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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 4001-4004

www.thepharmajournal.com
Received: 16-10-2022
Accepted: 19-11-2022

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Efficacy of different insecticides against American serpentine leaf miner, (*Liriomyza trifolii*) infesting watermelon, (*Citrullus lanatus* Thunb.)

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Abstract
The field experiment for study the efficacy of different insecticides against American serpentine leaf miner, (*Liriomyza trifolii*) infesting watermelon, (*Citrullus lanatus* Thunb.) was carried out at Vegetable Improvement Scheme (VIS), Central experimental Station, Wakavali during *summer* 2021-22. From the investigation the efficacy of Chlorantraniliprole, Emamectin benzoate, Spirotetramat, Thiomethoxam, Pyriproxyfen, Azadirachtin and *Beauveria bassiana* was evaluated. The chemical insecticide Emamectin benzoate 5 SG recorded (9.28%) percent leaf infestation and was found most effective to control leaf miner also Chlorantraniliprole 18.5 SC (10.95%), Spirotetramat 150 OD (12.37%), Thiamethoxam 25 WG (12.62%) and Pyriproxyfen 10 EC (14.43%) found significant to control leaf miner. In the bio chemical treatments Azadirachtin (15.15%) gave better results than *Beauveria bassiana* (17.18%) and was less effective as compared to the chemical treatments. All the treatments were significantly better over control.

Keywords: Watermelon, leaf miner, *Liriomyza trifolli*, insecticides, management

1. Introduction
India is the second largest vegetables producing country succeeding to China with an annual production of 200.45 million metric tons (Anonymous, 2020) [1]. Indian sub-continent with its rich biodiversity is the primary centre of origin for cucurbits like cucumber, ridge gourd, sponge gourd, ash gourd, pointed gourd and secondary origin for watermelon and bottle gourd. Nearly 30 species under family cucurbitaceae are commercially exploited for vegetable purpose.

From Africa, it was introduced to India at about 800 CE and China at 900 CE that was further extended to Southeast Asia, Japan, Europe and America in the late 1500s (Erhirhie and Ekene, 2013) [4]. Watermelon is mainly a warm season crop and it can be grown in tropics throughout the year. Based on statistical data from the Food Agriculture Organization (FAO) in 2019, the total production of watermelon fruit world-wide reached 100 million tons with the watermelon plant area recorded nearly 3 million hectors spread throughout the world. From the distribution point of view, the Asian continent is still the centre of watermelon production with a total harvest of 79 million tons (79% of total world-wide production), followed by African continent with 7.5 million tons (7.5% of total world-wide production) and Americans with production reaching 6.9 million tons (6.9% of the worldwide watermelon production).

American serpentine leaf miner, *L. trifolii* is one of the most important pest causing damage in initial stages of crop. It is polyphagous pest and damage is mainly caused by the maggots. It mines the leaf through mesophyll tissues leaving the epidermis intact, resulting in the zigzag mines on upper leaf surface. High infestation cause desiccation and drying of leaves (Chandler and Thomes, 1983) [3].

The management of leaf miner is also important, therefore the present study was carried out to know the efficacy of insecticides against leaf miner infesting watermelon in Konkan region.

2. Materials and Methods
2.1 Location: The experiment for the management of American serpentine leaf miner, (*L. trifolii)* infesting watermelon was conducted at Vegetable Improvement Scheme (VIS), Central Experiment Station, Wakavali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during *Summer* season of 2021-22.

2.2 Experimental Details
An Experiment was laid on Randomized Block Design (RBD) with three replications. The experiment consisted of eight treatments and three replications during *Summer* season of 2021-22 to study the efficacy of different insecticides against American serpentine leaf miner infesting watermelon. Seven different insecticides viz., Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Spirotetramat 150OD, Thiomethoxam 25 WG, Pyriproxyfen 10EC, Azadirachtin 10000 ppm and *Beauveria bassiana* 2 $X10^8$ cfu/ml along with untreated control were evaluated. Augusta variety of watermelon was used for the study.

2.3 Method and period of insecticide application
The quantity of spray suspension required for spraying was calculated by spraying water over the controlled plots before the application of insecticides. The spray suspension of the desired strength of each insecticide was prepared against pests on the field and spraying was done. The spraying of insecticides was done twice. First spray of each insecticide was applied on the fourth week of March peak incidence of pest was noticed, while remaining spray was given after 15 days i.e. second week of April with the help of manually operated knapsack sprayer. The observations were recorded on ten randomly selected and marked vines in each treatment.

