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Biosafety evaluation of different insecticides for natural fauna (Coccinellids) in rice ecosystem

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Abstract
The present investigation entitled "Biosafety evaluation of different insecticides for natural fauna (Coccinellids) in rice ecosystem" was carried out at Research cum Instructional Farm, Raipur, and Under College of Agriculture Raipur (C.G.) during Rabi 2024-25. The biosafety evaluation conducted during both the cropping seasons demonstrated that the evaluated insecticidal schedules did not exert any significant adverse effect on the populations of coccinellids, in the rice ecosystem. Although the untreated control plots recorded comparatively higher populations of these beneficial arthropods throughout the observation period, the differences among the insecticidal treatments were statistically non-significant. The sequential application of Pymetrozine 50 WG followed by Triflumezopyrim 10% SC (T_4) effectively suppressed the brown planthopper population while conserving the abundance of coccinellids. Similar observations were recorded with other insecticidal schedules, indicating that the insecticides evaluated in the present investigation were relatively safe to beneficial fauna when applied at the recommended doses. The compatibility of these insecticides with natural enemies suggests that they can be successfully integrated into Integrated Pest Management (IPM) programmes for sustainable rice production without causing serious disruption to the ecological balance of rice ecosystems. These findings further indicate that judicious use of selective insecticides can effectively manage brown planthopper while simultaneously conserving naturally occurring biological control agents.

Keywords: Triflumezopyrim 10 SC, Pymetrozine 50 WG, Dinotefuran 20% SG, coccinelids, rice, biosafety, integrated pest management (IPM)

Introduction
Rice (*Oryza sativa* L.) (2n = 24) a cereal crop, belongs to the family Gramineae, which takes up nearly one-fifth of all cereal-covered land. One of the most popular staple meals in the world, especially in Asia, is rice. The *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice) plant is the source of this cereal grain. Known for its adaptability, rice is available in white, brown, black, and red variants, each with varying nutritional content. The largest area under paddy farming is in India, followed by China and Indonesia. The four central states of West Bengal, Punjab, Uttar Pradesh, and Andhra Pradesh account for about half of India's rice production. The other states that produce a lot of rice are Bihar, Tamil Nadu, Orissa, In sequence of significance, Telangana, Assam, Chhattisgarh, Haryana, Madhya Pradesh, Karnataka, Jharkhand and Maharashtra (Anon 2022). known as the "Rice Bowl of India," Chhattisgarh has an area of about 3.91 million hectares, produces 10.37 million tons, and has a productivity of 2655 kg per hectare (Government of India – Department of Agriculture & Farmers Welfare, DA&FW 2024) [5]. Limited irrigation (28.0%), a lack of better varieties in various ecosystems and in suitable nutrients, a number of insect pest limitations and crop management techniques are the main causes of Chhattisgarh's low rice productivity. In Chhattisgarh, the brown planthopper can cause significant losses to the paddy crop up to 34.4% (Gangrade *et al.* 1978) [2]. Natural enemies of paddy or rice insect pests have a wide extent of parasitoids and predators. Predation is a common phenomenon between insects. The predators make biological control cases successful. Insects such as coccinellid beetles, carabid beetles, terrestrial predatory and aquatic bugs, insectivorous birds, spiders, dragon flies are different varieties of predators (Heinrichs, 1994) [6].

Predators and parasitoids are significant biocontrol agents. Most important predators of rice insect pest are coccinellids and spiders. Coccinelids and spiders constitute 80% of the predatory fauna in the ecosystem of rice. In rice field, host insect population reduction has been reported by various species of Coccinelids and spiders.

Research has manifested that rice ecosystems are magnificent in natural enemies and yield loss is reduced by them. (Singh, 1990)[8]. The pest's population in rice is suppressed by natural enemies are proved by ample of evidence to justify its important role in India

In order to reduce the usage of synthetic pesticides, it is increasingly essential to look for alternate methods of controlling pests. Because they have a variety of qualities, such as toxicity to the pest, repellency, antifeedants and insect growth regulation actions against pests of agricultural importance botanical pesticides are significant options to reduce or eliminate the usage of synthetic pesticides.

