



# **Efficacy of Chlorantraniliprole 5DT against Yellow Stem Borer (*Scirpophaga incertulas* Walker) and Leaf Folder (*Cnaphalocrocis medinalis* Guenee) of Rice**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Aim:** An experiment was conducted to evaluate the bio-efficacy of Chlorantraniliprole 5DT at various doses compared to other chemicals for management of yellow stem borer and leaf folder in rice

**Study Design:** Randomised Block Design with nine treatments and three replications

**Place and Duration of Study:** Regional Agricultural Research Station, Anakapalle, Andhra Pradesh during 2020 and 2021.

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**Methodology:** Thirty days old seedlings of rice variety, RGL 2537 were transplanted with a spacing of 20 ×15 cm<sup>2</sup> in a plot of 5×8 m<sup>2</sup> and all agronomical practices recommended for the region were followed to raise the crop except for the plant protection measures for pests. Nine treatments(chlorantraniliprole 5DT @ 30 ga.i/ha, Chlorantraniliprole 5DT @ 40 ga.i/ha, Chlorantraniliprole 5DT @ 50 ga.i/ha, Chlorantraniliprole 5DT @ 60 gm a.i/ha, Chlorantraniliprole 5DT @ 70 gm a.i/ha, Chlorantraniliprole 0.4%GR @ 40 ga.i/ha, Fipronil 80%WG @ 50 ga.i/ha, Cartap hydrochloride 4%GR @ 10 ga.i/ha (chemical check) and untreated control) were imposed and the time of application was 15-25 days after transplanting and again after 20-25 days after the first application.

**Results:** The results revealed that the treatment Chlorantraniliprole 5DT @ 70 ga.i. ha<sup>-1</sup>recorded 79.35 per cent reduction over control followed by Chlorantraniliprole 5DT @ 60 ga.i. ha<sup>-1</sup>which recorded 78.07 per cent reduction over control with regard to yellow stem borer. Similarly, with regard to leaf folder, Chlorantraniliprole 5DT @ 70 g a.i. ha<sup>-1</sup>recorded 96.35 per cent reduction over control followed by Chlorantraniliprole 5DT @ 60 ga.i. ha<sup>-1</sup>which recorded 95.62 per cent reduction over control. Highest yield was recorded in the treatment Chlorantraniliprole 5DT @ 60 ga.i. ha<sup>-1</sup> (48.40 qha<sup>-1</sup> during 2020and 51.22 qha<sup>-1</sup> during 2021) which was followed by Chlorantraniliprole 5DT @ 70 ga.i. ha<sup>-1</sup> (46.32 qha<sup>-1</sup> during 2020 and 50.40 qha<sup>-1</sup> during 2021).

**Conclusion:** Chlorantraniliprole 5DT @ 70 gm a.i. ha<sup>-1</sup> and Chlorantraniliprole 5DT @ 60 gm a.i. ha<sup>-1</sup> were most effective in management of yellow stem borer and leaf folder in rice also recorded higher yield.

**Keywords:** Yellow stem borer; leaf folder; rice; chlorantraniliprole.

## 1. INTRODUCTION

Rice (*Oryza sativa* L.) is the primary source of sustenance for nearly half of the global population and its cultivation is a reliable source of livelihood for more than 2000 million people. Rice is the staple food of 65% of the total population in India. It constitutes about 52% of the total food grain production and 55% of total cereal production. In India, paddy is grown in 44.06million ha constituting 34.4% of the total cultivable area. About 70% of our farmers are cultivating paddy and the production is about 118.4 million tonnes and productivity being 2705t/ha. (Sharanappa et al.,2017 and Anonymous 2021). About 90 percent of the rice produced in India is consumed within the country (Balasubramamiam and Kumar, 2019). Rice grains are rich in (per 100 g dry weight) nutrients like protein (8.1 2 g), fat (0.8 g), carbohydrates (91 g), minerals like calcium (32 mg), Magnesium (28 mg), Sodium (6 mg), Vitamins Like Thiamin (B1) (0.08 mg), Niacin (B3) (1.82 mg) and Fats (0.60 g) (Singh and Singh, 2017). About 300 species of insects have been reported to attack rice crop in India, out of which 20 have been found to be the major pests. Among the insect pests, yellow stem borer, brown plant hopper, green leafhopper, ear head bug, leaf folder and case worm. The average yield loss in rice have been accounted for 30% loss in stem borers, while plant hoppers 20%, gall midge 15%, leaf folder

10% and other pests 25% respectively (Parasappa, 2017).

