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Efficacy of some insecticide modules against major insect pests and spider population of rice, *Oryza sativa* L.

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ABSTRACT: Experiments were carried out to assess some insecticide modules against major insect pests of rice. Each module consists of a basal application of carbofuran 3G @ 1 kg a.i ha^{-1} at 20 DAT and Rynaxypyr 20 SC @ 30 g a.i ha^{-1} at 45 DAT except untreated control. All modules differ with each other only in third treatment which was applied in 65 DAT. The third treatment includes: Imidacloprid 17.8 SL @ 27 g a.i ha^{-1}, Pymetrozine 50 WG @ 150 g a.i ha^{-1}, Triflumezopyrim 106 SC @ 27 g a.i ha^{-1}, Buprofezin 25 SC @ 250 g a.i ha^{-1}; Glamore (Imidacloprid 40+Ethiprole 40% w/w) 80 WG @ 100 g a.i. ha^{-1}, Thiacloprid 24 SC @ 60 g a.i ha^{-1}, Azadirachtin 0.03 EC @ 8 g a.i ha^{-1}, Dinotefuran 20 SG@ 40 g a.i ha^{-1} and untreated control. All the treated plots recorded significantly lower percent of dead heart, white ear- head caused by stem borer and silver shoot caused by gall midge. Module with Pymetrozine 50 WG @ 150 g a.i ha^{-1} treated plot recorded significantly higher per cent reduction of plant hoppers (>80% over untreated control) and produced higher grain yield (50.75 qha^{-1}) than the other modules. Among the different treated modules the maximum number of spiders was found in Azadirachtin 0.03 EC @ 8 g a.i ha^{-1} treated module plot followed by other treatments. © 2018 Association for Advancement of Entomology

KEYWORDS: Stem borer, plant hoppers, gall midge, spiders, insecticide modules, rice

INTRODUCTION

Rice (*Oryza sativa L.)* is one of the most important cereal crops providing a staple food for nearly half of the global population (FAO, 2004). In India, it is cultivated almost in one-fourth of the total cropped area providing food to about half of the Indian population. It thrives well under varying ecosystems starting from rain fed upland to rain fed lowland and the deep water condition. But, introduction and wide adoption of high yielding varieties has led to severe incidence of different insect pests. Nearly 300 species of insect pests attack the rice crop at different stages and among them only 23 species cause notable damage (Pasalu and Katti, 2006). Among them, yellow stem borer (YSB) - *Scirpophaga incerulas* (Walk.), brown plant hopper (BPH) - *Nilaparvata lugens* (Stål), white backed plant hopper (WBPH) - *Sogatella furcifera* (Horvath) and Asian rice gall midge (GM) - *Orseolia oryzae* (Wood-Mason) are the major cause for the economic crop loss in rice. Chemical insecticides are still effective method to control insect pests particularly in the rice crop. Many conventional insecticides though have been evaluated against these insects, yet, most of the chemicals have failed to provide adequate control. Hence, new molecules are being added for their

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evaluation with an aim of least disruption to environmental quality. For this, the present study was carried out to find the efficacy of certain insecticide modules with new and conventional molecules against major insect pests and spider population in rice.

MATERIALS AND METHODS

The experiment was conducted in the experimental farm of Regional Research and Technology Transfer Station (OUAT), Chiplima, Sambalpur, Odisha, during *kharif* 2016 and 2017. The Station is situated at $20^0$21' N latitude and $80^0$55'E longitude in Dhankauda block of Sambalpur district at an altitude of 178.8 m above MSL. The climate of the area is warm sub humid. The experiment was conducted in Randomized Block Design (RBD), having 9 modules which were replicated thrice in a net experimental area of 5 m x 4 m each. Nursery of rice variety Swarna was raised in the first week of July and transplanting was done after 25 days of sowing at 20 cm x 15 cm hill spacing. All the agronomic practices were followed during crop growth period.