2.4 Method of recording observations
The infestation of leaf miner was calculated by counting healthy and infested leaves on ten randomly selected and marked vines from each plot of treatment. The infestation of leaf miner before spraying and on 3rd, 7th, 10th and 14th days after spraying of insecticides was recorded and calculated with the help of following formula,

$$\text{Percent leaf miner infestation} = \frac{\text{No. of infested leaves observed}}{\text{Total no. of leaves observed}} \text{ X } 100$$

2.5 Statistical methods
The data obtained were subjected to arc sin and statistically analyzed.

3. Results and Discussion
The efficacy of various tested insecticides against *L. trifolli* showed the significant reduction in the percent leaf infestation by the *L. trifolli* given in Table 1 and depicted in Fig. 1 and the detailed results are presented below,

3.1 First spray
The results of overall mean percent leaf infestation of leaf miner after first spray indicated that as compared to untreated control all the other treatments recorded significantly less leaf miner infestation. The mean leaf miner infestation recorded 11.99% to 21.53% after first spray. The treatment Emamectin benzoate 5 SG @ 0.5 g lit-1 found to be most effective treatment after first spray recorded lowest (11.99%) leaf miner infestation. The next best treatment was found to be Chlorantraniliprole 18.5 SC @ 0.4 ml lit-1, which recorded (13.84%) leaf miner infestation and it was at par with the treatments Spirotetramat 150 OD @ 0.5 ml lit-1 (14.63%) and Thiamethoxam 25 WG @ 0.5 g lit-1 (14.93%). The treatment Pyriproxyfen 10 EC @ 1ml lit-1 recorded (16.34%) infestation of leaf miner and it was at par with Azadirachtin @ 3 ml lit-1 recorded (17.26%) leaf miner infestation. The treatment *Beauveria bassiana* @ 5 ml lit-1 recorded (19.28%) leaf miner infestation. The maximum (21.53%) leaf miner infestation was observed in the untreated control.

3.2 Second spray
The results of overall mean percent leaf infestation of leaf miner after second spray indicated that as compared to untreated control all the other treatments recorded significantly less leaf miner infestation. The mean leaf miner infestation recorded from 6.57% to 17.78% after second spray. The treatment Emamectin benzoate 5 SG @ 0.5 g lit-1 found to be most effective treatment after second spray recorded least (6.57%) leaf miner infestation. The next best treatment was found to be Chlorantraniliprole 18.5 SC @ 0.4 ml lit-1 which recorded (8.06%) leaf miner infestation. The treatment Spirotetramat 150 OD @ 0.5ml lit-1 recorded (10.12%) leaf miner infestation and it was at par with Thiamethoxam 25 WG @ 0.5g lit-1 (10.32%). The treatment Pyriproxyfen 10 EC @ 1ml lit-1 recorded (12.53%) infestation of leaf miner and it was at par with Azadirachtin @ 3ml lit-1 recorded (13.04%) leaf miner infestation. The treatment *Beauveria bassiana* @ 5 ml lit-1 recorded (15.08%) leaf miner infestation. The maximum (17.78%) leaf miner infestation was observed in the untreated control.

Table 1: Cumulative efficacy of insecticides against leaf miner *(Liriomyza trifolii)* infesting watermelon