Among the insect pests, yellow stem borer, *Scirpophaga incertulas* (Walker) and leaf folder, *Cnaphalocrocis medinalis* Guenee are the most important and devastating insect pest of rice ecosystem and causing yield losses up to 20-70% every year (Sharma et al., 2018, Reddy et al.; 2023 and Bhagat et al., 2022). The stem borer larvae bore into the stem and destroy the growing tips by feeding the internal contents. This in turn disrupts the flow of water and nourishment to the plant, thereby causing dead heart during vegetative stage. When the infestation occurs at the flowering stage, the ear heads become chaffy (Omprakash et al., 2017). The leaf folder larvae web the leaves vertically or horizontally and feed internally resulting in white patches (Reddy et al., 2023, Balasubramaniam, & Kumar, 2019). Owing to the internal feeding nature, management of yellow stem borer and leaf folder has become challenging, leading to the use of only chemical control as a most preferred management strategy. Hence it is imperative to conduct field evaluation of newer compounds with novel mode of action.

Chlorantraniliprole,3-bromo-N-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide is an anthranilic diamide insecticide with a novel mode of action called 'Ryanodine muscle

contraction' is found effective against several lepidopteran as well as coleopteran, dipteran, and hemipteran pests. It has very low toxicity for mammals (both acute and chronic), high intrinsic activity on target pests, strong ovicidal and larvicidal properties, long lasting crop protection and no cross-resistance to any existing insecticide. Chlorantraniliprole has excellent profile of safety to beneficial arthropods, pollinators, honeybees and non-target organisms such as earthworms and soil microorganisms (Dinter et al., 2008). The remarkably favourable toxicity profile of chlorantraniliprole, combined with low use rates, provides large margins of safety for consumers and agricultural workers (Sharma et al., 2013, Bhardwaj et al., 2019). With this background, a study has been carried out to assess the bio-efficacy of chlorantraniliprole 5DT at various doses in comparison to other chemicals for management of yellow stem borer and leaf folder in rice.

## 2. MATERIALS AND METHODS

The research work was carried out at the Regional Agricultural Research Station, Anakapalle, Visakhapatnam, Andhra Pradesh during 2020 and 2021 to assess the bio-efficacy of chlorantraniliprole 5DT at various doses in comparison to other chemicals for management of yellow stem borer and leaf folder in rice.

### 2.1 Cultivation of Rice

The rice crop was raised in randomized block design replicated thrice with nine treatments as detailed in Table 1. Thirty days old seedlings of rice variety, RGL 2537 were transplanted with a spacing of 20 × 15 cm<sup>2</sup> in a plot of 5 × 8 m<sup>2</sup> and all agronomical practices recommended for the region were followed to raise the crop except for the plant protection measures for pests. The

treatments were imposed when pest reached ETL level.

### 2.2 Data on Damage by Yellow Stem Borer

The per cent incidence of dead hearts and white ears were recorded at ten days interval starting from 30 days after transplanting up to 60 days after transplanting. The per cent incidence of damage made yellow stem borer was calculated by counting the number of damaged tillers and total number of tillers per hills. Per cent reduction in dead hearts/ white ears over control was worked out at final observation for dead heart and white ear incidence. Dead heart and white ears number present per hill based on observation taken on ten randomly selected hills per plot was recorded. The data on % incidence of dead hearts/ white ears was calculated by below formula (Singha and Pandey, 1997);

$$\text{Stem borer incidence (\%)} = \frac{\text{No. of dead heart/White ears hill}^{-1}}{\text{Total number of tillers/Panicles hill}^{-1}} \times 100$$

### 2.3 Data on Damage by Leaf Folder

The per cent incidence of leaf folder was recorded at ten days interval starting from 30 days after transplanting up to 60 days after transplanting. Data on damaged leaves present per hill and total number of leaves per hill was recorded on ten randomly selected plants based on observation taken on ten randomly selected hills per plot. The data on leaf folder incidence % was calculated using the below formula (Singha and Pandey, 1997);

$$\text{Leaf folder incidence (\%)} = \frac{\text{No. of damaged leaves hill}^{-1}}{\text{Total number of leaves hill}^{-1}} \times 100$$

**Table 1. Details of the treatments**

S.No	Treatment	Time and method of application
1	Chlorantraniliprole 5DT @ 30 gm a.i/ha	2 applications (1st placement of at 15-25 days after transplanting in the field and 2nd placement at 20-25 days after the 1st application)
2	Chlorantraniliprole 5DT @ 40 gm a.i/ha	
3	Chlorantraniliprole 5DT @ 50 gm a.i/ha	
4	Chlorantraniliprole 5DT @ 60 gm a.i/ha	
5	Chlorantraniliprole 5DT @ 70 gm a.i/ha	
6	Chlorantraniliprole 0.4%GR @ 40 gm a.i/ha	
7	Fipronil 80%WG @ 50 gm a.i/ha	
8	Cartap hydrochloride 4%GR @ 10 gm a.i/ha (chemical check)	--
9	Untreated control	

## 2.4 Data on Natural Enemies

For recording natural enemy population, ten hills were selected randomly from each of the treated plots. Each hill was examined one day before application and 10 days after application to count the number of natural enemies (mirid bugs and spiders).

