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Field efficacy of newer insecticides against yellow stem borer (*Scirpophaga incertulas* Walker) on rice

VK Bhagat, KL Painkra, GP Painkra and PK Bhagat

Abstract
A field experiment was conducted to evaluate the efficacy of newer insecticides *i.e.* Thiamethoxam 25% WG (seed treatment), carbofuron 3% CG (nursery treatment alone at 15 DAS), fipronil 0.3% GR (nursery treatment alone at 15 DAS), chlorantraniliprole 0.4% GR (nursery treatment alone at 15 DAS), carbofuron 3% CG (main field alone at 25 DAT), fipronil 0.3% GR (main field alone at 25 DAT), chlorantraniliprole 0.4% GR (main field alone at 25 DAT), Thiamethoxam 25% WG + fipronil 0.3% GR (seed treatment + main field at 25 DAT), Thiamethoxam 25% WG + chlorantraniliprole 0.4% GR (seed treatment + main field at 25 DAT), Thiamethoxam 25% WG + [cartap hydrochloride 4% + fipronil 0.5% CG] (seed treatment + main field at 25 DAT), fipronil 0.3% GR + chlorantraniliprole 0.4% GR (nursery + main field at 25 DAT), carbofuron 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG] (nursery + main field at 25 DAT) and untreated control against yellow stem borer (*Scirpophaga incertulas* Walker) on rice during *Kharif* -2021. The result revealed that the chlorantraniliprole 0.4% GR (main field alone at 25 DAT) was found to be most effective treatment with lower per cent of dead heart and white earhead (2.19 and 2.59%, respectively) followed by fipronil 0.3% GR + chlorantraniliprole 0.4 GR (2.22 and 2.97%, respectively) and thiamethoxam 25% WG + chlorantraniliprole 0.4 GR (2.98 and 3.63%, respectively). Rests of the treatments were moderately effective but significantly superior over untreated control. Whereas in untreated plot recorded maximum number of dead heart and white earhead (7.02% and 7.90%, respectively).

Keywords: Field efficacy, newer insecticides, rice, yellow stem borer, Chhattisgarh

Introduction
The cereal's princess in India, rice is a life and staple food for 65 per cent of the people. Rice may be grown in a variety of environments, including irrigated, rainfed lowland, rainfed upland and flood-prone ecosystems. India is the world's top rice producer, while China is the world's largest rice producer (Kakde and Patel, 2014) [7].

India is first in terms of area under rice cultivation with 43.79 million hectares, and second in terms of rice production with 116.42 million tones, accounting for 22.81 per cent of global rice production with an average productivity of 26.59 q/ha. With 55% of India's cereal production, it contributes to 65% of the total population and hence plays a critical role in maintaining food sufficiency in the country (Anonymous, 2019) [1].

Chhattisgarh also called as the rice-bowl of the India and it has been estimated rice covers 3.61 million ha of the total 6.53 million ha of farmed land, yielding 1.81 tons/ha. The state of Chhattisgarh produces 5.61 per cent of the country's rice. However, compared to other states such as Punjab (41.32 q/ha), Haryana (31.21 q/ha) and West Bengal (29.06 q/ha), rice production and productivity per unit area is quite low (Anonymous, 2019) [1]. Rice is primarily farmed in a rainfed habitat in Chhattisgarh during the Kharif season, and it is entirely reliant on the monsoon.

It has been reported that the rice crop was affected by more than 100 species of insect pests and out which 20 of them can cause serious economic damage (Heinrichs *et al*. 2017) [5]. Among these, the yellow stem borer (YSB) is considered as one of the most destructive and widely distributed monophagous insect-pest in Indian subcontinent. YSB infests rice plant throughout the cropping period. The extent of yield losses in rice due to YSB has been estimated as 20-70 per cent (Sharma *et al*., 2018) [14]. The presence of this pest in field can be easily identified by “dead heart” or “white ear” in hills at vegetative stage and panicles at reproductive stages, respectively due to larval feeding and subsequent inter-nodal penetration (Dutta and Roy, 2018) [4].

In the advent of newer group of insecticides, newer insecticides with novel mode of action are used to control the yellow stem borer (*S. incertulas* Walker) and achieved successful control. Keeping in view the importance of rice crop and the management of yellow stem borer with certain newer insecticides, the present study are undertaken.

