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Bio-efficacy of different insecticides evaluated against aphids infesting coriander

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Abstract
A field experiment was conducted at Anand Agricultural University, Anand during *Rabi* season 2019-20 to assess the bio-efficacy of various insecticides against aphids infesting coriander. Of the nine evaluated insecticides tolfenpyrad 15 EC, flonicamid 50 WG and afidopyropen 5 DC were found the most effective in reducing the incidence of aphids infesting corinader. However, thimethoxam 25 WG, flupyradifurone 200 SL, dinotefuran 20 SG and sulfloxaflor 21.8 SC were found moderate in their effectiveness. Maximum coriander seed yield was recorded from the plots treated with tolfenpyrad 15 EC (1441 kg/ha) which was at par with flonicamid 50 WG (1400 kg/ha) and afidopyropen 5 DC (1391 kg/ha).

Keywords: Coriander, aphids, insecticides, flupyradifurone, afidopyropen

Introduction
Coriander (*Coriandrum sativum* L.) is very important spice and it is mainly a crop of tropics and sub-tropics and the crop is the native of Mediterranean region near east region. India is the largest producer, consumer and exporter of coriander in the world. It is extensively grown in the arid to semi-arid regions of India. Andhra Pradesh, Assam, Madhy Pradesh, Odisha, Rajasthan, Uttar Pradesh and West Bengal are the major coriander producing states of India covering an area of about 0.628 million ha with the production of 0.75 million tonnes (Anon., 2019a) [1]. Rajasthan and Gujarat states have emerged as seed spice bowl and together contribute more than 80 per cent of the total coriander production in the country. Gujarat, covering an area of about 86.175 thousand ha with production of 129150 MT production (Anon., 2019b) [2]. Insect-pests are one of the major limiting factor for higher production of good quality coriander leaves as well as seeds. These include: aphid, *Hyadaphis coriandri* (Das.), *Bemisia tabaci* (Genn), *Agonoscelis nubile* (Fab.), *Spodoptera exigua* (Hub.), *Myzus persicae* (Sulzer), *Thrips tabaci* (Lindeman) and mite, *Petrobia latens* (Muller) (Jain and Yadava, 1988) [3]. Among the insect-pests infesting coriander, the aphid, *Hyadaphis coriandri* (Das.) has been reported as a regular and major pest in Rajasthan and other parts of the country (Hameed *et al.*, 1975; Jain, 1984) [5, 4]. Aphids cause both the quantitative and qualitative loss in the seed yield and deteriorate the green leaves by sucking cell sap. Morover, it exudes copious quantity of honey dew, which favour the growth of sooty mould and results into retarded growth of the plant. In case of severe infestation the growing points and flower stalks wither and dry up and at flowering and fruiting stage, the seeds are not formed and if they are formed, they are shriveled and of poor quality.

Materials and Methods
For evaluation of various insecticides against aphid infesting coriander an experiment was conducted under field conditons at B. A. College of Agriculture, Anand Agricultural University, Anand during 2019-20. The experiment was laid out in Random Blocked Design with ten treatments *viz.*, dimethoate 30 EC, sulfloxaflor 21.8 SC, flonicamid 50 WG, flupyradifurone 200 SL, dinotefuran 20 SG, pymetrozine 50 WG, afidopyropen 5 DC, thiamethoxam 25 WG, tolfenpyrad 15 EC and control (No. spray) along with three replications with a view to evaluate bio-efficacy of various insecticides against aphids infesting coriander. The first spray of resepective insecticides was given on apperance of aphids and second spray was given after 15 days of first spray.

For recording observations, 5 plants were randomly selected from each plot and 3 shoots each of 5 cm was selected randomly from each plant and count the number of aphids and also count their natural enemies. The observations were recorded before first spray as well as 1, 3, 5, 7, 10 and 15 days after each spray. The seed yield was also recorded. The data obtained were analyzed by following standard statistical technique (Steel and Torrie, 1980) [6]. On the basis of coriander seed yield harvested from various treatments under study, the avoidable losses due to aphids was calculated with the help of formula described by Khosla (1977) [9].

$$\text{Avoidable losses (\%)} = \frac{\text{Yield of treatment which gave the highest yield - Yield of respective treatment}}{\text{Yield of treatment which gave the highest yield}} \text{ x100}$$

Results and Discussion

The population of aphids was homogenous before spray in all the treatments as treatments did not differ significantly. All the evaluated insecticdes were significantly superior to control up to 15 days of spray.

