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Efficacy of different insecticides against 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 showed significantly, lowest (9.57%) per cent leaf infestation of leaf miner on 15 cm apical twig was recorded in spinosad 45 SC and it was at par with spinetoram 11.7 SC (10.30%), cyantraniliprole 10.26 OD (10.67%) and spirotetramat 120 SC + imidacloprid 120 SC (11.10%), respectively. The next best treatments in order were abamectin 0.15 EC (12.73%), acetamiprid 20 SP (13.03%), buprofezin 25 SC (13.37%), emamectin benzoate (13.40%) and azadirachtin 10000 ppm (14.00%), respectively at 14 days after spray.

Keywords: Citrus leaf miner, acid lime, per cent infestation, 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, Tamilnadu, 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, 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.

Method of Recording Observations of citrus leaf miner

A single plant per treatment per replication have been selected for observation. The leaf miner observations were recorded on 15 cm terminal shoot by counting total number of leaves and leaf miner infested leaves to work out per cent infestation. Five terminal shoots were counted from each plant. The observations were recorded at 0 day as pre count and a post count at 3rd, 7th and 14th days after each application. First application had been given at ETL of pest population and second at 15 days after the first application. Mean % leaf miner infestation was computed by using the following formula.

$$\% \text{ Leaf miner infestation} = \frac{\text{Leaf miner infested leaves per 15 cm terminal shoots} \times 100}{\text{Total number of leaves per 15 cm terminal shoot}}$$

Table 1: 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 per cent infestation of citrus leaf miner 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 percentage of leaf miner infestation.

The observations on average leaf miner infestation recorded at 3 days after first and second spray revealed that, all the treatments were significantly superior over untreated control in and recorded infestation in the range of 15.03-27.33 per cent, respectively.

Spinosad 45 SC was significantly superior over all the treatments recording lowest 15.03 per cent leaf infestation of citrus leaf miner on 15 cm apical twig. This treatment found at par with the spinetoram 11.7 SC and cyantraniliprole 10.26 OD. Recording 16.87 and 17.20 per cent infestation, respectively. Spirotetramat 120 SC + imidacloprid 120 SC recorded 18.80 per cent leaf miner infestation was next better treatment. Next better treatment was abamectin 0.15 EC which recorded 19.20 per cent leaf miner infestation. This was followed by the acetamiprid 20 SP, buprofezin 25 SC, emamectin benzoate 5 SG and azadirachtin (10000 ppm) recording 19.45, 19.50, 19.83 and 20.77 per cent leaf infestation of citrus leaf miner, respectively. Highest per cent leaves infestation 27.33 per cent was recorded in untreated control.

At 7 days minimum per cent infestation recorded in spinosad 45 SC that was 12.20 per cent 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 12.77, 13.07 and 13.63 per cent infestation, respectively. The next better treatment was abamectin 0.15 EC recorded 15.80 per cent leaf miner infestation. It was superior over acetamiprid 20 SP 16.10, buprofezin 25 SC 16.33, emamectin benzoate 5 SG 15.67 and azadirachtin (10000 ppm) 16.63 per cent leaf miner infestation, respectively. Whereas highest (27.67%) leaf miner infestation were recorded in untreated control.

At 14 days results showed that spinosad 45 SC recorded least (9.27 per cent) leaf infestation. It was found at par with the spinetoram 11.7 SC, cyantraniliprole 10.26 OD and spirotetramat 120 SC + imidacloprid 120 SC recorded 10.30, 10.67 and 11.10 per cent leaf infestation, respectively. The next better treatment was abamectin 0.15 EC which showed

12.73 per cent leaf infestation. Followed by acetamiprid 20 SP 13.03, buprofezin 25 SC 13.37, emamectin benzoate 5 SG 13.40 and azadirachtin (10000 ppm) 14.00 per cent leaf infestation, respectively. Whereas highest (30.32%) leaf miner infestation found in untreated control.

