**Original Research Article**

**Efficacy of Chlorantraniliprole 5DT against yellow stem borer (*Scirpophaga incertulas* Walker) and leaf folder *(Cnaphalocrocis medinalis* Guenee*)* of rice**

**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 2001 and 2021

**Methodology**: Thirty days old seedlings of rice variety, RGL 2537 were transplanted with a spacing of 20 ×15 cm2 in a plot of 5×8 m2 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 g a.i/ha, chlorantraniliprole 5DT @ 40 g a.i/ha, chlorantraniliprole 5DT @ 50 g a.i/ha, chlorantraniliprole 5DT @ 60 g a.i/ha, chlorantraniliprole 5DT @ 70 g a.i/ha, chlorantraniliprole 0.4%GR @ 40 g a.i/ha, fipronil 80%WG @ 50 g a.i/ha, cartap hydrochloride 4%GR @ 10 g a.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 g a.i. ha-1recorded 79.35 per cent reduction over control followed by chlorantraniliprole 5DT @ 60 g a.i. ha-1which 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-1recorded 96.35 per cent reduction over control followed by chlorantraniliprole 5DT @ 60 g a.i. ha-1which recorded 95.62 per cent reduction over control. Highest yield was recorded in the treatment chlorantraniliprole 5DT @ 60 g a.i. ha-1 (48.40 qha-1 during 2020and 51.22 qha-1 during 2021) which was followed by chlorantraniliprole 5DT @ 70 g a.i. ha-1 (46.32 qha-1 during 2020 and 50.40 qha-1 during 2021).

**Conclusion**: Chlorantraniliprole 5DT @ 70 g a.i. ha-1 and chlorantraniliprole 5DT @ 60 g a.i. ha-1 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 belong to family Poaceae or Gramineae, the rice is life and princess among the cereals, 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 44.06 million ha constituting 34.4% of the total cultivable area. About 70% of our farmers are cultivating paddy and

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the production is about 118.4 million tonnes and productivity being 2705 t/ha. (Sharanappa et al., 2017 and Anonymous 2021). About 90 per cent 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 (8.12 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, C*naphalocrocis 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). Owing to their 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 ovilarvicidal 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, honey bees 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). 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.

1. **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 cm2 in a plot of 5×8 m2 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);

Stem borer incidence (%)

= No. of dead heart/White ears hill-1  X 100

 Total number of tillers/Panicles hill-1

**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);

Leaf folder incidence (%)

= No. of damaged leaves hill-1  X 100

 Total number of leaves hill-1

**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.

1. **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 indicate that treatment with chlorantraniliprole 5DT @ 70 g a.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 g a.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 per cent incidence of dead hearts/ white ears (17.24 per cent). The treatment chlorantraniliprole 5DT @ 70 g a.i. per hectare recorded 79.35 per cent reduction over control followed by chlorantraniliprole 5DT @ 60 g a.i. per hectare which recorded 78.07 per cent reduction over control (Table 2). 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 G (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). Similar findings were also reported by Chatterjee et al., (2019), Sachan et al., (2018) and Singh and Singh (2017).

Similarly, with respect to leaf folder damage, the treatment with chlorantraniliprole 5DT @ 70 g a.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. However, this treatment was statistically on par with chlorantraniliprole 5DT @ 60 g a.i. per hectare (0.42 per cent leaf folder incidence). The next best treatments were chlorantraniliprole 5DT @ 50 g a.i. per hectare ( 1.64 per cent leaf folder incidence) and chlorantraniliprole 0.4% G @ 40 g a.i. per hectare (1.81 per cent leaf folder incidence). The untreated control registered the highest percent incidence (9.61 per cent) of leaf folder (Table 2). Present findings are supported by Sarao and Kaur (2014) who reported that chlorantraniliprole 0.4% g @ 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.

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 g a.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. Jaglan et al., 2023 and Dhanapati et al., 2023, also noticed that chlorantraniliprole did not have any adverse effect on the natural enemy populations.

 Highest yield was recorded in the treatment chlorantraniliprole 5DT @ 60 g a.i. per hectare (48.40 q/ha during 2020 and 51.22 q/ha during 2021) which was followed by Chlorantraniliprole 5DT @ 70 g a.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 Ferterra 0.4% G 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 G 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-1) was recorded in the treatment with two applications of chlorantraniliprole 0.4 G.

**CONCLUSION**

The results of the experiment revealed that, among all the treatments, chlorantraniliprole 5DT @ 70 g a.i. ha-1 and chlorantraniliprole 5DT @ 60 g a.i. ha-1 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.

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**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 | -- |

**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****(g a.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****(gm a.i/ha)** | **No. of mirid bugs/ hill** | **No. of spiders/ hill** | **Yield****(q/ha)** |
| ***1st application*** | ***2nd application*** | ***1st application*** | ***2nd application*** | **2020** | **2021** |
| **1 DBA\*** | **10 DAA\*** | **1 DBA** | **10 DAA** | **1 DBA** | **10 DAA** | **1 DBA** | **10 DAA** |
| T1 | Chlorantraniliprole 5DT | 30 | 3.32 | 3.34 | 4.03 | 4.27 | 1.93 | 1.98 | 2.77 | 3.10 | 42.20 | 43.86 |
| T2 | Chlorantraniliprole 5DT | 40 | 3.64 | 3.67 | 4.18 | 4.24 | 2.10 | 2.25 | 2.42 | 2.62 | 42.75 | 44.40 |
| T3 | Chlorantraniliprole 5DT | 50 | 3.61 | 3.43 | 3.91 | 3.80 | 1.91 | 1.83 | 2.25 | 2.17 | 43.30 | 46.35 |
| T4 | Chlorantraniliprole 5DT | 60 | 3.38 | 3.23 | 4.13 | 4.93 | 2.02 | 1.89 | 2.24 | 2.70 | 48.40 | 51.22 |
| T5 | Chlorantraniliprole 5DT | 70 | 3.75 | 2.71 | 3.11 | 2.70 | 2.02 | 1.39 | 1.85 | 1.41 | 46.32 | 50.40 |
| T6 | 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 |
| T7 | Fipronil 80% WG | 50 | 3.94 | 3.89 | 4.20 | 3.93 | 2.13 | 1.84 | 1.75 | 1.60 | 44.34 | 46.84 |
| T8 | 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 |
| T9 | 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