Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 2625-2628
Received: 28-05-2019
Accepted: 30-06-2019

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Bioefficacy of certain insecticides against rice yellow stem borer, *Scirpophaga incertulas* (Walker)

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Abstract
A field experiment was conducted to evaluate the efficacy of ten insecticides against Yellow Stem Borer (YSB), *Scirpophaga incertules* (Walker) infestation in rice variety Samba mashuri, BPT-5204. All the treatments were found significantly effective in reducing the infestation of YSB and increasing the yield compared with control. Chlorantraniliprole 18.5 SC @ 0.3 mL/L shows most effective with lowest dead hearts and white earheads and cartap hydrochloride 50 SP @ 2 g/L shows least effective.

Keywords: Yellow Stem Borer (YSB), *Scirpophaga incertulas*, dead hearts and white earheads

1. Introduction
Rice, *Oryza sativa* (Linneaus) is the most important cereal food crop and grown worldwide over an area of 153 million hectares with annual production of more than 600 million tonnes [5]. It occupies largest area among all food crops in India and is cultivated in an area of 43.19 million hectares with 110.15 million tonnes of production and 2550 kg/ha of productivity [1]. Rice cultivation is commonly encountered by different biotic factors and among these insect pests are the main causes of low yields in India [2]. Rice crop is attacked by more than 100 species of insects, but 20 species are of economic importance. Insect pests *viz.*, stem borer, leaf folder, gall midge and planthoppers are the major constraints in achieving desired level of rice yield. The yield losses caused by the insect pests in rice have been reported to the tune of 25 per cent [3].
Among the insect pests, Yellow Stem Borer (YSB), *Scirpophaga incertulas* (Walker) is the major stem borer accounting 30-80 per cent yield losses [5] and the insecticides are commonly used by the farmers to manage YSB in rice[8]. By the change in the resistance level of pest and discovery of new chemicals with insecticidal activities always provide room to conduct field trials to evaluate their efficacy. Keeping in view of the above, in the present study, an attempt has been made to evaluate the efficacy of certain insecticides against YSB in transplanted rice.

2. Material and Methods
A field experiment was conducted during *rabi*, 2017-18 in the Wetland Farm of S.V. Agricultural College, Tirupati to evaluate the efficacy of certain insecticides against rice stem borer in a randomized block design with three replications. Thirty days old seedlings of rice variety, Samba mashuri (BPT-5204) was transplanted with a spacing of 15×10 cm in a plot of 20 sq.m and all agronomical practices recommended for the region were followed to raise the crop. There were ten treatments which comprised of carbofuran 3G @10 kg/acre, cartap hydrochloride 4G @ 8 kg/acre, acephate 75 SP @ 1.5 g/L, cartap hydrochloride 50 SP @ 2 g/L, chlorantraniiprole 18.5 SC @ 0.3 mL/L, chlorpyrifos 20 EC @ 2.5 mL/L, dichlorvos 76 EC @ 1 mL/L, flubendiamide 20 WDG @ 0.25 g/L, monocrotophos 36 SL @ 1.6 mL/L, profenofos 50 EC @ 2 mL/L and one untreated control. Each treatment was applied twice during the crop growing season at 40 and 60 days after transplanting.
Observations on infestation of yellow stem borer as dead hearts and white earheads were recorded from 10 randomly selected hills from each plot at one day before and 5,10 and 15 days after insecticide application. The WEH (%) formation was recorded one day before crop harvest. The yield obtained from various treatments were expressed as quintal/ha prior to statistical analysis. Percentage of DH and WEH formation was computed as follows:

$$DH\ \% = \frac{\text{Total number of dead hearts in 10 hills}}{\text{Total number of tillers (dead hearts + healthy tillers) in 10 hills}} \times 100$$

$$WEH\ \% = \frac{\text{Total number of white earheads in 10 hills}}{\text{Total number of ear bearing tillers (white earheads + healthy ears) in 10 hills}} \times 100$$