Materials and Method

The present research work was conducted at the Research-cum-Instructional Farm of R.M.D College of Agriculture and Research Station, Ambikapur (C.G.) during Kharif 2021 to record *S. incertulas*. The trials were laid in Randomized Block Design with the three replications and 13 treatments. The crop variety MTU 1010 was transplanted in the main field having 5x4m^2, plot size with 20 cm x 15 cm (R x P).

The treatment details are following

Table 1: Treatment details

Crop stage	S. No	Treatments	Dosage
Seed Treatment	T_1	Thiamethoxam 25% WG	4 g/kg seed
Nursery alone at one week before transplantation	T_2	Carbofuran 3% CG	33 kg/ha
	T_3	Fipronil 0.3% GR	25 kg/ha
	T_4	Chlorantraniliprole 0.4% GR	10 kg/ha
Main field alone at 25 DAT	T_5	Carbofuran 3% CG	33 kg/ha
	T_6	Fipronil 0.3% GR	25 kg/ha
	T_7	Chlorantraniliprole 0.4% GR	10 kg/ha
Seed treatment + Main field at 25 DAT	T_8	Thiamethoxam 25% WG + Fipronil 0.3% GR	4 g/kg seed +25 kg/ha
	T_9	Thiamethoxam 25% WG + Chlorantraniliprole 0.4% GR	4 g/kg seed +10 kg/ha
	T_{10}	Thiamethoxam 25% WG + [Cartap hydrochloride 4% + Fipronil 0.5% CG]	4 g/kg seed +20 kg/ha
Nursery at one week before transplantation + Main field at 25 DAT	T_{11}	Fipronil 0.3% GR + Chlorantraniliprole 0.4% GR	25 kg/ha +10 kg/ha
	T_{12}	Carbofuran 3% CG + [Cartap hydrochloride 4% + Fipronil 0.5% CG]	33 kg/ha +25 kg/ha
Untreated control	T_{13}	Water spray	-

The required quantity of insecticide was calibrated and applied in the field.

Observations of yellow stem borer as per cent dead heart and white earhead

The data of yellow stem borer (*S. incertulas*) in term of dead heart and white earhead were recorded from randomly selected 10 hills in each treatment at 35 DAT & 55 DAT in vegetative stage and 65 DAT in reproductive stage. The effectiveness of treatments against yellow stem borer of rice was assessed on the basis of total number of dead hearts and white ears.

$$\text{Dead heart (\%)} = \frac{\text{Number of dead heart}}{\text{Total number of tiller}} \times 100$$

$$\text{White earhead (\%)} = \frac{\text{No.of white earshead}}{\text{No.of producative tillers}} \times 100$$

Results and Discussion

Dead heart infestation caused by yellow stem borer

The observations of yellow stem borer as per cent dead heart was recorded at 35 DAT and 55 DAT of rice and the result revealed that there was a significant difference among the treatments recorded, which are presented in Table 2 and depicted in Fig. 2.

Dead heart infestation at 35 DAT

At 35 DAT among all the treatments, fipronil 0.3% GR + chlorantraniliprole 0.4% GR (Nursery treatment at one week before transplantation + Main field at 25 DAT) resulted in significantly superior with lowest per cent of infestation (1.98% DH), followed by chlorantraniliprole 0.4% GR (Main field treatment at 25 DAT), chlorantraniliprole 0.4% GR (Nursery treatment at one week before transplantation), thiamethoxam 25% WG + chlorantraniliprole 0.4% GR (Seed treatment + Main field treatment at 25 DAT) and carbofuran 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG] (Nursery treatment at one week before transplantation + Main field treatment at 25 DAT), which gave the per cent of dead heart 2.08, 2.79, 2.83, and 3.18%, respectively. However, the highest infestation (6.86% DH) was recorded from untreated control.

Dead heart infestation at 55 DAT

The observations of dead heart at 55 DAT proved that among all the insecticides, chlorantraniliprole 0.4% GR (Main field treatment at 25 DAT) was showed significantly lower per cent of dead heart (2.31%), which was statistically at par with fipronil 0.3% GR + chlorantraniliprole 0.4% GR (Nursery treatment at one week before transplantation + Main field at 25 DAT), carbofuran 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG] (Nursery treatment at one week before transplantation + Main field treatment at 25 DAT), thiamethoxam 25% WG + chlorantraniliprole 0.4% GR (Seed treatment + Main field treatment at 25 DAT), and thiamethoxam 25% WG + [cartap hydrochloride 4% + fipronil 0.5% CG] (Nursery treatment at one week before transplantation + Main field treatment at 25 DAT), which gave the per cent of dead heart 2.46, 3.09, 3.13 and 3.31%, respectively. However, the highest per cent dead hearts were found under untreated control *i.e.* 7.18%.

