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Evaluation of insecticide efficacy, safety and economics for managing chilli thrips, *Scirtothrips dorsalis* (Hood) (Thysanoptera: Thripidae)

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ABSTRACT: The present investigation was conducted during 2021 and 2022 at the Department of Entomology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, to evaluate the bioefficacy of five insecticides against chilli thrips, *Scirtothrips dorsalis*, and their effects on coccinellid populations. The efficacy of the insecticides was assessed based on thrips incidence, abundance of coccinellids (immature and adult stages), and marketable fruit yield in treated and untreated (control) plots. The results revealed that cyantraniliprole 10.26% OD applied at 60 and 120 g a.i./ha provided the highest suppression of thrips, followed by imidacloprid 17.8% SL at 25 and 50 g a.i./ha. Moderate efficacy was recorded with spirotetramat 15.31% OD (60 and 120 g a.i./ha) and fenazaquin 10% EC (125 and 250 g a.i./ha), whereas flubendiamide 20% WG (50 and 100 g a.i./ha) was the least effective against *S. dorsalis*. The highest coccinellid populations were recorded in plots treated with flubendiamide and cyantraniliprole, while the lowest populations occurred in imidacloprid-treated plots, indicating its comparatively greater adverse effect on these beneficial insects. Cyantraniliprole applied at 60 and 120 g a.i./ha also produced the highest marketable yield during both cropping seasons. Overall, cyantraniliprole demonstrated superior efficacy against chilli thrips while exerting relatively lower adverse effects on coccinellids, making it a promising option for sustainable chilli pest management.

Keywords: Bioefficacy, chilli, phytoxicity, pesticides, natural enemies

INTRODUCTION

Chilli (*Capsicum annuum* L.), an important vegetable crop belonging to the family Solanaceae, is widely cultivated in tropical and subtropical regions owing to its wide adaptability (Kim *et al.,* 2020). Chilli fruits are rich in bioactive compounds, particularly capsaicin, which imparts pungency and possesses important pharmaceutical and medicinal properties (Chakrabarty *et al.,* 2017). In India, chilli is cultivated over an area of 471 thousand hectares, with an annual production of 5,754 thousand metric tons. In Himachal Pradesh, it is cultivated over approximately 1.27 thousand hectares, with an annual production of 14.18 thousand metric tons (MoA&FW, 2025). Its cultivation is adversely affected by several insect pests, *viz.,* aphids (*Aphis gossypii* (Glover) (Hemiptera: Aphididae), whitefly (*Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), and fruit borers (*Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), mites (*Polyphagotarsonemus latus* (Banks) (Acarina: Tarsonemidae). Among these, chilli thrips, *Scirtothrips dorsalis* (Hood) (Thysanoptera: Thripidae), is recognized as a major and highly destructive pest of chilli in India (Kumar *et al*., 2014; Moanaro and Choudhary, 2018).

Chilli thrips complex has been reported to cause yield losses ranging from 50% to 90% under favorable conditions (Sireesha *et al*., 2021). In addition to direct feeding injury, *S. dorsalis* acts as a vector of several plant viruses, including tomato spotted wilt virus and tobacco streak virus, as well as other plant pathogens, leading to severe crop losses (Rotenberg *et al*., 2015). Consequently, chemical pesticides remain the primary management strategy for controlling *S. dorsalis* and reducing yield losses; however, their indiscriminate and excessive use has led to environmental contamination and health concerns. Continuous and repeated exposure to organophosphate and carbamate insecticides has resulted in the development of resistance in *S. dorsalis* populations, with LC_{50} values significantly higher than those in susceptible populations (Kaur *et al*., 2023; Kim *et al.,* 2025). This resistance is further intensified by the pest's biological characteristics, including its small size, high reproductive potential, cryptic feeding habit, and continuous availability of host plants throughout the year, all of which contribute to its persistence and management difficulty.