3. Results and Discussion

3.1 Efficacy of insecticides against dead hearts formation after first application

The initial percentages of rice dead hearts ranged from 8.73 to 9.17 one day before insecticidal application (Table 1). The insecticides flubendiamide (8.85%), chlorantraniliprole (9.07%), chlorpyrifos (9.24%), profenofos (9.26%) and monocrotophos (9.28%) were most effective and were on par with each other in their efficacy against rice stem borer infestation at 5 days after insecticidal application in the formation of dead hearts. The least effective insecticide was acephate (9.73%) followed by dichlorvos, cartap hydrochloride 50 SP, cartap hydrochloride 4 G and carbofuran with the dead heart percentages of 9.71, 9.50, 9.39 and 9. 32 in which there is no significant difference with each other in their efficacy. At 10 days after insecticidal application, flubendiamide followed by chlorantraniliprole, chlorpyrifos, profenofos, monocrotophos were in the order of their efficacy as superior ones with dead heart percentages of 9.23, 9.26, 9.69, 9.71 and 9.89. The cartap hydrochloride 50 SP with the dead heart percentage of 11.03 represents the least effective one followed by dichlorvos (10.95%), acephate (10.87%) and cartap hydrochloride 4 G (10.39%). The insecticide chlorantraniliprole with the dead heart percentage of 9.50 shows the superior one among all the other insecticides followed by flubendiamide (9.79%) as the next best treatment at 15 days after insecticidal application. The remaining order of efficacy against rice stem borer infestation follows the same trend as that of in 10 days after insecticidal application. The mean per cent dead hearts over untreated control was observed as lowest in chlorantraniliprole (9.28%) followed by flubendiamide (9.29%), chlorpyrifos (9.75%) and profenofos (9.83%) while highest was recorded in cartap hydrochloride 50 SP (11.04%) followed by dichlorvos (11.03%), acephate (10.90%) and cartap hydrochloride 4 G (10.38%) treated plots (Table 1).

3.2 Efficacy of insecticides against dead hearts formation after second application

One day before the insecticidal application, the rice dead hearts percentages were ranged from 9.94 to 19.94. With the lowest dead heart percentage of 10.09, the chlorantraniliprole stand as the superior one in efficacy when compared to the other insecticides at 5 days after insecticidal application. The remaining insecticides viz., flubendiamide, chlorpyrifos, profenofos, monocrotophos, carbofuran, cartap hydrochloride 4 G, acephate, dichlorvos and cartap hydrochloride 50 SP remains as the next best in the order of their efficacy against occurrence of rice dead hearts. At 10 and 15 days of insecticidal application, the order of efficacy of different insecticides follows the same trend as that of 5 days after insecticidal application (Table 2).

After two insecticidal applications, the cumulative mean per cent dead hearts over untreated control indicated that the chlorantraniliprole shows most effective with lowest dead heart per cent of 9.83 followed by flubendiamide, chlorpyrifos and profenofos as the next best treatments with the dead heart percentages of 10.21, 11.02 and 11.17. The least effective treatment was cartap hydrochloride 50 SP with dead heart per cent of 13.73 followed by dichlorvos (13.57%), acephate (13.36%) and cartap hydrochloride (12.35%) (Table 3).

3.3 Efficacy of insecticides against white earheads formation

Before harvesting the rice crop, the white earheads damage percentages were observed and the insecticide chlorantraniliprole with 4.59% remain as the superior one followed by flubendiamide (5.92%), and were not on par with each other in their efficacy and the next best treatrments were chlorpyrifos (6.53%) and profenofos (7.72%). The least effectivity against formation of rice white earheads was observed in cartap hydrochloride 50 SP (14.15%) followed by dichlorvos (13.23%), acephate (12.47%) and cartap hydrochloride 4 G (11.35%) treated plots (Table 2).

3.4 Efficacy of insecticides against grain yield

From the table 2, it is evident that the all the insecticides were effective and gives more grain yield when compared to untreated control. The insecticide chlorantraniliprole (57.92 q/ha) gives more yield followed by flubendiamide (55.88 q/ha) and chlorpyrifos (54.85 q/ha) and were on par with each other in their efficacy against grain yield. The lowest yield was recorded in cartap hydrochloride 50 SP (46.05 q/ha) followed by dichlorvos and acephate with the yield of 47.15 and 48.68 q/ha and there is no significant difference with each other in grain yield.

