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Bio-efficacy of chemical insecticides against aphid, *Aphis craccivora* koch infesting fenugreek

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Abstract
The treatment of flonicamid 0.015% and acephate + imidacloprid 0.052% were found most effective in suppressing the aphid population followed by thiamethoxam 0.01% and imidacloprid 0.014%. The highest seed yield was obtained from the plots treated with flonicamid followed by acephate + imidacloprid. The maximum net realization was obtain in the treatment of flonicamid followed by acephate + imidacloprid. Maximum ICBR was registered in diamethoate followed by acephate + imidacloprid.

Keywords: Fenugreek, Aphis craccivora, Bio-efficacy, ICBR

Introduction
Fenugreek, *Trigonella foenum-graecum* (L.) is a self-pollinated annual dicotyledonous leguminous crop belonging to the sub family Papilionaceae under the family Fabaceae. It is known as *Methi* (Hindi, Gujarati, Urdu, Punjabi and Marathi), *Hulba* (Arabic), *Moshoseitaro* (Greek), *Uluva* (Malayalam), *Shoot* (Hebrew), *Dari* (Persian) and *Hayseed* in English. Fenugreek is one of the oldest medicinal plants from Fabaceae family originated in Central Asia-4000 BC (Ahmad *et al*., 2015) [1]. The major producers of fenugreek in the worlds are India, Morocco, Spain, Turkey, China and Pakistan. In India, fenugreek is mainly cultivated in Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh. Rajasthan which accounts about 75 to 85 per cent of the total production, while in Gujarat, it is mainly grown in Banaskantha and Mehsana districts and sporadically in Saurashtra region (Anon., 2015) [2]. Insect pests attacking the fenugreek crop are Aphid, *Aphis craccivora*; Koch, Leaf hopper, *Empoasca kerri* Pruthi; Whitefly, *Bemisia tabaci* Gennadius; Leaf miner *Liriomyza congesta* Becker, Leaf eating caterpillar, *Spodoptera litura* Fabricius, Weevil, *Hypera branneipennis* Boh.; Mite, *Petrobia lateens* Muller and Thrips, *Thrips tabaci* (Manjula *et al*., 2015) [3].

Materials and methods
In order to determine the relative bio-efficacy of chemical insecticides against *A. craccivora* on fenugreek (Gujarat Methi-2), a field experiment was conducted during *Rabi* 2015-16 at Main Vegetable Research Station, Anand Agricultural University, Anand. Requirement of gross plot area was 3.0 m x 1.8 m and net pot area was 2.8 m x 1.2 m for each treatment plot. Total eight insecticidal treatment and one untreated control (water spray) were taken for evaluate the bio-efficacy. All the recommended agronomical practices were adopted for crop grown. Insecticides sprays was applied during January 18, 2016. For the purpose of recording the observations, five plants were randomly selected from net plot area and tagged. Observations on number of aphids present on 10 cm terminal part of central shoot of each tagged plant were recorded prior as well as 1, 3, 7, 10 and 15 days after each spray. Effectiveness of the treatments was judged based on the efficacy of the chemical insecticides against *A. craccivora*, seed yield and economics. The data on number of aphids per 10 cm central shoot were analyzed after transforming them into square root while, the data on yield were analyzed without any transformation. The data were analyzed by using RBD design periodically and pooled over periods to see the consistency of the treatment performance. For determine of increase in yield over control and avoidable losses, following formula given by Poul (1976) [5] were used:

$$\text{Per cent increase in yield over control} = \frac{\text{Yield of treatment} - \text{Yield of control}}{\text{Yield of control}} \times 100$$

$$\text{Avoidable loss (\%)} = \frac{\text{Highest yield in treated plot} - \text{yield in treated plot}}{\text{Highest yield in treated plot}} \times 100$$

Results and discussion

The results presented in Table 1. At one days after spray revealed the lowest (13.49/central shoot) aphid population in the plots treated with flonicamid 0.015%, while, the second lowest (22.73) aphid population was observed in plot treated with thiamethoxam 0.01% and it was at par with acephate 50% + imidacloprid 1.8% EC 0.052% and imidacloprid 70 WG 0.014%. Acephate 75 SP 0.075% was found least effective and recorded maximum (36.59) aphid population. However, it was at par with triazophos 40 EC 0.08% and diafenthiuron 50 WP 0.05%. More or less similar type of results were found during 3, 7, 10, and 15 days after spraying. While, the data on pooled over periods revealed that the lowest (3.26) aphid population was recorded in flonicamid 0.015% treated plots. The treatment of acephate + imidacloprid 0.052%, thiamethoxam 0.01% and imidacloprid 0.014% were next in order and at par with each other. The treatment acephate 0.075% was found least effective and recorded significantly the highest (16.31) population of aphid and it was at par with triazophos 0.08%, diafenthuron 0.05% and dimethoate 0.03%.