In this context, several insecticides such as Cyantraniliprole 10.26% OD, Spirotetramat 15.31% OD, and Imidacloprid 17.81% SL have been recommended by the Central Insecticide Board and Registration Committee (CIBRC) for the management of chilli thrips. Their bioefficacy has also been reported under different agro-climatic conditions by various researchers (Layek *et al*., 2024; Poornima *et al*., 2023; Lokare *et al*., 2025). However, in Himachal Pradesh, limited information is available on the comparative bioefficacy of these insecticides against *S. dorsalis* under field conditions, particularly with respect to their impact on beneficial arthropods such as coccinellid predators.

Therefore, there is a need to generate location-specific information on the effectiveness and safety of these insecticides under mid-hill chilli ecosystems to support their inclusion in Integrated Pest Management (IPM) programmes. Accordingly, the present study was undertaken to evaluate the bioefficacy of selected insecticides against chilli thrips and their safety to natural enemies under mid-hill conditions of Himachal Pradesh.

MATERIAL AND METHODS

Bioefficacy of various insecticides against chilli thrips (*S. dorsalis*) during the kharif season of two consecutive years, 2021 and 2022, on the DKC-8 variety was carried out at Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan, H.P. The study area was situated at 30°51'23″ N latitude and 77°107″ E longitude at an altitude of 1300 m, with soil ranging from loamy to clay texture and a pH of 6.85 to 7.24, indicating slightly acidic to neutral conditions. The climatic conditions vary between 17.70 to 31.50°C, with an annual rainfall of approximately 1156.19 mm. The study consisted of fifteen treatments, each replicated thrice, pesticide applications administered at a 10-day interval. Control plots were maintained with water spray using a knapsack sprayer equipped with a hollow cone nozzle. The experiment was laid out in a randomized block design (RBD) with three replications. The pesticides and their dosages used in the experiment were as follows: T_0 - Untreated control, T_1 - Cyantraniliprole (10.26% OD) (@ 45 g a.i./ha), T_2 - Cyantraniliprole (10.26% OD) (@ 60 g a.i./ha), T_3 - Cyantraniliprole (10.26% OD) (@ 120 g a.i./ha), T_4 - Imidacloprid (17.8% SL) (@ 19 g a.i./ha), T_5 - Imidacloprid (17.8% SL) (@ 25 g a.i./ha), T_6 - Imidacloprid (17.8% SL) (@ 50 g a.i./ha), T_7 - Spirotetramat (15.31% OD) (@ 45 g a.i./ha), T_8 - Spirotetramat (15.31% OD) (@ 60 g a.i./ha), T_9 - Spirotetramat (15.31% OD) (@ 120 g a.i./ha), T_{10} - Flubendiamide (20% WG) (@ 38 g a.i./ha), T_{11} - Flubendiamide (20% WG) (@ 50 g a.i./ha), T_{12} - Flubendiamide (20% WG) (@ 100 g a.i./ha), T_{13} - Fenazaquin (10% EC) (@ 94 g a.i./ha), T_{14} - Fenazaquin (10% EC) (@ 125 g a.i./ha), T_{15} - Fenazaquin (10% EC) (@ 250 g a.i./ha). Observations were made on five randomly selected chilli plants from each plot. Chilli plants were tapped gently over a white sheet of paper to dislodge thrips, after which the numbers of adults and nymphs were counted. The population of coccinellids (grubs and adults) of *Coccinella septempunctata* (Linnaeus) was recorded from five randomly selected plants in each replication and compared with that in the untreated control plots. Observations on thrips and coccinellid populations were recorded one day before insecticide application and subsequently at 1, 3, 5, 7, and 10 days after spraying. The data were subjected to arc sine and square root transformation, and the transformed data were analysed using analysis of variance (ANOVA) following the procedure of Gomez and Gomez (1984). The per cent reduction in thrips population in insecticide-treated plots over the untreated control was calculated using the Henderson and Tilton formula (Equation 1) (Henderson and Tilton, 1955).

$$\text{Per cent reduction in population} = 100\left(1 - \frac{Ta}{Tb} \times \frac{Cb}{Ca}\right) \quad (1)$$

Where, T_a = Number of insects after treatment

T_b = Number of insects before treatment

C_a = Number of insects in untreated control after treatment

C_b = Number of insects in untreated control before treatment.