Overall mean of dead heart infestation

The perusal of overall mean data revealed that all the treatments showed significantly affect in minimum infestation of dead heart over control. Among the all, chlorantraniliprole 0.4% GR (Main field treatment 20-25 DAT) gave minimum per cent of dead heart (2.19%) which showed significantly superior over all the treatment, but closely followed by fipronil 0.3% GR + chlorantraniliprole 0.4% GR (Nursery + Main field treatment), thiamethoxam 25% WG + chlorantraniliprole 0.4% GR (Seed treatment + Main field), carbofuran 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG] (Nursery + Main field treatment) and fipronil 0.3% GR (Main field treatment at 20-25 DAT), which were gave the per cent of dead heart 2.22, 2.98, 3.14 and 3.44%,

respectively. The highest per cent of dead hearts were found under untreated control plot as 7.02%.

White earhead infestation at before harvesting

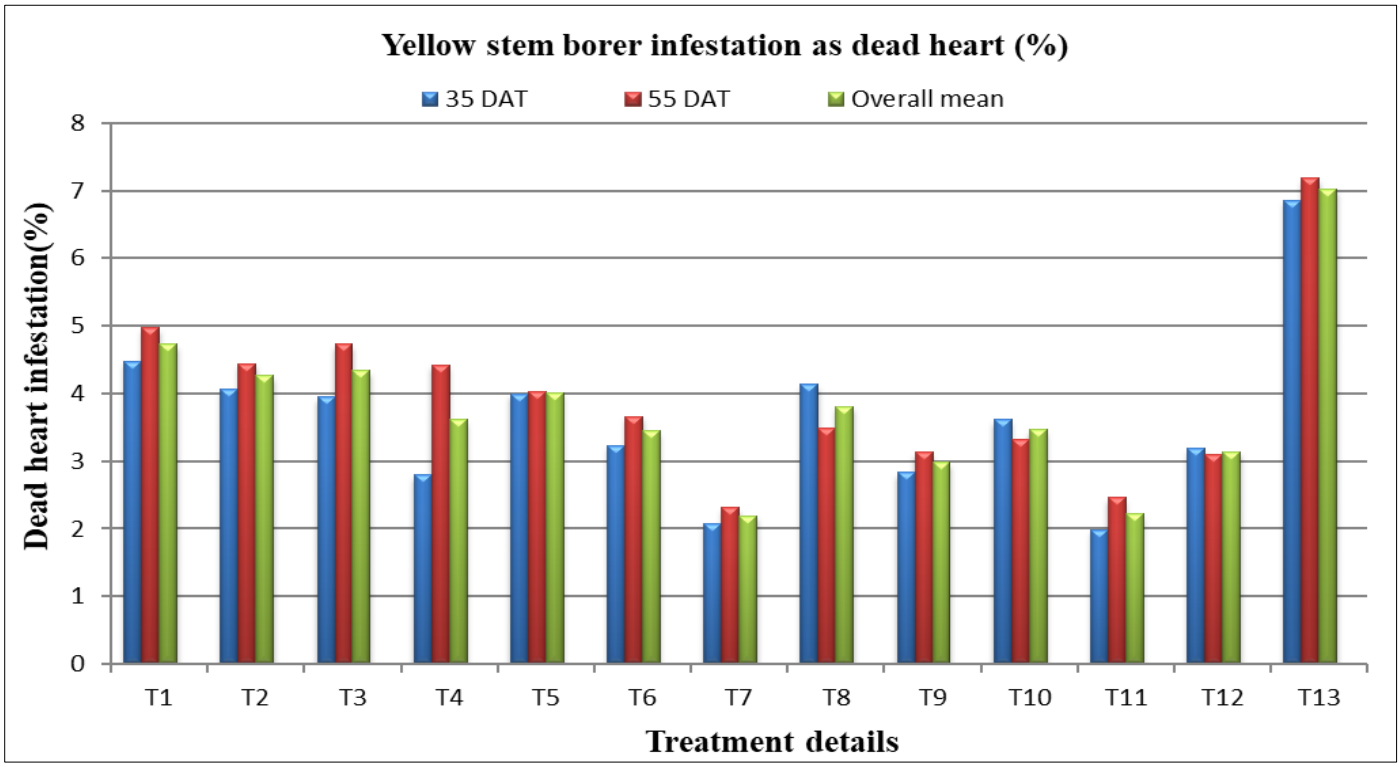
The observations regarding white earhead was recorded at before harvesting of crop, and the result showed that significant difference among different insecticides and their combinations of different crop stages. Chlorantraniliprole 0.4% GR (Main field treatment at 25 DAT) was showed significantly lower per cent of white earhead (2.59%) at before harvesting of the crop, followed by fipronil 0.3% GR + chlorantraniliprole 0.4% GR (Nursery + Main field treatment), thiamethoxam 25% WG + chlorantraniliprole 0.4% GR (Seed treatment + Main field treatment) and carbofuran 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG] (Nursery + Main field treatment), which were gave the per cent white earhead of 2.97, 3.63 and 3.83%, respectively. The highest per cent of white earhead were recorded under untreated control plot *i.e.* 7.90%.

