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Research Article

BIOEFFICACY OF INSECTICIDE MIXTURES AGAINST CHILLI THRIPS, *SCIRTOTHRIPS DORSALIS* HOOD AND MITES, *POLYPHAGOTARSONEMUS LATUS* BANKS

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Abstract: The bioefficacy of insecticides mixtures against chilli thrips and mites were evaluated at College of Agriculture, Vellayani and Kalliyur Panchayath,Thiruvananthapuram, Kerala. Fipronil 40% + imidacloprid 40% WG @ 175 + 175 g a.i ha^{-1} was found to be effective in controlling both thrips and mites simultaneously followed by betacyfluthrin 8.91% + imidacloprid 19.81 % OD@ 15.75 + 36.75 g a.i ha^{-1}. Spiromesifen 22.9 SC @ 96 g a.i. ha^{-1} was found to be effective in reducing chilli mite population alone. The leaf curling symptom due to the feeding of mites and thrips was least in spiromesifen and Fipronil 40% + imidacloprid sprayed plants.

Keywords: *Insecticide Mixture, Fipronil + Imidacloprid, Chilli Thrips, Chilli Mites*

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Introduction

Chilli (*Capsicum annuum* L.) is one of the major vegetable and spice crop grown in the country. It is an important versatile spice as well as vegetable crop. India is the largest consumer and exporter of chilli in the world with a production of 34.06 lakh MT from an area of 2.87 lakh hectares, but having a lower productivity [1]. A major bottle neck in the production is the pest complex of chilli with more than 293 insects and mite species debilitating the crop in the field as well as in storage. The major insect pests that attack chilli are aphids (*Myzus persicae* Sulzer and *Aphis gossypii* Glover), mites (*Polyphagotarsonemus latus* Banks) and thrips (*Scirtothrips dorsalis* Hood). The crop loss reported by the two major pests, *viz*. thrips (30-50%) and mites (30-70%) considerably reduce the production of chilli. To manage these sucking pests, Indian farmers used to apply minimum of 25 to 30 rounds of pesticides which not only increases the cost of cultivation but often causes problems like resistance, resurgence and secondary pest outbreak. An alternative way to tackle all these problems is the use of insecticide mixture. Insecticide mixtures involve combinations of two or more insecticides having different mode of action into a single spray solution which entails exposing individual in an arthropod pest population to each pesticide simultaneously [2]. Mixing pesticides with different modes of action may mitigate resistance development within pest populations because the mechanisms required to resist each pesticide in the mixture may not be exist in insect population.

Materials and Methods

Laboratory evaluation of insecticide mixtures against chilli thrips and mites

A laboratory evaluation was conducted to find out four effective insecticide mixtures from seven insecticides [Table-1]. The experiment was laid out in completely randomized block design (CRD) with three replications and an untreated control. The test plants (Variety- Vellayani Athulya) were raised in plastic pots during September 2018. These plants were kept for natural infestation of chilli thrips and mites. After infestation the above mentioned insecticide mixtures were sprayed at the recommended doses and the percentage mortality were calculated during 1, 3, 5, 7, 10 and 15 DAS by using Abbott's formula [3].

Field evaluation of insecticide mixtures against chilli thrips and mites

Four effective insecticides were selected from laboratory evaluation and they were further tested at field conditions. The field experiment was conducted at Kalliyur Panchayath of Thiruvanathapuram district during October 2018 to December 2018. The crops were raised as per the recommendations given in the Package of Practices of Kerala Agricultural University [4]. The design was RBD with 5 replications and the variety used was 'Vellayani Athulya'. The new generation insecticide mixtures were sprayed at their recommended doses in chilli as and when ten per cent infestation was noticed. Six leaves, from the top of the canopy were closely observed for chilli thrips and mites and counted them by using stereo microscope. Mean number of thrips and mites present in each plant was calculated (5 plants replication^{-1}) at 1, 3, 5, 7, 10 and 15 DAS.

