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Evaluation of insecticides and bio-pesticides against coriander aphid

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Abstract
The present investigation entitled Studies on insect pests of coriander with special reference to seasonal incidence and management of Aphid, *Hyadaphis coriandri* (Das) was conducted in the Horticultural research farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (Chhattisgarh), during *Rabi* season in 2022 -2023.

The mean on number of aphids/umbels/plants recorded after first and second spray showed that average aphids survival population per plant ranging from 2.00 to 7.03, compared to 11.95 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest thrips (2.00 aphids/ umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (2.76 aphids/ umbels/plant) was the second-best treatment, followed by Dinotefuran 20% SG (3.17 aphids/ umbels/plant) and Imidacloprid 17.8% SL (3.32 aphids/ umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (6.28 aphids/ umbels/plant) followed by *Metarhizium anisopliae* 10% (1×109 CFU/ml) (6.87 aphids/ umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (7.03 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (11.95 aphids/umbels/plant).

The cost benefit ratio of different insecticidal treatments applied for the management of aphids has been worked out. The highest cost benefit ratio was found in treatment T_1- Imidacloprid 17.8% SL (1:5.85) followed by T_2- Thiacloprid 21.7% SC (1:5.61) and T_3- Dinotefuran 20% SG (1:11).

Keywords: Coriander, biopesticide, aphid (*Hyadaphis coriandri* Das), *Beauveria bassiana*, *Lecanicillium lecanii*, *Metarhizium anisopliae*

Introduction
In ancient times, India has been known as the "home of spices" due to the wide variety of spices it produces and their exotic flavour, taste, and medicinal properties. Over 70 different types of spices are grown worldwide, but the most popular ones in our country are pepper, cardamom, ginger, turmeric, coriander, and chilies. (Paswan *et al.*, 2021) [2].

Coriander (*Coriandrum sativum* Linn.), also referred to as "Dhaniya," is a significant annual seed spice crop cultivate in India and all over the world. It is a cross- pollinated, diploid crop that belongs to the Apiaceae/Umbelliferae families. (Patidar, 2009) [3]

Coriander is one of the important seed spices in India which cover 6.31 lakh ha and 8.00 lakh tonne production. In Chhattisgarh total area, Production and Productivity of coriander crop is 2.95 lakh ha, 0.85 mt and 0.29 mt/ha respectively. In Bilaspur (C.G.) 1259 hectares of land is dedicated to coriander seed farming. The yield of this area is approximately 387 metric tonnes with an average productivity of 0.29 metric tonnes/hectare. (Spice Board of India 2022, *Indiastat.com*)

Coriander is susceptible to insect pests and short duration cash crop to increase coriander production's output and quality one of the key controlling factors is pest and insect control. The aphid, *Hyadaphis coriandri* (Das), white fly (*Bemisia tabaci*) (Gennadius), green peach aphid (*Myzus persicae*) (Sulzer), mite (*Petrobia latens*) (Muller), and thrips (*Thrips tabaci*) (Lindeman) have all been discovered to infest coriander. These pests cause damage to the crop from the time of germination of seed to till maturity of the crop. (Susan E. Halbert, 2021) [4].

The plant suffers significant damage from tender shoots to umbels as a result of the insect pests, *Hyadaphis coriandri* (Das), sucking plant cell sap (as they prefer tender areas for feeding and breeding). They later consume the sap from growing seeds as food. Additionally, to causing direct harm, it encourages the growth of sooty mould. The insect excretes chemicals known as honey dew that prevent plants from photosynthesis.

Aphid nymphs and adults both caused quantitative and qualitative losses to coriander seeds and production from blossoming to full crop maturity during the crop season (mostly February to March). Climate conditions play a key role in how frequently insect pests occur. (Swami *et al.*, 2018) [1].

Materials and Methods

Evaluation of insecticides and biopesticides against coriander aphid

Method of observation

Two foliar sprays were given using knapsack sprayer. First spray was done when the pest incidence crossed ETL (1.0 aphid index) and second when the aphid population was normally distributed. The aphids on three inflorescence/ umbels from each tagged plant were counted. Pre-population count was recorded one day before the application of treatments, and post treatment data after 1, 3, 7,12 and 15 days. Similar observations were made after the second application.

