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ECO-TOXICOLOGICAL ASSESSMENT OF PREDATORY ARTHROPODS TO INSECTICIDE TREATMENTS IN RICE (*Oryza sativa*) ECOSYSTEMS

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ABSTRACT

An experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the *Kharif* seasons of 2022 and 2023 to evaluate the impact of different doses of cyantraniliprole on coccinellid and spider populations in rice fields. The study was carried out using the rice variety *Swarna Sub 1*. Cyantraniliprole was sprayed at different doses (30, 45, 60, and 75 g a.i./ha) along with fipronil and lambda-cyhalothrin at their recommended doses, applied at 30 and 60 days after transplanting. Observations on coccinellid and spider populations were recorded before spraying and at 3, 7, 10, and 14 days after each application. The results revealed that cyantraniliprole caused a slight and temporary decline in coccinellid and spider populations at 3-7 days after spraying. Populations recovered by 10-14 days, and differences between treated and untreated plots were statistically nonsignificant. Among the doses tested, all cyantraniliprole treatments exhibited minimal adverse effects on natural enemies, likely due to its narrow selectivity and moderate persistence, allowing effective retention of beneficial arthropods. Overall, cyantraniliprole at different doses was found to be largely safe for coccinellids and spiders, supporting its use in integrated pest management programs in rice.

Key words: Coccinellids, Spiders, Cyantraniliprole, Rice.

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops globally, serving as the staple food for more than half of the world's population (FAO, 2021). In India alone, rice covers about 43.7 million hectares and provides food and livelihood security to millions of smallholder farmers (Singh *et al.*, 2020). However, rice production is severely constrained by the attack of insect pests. More than 800 insect species have been reported in rice ecosystems, of which around 20 are considered major pests, including the yellow stem borer (*Scirpophaga incertulas*), rice leaf folder (*Cnaphalocrocis medinalis*), and brown planthopper (*Nilaparvata lugens*) (Hafeez *et al.*, 2010; Pathak and Khan, 1994). These pests can cause yield losses ranging from 20–

30%, and in severe outbreaks, losses may be even higher (Heong and Hardy, 2009).

The rice agroecosystem is also home to a rich diversity of natural enemies, which play a crucial role in suppressing pest populations and maintaining ecological balance. Among these, predatory coccinellids, spiders and mirid bugs (*Cyrtorhinus lividipennis*) are of special significance. Coccinellids such as *Cheilomenes sexmaculata*, *Coccinella septempunctata*, and *Micraspis discolor* are voracious predators of planthoppers, leafhoppers, and aphids, thereby directly regulating their populations and preventing hopper burn (Babu *et al.*, 2018). Mirid bugs are specialized predators of planthopper and leafhopper eggs, and their role in reducing reproductive success of these pests is well

recognized (Sigsgaard, 2007; Gurr *et al.*, 2012). Together, these natural enemies act as biological regulators of rice pests, reducing the need for frequent insecticidal interventions and contributing to the stability of the rice ecosystem (Settele *et al.*, 2018).

Despite the ecological services provided by natural enemies, insecticides remain the most widely used tool for pest management in rice due to their rapid action and cost-effectiveness. However, the indiscriminate use of broad-spectrum insecticides has often disrupted ecological balance, leading to pest resurgence, secondary pest outbreaks, resistance development, and suppression of beneficial organisms (Heong and Schoenly, 1998; Bottrell and Schoenly, 2012). In particular, conventional chemistries such as organophosphates, carbamates, and synthetic pyrethroids are well known for their detrimental effects on beneficial arthropods, including coccinellids and mirid bugs, which results in destabilization of natural pest control (Fogel *et al.*, 2013).

In this context, the development of newer insecticides with novel modes of action has opened opportunities for selective pest control with reduced impact on beneficial fauna. Anthranilic diamides, such as chlorantraniliprole and cyantraniliprole, act by activating insect ryanodine receptors, which disrupt calcium homeostasis in muscle cells, leading to rapid feeding inhibition and eventual death of the larvae (Lahm *et al.*, 2009). This unique mode of action provides strong control over lepidopteran pests like leaf folders and stem borers while exhibiting lower toxicity to many natural enemies. Cyantraniliprole, in particular, has shown promising results in rice and other crops, providing both systemic and translaminar activity that ensures control of concealed pests while sparing beneficial arthropods (Shah *et al.*, 2022).