## 2.5 Yield

Plot wise yield excluding two border rows was recorded at the time of harvest for all the replicated treatments for the two consecutive years, 2020 and 2021. Yield per hectare was calculated and expressed as quintals per hectare.

## 2.6 Statistical Analysis

The experiment was laid out in randomized block design with nine treatments and was been replicated thrice during two subsequent years, 2020 and 2021. The data on pest incidence (yellow stem borer and leaf folder), incidence of natural enemies (mirid bug and spiders) and yield from field experiments was statistically screened by ANOVA (analysis of variance) after getting transformed as per Gomez (1984). Pooled RBD ANOVA was done using Microsoft excel. Critical difference was calculated at 5 per cent probability level and treatments mean values were compared using Duncan's Multiple Range Test (DMRT) as per Gomez and Gomez, (1984).

## 3. RESULTS AND DISCUSSION

The pooled data on various parameters on bio-efficacy of different doses of Chlorantraniliprole 5DT in comparison to other chemicals against yellow stem borer and leaf folder on rice are presented in Table 2 and Table 3 and elaborated hereunder.

Overall performance of various insecticidal treatments indicates that treatment with chlorantraniliprole 5DT @ 70 ga.i. per hectare was found to be most effective in reducing the dead hearts/white ears to minimum level of 3.56 per cent at 60 days after transplanting. However, this treatment was statistically on par with Chlorantraniliprole 5DT @ 60 ga.i. per hectare (3.78 per cent dead hearts/white ears). All the remaining treatments were statistically on par with each other (5.03-6.22 per cent dead

hearts/white ears). The untreated control registered the highest percent incidence of dead hearts/ white ears (17.24 per cent). The treatment chlorantraniliprole 5DT @ 70 ga.i. per hectare recorded 79.35 per cent reduction over control followed by chlorantraniliprole 5DT @ 60 ga.i. per hectare which recorded 78.07 per cent reduction over control (Table 2). The treatments, Chlorantraniliprole 0.4GR @ 40g a.i per hectare, Fipronil 80% WG @ 50g a.i per hectare and Cartap hydrochloride @ 0.4GR @ 10g a.i per hectare were next best treatments with 70.06-70.82 per cent reduction in pest load. The present findings are supported by Chormule et al. (2014) who also reported that chlorantraniliprole 0.4 GR was best for reducing the infestation of yellow stem borer. Chlorantraniliprole 0.4 GR (3.08%) was found significantly superior in reducing the population of yellow stem borer as well as increasing yield supported by Omprakash et al., (2017). Use of granulated insecticides for the control yellow stem borer and other rice stem borers was also expounded by Chatterjee et al., (2019), Sachan et al., (2018) and Singh and Singh (2017). The higher efficacy of Chlorantraniliprole granules can be attributed to novel mode of action called 'Ryanodine muscle contraction' having high intrinsic activity on target pests. Moreover, the water dispersible formulation of the molecule under testing, Chlorantraniliprole 5DT, supposedly added to the efficacy.

Similarly, with respect to leaf folder damage, the treatment with chlorantraniliprole 5DT @ 70 ga.i. per hectare was found to be most effective recording minimum level of 0.35 per cent leaf folder incidence at 60 days after transplanting, reflected as 96.35 per cent reduction over control. However, this treatment was statistically on par with Chlorantraniliprole 5DT @ 60 ga.i. per hectare (0.42 per cent leaf folder incidence), enumerated as 95.62 per cent reduction over control. The next best treatments were chlorantraniliprole 5DT@ 50 ga.i. per hectare (1.64 per cent leaf folder incidence) and Chlorantraniliprole 0.4% G @ 40 ga.i. per hectare (1.81 per cent leaf folder incidence). The treatments, Chlorantraniliprole 0.4GR @ 40g a.i per hectare, Fipronil 80% WG @ 50g a.i per hectare and Cartap hydrochloride @ 0.4GR @ 10g a.i per hectare were next best treatments with 75.13-81.16 per cent reduction in leaf folder damage. The untreated control registered the highest percent incidence (9.61 per cent) of leaf folder (Table 2).

