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Assessing the bioefficacy of Cyantraniliprole 10.26% OD against fruit borer and thrips on chilli under field condition

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ABSTRACT

During the *rabi* season of 2020, a trial was performed to estimate the efficacy of Cyantraniliprole 10.26 % OD at different doses (30, 60, 90, and 120 g a.i./ha respectively) together with Imidacloprid 17.8% SL (20 g a.i./ha) and Spinosad 45% SC (73 g a.i./ha) to evaluate their efficacy against the fruit borer and thrips infesting chilli (variety SHP-4884). The trial was performed in randomized block design containing three replications. The results showed that Cyantraniliprole 10.6% OD @ 120 g a.i./ha was the most efficient insecticide among the others and recorded the maximum reduction (84.13 % in larval population of fruit borer and 78.03 % in thrips population) in both the pest populations over the untreated check. However, Cyantraniliprole 10.6% OD @ 90 g a.i./ha was noted as the next best insecticide.

Introduction

In India, chilli (*Capsicum annuum* L.) is a crucial spice covering around 0.81 million hectares of total chilli production (Raj and Christopher, 2009). It is the world's second-most essential vegetable after the tomato and the thick flesh cultivar is comparatively not pungent (Sukhi *et al.,* 2020). When compared to other chilli growing countries, India's crop productivity is quite low, and it is attributed to a number of limiting conditions (Vanisree *et al.,* 2013). Among them, the ravages caused by insect pests are vital ones. This crop is being infested with a wide range of insect pests, of these, mites (*Polyphagotarsonemus latus* (Banks)), aphid (*Aphis gossypii* Glover), jassids (*Amrasca biguttula* Ishida), thrips (*Scirtothrips dorsalis* Hood), and fruit borer (*Helicoverpa armigera* (Hübner)) are the major production constraints of chilli, and causes about 70-80% yield loss (Subhashree *et al.,* 2020).

In recent decades, to gain higher yield and to minimize the chilli's pests, the indiscriminate use of conventional insecticides like organophosphates, synthetic pyrethroids has increased in chilli crop (Nayak *et al.,* 2014). Sometimes, throughout the cropping season, farmers in Southeast Asian nations like Bangladesh and India use more than 30 to 40 rounds of spraying (Alam, 2019a). As a result of this, in addition to pest resurgence, pesticide resistance and the elimination of natural enemies have impeded both domestic consumption and export of chilli (Subhashree *et al.,* 2020). Additionally, the consumption of excessive chemical insecticidal residue harms the ecosystem by causing difficulties with human health, ecological imbalance, water pollution, and the eradication of beneficial wildlife (Gundannavar *et al.,* 2007). Keeping this view and overcoming these problems, therefore, several

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aspects need to be reexamined and evaluated in order to develop a sound management programme with novel or residue-free pesticide usage. There is less information about the efficacy on the insect pests that infest chilli. In this experiment, we have used a newer molecule of insecticides, i.e., Cyantraniliprole 10.26 % OD at different doses to evaluate its effect on the major two pests of chilli *i.e.,* thrips and fruit borer. However, a few workers had previously assessed the field bio-efficacy of Cyantraniliprole at various doses against sucking pests (Patel and Kher, 2012a; Misra 2012; Mandal 2012; Patel and Kher, 2012b) on other crops. Cyantraniliprole (IRAC MoA 28) is a second-generation anthranilic diamide insecticide discovered by DuPont Crop Protection. The 10.6% OD formulation refers to the concentration of Cyantraniliprole in the specific product (oil dispersion formulation) being used. The mode of action of Cyantraniliprole involves targeting the insect's muscular and nervous systems. It selectively acts on the insect ryanodine receptor, which is an important calcium channel involved in muscle contraction and regulation of neuro transmitter release in insects. Though this is a systemic insecticide which is active through both ingestion and contact routes, it is more potent via ingestion (Sattelle *et al.,* 2008; IRAC, 2012). It is the first insecticide to control a crossspectrum of sucking (Hemiptera) and chewing (Lepidoptera) pests (Anonymous, 2012). In the present research, insecticides currently employed to control targeted pests in three consecutive sprayings displayed a varied level of field-efficacy through specific treatment schedules described in detail below.