Leaf curl index (LCI)

In order to identify the extent of damage caused by chilli mite and thrips, LCI was calculated. The intensity of leaf curl was assessed visually by looking in to the standard [Table-1] Details of the insecticides used for the experiment. Scoring procedure [5] mentioned in Table 2. Ten plants were selected randomly in each plot and scored for leaf curling visually by following the standard scoring procedure mentioned in the table 2, before insecticidal spraying and 15, 30 and 45 DAS.

$$LCI = \frac{\begin{array}{c}(0\ x\ number\ of\ plants\ under\ score\ '0') + \\ (1\ x\ number\ of\ plants\ under\ score\ '1') + \\ (3\ x\ number\ of\ plants\ under\ score\ '3') + \\ (4\ x\ number\ of\ plants\ under\ score'4')\end{array}}{10}$$

Results and Discussion

Laboratory evaluation of insecticide mixtures against chilli thrips and mites

The results on the effectiveness of insecticide mixtures against the chilli thrips and mites when evaluated under laboratory conditions are presented in Table 3. Thiamethoxam 25 % WG showed higher mortality (66.61 %) of thrips on first day after spraying followed by betacyfluthrin 8.91% + imidacloprid 19.81 % OD (63.46 %) and fipronil 40% + imidacloprid 40% WG (59.50).

Table-1 *Field evaluation of selected insecticide mixtures against chilli thrips and mites*

SN	Details of insecticides				
	Chemical name	Trade name	Chemical group	Mode of action as per IRAC	Dosage (g ai ha-1)
1	Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	Alika	Neonicotinoid + Synthetic pyrethroid	Nicotinic acetylcholine receptor competitive modulators+ Sodium channel modulators	33 + 15.75
2	Betacyfluthrin 8.91% + Imidacloprid 19.81 % OD	Solomon	Synthetic pyrethroid + Neonicotinoid	Sodium channel modulators + Nicotinic acetylcholine receptor competitive modulators	15.75 +36.75
3	Flubendiamide 19.92% + Thiacloprid 19.92 % SC	Belt expert	Diamide + Neonicotinoid	Ryanodine receptor modulators + Nicotinic acetylcholine receptor competitive modulators	48 + 48
4	Fipronil 40% + Imidacloprid 40% WG	Fipromida	Phenyl pyrazole + Neonicotinoid	GABA gated chloride channel bolckers + Nicotinic acetylcholine receptor competitive modulators	175 + 175
5	Hand mixing of Spiromesifen 22.9% SC + Thiamethoxam 25 % WG (1:1)	Spiromesifen + Citara	Tetronic and tetramic acid derivatives+ Neonicotinoid	Inhibitors of acetyl co enzyme A carboxylase + Nicotinic acetylcholine receptor competitive modulators	-
6	Spiromesifen 22.9% SC (positive control 1)	Oberon	Tetronic and tetramic acid derivatives	Inhibitors of acetyl co enzyme A carboxylase	96
7	Thiamethoxam 25 % WG (positive control 2)	Actara	Neonicotinoid	Nicotinic acetylcholine receptor competitive modulators	50

Table-2 *Score chart for the calculation of LCI*

Score	Symptom
0	No symptom
1	1 to 25% leaves/ plant show curling
2	26 to 50% leaves/ plant show curling
3	51 to 75% leaves/ plant show curling, heavily damaged, malformation of growing points and reduction in plant height.
4	More than 75% leaves/ plant show curling, severe and complete destruction of growing points, drastic reduction in plant height, defoliation and severe malformation

Table-3 *Mortality of thrips and mites at different intervals after spraying (Laboratory evaluation)*