There were eight insecticide modules and each module consists of application of carbofuran 3G @ 1 kg a.i ha^{-1} at 20 DAT and Rynaxypyr 20 SC @ 30 g a.i ha^{-1}at 45 DAT. All insecticide modules differ with each other only in the third application at 65 DAT. The third application include: Imidacloprid 17.8 SL @ 27 g a.i ha^{-1}, Pymetrozine 50 WG @ 150 g a.i ha^{-1}, Triflumezopyrim 106 SC @ 27 g a.i ha^{-1}, Buprofezin 25 SC @ 250 g a.i ha^{-1}; Glamore (Imidacloprid 40+Ethiprole 40% w/w) 80 WG @ 100 g a.i ha^{-1}, Thiacloprid 24 SC @ 60 g a.i ha^{-1}, Azadirachtin 0.03 EC @ 8 g a.i $ha^{-1}$and Dinotefuran 20 SG @ 40 g a.i ha^{-1}respectively in 1^{st} to 8th module. Module nine was untreated control. The insecticides were applied as high volume sprays using 500 litres of spray waterha^{-1}. Observations on the incidence of dead heart and silver shoot were taken on 10 randomly selected hills per plot from each replication at 30 and 55 days after transplanting. The white ear head was counted on 10 randomly selected hills from each plot just before harvest. Then percentage of dead hearts, white ear heads and silver shoot was worked out. The hopper population per 10 hills was recorded 7 days after third spray. The spider (natural enemies) population per 10 hills was recorded 55 and 75 days after transplanting. Mean value of data obtained from field experiments were transformed into square root values and analyzed statistically by ANOVA. Finally the grain yield was recorded per plot basis and expressed in quintal ha^{-1}.

RESULTS AND DISCUSSION

Stem borer management: The result showed that all the insecticide modules were effective in reducing the infestation of rice yellow stem borer (YSB) and thus, reducing the formation of dead hearts and white ear heads significantly as compared to the untreated control (Table 1). In treated plots, in 2016, the yellow stem borer infestation recorded as dead hearts ranged from 3.21 to 3.87% and white ears ranged from 4.26 to 7.13% as against 8.82 and 12.01% in control respectively. Whereas, in 2017, the dead hearts ranged from 3.41 to 4.26% and white ears ranged from 4.58 to 7.03% as against 9.36 and 10.68% in control respectively.

Gall midge management: Gall midge is one of the major insect pests of rice in Hirakud command area, Chiplima, Sambalpur. From the experimental result, it is observed that all the insecticide modules were effective in reducing the infestation of gall midge (GM) and thus, suppressing the formation of silver shoot significantly as compared to the untreated control (Table 2). In insecticide treated plots, in 2016 the gall midge infestation recorded as silver shoot ranged from 5.76 to 6.44% as against 14.27% in control. Whereas, in 2017 the silver shoot ranged from 5.78 to 6.97% as against 12.03% in untreated control.

Plant Hoppers management: Module with Pymetrozine 50 WG @ 150 g a.i ha^{-1} recorded significantly superior (>80 % reduction over control) in efficacy against plant hoppers during both the years followed by treatment with Triflumezopyrim 106 SC @ 27 g a.i ha^{-1}, Thiacloprid 24 SC @ 60 g a.i ha^{-1}, Glamore (Imidacloprid 40+Ethiprole 40%

Table 1. Efficacy of different insecticide modules against stem borer of rice

Modules*	Dead Hearts(%)		Pooled	White Ear Head (%)		Pooled
	2016	2017		2016	2017	
1	3.42 (1.98)	3.91 (2.10)	3.67 (2.04)	5.42 (2.43)	5.63 (2.48)	5.53 (2.45)
2	3.41 (1.98)	3.89 (2.09)	3.65 (2.04)	4.26 (2.18)	4.58 (2.25)	4.42 (2.22)
3	3.63 (2.03)	4.26 (2.18)	3.94 (2.11)	4.60 (2.26)	4.89 (2.32)	4.75 (2.29)
4	3.21 (1.92)	3.41 (1.97)	3.31 (1.94)	6.29 (2.61)	6.56 (2.66)	6.43 (2.63)
5	3.87 (2.09)	4.10 (2.14)	3.98 (2.11)	4.97 (2.34)	5.88 (2.52)	5.43 (2.43)
6	3.40 (1.97)	3.79 (2.07)	3.70 (2.05)	5.20 (2.39)	5.53 (2.46)	5.37 (2.42)
7	3.61 (2.02)	3.83 (2.07)	3.72 (2.04)	7.13 (2.76)	7.03 (2.74)	7.08 (2.75)
8	3.42 (1.98)	3.64 (2.03)	3.53 (2.01)	6.31 (2.61)	5.96 (2.54)	6.13 (2.57)
9	8.82 (3.05)	9.36 (3.14)	9.09 (3.10)	12.01(3.53)	10.68 (3.34)	11.34 (3.44)
S.Em	0.08	0.10	0.08	0.05	0.05	0.04
CD (5%)	0.24	0.31	0.23	0.16	0.16	0.12