Material and Methods

The study was operated at Jaguli Instructional Farm (23.56°N; 88.32° E), BCKV (Bidhan Chandra Krishi Viswavidyalaya), West Bengal, during *rabi* season using the chilli variety SHP-4884. The details of the insecticides used for the study are described in Table 1. The crop was grown in the nursery bed for one month before being transplanted in the main field in plots of a 4 m^2 area with a spacing of 45cm x 45cm in the last week of October 2020. All the observations were collected by closely inspecting the leaves and plant growth. Following the target pests' infestation, three successive sprayings were carried out ten days apart. Observations were made one day prior and 3, 7 and 10 days after the spraying of insecticides for counting adults and nymphs of thrips and the larval populations of fruit borer. All observations were registered from five tagged plants using three leaves that covered the plants' bottom, middle and top leaves (Jeyarani and Chandrasekaran, 2006). Analysis of variance was done following randomized block design after suitable transformation. All the statistical tests were performed in the OP Stat, CCS Haryana Agricultural University.

Table 1: The details of the insecticidal treatments

Tr. No.	Insecticide	Formulation	Dosage (g a.i./ha)	Group of Chemical
T_1	Cyantraniliprole	10.6% OD	30	Anthanilic Diamides
T_2	Cyantraniliprole	10.6% OD	60	Anthranilic Diamides
T_3	Cyantraniliprole	10.6% OD	90	Anthanilic Diamides
T_4	Cyantraniliprole	10.6% OD	120	Anthranilic Diamides
T_5	Imidacloprid	17.8% SL	20	Neonicotinoid
T_6	Spinosad	45 % SC	73	Spinosyns
T_7	Untreated control	-	-	-

Results and Discussion

The different treatments used against chilli pests in open field conditions were imposed sequentially at ten days intervals during 2020-21. The results obtained are presented here.

Fruit borer (*Helicoverpa armigera* Hübner):

First spray: The mean numbers of larvae before the starting of spray are significantly similar among different plots (1.12 to 1.96 fruit borer/3 leaves) (Table 2) as the data are statistically nonsignificant ($F_{6,12}$ = 0.40, P = 0.8634) (CD = non-significant; SEm± = 0.15). After 3rd day of spraying, the minimum fruit borer larvae were recorded in T_4 (0.74 fruit borer /3 leaves) and was at par with T_3 (0.80 fruit borer/3 leaves). The treatment of T_7 (2.20 fruit borer/3 leaves) recorded a significantly higher population than the rest of the treatments ($F_{6,12}$ = 5.95, P = 0.0043) (CD = 0.21; SEm± = 0.07). After seven days after the first spraying, T_4 recorded the lowest fruit borer population (0.52 fruit borer/3 leaves) and was also at par with the treatment of T_3 (0.60 fruit borer/3 leaves) ($F_{6,12}$ = 9.07, P = 0.0006) (CD = 0.22; SEm± = 0.07). On the 10th day after spray, T_3 was found to be the most effective treatment (0.53 fruit borer/3 leaves) and was at par with the treatment T_4 (0.62 fruit borer/3 leaves) ($F_{6,12}$ = 10.25, P = 0.0003) (CD = 0.22; SEm± = 0.07). The maximum (2.62 fruit borer population per three leaves) per plant were recorded in the untreated control (Table 2).

