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Efficacy of different insecticides against Larval count of citrus leaf miner (*Phyllocnistis citrella*) stainton on acid lime (*Citrus aurantifolia*)

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Abstract
The experiment on, "efficacy of different insecticides against citrus leaf miner (*Phylocnistis citrella*) on acid lime (*Citrus aurantifolia*)." was undertaken at Horticultural farm of Krishi Vigyan Kendra, Dahigaon ne and College of Agriculture, Dhule during 2020-2021. The experiment was planned out in Randomized Block Design with ten treatments and three replications. The variety used for study was Phule Sharbati. Total ten treatments were used in present investigation consisting of insecticides viz, spirotetramat 120 SC + imidacloprid 120 SC @ 0.5 ml/l, cyantraniliprole 10.26 OD @ 1.8 ml/l, abamectin 0.15 EC @ 0.37 ml/l, spinetoram 11.7 SC @ 0.5 ml/l, buprofezin 25 SC @ 1.25 ml/l, spinosad 45 SC @ 0.3ml/l, acetamiprid 20 SP @ 0.3 g/l, neem formulation azadirachtin (10000 ppm) @ 3.0ml/l, emamectin benzoate 5 SG @ 0.25 g/l and untreated control. As regards the efficacy of different insecticides, all the insecticides were significantly superior over untreated control in recording the lowest percentage of citrus leaf miner per cent infestation.
Average effect revealed that, lowest larval count were recorded in treatment spinosad 45 SC (3.03 larvae / 15 cm apical twig) was significantly superior and it was found at par with the treatments spinetoram 11.7 SC, cyantraniliprole 10.26 OD and spirotetramat 120 SC+ imidacloprid 120SC recording 3.60, 4.26 and 4.23 larvae / 15cm twig respectively. The next better treatments in order were abamectin 0.15 EC (4.86), acetamiprid 20 SP (5.06), buprofezin 25 SC (5.40), emamectin benzoate 5 SG (5.60) and azadirachtin (10000 PPM) (5.90) citrus leaf miner larvae / 15cm apical shoots, respectively.

Keywords: citrus leaf miner, acid lime, larval count, insecticides

Introduction
Acid lime (*Citrus aurantifolia*) is thought to have originated in Southeast Asia. Acid lime is commercially growned in Maharashtra, Andhra Pradesh, Karnataka, Gujrat, Rajasthan, Orissa, Jharkhand, Tamil Nadu, and other Indian states. Acid lime is grown in Maharashtra's Akola, Ahmednagar, Pune, Solapur, Jalgaon, Buldhana, Beed, Parbhani, Osmanabad, Aurangabad, and Jalna districts. It is one among the most popular fruits in India. It is valued not only for its appealing appearance and flavour, but also for the development of value-added goods such as squash, syrup, cordials, pickles, the synthesis of citric acid, cosmetic purposes, and culinary uses. The best part of it having plenty of vitamin 'C' which can provide antioxidants. Improved varieties of Acid lime are Pramalini, Vikram, Sai Sarbati, Phule Sharbati, Balaji have been introduced in Maharashtra State. They also provide a good source of fibre. Fibre has a number of health benefits, including aiding weight loss and boosting digestive health. Citrus fruits have low calorie content. They may help to lower the risk of kidney stones. They aid in the prevention or treatment of cancer. Fruit contains nutrients that are good for your heart. Citrus flavonoids may protect the brain from neurodegenerative disorders like Alzheimer's and Parkinson's, which are caused by the breakdown of cells in the nervous system.
Citrus is India's third most important fruit crop. It accounts for around 9% of the overall fruit crop area. The citrus fruit crop covers about 1078 thousand hectares in India, with a production of 115.15 million tonnes. It covers 14.93 percent of India's total land area and accounts for 12.52 per cent of the country's total fruit production. Citrus has a productivity of 12.35 MT/hectare. Andhra Pradesh is the leading state for citrus fruit production, accounting for 39.46% of India's total fruit production. With 15.79 percent of total citrus fruit production, Maharashtra comes in second. The acid lime fruit crop covers 286.2 thousand hectares, yielding 3148.5 thousand MT of citrus fruit. In Maharashtra, citrus productivity is 5.57 MT/ha. while India's productivity is 11.00 MT/ha.

Leaf miner, *Phyllocnistis citrella*, larvae cause damage in the form of mine on immature foliage. Twisted and curled leaves are generally the first symptoms noticed. When larvae cause damages on leaf it become the severe infestation, ultimately the plant can retard the growth and yield, but their effect on mature trees is less serious than nursery, such infestation usually occur in summer. They rarely occur in spring because the production of new growth is prolific and synchronised and quickly become immune to attack.

Activity of this pest is normally observed throughout the year due to its overlapping generations. The infestation and severity of citrus canker is more in leaf mined leaves. Although citrus leaf miner causes indirect damage to young leaves, which predisposes them to infection by canker. Thus, controlling citrus leaf miner is vital component of canker management. The average infestation rate of citrus leaf miner varied from 17 to 35%. The pest had about 5 -9 generations over the year, with peak period in early summer and early autumn.