Compared to synthetic pesticides, botanical pesticides have many advantages, such as: they generally have low mammalian toxicity, which means they pose little to no health risks and environmental pollution; there is virtually no risk of developing pest resistance to these products; when used in their natural forms, they pose fewer risks to non-target organisms and pest resistance has not been reported, with the exception of synthetic pyrethroids; they have no negative effects on plant growth, seed viability and grain cooking quality and they are more readily available and less expensive due to their natural occurrence.

Material and Method

Natural enemies: The numbers of Coccinellids on 10 randomly selected hills were recorded at each observation date and presented as average number hill. Data recorded on pest and natural enemies population and grain yields from the experiment was transformed and analyzed to draw a meaningful conclusion as suggested by Gomez and Gomez (1984)[4].

To determine biosafety evaluation of essential oils and chemical insecticides on the population of coccinellids in rice field the field experiment was conducted during Kharif 2024-25 in a randomized block design with eight treatments and four replications. The seedling of variety Swarna was transplanted in a plot size of 20 m2 with a spacing of 20x15 cm and normal agronomical practices was adopted. The knapsack sprayer and spray volume @ 500 l/ha was used with a hollow cone nozzle to impose the spray treatments. Teepol at the rate of 1ml/liter of water was added in the solution of essential oils to make the oil mixed with water.

Treatment details:

Different insecticidal schedules were evaluated for their biosafety evaluation of different insecticides for natural fauna in rice ecosystem variety Shwarna. Insecticides were applied two times the first application was done at maximum tillering stage and the second application was done at maximum booting stage. Data was collected before the application and on the 1st, 3rd, 7th ,14th and 21th days after each application.

Treatment	Chemicals name	Application Stage	Dose
T1	Triflumezopyrim 10% + Pymetrozine 50 WG	At Max. Tillering + At Max. booting n	236ml/ha + 300ml/ha
T2	Pymetrozine 50 WG + Dinotefuran 20% SG	At Max. Tillering + At Max. booting	300ml/ha + 200g/ha
T3	Triflumezopyrim 10% + Essential oil	At Max. Tillering + At Max. booting	236ml/ha + 2ml per liter
T4	Pymetrozine 50 WG + Triflumezopyrim 10.6% SC	At Max. Tillering + At Max. booting	300ml/ha + 236ml/ha
T5	Dinotefuran 20% SG + Pymetrozine 50 WG	At Max. Tillering + At Max. booting	200g/ha + 300ml/ha
T6	Essential oil 2ml/liter + Triflumezopyrim 10.6% SC	At Max. Tillering + At Max. booting	2ml per liter + 236ml/ha
T7	Water spray	At Max. Tillering + At Max. booting	500liter/ha
T8	Untreated Control		-

Result and Disscusion

The field experiment was conducted at ―Research Cum Instructional farm and the laboratory studies were carried out in glass house of Department of Entomology, College of Agriculture, IGKV, Raipur during Kharif, 2024 [5]-25.

First insecticidal treatment application during kharif 2024-25.

Pre treatment observation

The data presented in Table that evaluation of different insecticides for natural fauna in rice ecosystem. revealed that the pre- treatments observations were non-significant to each other which ranged from 6.67 to 4.56 per ten hills in the field experiment during kharif 2024-25. Non-significant differences among coccinelids population were observed among different treatments before spray.

Post treatment observation

After 1 days of first spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 5.87-3.00 where highest coccinelids population observed in T8-(untreated control) 5.87 coccinelids per ten hills and lowest population observed in T6 – (Essential oil + Triflumezopyrim 10% SC) 3.00 coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy Coccinelids.

After 3 days of first spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 5.12-3.00 where highest coccinelids population observed in T8- (untreated control) 5.12 coccinelids per ten hills and lowest population observed in T1 – (Triflumezopyrim 10% SC+ Pymetrozine 50 WG) 3.00 Coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy coccinelids.