Second spray: The mean larvae of the fruit borer population after three days of application of insecticides indicated that T_3 was found to be the most effective treatment, which gave 0.38 mean larvae of the fruit borer population. However, it was statistically at par with T_4 (0.52) and T_2 (0.60) fruit borer/3 leaves ($F_{6,12}$ = 13.98, P = 0.00009) (CD = 0.20; SEm± = 0.07). After seven days of second spraying, T_3 recorded the lowest fruit borer population (0.26 fruit borer/3 leaves) and was also at par with the treatment of T_4 (0.32 fruit borer/3 leaves) ($F_{6,12}$ = 20.60, P = 0.00001) (CD = 0.19; SEm± = 0.06). On the 10th day after spray, T_4 was found to be the most effective treatment (0.38 fruit borer/3 leaves) and was at par with the treatment T_3 (0.40 fruit borer/3 leaves) ($F_{6,12}$ = 23.47, P = 0.00001) (CD = 0.20; SEm± = 0.06). The maximum (3.10 fruit borer population per three leaves) larval population per plant were recorded in the untreated control (Table 2).

Third spray: After three days of the third spray, the maximum mean population of fruit borer was recorded at 2.86 per three leaves per plant in T_7, and the minimum was recorded from T_4 (0.12 fruit borer/3 leaves) and T_3 (0.32 fruit borer/3 leaves) ($F_{6,12}$ = 33.06, P = 0.0000) (CD = 0.17; SEm± = 0.05). After the 7th day of spraying, the larval population was nil in plots treated with T_4, followed by T_3 and T_1 (0.24 and 0.26 fruit borer larvae/3 leaves respectively) ($F_{6,12}$ = 62.97, P = 0.0000) (CD = 0.15; SEm± = 0.05). After ten days of the third spray among the different insecticide treatments, T_4 gave the best result in managing fruit borer populations (0.06 larvae/3 leaves) ($F_{6,12}$ = 25.80, P = 0.0000) (CD = 0.23; SEm± = 0.07) followed by T_3 (0.16 fruit borer larvae/3 leaves) and T_2 (0.22 fruit borer larvae/3 leaves). The maximum (3.42 fruit borer larvae/3 leaves) population was found in the untreated control (Table 2). So, depending on the mean number of fruit borer (larvae), the decreasing efficacy rate of different insecticidal treatments was as follows: $T_4 > T_3 > T_2 > T_6 > T_1 > T_5 > T_7$ (Fig. 1).

Thrips (*Scirtothrips dorsalis* Hood):

First spray: One day before 1st spray, the maximum mean population of thrips was 10.98 /3 leaves in T_7, and the minimum was recorded at 8.98 thrips /3 leaves in T_5 ($F_{6,12}$ = 0.57, P = 0.7468), showed that there was no significant difference of thrips population in different treatments (CD = non-significant; SEm± = 0.15) (Table 3). Three days after spraying, the maximum mean population of thrips was recorded at 11.56 thrips/3 leaves in T_7, and the minimum was 3.38 thrips/3 leaves in T_4 and T_3 (3.62 thrips/3 leaves) ($F_{6,12}$ = 4.515, P = 0.0127) (CD = 0.71; SEm± = 0.23). Seven days after spraying, the maximum mean population of thrips was observed in T_7 (11.82 thrips/3 leaves), and the minimum was recorded in T_4 (2.64 thrips/3 leaves) ($F_{6,12}$ = 6.69, P = 0.0026) (CD = 0.66; SEm± = 0.21). After ten days of the first spray, T_4 gave the best result in managing thrips populations 2.84 thrips/ 3 leaves ($F_{6,12}$ = 8.30, P = 0.0010) (CD = 0.61; SEm± = 0.20) followed by T_3 (3.02 thrips/3 leaves) and T_2 (4.30 thrips/3 leaves).

