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Research Article

Bioefficacy of certain chemical insecticides against rice yellow stem borer (*Scirpophaga incertulas* Wlk.)

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Abstract
Rice is the major staple food in Jharkhand in India and is threatened by various biotic and abiotic stresses. Among the insect pests that imperil the rice cultivation in Jharkhand, the yellow stem borer (*Scirpophaga incertulas* Wlk.) is one of the most notorious ones. The present investigation was conducted in *Kharif* 2018 to study the bioefficacy of certain chemical insecticidal treatments against yellow stem borers in rice measured in terms of mean values of dead heart (% DH) and white ear (%WE). Ten insecticidal treatments, namely, T_1 - Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 200 ml/ha, T_2 - Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 250 ml/ha, T_3 - Imidacloprid 17.8 SL @150 ml/ha, T_4 - Flubendiamide 480 SC @ 50 ml/ha, T_5 - Rynaxypyr 20 SC @150 ml/ha, T_6 - Fipronil 80 WG @ 65 g/ha, T_7 - Dinotefuran 20 SG @ 200 g/ha, T_8 - Fipronil 0.3 GR followed by Chlorpyriphos 20 EC @2000 ml/ha, T_9 - Chlorpyriphos 20 EC@ 2000 ml/ha and T10 - untreated control were taken for the experiment. The results showed that two of the insecticidal treatments,namely T_2- flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha (2.07% DH and 2.30% WE) and T_4 - flubendiamide 480 SC @ 50 ml/ha (1.89% DH and 2.49% WE), were at par with each other. They performed better than all the other treatments, suggesting that using these two newer insecticidal treatments could provide all-around protection for the rice crop against rice yellow stem borer in terms of both dead heart and white ear.

Keywords: Bioefficacy, Insecticides, Rice, *Scirpophaga incertulas,* Yellow stem borer

INTRODUCTION

The constant surge in the global population has resulted in an ever-increasing demand for food grain production. Rice (*Oryza sativa* L.) is an important cereal crop grown worldwide. It is the staple food and primary source of nutrition for about two-thirds of the world's population. It is also a rich source of various phytochemicals and has vast therapeutic potential that could be exploited more (Sen *et al*., 2020). However, the surmounting infestation of pests and a paradigm shift in the existing pests of rice ecosystem has been threatening rice yields in India (Jena *et al*., 2018).. One of the notable pests of rice crops is the yellow stem borer *Scirpophaga incertulas* Wlk. (Pathak and Khan, 1994). It has been found to damage the rice crop almost all over the world wherever it is cultivated. It has been estimated to cause a loss of up to 10-40% in grain yields in India (Chatterjee and Mondal, 2014) and it is a major pest occurring with moderate to severe intensity throughout the state of Jharkhand (Yadav *et al*., 2018). This pest attacks rice in both vegetative and reproductive stages. The larvae bore into the young rice plant, causing the central shoot to die, ultimately resulting in the death of the plant; hence, this symptom is called a "dead heart". In the reproductive stage, feeding damage by yellow stem borers results in forming a "white ear" where the individual grains do not get filled and the earheads remain chaffy and white, thus leading to direct yield losses (Baskaran *et al.,* 2019). Therefore, the timely management of this notorious pest is needed to meet the increasing global demand for rice. Chemical

control is an integral and essential part of pest management strategies. Especially with major insect pests such as rice yellow stem borers, careful and timely application of chemical insecticides is crucial for their successful management. (Rahaman and Stout, 2019) In this context, the current study aimed to determine the bioefficacy of certain insecticidal treatments and their performance against yellow stem borer *S. incertulas* in terms of both dead hearts and white ears.

