Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(2): 1019-1022

Received: 13-01-2021
Accepted: 15-02-2021

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Integrated management of aphid (*Hydaphis coriandri* (Das) and powdery mildew in coriander

Reena Nair, SB Das and Jyothsna J

Abstract
Coriander is an annual spice herb whose fresh and dried leaves; and seeds are used as food flavoring agents. The crop is prone to various pest and diseases, despite of the sowing season. The major pest of coriander namely three aphid species, *Hyadaphis coriandri, Myzus persicae* and *Aphis carccivora* results in 45 to 50 percent loss in yield, provided proper control measures are not taken. The powdery mildew of coriander, caused by *Erysiphe polygoni*, is the major disease that is as devastating as it could cause 50 per cent yield loss in absence of effective management. In order to scheme an integrated management strategy both controlling both the pest and disease, an experiment was taken up involving integrated application of biocontrol agent, fungicides and insecticides at different stage of crop growth. There were ten treatments, replicated thrice, involving the foliar application of biocontrol agent of *Lecanicillium lecanii* and pesticides namely Propiconozole, Carbendazim and Acetamiprid. This experiment was carried out at the Horticulture farm, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh. Two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×109 cfu/g) (40 g/10 L.) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first spray) + spray of Carbendazim @ 0.1% (second spray) resulted the lowest aphid population (5.59%). Similarly, it was found that the two foliar sprays of *Lecanicillium lecanii* + spray of Carbendazim (first spray) + spray of Propiconazole (second spray) was found to be superior over all the other treatment with lowest percent disease incidence (12.27%). The integrated use of biocontrol agents, fungicides and insecticides offer an effective management against the aphids and powdery mildew disease of coriander.

Keywords: coriander, aphids, powdery mildew, biocontrol agent, acetamiprid, propiconazole, carbendazim

Introduction
The coriander (*Coriandrum sativum* L.) is an essential spice of Indian cuisine which is widely used for its foliage and seeds. During 2019-20, India produced 7,56,000 MT of coriander from an area of 6,29,000 ha (NHB, 2021) [8]. Among the Indian states, Madhya Pradesh, Rajasthan and Gujarat tops in the volume of coriander seed production (Statista, 2021) [11]. The major limiting constraints of the coriander production are the pest and diseases. The coriander aphid (*Hyadaphis coriandri*) (Chaudhary *et al.*, 2015) [1] and the powdery mildew disease (caused by *Erysiphe polygoni*) are found to be the most destructing pest and diseases of coriander, respectively (Ushamalini and Nakkeeran, 2017) [10].

The crop is prone to various pest and diseases, despite of the sowing season. A complex of sucking pest damages the coriander crop, among which the aphids causes the economic damage. The major pest of coriander namely three aphid species, *Hyadaphis coriandri, Myzus persicae* and *Aphis carccivora* results in 45 to 50 percent loss in yield, provided proper control measures are not taken. *Hyadaphis coriandri* is the major species of aphid infesting the coriander with a globe wide distribution. It is potential to cause upto 50 per cent yield loss during the flowering stage just with a population of 55-70 aphids/5 plants (Jain and Yadava, 1989) [4]. The maximum multiplication of pest population occurs during existence of a conducive temperature between 20-25 ºC and 60-65 per cent relative humidity in the environment (Meena *et al.*, 2002) [7]. Amid various diseases infecting the coriander, the powdery mildew is one of the devastating diseases which could attribute to a huge loss in yield. The indiscriminate and intensive use of pesticides and fungicides have resulted various undesirable effects namely resistance, resurgence and environmental pollution. Bearing this in mind, this investigation is an attempt to derive a promising schedule of integrated pest and disease management in coriander.