First spray

The lowest (19.21/5 cm shoot) population of aphids were recorded from plots treated with tolfenpyrad 15 EC which was at par with flonicamid 50WG (19.75/5 cm shoot) and afidopyropen 5 DC (20.20/5 cm shoot) at one day after first spray (Table 1). These three insecticides were found to be significantly superior to the remaining treatments. Among the evaluated insecticides, the highest (46.69/5 cm shoot) population of aphids was observed in plots treated with pymetrozine 50 WG and it was at par with dimethoate 30 EC (42.79/5 cm shoot). Similarly, Population of aphid showed analogous trend at three days after spray and it was noticed to be the minimum (15.74/5 cm shoot) from plots treated with tolfenpyrad 15 EC which was at par with flonicamid (16.39/5 cm shoot) and afidopyropen (17.39/5 cm shoot) after five days of spray. Whereas, the treatment of thiamethoxam 25 WG (25.81/5 cm shoot) was at par with flupyradifurone 200 SL (25.51/5 cm shoot) and dinotefuran 20 SG (26.64/5 cm shoot) significantly affected the pest population. Among the evaluated insecticides, the maximum population of aphids was found in the plot treated with pymetrozine 50 WG (35.74/5 cm shoot) and it was at par with sulfoxaflor (26.43/5 cm shoot) and dimethoate 30 EC (35.38/5 cm shoot). More or less undistinguishable results were obtained at seven days after first spray.

Likewise, ten days after spray, tolfenpyrad 15 EC (14.47/5 cm shoot), flonicamid 50WG (14.55/5 cm shoot) and afidopyaropen 5 DC (16.88/5 cm shoot) were most effective and at par with each other while, thiamethoxam 25 WG (25.00/5 cm shoot), flupyayradifurone 200 SL (24.20/5 cm shoot), dinotefuran 20 SG (24.30/5 cm shoot) and sulfloxaflor 21.8 SC (24.40/5 cm shoot) also exhibited significant efficacy. The treatments pymetrozine 50 WG (34.19/5 cm shoot) and dimethoate 30 EC (31.30/5 cm shoot) were found the least effective. Again, fifteen days after first spray, tolfenpyrad showed the lowest (15.38/5 cm shoot) population of aphids and it was at par with flonicamid 50 WG (16.39/5 cm shoot) and afidopyropen 5 DC (18.53/5 cm shoot). Among the tested insecticides, thiamethoxam (27.46/5 cm shoot), flupyradifurone 200 SL (27.51/5 cm shoot), dinotefuran 20 SG (27.66/5 cm shoot) revealed significantly lower population of aphid in coriander. The plots treated with pymetrozine recorded the maximum (39.28/5 cm shoot) population of aphids and it was at par with dimethoate (38.89/5 cm shoot). Pooled over periods data (Table 1) of first spray showed that tolfenpyrad (14.98/5 cm shoot), flonicamid (15.71/5 cm shoot) and afidopyropen (17.32) were found significantly superior among all the evaluated insecticides. However, the insecticidal treatments, thiamethoxam, flupyradifurone, dinotefuran and sulfloxaflor were also effective and registered aphid population as 25.40, 25.61, 26.22 and 26.74 aphis/5 cm shoot, respectively. The plot treated with pymetrozine recorded the highest (35.74/5 cm shoot) population of aphids and it was at par with dimethoate (34.78/5 cm shoot).