Benefit cost ratio

The cost benefit ratio of different treatments was calculated to assess their economic feasibility. The total cost of cultivation included fixed costs (common to all treatments) and variable costs such as insecticide cost and labour charges for spraying. Insecticide cost was calculated based on the dose and prevailing market price. Fruit yield per hectare (q/ha) was computed from plot yield and used to estimate gross income by multiplying with the market price (Rs./q). Net income was obtained by subtracting the total cost of cultivation from the gross income. The benefit cost ratio was calculated for all treatments, including the untreated control, to compare their profitability.

Benefit cost ratio was calculated by using formula (Equation 2):

$$BCR = \frac{\text{Net income}}{\text{Total cost of cultivation}} \quad (2)$$

RESULT AND DISCUSSION

Bioefficiency studies

Pre-treatment observations conducted one day prior to spray application indicated that the population of thrips (*Scirtothrips dorsalis*) ranged from 5.01 to 6.41 individuals per plant. Post-treatment assessments at 1, 3, 5, 7, and 10 days after each spray revealed that all insecticidal treatments significantly reduced thrips population compared to the untreated control.

Among the treatments, Cyantraniliprole at 120 g a.i./ha recorded the highest suppression of thrips population, achieving 81.90% and 84.23% reduction after the first and second sprays, respectively, followed by its lower dose at 60 g a.i./ha (77.15% and 82.12%). Moderate efficacy was observed with Imidacloprid (19, 25, and 50 g a.i./ha), Spirotetramat (45, 60, and 120 g a.i./ha), and Fenazaquin (94, 125, and 250 g a.i./ha), with percent reductions ranging from 52.09% to 75.91% and 53.85% to 78.01% after the first and second sprays, respectively. In contrast, Flubendiamide treatments exhibited the lowest efficacy, with population reduction remaining below 41%. A similar trend was observed during the second season, wherein pre-treatment thrips population ranged from 5.40 to 6.67 individuals per plant. Cyantraniliprole at 120 and 60 g a.i./ha again recorded the highest suppression, with reductions of 83.89% and 81.89% after the first spray, and 86.65% and 83.43% after the second spray, respectively. Intermediate levels of control were recorded with Imidacloprid, Spirotetramat, and Fenazaquin, with reductions ranging from 55.86% to 78.12% and 58.28% to 79.43% following the first and second sprays, respectively. Flubendiamide remained the least effective treatment, with population reduction below 47% (Table 1).

The present findings are in agreement with those reported by Sahani and Mondal (2020) and Layek *et al*. (2024), who demonstrated that application of Cyantraniliprole 10.26% OD at higher doses provided effective control of thrips in chilli. Similar results have been reported in other crops, where Cyantraniliprole exhibited high efficacy against thrips in cotton (Karthik *et al*., 2017; Patel *et al*., 2014). Although Imidacloprid (@ 50 g a.i./ha) has been reported to provide effective control of thrips (Priyadarshini *et al*., 2019), in the present study it was comparatively less effective than Cyantraniliprole, ranking as the second-best treatment. In contrast, Flubendiamide recorded the lowest reduction in thrips population, which is consistent with the findings of Vanisree *et al*. (2017), who reported 42.12% reduction in thrips population 14 days after application of Flubendiamide at 0.012% concentration in chilli.