**Table 2. Bio-efficacy of Chlorantraniliprole 5DT against yellow stem borer (*S. incertulas*) and leaf folder (*C. medinalis*) in rice (Pooled data)**

Tr. No.	Treatments	Dose (ga.i/ ha)	Yellow stem borer damage					Leaf folder damage				
			% Dead heart/White ears				Percent Reduction over control	% Dead heart/White ears				Percent Reduction over control
			30 DAT*	40 DAT	50 DAT	60 DAT		30 DAT	40 DAT	50 DAT	60 DAT	
T1	Chlorantraniliprole 5DT	30	4.34 (12.25)	5.30 (13.20)	5.53 (13.48)	6.22 (15.46)	63.92	2.52 (9.20)	2.62 (8.91)	2.35 (8.82)	2.73 (7.82)	71.59
T2	Chlorantraniliprole 5DT	40	1.98 (8.42)	1.73 (7.7)	3.66 (11.29)	5.40 (13.41)	68.67	2.46 (9.14)	2.36 (8.62)	2.03 (8.17)	2.66 (7.71)	72.32
T3	Chlorantraniliprole 5DT	50	1.20 (6.40)	1.50 (8.33)	3.18 (10.68)	5.27 (13.39)	69.43	2.52 (9.08)	1.19 (6.26)	1.35 (3.39)	1.64 (6.20)	89.17
T4	Chlorantraniliprole 5DT	60	0.90 (5.36)	1.16 (6.15)	2.60 (9.23)	3.78 (11.21)	78.07	0.65 (4.62)	0.77 (5.65)	0.31 (3.19)	0.42 (4.01)	95.62
T5	Chlorantraniliprole 5DT	70	0.88 (5.28)	1.05 (5.88)	2.56 (9.21)	3.56 (10.84)	79.35	0.56 (4.19)	0.73 (5.53)	0.29 (3.09)	0.35 (3.85)	96.35
T6	Chlorantraniliprole 0.4% GR	40	2.43 (9.54)	3.10 (10.14)	4.44 (12.12)	5.03 (13.06)	70.82	2.00 (8.13)	1.83 (7.56)	0.78 (5.07)	1.81 (6.57)	81.16
T7	Fipronil 80% WG	50	3.22 (10.24)	5.13 (13.09)	5.92 (14.10)	5.06 (13.10)	70.64	2.21 (8.55)	2.19 (7.89)	2.03 (8.19)	1.84 (6.64)	80.85
T8	Cartap hydrochloride 4%GR (chemical check)	10	5.26 (13.42)	5.45 (13.50)	5.62 (13.90)	5.16 (13.12)	70.06	2.28 (8.60)	2.24 (8.12)	2.28 (8.68)	2.39 (7.49)	75.13
T9	Untreated control	-	8.06 (20.13)	17.42 (24.67)	15.01 (22.78)	17.24 (24.52)	-	5.28 (15.62)	8.12 (16.55)	9.41 (17.62)	9.61 (18.01)	-
CD at 5%			2.62	2.40	2.06	2.51		1.74	1.24	1.21	1.32	
CV			12.6	12.4	14.06	13.6		13.7	12.8	14.1	12.2	

\*DAT – Days after transplanting

**Table 3. Impact of Chlorantraniliprole 5DT on natural enemies in rice and yield (Pooled data)**

Tr. No.	Treatments	Dose (ga.i/ha)	No. of mirid bugs/ hill				No. of spiders/ hill				Yield (q/ha)	
			1 <sup>st</sup> application		2 <sup>nd</sup> application		1 <sup>st</sup> application		2 <sup>nd</sup> application		2020	2021
			1 DBA*	10 DAA*	1 DBA	10 DAA	1 DBA	10 DAA	1 DBA	10 DAA		
T <sub>1</sub>	Chlorantraniliprole 5DT	30	3.32	3.34	4.03	4.27	1.93	1.98	2.77	3.10	42.20	43.86
T <sub>2</sub>	Chlorantraniliprole 5DT	40	3.64	3.67	4.18	4.24	2.10	2.25	2.42	2.62	42.75	44.40
T <sub>3</sub>	Chlorantraniliprole 5DT	50	3.61	3.43	3.91	3.80	1.91	1.83	2.25	2.17	43.30	46.35
T <sub>4</sub>	Chlorantraniliprole 5DT	60	3.38	3.23	4.13	4.93	2.02	1.89	2.24	2.70	48.40	51.22
T <sub>5</sub>	Chlorantraniliprole 5DT	70	3.75	2.71	3.11	2.70	2.02	1.39	1.85	1.41	46.32	50.40
T <sub>6</sub>	Chlorantraniliprole 0.4% GR*	40	3.66	3.63	4.10	3.82	1.92	1.80	2.18	1.92	44.42	47.00
T <sub>7</sub>	Fipronil 80% WG	50	3.94	3.89	4.20	3.93	2.13	1.84	1.75	1.60	44.34	46.84
T <sub>8</sub>	Cartap hydrochloride 4%GR (chemical check)	10	3.81	3.90	4.43	4.22	2.10	2.00	2.54	2.36	43.05	45.66
T <sub>9</sub>	Untreated control	-	5.50	5.75	6.0	5.86	2.08	2.28	3.21	3.65	38.80	40.10
CD at 5%			NS	0.20	0.30	0.27	NS	0.33	0.33	0.77	1.84	1.75
CV			10.4	11.7	12.1	12.5	10.9	12.9	11.4	12.7	13.4	12.7