Table 2: Efficacy of insecticides on per cent infestation of citrus leaf miner

Tr. No	Treatments	Per cent infestation of citrus leaf miner after 1st spray				Per cent infestation 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	27.33(31.52)	22.40(28.25)	16.40(23.89)	14.47(22.36)	12.00(20.27)	9.73(18.18)	6.13(14.33)
2	Cyantraniliprole 10.26 OD	27.30(31.50)	22.00(27.97)	17.40(24.65)	15.60(23.26)	12.27(20.50)	9.80(18.24)	6.60(14.89)
3	Abamectin 0.15 EC	27.83(31.40)	24.00(29.33)	20.33(26.80)	18.00(25.10)	13.60(21.64)	11.27(19.62)	8.07(16.50)
4	Spinetoram 11.7 SC	27.50(31.63)	21.50(27.62)	16.13(23.68)	14.00(21.97)	11.93(20.21)	9.73(18.18)	7.33(15.71)
5	Buprofezin 25 SC	26.67(31.09)	24.93(29.95)	19.67(26.33)	18.27(25.30)	14.07(22.03)	11.60(19.91)	8.47(16.92)
6	Spinosad 45 SC	26.90(31.34)	19.93(26.51)	15.93(23.52)	13.33(21.41)	10.20(18.63)	8.50(16.95)	5.80(13.94)
7	Acetamiprid 20 SP	27.97(31.93)	24.47(29.65)	20.73(27.08)	18.20(25.25)	13.93(21.91)	11.47(19.80)	8.40(16.85)
8	Neem formulation Azadirachtin (10000 ppm)	27.40(31.56)	25.33(30.22)	21.20(27.42)	18.93(25.79)	14.33(22.24)	12.07(20.33)	9.08(17.54)
9	Emamectin benzoate 5 SG	28.40(32.20)	25.30(30.20)	21.07(27.32)	17.00(24.35)	13.60(21.64)	11.67(19.98)	8.50(16.95)
10	Untreated control (water spray)	22.33(28.20)	25.67(30.44)	25.73(30.48)	27.10(31.37)	29.00(32.58)	29.60(32.96)	33.35(35.27)
F test		NS	SIG	SIG	SIG	SIG	SIG	SIG
SE (M) ±			0.47	0.82	0.96	0.77	0.72	0.84
CD at 5%			2.47	2.44	2.78	2.28	2.13	2.50

Table 3: Efficacy of insecticides on average of two sprays

Tr No.	Treatments	Dose (g/ml/L)	Per cent infestation of citrus leaf miner on 15 cm apical twig (after average of two sprays)		
			3 DAS	7 DAS	14 DAS
1	Spirotetramat 120 + Imidacloprid 120SC	0.5	18.80(25.70)	13.07(21.19)	11.10(19.46)
2	Cyantraniliprole 10.26 OD	1.8	17.20(24.50)	13.63(21.67)	10.67(19.07)
3	Abamectin 0.15 EC	0.37	19.20(25.99)	15.80(23.42)	12.73(20.90)
4	Spinetoram 11.7 SC	0.5	16.87(24.25)	12.77(20.94)	10.30(18.72)
5	Buprofezin 25 SC	1.25	19.50(26.21)	16.33(23.84)	13.37(21.45)
6	Spinosad 45 SC	0.3	15.03(22.81)	12.20(20.44)	9.57(18.02)
7	Acetamiprid 20 SP	0.3	19.45(26.17)	16.10(23.66)	13.03(21.16)
8	Neem Formulation Azadirachtin (10000 ppm)	3.0	20.77(27.11)	16.63(24.07)	14.00(21.97)
9	Emamectin benzoate 5 SG	0.25	19.83(26.47)	15.67(23.32)	13.40(21.47)
10	Untreated Control (Water spray)	-	27.33(31.52)	27.67(31.74)	30.32(33.40)
F test			SIG	SIG	SIG
SE (M) ±			0.69	0.67	0.62
CD at 5%			2.07	1.99	1.84

*Figures in the parentheses are corresponding values of arc sin transformation

Conclusion

In efficacy studies of per cent infestation of citrus leaf miner treatment with Spinosad 45 SC @ 0.3 ml/l (9.57%) was superior in recording lowest per cent infestation. This was found at par with the Spinetoram 11.7 SC @ 0.5 ml/l, Cyantraniliprole 10.26 OD @ 1.8 ml/l and spinetoram 120 SC + imidacloprid 120 SC @ 0.5 ml/l which recorded 10.30%, 10.67% and 11.10% per cent leaf miner infestation, respectively. This was followed by the treatments abamectin 0.15 EC @ 0.37 ml/l (12.73%) and acetamiprid 20 SP @ 0.3 g/l (13.03%), respectively. The next better treatments were buprofezin 25 SC @ 1.25 ml/l (13.375), emamectin benzoate 5 SG @ 0.25 g/l (13.40%) per cent infestation, respectively. The highest per cent infestation of citrus leaf miner recorded in untreated control (30.32%). All these treatments provide better yield and higher Incremental Cost Benefit Ratio.

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