Table 1: Population of *A. craccivora* on fenugreek in chemical insecticides treated plot

Tr. No.	Treatments	Conc. in % a.i.	ml or g/10 litre water	Population of aphid per 10 cm central shoot						
				Before spray	1 Das	3 Das	7 Das	10 Das	15 Das	Pooled over periods
1	2	3	4	5	6	7	8	9	10	11
T_1	Acephate 75 SP	0.075	10 g	6.70 (44.39)	6.09cd (36.59)	4.11d (16.39)	3.76c (13.64)	3.08b (8.99)	3.47c (11.54)	4.10c (16.31)
T_2	Imidacloprid 70 WG	0.014	2 g	6.66 (43.86)	4.90b (23.51)	3.12bc (9.23)	2.03a (3.62)	1.96a (3.34)	2.25b (4.56)	2.85b (7.62)
T_3	Flonicamid 50 WG	0.015	3 g	7.00 (48.50)	3.74a (13.49)	2.11a (3.95)	1.52a (1.81)	1.23a (1.01)	1.12a (0.75)	1.94a (3.26)
T_4	Diafenthuron 50 WP	0.050	10 g	6.74 (44.93)	5.67bc (31.65)	3.99cd (15.42)	3.62bc (12.60)	3.08b (8.99)	3.33c (10.59)	3.94c (15.02)
T_5	Triazophos 40 EC	0.080	20 ml	7.11 (50.05)	5.99cd (35.38)	4.05d (15.90)	3.69c (13.12)	3.13b (9.30)	3.38c (10.92)	4.05c (15.90)
T_6	Thiamethoxam 25 WG	0.010	4 g	7.47 (55.30)	4.82b (22.73)	3.09bc (9.05)	2.02a (3.58)	1.92a (3.19)	2.23b (4.47)	2.81b (7.40)
T_7	Acephate 50 % + Imidacloprid 1.8% EC	0.052	10 ml	7.11 (50.05)	4.83b (22.83)	3.02ab (8.62)	1.81a (2.78)	1.84a (2.89)	2.19b (4.30)	2.74b (7.01)
T_8	Dimethoate 30 EC	0.030	10 ml	6.95 (47.80)	5.58bc (30.64)	3.94cd (15.02)	2.88b (7.79)	2.76b (7.12)	3.23c (9.93)	3.68c (13.04)
T_9	Control	-	-	7.18 (51.05)	6.75d (45.06)	7.01e (48.64)	7.23d (51.77)	7.53c (56.20)	7.70d (58.79)	7.26d (52.21)
S. Em. ± T		-	-	0.43	0.35	0.30	0.26	0.25	0.27	0.15
P		-	-	-	-	-	-	-	-	0.09
T x P		-	-	-	-	-	-	-	-	0.27
C.D. at 5% T		-	-	NS	1.06	0.91	0.79	0.74	0.80	0.44
P		-	-	-	-	-	-	-	-	0.26
T x P		-	-	-	-	-	-	-	-	0.77
C.V. %		-	-	10.54	11.34	13.72	14.29	14.55	14.45	12.64

Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$

Treatment means with letter(s) in common are not significant by lsd at 5 % level of significance

Plots treated with different chemical insecticides yielded (Table 2) significantly higher fenugreek seed yield (27.38 to 20.78 q/ha) than control (13.79). The maximum (27.38 q/ha) yield was obtained from the plots treated with flonicamid 0.015% followed by acephate + imidacloprid 0.052% (25.50), thiamethoxam 0.01% and imidacloprid 0.014%. The fenugreek plot treated with triazophos yielded significantly lower (20.78 q/ha) but they were significantly superior over control. Increase in yield over control in fenugreek crop was worked out for different insecticidal treatments (Table 2) and indicated that maximum (98.55) per cent of increase in yield found in plots treated with flonicamid 0.015% followed by acephate + imidacloprid 0.052% (84.92) and thiamethoxam 0.01% (66.21). Avoidable losses due to the attack of aphid, *A. craccivora* in fenugreek crop was worked out for different treatments (Table 2) and indicated that maximum (49.64%) losses due to the pest was found in untreated plots, whereas it was minimum (6.87%) in acephate + imidacloprid 0.052% followed by thiamethoxam 0.01% (16.29%). The details of Incremental Cost Benefit Ratio (ICBR) calculated for different treatments of chemical insecticides are presented in Table 3. Data indicated that maximum (Rs. 40770/ha) realization was found in the treatment of flonicamid 0.015% followed by acephate + imidacloprid 0.052% (Rs. 35430/ha), imidacloprid 0.014% (Rs. 27240/ha) and diafenthuron 0.05% (Rs. 26,790/ha). While, minimum realization was obtain from the acephate 0.075% followed by thiamethoxam 0.01% (24390). Maximum (1: 38.79) ICBR was registered in dimethoate 0.03% followed by acephate + imidacloprid 0.052% (1: 35.54) and acephate 0.075% (1: 30.97). While, lowest (1: 12.21) ICBR was recorded in the plot treated with diafenthuron 0.05% followed by triazophos 0.08% (1: 20.03). Similar results were recorded by Ghelani *et al*. (2014) [3] and Vaani *et al*. (2016) [8]. Ghelani *et al*. (2014) [3] revealed that the treatment of flonicamid 0.02% was significantly superior for the control of aphid among the selected insecticides on cotton. While, Vaani *et al*. (2016) [8] also reported flonicamid 50 WG @ 0.1 g/liter as highly effective against aphid, seed yield and Benefit Cost Ratio in safflower crop. Swarnalata *et al*. (2015) [7] also observed similar performance among the