Materials and Methods

The experiment was carried out in a randomized block design (RBD) with ten treatments, replicated thrice. The treatment details are furnished in table 1. The dimension of the experimental plot was 3.0 m × 2.40 m and a spacing of 30 cm between rows and 10 cm between the plants were adopted. To control the aphid pest, chemical insecticide acetamiprid 20 SP and entomo-pathogenic fungi, *Lecanicillium lecanii* 1.15 WP were employed in the experiment. The chemical fungicides namely propiconazole 25 EC and carbendazim 50 WP were put to study their effects in controlling the powdery mildew disease. All the chemical and bio-pesticides were given as foliar sprays, applied twice.

The observations on aphid population and powdery mildew incidence were recorded from randomly selected and tagged plants in each plot. The aphid population was observed a day prior and 3, 5 and 7 days after the insecticide and entomopathogen application whereas, the observation pertaining to powdery mildew disease was made a day before and 3, 5, 7 and 10 days after the fungicides sprays. The observations on plant growth parameters were recorded at the appropriate growth stages. The crop was raised with the recommended package of practices.

Result and Discussion

Effect of chemical insecticide and entomopathogenic fungi on control of aphid population

The aphid population prior to the treatment was found insignificant among the different treatments while the effect of different pesticides imparted significant effect on the aphid population (Table 2). After 3 days of the first spray, the maximum reduction of aphid population (6.16) was exhibited by the treatment T5 that consisted of two foliar sprays of *Lecanicillium lecanii* + spray of Propiconazole (first spray) + spray of Carbendazim (second spray). It was observed that the aphid population decreased during the time after both the sprays. This treatment was followed by T8 (Two foliar sprays of Acetamiprid 20SP (0.004%) + spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray)) and T7 (Two foliar sprays of Acetamiprid 20SP (0.004%) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first spray) + spray of Carbendazim 50 WP @ 0.1% (20 g/10L water) (second spray)). These results were in line the reports of Meena (2018) [6], Prajapati *et al.* (2019) [9] and Trinh *et al.* (2020) [12]. The least reduction of aphid population was noted in the untreated plants.

Effect of fungicides on control of powdery mildew disease incidence

The pre-count of the disease incidence was recorded to be non-significant however the pesticide treatments recorded significance across the various treatments (Table 3). After both the first and second sprays, maximum reduction in disease incidence per cent was observed under the treatment T6 that consisted of two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×109 cfu/g) (40g/10 L) + spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray). This was followed by the treatments T7 (Two foliar sprays of Acetamiprid 20SP (0.004%) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first spray) + spray of Carbendazim 50 WP @ 0.1% (20 g/10L water) (second spray)) and T8 (Two foliar sprays of Acetamiprid 20SP (0.004%) + spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray)). Similar results were reported by Deshmukh *et al.* (2018) [2], Goswami *et al.* (2018) [3] and Khunt *et al.* (2017) [5]. The least reduction of powdery mildew disease incidence was noted in the untreated plants.

Effect of pesticides on growth, yield and yield related traits

The growth and yield traits namely germination percentage, days to 50 per cent flowering, number of umbels plant^{-1}, number of umbellets umbel^{-1}, number of seeds umbel^{-1}, test weight and seed yield ha^{-1}. The growth traits namely germination percentage and days to 50 per cent flowering was found insignificant and the yield parameters were found significant (Table 4). The treatment T6 subjected to two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×109 cfu/g) (40g/10 L) + spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray) recorded the maximum seed yield ha^{-1} (12.03 q ha^{-1}).