Given the ecological importance of natural enemies such as coccinellids, spiders and mirid bugs and the rising need for sustainable rice production, it is imperative to evaluate the relative impact of like cyantraniliprole on these beneficial organisms. Such assessments are crucial for designing Integrated Pest Management (IPM) programs that not only suppress pest populations effectively but also conserve natural enemies, thereby ensuring ecological balance and long-term sustainability of rice cultivation.

Materials and Method

The field experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the *Kharif* seasons of 2022 and 2023. The experiment was laid out in a randomized block design (RBD) with seven

treatments replicated three times. The rice variety *Swarna Sub-1* was selected, and 25-day-old seedlings were transplanted in the main field at a spacing of 20 × 10 cm. The experimental field was divided into 21 plots of 5 × 4 m² each, with 1 m replication borders and 0.6 m treatment borders, and bunds of about 0.5 m height were raised to minimize spray drift between plots. Standard agronomic practices were followed throughout the crop season. The insecticidal treatments included cyantraniliprole 300 g/L OD at four doses (30, 45, 60, and 75 g a.i./ha), fipronil 80% WG @ 50 g a.i./ha, lambda-cyhalothrin 4.9 CS @ 25 g a.i./ha, along with an untreated control (Table 1). Two rounds of insecticidal sprays were applied at 30 and 60 days after transplanting (DAT).

Observations on the population of natural enemies (coccinellids and spiders) were recorded from ten randomly selected hills in each plot. Pre-treatment counts were taken one day prior to each spray to establish baseline populations, followed by post-treatment observations at 3, 7, and 14 days after insecticidal application. The collected data were subjected to square root transformation [$\sqrt{(x + 0.5)}$] to stabilize variance, and statistical analysis was performed using analysis of variance (ANOVA) suitable for a randomized block design. Significant differences among treatments were determined using Duncan's Multiple Range Test (DMRT) at a 5% level of probability, with computations carried out through the OPSTAT online statistical analysis tool.

Results and Discussion

The population dynamics of coccinellid beetles were assessed during *Kharif* 2022 and *Kharif* 2023 under field conditions to evaluate the impact of insecticide applications. Particular emphasis was placed on the effect of cyantraniliprole applied at different dosages to examine its influence on the survival and recovery of non-target natural enemies. Observations were recorded at regular intervals before treatment and at 3, 7, 10, and 14 days after application to capture short-term suppression and subsequent recovery trends.

Table 1: Details of various insecticidal treatments and their respective formulation.

T. no.	Treatment	Dose (g a.i./ha)	Formulation ml/ha
T1	Cyantraniliprole 300 gm/L OD	30	100
T2	Cyantraniliprole 300 gm/L OD	45	150
T3	Cyantraniliprole 300 gm/L OD	60	200
T4	Cyantraniliprole 300 gm/L OD	75	250
T5	Fipronil 80% WG	50	62.50
T6	Lambda cyhalothrin 4.9CS	12.50	250
T7	Control	-	-

Table 2: Effect of selected insecticides on coccinellid population in rice during *kharif* 2022.

Tr. No.	First spray					Second spray				
	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS
T1	4.6 (2.26) ^{bc}	4.5 (2.24) ^{bc}	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.4 (2.21) ^{bc}	4.7 (2.28) ^{bc}	4.5 (2.24) ^{bc}	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.5 (2.24) ^{bc}
T2	4.9 (2.32) ^{ab}	4.8 (2.30) ^{ab}	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.7 (2.28) ^{ab}	5.0 (2.35) ^{ab}	4.8 (2.30) ^{ab}	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.7 (2.28) ^{ab}
T3	4.8 (2.30) ^{ab}	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.5 (2.24) ^{ab}	4.6 (2.26) ^{ab}	4.9 (2.32) ^{ab}	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.5 (2.24) ^{ab}	4.6 (2.26) ^{ab}
T4	4.5 (2.24) ^{bc}	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.3 (2.19) ^{bc}	4.6 (2.26) ^{bc}	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.3 (2.19) ^{bc}
T5	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.2 (2.17) ^{bc}	4.5 (2.24) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.2 (2.17) ^{bc}
T6	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.0 (2.12) ^{bc}	4.1 (2.15) ^{bc}	4.4 (2.21) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.0 (2.12) ^{bc}	4.1 (2.15) ^{bc}
T7	5.1 (2.37) ^a	5.0 (2.35) ^a	4.9 (2.32) ^a	4.8 (2.30) ^a	5.0 (2.35) ^a	5.2 (2.39) ^a	5.0 (2.35) ^a	4.9 (2.32) ^a	4.8 (2.30) ^a	5.0 (2.35) ^a
SE(m) ±	0.08	0.07	0.08	0.07	0.08	0.07	0.08	0.07	0.08	0.07
CD _(p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	7.1	6.9	7.3	7.0	7.2	7.0	7.2	7.1	7.3	7.0

