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Bio-efficacy of newer insecticides in combination with neem product against plant hoppers of rice

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Abstract
A field experiment on bio-efficacy of new insecticides in combination with neem products against plant hoppers of rice was conducted during *kharif* 2017 at Central Research Farm, Department of Entomology, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar. Insects recorded on rice during the period of study were white-backed plant hopper, *Sogatella furcifera* (Hovarth), brown plant hopper, *Nilaparvata lugens* (Stal.). Seven insecticidal treatments *viz.* flonicamid 50% WG @ 75g a.i./ha, buprofezin 25% SC @ 200 ml a.i/ha, imidacloprid17.8% SL@35gm a.i/ha, flonicamid 50%WG @ 37.5 g a.i./ha + multineem (300ppm) @ 1.25l/ha, buprofezin25%SC @ 100 ml a.i./ha + multineem (300ppm) @ 2.5l/ha, imidacloprid 17.8%SL @ 17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha, multineem (300ppm) @ 2.5l/ha were field evaluated against WBPH and BPH. Results revealed that foliar spray of imidacloprid 17.8%SL @ 17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha at 55 DAT and 70 DAT was adjudged to be the most effective treatment followed by imidacloprid 17.8% SL@35gm a.i/ha taking into account of its better efficacy on plant hoppers with 87.59 percent reduction in WBPH and 89.65 percent reduction in BPH. Hence imidacloprid (17.8% SL @ 17.5 ml a.i./ha) in combination with neem [multineem (300ppm) @ 1.25l/ha] may be recommended for control of WBPH and BPH in rice.

Keywords: Bio-efficacy, Flonicamid, Imidacloprid, Buprofezin, Neem, WBPH, BPH

1. Introduction
Rice is life, for most people living in Asia, it has shaped the cultures, diets and economies of thousands of millions of people. One-third of the economy in the Asian region is dependent on rice production, marketing and consumption. The attack of an array of insect pests at various growth stages of rice is considered as one of the major biotic constraint limiting realization of potential yield. Among these insect pests, brown plant hopper (*Nilaparvata lugens* Stal.) and white backed plant hopper (*Sogatella furcifera* Horvath) have emerged as serious sucking pests in many rice (Park *et al*.) [5]. Frequent crop failure due to persistent outbreak of brown plant hopper (BPH) is now very common in rice growing regions of India with 100 percent crop damage. Attack by white backed plant hopper through sap feeding results 11-39 percent yield loss in rice cultivars (Prakash and Rao) [6]. Zhou *et al.* [12] claimed that white backed plant hopper (WBPH), which was not a vector earlier for viral diseases, has been found to spread Southern Rice Black Streaked Dwarf Virus (SRBDSV) that causes stunting, leaf darkening and small enations on the stem and leaf of rice plants. Extensive application of synthetic pesticides has caused various problems to humans and environment (Carroll *et al*.) [1]. Sole reliance on synthetic insecticides has led to the destruction of natural enemies, causing the resurgence of several primary and secondary pest species and the development of insecticide-resistant pest populations. Synthetic pesticides with single active principle are likely to induce the development of resistance in insects. Botanicals like neem (*Azadiracta indica* A. Juss.) on the other hand contain complex array of compounds with multiple effects such as repellent, antifeedant and insecticidal activity and are unlikely to lead to pesticide resistance. Combining bio-rational product with synthetic pesticides often help to minimize the application rate of conventional active ingredient and still retain their benefits such as long residual activity. Keeping this in view, the present investigation aims to evaluate the bio-efficacy of newer insecticides in combination with neem product against plant hoppers of rice under coastal agroclimatic condition of Odisha.

2. Materials and Methods
2.1 Experimental location and season
Field experiment was conducted at Central Research Farm, Department of Entomology, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar.

The farm is located at 20⁰15'N latitude and of 85⁰52' E longitude with an altitude of 23 m above MSL (Mean sea level). The climate of the area under research is sub-tropical with an annual rainfall of 1500 mm.

2.2 Experimental details
2.2.1 Design and layout
The experiment was laid out in Randomized Block Design (RBD) with eight treatments including untreated control and three replications. The size of each plot was 2.5m X 4.0m.

2.2.2 Crop variety tested
Swarna the most popular variety of coastal Odisha which is a medium duration variety that matures in 110-120 days was taken.

2.2.3 Land preparation and transplanting
The field was divided into 24 plots each measuring 2.5m X 4.0m= 10m^2. Appropriate water and drainage channels were provided to facilitate entry and drainage of water as and when required. 21 days old rice seedlings were transplanted at a spacing of 20 x 10 cm to accommodate 80 hills per plot. Care was taken for establishment of the seedlings.

2.2.4 Application of insecticides
Foliar spray of insecticides was done with high volume knapsack sprayer using 500 L of spray fluid per ha during afternoon hours. First spraying of various insecticides was imposed at 55 DAT when the pest population crossed the ETL. Second spraying was done at 15 intervals (70 DAT).

2.2.5 Details of the treatments
Three newer insecticides, neem product alone and these three newer insecticides combined with neem product were tested for their efficacy against plant hoppers in rice under field conditions. The details of the treatments undertaken in the study have been presented in Table 1.

2.2.6 Recording of observations
Observations were recorded on the population of plant hoppers (WBPH and BPH) from 10 randomly selected hills per plot, 1 day before and 3, 7, 10 and 15 days after each spraying and their average was calculated.

2.2.7 Statistical analysis
Data recorded on pest population from the experiment were suitably transformed and analyzed statistically to arrive at meaningful conclusion as suggested by Gomez and Gomez [4]. Treatment variations were tested for their significance by mean standard error *i.e.*, SE (m) ± and critical difference (CD) at 5% level of significance.