Table 1: Treatment details

T_1	Sprays of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first & second spray) + Two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×10^9 cfu/g) (40 g/10 L.)
T_2	Spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first & second spray) + Two foliar sprays of Acetamiprid 20SP (0.004%)
T_3	Spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first & second spray) + Two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×10^9 cfu/g) (40g/10 L.)
T_4	Spray of Carbendazim 50 WP @ 0.1% (20 g /10 L water) (first & second spray) + Two foliar sprays of Acetamiprid 20SP (0.004 %)
T_5	Two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×10^9 cfu/g) (40 g/10 L.) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first spray) + spray of Carbendazim @ 0.1% (second spray)
T_6	Two foliar sprays of *Lecanicillium lecanii* 1.15WP (1×10^9 cfu/g) (40g/10 L) + spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray)
T_7	Two foliar sprays of Acetamiprid 20SP (0.004%) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (first spray) + spray of Carbendazim 50 WP @ 0.1% (20 g/10L water) (second spray)
T_8	Two foliar sprays of Acetamiprid 20SP (0.004%) + spray of Carbendazim 50 WP @ 0.1% (20 g/10 L water) (first spray) + spray of Propiconazole 25 EC @ 0.05% (10 ml/10 L) (second spray)
T_9	Two foliar sprays of Imidachloprid (0.05%) + One foliar spray of SAAF (12% Carbendazim + 63% WP Mancozeb) @ 0.25% (first spray) + one spray Carbendazim 50 WP @ 0.1% (20 g/10 L water) (second spray)
T_{10}	Untreated control

Table 2: Bio-efficacy of bio-pesticides and insecticide against aphid infesting coriander

Treatments	Pretreatment population Aphid/10 cm twig	Reduction in aphid population (%)							
		After first spray				After second spray			
		3 DAS*	5 DAS	7 DAS	Mean of first spray	3DAS	5DAS	7DAS	Mean of second spray
T_1	62.93 (7.96)	60.90 (7.83)	50.51 (7.14)	44.88 (6.73)	7.233**	43.36 (6.62)	40.30 (6.37)	36.48 (6.06)	6.350**
T_2	63.04(7.97)	53.20 (7.33)	37.94 (6.19)	40.40 (6.39)	6.637	28.30 (5.32)	25.55(5.08)	20.72(4.58)	4.993
T_3	62.31(7.93)	57.24 (7.59)	52.34 (7.26)	49.11 (7.03)	7.293	43.47 (6.61)	37.69(6.16)	34.73(5.93)	6.233
T_4	63.11(7.97)	55.97 (7.51)	48.86 (7.02)	40.54 (6.39)	6.973	34.59 (5.91)	30.92(5.59)	26.39(5.17)	5.557
T_5	63.40(7.99)	37.49 (6.16)	30.86 (5.60)	25.07 (5.03)	5.597	16.36 (4.08)	12.21(3.52)	10.01(3.23)	3.610
T_6	61.70 (7.88)	59.53 (7.75)	50.66 (7.15)	40.40 (6.38)	7.093	35.40 (5.98)	30.27(5.53)	27.45(5.25)	5.587
T_7	62.40(7.93)	41.10 (6.45)	33.84 (5.85)	30.87 (5.60)	5.967	26.65 (5.19)	21.20 (4.64)	17.27 (4.14)	4.657
T_8	62.33(7.93)	38.53 (6.25)	32.79 (5.77)	29.86 (5.50)	5.840	21.90 (4.68)	17.51(4.19)	14.73 (3.84)	4.237
T_9	60.25(7.79)	56.29 (7.53)	51.41 (7.20)	47.54 (6.92)	7.217	39.42 (6.31)	36.34(6.05)	31.16(5.61)	5.990
T_{10}	62.81(7.96)	62.27 (7.91)	60.91 (7.83)	62.53 (7.92)	7.887	61.61 (7.87)	63.78(8.01)	62.87(7.96)	7.947
C.D.	NS	0.48	7.49	0.79	0.40	12.01	9.26	10.27	0.27
SE(m)	0.06	0.16	5.49	0.25	0.13	4.01	3.09	3.43	0.09
SE(d)	0.09	0.23	5.60	0.37	0.19	5.67	4.37	4.85	0.13
C.V.	1.41	3.82	7.36	7.17	3.42	19.79	16.96	21.09	2.89

* DAS- Days After Spraying **Figure in parentheses are transformed value

Table 3: Effect of bio-pesticides and fungicides on Percent disease incidence of Powdery mildew in coriander