After 7 days of first spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 6.68-4.00 where highest coccinelids population observed in T8- (untreated control) 6.68 coccinelids per ten hills) and lowest population observed in T6 – (Essential oil + Triflumezopyrim 10% SC) 4.00 coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy coccinelids.

After 14 days of first spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 7.33-4.33 where highest coccinelids population observed in T8-(untreated control) 7.33 coccinelids per ten hills and lowest population observed in T6 – (Essential oil + Triflumezopyrim 10% SC) 4.33 coccinelids per ten hills) which revealed that tested insecticides were safe to natural enemy.

After 21 days of first spray, the coccinelids population were showed statistically non-significant difference among the treatments with range from 7.67-5.00 where highest coccinelids population observed in T8-(untreated control) 7.67 coccinelids per ten hills and lowest population observed in T2– (Pymetrozine 50 WG + Dinotefuran 20% SG) 5.00 coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy.

Second insecticidal treatment application during kharif 2024-25.

Pretreatment observation

The data presented in Table that evaluation of different insecticides for natural fauna in rice ecosystem. revealed that the pre- treatments observations were non-significant to each other which ranged from 10.00 to 7.00 per ten hills in the field experiment during kharif 2024-25. Non-significant differences among coccinelids population were observed among different treatments before spray.

Post treatment observation

After 1 days of second spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from7.24-5.00 where highest coccinelids population observed in T8-(untreated control) 7.24 coccinelids per ten hills) and lowest population observed in T6 – (Essential oil + Triflumezopyrim 10% SC) 5.00 coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy coccinelids.

After 3 days of second spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 7.86-5.00 where highest coccinelids population observed in T8- (untreated control) 7.86 coccinelids per ten hills and lowest population observed in T1 – (Triflumezopyrim 10% SC+ Pymetrozine 50 WG) 5.00 coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy Coccinelids.

After 7 days of second spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 9.67-5.12 where highest coccinelids population observed in T8-(untreated control) 9.67 coccinelids per ten hills and lowest population observed in T2– (Pymetrozine 50 WG + Dinotefuran 20% SG) 5.12 coccinelids per ten hills which revealed that tested insecticides were safe to natural enemy coccinelids.

After 14 days of second spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 10.33-5.33 where highest coccinelids population observed in T8-(untreated control) 10.33 and lowest population observed in T2– (Pymetrozine 50 WG + Dinotefuran 20% SG) 5.33 which revealed that tested insecticides were safe to natural enemy.

After 21 days of second spray, the coccinelids population were showed statistically non-significant difference among the treatments with ranged from 10.67-6.00 where highest coccinelids population observed in T8-(untreated control) 10.67 and lowest population observed in T2– (Pymetrozine 50 WG + Dinotefuran 20% SG) 6.00 which revealed that tested insecticides were safe to natural enemy.

4.2.1.12 Overall mean

The data revealed that after all two sprays, the overall mean of coccinelids population ranged from 7.86 to 4.84 per ten hills across different treatments. The significantly highest coccinelids population observed in T8- (untreated control) 7.86 coccinelids per ten hills) indicating it was the best treatment against coccinelids population, followed by T4- (Pymetrozine 50 WG + Triflumezopyrim 10% SC) 6.78, T7- (water spray) 6.39, T1 – (Triflumezopyrim 10% SC+ Pymetrozine 50 WG) 5.92, T5 – (Dinotefuran 20% SG + Pymetrozine 50 WG) 5.64, T3- (Triflumezopyrim 10% SC+ Essential oil) 5.47 and T6 – (Essential oil + Triflumezopyrim 10% SC) 5.23. The lowest coccinelids population was recorded in the T2– (Pymetrozine 50 WG + Dinotefuran 20% SG) 4.84. Which revealed that tested insecticides are safe to natural enemy.

The result of present investigation is in accordance with Shivaji (2021)[9] Reported that the given insecticidal treatments were safe to natural enemies and reported Pymetrozine 50 WG was least effective to coccinelids.