Effective on natural enemies

The effect of different insecticides on coccinellid population during 2021 is presented in Table 2. Pre-treatment observations (0.80-1.13 beetles per five plants) indicated no significant differences among treatments, suggesting uniform distribution of coccinellids across the experimental plots. Following insecticidal applications, a significant reduction in coccinellid population was observed across all treatments, with a more pronounced decline after the second spray compared to the first spray. The untreated control maintained the highest population (1.20 and 1.31 coccinellids per five plants after first and second spray, respectively), whereas insecticide-treated plots showed varying levels of suppression. Among the treatments, Imidacloprid applied at 19, 25, and 50 g a.i./ha recorded the lowest coccinellid population, with mean values ranging from 0.30 to 0.43 and 0.23 to 0.29 coccinellids per five plants after the first and second sprays, respectively, indicating higher toxicity, followed by Fenazaquin (0.36–0.46 and 0.35–0.39 coccinellids per five plants at 94, 125, and 250 g a.i./ha). Spirotetramat (45, 60, and 120 g a.i./ha) exhibited moderate toxicity, recording values of 0.48–0.67 and 0.49–0.59 coccinellids per five plants after first and second sprays, respectively. In contrast, Cyantraniliprole (45, 60, and 120 g a.i./ha) and Flubendiamide (38, 50, and 100 g a.i./ha) maintained relatively higher populations, with values ranging from 0.53–0.69 and 0.51–0.59 and 0.55–0.80 and 0.57–0.65 after first and second sprays, respectively, indicating their comparatively safer effect on coccinellids. Similar trends were observed during 2022, and the data are presented in Table 2. Pre-treatment population of coccinellids ranged from 0.33 to 0.80 beetles per five plants, with no significant differences among treatments. Post-treatment observations revealed a significant decline in coccinellid population across all treatments. Imidacloprid (19, 25, and 50 g a.i./ha) recorded the lowest population (0.29–0.42 and 0.22–0.31 coccinellids per five plants after first and second sprays, respectively), followed by Fenazaquin (0.35–0.42 and 0.25–0.38). Spirotetramat showed moderate effects, whereas Cyantraniliprole and Flubendamide maintained comparatively higher populations across both sprays, indicating their relative safety to natural enemies.

These findings were in agreement with the studies conducted by Sudhanan *et al.* (2017) who reported that

Table 1: Effect of different pesticides on chilli thrips (*Scirtothrips dorsalis*) during 2021 and 2022