Treatments	Pre treatment Incidence	Reduction in percent disease incidence									
		After first spray				Mean of first spray	After second spray				Mean of second spray
		3 DAS	5 DAS	7 DAS	10DAS		3DAS	5DAS	7DAS	10DAS	
T_1	21.88	20.08	18.02	17.21	16.11	17.86	15.05	14.31	13.47	11.40	13.56
T_2	21.29	24.11	23.67	23.03	21.28	23.02	19.35	17.81	17.06	16.34	17.64
T_3	21.94	21.48	19.75	18.95	17.11	19.32	15.84	14.59	14.24	12.33	14.25
T_4	21.84	25.35	24.96	24.92	23.07	24.58	21.91	21.04	20.36	19.06	20.59
T_5	21.60	23.41	22.63	21.62	19.84	21.88	18.08	16.76	15.93	13.89	16.17
T_6	21.15	13.99	12.34	11.90	10.86	12.27	9.35	8.24	7.47	6.73	7.95
T_7	21.50	15.99	13.87	13.00	12.09	13.74	10.83	9.58	8.49	7.93	9.21
T_8	21.55	17.21	15.64	14.85	13.83	15.38	12.87	11.27	10.77	9.52	11.11
T_9	21.23	22.31	21.17	20.32	18.12	20.48	17.07	16.28	15.07	14.80	15.81
T_{10}	21.68	24.17	24.92	25.52	26.68	25.32	26.93	26.86	26.01	26.13	26.48
C.D.	NS	0.63	0.54	0.43	0.50	1.30	0.34	0.46	0.63	0.73	3.46
SE(m)	0.33	0.21	0.18	0.14	0.18	0.45	0.11	0.15	0.21	0.24	1.15
SE(d)	0.46	0.29	0.25	0.21	0.24	0.63	0.16	0.22	0.29	0.34	1.63
C.V.	2.62	1.75	1.58	1.31	1.64	4.61	1.16	1.72	2.45	3.05	14.27

Table 4: Effect of bio-pesticides and chemical fungicides on plant growth, yield and yield related traits in coriander

S. No	Treatments	Germination %	Days to 50% flowering	Number of umbels per plant	Number of umbellets per umbel	Number of seeds per umbels	Test weight, g	Seed yield (q/ha)
1.	T_1	60.26	62.67	23.01	4.99	18.27	8.02	9.22
2.	T_2	61.29	64.67	23.55	4.62	18.73	8.90	9.27
3.	T_3	60.28	64.33	22.63	5.28	23.35	8.35	8.79
4.	T_4	61.84	65.67	25.59	5.24	23.79	9.49	9.05
5.	T_5	62.50	64.00	26.26	5.63	30.49	11.26	10.36
6.	T_6	61.31	65.00	20.87	5.68	21.34	10.46	12.03
7.	T_7	59.27	66.67	21.17	4.67	20.62	8.47	8.28
8.	T_8	61.65	64.00	20.69	5.75	23.79	8.43	8.54
9.	T_9	61.37	61.67	20.43	4.19	21.20	9.38	9.76
10.	T_{10}	60.53	67.00	19.34	4.43	18.10	7.91	7.75
	C.D.at 5%	NS	NS	2.83	0.76	4.09	1.75	2.13

	SE(m)±	0.83	1.08	0.94	0.26	1.36	0.58	0.71
	C.V.%	2.35	2.90	7.32	8.77	10.76	11.17	13.25

Conclusion

With the effective control of aphid and powdery mildew incidence, the yield of coriander can be greatly enhanced. Through this study, it is well witnessed that the control of aphids with the biocontrol agents *Lecanicillium lecanii* is more efficient than the chemical control and offers the advantage of avoiding the environmental pollution from the chemical insecticides. Though the treatment T5 was found effective in controlling the aphids, it doesn't offer a good control against the powdery mildew pathogen *Erysiphe polygoni.* The treatment T6 proved effective control against the powdery mildew disease as well as produced the highest seed yield ha^{-1}. Therefore, two foliar sprays of *Lecanicillium lecanii* + spray of Propiconazole (first spray) + spray of Carbendazim (second spray) could be an effective integrated pest and disease management strategy for controlling aphid and powdery mildew disease in coriander.

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