Figures in parentheses are square root transformed values
*Module 1**: A+B+ Imidacloprid 17.8 SL @ 27 g a.iha^{-1}, Module 2: A+B+Pymetrozine 50 WG @ 150 g a.i ha^{-1} Module 3: A+B+ Triflumezopyrim 106 SC @ 27 g a.iha^{-1} Module 4: A+B+ Buprofezin 25 SC @ 250 g a.iha^{-1} Module 5: A+B+ Glamore (Imidacloprid 40+Ethiprole 40% w/w) 80 WG @ 100 g a.i ha^{-1} Module 6: A+B+ Thiacloprid 24 SC @ 60 g a.iha^{-1} Module 7: A+B+ Azadirachtin 0.03 EC @ 8 g a.iha^{-1} Module 8: A+B+ Dinotefuran 20 SG@ 40 g a.iha^{-1} and Module 9: untreated control.
**A+ B = Carbofuran 3G @ 1 kg a.i ha^{-1} at 20 DAT and Rynaxypyr 20 SC @ 30 g a.i ha^{-1} at 45 DAT

Table 2. Efficacy of different insecticide modules against gall midge and plant hoppers in rice

Modules*	Silver shoot (%)		Pooled	Plant Hoppers 10 hills^{-1}		Pooled
	2016	2017		2016	2017	
1	6.42 (2.63)	6.97 (2.73)	6.69 (2.68)	68.00	94.67	81.33
2	5.76 (2.50)	6.05 (2.55)	5.91 (2.53)	28.33	39.67	34.00
3	5.98 (2.54)	6.17 (2.58)	6.07 (2.56)	32.33	45.67	39.00
4	6.43 (2.63)	6.16 (2.58)	6.29 (2.60)	70.33	97.67	84.00
5	6.44 (2.63)	6.25 (2.59)	6.34 (2.62)	56.33	82.00	69.17
6	5.94 (2.54)	6.10 (2.57)	6.02 (2.55)	52.33	72.33	62.33
7	6.19 (2.58)	6.21 (2.59)	6.20 (2.59)	78.00	107.00	92.50
8	6.42 (2.63)	5.78 (2.50)	6.10 (2.57)	62.00	83.67	72.83
9	14.27 (3.84)	12.03 (3.54)	13.15 (3.69)	150.67	190.67	170.67
S.Em	0.07	0.09	0.07	1.78	2.31	1.42
CD (5%)	0.21	0.28	0.20	5.34	6.93	4.25

Figures in parentheses are square root transformed values
*Module details are given in table 1

w/w) 80 WG @ 100 g a.i ha^{-1}, Dinotefuran 20 SG@ 40 g a.i ha^{-1},Imidacloprid 17.8 SL @ 27 g a.iha^{-1}, Buprofezin 25 SC @ 250 g a.i ha^{-1} and Azadirachtin 0.03 EC @ 8 g a.i ha^{-1}. Module with Imidacloprid 17.8 SL @ 27 g a.i ha^{-1} and Buprofezin 25 SC @ 250 g a.i ha^{-1}were at par in efficacy against hoppers. All the modules were superior in plant hopper management and differed significantly from untreated control plot (Table 2).