Insecticide	Dosage (a.i. g/ha)	2021			2022		
		Pre count (Mean No. of thrips/ plant) *	Per cent reduction/control		Pre count (Mean No. of thrips/ plant) *	Per cent reduction/control	
			Mean (1st spray)#	Mean (2nd Spray)#		Mean (1st Spray)#	Mean (2nd Spray)#
Untreated control	-	5.03 (2.45)	-	-	6.30(2.7)	-	-
Cyantraniliprole (10.26 %OD) (x)	45	5.01 (2.45)	63.38 (52.78) ^{f,g}	72.57 (58.61) ^{c}	6.67 (2.77)	67.69 (55.40) ^{d,e}	72.95 (58.76)^{d}
Cyantraniliprole (10.26 %OD) (X)	60	5.19 (2.49)	77.15 (61.53) ^{b}	82.12 (65.28) ^{a}	5.62 (2.57)	81.89 (65.14) ^{b}	83.43 (66.49)^{b}
Cyantraniliprole (10.26 %OD) (2X)	120	5.42 (2.53)	81.90 (64.93) ^{a}	84.23(66.95) ^{a}	5.93 (2.63)	83.89 (66.61) ^{a}	86.65 (69.20)^{a}
Imidacloprid (17.8 % SL) (x)	19	5.22 (2.49)	60.05 (50.81) ^{h}	65.02 (53.79) ^{f}	6.31 (2.70)	65.01 (53.76) ^{g}	68.80 (56.06)^{e}
Imidacloprid (17.8 % SL) (X)	25	6.02 (2.65)	73.14 (58.80)^{c}	74.74 (60.12) ^{c}	5.57 (2.56)	76.29 (60.94) ^{c}	77.75 (61.94)^{c}
Imidacloprid (17.8 % SL) (2X)	50	6.41 (2.72)	75.91 (60.66) ^{b}	78.01 (62.53) ^{b}	5.87 (2.62)	78.12 (62.18) ^{c}	79.43 (63.25)^{c}
Spirotetramat (15.31 % OD) (x)	45	6.21 (2.68)	54.67 (47.68) ^{i}	56.07 (48.49) ^{g}	6.30 (2.70)	59.05 (50.23) ^{h}	61.64 (51.81)^{f}
Spirotetramat (15.31 % OD) (X)	60	5.68 (2.58)	64.36 (53.37) ^{e}	67.64 (55.39) ^{d,e,f}	6.67 (2.77)	65.13 (53.90) ^{f,g}	69.72 (56.77)^{e}
Spirotetramat (15.31 % OD) (2X)	120	6.25 (2.69)	68.54 (55.94)^{d}	69.93 (56.80) ^{d}	6.41 (2.72)	68.25 (55.82) ^{d}	7 4.89 (60.04)^{d}
Flubendiamide (20 % WG) (x)	38	5.32 (2.51)	31.94 (34.36)^{k}	34.54 (35.94) ^{j}	5.70 (2.59)	34.83 (36.10) ^{k}	36.77 (37.24)^{i}
Flubendiamide (20 % WG) (X)	50	5.23 (2.49)	32.35 (34.59) ^{k}	37.55 (37.75)^{i}	5.96 (2.64)	36.81 (37.21) ^{k}	44.41 (41.75)^{h}
Flubendiamide (20 % WG) (2X)	100	5.20 (2.49)	37.07 (37.44) ^{j}	41.49 (40.05) ^{h}	5.93 (2.63)	41.94 (40.33) ^{j}	47.00 (43.24)^{h}
Fenazaquin (10 % EC) (x)	94	5.93 (2.63)	52.09 (46.18) ^{i}	53.85 (47.20) ^{g}	5.93 (2.63)	55.86 (48.37) ^{i}	58.28 (49.79)^{g}
Fenazaquin (10 % EC) (X)	125	5.61 (2.57)	60.42 (51.07) ^{g,h}	65.20 (53.89) ^{e,f}	5.40 (2.53)	60.87 (51.34) ^{h}	64.42 (53.44)^{f}
Fenazaquin (10 % EC) (2X)	250	5.47 (2.54)	66.11 (54.41)^{d,e,f}	68.12 (55.70) ^{d}	6.13 (2.67)	65.78 (54.30) ^{e,f,g}	68.60 (56.05)^{e}
$CD_{at\ 5\%}$	-	**NS**	**1.70**	**1.74**	**NS**	**1.33**	**1.68**

#Figure in parentheses is arc sine transformed values; *Figure in parentheses is square root transformed values; x= less than the recommended dose, X= recommended dose, 2X= double the recommended dose

Table 2: Effect of different pesticides on coccinellid population during 2021 and 2022