The aphid index will be fixed as per Yadav (1980) for estimating the average aphid index was worked out by adopting the following formula.

$$\text{Average aphid index} = \frac{0N+1N+2N+3N+4N+5N}{\text{Total number of plants observed}}$$

Where

The aphid index is 0, 1, 2, 3, 4, 5,

N = Number of plants with respective aphid index

Aphid Index

0	=	The aphid free plant.
1	=	Aphid present but not built-up colonies. No injury due to pest appearance on plant.
2	=	Small colonies of aphid present on leaves of plant. Such leaves exhibit slight curling due to aphid feeding.
3	=	Large colonies of aphid present on leaves and other parts, damage symptoms visible due to aphid feeding.
4	=	Most leaves are covered with colonies of aphids. Counts are not possible and the plant shows more damage symptoms due to aphid feeding.
5	=	The plant is completely covered with aphid colonies and due to pest feeding, plant growth is impeded.

Table 1: Details of different insecticides & biopesticides treatments

Treatment	Name of treatment/ Chemical Name/Formulation	Dose/lit. of water	Trade name
T1	Imidacloprid 17.8% SL	0.30 ml/litre	Admire
T2	Thiacloprid 21.7% SC	0.25 ml/litre	Alanto
T3	Dinotefuran 20% SG	0.25 gm/litre	Dominant
T4	Spinetoram 11.7% SC	0.90 ml/litre	Delegate
T5	*Beauveria bassiana* 10% (1 × 109 CFU/ml)	10 ml/litre	------
T6	*Lecanicillium lecanii* 10% (1 × 109 CFU/ml)	10 ml/litre	-----
T7	*Metarhizium anisopliae* 10% (1 × 109 CFU/ml)	10 ml/litre	-------
T8	Untreated Control		

Results and Discussion

First Spray

1st day after spray

The data on number of aphids/ umbels/plants recorded at first day after first spray presented in Table 1 and depicted in Fig. 1 showed that average aphids survival population per plant ranging from 4.00 to 9.13, compared to 9.47 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (4.00 aphids/ umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (4.40 aphids/ umbels/plant) was the second-best treatment, followed by Dinotefuran 20% SG (5.00 aphids/ umbels/plant) which were at par with Imidacloprid 17.8% SL (5.33 aphids/ umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (7.93 aphids/ umbels/plant) followed by *Beauveria bassiana* 10% (1×109 CFU/ml) (9.07 aphids/ umbels/plant) which were at par with *Metarhizium anisopliae* 10% (1×109 CFU/ml) (9.13 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (9.47 aphids/umbels/plant).

3rd day after spray

The data on number of aphids/umbels/plants recorded at third day after first spray presented in Table 1 and depicted in Fig. 1 showed that average aphids survival population per plant ranging from 3.07 to 8.07, compared to 9.67 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (3.07 aphids/umbels/plant) and was shown to be substantially superior to all other treatments which were at par with Spinetoram 11.7% SC (3.40 aphids/umbels/plant). Dinotefuran 20% SG (3.80 aphids/umbels/plant) was the second- best treatment, followed by Imidacloprid 17.8% SL (4.13 aphids/umbels/plant). The next best treatment was *Metarhizium anisopliae* 10% (1×109 CFU/ml) (6.47 aphids/umbels/plant) followed by *Lecanicillium lecanii* 10% (1×109 CFU/ml) (7.67 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (8.07 aphids/ umbels/ plant) were effective in lowering aphids' population and substantially superior to the untreated control (9.67 aphids/umbels/plant).

7th day after spray

The data on number of aphids/umbels/plants recorded at seventh day after first spray presented in Table 1 and depicted in Fig. 1 showed that average aphids survival population per plant ranging from 2.73 to 6.00, compared to 9.93 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphid (2.73 aphids/umbels/plant) and was shown to be substantially superior to all other treatments which were at par with Spinetoram 11.7% SC (3.07 aphids/umbels/plant), Dinotefuran 20% SG (3.13 aphids/umbels/plant) and Imidacloprid 17.8% SL (3.20 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (5.67 aphids/umbels/plant) which were at par with *Metarhizium*

anisopliae 10% (1×109 CFU/ml) (5.73 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (6.00 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (9.93 aphids/umbels/plant).

12th day after spray

The data on number of aphids/umbels/plants recorded at twelve days after first spray presented in Table 1 and depicted in Fig. 1 showed that average aphids survival population per plant ranging from 0.53 to 5.87, compared to 10.20 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (0.53 aphids/umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (2.13 aphids/umbels/plant) was the second-best treatment, which were at par with Dinotefuran 20% SG (2.20 aphids/umbels/plant) and Imidacloprid 17.8% SL (2.40 aphids/umbels/plant). The next best treatment was *Beauveria bassiana* 10% (1×109 CFU/ml) (4.00 aphids/umbels/plant) followed by *Lecanicillium lecanii* 10% (1×109 CFU/ml) (4.60 aphids/umbels/plant) and *Metarhizium anisopliae* 10% (1×109 CFU/ml) (5.87 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (10.20 aphids/umbels/plant).