DBA – Days before application; DAA – Days after application

Present findings are supported by Sarao and Kaur, (2014) and Urvashi et al (2019), who reported that chlorantraniliprole 0.4% GR @30, 40 and 50 g a.i./ha was found effective against stem borer and leaf folder in basmati rice. Jaglan et al., (2023) also reported efficacy of Chlorantraniliprole 0.4% GR against yellow stem borer and leaf folder in rice. Saikia et al (2024) also reported that Chlorantraniliprole 18.5 SC showed the best result in minimizing yellow stem borer and rice leaf folder infestation. The effectiveness of Chlorantraniliprole 5DT can be ascribed to the novel water dispersible formulation which would reach the larval muscles faster, activating ryanodine receptors leading to paralysis.

Observations on effect of different chemical treatments (excluding untreated control) on incidence of natural enemies, ten days after second application, revealed that the incidence of mirid bugs ranged between 2.70 to 4.93 per hill and spiders ranged from 1.41 to 2.7 per hill. The treatment with chlorantraniliprole 5DT @ 70 ga.i. per hectare showed the least population of natural enemies may be owing to high toxicity level (Table 3). The present finding is in accordance with Shanwei et al. (2009) who reported chlorantraniliprole 20 SC @40 g a. i./ha as highly safe to the beneficial predatory coccinellids and spiders in the rice ecosystem. Similarly, Jafar et al. (2013) also reported that chlorantraniliprole was safer to the natural enemies of rice insect pests. Saikia et al (2024), Jaglan et al 2023 and Dhanapati et al., (2024), also noticed that chlorantraniliprole did not have any adverse effect on the natural enemy populations. Chlorantraniliprole is less harmful to beneficial insects due to its mode of action, as it is ryanodine receptor agonist, whereas many pesticides are sodium channel modulators leading to rapid paralysis and death of bees. Also, Chlorantraniliprole generally has a higher LD50 for honey bees indicating lower toxicity compared to other pesticides.

Highest yield was recorded in the treatment Chlorantraniliprole 5DT @ 60 ga.i. per hectare (48.40 q/ha during 2020 and 51.22 q/ha during 2021) which was followed by Chlorantraniliprole 5DT @ 70 ga.i. per hectare (46.32 q/ha during 2020 and 50.40 q/ha during 2021). The untreated control recorded the lowest yields of 38.80 q/ha during 2020 and 40.10 q/ha during 2021 (Table 3). The present findings are in accordance with that of Sarao and Kaur (2014) who reported that Chlorantraniliprole 0.4% GR

was effective in the management of rice stem borers and leaf folder in basmati rice and gave the highest yield (40.53 q/ha) at a dose of 50 g a.i./ha which was at par with 40 g a.i./ha. Rana and Singh, (2017) studied that Chlorantraniliprole 18.5% SC was found most effective with the highest pooled yield of 44.58 q/ha and similarly chlorantraniliprole 0.4 GR was found to be contributing significantly to increased yield by Omprakash et al., (2017), Nile and Kumar (2023) reported that lowest yellow stem borer infestation per hill (3.08) and highest yield (49.1 qha<sup>-1</sup>) was recorded in the treatment with two applications of Chlorantraniliprole 0.4 GR.

#### 4. CONCLUSION

The results of the experiment revealed that, among all the treatments, Chlorantraniliprole 5DT @ 70 ga.i. ha<sup>-1</sup> and Chlorantraniliprole 5DT @ 60 ga.i. ha<sup>-1</sup> were most effective in management of yellow stem borer and leaf folder in rice and recorded higher yield with no adverse effect on natural enemies.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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