Table 2: Bio efficacy of Cyantraniliprole 10.6% OD against fruit borer (larval count) on chili during 2020

	Treatment Details	Dose (g.a.i/ Ha)	Pre-treatment	Mean larval populations/ 3 leaves									ROC (%)
				1st Spray*			2nd Spray*			3rd Spray*			
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T1	**Cyantraniliprole 10.6% OD**	**30**	1.38 (1.53)	1.02 (1.42)	0.72 (1.31)	0.86 (1.36)	0.68 (1.29)	0.54 (1.24)	0.60 (1.26)	0.48 (1.21)	0.26 (1.12)	0.32 (1.15)	**74.80**
T2	**Cyantraniliprole 10.6% OD**	**60**	1.28 (1.50)	0.94 (1.39)	0.68 (1.29)	0.72 (1.31)	0.60 (1.26)	0.48 (1.21)	0.54 (1.24)	0.42 (1.19)	0.34 (1.15)	0.22 (1.10)	**77.15**
T3	**Cyantraniliprole 10.6% OD**	**90**	1.42 (1.55)	0.80 (1.34)	0.60 (1.26)	0.53 (1.23)	0.38 (1.17)	0.38 (1.17)	0.40 (1.18)	0.32 (1.15)	0.24 (1.11)	0.16 (1.08)	**81.23**
T4	**Cyantraniliprole 10.6% OD**	**120**	1.12 (1.45)	0.74 (1.31)	0.52 (1.23)	0.62 (1.27)	0.44 (1.20)	0.32 (1.15)	0.38 (1.17)	0.12 (1.06)	0.00 (1.00)	0.06 (1.03)	**84.13**
T5	**Imidacloprid 17.8 SL**	**100**	1.88 (1.68)	1.34 (1.53)	1.12 (1.45)	1.04 (1.43)	0.86 (1.36)	0.68 (1.29)	0.72 (1.31)	0.56 (1.25)	0.42 (1.19)	0.48 (1.21)	**66.57**
T6	**Spinosad 45% SC**	**73**	1.56 (1.59)	1.10 (1.44)	0.88 (1.37)	0.76 (1.32)	0.62 (1.27)	0.50 (1.22)	0.42 (1.19)	0.38 (1.17)	0.24 (1.11)	0.30 (1.14)	**75.17**
T7	**Untreated control**		1.96 (1.70)	2.20 (1.79)	2.38 (1.84)	2.62 (1.90)	2.54 (1.88)	2.78 (1.94)	3.10 (2.02)	2.86 (1.96)	3.36 (2.09)	3.42 (2.09)	**0.00**
C.D			**NS**	**0.21**	**0.22**	**0.22**	**0.20**	**0.19**	**0.20**	**0.17**	**0.15**	**0.23**	
SEm±			**0.15**	**0.07**	**0.07**	**0.07**	**0.07**	**0.06**	**0.06**	**0.05**	**0.05**	**0.07**	
F_{cal}			**0.403**	**5.950**	**9.073**	**10.250**	**13.983**	**20.605**	**23.471**	**33.066**	**62.970**	**25.806**	
P			**0.8634**	**0.00437**	**0.00069**	**0.00039**	**0.00009**	**0.00001**	**0.00001**	**0.00000**	**0.00000**	**0.00000**	

Values in the parenthesis are square root transformed. NS – Nonsignificant, DAS - Days After Spray. ROC – Mean reduction over control. (*) - Mean value

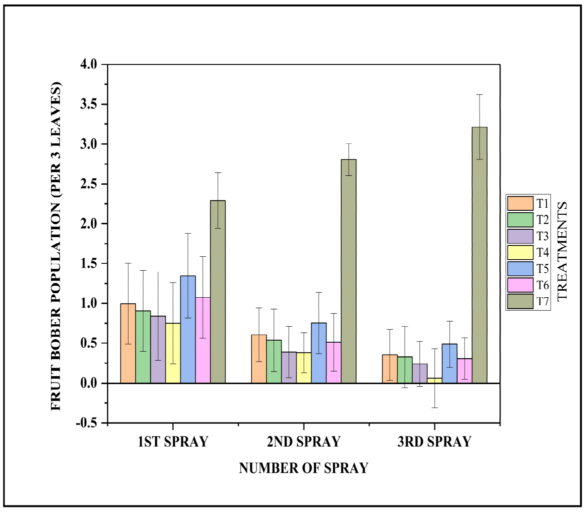

Fig. 1: Graphical representation of the effect of insecticides on the population of chilli fruit borer in three different insecticidal sprayings

The maximum thrips population (12.10 thrips/ 3 leaves) was found in untreated control which was significantly higher than all other insecticidal treatments.