15th day after spray

The data on number of aphids/umbels/plants recorded at fifteenth day after first spray presented in Table 1 and depicted in Fig. 1 showed that average aphids survival population per plant ranging from 2.53 to 6.53, compared to 10.47 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (2.53 aphids/umbels/plant) and was shown to be substantially superior to all other treatments which were at par with Spinetoram 11.7% SC (2.87 aphids/umbels/plant). The next best treatment was Dinotefuran 20% SG (3.07 aphids/umbels/plant) which were at par with Imidacloprid 17.8% SL (3.13 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (6.20 aphids/umbels/plant) which were at par with *Metarhizium anisopliae* 10% (1×109 CFU/ml) (6.47 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (6.53 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (10.47 aphids/umbels/plant).

Second Spray

1st day after spray

The data on number of aphids/umbels/plants recorded at first day after second spray presented in Table 2 and depicted in Fig. 2 showed that average aphids survival population per plant ranging from 1.93 to 7.80, compared to 11.33 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (1.93 aphids/umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (2.60 aphids/umbels/plant) was the second-best treatment, which were at par with Dinotefuran 20% SG (2.80 aphids/umbels/plant) and Imidacloprid 17.8% SL (2.87 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (7.60 aphids/umbels/plant) which were at par with *Metarhizium anisopliae* 10% (1×109 CFU/ml) (7.73 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (7.80 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (11.33 aphids/umbels/plant).

3rd day after spray

The data on number of aphids/umbels/plants recorded at third day after second spray presented in Table 2 and depicted in Fig. 2 showed that average aphids survival population per plant ranging from 0.00 to 6.47, compared to 12.33 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (0.00 aphids/umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (1.33 aphids/umbels/plant) was the second-best treatment, followed by Dinotefuran 20% SG (2.07 aphids/ umbels/plant) which were at par with Imidacloprid 17.8% SL (2.20 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (4.07 aphids/ umbels/plant) followed by *Metarhizium anisopliae* 10% (1×109 CFU/ml) (6.00 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (6.47 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (12.33 aphids/umbels/plant).

7th day after spray

The data on number of aphids/umbels/plants recorded at seventh day after second spray presented in Table 2 and depicted in Fig. 2 showed that average aphids survival population per plant ranging from 0.00 to 6.80, compared to 16.73 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (0.00 aphids/umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (1.07 aphids/umbels/plant) was the second-best treatment, followed by Dinotefuran 20% SG (1.67 aphids/umbels/plant) and Imidacloprid 17.8% SL (2.13 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (5.40 aphids/umbels/plant) followed by *Metarhizium anisopliae* 10% (1×109 CFU/ml) (6.53 aphids/umbels/plant) were at par with *Beauveria bassiana* 10% (1×109 CFU/ml) (6.80 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (16.73 aphids/umbels/plant).

12th day after spray

The data on number of aphids/umbels/plants recorded at twelve days after second spray presented in Table 2 and depicted in Fig. 2 showed that average aphids survival population per plant ranging from 2.60 to 7.00, compared to 14.27 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (2.60 aphids/umbels/plant) and was shown to be substantially superior to all other treatments which were at par with Spinetoram 11.7% SC (3.07 aphids/umbels/plant). Dinotefuran 20% SG (3.67 aphids/umbels/plant) was the second-best treatment, which were at par with Imidacloprid 17.8% SL (3.87 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (5.60 aphids/umbels/plant) followed by *Metarhizium anisopliae* 10% (1×109 FU/ml) (6.27 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (7.00 aphids/umbels/plant) were effective in lowering aphids' population and substantially

superior to the untreated control (14.27 aphids/umbels/plant).

15th day after spray

The data on number of aphids/umbels/plants recorded at fifteenth day after second spray presented in Table 2 and depicted in Fig. 2 showed that average aphids survival population per plant ranging from 2.60 to 8.60, compared to 15.13 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (2.60 aphids/umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (3.60 aphids/umbels/plant) was the second-best treatment, which were at par with Imidacloprid 17.8% SL (3.93 aphids/umbels/plant) and Dinotefuran 20% SG (4.33 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (8.07 aphids/umbels/plant) which were at par with *Metarhizium anisopliae* 10% (1×109 CFU/ml) (8.47 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (8.60 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (15.13 aphids/umbels/plant).