Effect on spiders: Spiders are most important predators of rice hoppers and other insect pests. But, indiscriminate and nonselective use of insecticides causes disruption in their life cycle. Most of the spiders in rice fields seem to leave the field after application of chemical insecticides, thus their predatory capacity was suppressed and caused a positive impact on the population densities of major insect pests of rice. For this, selection of insecticides is very important for insect management point of view. The results on the presence of spiders in different treatments (Table 3) showed that highest numbers of spiders were found in the un-treated control (8 per 10 hills) than in other treated plots. The abundant spider families are Araneidae *(Argiope catenulate)*, Lycosidae (*Lycosa pseudoannulata)*, Tetragnathidae *(Tetragnatha sp.)*,Therididae *(Argyrodes sp.)* and Salticidae (*Plexippus sp)*.It is also observed that hunter spiders were more abundant in treated plots than weaving spiders which were more common in untreated control plots. It means the treatment had a strong effect on weaving spiders. Among different insecticide treatments, it was found that maximum spider population was present in module with Azadirachtin 0.03 EC @ 8 g a.i ha^{-1}treated plot (6 per 10 hills) followed by buprofezin 25 SC @ 250 g a.i ha^{-1}, Pymetrozine 50 WG @ 150 g a.i ha^{-1}, Triflumezopyrim 106 SC @ 27 g a.i ha^{-1}, Thiacloprid 24 SC @ 60 g a.i ha^{-1}, Dinotefuran 20 SG @ 40 g a.i ha^{-1},Imidacloprid 17.8 SL @ 27 g a.i ha^{-1} and Glamore (Imidacloprid 40+Ethiprole 40% w/w) 80 WG @ 100 g a.i ha^{-1} treated modules.

Table 3. Effect of different insecticide modules against spiders

Modules*	Spider 10 hills^{-1}		Pooled
	2016	2017	
1	2.0 (1.58)	1.7 (1.46)	1.83 (1.53)
2	4.7 (2.27)	5.0 (2.34)	4.83 (2.31)
3	2.7 (1.77)	2.3 (1.68)	2.50 (1.73)
4	5.0 (2.35)	5.3 (2.41)	5.17 (2.38)
5	1.3 (1.34)	2.0 (1.58)	1.67 (1.47)
6	2.3 (1.68)	2.0 (1.58)	2.17 (1.63)
7	5.7 (2.48)	6.3 (2.61)	6.00 (2.55)
8	2.0 (1.56)	2.3 (1.68)	2.17 (1.63)
9	8.3 (2.97)	7.7 (2.85)	8.00 (2.91)
S.Em	0.10	0.12	0.06
CD (5%)	0.29	0.35	0.19

Figures in parentheses are square root transformed values; *Module details are given in table 1

Grain Yield: Pymetrozine 50 WG @ 150 g a.i ha^{-1} (module 2) treated plot recorded highest grain yield of 50.75 qha^{-1} followed by Triflumezopyrim 106 SC @ 27 g a.i ha^{-1} (49.33 qha^{-1}), Glamore (Imidacloprid 40+Ethiprole 40% w/w) 80 WG @ 100 g a.i ha^{-1} (47.54 qha^{-1}), Thiacloprid 24 SC @ 60 g a.i ha^{-1} (47.5 qha^{-1}), Imidacloprid 17.8 SL @ 27 g a.i ha^{-1} (46.18 qha^{-1}), Dinotefuran 20 SG @ 40 g a.i ha^{-1} (46.17 qha^{-1}), Buprofezin 25 SC @ 250g a.i ha^{-1} (45.17 qha^{-1}) and Azadirachtin 0.03 EC @ 8 g a.i ha^{-1} (44.25 qha^{-1}) treated modules. All the treatments imparted plots gave superior yield than untreated control plot (32.08 qha^{-1}) (Table 4).