Second spray: On the 3rd day of the second spray, the thrips population ranges from 1.98 to 11.92 per three leaves per plant ($F_{6,12}$ = 7.76, P = 0.0014) (CD = 0.69; SEm± = 0.22) (Table 3). It is observed that, at the end of the 7th and 10th days of spraying, the decreasing trend in the population of thrips followed the results of the first spray and T_4 recorded the maximum reduction in the mean population of thrips ($F_{6,12}$ = 16.31, P = 0.0000; $F_{6,12}$ = 15.98, P = 0.0000 respectively) (CD = 0.51, SEm± = 0.17; CD = 0.50; SEm± = 0.16) which was immediately followed by T_3.

Third spray: On the third day after the 3rd spray, the thrips population ranges from 0.82 to 12.34 per three leaves per plant. the maximum mean population of thrips was recorded in T_7 (12.34 thrips/3 leaves), and the minimum was recorded in T_4 (0.82 thrips/3 leaves) and T_3 (1.58 thrips/3 leaves) ($F_{6,12}$ = 12.99, P = 0.0001) (CD = 0.65; SEm± = 0.21). Then, seven days after the third spray, the maximum mean population of thrips was 12.58 thrips/3 leaves observed in T_7 ($F_{6,12}$ = 14.37, P = 0.0000) (CD = 0.66; SEm± = 0.21), and the minimum was recorded in T_4 (0.64 thrips/3 leaves) (Table 3). After ten days of the third spraying among the different insecticide treatments, T_3 recorded the minimum number of thrips populations (0.90 thrips/3 leaves) followed by T_4 (0.98 thrips/3 leaves) and T_6 (1.98 thrips/3 leaves) ($F_{6,12}$ = 21.26, P = 0.0000) (CD = 0.54; SEm± = 0.17). So, depending on the mean number of thrips (adult and nymph), the decreasing efficacy rate of different insecticidal treatments was as follows: $T_4 > T_3 > T_2 > T_6 > T_1 > T_5 > T_7$ (Fig. 2). Insecticide resistance poses a noteworthy concern in the context of effective pest management programs. To address this challenge, resistance management strategies are currently in development, focusing on incorporating safer and newer chemical agents and implementing insecticide rotation modules. A critical facet of resistance management for chilli pests involves the judicious use of chemicals to which resistance has already manifested and the incorporation of novel modes of action. Among the emerging class of insecticides, cyantraniliprole stands out with its unique mode of action, holding significant potential for integration into existing pest management protocols (Tiwari and Stelinski, 2013). Cyantraniliprole belongs to the anthranilic diamide class of chemistry and represents the second active ingredient within this class to be commercialized for the control of a diverse spectrum of pests, encompassing both chewing and sucking insect species (such as leafminers, leaf-feeding beetles, fruit flies, whiteflies, psyllids, and lepidopteran insects) (Lahm *et al.,* 2013; Selby *et al.,* 2013; Lahm *et al.,* 2007; Cordova *et al.,* 2006; Lahm *et al.,* 2005). Notably, cyantraniliprole has exhibited effectiveness in managing insect pests while potentially exerting a lesser detrimental impact on natural enemies populations when compared to conventional broad-spectrum chemical agents. The strategic application of cyantraniliprole during specific times of the year may contribute to the preservation of biological control agents, distinguishing it from alternative broad-spectrum chemicals (Tiwari and Stelinski, 2013). The present field experiment has further substantiated the efficacy of foliar cyantraniliprole applications at different dosages in mitigating populations of fruit borer and thrips in chilli. Our findings underscore the promising broad-spectrum activity of cyantraniliprole within the context of chilli pest management strategies.