MATERIALS AND METHODS

The study was conducted in *Kharif* 2018 at the Rice Research Farm of Birsa Agricultural University, Ranchi, Jharkhand. IR-64 Drt 1, a mid-early maturing (120 days) drought tolerant rice variety, was selected for this study. Ten insecticidal treatments were selected for the experiment, namely, T_1 - Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 200 ml/ha, T_2 - Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 250 ml/ha, T_3 - Imidacloprid 17.8 SL @150 ml/ha, T_4 - Flubendiamide 480 SC @ 50 ml/ha, T_5 - Rynaxypyr 20 SC @150 ml/ha, T_6 - Fipronil 80 WG @ 65 g/ha, T_7 - Dinotefuran 20 SG @ 200 g/ha, T_8 - Fipronil 0.3 GR followed by Chlorpyriphos 20 EC @2000 ml/ha, T_9 - Chlorpyriphos 20 EC@ 2000 ml/ha and T_{10} -untreated control. The experimental design used was a randomised block design, and the treatments were replicated three times. The experiment was conducted using the methodology as followed by Kumari *et al.* (2019), and the insecticidal sprays were given to the rice crop three times at 30, 50 and 85 DAT (days after transplanting). The percentage dead heart (DH%) incidence before spray and at 5, 10 & 15 days after each foliar spray and the mean values were observed and tabulated. Similarly, the incidence of yellow stem borer, *S. incertulas* in terms of white ear (%WE) was also recorded during both the dough and maturity stages. The means were recorded in the form of a table. All the mean %DH and mean %WE values were subjected to angular transformation since the original experimental data were expressed as percentages. The transformed values were taken for statistical analysis by the software OPSTAT (Sheoran *et al.,* 1998).

RESULTS AND DISCUSSION

Dead heart before spray

In the present study, the range of rice yellow stem borer, *S. incertulas* infestation before spraying was observed to be from 6.23% DH to 7.83% DH. The data were examined closely, and it was deduced from the data that the infestation was uniformly distributed as no significant difference was observed among the experimental units based on the analyzed C.D. value (Table 1).

Dead heart after 1st spray

A diligent study of the mean %DH values after 1st spray at 30 DAT (Table 1) showed that the treatment that recorded the least damage by yellow stem borer was flubendiamide 240 SC + thiacloprid 240 SC @250 ml/ha (T2) with 2.71%DH which was at par with the treatment flubendiamide 480 SC @ 50 ml/ha (T4) which showed 3.89%DH. These two treatments proved to be superior to the other treatments in controlling the yellow stem borer at the 30 DAT stage.

Dead heart after 2nd spray

The second application of insecticides was given at 50 DAT, and subsequently, the dead heart data were collected. The mean %DH values following the second spray revealed that again, the treatments flubendiamide 240 SC + thiacloprid 240 SC @250 ml/ha (T_2) (2.34%DH) and flubendiamide 480 SC @ 50 ml/ha (T_4) (2.69%DH) were at par with each other and were significantly superior to all other in reducing the level of stem borer attack in the vegetative stage of the rice crop, i.e., dead heart damage.

Dead heart after 3rd spray

The third application of insecticide was planned to counter the effect of stem borer in the reproductive stage, hence given at 85 DAT. At this point of time, the crop had already transitioned from the vegetative stage and entered the beginning of the reproductive stage. Combined with the effect of two previous insecticidal sprays, the %DH recorded was lower than the previous instances on average. The mean %DH after the third application was studied carefully (Table 1), and it indicated that the flubendiamide 480 SC @ 50 ml/ha treatment (T_4) showed the lowest incidence of yellow stem borers in terms of dead hearts (1.89% DH), which was on par with flubendiamide 240 SC + thiacloprid 240 SC @250 ml/ha (T_2) (2.07% DH). These two treatments were consistent in proving to be the superior treatments in terms of control obtained over the dead heart values among all the treatments under study. In all three cases, the untreated control received the maximum level of pest attack in terms of dead heart, whereas all the other treatments performed significantly better than the untreated control.