S	Treatments	Dosage	Mortality (%)					
		(g ai ha-1)	Thrips (DAS)			Mites (DAS)		
			1	7	15	1	7	15
1	T1-Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5 % ZC	33+15.75	54.54(7.41)	81.32(9.04)	100.00(10.02)	44.94(6.73)	83.07(9.14)	98.62(9.95)
2	T2- Betacyfluthrin 8.91% + Imidacloprid 19.81 % OD	15.75+36.75	63.46(7.99)	100.00(10.02)	100.00(10.02)	44.94(6.73)	100.00(10.02)	98.62(9.95)
3	T3- Flubendiamide 19.92% + Thiacloprid 19.92 % SC	48+48	59.50(7.74)	85.54(9.27)	100.00(10.02)	33.02(5.78)	62.67(7.94)	71.75(8.49)
4	T4 -Fipronil 40% + Imidacloprid 40% WG	175+175	59.61(7.75)	100.00(10.02)	99.33(9.99)	65.29(8.10)	100.00(10.02)	98.62(9.95)
5	T5-Hand mixing of Spiromesifen 22.9% SC+Thiamethoxam 25 % WG (1:1)	96+50	37.18(6.13)	71.68(8.49)	81.93(9.07)	44.95(6.73)	76.76(8.78)	84.83(9.23)
6	T6-Spiromesifen 22.9% SC (positive control 1)	96	22.10(4.74)	72.66(8.55)	74.83(8.67)	98.16(9.93)	100.00(10.02)	99.31(9.99)
7	T7- Thiamethoxam 25 % WG (positive control 2)	50	66.11(8.16)	99.33(9.99)	100.00(10.02)	29.35(5.46)	59.15(7.72)	69.65(8.37)
CD(0.05)			-0.378	-0.147	-0.086	-0.401	-0.122	-0.122

Table-4 *Mean number of thrips and mites and LCI at different intervals after spraying (Field evaluation)*

Treatments	Dosage	Number of insects (per leaf)						LCI	
	(g ai ha-1)	Thrips (DAS)			Mites (DAS)				
		1	7	15	1	7	15	15 DAS	45DAS
Betacyfluthrin 8.91% + Imidacloprid 19.81 % OD	15.75+36.75	3.93(1.98)	2.23(1.65)	0.50(0.99)	4.30(2.0)	2.30(1.67)	0.00(0.70)	0.08(0.76)	0.06(0.74)
Fipronil 40% +bImidacloprid 40% WG	175+175	3.13(1.76)	0.13(0.79)	0.00(0.70)	4.13(2.03)	1.63(1.45)	0.00(0.70)	0.08(0.76)	0(0.70)
Spiromesifen 22.9% SC	96	6.60(2.56)	3.76(2.06)	0.56(1.02)	3.30(1.81)	0.00(0.70)	0.00(0.70)	0.04(0.73)	0.00(0.70)
Thiamethoxam 25 % WG	50	4.70(2.16)	1.73(1.49)	0.06(0.74)	6.00(2.44)	2.46(1.72)	1.56(1.43)	0.22(0.84)	0.12(0.78)
Control	_	7.80(2.79)	8.20(2.94)	7.86(2.89)	7.10(2.66)	7.50(2.82)	7.53(2.83)	3.94(2.10)	4.00(2.12)
CD (0.05)		-0.058	-0.097	-0.102	-0.062	-0.086	-0.034	-0.036	-0.023

