (P=0.05)	160.48	0356.49	0189.28	410.93	142.10	-	-	-	-	-
CV %	022.60	0026.86	0016.65	21.43	24.34	-	-	-	-	-

Table 4 : Correlation coefficient- aphid population Vs. temperature (oC)- Promising treatment (Thiamethoxam and Acetamiprid)

MW	2004-05			2005-06			2006-07			2007-08		
	Aphid population	Max. temp.	Min. temp.	Aphid population	Max. temp.	Min. temp.	Aphid population	Max. temp.	Min. temp.	Aphid population	Max. temp.	Min. temp.
41	0	32.9	22.3	0	32.9	20.0	0	33.3	20.5	0.00	34.5	19.7
42	4.5	32.0	16.2	0	29.8	20.4	0	34.2	18.9	0.00	33.7	18.1
43	10	32.7	19.1	6	31.6	19.4	5.0	33.2	19.3	2.50	33.3	18.3
44	12.5	32.5	18.8	18	31.6	17.4	10.6	31.9	19.8	6.00	31.8	19.0
45	14	31.3	18.9	20.7	31.4	13.8	15.5	30.1	18.5	28.0	34.5	17.4
46	20	33.3	18.5	24.5	31.6	11.9	25.0	31.4	16.3	45.80	32.2	13.9
47	1.67	32.3	14.0	20.5	32.3	13.1	10.0	30.8	19.3	9.0	31.0	12.1
48	1.5	31.1	14.2	19.0	31.7	14.9	5.0	31.9	17.8	4.17	31.2	14.5
49	1	30.9	12.1	10.0	31.7	16.2	2.0	31.3	14.7	2.0	30.1	14.8
50	0	31.1	12.7	0	31.1	11.2	0	31.2	13.8	3.20	31.1	15.5
51	0	31.7	11.5	10.0	30.9	13.0	3.0	30.5	11.3	0.00	33.2	16.6
52	2	31.0	15.0	5.0	29.7	11.8	5.0	30.6	12.8	0.00	34.0	15.0
1	2	34.4	17.8	0	29.9	12.0	0	30.3	12.4	0.00	31.7	14.8
2	1.5	36.4	16.2	2.0	31.9	15.7	0	29.9	13.2	0.00	32.2	14.1
3	0	31.2	13.8	0	34.2	15.3	0	32.4	14.5	0.00	33.1	13.9
4	0	33.2	18.7	0	30.8	11.4	0	33.3	15.3	0.00	31.1	11.2
5	0	29.9	15.4	0	33	13.0	0	33.2	17.7	0.00	31.5	11.7
6	0	34.4	17.8	0	33	13.9	0	33.9	16.7	0.00	30.8	15.2
7	0	36.4	16.2	0	34.5	15.7	0	31.9	21.1	0.00	32.8	22.7
8	0	35	17.6	0	37.7	18.1	0	34.2	16.0	0.00	36.1	18.1
	r value	-0.057	0.411	r value	-0.212	-0.169	r value	-0.354	0.196	r value	0.046	-0.100

Table value of r at n-1 df I.e. 20-1=19 0.4239 @ 0.05%, Table value of r at n-1 df I.e. 20-1=19 0.5487 @ 0.01%
Regression equation- Y= a + bX, where, Y= Aphid population (dependent), a- Intercept (Constant-Coefficient),
X= Minimum temperature (Independent), b- Variable coefficient (X)

(12.93 and 5.92) registered the less aphid population than the recommended dimethoate @ 0.03% (6.03 and 10.04) after both the sprays during all four seasons and provided efficient control of safflower aphid. However, thiamethoxam and acetamiprid were at par with each other in respect of aphid population after both the sprays during all the seasons.

The mean seed yield of safflower (Table 3) varied from 265 to 1224 kg/ha. All the treatments yielded significantly higher than absolute control. Significantly highest seed yields of 1224 kg/ha and 1035 kg/ha were produced by thiamethoxam and acetamiprid, respectively over rest of the treatments followed by dimethoate (866 kg/ha) and imidachloprid (836 kg/ha) and were at par with each other. However, the yield level of 2004-05 was lower compared to later three years due to scanty rainfall during the crop growth period. The economics of the treatments showed that the treatment 0.005% thiamethoxam recorded highest B:C ratio of 2.28 followed by 0.004% acetamiprid (1.86), 0.03% dimethoate (1.82) and 0.0045% imidachloprid (1.69). Rest of the treatments were economically ineffective.