White ear

Yellow stem borer infestation in terms of white ears is common in the reproductive stages and is especially pronounced during the dough stage and maturation stage. Therefore, the %WE infestation during the above two stages was recorded, and their mean values were tabulated (Table 2). After careful perusal of the mean % WE, the minimum level of infestation during the dough stage (2.00% WE) was found to be from the flubendia-

Table 1. Effect of certain chemical insecticides on the incidence of dead hearts caused by yellow stem borers (*Scirpophaga incertulas* Walk.) infesting rice

Trt no.	Insecticidal treatments	DH% before spray	Mean DH% after 1st	Mean DH% after 2nd	Mean DH% after 3rd
T_1	Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 200 ml/ha	6.23 (13.55)	4.48 (12.18)	3.90 (11.38)	3.40 (10.57)
T_2	Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 250 ml/ha	7.14 (13.72)	2.71 (9.46)	2.34 (8.75)	2.07 (8.11)
T_3	Imidacloprid 17.8 SL @150 ml/ha	6.55 (14.77)	5.08 (13.01)	3.86 (11.29)	2.85 (9.62)
T_4	Flubendiamide 480 SC @ 50 ml/ha	6.45 (14.19)	3.89 (11.31)	2.69 (9.40)	1.89 (7.71)
T_5	Rynaxypyr 20 SC @150 ml/ha	7.60 (15.72)	5.78 (13.90)	4.87 (12.74)	4.15 (11.70)
T_6	Fipronil 80 WG @ 65 g/ha	6.38 (14.19)	4.63 (12.42)	4.47 (12.17)	4.17 (11.72)
T_7	Dinotefuran 20 SG @ 200 g/ha	7.83 (15.78)	6.46 (14.7)	5.39 (13.41)	3.99 (11.37)
T_8	Fipronil 0.3 GR followed by Chlorpyriphos 20 EC @2000 ml/ha	6.73 (14.43)	3.11 (10.11)	4.06 (11.58)	5.12 (13.07)
T_9	Chlorpyriphos 20 EC@ 2000 ml/ha	6.85 (14.23)	3.93 (11.33)	3.57 (10.88)	3.11 (10.14)
T_{10}	Untreated control	6.77 (12.41)	8.59 (17.03)	12.08 (20.32)	16.70 (24.11)
	SEm (±)	(3.66)	(0.66)	(0.53)	(0.90)
	C.D. (P=0.05)	NS	(1.91)	(1.58)	(2.68)
	C.V. (%)	(15.60)	(8.82)	(7.52)	(13.13)

Figures under parentheses correspond to angular transformed values; NS- Non significant

mide 240 SC + thiacloprid 240 SC@250 ml/ha treatment, which was on par with the flubendiamide 480 SC@50 ml/ha treatment (2.30% WE). Similarly, during the maturity stage, the same two treatments, flubendiamide 240 SC + thiacloprid 240 SC@250 ml/ha (2.60% WE) and flubendiamide 480 SC@50 ml/ha (2.68% WE), showed better control over yellow stem borers than all the other treatments. The critical dosage of these two newer molecule insecticides may play a major role in their efficacy against the rice yellow stem borer.

The mean %WE values from both stages were averaged, and the pooled mean values were scrutinized thoroughly to find the best insecticide treatment. The pooled data revealed that the flubendiamide 240 SC + thiacloprid 240 SC@250 ml/ha (2.30% WE) and flubendiamide 480 SC@50 ml/ha (2.49% WE) treatments performed better than the all the other treatments under study and were at par with each other in terms of the mean% WE level.

The above findings were found to be in line with the experimental findings of Netam (2015), who also performed a study on the bioefficacy evaluation of synthetic insecticides and biopesticides on rice yellow stem borers and their natural enemies. Their experiments showed that the most effective treatment in minimising the number of dead hearts and white ears was flubendiamide 24%+ thiacloprid 24% (48%) SC @ 200 ml/ha, followed by flubendiamide 48% SC @125 ml/ha and cartap hydrochloride 50% WP @ 750 g/ha.