On seventh and fifteenth day after spraying both betacyfluthrin 8.91% + imidacloprid 19.81 % OD and fipronil 40% + imidacloprid 40% WG showed cent percent mortality against thrips. Among all the treatments spiromesifen showed lower average mortality (56.53 %). While coming to the mortality of mite, spiromesifen showed higher mortality on first day followed by fipronil 40% + imidacloprid 40% WG. On the seventh day after spraying betacyfluthrin 8.91% + imidacloprid 19.81 % OD, fipronil 40% + imidacloprid 40% WG and spiromesifen showed cent percent mortality. The treatments fipronil + imidacloprid, beta cyfluthrin + imidacloprid, thiamethoxam and spiromesifen were found to be effective in controlling thrips and mites under laboratory conditions and they were further evaluated under field conditions. The data on population of thrips and mites, and leaf curl index during field evaluation are given on Table 4. The treatment fipronil 40% + imidacloprid 40% WG showed less number of thrips (3.13) followed by betacyfluthrin 8.91% + imidacloprid 19.81 % OD (3.93) on the first day after spraying. No thrips were observed on plants sprayed with fipronil 40% + imidacloprid 40% WG on fifteenth day after spraying. On the first day after spraying a relatively lower number of mites were observed on plants treated with spiromesifen (3.30) followed by fipronil 40% + imidacloprid 40% WG (4.13). On seventh and fifteenth day after spraying, no mites were observed in spiromesifen treatment. The number of thrips on on plants treated with fipronil 40% + imidacloprid 40% WG on seventh day after spraying was comparatively low (1.10) and after fiftten days of spraying no mites were seen in fipronil 40% + imidacloprid 40% WG treatment. Fipronil is a phenyl pyrazole compound which is well-known for disturbing the ligand-gated chloride channels from the cell membranes of insects [6]. Blockage of the GABA-gated chloride channels by fipronil reduces neuronal inhibition and leads to hyper-excitation of the central nervous system, convulsions and death. Glutamate-gated GABA chloride channels appear to be a critical target for fipronil and, since these channels are only found in invertebrates, possibly explains the high selectivity of fipronil for invertebrate pests. Imidacloprid works by interfering with the transmission of stimuli in the insect nervous system causing irreversible blockage of acetylcholine receptors. These receptors are rendered incapable of receiving acetylcholine molecule and an accumulation of acetylcholine occurs, resulting in the insect's paralysis and eventual death. Thus, the insecticide mixture fipronil + imidacloprid became the best treatment for the sucking pests and leaf eating caterpillar of chilli. Several studies have been conducted by using fipronil and imidacloprid as single insecticide against sucking pest complex of chilli. [7] Reported that imidacloprid suppresses S. dorsalis populations for longer periods.

Present findings on the effectiveness of imidacloprid on the chilli thrips supports observations of [8], where they found that imidacloprid 17.8 SL reduced maximum thrips population (82.46%) followed by acephate 75 SP (80.86%). [9] also reported that fipronil 5 SC @ 2mL L^{-1} was the best treatment for managing chilli thrips population and was statistically on par with imidacloprid 17.8 SL @ 0.2 mL L^{-1}. Fipronil 5% SC @ 0.01% more effective in reducing mite population in chilli was reported by [10]. [11] also found that fipronil 80 WG was the best treatment for controlling the population of chilli mite, P. latus. [12] Also reported the same. The results of the present study are in line with these research findings. Several studies have been conducted on the efficacy of spiromesifen against chilli mite and results revealed that it is a good acaricide.[13] and [14] reported that spiromesifen 240 SC @ 120 g a.i ha^{-1} showed 91.7 % reduction in chilli mite population.

Conclusion

The present study on evaluation of insecticide mixture revealed that, fipronil 40% + imidacloprid was superior in checking down the population of both thrips and mite simultaneously. The insecticide mixture betacyfluthrin 8.91% +imidacloprid 19.81 % was also found as good for reducing the population of thrips and mite, next to fipronil + imidacloprd.

Application of research: To control more than one pest by using a single insecticide mixture, that in turn reduces pest resistance, pest resurgence, pesticide residues and save time and energy.

Research Category: Pest Management

Abbreviations: DAS- Days after spraying, LCI- Leaf curl index, Kg- Kilogram, a.i- active ingredient, %- percent, @- at the rate of, SC- Suspension Concentrate, SL- soluble liquid, WG- Wettable granules, ZC- Zeon capsules, ha- Hectare, OD- oil dispersion, g- gram

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Study area / Sample Collection: Kalliyur Panchayath of Thiruvanathapuram district

Cultivar / Variety name: Chilli - Vellayani Athulya

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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