Table 3: Bio efficacy of Cyantraniliprole 10.6% OD against thrips (adult and nymph count) on chili during 2020

	Treatment Details	Dose (g.a.i/ Ha)	Pre-treatment	Mean thrips population/ 3 leaves									ROC (%)
				1st Spray*			2nd Spray*			3rd Spray*			
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T1	**Cyantraniliprole 10.6% OD**	**30**	10.56 (3.39)	5.30 (2.48)	4.76 (2.39)	4.66 (2.36)	3.80 (2.16)	3.62 (2.14)	3.50 (2.10)	2.28 (1.80)	2.14 (1.76)	2.32 (1.81)	**64.41**
T2	**Cyantraniliprole 10.6% OD**	**60**	9.40 (3.22)	4.74 (2.38)	4.16 (2.26)	4.30 (2.28)	3.62 (2.12)	3.16 (2.02)	3.32 (2.07)	2.42 (1.83)	2.08 (1.71)	2.28 (1.79)	**67.28**
T3	**Cyantraniliprole 10.6% OD**	**90**	10.02 (3.32)	3.62 (2.12)	3.14 (2.01)	3.02 (1.98)	2.38 (1.82)	1.94 (1.69)	2.06 (1.73)	1.58 (1.58)	1.12 (1.45)	0.90 (1.37)	**75.32**
T4	**Cyantraniliprole 10.6% OD**	**120**	9.12 (3.18)	3.38 (2.07)	2.64 (1.89)	2.84 (1.95)	1.98 (1.71)	1.72 (1.64)	2.34 (1.82)	0.82 (1.34)	0.64 (1.28)	0.98 (1.39)	**78.07**
T5	**Imidacloprid 17.8 SL**	**100**	8.98 (3.16)	5.82 (2.60)	5.12 (2.46)	4.86 (2.42)	3.98 (2.22)	3.70 (2.15)	3.84 (2.19)	3.08 (1.98)	2.74 (1.91)	3.12 (2.02)	**62.51**
T6	**Spinosad 45% SC**	**73**	10.46 (3.38)	5.12 (2.46)	4.64 (2.34)	4.42 (2.31)	3.76 (2.16)	3.54 (2.12)	3.62 (2.14)	2.36 (1.81)	2.12 (1.72)	1.98 (1.71)	**65.17**
T7	**Untreated control**		10.98 (3.45)	11.56 (3.53)	11.82 (3.57)	12.10 (3.62)	11.92 (3.58)	12.24 (3.63)	12.42 (3.65)	12.34 (3.64)	12.58 (3.67)	12.70 (3.70)	**0.00**
C.D			**NS**	**0.71**	**0.66**	**0.61**	**0.69**	**0.51**	**0.50**	**0.65**	**0.66**	**0.54**	
SEm±			**0.15**	**0.23**	**0.21**	**0.20**	**0.22**	**0.17**	**0.16**	**0.21**	**0.21**	**0.17**	
F_{cal}			**0.570**	**4.515**	**6.695**	**8.307**	**7.761**	**16.316**	**15.980**	**12.994**	**14.376**	**21.267**	
P			**0.74682**	**0.01276**	**0.00268**	**0.00104**	**0.00141**	**0.00004**	**0.00004**	**0.00012**	**0.00007**	**0.00001**	

Values in the parenthesis are square root transformed. NS – Nonsignificant, DAS - Days After Spray. ROC – Mean reduction over control. (*) - Mean value

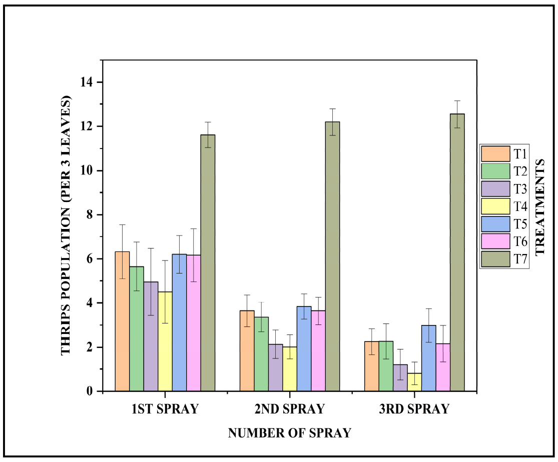

Fig. 2: Graphical representation of the effect of insecticides on the population of chilli thrips in three different insecticidal sprayings