From the data (Table 4) it is observed that there was negative correlation between maximum temperatures and aphid population recorded in promising treatments during first three years (2004-05, 2005-06 and 2006-07) whereas, it was positive during fourth year (2007-08). However, the minimum temperature during 2004-05 and 2006-07 showed positive correlation with aphid population recorded in promising treatment (r value 0.411 and 0.196). On the contrary, negative correlation coefficient (r value -0.212 and -0.100) was found during 2005-06 and 2007-08, respectively for the same parameters may be due to increase in the minimum temperature in 7th and 8th MW (15.7 ^{0}C and 18.1 ^{0}C during 2005-06 and 22.7 ^{0}C and 18.1 ^{0}C during 2007-08).

The data presented in Table 5 indicated that aphid population recorded in control plots had negative correlation with both maximum and minimum temperatures during all four years. The peak aphid incidence was observed during 49th to 52nd MW when the minimum temperatures lowered down around/below 15 ^{0}C. Thus, minimum temperature plays an important role in increasing the aphid population. The weather conditions existing during 49th to 52nd MW were most congenial for the development of aphid population. Overall

Table 5 : Correlation coefficient- aphid population Vs. temperature (oC)- Absolute control

MW	2004-05			2005-06			2006-07			2007-08		
	Aphid Population	Max. Temp.	Min. Temp.	Aphid Population	Max. Temp.	Min. Temp.	Aphid Population	Max. Temp.	Min. Temp.	Aphid Population	Max. Temp.	Min. Temp.
41	0	32.9	22.3	0	32.9	20.0	0.00	33.3	20.5	0.66	34.5	19.7
42	4.5	32.0	16.2	0	29.8	20.4	0.00	34.2	18.9	3.00	33.7	18.1
43	10	32.7	19.1	6	31.6	19.4	5.00	33.2	19.3	5.00	33.3	18.3
44	12.5	32.5	18.8	18	31.6	17.4	10.60	31.9	19.8	10.00	31.8	19.0
45	14	31.3	18.9	20.7	31.4	13.8	15.50	30.1	18.5	31.00	34.5	17.4
46	34	33.3	18.5	24.5	31.6	11.9	25.00	31.4	16.3	46.00	32.2	13.9
47	125	32.3	14.0	51.7	32.3	13.1	65.00	30.8	19.3	47.67	31.0	12.1
48	138	31.1	14.2	58.3	31.7	14.9	88.00	31.9	17.8	58.00	31.2	14.5
49	150	30.9	12.1	139.3	31.7	16.2	170.00	31.3	14.7	75.00	30.1	14.8
50	125	31.1	12.7	197.7	31.1	11.2	160.00	31.2	13.8	70.00	31.1	15.5
51	100	31.7	11.5	204.3	30.9	13.0	128.00	30.5	11.3	71.00	33.2	16.6
52	92.5	31.0	15.0	255	29.7	11.8	130.00	30.6	12.8	40.00	34.0	15.0
1	62.5	34.4	17.8	195	29.9	12.0	100.00	30.3	12.4	32.30	31.7	14.8
2	50	36.4	16.2	177.7	31.9	15.7	90.57	29.9	13.2	27.70	32.2	14.1
3	42.5	31.2	13.8	160	34.2	15.3	70.00	32.4	14.5	32.0	33.1	13.9
4	25	33.2	18.7	78	30.8	11.4	65.50	33.3	15.3	30.00	31.1	11.2
5	15	29.9	15.4	60	33	13.0	50.00	33.2	17.7	38.00	31.5	11.7
6	18	34.4	17.8	40	33	13.9	38.00	33.9	16.7	17.50	30.8	15.2
7	15	36.4	16.2	20	34.5	15.7	25.00	31.9	21.1	12.00	32.8	22.7
8	10	35	17.6	8	37.7	18.1	12.00	34.2	16.0	8.00	36.1	18.1
	r value	-0.387	-0.778	r value	-0.390	-0.563	r value	-0.560	-0.758	r value	-0.521	-0.523