Second spray

One day after second spray (Table 2), tolfenpyrad (10.19/5 cm shoot), flonicamid (11.47/5 cm shoot) and afidopyropen (20.02/5 cm shoot) were effective in reducing the population of aphid infesting coriander. While, thiamethoxam (19.84/5 cm shoot), flupyradifurone (20.11/5 cm shoot) and dinetofuran (19.57/5 cm shoot) also significantly reduced the pest population. Maximum population of aphid (29.80/5 cm shoot) was recorded from the plots treated with pymetrozine and it was at par with sulfoxaflor (20.20/5 cm shoot) and dimethoate (27.90/5 cm shoot). Population of aphids were noticed the lowest (9.93/5 cm shoot) in plots treated with tolfenpyrad which was at par with flonicamid (10.06/5 cm shoot) and afidopyropen (10.06/5 cm shoot) after three days of spray. Whereas, thiamethoxam (17.99/5 cm shoot), flupyradifurone (18.16/5 cm shoot) and dinotefuran (17.73/5 cm shoot) also revealed significantly lower activity of aphids. Among the evaluated insecticides, the highest (27.90/5 cm shoot) population of aphids was recorded from the plots treated with pymetrozine and it was at par with dimethoate (26.54/5 cm shoot). Comparatively similar results were observed at five and seven days after second spray.

The lowest (5.30/5 cm shoot) population of aphids was registered in plots treated with tolfenpyrad and it was at par with flonicamid (6.62/5 cm shoot) and afidopyropen (6.89/5 cm shoot) at ten days after second spray. These three insecticides were found to be significantly superior to rest of the insecticides. The plots treated with thiamethoxam (12.53/5 cm shoot), flupyradifurone (12.67/5 cm shoot) and dinotefuran (12.82/5 cm shoot) also recorded significantly lower population of aphid. Amidst the evaluated insecticides, the maximum (19.93/5 cm shoot) population of aphids were recorded from plots treated with pymetrozine**.**

More or less, same trend in efficacy of treatments observed at fifteen days after second spray. The data (Table 2) on pooled over periods of second spray indicated that the lowest (4.69/5 cm shoot) population of aphid was recorded from plots with the treatment of tolfenpyrad which was at par with flonicamid (5.35/5 cm shoot) and afidopyropen (5.50/5 cm shoot). Thiamethoxam (10.06/5 cm shoot), flupyradifurone (10.19/5 cm shoot), dinotefuran (10.12/5 cm shoot) and sulfloxaflor (10.39/5 cm shoot) were next effective and remained at par with each other and recording lower count of aphids. While, the plots treated with pymetrozine recorded the highest (15.26/5 cm shoot) population of aphids and it was at par with dimethoate (15.18/5 cm shoot).

Overall pooled

Pooled over sprays results (Table 2) revealed that tolfenpyrad (7.62/5 cm shoot) was found significantly superior among all the evaluated insecticides except flonicamid (8.32/5 cm shoot) and afidopyropen (8.44/5 cm shoot). thiamethoxam (15.10/5 cm shoot), flupyradifurone (15.18/5 cm shoot), dinetofuran (15.02/5 cm shoot) and sulfloxaflor (15.58/5 cm shoot) were the next effective treatments. The plots treated with pymetrozine recorded the maximum (23.21/5 cm shoot) population of aphids and it was at par with dimethoate (22.15/5 cm shoot).

Thus, from the above outcome, it can be deduced that the treatments of tolfenpyrad, flonicamid and afidopyropen were found to be more effective on the basis of aphids incidence. Whereas, thimethoxam, flupyradifurone, dinetofuran and sulfloxaflor were mediocre in their effectiveness. However, pymetrozine and dimethoate were found less effective in reducing the incidence of aphids infesting coriander.

Effect on coriander seed yield

The yield of coriander seed from various insecticidal treatments were recorded along with the control treatment and data are presented in Table 3. Maximum (1441 kg/ha) coriander seed yield was recorded from plots treated with tolfenpyrad which was at par with flonicamid (1400 kg/ha) and afidopyropen (1391 kg/ha). While, thiamethoxam (1199 kg/ha), flupyradifurone (1183 kg/ha) and dinotefuran (1170 kg/ha) were found average in yield performance. Among tested insecticides, the lowest (927 kg/ha) coriander seed yield was recorded from pymertrozine and it was at par with dimethoate (954 kg/ha). Increase in yield over control in coriander was worked out for different insecticidal treatments and indicated that maximum (84.98%) increase in yield over control was found from plots treated with tolfenpyrad, followed by flonicamid (79.71%) and afidopyropen (78.56%). Plots treated with thiamethoxam (53.91%), flupyadifurone (51.86%) and dinotefuron (50.19%) provided with average increase in the yield. Whereas, among the tested insecticides, minimum (18.99%) increase in yield was found from plots treated with pymetrozine followed by dimethoate (22.46%). Overall, it revealed tolfenpyrad, flonicamid, afidopyropen, thiamethoxam, flupyradifurone and dinotefuran recorded relatively higher seed yield in coriander than the remaining tested treatments.