Tr. No	Treatment	Dose per litre	Mean percent leaf infestation of leaf miner											
			Pre count	First spray					Second spray					Cumulative mean
				3 DAS**	7 DAS	10 DAS	14 DAS	Mean of First spray	3 DAS	7 DAS	10 DAS	14 DAS	Mean of second spray	
1.	Clorantraniliprole 18.5 SC	0.4 ml	20.78 (27.11)*	12.71 (20.87)	10.82 (19.19)	14.33 (22.23)	17.49 (24.71)	13.84 (21.75)	10.34 (18.75)	8.26 (16.69)	7.31 (15.68)	6.34 (14.58)	8.06 (16.42)	10.95 (19.09)
2.	Emamectin benzoate 5 SG	0.5 g	20.53 (26.94)	10.56 (18.96)	8.64 (17.09)	12.47 (20.67)	16.27 (23.78)	11.99 (20.13)	9.76 (18.20)	7.60 (16.00)	5.22 (13.20)	3.71 (11.10)	6.57 (14.63)	9.28 (17.38)
3.	Spirotetramat 150 OD	0.5 ml	20.37 (26.82)	13.72 (21.74)	11.32 (19.66)	15.67 (23.31)	17.81 (24.96)	14.63 (22.42)	12.32 (20.54)	10.77 (19.15)	9.84 (18.28)	7.54 (15.93)	10.12 (18.48)	12.37 (20.45)
4.	Thiomethoxam 25 WG	0.5 g	20.75 (27.10)	14.70 (22.54)	12.36 (20.58)	15.82 (23.43)	16.82 (24.21)	14.93 (22.69)	13.89 (21.88)	11.19 (19.54)	9.19 (17.64)	7.02 (15.36)	10.32 (18.61)	12.62 (20.65)
5.	Pyriproxyfen 10 EC	1ml	20.97 (27.25)	16.89 (24.26)	14.23 (22.16)	16.13 (23.68)	18.09 (25.17)	16.34 (23.82)	15.29 (23.01)	13.76 (21.77)	11.38 (19.71)	9.69 (18.13)	12.53 (20.66)	14.43 (22.24)
6.	Azadirachtin 10000ppm	3 ml	20.56 (26.95)	16.27 (23.78)	15.86 (23.46)	17.42 (24.66)	19.49 (26.19)	17.26 (24.52)	15.73 (23.36)	13.54 (21.58)	12.24 (20.47)	10.63 (19.02)	13.04 (21.11)	15.15 (22.82)
7.	*Beauveria bassiana*	5 ml	20.68	19.91	18.63	19.24	19.32	19.28	18.83	16.65	13.11	11.73	15.08	17.18

			(27.04)	(26.50)	(25.57)	(26.01)	(26.07)	(26.04)	(25.71)	(24.08)	(21.22)	(20.02)	(22.76)	(24.40)
8.	Untreated control	-	20.47 (26.90)	20.59 (26.98)	21.06 (27.32)	21.98 (27.96)	22.47 (28.29)	21.53 (27.64)	22.11 (28.05)	20.53 (26.94)	16.46 (23.93)	12.03 (20.29)	17.78 (24.80)	19.65 (26.22)
SEm (±)			0.50	0.41	0.38	0.43	0.46	0.42	0.39	0.35	0.32	0.29	0.34	0.38
CD (p=0.05)			NS	1.24	1.16	1.29	1.40	1.27	1.17	1.07	0.97	0.88	1.02	1.15

*Figures in parenthesis are Arc sine transformed values
**DAS: Days after spraying

3.3 Overall spray

The results regarding cumulative mean percent leaf infestation of leaf miner of two sprays indicated that all the treatments were recorded significantly lower leaf miner infestation as compared to untreated control. The mean leaf miner infestation ranged from 9.28% to 19.65%. The data revealed that, the treatment Emamectin benzoate 5 SG @ 0.5 g lit-1 found to be most effective treatment which recorded less (9.28%) leaf miner infestation. The next best treatment was found to be Chlorantraniliprole 18.5 SC @ 0.4ml lit-1 which recorded (10.95%) leaf miner infestation. The treatment Spirotetramat 150 OD @ 0.5ml lit-1 recorded (12.37%) leaf miner infestation and it was at par with Thiamethoxam 25 WG @ 0.5 g lit-1 (12.62%). The treatment Pyriproxyfen 10 EC @ 1 ml lit-1 recorded (14.43%) infestation of leaf miner and it was at par with Azadirachtin @ 3 ml lit-1 recorded (15.15%) leaf miner infestation. The treatment *Beauveria bassiana* @ 5 ml lit-1 with recorded (17.18%) leaf miner infestation. The maximum (19.65%) leaf miner infestation was noticed in untreated control.

The data reported that after two sprays the mean leaf infestation recorded significantly less in all the treatments except untreated control treatment Emamectin benzoate 5 SG @ 0.5 g lit-1 (9.28%) leaf miner infestation followed by Chlorantraniliprole 18.5 SC @ 0.4 ml lit-1 (10.95%), Spirotetramat 150 OD @ 0.5 ml lit-1 (12.37%), Thiamethoxam 25 WG @ 0.5g lit-1 (12.62%), Pyriproxyfen 10 EC @ 1 ml lit-1 (14.43%) Azadirachtin @ 3ml lit-1(15.15%) and *Beauveria bassiana* @ 5 ml lit-1 (17.18%).

Present results were discussed in the light of following workers.

Neem oil, a plant product, was found to cause more than 80% mixed larval and pupal mortality of the cucumber leaf miner *Liromyza trifolii* Burgess (Agromyzidae: Diptera), according to Azam (1991) [2].