The results which were presented in the tables 1 to 3 revealed that, all the treatments had significant control of rice dead hearts and white earheads formation and gives more yield over untreated control. Chlorantraniliprole @ 0.3 mL/L was found most effective insecticide against rice stem borer infestation in the formation of dead hearts and white earheads followed by flubendiamide, chlorpyrifos and profenofos while cartap hydrochloride 50 SP @ 2 g/L was found to be least effective. The results obtained in the present study are in coincidence with the findings of Sachan *et al.* [7] who reported that application of chlorantraniliprole 18.5 SC @ 150 mL/ha was the most effective and superior treatment in reducing the stem borer infestation at all observational interval resulting higher grain yield (44.10 q/ha). The results obtained to Vikas and Ajai [10] revealed that flubendiamide 48% SC @ 50 mL/ha was found most promising with minimum dead heart and white ears and gives more yield. Randhawa *et al.* [6] and Sandhu and Dhaliwal[8] efficacy studies showed that there is a significant reduction in dead hearts and white ears and minimized the yield loss in plots treated with flubendiamide @ 50 mL/ha as compared with other insecticidal treatments. Sharanappa *et al.* [9] reported that the highest reduction per cent of rice stem borer and highest yield was recorded in monocrotophos, followed by chloropyrifos, flubendiamide, acephate, cartap hydrochloride, imidacloprid and fipronil. Similarly Devi and Singh [4] observed that flubendiamide 39.35 SC @ 24 g a.i./ha was found quite effective against rice yellow stem borer recording mean per cent DH and WEH of 3.48 and 1.32 respectively and gives highest grain yield of 60.3 q/ha.

Table 1: Efficacy of treatments against rice dead hearts formation after first application during *rabi*, 2017-18

S. No	Treatments	Dosage	Pre-treatment DH%	Post treatment DH%			Mean
				5 DAIA	10 DAIA	15 DAIA	
T_1	Carbofuran 3 G	10 kg/acre	8.73 (17.18)	9.32 (17.77)^{bcd}	10.31 (18.73)^{c}	11.28 (19.62)^{d}	10.30 (18.72)^{c}
T_2	Cartap hydrochloride 4 G	8 kg/acre	9.05 (17.50)	9.39 (17.85)^{bcd}	10.39 (18.80)^{cd}	11.35 (19.69)^{d}	10.38 (18.79)^{c}
T_3	Acephate 75 SP	1.5 g/L	8.96 (17.42)	9.73 (18.17)^{d}	10.87 (19.25)^{de}	12.11 (20.36)^{e}	10.90 (19.28)^{d}
T_4	Cartap hydrochloride 50 SP	2 g/L	8.94 (17.39)	9.50 (17.95)^{bcd}	11.03 (19.40)^{e}	12.58 (20.78)^{f}	11.04 (19.40)^{d}
T_5	Chlorantraniliprole 18.5 SC	0.3 mL/L	8.92 (17.37)	9.07 (17.53)^{ab}	9.26 (17.71)^{a}	9.50 (17.95)^{a}	9.28 (17.73)^{a}
T_6	Chlorpyrifos 20 EC	25 mL/L	8.88 (17.33)	9.24 (17.70)^{ab}	9.69 (18.13)^{ab}	10.31 (18.73)^{b}	9.75 (18.19)^{b}
T_7	Dichlorvos 76 EC	1 mL/L	9.17 (17.62)	9.71, (18.16)^{cd}	10.95 (19.32)^{e}	12.42 (20.63)^{ef}	11.03 (19.39)^{d}
T_8	Flubendiamide 20 WDG	0.25 g/L	8.77 (17.22)	8.85 (17.30)^{a}	9.23 (17.68)^{a}	9.79 (18.23)^{a}	9.29 (17.74)^{a}
T_9	Monocrotophos 36 SL	1.6 mL/L	8.92 (17.37)	9.28 (17.73)^{abcd}	9.89 (18.33)^{bc}	10.74 (19.13)^{c}	9.97 (18.41)^{b}
T_{10}	Profenofos 50 EC	2 mL/L	8.90 (17.35)	9.26 (17.72)^{abc}	9.71 (18.15)^{ab}	10.51 (18.91)^{bc}	9.83 (18.27)^{b}
T_{11}	Untreated control	-	9.15 (17.60)	11.81 (20.10)^{e}	14.50 (22.38)^{f}	17.19 (24.49)^{g}	14.50 (22.38)^{e}
	SE(m)		-	0.14	0.15	0.13	0.09
	CD (P=0.05)		-	0.40	0.44	0.38	0.27