An experiment by Chormule et al. (2014) also revealed that the infestation of stem borer was effectively checked due to a spray of fipronil 5 SC @ 30 g a.i./ha (4.08 %DH and 4.33%WE). The next best treatment in order of effectiveness was found to be flubendiamide 480 SC @ 30 g a.i./ha (4.44 %DH and 4.81 %WE).

Another study by Pallavi *et al.* (2018) reported that in controlling infestation by yellow stem borers, newer insecticide molecules, viz. chlorantraniliprole 0.4 GR and flubendiamide 480 SC @ 0.1 ml/L proved to be

Table 2. Effect of certain chemical insecticides on the incidence of white ear caused by yellow stem borer (*Scirpophaga incertulas* Walk.) infesting rice

Trt no.	Insecticidal treatments	White ear (WE%) incidence after insecticidal treatments at		Mean WE%
		Dough stage	Maturity stage	
T_1	Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 200 ml/ha	3.48 (10.63)	3.98 (11.46)	3.73 (11.07)
T_2	Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 250 ml/ha	2.00 (8.08)	2.60 (9.23)	2.30 (8.71)
T_3	Imidacloprid 17.8 SL @150 ml/ha	4.70 (12.44)	5.30 (13.29)	5.00 (12.91)
T_4	Flubendiamide 480 SC @ 50 ml/ha	2.30 (8.60)	2.68 (9.35)	2.49 (9.00)
T_5	Rynaxypyr 20 SC @150 ml/ha	4.90 (12.71)	5.30 (13.28)	5.10 (13.01)
T_6	Fipronil 80 WG @ 65 g/ha	4.70 (12.49)	4.96 (12.80)	4.83 (12.66)
T_7	Dinotefuran 20 SG @ 200 g/ha	5.60 (13.65)	5.85 (13.94)	5.73 (13.84)
T_8	Fipronil 0.3 GR followed by Chlorpyriphos 20 EC @2000 ml/ha	4.60 (12.36)	5.13 (13.05)	4.87 (12.73)
T_9	Chlorpyriphos 20 EC@ 2000 ml/ha	4.72 (12.48)	5.26 (13.2)	4.99 (12.89)
T_{10}	Untreated control	13.40 (21.45)	14.70 (22.52)	14.05 (21.99)
	SEm (±)	(0.89)	(0.73)	(0.64)
	C.D. (P=0.05)	(2.68)	(2.18)	(1.91)
	C.V. (%)	(12.40)	(9.53)	(8.56)

Figures under parentheses correspond to angular transformed values

more effective than the other insecticidal treatments taken for the experiment namely, Chlorantraniliprole 18.5 SC@ 0.3 ml/L, Acephate 95SG @ 1.2 ml/L, Fipronil 0.3GR @ 10 kg /ac, Chlorantraniliprole 0.4GR @ 4kg/ha, Lambdacylothrin 4.9 CS @ 0.5 ml/L and Chlorpyriphos 20 EC @ 2 ml/L. Sandhu and Dhaliwal (2018) opined that the insecticide treatment flubendiamide 480 SC @ 50 ml/ha was the most promising treatment in reducing both the dead heart and white ear symptoms of the rice yellow stem borer, thus proving to be providing better control during both the vegetative and reproductive stages. While these results are also in association with the findings of the current study, in all the various experiments conducted by multiple researchers, the dosage of these newer insecticidal molecules suggested for effective control varies. The critical dosage of these insecticides may be an impacting factor which plays a major role in imparting control over the rice yellow stem borer under Jharkhand conditions.

Conclusion

The overall results comparing both the mean % DH and mean % WE showed that in minimising the infestation of rice yellow stem borer, *Scirpophaga incertulas* in terms of both dead heart and white ear, two insecticide treatments namely, flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha (T_2) and flubendiamide 480 SC @ 50 ml/ha (T_4) outperformed all the other treatments thus proving that these treatments could effectively provide all around control of the pest throughout the cropping season (Kharif).

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Conflict of interest

The authors declare that they have no conflict of interest.

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