Citrus leaf miner chemical management is challenging due to its great capacity to migrate from outside orchards, high fecundity, the presence of a protective epidermis on the citrus leaf, and the difficulties of contacting the larval body directly with chemicals. Many pesticides from other chemical classes, however, have been evaluated and proved to be useful in its treatment. Insecticides are widely available these days, and they have been employed extensively in another crop to control internal feeder and sucking pests. Insecticides that are often used are unable to entirely control it. Therefore, Therefore, under present investigation, it was planned and selected, insecticides which has broad spectrum activity for managing this pest with objective to study the efficacy of different insecticides against citrus leaf miner.

Materials and Methods

The field experiment was conducted during rabi season of 2020-2021 at farm of Krishi Vigyan Kendra, Dahigaon ne and college of agriculture Dhule. The variety used for study was Phule sharbati with spacing 6 × 6 m.

Observation on Larval Mortality

The larval count was taken from selected 15cm five terminal shoots from each plant. The larval count was taken at 0 days as a pre count and post count at 3rd, 7th, and 14th days after 1st and 2nd spray. The % larval mortality was worked out from the following formula,

$$\text{Per cent larval mortality} = \frac{\text{Number of leaf miner dead larvae}}{\text{Initial larval count}} \times 100$$

Treatment Details

Treatments	Name of Biopesticides / Insecticides	Dosage / ha (g/ml per l).
T_1	Spirotetramat 120 SC + Imidacloprid 120 SC	0.5
T_2	Cyantraniliprole 10.26% OD	1.8
T_3	Abamectin 0.15% EC	0.37
T_4	Spinetoram 11.7% SC	0.5
T_5	Buprofezin 25%SC	1.25
T_6	Spinosad 45% SC	0.3
T_7	Acetameprid 20% SP	0.3
T_8	Neem formulation (Azadirachtin)10000 ppm	3
T_9	Emamectin benzoate 5% SG	0.25
T_{10}	Untreated control (water spray)	-

Results and Discussion

To evaluate efficacy of insecticides on citrus leaf miner larvae total ten treatments were used with the untreated control. The result indicated that, all the insecticidal treatments were significantly superior over untreated control in recording lowest larval count of citrus leaf miner infestation.

The observations of larval count recorded at 3 days after first and second spray revealed that, all the treatments were significantly superior over untreated control and recorded larval count in the range of 6.05-19.83 larvae/15 cm twig, respectively.

Spinosad 45 SC was significantly superior over all the treatments recording lowest (6.05) citrus leaf miner/ 15 cm apical twig. This treatment found at par with the spinetoram 11.7 SC and cyantraniliprole 10.26 OD recording 7.23 and 7.37 larvae/15 cm twig, respectively. Spirotetramat 120 SC + imidacloprid 120 SC recorded 7.76 larvae/15 cm twig was next better treatment. Next better treatment was abamectin 0.15 EC which recorded 8.8 larvae/15 cm apical twig. This was followed by the acetamiprid 20 SP, buprofezin 25 SC, emamectin benzoate 5 SG and azadirachtin (10000 ppm) recording 9.06, 9.23, 9.50 and 19.70 larvae/15 cm apical twig, respectively. Highest larval count (9.83) was recorded in untreated control.

At 7 days minimum larval count was recorded in spinosad 45 SC that was 4.66 larvae/15 cm twig which is superior over all the treatments except spinetoram 11.7 SC, spirotetramat 120 SC + imidacloprid 120 SC and cyantraniliprole 10.26 OD as they were at par with Spinosad recording 5.3, 5.9 and 6.1 larvae/ 15 cm twig, respectively. The next better treatment was abamectin 0.15 EC recorded 6.93 larvae/15 cm twig. It was superior over acetamiprid 20 SP 7.17, buprofezin 25 SC 7.35, emamectin benzoate 5 SG 7.63 and azadirachtin (10000 ppm) 8.00 larvae/15 cm apical twig, respectively. Whereas highest (22.85) larval count were recorded in untreated control.

At 14 days results showed that spinosad 45 SC recorded least (3.03 larvae/ 15 cm twig) larval count. It was found at par with the spinetoram 11.7 SC, cyantraniliprole 10.26 OD and spirotetramat 120 SC + imidacloprid 120 SC recorded 3.60, 4.16 and 4.23 larvae/ 15cm apical twig, respectively. The next better treatment was abamectin 0.15 EC which showed 4.86 larvae/ 15 cm apical twig. Followed by acetamiprid 20 SP 5.06, buprofezin 25 SC 5.40, emamectin benzoate 5 SG 5.60 and azadirachtin (10000 ppm) 5.90 larvae/ 15 cm twig, respectively. Whereas highest (23.10) larval count recorded in untreated control.