Overall mean of number of aphids/umbels/plant (average of two spray)

The mean on number of aphids/umbels/plants recorded after first and second spray presented in Table 3 showed that average aphids survival population per plant ranging from 2.00 to 7.03, compared to 11.95 in the untreated control. In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (2.00 aphids/umbels/plant) and was shown to be substantially superior to all other treatments. Spinetoram 11.7% SC (2.76 aphids/umbels/plant) was the second-best treatment, followed by Dinotefuran 20% SG (3.17 aphids/umbels/plant) and Imidacloprid 17.8% SL (3.32 aphids/umbels/plant). The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (6.28 aphids/umbels/plant) followed by *Metarhizium anisopliae* 10% (1×109 CFU/ml) (6.87 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (7.03 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (11.95 aphids/umbels/plant).

More or less the present findings are agreement with the findings of Patel *et al.*, 2021 [5] who experiment 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 coriander. However, thiamethoxam 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).

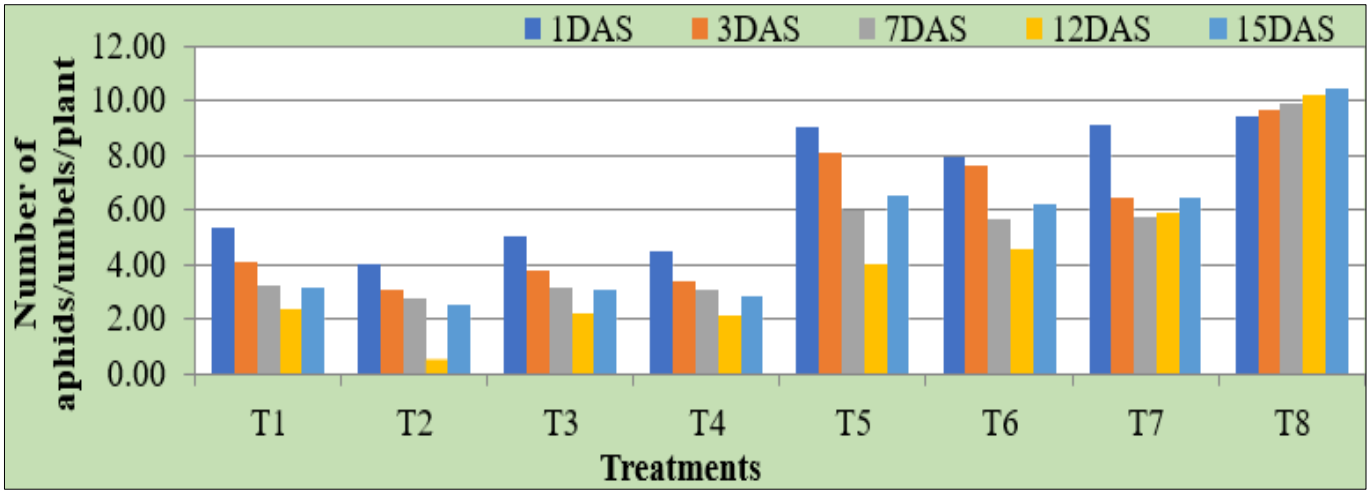

Fig 1: Number of aphids/umbels/plant after first spray

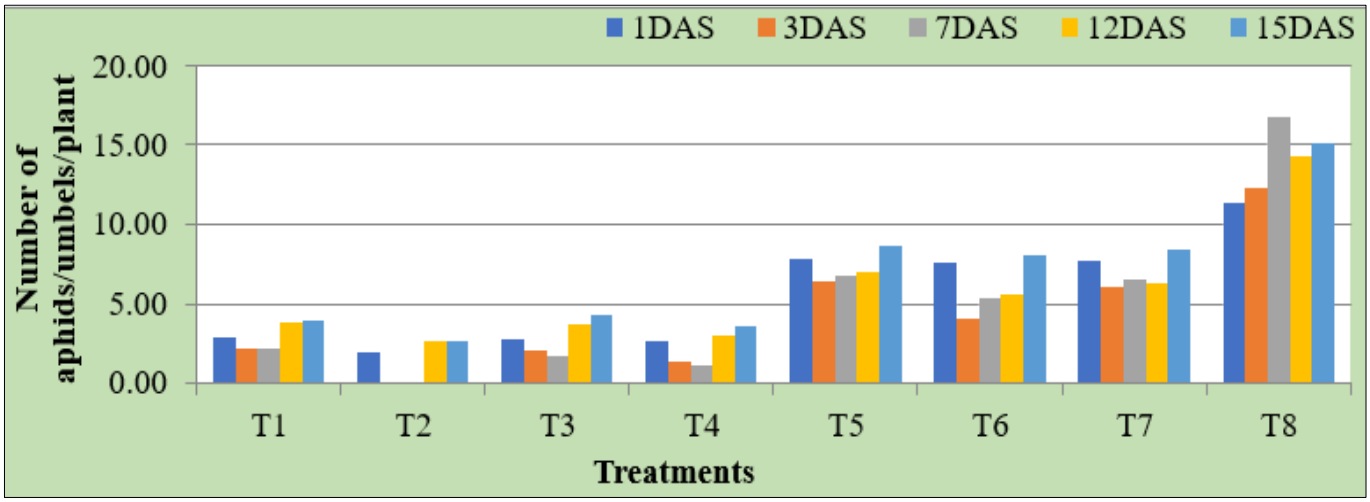

Fig 2: Number of aphids/umbels/plant after second spray

Table 1: Effect of different bio-pesticide and insecticides on coriander aphid (*Hyadaphis coriandri*) after first spray