Insecticide	Dosage (a.i. g/ ha)	2021			2022		
		Pre count (Mean No. of coccinellid/ plant)	No. of coccinellids per plants		Pre count (Mean No. of coccinellid/ plant)	No. of coccinellids per five plants	
			Mean (1st spray)	Mean (2nd Spray)		Mean (1st Spray)	Mean (2nd Spray)
Untreated control	-	1.07 (1.44)	1.20 (1.51)a	1.31 (1.52)a	0.73 (1.31)	0.85 (1.36)a	0.93 (1.39)a
Cyantraniliprole (10.26 %OD) (x)	45	1.00 (1.41)	0.69 (1.30)b	0.59 (1.26)b	0.67 (1.29)	0.57 (1.25)b	0.55 (1.24)b
Cyantraniliprole (10.26 %OD) (X)	60	0.80 (1.34)	0.60 (1.26)c	0.57 (1.25)b	0.80 (1.34)	0.48 (1.21)c	0.47 (1.21)b
Cyantraniliprole (10.26 %OD) (2X)	120	1.13 (1.46)	0.53 (1.24)c	0.51 (1.23)b	0.60 (1.26)	0.48 (1.22)c	0.41 (1.19)b
Imidacloprid (17.8 % SL) (x)	19	1.07 (1.44)	0.43 (1.19)d	0.29 (1.13)d	0.53 (1.24)	0.42 (1.16)d	0.31 (1.14)c
Imidacloprid (17.8 % SL) (X)	25	0.93 (1.39)	0.36 (1.16)d	0.23 (1.11)d	0.60 (1.26)	0.31 (1.14)d	0.30 (1.13)c
Imidacloprid (17.8 % SL) (2X)	50	0.80 (1.34)	0.30 (1.14)d	0.23 (1.11)d	0.47 (1.21)	0.29 (1.14)d	0.22 (1.11)d
Spirotetramat (15.31 % OD) (x)	45	1.13 (1.46)	0.67 (1.28)b	0.59 (1.26)b	0.67 (1.29)	0.57 (1.23)c	0.53 (1.24)b
Spirotetramat (15.31 % OD) (X)	60	1.07 (1.44)	0.56 (1.24)c	0.53 (1.24)b	0.53 (1.24)	0.43 (1.21)c	0.44 (1.20)b
Spirotetramat (15.31 % OD) (2X)	120	1.13 (1.46)	0.48 (1.21)c	0.49 (1.22)c	0.73 (1.31)	0.43 (1.19)c	0.41 (1.19)b
Flubendiamide (20 % WG) (x)	38	1.00 (1.41)	0.80 (1.34)b	0.65 (1.28)b	0.67 (1.29)	0.65 (1.28)b	0.57 (1.25)b
Flubendiamide (20 % WG) (X)	50	0.93 (1.39)	0.69 (1.30)b	0.59 (1.26)b	0.73 (1.31)	0.63 (1.27)b	0.50 (1.22)b
Flubendiamide (20 % WG) (2X)	100	0.80 (1.34)	0.55 (1.24)c	0.57 (1.25)b	0.47 (1.21)	0.51 (1.23)c	0.43 (1.20)b
Fenazaquin (10 % EC) (x)	94	1.00 (1.41)	0.46 (1.21)c	0.39 (1.18)c	0.33 (1.15)	0.42 (1.20)c	0.38 (1.17)c
Fenazaquin (10 % EC) (X)	125	0.80 (1.34)	0.37 (1.17)d	0.37 (1.17)c	0.60 (1.26)	0.39 (1.19)c	0.32 (1.14)c
Fenazaquin (10 % EC) (2X)	250	0.80 (1.34)	0.36 (1.18)d	0.35 (1.16)d	0.67 (1.29)	0.35 (1.16)d	0.25 (1.12)d
CD (5%)		**NS**	**0.06**	**0.05**	**NS**	**0.05**	**0.06**

Figure in parentheses is square root transformed values; x= less than the recommended dose, X= recommended dose, 2X= double the recommended dose

Table 3: Economics of insecticidal treatments used against chilli thrips (*Scirtothrips dorsalis*) during 2021 and 2022