Table 1: Efficacy of insecticides on Larval Count of Citrus Leaf Miner

Tr. No	Treatments	Larval count of citrus leaf miner after 1st spray				Larval count of citrus leaf miner after 2nd spray		
		Pre count	3DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
1	Spirotetramat 120 + Imidacloprid 120SC	15.9 (4.04)	11.13 (3.40)	9.33 (3.13)	6.86 (2.70)	4.06 (2.12)	2.90 (1.81)	1.46 (1.35)
2	Cyantraniliprole 10.26 OD	16.56 (4.13)	11.00 (3.38)	9.06 (3.08)	6.60 (2.65)	3.73 (2.05)	2.76 (1.78)	1.20 (1.27)
3	Abamectin 0.15 EC	15.66 (4.02)	12.80 (3.62)	10.13 (3.25)	7.73 (2.86)	4.66 (2.24)	3.73 (1.98)	2.00 (1.50)
4	Spinetoram 11.7 SC	14.63 (3.88)	10.80 (3.33)	8.53 (3.00)	6.13 (2.57)	3.66 (2.02)	2.06 (1.59)	1.06 (1.24)
5	Buprofezin 25 SC	15.43 (3.99)	13.26 (3.67)	10.80 (3.34)	8.00 (2.89)	5.02 (2.34)	4.00 (2.07)	2.80 (1.73)
6	Spinosad 45 SC	14.63 (3.89)	10.33 (3.27)	7.8 (2.87)	5.6 (2.46)	2.66 (1.76)	1.56 (1.43)	0.46 (0.97)
7	Acetamiprid 20 SP	15.93 (4.05)	13.07 (3.65)	10.47 (3.30)	7.87 (2.87)	5.06 (2.33)	3.87 (2.05)	2.27 (1.59)
8	Neem formulation Azadirachtin (10000ppm)	15.97 (4.06)	13.66 (3.72)	11.33 (3.42)	8.47 (2.98)	5.80 (2.46)	4.67 (2.22)	3.33 (1.88)
9	Emamectin benzoate 5 SG	15.40 (3.98))	13.53 (3.73)	11.00 (3.39)	8.27 (2.94)	5.47 (2.40)	4.26 (2.12)	2.93 (1.78)
10	Untreated control (water spray)	15.27 (3.96)	16.40 (4.05)	20.87 (4.61)	22.40 (4.77)	23.37 (4.87)	24.83 (5.02)	25.77 (5.13)
F test		NS	SIG	SIG	SIG	SIG	SIG	SIG
SE (M) ±			0.10	0.12	0.12	0.16	0.17	0.17
CD at 5%			0.30	0.36	0.36	0.47	0.51	0.50

Table 2: Efficacy of insecticides against citrus leaf miner larvae on average of two sprays

Tr No.	Treatments	Dose (g/ml/L)	Average of larval count of citrus leaf miner on acid lime		
			3 DAS	7 DAS	14 DAS
1	Spirotetramat 120 + Imidacloprid 120SC	0.5	7.76 (2.86)	6.1 (2.55)	4.23 (2.17)
2	Cyantraniliprole 10.26 OD	1.8	7.37 (2.39)	5.9 (2.51)	4.16 (2.15)
3	Abamectin 0.15 EC	0.37	8.8 (3.02)	6.93 (2.70)	4.86 (2.30)
4	Spinetoram 11.7 SC	0.5	7.23 (2.76)	5.3 (2.40)	3.60 (2.02)
5	Buprofezin 25 SC	1.25	9.23 (3.08)	7.35 (2.78)	5.40 (2.39)
6	Spinosad 45 SC	0.3	6.5 (2.63)	4.66 (2.26)	3.03 (1.87)
7	Acetamiprid 20 SP	0.3	9.06 (3.06)	7.17 (2.75)	5.06 (2.33)
8	Neem Formulation Azadirachtin (10000 ppm)	3.0	9.70 (3.15)	8.00 (2.89)	5.90 (2.49)
9	Emamectin benzoate 5 SG	0.25	9.50 (3.13)	7.63 (2.83)	5.60 (2.43)
10	Untreated Control (Water spray)	-	19.83 (4.50)	22.85 (4.82)	23.10 (4.85)
F test			SIG	SIG	SIG
SE (M) ±			0.09	0.12	0.12
CD at 5%			0.26	0.36	0.34

*Figures in the parentheses are corresponding values of square root +0.5 (√x+0.5) transformed values.

Conclusion

In efficacy studies of larval count of citrus leaf miner on acid lime showed that treatment with spinosad 45 SC recording (3.03 larvae / 15 cm apical twig) was significantly superior and it was found at par with the spinetoram 11.7 SC, cyantraniliprole 10.26 OD and spirotetramat 120 SC+ imidacloprid 120SC recording 3.60, 4.26 and 4.23 larvae / 15cm twig respectively. The next better treatments in order were abamectin 0.15 EC (4.86), acetamiprid 20 SP (5.06), buprofezin 25 SC (5.40), emamectin benzoate 5 SG (5.60) and azadirachtin (10000 PPM) (5.90) citrus leaf miner larvae / 15cm apical shoots, respectively. All these treatments provide better yield and higher Incremental Cost Benefit Ratio.

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