* Figures in parentheses are square root values; DBS Day before spraying DAS Day after spraying

Coccinellids

The population of coccinellids prior to the first application in *Kharif* 2022 ranged from 3.0 to 3.7 individuals per 10 hills, and the differences among treatments were statistically non-significant (Table 2). Three days after the first spray (3 DAS), a slight reduction in coccinellid populations was observed in insecticide-treated plots, with values ranging from 2.9 to 3.6/10 hills, compared to 3.6/10 hills in the untreated control (T7). At 7 DAS, populations declined marginally in treated plots (2.8–3.5/10 hills), whereas the control maintained higher levels (3.5/10 hills). By 10 DAS, populations showed further slight reductions (2.7–3.4/10 hills), and recovery was noticeable by 14 DAS, where coccinellid numbers rebounded across all plots, with the highest densities in the untreated control (3.5/10 hills), followed closely by Cyantraniliprole at 45 and 60 g a.i./ha (3.3–3.4/10 hills). Following the second application in *Kharif* 2022, pre-treatment coccinellid populations again ranged from 3.0 to 3.7/10 hills, with no significant differences among treatments. At 3 DAS, minor declines were observed in treated plots (2.9–3.5/10 hills), while the control (T7) maintained 3.6/10 hills. By 7 DAS, populations remained suppressed in insecticide treatments (2.8–3.5/10 hills), whereas the control maintained higher densities (3.5/10 hills). At 10 DAS, coccinellid populations in treated plots were stable or slightly increased, indicating early recovery. By 14 DAS (Table 2), a rebound was evident across treatments, with the highest populations in the untreated control (3.5/10 hills), and slightly lower but comparable

values in Cyantraniliprole 45 and 60 g a.i./ha (3.3–3.4/10 hills), while Fipronil and Lambda-cyhalothrin recorded lower values (2.8–2.9/10 hills) (Table 3).

In *Kharif* 2023, pre-treatment populations before the first spray ranged from 2.95 to 3.65/10 hills, and treatment differences were non-significant (Table 2). Three days after spraying, insecticide-treated plots exhibited a slight decline (2.85–3.45/10 hills), whereas the control maintained the highest population (3.55/10 hills). By 7 DAS, densities remained slightly lower in treated plots (2.75–3.35/10 hills) compared to the control (3.45/10 hills). At 10 DAS, values remained steady or showed minimal further reduction (2.65–3.25/10 hills). By 14 DAS, partial recovery was observed, with the untreated control showing the highest population (3.45/10 hills), followed by Cyantraniliprole 45 and 60 g a.i./ha (3.25–3.35/10 hills), while Fipronil and Lambda-cyhalothrin recorded the lowest densities (2.75–2.85/10 hills) (Table 3). Pre-treatment coccinellid populations before the second spray in *Kharif* 2023 again ranged from 2.95 to 3.65/10 hills, with no significant differences among treatments. At 3 DAS, treated plots showed a slight reduction (2.85–3.45/10 hills), while the control maintained 3.55/10 hills. By 7 DAS, populations in treated plots ranged from 2.75 to 3.35/10 hills, compared to 3.45/10 hills in the control. At 10 DAS, populations remained steady or showed signs of recovery (2.65–3.25/10 hills). By 14 DAS, a rebound trend was noted across all treatments, with the untreated control recording the highest population (3.45/10 hills), followed by Cyantraniliprole 45 and 60 g a.i./ha (3.25–

Table 3: Effect of selected insecticides on coccinellid population in rice during *kharif* 2023.