Figures in parentheses are angular transformed values; DAIA: Days After Insecticidal Application The values followed by same letter did not differ significantly as per DMRT

Table 2: Efficacy of treatments against rice dead hearts and white earheads formation after second application and yield during *rabi*, 2017-18

S. No	Treatments	Dosage	Pre-treatment DH%	Post treatment DH%				white earheads (WEH)%	Yield (q/ha)
				5 DAIA	10 DAIA	15 DAIA	Mean		
T_1	Carbofuran 3 G	10 kg/acre	12.67(20.85)^{e}	13.13 (21.25)^{e}	14.25 (22.17)^{e}	15.40 (23.11)^{e}	14.26 (22.19)^{e}	9.45 (17.88)^{d}	51.98^{cde}
T_2	Cartap hydrochloride 4 G	8 kg/acre	12.75 (20.92)^{e}	13.13(21.25)^{e}	14.33 (22.24)^{e}	15.49 (23.17)^{e}	14.31 (22.23)^{e}	11.35 (19.66)^{e}	50.35^{def}
T_3	Acephate 75 SP	1.5 g/L	13.73 (21.74)^{f}	14.56 (22.43)^{f}	15.77 (23.40)^{f}	17.13 (24.45)^{f}	15.82 (23.44)^{f}	12.47 (20.67)^{ef}	48.68^{efg}
T_4	Cartap hydrochloride 50 SP	2 g/L	14.16 (22.10)^{f}	14.80 (22.63)^{f}	16.44 (23.92)^{g}	18.04 (25.13)^{g}	16.43 (23.91)^{h}	14.15 (22.09)^{f}	46.05^{g}
T_5	Chlorantraniliprole 18.5 SC	0.3 mL/L	9.94 (18.38)^{a}	10.09 (18.52)^{a}	10.34 (18.76)^{a}	10.73 (19.12)^{a}	10.39 (18.80)^{a}	4.59 (12.31)^{a}	57.92^{a}
T_6	Chlorpyrifos 20 EC	25 mL/L	11.24 (19.59)^{c}	11.69 (19.99)^{c}	12.24 (20.48)^{c}	12.95 (21.09)^{c}	12.29 (20.52)^{c}	6.53 (14.77)^{bc}	54.85^{abc}
T_7	Dichlorvos 76 EC	1 mL/L	14.18 (22.12)^{f}	14.70 (22.54)^{f}	16.02 (23.60)^{fg}	17.64 (24.83)^{g}	16.12 (23.67)^{g}	13.23 (21.31)^{ef}	47.15^{fg}
T_8	Flubendiamide 20 WDG	0.25 g/L	10.44 (18.85)^{b}	10.59 (19.00)^{b}	11.10 (19.46)^{b}	11.72 (20.02)^{b}	11.14 (19.49)^{b}	5.92 (14.08)^{b}	55.88^{ab}
T_9	Monocrotophos 36 SL	1.6 mL/L	11.88 (20.16)^{d}	12.30 (20.53)^{d}	12.96 (21.10)^{d}	13.91 (21.90)^{d}	13.06 (21.18)^{d}	8.51 (16.92)^{d}	53.02^{bcd}
T_{10}	Profenofos 50 EC	2 mL/L	11.56 (19.88)^{cd}	11.93 (20.20)^{cd}	12.40 (20.62)^{c}	13.23 (21.33)^{c}	12.52 (20.72)^{c}	7.72 (16.11)^{cd}	54.05^{bcd}
T_{11}	Untreated control	-	19.94 (26.52)^{g}	22.71 (28.46)^{g}	25.38 (30.25)^{h}	28.08 (32.00)^{h}	25.39 (30.26)^{i}	17.15 (24.45)^{g}	41.62^{h}
	SE(m)		-	0.13	0.13	0.11	0.06	0.59	0.68
	CD (P=0.05)		-	0.39	0.39	0.34	0.19	1.74	2.02