Table value of r at n-1 df I.e. 20-1=19 0.4239 @ 0.05%, Table value of r at n-1 df I.e. 20-1=19 0.5487 @ 0.01%
Regression equation- Y= a + bX, where, Y= Aphid population (dependent), a- Intercept (Constant-Coefficient),
X= Minimum temperature (Independent), b- Variable coefficient (X)

results based on table r values at 0.05 and 0.01 per cent for all four years in respect of above parameters showed the significant correlations. The aphid occurrence was started in 41-42 MW and reached to the ETL (15-20 aphid/ 5 cm twig/plant) during 45-46 MW. Therefore, the first insecticide spray was given in 46 MW and second spray 15 days thereafter *i.e.* in 48th MW. The other weather parameters *viz*., relative humidity, rainfall and wind velocity had no influence on the aphid population as these parameters were correlated in the same way with pest population under both treated and untreated conditions. According to the regression analysis between dependent (aphid population) Vs. independent (minimum temperature) in absolute control, the results (F value) were significant whereas, it was found non significant in respect of promising treatments because the aphid population was checked after the sprayings. Also, the equation indicated that whenever minimum temperature lowered down below 20 ^{0}C pest population attained its ETL which essentially requires plant protection measures particularly during 46th MW. The decrease in aphid population was observed when the maximum and minimum temperature go above 32 ^{0}C and 17 ^{0}C, respectively. At the same pre maturity crop stage becomes hard which tends the pest unsuitable for feeding.

The results of present investigation in respect of effectiveness and compatibility of thiamethoxam 70 WS when used as seed dresser for sucking pests are in agreement with Satpute *et al.* (2002), Prasanna *et al.* (2002) and Bhat *et al*.(2003). Rathod (2003) reported that acetamiprid 20 SP @ 20 g a.i./ha gave maximum protection against sucking pest of cotton. The effectiveness of imidachloprid 17.8 SL @ 20 g a. i./ha and acetamiprid 20 SP @ 40 g a.i./ha in the management of sucking pests of okra was also reported by Gosalwad *et al*.(2008). Hegde (2005) reported that thiamethoxam 25 WG @ 25 g a.i../ha and imidachloprid 17.8 SL @ 25 g a. i./ha were equally effective in reducing the population of brown plant hopper on rice. Godase *et al.* (2008) also tested thiamethoxam 25 WG at concentrations of 0.0125 and 0.0250 per cent against mango hoppers and found equally effective and significantly superior over carbaryl 0.15 per cent, endosulfan 0.05 per cent, monocrotophos 0.05 per cent, cypermethrin 0.0075 per cent and nimbicidine 0.2 per cent. Srivastava *et al.* (1995) reported the range of maximum temperature 15.8 to 27.7 ^{0}C, minimum temperature 10.2 to 16.0^{0}C and relative humidity 61 to 65 per cent prevailing in February were conducive for the rapid multiplication of aphid on Indian mustard. However, the findings of present investigation in respect of weather parameters and aphid incidence are more or less similar as that of Akashe *et al*.(1995) and Akashe *et al*.(2008).

Conclusion:

Overall pooled results showed that the two sprayings of thiamethoxam 0.005% or acetamiprid 0.004% one at the ETL (46 MW) when minimum temperature goes below 20^{0}C and second spray 15 days thereafter (48 MW, minimum temperature around 15^{0}C) are beneficial for the effective management of safflower aphid as well as for producing the good seed yield of safflower under dry land conditions. The lowest B:C ratio of 0.53 noticed in absolute control indicated the importance of aphid management through such newer insecticides having different chemical class and novel mode of actions as an alternative to the earlier recommended one.

Recommendation:

For the effective and efficient control of safflower aphid and producing higher seed yields, two sprayings either of 0.005% Thiamethoxam (Actra) 25 WG or 0.004% Acetamiprid (Pride) 20 SP or one spray each alternatively first at ETL *i.e*. 40-45 DAS (46 MW, minimum temperature below 20^{0}C) and second spray 55-60 DAS (48 MW, minimum temperature around 15^{0}C) are recommended particularly in the safflower growing scarcity zone of Maharashtra, India (Anonymous, 2008b).

Acknowledgement:

The authors are sincerely thankful to the Hon. Vice-Chancellor, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722, Dist. Ahmednagar (MS), India for encouragement during the period of investigation. The financial assistance received from Indian Council of Agricultural Research, New-Delhi, India for these investigations is also gratefully acknowledged. Senior author is grateful to Dr. J. R. Kadam, Associate Director of Research, NARP, Solapur, India and Director of Research of university for the help, guidance and cooperation.

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Received : February, 2009; Accepted : April, 2009