Sr. no.	Treatment	Pre-count		Number of aphids/umbels/plants				
			1 DAS	3 DAS	7 DAS	12 DAS	15 DAS	Overall mean of first spray
T_1	Imidaclopri d 17.8% SL	6.80 (2.79)	5.33 (2.51)	4.13(2.26)	3.20 (2.05)	2.40 (1.84)	3.13 (2.03)	3.64 (2.03)
T_2	Thiacloprid 21.7% SC	8.07 (3.00)	4.00 (2.23)	3.07 (2.01)	2.73 (1.93)	0.53 (1.20)	2.53 (1.88)	2.57 (1.75)
T_3	Dinotefuran 20% SG	8.07 (2.98)	5.00 (2.45)	3.80 (2.19)	3.13 (2.03)	2.20 (1.79)	3.07 (2.01)	3.44 (1.98)
T_4	Spinetoram 11.7% SC	6.53 (2.74)	4.47 (2.34)	3.40 (2.09)	3.07 (2.01)	2.13 (1.77)	2.87 (1.96)	3.19 (1.92)
T_5	*Beauveria bassiana* 10% (1×109 CFU/ml)	7.07 (2.82)	9.07 (3.16)	8.07 (2.96)	6.00 (2.63)	4.00 (2.23)	6.53 (2.73)	6.73 (2.69)
T_6	*Lecanicillium lecanii* 10% (1×109 CFU/ml)	5.93 (2.63)	7.93 (2.99)	7.67 (2.91)	5.67 (2.56)	4.60 (2.36)	6.20 (2.66)	6.41 (2.63)
T_7	*Metarhizium anisopliae* 10% (1×10 CFU/ml)	7.47 (2.91)	9.13 (3.17)	6.47 (2.73)	5.73 (2.59)	5.87 (2.61)	6.47 (2.73)	6.73 (2.69)
T_8	Untreated Control	5.73 (2.59)	9.47 (3.23)	9.67 (3.26)	9.93 (3.30)	10.20 (3.34)	10.47 (3.39)	9.95 (3.23)
	C.D. (5%)	N/A	0.406	0.604	0.470	0.380	0.412	1.24
	SEm (±)	0.177	0.132	0.197	0.154	0.124	0.135	0.40
	C.V. (%)	10.901	8.317	13.382	11.148	10.030	9.623	13.27

*Figures in parentheses are the square root transformed values

Table 2: Effect of different bio-pesticide and insecticides on coriander aphid (*Hyadaphis coriandri*) after second spray