The obtained results clearly indicated that application of insecticides significantly reduced the damage caused by yellow stem borer in rice crop compared with control treatment. Newer insecticide molecules show higher efficacy in controlling yellow stem borer damage in rice due to their new broad spectrum and high insecticidal activity with novel mode of action. The current findings are supported with the work of Nirmalkar *et al.* (2015) [9]; Omprakash *et al.* (2017) [10] who found that chlorantraniliprole 0.4% GR was most effective insecticide followed by chlorantraniliprole 18.5% SC in controlling the rice yellow stem borer damage due their novel mode of action compare to other insecticides. Similarly, Justin and Preetha (2014) [6]; Chormule *et al.* (2014) [2] also reported that chlorantraniliprole 0.4% GR proved to be the best over remaining all tested insecticides with reduced stem borer infestation and recorded higher yield. Similar results were reported by Tondon and Shrivastav (2016) [15], who found that chlorantranilprole 20% SC @ 150 ml/ha were most promising with minimum dead heart and white earhead.

These findings are also in agreement with Rana and Singh (2017) [12] and Sachan *et al.* (2018) [13], they reported that chlorantraniliprole 18.5% SC and chlorantraniliprole 0.4% GR were found most effective treatments in reducing yellow stem borer infestation while, chlorantraniliprole 18.5% EC @150 ml/ha was superior against the pest as reported by Karthikeyan and Christy (2014) [18]. The other finding of Pallavi *et al.* (2018) [11] who reported the flubendiamide 480% SC and chlorantraniliprole 0.4% GR were very effective for reducing infestation of YSB in comparison to lambda cyhalothrin 4.9% CS, acephate 95% SG, fipronil 0.3% GR and to standard check chlorpyriphos 20% EC. Similarly, Dash and Mukherjee (2003) [3] also reported that fipronil 5% SC was more effective and Chlorantraniliprole 0.4% GR was second best treatment to control the *S. incertulas*, but the current finding showed the Chlorantraniliprole 0.4% GR was the best treatment followed by fipronil 0.3% GR + chlorantraniliprole 0.4% GR, carbofuran 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG], and thiamethoxam 25% WG + chlorantraniliprole 0.4% GR.