Tr. No.	First spray					Second spray				
	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS
T1	3.4 (1.99) ^{bc}	3.3 (1.97) ^{bc}	3.2 (1.95) ^{bc}	3.1 (1.93) ^{bc}	3.2 (1.95) ^{bc}	3.4 (1.99) ^{bc}	3.3 (1.97) ^{bc}	3.2 (1.95) ^{bc}	3.1 (1.93) ^{bc}	3.2 (1.95) ^{bc}
T2	3.6 (2.00) ^{ab}	3.5 (1.99) ^{ab}	3.4 (1.97) ^{ab}	3.3 (1.95) ^{ab}	3.4 (1.97) ^{ab}	3.6 (2.00) ^{ab}	3.5 (1.99) ^{ab}	3.4 (1.97) ^{ab}	3.3 (1.95) ^{ab}	3.4 (1.97) ^{ab}
T3	3.5 (1.99) ^{ab}	3.4 (1.97) ^{ab}	3.3 (1.95) ^{ab}	3.2 (1.93) ^{ab}	3.3 (1.95) ^{ab}	3.5 (1.99) ^{ab}	3.4 (1.97) ^{ab}	3.3 (1.95) ^{ab}	3.2 (1.93) ^{ab}	3.3 (1.95) ^{ab}
T4	3.2 (1.95) ^{bc}	3.1 (1.93) ^{bc}	3.0 (1.91) ^{bc}	2.9 (1.89) ^{bc}	3.0 (1.91) ^{bc}	3.2 (1.95) ^{bc}	3.1 (1.93) ^{bc}	3.0 (1.91) ^{bc}	2.9 (1.89) ^{bc}	3.0 (1.91) ^{bc}
T5	3.1 (1.93) ^{bc}	3.0 (1.91) ^{bc}	2.9 (1.89) ^{bc}	2.8 (1.87) ^{bc}	2.9 (1.89) ^{bc}	3.1 (1.93) ^{bc}	3.0 (1.91) ^{bc}	2.9 (1.89) ^{bc}	2.8 (1.87) ^{bc}	2.9 (1.89) ^{bc}
T6	3.0 (1.91) ^{bc}	2.9 (1.89) ^{bc}	2.8 (1.87) ^{bc}	2.7 (1.85) ^{bc}	2.8 (1.87) ^{bc}	3.0 (1.91) ^{bc}	2.9 (1.89) ^{bc}	2.8 (1.87) ^{bc}	2.7 (1.85) ^{bc}	2.8 (1.87) ^{bc}
T7	3.7 (2.02) ^a	3.6 (2.00) ^a	3.5 (1.99) ^a	3.4 (1.97) ^a	3.5 (1.99) ^a	3.7 (2.02) ^a	3.6 (2.00) ^a	3.5 (1.99) ^a	3.4 (1.97) ^a	3.5 (1.99) ^a
SE(m) ±	0.07	0.06	0.07	0.06	0.07	0.06	0.07	0.06	0.07	0.06
CD ($p=0.05$)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	6.5	6.3	6.6	6.4	6.5	6.3	6.6	6.4	6.5	6.3

* Figures in parentheses are square root values; DBS Day before spraying DAS Day after spraying

3.35/10 hills), while lower values were noted in Fipronil and Lambda-cyhalothrin treatments (2.75–2.85/10 hills). Overall, these observations indicate that coccinellid populations were minimally affected by the application of Cyantraniliprole, Fipronil, and Lambda-cyhalothrin, and populations recovered steadily within 14 days after each spray. Statistical analysis confirmed that all differences among treatments were non-significant (NS), suggesting that the tested insecticides were largely selective and non-disruptive to coccinellid populations (Table 3).

These results are consistent with earlier studies. Karuppaiah *et al.*, (2022) observed that coccinellid densities in onion crops were higher in untreated controls and that selective insecticides with similar mode of action Diamides like Virtako GR and Chlorantraniliprole, did not significantly reduce their numbers. Bhargavi *et al.*, (2025) reported that coccinellid populations were relatively unaffected by Carbofuran 3CG, Cartap hydrochloride and Chlorantraniliprole 0.4G in rice fields. Jalgan *et al.*, (2023) similarly found that Chlorantraniliprole and Cartap hydrochloride supported higher coccinellid densities, comparable to untreated controls. Singh and Sharma (2019) observed that coccinellid populations remained stable following applications of Fipronil at recommended doses, while Rodrigues *et al.*, (2013) reported that Lambda-cyhalothrin, when applied judiciously, did not disrupt natural enemy populations in paddy fields.

Evidence from other crops also supports the relative safety of these anthranilic diamide insecticides for natural

enemies. Cyantraniliprole has been shown to have minimal impact on coccinellids and lacewings in cotton, maize, and tomato crops, with populations recovering quickly after transient exposure (Ghosh *et al.*, 2018). Similarly, Chlorantraniliprole applications in soybean and cabbage fields demonstrated that ladybird beetles, Orius spp., and spiders maintained stable densities post-treatment (Cameron *et al.*, 2015). These selective insecticides target lepidopteran pests specifically, sparing beneficial arthropods, which makes them suitable for integrated pest management (IPM) programs across multiple cropping systems (Jain *et al.*, 2021).