Figures in parentheses are angular transformed values; DAIA: Days After Insecticidal Application
The values followed by same letter did not differ significantly as per DMRT

Table 3: Cumulative efficacy of treatments against rice dead hearts formation after two applications during *rabi*, 2017-18

S. No	Treatments	Dosage	Pre treatment DH%	Post treatment DH%			Mean
				5 DAIA	10 DAIA	15 DAIA	
T_1	Carbofuran 3 G	10 kg/acre	10.70 (19.09)^{de}	11.22 (19.57)^{d}	12.28 (20.51)^{e}	13.34 (21.42)^{e}	12.28 (20.51)^{e}
T_2	Cartap hydrochloride 4 G	8 kg/acre	10.90 (19.27)^{ef}	11.26(19.61)^{d}	12.36 (20.58)^{e}	13.42 (21.49)^{e}	12.35 (20.57)^{e}
T_3	Acephate 75 SP	1.5 g/L	11.34 (19.68)^{fg}	12.14 (20.39)^{e}	13.32 (21.40)^{f}	14.62 (22.48)^{f}	13.36 (21.44)^{f}
T_4	Cartap hydrochloride 50 SP	2 g/L	11.55 (19.86)^{g}	12.15 (20.40)^{e}	13.73 (21.75)^{f}	15.31 (23.03)^{g}	13.73 (21.75)^{g}
T_5	Chlorantraniliprole 18.5 SC	0.3 mL/L	9.43 (17.88)^{a}	9.58 (18.03)^{a}	9.80 (18.24)^{a}	10.11 (18.54)^{a}	9.83 (18.27)^{a}
T_6	Chlorpyrifos 20 EC	25 mL/L	10.06 (18.49)^{bc}	10.46 (18.87)^{b}	10.97 (19.34)^{c}	11.63 (19.94)^{c}	11.02 (19.39)^{c}
T_7	Dichlorvos 76 EC	1 mL/L	11.67 (19.98)^{g}	12.21 (20.45)^{e}	13.49 (21.55)^{f}	15.03 (22.81)^{g}	13.57 (21.62)^{fg}
T_8	Flubendiamide 20 WDG	0.25 g/L	9.61 (18.05)^{ab}	9.72 (18.17)^{a}	10.16 (18.59)^{b}	10.75 (19.14)^{b}	10.21 (18.64)^{b}
T_9	Monocrotophos 36 SL	1.6 mL/L	10.40 (18.81)^{cde}	10.79 (19.18)^{c}	11.43 (19.76)^{d}	12.33 (20.55)^{d}	11.51 (19.84)^{d}
T_{10}	Profenofos 50 EC	2 mL/L	10.23 (18.65)^{cd}	10.59 (18.99)^{bc}	11.05 (19.42)^{cd}	11.87 (20.15)^{c}	11.17 (19.53)^{c}
T_{11}	Untreated control	-	14.55 (22.42)^{h}	17.26 (24.55)^{f}	19.94(26.52)^{g}	22.63 (28.41)^{h}	19.94 (26.53)^{h}
	SE(m)		-	0.07	0.10	0.09	0.06
	CD (P=0.05)		-	0.20	0.31	0.28	0.18

4. Conclusions

The study was conducted to assess the efficacy of different insecticides in controlling rice yellow stem borer and it was found and concluded that chlorantraniliprole followed by flubendiamide were effective against dead hearts and white earheads formation and gives more yield when compared to other trearments and untreated control. However different insecticides should be used alternatively to avoid risk of development of resistant to rice yellow stem borer.

5. Acknowledgment

This research article is the outcome of the Ph.D programme. The authors were thankful to the Associate Dean, S V Agricultural College, Tirupati, Andhra Pradesh for providing

infrastructural and other required facilities to carry out the experiment. We acknowledge Principal Scientist, Agricultural Research Station, Nellore, Andhra Pradesh, India for sponsoring the BPT-5204 rice variety for the study.

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