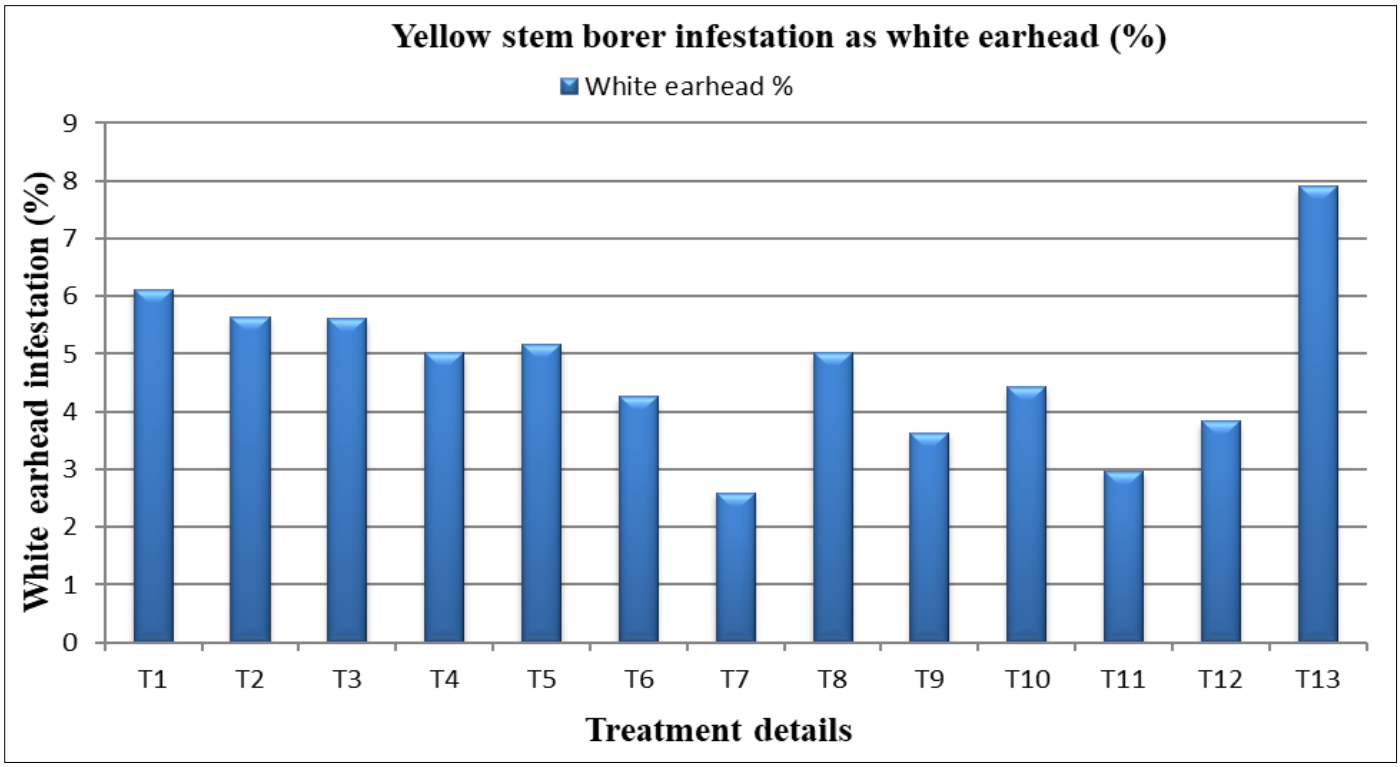
Table 2: Field efficacy of newer insecticides against YSB as dead heart/white earhead infestation (%) in rice during Kharif -2021