Lee *et al.* (2006) [6] who reported that the treatment emamectin benzoate effectively suppress the *Liriomyza trifolii*.

The findings of Tarate *et al.* (2016) are in partial conformity with present study who reported the application of emamectin benzoate 5 SG at 25, 45, and 65 days after transplanting indicated that the most effective pesticide against leaf miner *Liriomyza trifolii* Burgess.

Hirekurubar and Tatagar (2018) [5] found chlorantraniliprole 18.5 SC and thiamethoxam 25 WG effective for reducing leaf miner.

The present investigations are in partial conformity with the findings of Ravipati *et al.* (2021) [7] who studied the efficacy of certain insecticides and botanicals on leaf miner it revealed chlorantraniliprole 18.5 SC was found to be superior over Azadirachtin 0.3%.

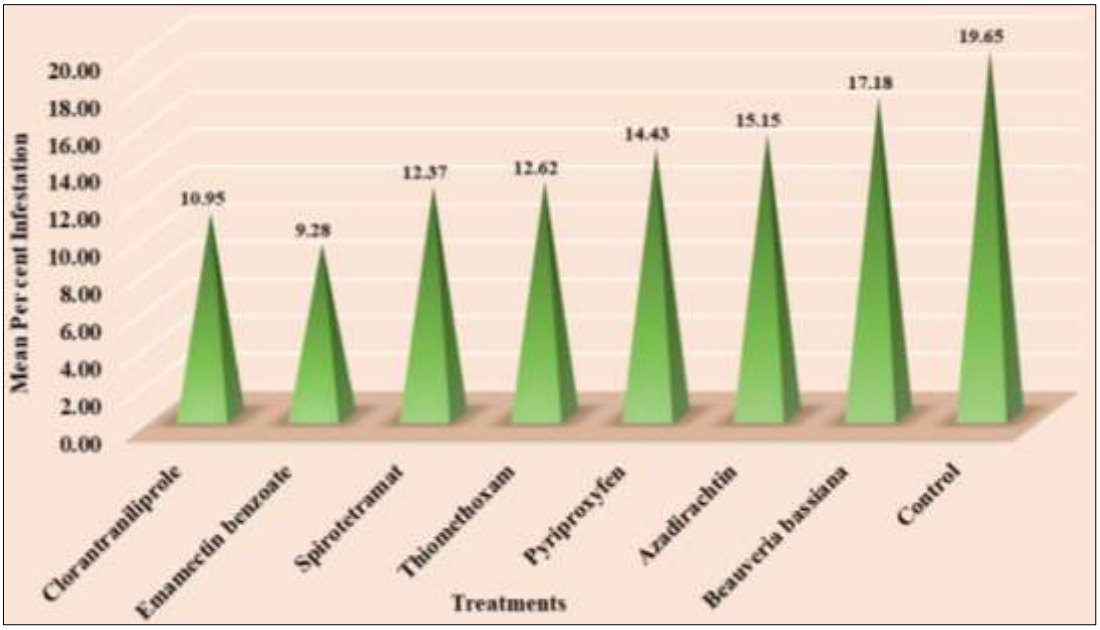

Fig 1: Cumulative efficacy of different insecticides against leaf miner (*Liriomyza trifolii* Burgess) infesting watermelon

4. Conclusion

The overall results revealed that, even though American serpentine leaf miner, (*L. trifolii)* of watermelon, it can be managed very effectively by following spray schedule as experienced in the present findings. The chemical insecticide Emamectin benzoate 5 SG (9.28%) was found most effective to control leaf miner infestation also Chlorantraniliprole 18.5 SC (10.95%), Spirotetramat 150 OD (12.37%), Thiamethoxam 25 WG (12.62%) and Pyriproxyfen 10 EC (14.43%) found significant. In the bio chemical treatments Azadirachtin (15.15%) gave better results than *Beauveria bassiana* (17.18%) and was less effective as compared to the

chemical treatments. The present investigation results are based on one season and one location data. Therefore, in order to arrive a sound conclusion, it is necessary to continue the studies with long duration trail including improved pest management practices based on IPM techniques to keep the pest infestation at low level and to get higher returns of yield.

5. Acknowledgement

Authors are thankful to Department of Agricultural Entomology of College of Agriculture and Department of Horticulture, College of Horticulture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli-415712, dist- Ratnagiri, Maharashtra (India), to provide necessary facility and valuable suggestion during investigation.

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