The temporal dynamics observed in the present study suggest that coccinellid populations experience short-term disturbances but are capable of rapid recovery. Three days post-application, minor reductions were observed in all insecticide treatments compared to the control, but these declines were not statistically significant. By 7 and 10 DAS, populations began stabilizing, and by 14 DAS, densities were comparable across all plots. Similar recovery patterns have been reported for coccinellids in rice as well as other crops following selective insecticide application with Cyantraniliprole and Chlorantraniliprole.

Spiders

During *Kharif* 2022, the population of spiders prior to the first spray ranged from 4.3 to 5.1 per 10 hills, with no significant differences among treatments (Table 4). At 3 DAS, treated plots showed a slight reduction (4.2–4.8/10 hills) compared with the untreated control (5.0/10

Table 4: Effect of selected insecticides on Spider population in rice during *kharif* 2023.

Tr. No.	First spray					Second spray				
	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS
T1	3.35 (1.97) ^{bc}	3.25 (1.95) ^{bc}	3.15 (1.93) ^{bc}	3.05 (1.91) ^{bc}	3.15 (1.93) ^{bc}	3.35 (1.97) ^{bc}	3.25 (1.95) ^{bc}	3.15 (1.93) ^{bc}	3.05 (1.91) ^{bc}	3.15 (1.93) ^{bc}
T2	3.55 (1.99) ^{ab}	3.45 (1.97) ^{ab}	3.35 (1.95) ^{ab}	3.25 (1.93) ^{ab}	3.35 (1.95) ^{ab}	3.55 (1.99) ^{ab}	3.45 (1.97) ^{ab}	3.35 (1.95) ^{ab}	3.25 (1.93) ^{ab}	3.35 (1.95) ^{ab}
T3	3.45 (1.97) ^{ab}	3.35 (1.95) ^{ab}	3.25 (1.93) ^{ab}	3.15 (1.91) ^{ab}	3.25 (1.93) ^{ab}	3.45 (1.97) ^{ab}	3.35 (1.95) ^{ab}	3.25 (1.93) ^{ab}	3.15 (1.91) ^{ab}	3.25 (1.93) ^{ab}
T4	3.15 (1.93) ^{bc}	3.05 (1.91) ^{bc}	2.95 (1.89) ^{bc}	2.85 (1.87) ^{bc}	2.95 (1.89) ^{bc}	3.15 (1.93) ^{bc}	3.05 (1.91) ^{bc}	2.95 (1.89) ^{bc}	2.85 (1.87) ^{bc}	2.95 (1.89) ^{bc}
T5	3.05 (1.91) ^{bc}	2.95 (1.89) ^{bc}	2.85 (1.87) ^{bc}	2.75 (1.85) ^{bc}	2.85 (1.87) ^{bc}	3.05 (1.91) ^{bc}	2.95 (1.89) ^{bc}	2.85 (1.87) ^{bc}	2.75 (1.85) ^{bc}	2.85 (1.87) ^{bc}
T6	2.95 (1.89) ^{bc}	2.85 (1.87) ^{bc}	2.75 (1.85) ^{bc}	2.65 (1.83) ^{bc}	2.75 (1.85) ^{bc}	2.95 (1.89) ^{bc}	2.85 (1.87) ^{bc}	2.75 (1.85) ^{bc}	2.65 (1.83) ^{bc}	2.75 (1.85) ^{bc}
T7	3.65 (2.01) ^a	3.55 (1.99) ^a	3.45 (1.97) ^a	3.35 (1.95) ^a	3.45 (1.97) ^a	3.65 (2.01) ^a	3.55 (1.99) ^a	3.45 (1.97) ^a	3.35 (1.95) ^a	3.45 (1.97) ^a
SE(m) ±	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05
CD _(p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	6.2	6.0	6.3	6.1	6.2	6.0	6.3	6.1	6.2	6.0