Crop stage	Treat. no.	Treatments	Dose/ha	Yellow stem borer infestation as dead heart (%)			White earhead infestation (%)
				35 DAT	55 DAT	Overall mean	
Seed Treatment	T_1	Thiamethoxam 25% WG	4 g/kg seed	4.48 (12.16)	4.97 (12.85)	4.73 (12.52)	6.12 (14.28)
Nursery alone at one week before transplantation	T_2	Carbofuran 3% CG	33 kg/ha	4.07 (11.56)	4.44 (12.09)	4.26 (11.83)	5.64 (13.71)
	T_3	Fipronil 0.3% GR	25 kg/ha	3.95 (11.38)	4.73 (12.55)	4.34 (11.98)	5.62 (13.71)
	T_4	Chlorantraniliprole 0.4% GR	10 kg/ha	2.79 (9.58)	4.42 (12.12)	3.61 (10.93)	5.02 (12.91)
Main field alone at 25 DAT	T_5	Carbofuran 3% CG	33 kg/ha	3.99 (11.44)	4.03 (11.54)	4.01 (11.49)	5.16 (13.11)
	T_6	Fipronil 0.3% GR	25 kg/ha	3.23 (10.24)	3.66 (10.99)	3.44 (10.64)	4.26 (11.89)
	T_7	Chlorantraniliprole 0.4% GR	10 kg/ha	2.08 (8.24)	2.31 (8.72)	2.19 (8.48)	2.59 (9.25)
Seed treatment + Main field at 25 DAT	T_8	Thiamethoxam 25% WG + Fipronil 0.3% GR	4 g/kg seed + 25 kg/ha	4.13 (11.66)	3.49 (10.75)	3.81 (11.22)	5.02 (12.94)
	T_9	Thiamethoxam 25% WG + Chlorantraniliprole 0.4% GR	4 g/kg seed + 10 kg/ha	2.83 (9.63)	3.13 (10.15)	2.98 (9.91)	3.63 (10.86)
	T_{10}	Thiamethoxam 25% WG + [Cartap hydrochloride 4% + Fipronil 0.5% CG]	4 g/kg seed + 20 kg/ha	3.61 (10.92)	3.31 (10.47)	3.46 (10.70)	4.42 (12.13)
Nursery at one week before transplantation + Main field at 25 DAT	T_{11}	Fipronil 0.3% GR + Chlorantraniliprole 0.4% GR	25 kg/ha + 10 kg/ha	1.98 (7.92)	2.46 (8.98)	2.22 (8.48)	2.97 (9.86)
	T_{12}	Carbofuran 3% CG + [Cartap hydrochloride 4% + Fipronil 0.5% CG]	33 kg/ha + 25 kg/ha	3.18 (10.24)	3.09 (10.08)	3.14 (10.19)	3.83 (11.24)
Untreated control	T_{13}	Water spray	-	6.86 (15.17)	7.18 (15.54)	7.02 (15.35)	7.90 (16.32)
CD at 5%				1.583	1.083	1.275	1.262
SE(m±)				0.539	0.369	0.434	0.430
*Figure in Parenthesis are arcsine transformed values X'= arcsin √x CD at 5% level of significance							



T_1 - Thiamethoxam 25% WG, T_2 - Carbofuran 3% CG, T_3 - Fipronil 0.3% GR, T_4 - Chlorantraniliprole 0.4% GR, T_5- Carbofuran 3% CG, T_6 - Fipronil 0.3% GR, T_7- Chlorantraniliprole 0.4% GR, T_8- Thiamethoxam 25% WG + Fipronil 0.3% GR, T_9- Thiamethoxam 25% WG + Chlorantraniliprole 0.4% GR, T_{10}- Thiamethoxam 25% WG + [Cartap hydrochloride 4% + Fipronil 0.5% CG], T_{11}- Fipronil 0.3% GR + Chlorantraniliprole 0.4% GR, T_{12}- Carbofuran 3% CG + [Cartap hydrochloride 4% + Fipronil 0.5% CG], T_{13}- Untreated control.

Fig 1: Field efficacy of newer insecticides against YSB as dead heart infestation (%) in rice during Kharif 2021



T_1 - Thiamethoxam 25% WG, T_2 - Carbofuran 3% CG, T_3 - Fipronil 0.3% GR, T_4 - Chlorantraniliprole 0.4% GR, T_5- Carbofuran 3% CG, T_6 - Fipronil 0.3% GR, T_7- Chlorantraniliprole 0.4% GR, T_8- Thiamethoxam 25% WG + Fipronil 0.3% GR, T_9- Thiamethoxam 25% WG + Chlorantraniliprole 0.4% GR, T_{10}- Thiamethoxam 25% WG + [Cartap hydrochloride 4% + Fipronil 0.5% CG], T_{11}- Fipronil 0.3% GR + Chlorantraniliprole 0.4% GR, T_{12}- Carbofuran 3% CG + [Cartap hydrochloride 4% + Fipronil 0.5% CG], T_{13}- Untreated control.

Fig 2: Field efficacy of newer insecticides against YSB as white earhead infestation (%) in rice during Kharif 2021

Fig 3: View of yellow stem borer (adult)

Fig 4: View of dead heart infested rice hill

Fig 5: View of white earhead infested rice hill

Fig 6: General view of experimental field

Conclusion

Based on the above findings, it is concluded that yellow stem borer (*Scirpophaga incertulas* Walker) was found to be the most damaging species and showed consistency with higher infestation during the crop period. Results showed that chlorantraniliprole 0.4% G was most effective insecticide followed by fipronil 0.3% GR + chlorantraniliprole 0.4% GR, thiamethoxam 25% WG + chlorantraniliprole 0.4% GR and carbofuran 3% CG + [cartap hydrochloride 4% + fipronil 0.5% CG] due to higher grain yield, low cost of the treatments and less damage by the pest.

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