Insecticide	Dosage (g a.i./ha)	2021			2022		
		Yield (q/ha)	Net Income (Rs in INR)	B:C	Yield (q/ha)	Net Income (Rs in INR)	B:C
Untreated control		115.60	273654.95	2.09	122.60	298154.95	2.28
Cyantraniliprole (10.26 %OD) (x)	45	144.20	363620.95	2.58	151.00	387420.95	2.75
Cyantraniliprole (10.26 %OD) (X)	60	164.40	430942.95	2.98	169.60	449142.95	3.11
Cyantraniliprole (10.26 %OD) (2X)	120	170.80	439830.95	2.78	175.00	454530.95	2.88
Imidacloprid (17.8 % SL) (x)	19	124.20	303002.95	2.30	131.20	327502.95	2.49
Imidacloprid (17.8 % SL) (X)	25	135.40	341954.95	2.59	139.80	357354.95	2.71
Imidacloprid (17.8 % SL) (2X)	50	139.60	355654.95	2.68	144.20	371754.95	2.80
Spirotetramat (15.31 % OD) (x)	45	126.60	309544.95	2.32	131.40	326344.95	2.44
Spirotetramat (15.31 % OD) (X)	60	137.60	347174.95	2.58	142.40	363974.95	2.71
Spirotetramat (15.31 % OD) (2X)	120	142.60	361194.95	2.62	147.00	376594.95	2.73
Flubendiamide (20 % WG) (x)	38	124.40	301341.67	2.25	129.20	318141.67	2.37
Flubendiamide (20 % WG) (X)	50	135.40	338814.95	2.51	138.20	348614.95	2.58
Flubendiamide (20 % WG) (2X)	100	138.20	344474.95	2.47	152.00	392774.95	2.82
Fenazaquin (10 % EC) (x)	94	143.20	364088.55	2.66	135.40	336788.55	2.46
Fenazaquin (10 % EC) (X)	125	151.00	389354.95	2.80	144.20	365554.95	2.63
Fenazaquin (10 % EC) (2X)	250	158.80	408454.95	2.77	148.60	372754.95	2.53

'x' is the dose less than the recommended dose and 'X' is the standard dose and 2X is the double the standard dose

after the untreated control (5.7/ten plants), the highest population of coccinellids was found in lower dose of Flubendiamide 20 WG (40 g a.i./ha) of 4.3/ten plants in sugarcane. Another study conducted by Narayan *et al.* (2019) also revealed that plots treated with Cyantraniliprole 10 % OD (0.0143 %) (1.34/plant) and Flubendiamide 39.36 % SC (0.0098 %) (1.08 beetles/plant) were less toxic to the coccinellid population. Also the field trials conducted by Kar (2017) showed the maximum reduction of coccinellid population when Imidacloprid 17.8 % SL @ 175 ml/ha (0 and 0.33 beetles/plant) was applied which is somehow in tune with the present study.

Benefit cost ratio

All pesticide treatments resulted in significantly higher marketable yields (124.20–170.80 q/ha and 129.20–175.00 q/ha) than the untreated control (115.60 and 122.60 q/ha) during the first and second seasons, respectively. Based on the yield data, the cost ratio of each treatment was calculated. The highest cost ratio (2.98:1 and 3.11:1) was recorded in plots treated with Cyantraniliprole at 60 g a.i./ha, whereas the untreated control recorded the lowest ratio (2.09:1 and 2.28:1) during 2021 and 2022, respectively (Table 3).

CONCLUSION

Based on two years of field evaluation, cyantraniliprole at 120 g a.i./ha was the most effective treatment for the management of chilli thrips, *S. dorsalis*, outperforming all other insecticides tested. Cyantraniliprole and Imidacloprid provided superior suppression of thrips, whereas Flubendiamide was the least effective. None of the insecticide treatments caused phytotoxic effects on chilli plants at the tested doses, indicating their safety for crop application. Among the insecticides evaluated, Flubendiamide was the safest to coccinellids, particularly at the lower dose, while Imidacloprid and

Fenazaquin had comparatively greater adverse effects on their populations. Although all insecticide treatments significantly increased chilli yield over the untreated control, Cyantraniliprole at 60 g a.i./ha recorded the highest cost:benefit ratio, making it the most economically viable treatment. Overall, Cyantraniliprole emerged as the most promising option for the sustainable management of chilli thrips by providing effective pest suppression, higher yield, economic returns, and relatively lower impact on beneficial coccinellids.

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AUTHOR CONTRIBUTIONS

Formal analysis, investigation, writing- original draft, writing- review & editing (S.B.); Conceptualization, supervision, methodology, review and editing (S.K.; S.S.).

CONFLICT OF INTEREST

Authors don't have conflict of interest to express

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