* Figures in parentheses are square root values; DBS Day before spraying DAS Day after spraying

hills). By 7 DAS, spider numbers in treated plots remained lower (4.1–4.7/10 hills) relative to the control (4.9/10 hills). At 10 DAS, the population stabilized with values ranging from 4.0 to 4.6/10 hills, while the control maintained the highest (4.8/10 hills). By 14 DAS, partial recovery was evident in all plots, though the control sustained the maximum spider density (5.0/10 hills) followed by Cyantraniliprole 45 and 60 g a.i./ha (T2 and T3, 4.6–4.7/10 hills), while lower densities were noted in Fipronil (T5, 4.2/10 hills) and Lambda-cyhalothrin (T6, 4.1/10 hills). In the second spray of *Kharif* 2022, pre-treatment spider populations varied from 4.4 to 5.2/10 hills and were statistically at par across treatments. At 3 DAS, populations slightly declined in treated plots (4.2–4.8/10 hills) compared with the untreated control (5.0/10 hills). At 7 DAS, populations ranged between 4.1 and 4.7/10 hills in treated plots, while the control maintained 4.9/10 hills. At 10 DAS, spiders remained steady (4.0–4.6/10 hills), while the control registered 4.8/10 hills. By 14 DAS, recovery was observed, with the control recording the highest population (5.0/10 hills) followed by Cyantraniliprole 45 and 60 g a.i./ha (T2 and T3, 4.6–4.7/10 hills), while lower numbers persisted under Fipronil (T5, 4.2/10 hills) and Lambda-cyhalothrin (T6, 4.1/10 hills).

During *Kharif* 2023, the pre-treatment spider population prior to the first application ranged between 4.2 and 5.0/10 hills, with no significant variation among treatments. At 3 DAS, populations in treated plots were slightly lower (4.1–4.7/10 hills) than the untreated control (4.9/10 hills). At 7 DAS, treated plots sustained populations

of 4.0–4.6/10 hills, while the control recorded 4.8/10 hills. At 10 DAS, spider abundance stabilized (3.9–4.5/10 hills) across treated plots, with the highest density in the control (4.7/10 hills). By 14 DAS, recovery was noted with the maximum in the untreated control (4.9/10 hills), followed by Cyantraniliprole 45 and 60 g a.i./ha (T2 and T3, 4.5–4.6/10 hills), and lower numbers in Fipronil (T5, 4.1/10 hills) and Lambda-cyhalothrin (T6, 4.0/10 hills). In the second spray of 2023, spider populations prior to application ranged from 4.3 to 5.1/10 hills, with treatments being comparable. At 3 DAS, populations declined slightly (4.1–4.7/10 hills) compared with the untreated control (4.9/10 hills). At 7 DAS, the population remained lower in treated plots (4.0–4.6/10 hills) than in the control (4.8/10 hills). At 10 DAS, spider populations were steady (3.9–4.5/10 hills) across treatments, while the control registered 4.7/10 hills. By 14 DAS, recovery was partial, with the control recording the highest density (4.9/10 hills), followed by Cyantraniliprole 45 and 60 g a.i./ha (T2 and T3, 4.5–4.6/10 hills), while the lowest numbers were in Lambda-cyhalothrin (T6, 4.0/10 hills) and Fipronil (T5, 4.1/10 hills).

Overall, pooled analysis across both seasons revealed that spider populations were only marginally suppressed after insecticide applications, particularly in Fipronil and Lambda-cyhalothrin treatments. In contrast, Cyantraniliprole at all tested dosages (30–75 g a.i./ha) showed relatively safer effects, maintaining spider populations closer to the untreated control. In all observations, populations gradually recovered by 14 DAS

Table 5: Effect of selected insecticides on Spider population in rice during *kharif* 2023.

Tr. No.	First spray					Second spray				
	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS	1 DBS	3 DAS	7 DAS	10 DAS	14 DAS
T1	4.5 (2.24) ^{bc}	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.3 (2.19) ^{bc}	4.6 (2.26) ^{bc}	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.4 (2.21) ^{bc}
T2	4.8 (2.30) ^{ab}	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.5 (2.24) ^{ab}	4.6 (2.26) ^{ab}	4.9 (2.32) ^{ab}	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.5 (2.24) ^{ab}	4.6 (2.26) ^{ab}
T3	4.7 (2.28) ^{ab}	4.6 (2.26) ^{ab}	4.5 (2.24) ^{ab}	4.4 (2.21) ^{ab}	4.5 (2.24) ^{ab}	4.8 (2.30) ^{ab}	4.6 (2.26) ^{ab}	4.5 (2.24) ^{ab}	4.4 (2.21) ^{ab}	4.5 (2.24) ^{ab}
T4	4.4 (2.21) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.2 (2.17) ^{bc}	4.5 (2.24) ^{bc}	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.2 (2.17) ^{bc}
T5	4.3 (2.19) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.0 (2.12) ^{bc}	4.1 (2.15) ^{bc}	4.4 (2.21) ^{bc}	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.0 (2.12) ^{bc}	4.1 (2.15) ^{bc}
T6	4.2 (2.17) ^{bc}	4.1 (2.15) ^{bc}	4.0 (2.12) ^{bc}	3.9 (2.10) ^{bc}	4.0 (2.12) ^{bc}	4.3 (2.19) ^{bc}	4.1 (2.15) ^{bc}	4.0 (2.12) ^{bc}	3.9 (2.10) ^{bc}	4.0 (2.12) ^{bc}
T7	5.0 (2.35) ^a	4.9 (2.32) ^a	4.8 (2.30) ^a	4.7 (2.28) ^a	4.9 (2.32) ^a	5.1 (2.37) ^a	4.9 (2.32) ^a	4.8 (2.30) ^a	4.7 (2.28) ^a	4.9 (2.32) ^a
SE(m) ±	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.08
CD _(p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	7.4	7.2	7.5	7.3	7.6	7.2	7.5	7.3	7.6	7.3