Present study revealed that all the tested modules were effective for major rice insect pests management. But, among the different modules, application of carbofuran 3G @ 1 kg a.i ha^{-1} at 20 days after transplanting followed by spraying of Rynaxypyr 20 SC @ 30 g a.i ha^{-1}at 45 days after transplanting and Pymetrozine 50 WG @ 300 g ha^{-1} at 65 days after transplanting were very effective for the management of rice stem borer, gall midge and plant hoppers. Karthikeyan and Christy (2014) observed significantly least stem borer damage in chlorantraniliprole18.5 EC @150 ml ha^{-1} treated plot over untreated check. Seni and Naik (2017) observed that Rynaxypyr 20 SC @ 30 g a.i ha^{-1} treated plot recorded significantly lower per-cent

Table 4. Effect of different insecticide modules on grain yield of rice

Modules*	Grain yield (qha^{-1})		Pooled
	Kharif, 2016	Kharif, 2017	
1	46.50	45.87	46.18
2	51.50	50.00	50.75
3	50.00	48.67	49.33
4	45.83	44.50	45.17
5	47.58	47.50	47.54
6	48.33	46.67	47.50
7	45.00	43.50	44.25
8	46.33	46.00	46.17
9	33.50	30.67	32.08
S.Em	0.43	0.67	0.40
CD (5%)	1.28	2.00	1.19

*Module details are given in table 1

of dead heart (0.42%) and white ear head (1.24%) and produced highest grain yield in comparison to other treatments. Application of granular insecticide, carbofuran 3G @ 20 kg ha^{-1} was found very effective in maintaining the yellow stem borer population below the economic threshold level and gave the highest grain yield (Singh *et al*.,1995; Kaul and Bhagat, 1997; Rath, 2013). Similarly, application of carbofuran @ 1.0 kg a.i ha^{-1} on 25 days after transplanting was quite effective against gall midge (Samalo *et al*., 1983). Harinkhere *et al*. (1993) showed that application of carbofuran granules at planting and at 30 days after transplanting @ 1.0 kg a.i ha^{-1} was the most effective treatment for controlling gall midge. Mardi *et al.* (2009) also studied the efficacy of some insecticide against the gall midge incidence and found lowest incidence of rice gall midge in the plots treated with Carbofuran 3G followed by Chloropyriphos 40EC and Phorate 10G.

It is observed that among different insecticide modules, module with Pymetrozine 50 WG @ 150 g a.i ha^{-1} was superior in efficacy against plant hoppers during both the years. Kirankumar (2016) and Seni and Naik (2017) also reported the effectiveness of Pymetrozine 50 WG @ 300 g ha^{-1} against brown plant hoppers. Among different insecticide treatments, maximum spider population was present in module with Azadirachtin 0.03 EC @ 8 g a.i ha^{-1} treated plot followed by other treatments. The present findings are in conformity with Kadam *et al*. (2005) who reported that the maximum number of spider populations was present in the plot treated with neem oil spray and NSKE. Seni and Naik (2017) found that Pymetrozine 50 WG @ 150 g a.i ha^{-1} and Buprofezin 25 SC @ 250 g a.i ha^{-1} treated plots had more number of spiders than other chemical treated plots and were safe for spiders. Tanaka *et al. (*2000) observed that imidacloprid was toxic to predatory spiders and mirid bugs in rice ecosystem. Our studies also revealed that neonicotinoid group of insecticides applied plots had less spiders in comparison to other plots. Although carbofuran has some toxic effect on spiders (Park and Lee, 2009) its application in the early date did not affect the spider population built up, as spider colonize actively in late vegetative stage of rice plant. Jafar *et al*. (2013) also reported that insecticides *viz*., chlorantraniliprole 18.5 SC at 30 g a.i ha^{-1}, cartap hydrochloride 50 SP at 500 g a.i ha^{-1} and fipronil 5 SC @ 625 ml ha^{-1} were found to be safe to natural enemies in the rice ecosystem. So, the adoption of the module (application of carbofuran 3G @ 1 kg a.i ha^{-1} at 20 days after transplanting followed by spraying of Rynaxypyr 20 SC @ 30 g a.i ha^{-1} at 45 days after transplanting and Pymetrozine 50 WG @ 300 g ha^{-1} at 65 days after transplanting) helps the farmers from indiscriminate spraying of insecticides and also remains safe to predators. So, the selection of insecticides which are target specific and harmless to natural enemies are very important as it will increase the effectiveness of natural control and maintains environmental health.

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