The flonicamid 50 WG (2.84%) recorded lowest avoidable losses followed by afidopyropen 5 DC (3.46%). The avoidable losses were 16.79, 17.90, 18.80, 21.37, 33.79 and 35.66 per cent in thiamethoxam 0.01%, flupyradifurone 0.05%, dinetofuran 0.008%, sulfloxaflor 0.0218%, dimethoate 0.03% and pymetrozine 0.015%, respectively. The highest losses was recorded in the control treatment (45.94%).

Hirpara (2017) [7] found that thiamethoxam 0.01per cent (1101 kg/ha), and flonicamid 0.015 per cent (1035 kg/ha) gave significantly higher yield over the control of coriander. Ghadage (2009) [8] studied the two applications of nine different insecticidal treatments against aphid of coriander and revealed that the treatments with dimethoate 0.03% was proved to be the most effective. Flupyradifurone, tolfenpyrad and afidopyropen being new insecticides, their effectiveness could not be compared with the past researchers.

Table 1: Bio-efficacy of insecticides against aphids infesting coriander after first spray

Tr. No.	Treatments	Conc. (%)	Before spray	No. of aphids/5 cm shoot at indicated days after spray						Pooled over periods
				1	3	5	7	10	15	
T1	Dimethoate 30 EC	0.03	7.58 (56.95)	6.58b (42.79)	5.99c (35.38)	5.52b (29.97)	5.39b (28.55)	5.64c (31.30)	6.26b (38.89)	5.94b (34.78)
T2	Sulfoxaflor 21.8 SC	0.0218	7.49 (55.60)	6.03bc (35.86)	5.19bc (26.43)	4.85bc (23.02)	4.70cd (21.59)	4.99bc (24.40)	5.54bc (30.43)	5.22c (26.74)
T3	Flonicamid 50 WG	0.015	7.41 (54.40)	4.50d (19.75)	4.11d (16.39)	3.87d (14.47)	3.40a (11.06)	3.88d (14.55)	4.10d (16.39)	3.98d (15.34)
T4	Flupyradifurone 200 SL	0.05	7.65 (58.02)	5.87c (33.95)	5.10b (25.51)	4.78 (22.34)	4.66d (21.21)	4.97c (24.20)	5.28c (27.51)	5.11c (25.61)
T5	Dinotefuran 20 SG	0.008	7.50 (55.75)	6.05bc (36.10)	5.21bc (26.64)	4.81c (22.63)	4.70cd (21.59)	4.98c (24.30)	5.29c (27.66)	5.17c (26.22)
T6	Pymetrozine 50 WG	0.015	7.50 (55.75)	6.87b (46.69)	6.02b (35.74)	5.63b (31.19)	5.41b (28.76)	5.89b (34.19)	6.28b (39.28)	6.02b (35.74)
T7	Afidopyropen 5 DC	0.01	7.63 (57.71)	4.55d (20.20)	4.23d (17.39)	4.01d (15.58)	3.48e (11.61)	4.17a (16.88)	4.34d (18.53)	2.19d (4.29)
T8	Thiomethoxam 25 WG	0.01	7.50 (55.75)	5.67c (31.64)	5.13b (25.81)	4.77c (22.25)	4.68d (21.40)	5.00c (25.00)	5.28b\c (27.46)	5.09c (25.40)
T9	Tolfenpyrad 15 EC	0.0225	7.52 (56.05)	4.44d (19.21)	4.03d (15.74)	3.70d (13.19)	3.38e (10.92)	3.87d (14.47)	3.96d (15.38)	3.90d (14.71)
T10	Control		7.50 (55.75)	7.94a (62.54)	8.01a (63.66)	8.10a (65.11)	8.13a (65.59)	8.17a (66.24)	8.25a (67.56)	8.10a (65.11)
S. Em. ± T		-	0.39	0.28	0.30	0.24	0.22	0.25	0.25	0.102
P		-	-	-	-	-	-	-	-	0.07
T x P		-	-	-	-	-	-	-	-	0.249
F test (T)		-	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. %		-	8.99	8.29	9.65	8.28	8.12	8.23	8.14	8.19