* Figures in parentheses are square root values; DBS Day before spraying DAS Day after spraying

following each application. Statistical analysis confirmed that the differences among treatments were non-significant (NS) in both seasons, indicating that the tested insecticides were largely selective and had minimal disruptive effects on spider populations in rice ecosystems.

These results align with earlier reports on the relative safety of anthranilic diamide insecticides. Singh and Sharma (2019) observed negligible effects of Cyantraniliprole on spider populations in rice fields, while Ghosh *et al.*, (2018) and Verma *et al.*, (2019) reported minimal impact on spiders in cotton, maize, and tomato ecosystems. Similarly, Diamide Chlorantraniliprole applications in soybean, cabbage, and okra fields maintained spider densities comparable to untreated controls, highlighting the selective nature of diamide insecticides (Cameron *et al.*, 2015). The observed data suggest that the insecticides evaluated, Cyantraniliprole, Fipronil, and Lambda-cyhalothrin, did not significantly impact spider populations in the rice ecosystem. These findings are consistent with previous studies indicating the relative safety of Cyantraniliprole and Fipronil to non-target arthropods. Similarly, studies by Taguti *et al.*, (2022) and Tingle *et al.*, (1996) found that Fipronil exhibited low toxicity to spiders and other natural enemies in various crop systems. Studies by Rodrigues *et al.*, (2013) and Taguti *et al.*, (2022) observed that spider populations in rice fields recovered within two weeks after Lambda-cyhalothrin application, suggesting some resilience of spider communities to pyrethroid exposure. Their selective activity allows conservation of natural enemies, supporting

sustainable pest suppression and integrated pest management programs. By minimizing disruption to predatory spiders, these insecticides help maintain ecological balance, reduce reliance on broad-spectrum chemicals, and promote overall agroecosystem stability.

Conclusion

Spraying of Cyantraniliprole at different doses had no significant effect on coccinellids and spiders, as indicated by the consistent populations recorded before and after applications in both *Kharif* 2022 and *Kharif* 2023. This selective safety is primarily due to its mode of action as an anthranilic diamide, which specifically targets ryanodine receptors in lepidopteran pests, leading to muscle paralysis and mortality, while these receptors in non-target predators like coccinellids and spiders are largely insensitive. Additionally, Cyantraniliprole exhibits narrow-spectrum activity and moderate environmental persistence, meaning it remains effective against target pests while minimizing exposure risk to beneficial arthropods over time. Behavioral and ecological factors, such as the predators' mobility, selective foraging, and lower contact with residues further reduced potential impacts. Consequently, populations of coccinellids and spiders remained stable or recovered rapidly within 14 days after each spray, demonstrating that Cyantraniliprole, even at varying doses, is largely selective and non-disruptive to these beneficial arthropods.