The results indicate that cyantraniliprole @ 120 g a.i. ha^{-1} and 90 g a.i. ha^{-1} reduces the larval population of chilli fruit borer by 84.13 % and 81.23 %, respectively, and these observations are in conformity with Kodandaram *et al.* (2015) where they clearly showed the effectiveness of cyantraniliprole @ 105 g a.i. ha^{-1} was found most effective and recorded significantly lowest per cent fruit damage against *Leucinodes orbonalis,* followed by cyantraniliprole @ 90 g a.i. ha^{-1} during 2010 and 2011. Mandal (2012) also reported Cyazypyr 10% OD @ 105 and 90 g a.i. ha^{-1} was highly effective against the fruit borer in tomato. Yadav *et al.* (2012) recorded the highest leaf damage reduction by flea beetle, *Scelodonta strigicollis* in grapes against cyantraniliprole @ 80 ga.i./ha. Tiwari *et al.* (2013) acknowledged that foliar application of cyantraniliprole reduced the numbers of *Diaphorina citri* adults and nymphs in citrus. Mishra and Mukherjee (2012) revealed that Cyazypyr 10% OD @ 105 and 90 g a.i. ha^{-1} to be most effective against red pumpkin beetles *Aulacophora foveicollis* on gherkins. All these findings support the present investigation and are very similar to the obtained results. Cyantraniliprole also have a compound movement through the leaf cuticle, which includes reduced losses through wash-off, volatilization and photodegradation, thus potentially providing improved coverage and better residual activity on target pests (Stevens et al., 1988; Buchholz and Nauen, 2002). In our results, the mean reduction of thrips over control was maximum in cyantraniliprole @ 120 g a.i. ha^{-1} (78.07 %) and cyantraniliprole @ 90 g a.i. ha^{-1} (75.32 %). This similar finding was also reported by Patel *et al*. (2014), where they reported cyantraniliprole 10% OD at 105 g a.i./ha was noted as more potent in minimizing thrips in chilli, and it was at par with cyantraniliprole 10% OD at 90 g a.i./ha. Misra (2012) also found that both the doses of cyantraniliprole, *i.e.,* 105 and 90 g a.i./ha, were equally effective against *T. tabaci* infesting tomato. Hence, it becomes imperative to assess the compatibility of insecticides within diverse cropping systems as part of an overarching effort to reduce environmental impacts while maintaining favourable toxicological profiles and employing minimal application rates. The current study represents a fundamental element of our broader objective, which revolves around the ongoing enhancement and refinement of integrated pest management strategies specifically designed to combat the fruit borer and thrips infestations in chilli cultivation.

Conclusion

To conclude, we can say that the findings indicate all the pesticide treatments were more successful than the control in lowering the thrips and fruit borer populations. The efficacy of Cyantraniliprole 10.6% OD is due to its root systemic activity with some translaminar movement. It is effective against the larval stages of lepidopteran insects, thrips, aphids, and some other chewing and sucking insects. Due to its selective mode of action, it is non only effective against targeted pests, but also safe to non-target arthropods and conserves natural parasitoids, predators and pollinators. So, Cyantraniliprole 10.6% OD @ 120 g a.i./ha can be a good substitute chemical to traditional insecticides for faster controlling, followed by Cyantraniliprole 10.6% OD @ 90 g a.i./ha. The dual activity of cyantraniliprole against both sucking and chewing insect pests underscores its significance in the context of integrated pest management (IPM) and insect resistance management (IRM) strategies. To ensure the continued viability of these compounds as a pest management option for farmers, it becomes imperative to implement comprehensive IPM and IRM practices.

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Conflict of interest
The authors declare that they have no conflict of interest.

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