Comparable results were noted by Hurali (2019) [7] reported that Dinotefuran 20% SG led to a lower brown planthopper population (73.49% ROC) achieving best for natural enemies.

Similarly, Ghosh (2014) [3] also reported minimal damage in natural enemies and higher grain yield.

Effects of different insecticidal treatments on coccinelids population present in the rice ecosystem during Kharif 2024-2025

S.N	Treatments	Dose g a.i./ha	Coccinellids Population per/10 hills												
			First Spray						Second Spray						Overall Mean
			Pre Trat.	Post Treatment					Pre Trat.	Post Treatment					
				1 DAS	3 DAS	7 DAS	14 DAS	21 DAS		1 DAS	3 DAS	7 DAS	14 DAS	21 DAS	
T1	Triflumezopyrim 10% SC + Pymetrozine 50 WG	236ml + 300ml	**5.00 (2.45)**	3.67 (2.26)	3.00 (1.92)	5.00 (2.46)	6.33 (2.46)	7.00 (2.83)	**8.00 (3.00)**	6.00 (2.64)	5.00 (2.45)	6.00 (2.64)	7.33 (2.88)	8.67 (3.06)	**5.92**
T2	Pymetrozine 50 WG + Dinotefuran 20% SG	300ml + 200g	**6.67 (2.68)**	3.33 (2.00)	3.33 (2.00)	4.00 (1.89)	4.33 (2.23)	5.00 (2.36)	**7.00 (2.74)**	5.12 (2.37)	5.00 (2.36)	5.12 (2.37)	5.33 (2.42)	6.00 (2.55)	**4.84**
T3	Triflumezopyrim 10%SC + Essential oil	236ml + 2ml	**4.67 (2.29)**	3.33 (2.00)	3.67 (2.08)	4.33 (2.14)	5.00 (2.36)	6.00 (2.56)	**7.32 (2.80)**	5.00 (2.35)	5.33 (2.42)	6.00 (2.55)	7.00 (2.73)	8.00 (2.90)	**5.47**
T4	Pymetrozine 50 WG + Triflumezopyrim 10% SC	300ml + 236ml	**5.33 (2.42)**	5.00 (2.36)	4.33 (2.36)	5.67 (2.50)	7.00 (2.74)	7.67 (2.85)	**8.33 (2.96)**	6.67 (2.67)	5.33 (2.42)	6.67 (2.67)	9.00 (3.07)	10.33 (3.26)	**6.78**
T5	Dinotefuran 20%SG + Pymetrozine 50 WG	200g + 300ml	**5.30 (2.42)**	3.67 (2.08)	3.00 (1.92)	4.00 (2.62)	5.67 (2.49)	6.33 (2.62)	**8.00 (2.91)**	5.00 (2.35)	5.33 (2.42)	6.33 (2.61)	7.00 (2.73)	8.00 (2.90)	**5.64**
T6	Essential oil + Triflumezopyrim 10% SC	2 ml + 236ml	**5.00 (2.36)**	3.00 (1.92)	3.33 (2.00)	4.00 (2.14)	4.33 (2.23)	6.33 (2.62)	**7.30 (2.79)**	5.00 (2.35)	5.12 (2.38)	5.33 (2.42)	6.00 (2.55)	8.00 (2.90)	**5.23**
T7	Water spray	500 L.	**4.56 (2.27)**	4.00 (2.15)	3.33 (2.00)	5.67 (2.46)	6.00 (2.56)	6.67 (2.68)	**9.00 (3.07)**	6.33 (2.61)	5.00 (2.36)	6.67 (2.67)	8.00 (2.90)	9.33 (3.12)	**6.39**
T8	Untreated Control	-	**5.67 (2.58)**	5.87 (2.62)	5.12 (2.47)	6.84 (2.41)	7.33 (2.89)	7.67 (2.94)	**10.00 (3.32)**	7.24 (2.87)	7.86 (2.98)	9.67 (3.26)	10.33 (3.36)	10.67 (3.41)	**7.86**
	CD at 5%		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**-**

(Figure in parentheses are square root transformed values), NS=Non-Significant, DAS=Days after spray, CD=Critical differences.