Note: 1. Figures in parentheses are retransformed values and those outside are √x +0.5 transformed values. 2. Treatment mean(s) with the letter(s) in common are not significant by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance.3. Significant parameters and its interactions: T, P and T X P. Where, T = Treatment and P = Period

Table 2: Bio-efficacy of insecticides against aphids infesting coriander after second spray

Tr. No.	Treatments	Conc. (%)	No. of aphids/5 cm shoot at indicated days after spray						Pooled over periods	Pooled over periods and sprays
			1	3	5	7	10	15		
T1	Dimethoate 30 EC	0.03	5.33bc (27.90)	5.20bc (26.54)	4.95bc (24.00)	4.70bc (21.59)	4.41bc (18.94)	3.96b (15.18)	4.76b (22.15)	5.35b (28.12)
T2	Sulfoxaflor 21.8 SC	0.0218	4.55cd (20.20)	4.36cd (18.50)	4.15cd (16.72)	3.96cd (15.18)	3.74bc (13.48)	3.30c (10.39)	4.01c (15.58)	4.61c (20.75)
T3	Flonicamid 50 WG	0.015	3.46e (11.47)	3.25e (10.06)	3.12e (9.23)	2.91e (7.96)	2.67d (6.62)	2.42d (5.35)	2.97d (8.32)	3.47d (11.54)
T4	Flupyradifurone 200 SL	0.05	4.54d (20.11)	4.32d (18.16)	4.11d (16.39)	3.92cd (14.86)	3.63c (12.67)	3.27c (10.19)	3.96c (15.18)	4.54c (20.11)
T5	Dinotefuran 20 SG	0.008	4.48d (19.57)	4.27d (17.73)	4.09d (16.22)	3.88d (14.55)	3.65c (12.82)	3.26c (10.12)	3.94c (15.02)	4.55c (20.20)
T6	Pymetrozine 50 WG	0.015	5.51b (29.80)	5.33b (27.90)	5.07b (25.20)	4.80b (22.54)	4.52b (19.93)	3.97b (15.26)	4.87b (23.21)	5.44b (29.09)
T7	Afidopyropen 5 DC	0.01	4.53e (20.02)	3.25e (10.06)	3.11e (9.17)	2.93e (8.08)	2.72d (6.89)	2.45d (5.50)	2.99d (8.44)	3.59d (12.38)
T8	Thiomethoxam 25 WG	0.01	4.51c (19.84)	4.30d (17.99)	4.12d (16.47)	3.92cd (14.86)	3.61c (12.53)	3.25c (10.06)	3.95c (15.10)	4.52c (19.93)
T9	Tolfenpyrad 15 EC	0.0225	3.27e (10.19)	3.23e (9.93)	3.07e (8.92)	2.85e (7.62)	2.41d (5.30)	2.28d (4.69)	2.85d (7.62)	3.37d (10.85)
T10	Control		9.97a (98.90)	9.66a (92.81)	9.41a (88.04)	8.43a (70.56)	7.61a (57.41)	6.19a (37.81)	8.54a (72.43)	8.32a (68.72)
S. Em. ± T		-							0.095	0.070
P		-							0.073	0.054
T x P		-							0.232	0.171
F test (T)		-	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. %		-	8.69	9.49	9.01	9.83	10.72	11.25	9.37	8.75

Note: Figures in parentheses are retransformed values and those outside are √x +0.5 transformed values. Treatment mean(s) with the letter(s) in common are not significant by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance. Significant parameters and its interactions: T, P and T X P.