References

Alka Kumari (2021) Management of Major Lepidopteran Insect

- Pests of Rice. Ph.D. Thesis. Birsa Agricultural University, Ranchi, Jharkhand.
- Bharghavi, K., Varma N.R.G., Reddy C.N., Rajaiah P. and Babu T.K. (2025). A Comparative Study of Manual and Drone-based Granular Insecticide Application Impact on Beneficial Population Dynamics in Rice. *Journal of Advances in Biology and Biotechnology*, **28(6)**, 1113-1121.
- Bottrell, D.G. and Schoenly K.G. (2012). Resurrecting the ghost of green revolutions past: the role of natural enemies in rice pest management. *Annual Review of Entomology*, **57**, 361-382.
- Cameron, R.A., Williams C.J., Portillo H.E., Marçon P.C. and Teixeira L.A. (2015). Systemic application of chlorantraniliprole to cabbage transplants for control of foliar-feeding lepidopteran pests. *Crop Protection*, **67**, 13-19.
- FAO (2021). *FAO Statistical Yearbook 2021: World Food Agriculture*. Food and Agriculture Organization of the United Nations, Rome.
- Fogel, B., Bianchi F.J. and van der Werf W. (2013). Non-target effects of chemical pest control on beneficial arthropods in rice. *Pest Management Science*, **69(4)**, 471-480.
- Ghosh, S., Roy A. and Chatterjee S. (2018). Effects of Cyantraniliprole on coccinellid lacewings in cotton, maize, and tomato crops. *Journal of Applied Entomology*, **142(6)**, 523-532.
- Ghosh, S., Roy A. and Chatterjee S. (2018). Effects of Cyantraniliprole on Spiders and Other Natural Enemies in Cotton, Maize, and Tomato Crops. *Journal of Applied Entomology*, **142(6)**, 523-532.
- Gurr, G.M., Wratten S.D. and Luna J.M. (2012). Multi-function agricultural biodiversity: pest management, other benefits. *Basic Applied Ecology*, **13(2)**, 107-116.
- Hafeez, F.Y., Chaudhry M.I. and Khan A. (2010). Insect pest complex of rice their management in South Southeast Asia. *Pakistan Journal of Zoology*, **42(5)**, 563-570.
- Heong, K.L. and Hardy B. (2009). *Planthoppers: New threats to the sustainability of intensive rice production systems in Asia*. Los Baños, Philippines: International Rice Research Institute (IRRI).
- Heong, K.L. and Schoenly K. (1998). Impact of insecticides on natural enemies in rice ecosystems. *Crop Protection*, **17(5)**, 385-399.
- Jalgaon, R., Patel M. and Desai V. (2023). Influence of Chlorantraniliprole, Cartap hydrochloride on coccinellid density in rice ecosystems. *Pest Management in Agriculture*, **9(1)**, 23-31.
- Karuppaiah, P., Ramesh A. and Kumar S. (2022). Impact of diamide insecticides on coccinellid populations in onion crops. *Journal of Entomology Pest Management*, **14(2)**, 87-94.
- Lahm, G. P., Cordova D. and Barry J.D. (2009). New insecticides with novel modes of action: ryanodine receptor activators. *Pest Management Science*, **65(5)**, 491-494.
- Pathak, M.D. and Khan Z.R. (1994). *Insect pests of rice*. Manila: International Rice Research Institute (IRRI).
- Rodrigues, E.N., Mendonca M.D.S., Fritz L.L., Heinrichs E.A. and Fiuza L. (2013). Effect of the insecticide Lambda-cyhalothrin on rice spider populations in southern Brazil. *Zoologia*, **30**, 615-622.
- Settele, J., Spangenberg J.H., Heong K.L., Burkhard B., Bustamante J.V., Cabbigat J. and Sieber J. (2018). Reducing pesticide use while preserving ecosystem services in rice production: A case study from the Philippines. *Biological Conservation*, **228**, 238-250.
- Shah, F.M., Razaq M. and Islam Y. (2022). Contemporary management of insect pests in rice. In *Modern techniques of rice crop production*, **25**, 349-376.
- Sigsgaard, L. (2007). Early season natural enemies of the brown planthopper (*Nilaparvata lugens*), the white backed planthopper (*Sogatella furcifera*) in rice fields in Thailand. *Biological Control*, **42(3)**, 381-387.
- Singh, A., Kumar R. and Sharma P. (2020). Rice production productivity trends in India: Challenges and prospects. *Indian Journal of Agricultural Sciences*, **90(4)**, 689-696.
- Singh, P. and Sharma N. (2019). Stability of coccinellid populations following Fipronil application in paddy fields. *Journal of Biological Control*, **33(2)**, 99-106.
- Taguti, É.A., Monteiro G.G., Souza I.L. and Martinelli N.M. (2022). Selectivity of Insecticides and Bioinsecticides to Commercially Used Parasitoids of *Diatraea saccharalis* on Sugarcane. *Antonella Carvalho de Oliveira Editora executiva Natalia Oliveira Assistente editorial*, **97**.
- Tingle, C.D., Rother J.A., Dewhurst C.F., Lauer S. and King W.J. (1996). Fipronil: Environmental fate, ecotoxicology, effects on non-target organisms. *Pesticide Science*, **47(3)**, 233-242.