same selected insecticides and they found imidacloprid 0.005 per cent was most effective followed by thiamethoxam 0.01 per cent. The highest pod yield and maximum per cent increase in pod yield of cowpea over control recorded from the plots treated with thiamethoxam 25 WG @ 0.01 per cent. As per the report of Rabari *et al*. (2016), treatment of imidacloprid 0.005%, acephate 0.075%, dimethoate 0.03% and imidacloprid 0.004% gave excellent results against *A. craccivora* infesting fenugreek. While, thiamethoxam 0.03% found moderately effective. In case of seed yield, maximum yield was found in the treatment of imidacloprid followed by dimethoate. Whereas, maximum plant protection cost benefit ratio was found in the treatment of dimethoate. The treatment of flonicamid and acephate + imidacloprid exhibited significantly more effective for the reduction of aphid and thereby producing higher seed yield as well as net realization over the control. Even though, there were higher difference in ICBR due to highly expensive. Among the chemical insecticides evaluated, maximum ICBR was found in the treatment of dimethoate 0.03%. But, it was less effective against aphid, *A. craccivora* infesting fenugreek and produced less seed yield.

Table 2: Impact of various chemical insecticides on fenugreek seed yield due to control of aphid, *A. craccivora*

Tr. No.	Treatments	Seed yield (q/ha)	Increase in yield over control (%)	Avoidable losses (%)
1	2	3	4	5
T_1	Acephate 0.075%	21.83c	58.30	20.27
T_2	Imidacloprid 0.014%	22.87bc	65.85	16.47
T_3	Flonicamid 0.015%	27.38a	98.55	0.00
T_4	Diafenthuron 0.05%	22.72bc	64.76	17.02
T_5	Triazophos 0.08%	20.78c	50.69	24.12
T_6	Thiamethoxam 0.01%	22.92bc	66.21	16.29
T_7	Acephate + Imidacloprid 0.052%	25.50ab	84.92	6.87
T_8	Dimethoate 0.03%	22.32bc	61.86	18.48
T_9	Control	13.79d	0.00	49.64
S. Em. ±		1.09	-	-
C.D. at 5%		3.27	-	-
C. V. (%)		8.50	-	-

Note: Treatment means with letter(s) in common are not significant by lsd at 5 % level of significance

Table 3: Economics of different insecticidal treatments evaluated against *A. craccivora* infesting fenugreek

Treatments	Quantity of insecticides (Lit. or kg/ha) required	Cost of treatments (□/ha)	Total cost of treatments including labour charges (□/ha)	Yield (q/ha)	Net gain over control (q/ha)	Total realization over control (□/ha)	Net realization over control	ICBR
1	2	3	4	5	6	7	8	9
Acephate 0.075%	0.50 kg	332	778.8	21.83	8.04	24,120	23,341.2	1:30.97
Imidacloprid 0.014%	0.10 kg	900	1346.8	22.87	9.08	27,240	25,893.2	1:20.23
Flonicamid 0.015%	0.15 kg	1513	1959.8	27.38	13.59	40,770	38,810.2	1:20.80
Diafenthuron 0.05%	0.50 kg	1747	2193.8	22.72	8.93	26,790	24,596.2	1:12.21
Triazophos 0.08%	1.00 lit.	600	1046.8	20.78	6.99	20,970	19,923.2	1:20.03
Thiamethoxam 0.01%	0.20 kg	670	1116.8	22.92	8.13	24,390	23,273.2	1:21.84
Acephate + Imidacloprid 0.052%	0.50 lit.	550	996.8	25.50	11.71	35,130	34,133.2	1:35.24
Dimethoate 0.03%	0.50 lit.	213	659.8	22.32	8.53	25,590	24,930.2	1:38.79
Control	-	-	-	13.79	-	-	-	-

Note: 1. Labour charges @ Rs. 296.80/- + 150/- per day/ha for application of insecticides
2. Price of fenugreek seed: 3,000 Rs. per quintal

Summary and conclusion

The lowest aphid population was observed in flonicamid 0.015% treated plots and found significantly superior to the other treatments. The treatment of acephate + imidacloprid 0.052% and thiamethoxam 0.01%, imidacloprid 0.014% were moderately effective and at par with each other. Acephate 0.075% was found least effective. The highest seed yield was obtained from the plots treated with flonicamid followed by acephate + imidacloprid. The fenugreek plots treated with triazophos recorded significantly lower seed yield. The maximum realization was obtained in the treatment of flonicamid 0.015% followed by acephate + imidacloprid 0.052%. Maximum ICBR was registered in dimethoate 0.03% followed by acephate + imidacloprid 0.052%. While, lowest ICBR was recorded in the plot treated with diafenthuron 0.05% followed by triazophos 0.08%.

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