Sr. No	Treatment	Number of aphids/umbels/plants						
		Pre-count	1 DAS	3 DAS	7 DAS	12 DAS	15 DAS	Overall mean of second spray
T_1	Imidaclopri d 17.8% SL	4.00 (2.16)	2.87 (1.96)	2.20 (1.78)	2.13 (1.77)	3.87 (2.20)	3.93 (2.21)	3.00 (1.87)
T_2	Thiacloprid 21.7% SC	4.40 (2.27)	1.93 (1.71)	0.00 (1.00)	0.00 (1.00)	2.60 (1.90)	2.60 (1.89)	1.43 (1.39)
T_3	Dinotefuran 20% SG	5.00 (2.39)	2.80 (1.95)	2.07 (1.74)	1.67 (1.62)	3.67 (2.16)	4.33 (2.31)	2.91 (1.85)
T_4	Spinetoram 11.7% SC	5.00 (2.39)	2.60 (1.90)	1.33 (1.52)	1.07 (1.43)	3.07 (2.01)	3.60 (2.14)	2.33 (1.68)
T_5	*Beauveria bassiana* 10% (1×109 CFU/ml)	3.80 (2.15)	7.80 (2.93)	6.47 (2.69)	6.80 (2.79)	7.00 (2.79)	8.60 (3.07)	7.33 (2.80)
T_6	*Lecanicilliu m lecanii* 10% (1×109 CFU/ml)	3.00 (1.94)	7.60 (2.90)	4.07 (2.21)	5.40 (2.52)	5.60 (2.57)	8.07 (3.01)	6.15 (2.58)
T_7	*Metarhizium anisopliae* 10% (1×109 CFU/ml)	4.20 (2.24)	7.73 (2.94)	6.00 (2.64)	6.53 (2.74)	6.27 (2.69)	8.47 (3.08)	7.00 (2.74)
T_8	Untreated Control	5.20 (2.45)	11.33 (3.51)	12.33 (3.65)	16.73 (4.18)	14.27 (3.90)	15.13 (3.98)	13.96 (3.80)
	C.D. (5%)	N/A	0.522	0.448	0.422	0.487	0.640	1.24
	SEm (±)	0.228	0.170	0.146	0.138	0.159	0.209	0.40
	C.V. (%)	12.673	11.934	11.765	10.579	10.900	13.366	12.83

*Figures in parentheses are the square root transformed values

Table 3: Effect of different bio-pesticide and insecticides on coriander aphid (*Hyadaphis coriandri*) (Average of first and second spray)

Sr. No.	Treatment		Number of aphids/umbels/plants	
		Overall mean of first spray	Overall mean of second spray	Average of first and second spray
T_1	Imidacloprid 17.8% SL	3.64 (2.03)	3.00 (1.87)	3.32 (2.08)
T_2	Thiacloprid 21.7% SC	2.57 (1.75)	1.43 (1.39)	2.00 (1.73)
T_3	Dinotefuran 20% SG	3.44 (1.98)	2.91 (1.85)	3.17 (2.04)
T_4	Spinetoram 11.7% SC	3.19 (1.92)	2.33 (1.68)	2.76 (1.94)
T_5	*Beauveria bassiana* 10% (1×109 CFU/ml)	6.73 (2.69)	7.33 (2.80)	7.03 (2.83)
T_6	*Lecanicillium lecanii* 10% (1×109 CFU/ml)	6.41 (2.63)	6.15 (2.58)	6.28 (2.70)
T_7	*Metarhizium anisopliae* 10% (1×109 CFU/ml)	6.73 (2.69)	7.00 (2.74)	6.87 (2.84)
T_8	Untreated Control	9.95 (3.23)	13.96 (3.80)	11.95 (3.62)
	C.D. (5%)	1.108	0.120	0.113
	SEm (±)	0.035	0.40	0.037
	C.V. (%)	13.27	12.83	12.58

Conclusions

- The mean on number of aphids/umbels/plants recorded after first and second spray showed that average aphids survival population per plant ranging from 2.00 to 7.03, compared to 11.95 in the untreated control.
- In chemical and biopesticides check treatment, Thiacloprid 21.7% SC recorded the lowest aphids (2.00 aphids/umbels/plant) and was shown to be substantially superior to all other treatments.
- Spinetoram 11.7% SC (2.76 aphids/umbels/plant) was the second-best treatment, followed by Dinotefuran 20% SG (3.17 aphids/umbels/plant) and Imidacloprid 17.8% SL (3.32 aphids/umbels/plant).
- The next best treatment was *Lecanicillium lecanii* 10% (1×109 CFU/ml) (6.28 aphids/umbels/plant) followed by Metarhizium anisopliae 10% (1×109 CFU/ml) (6.87 aphids/umbels/plant) and *Beauveria bassiana* 10% (1×109 CFU/ml) (7.03 aphids/umbels/plant) were effective in lowering aphids' population and substantially superior to the untreated control (11.95 aphids/umbels/plant).
- The cost benefit ratio of different insecticidal treatments applied for the management of aphids has been worked

out. The highest cost benefit ratio was found in treatment T_1- Imidacloprid 17.8% SL (1:5.85) followed by T_2-Thiacloprid 21.7% SC (1:5.61) and T_3-Dinotefuran 20% SG (1:11)

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