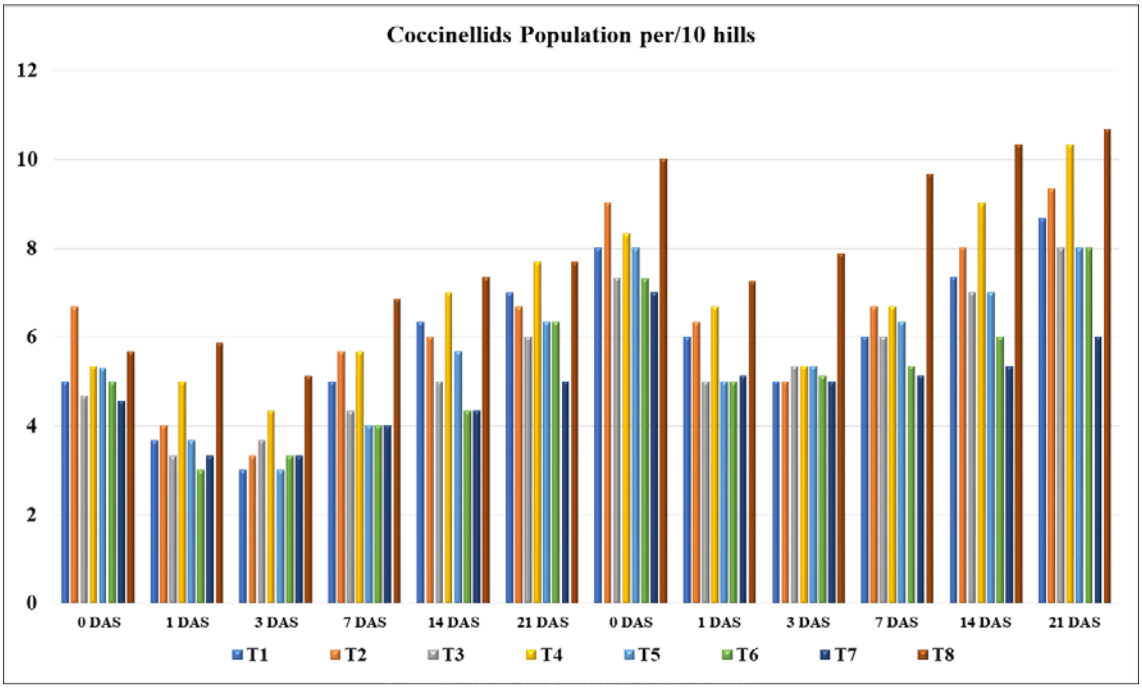

Fig: Coccinelids population in different insecticidal treatment during Kharif 2024-25.

Conclusion

The biosafety evaluation conducted during 2024-25 cropping seasons demonstrated that the evaluated insecticidal schedules did not exert any significant adverse effect on the populations of coccinelids in the rice ecosystem. Although the untreated control plots recorded comparatively higher populations of these beneficial arthropods throughout the observation period, the differences among the insecticidal treatments were statistically non-significant. The sequential application of Pymetrozine 50 WG followed by Triflumezopyrim 10% SC (T_4) effectively suppressed the brown planthopper population while conserving the abundance of predatory coccinelids. Similar observations were recorded with other insecticidal schedules, indicating that the insecticides evaluated in the present investigation were relatively safe to beneficial fauna when applied at the recommended doses. The compatibility of these insecticides with natural enemies suggests that they can be successfully integrated into Integrated Pest Management (IPM) programmes for sustainable rice production without causing serious disruption to the ecological balance of rice ecosystems. These findings further indicate that judicious use of selective insecticides can effectively manage brown planthopper while simultaneously conserving naturally occurring biological control agents.

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