Table 3: Effect of various insecticides on coriander yield

Tr. No.	Treatments	Yield (kg/ha)	Increase in yield over control (%)	Avoidable losses (%)
T_1	Dimethoate 30 EC	954c	22.46	33.79
T_2	Sulfoxaflor 21.8 SC	1133bc	45.44	21.37
T_3	Flonicamid 50 WG	1400a	79.71	2.84
T_4	Flupyradifurone 200 SL	1183b	51.86	17.90
T_5	Dinotefuran 20 SG	1170b	50.19	18.80
T_6	Pymetrozine 50 WG	927c	18.99	35.66
T_7	Afidopyropen 5 DC	1391a	78.56	3.46
T_8	Thiamethoxam 25 WG	1199b	53.91	16.79
T_9	Tolfenpyrad 15 EC	1441a	84.98	0.00
T_{10}	Control	779d	-	45.94
S. Em. ±		162.34	-	-
C.V. %		12.14	-	-

Note: Treatment mean with letter(s) in common are non-significant by DNMRT at 5% level of significance

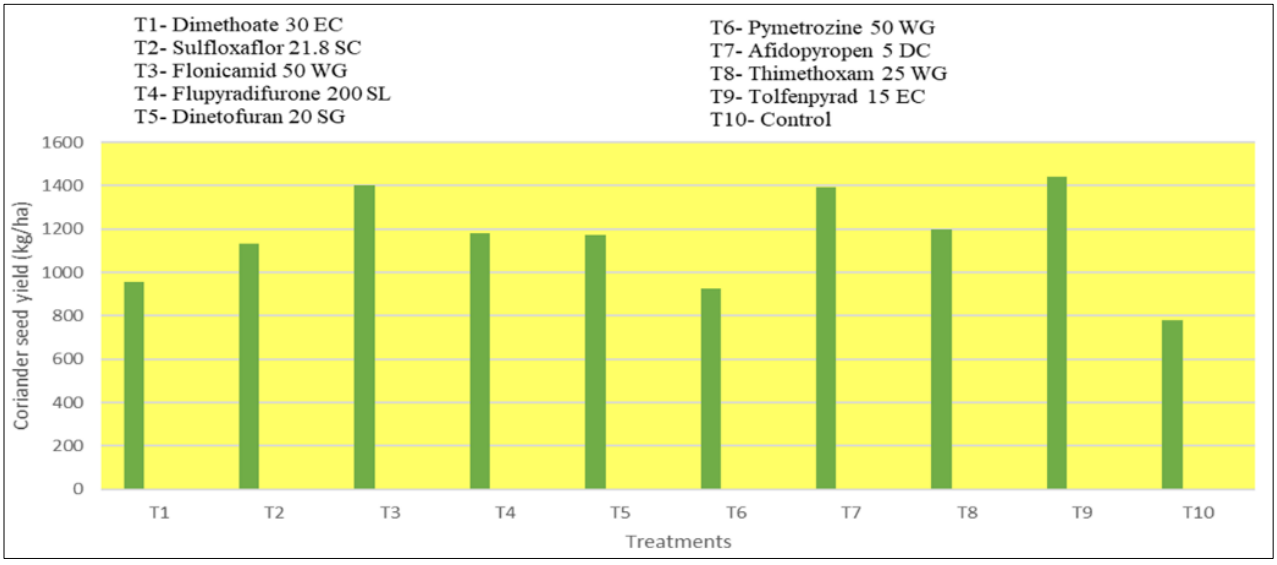

Fig 1: Effect of different insecticides on seed yield of coriander

Conclusion

Of the nine chemicals evaluated tolfenpyrad 15 EC, flonicamid 50 WG and afidopyropen 5 DC were found more effective on the basis of population of aphids, whereas thimethoxam 25 WG, flupyradifuron 200 SL and dinotefuran 20 SG were mediocre in their effectiveness. However, pymetrozine 50 WG, dimethoate 30 EC and sulfoxaflor 21.8 SC were found less effective in reducing the incidence of aphids infesting coriander. The coriander seed yield recorded from treatments *viz.*, tolfenpyrad, flonicamid, afidopyropen, thimethoxam, flupyradifuron, dinetofuran, sulfloxaflor, dimethoate and pymetrozine were 1441, 1400, 1391, 1199, 1183, 1170, 1133, 954 and 927 kg/ha, respectively.

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