3. Results and Discussion
The results on bioeffecacy of various insecticides against plant hoppers of rice have been presented in Table 2 and 3. The mean population of WBPH prior to insecticide spray was evenly distributed and varied between 10.97 to 18.37 per hill in various treatments. Fifteen days after second spray imidacloprid 17.8%SL @17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha proved significantly superior than other treatments recording a population of 0.30/hill and was at par with imidacloprid 17.8%SL @ 35 g a.i./ha(0.37/hill) and flonicamid 50%WG @ 37.5 g a.i./ha + multineem (300ppm) @ 1.25l/ha(0.43/hill). Reduction of WBPH population was highest (87.59%) in imidacloprid 17.8%SL @17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha and was closely followed imidacloprid 17.8%SL @ 35 g a.i./ha (85.40%).

The population of BPH was uniform before the imposition of treatments ranging from 4.4 to 6.93/hill (Table 3). Significantly the lowest overall mean for two sprays (55 DAT and 70 DAT) of BPH population(1.07/hill) was recorded in imidacloprid 17.8%SL @17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha and followed by imidacloprid 17.8 SL @ 35 g a.i./ha(1.32/hill) and flonicamid 50%WG @37.5 g a.i./ha + multineem (300ppm) @ 1.25l/ha(1.37/hill). Population reduction of the mean BPH population when averaged over two sprays was to the tune of 89.67 percent in the treatment imidacloprid 17.8%SL @17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha over untreated control was found to be the next best treatment in controlling BPH population. Imidacloprid 17.8%SL @ 35 g a.i./ha was found to be the next best treatment with population reduction of 87.71 percent.

From the above research studies it is evident that all the insecticidal treatments were effective in restricting WBPH population till 15 DAS (Days after spraying) compared to untreated control. However, imidacloprid 17.8%SL @17.5 ml a.i./ha + Multineem (300ppm) @ 1.25l/ha proved superior than other treatments and was at par with imidacloprid 17.8%SL @ 35 g a.i./ha and flonicamid 50%WG @ 37.5 g a.i./ha + multineem(300ppm) @ 1.25l/ha which might be due to synergistic effect of neem. Effectiveness of imidacloprid and flonicamid combined with neem oil against WBPH and BPH could not be traced out in literature. However, effectiveness of joint action of bio-rational products with synthetic pesticides has been reported against other crop pests by Raja *et al.* [8] and Sarode *et al.* [11]. Present results on higher efficacy of imidacloprid and flonicamid in combination with neem against WBPH and BPH can be corroborated with the findings of Dash *et al.* [2] who found that neem oil in combination with either monocrotophus or chloropyriphos performed significantly better in controlling WBPH compared with its application alone at 3 percent concentration. The present results are consistent with those of earlier findings by Prasad *et al.* [7] who have reported that the highest reduction in population of leaf hopper was obtained by the application of NSKE 8% + ½ doses of imidacloprid. The present results are also in conformity with the findings of Ramu *et al.* [9], Ghosh *et al.* [3] and Sangamithra *et al.* [10].

Table 1: Details of the treatments used in the experiment

Treatment	Chemical Name	Trade Name	Dose (g a.i/ha)	Dose (quantity/ha)
T_1	Flonicamid50%WG	Ulala 50WG	75	150g/ha
T_2	Buprofezin25%SC	Addvant 25SC	200	800ml/ha.
T_3	Imidacloprid17.8% SL	Media 17.8 SL	35	150ml/ha.
T_4	Flonicamid50%WG + Multineem(300 ppm)	Ullala 50% WG + Multineem 0.03%	37.5 + 300ppm	75g/ha + 1.25l/ha.
T_5	Buprofezin25%SC + Multineem (300ppm)	Addvant 25 SC + Multineem 0.03%	100 + 300ppm	400ml/ha + 1.25l/ha
T_6	Imidacloprid17.8%SL + Multineem(300ppm)	Media 17.8 SL + Multineem 0.03%	17.5 + 300ppm	75ml/ha + 1.25l/ha.
T_7	Multineem(300ppm azadirachtin)	Multineem 0.03%	300ppm	2.5l/ha.
T_8	Control	-	-	-

Table 2: Effect of different insecticides against white backed plant hopper (WBPH) during *Kharif* 2017

Tr No.	Treatments	Dose (g or ml a.i./ha)	Mean population of white backed plant hopper (nymphs and adults/hill)									Mean	Reduction over control (%)
			First spray					Second spray					
			1DBS	3DAS	7DAS	10DAS	15DAS	3DAS	7DAS	10DAS	15DAS		
T_1	Flonicamid 50%WG	75	11.10 (3.40)	0.47 (0.98)	1.67 (1.45)	2.70 (1.77)	6.70 (2.68)	0.57 (1.03)	1.20 (1.30)	1.77 (1.51)	0.60 (1.05)	1.96	81.29
T_2	Buprofezin 25% SC	200	16.00 (4.05)	9.40 (3.14)	8.53 (3.00)	4.03 (2.13)	6.80 (2.70)	0.90 (1.18)	1.33 (1.35)	2.00 (1.58)	0.67 (1.07)	4.20	59.92
T_3	Imidacloprid 17.8%SL	35	12.83 (3.64)	0.27 (0.87)	1.43 (1.38)	1.87 (1.52)	5.83 (2.52)	0.40 (0.94)	0.83 (1.15)	1.30 (1.33)	0.37 (0.93)	1.53	85.40
T_4	Flonicamid50%WG+Multineem (300 ppm)	37.5 g a.i./ha+1.25l/ha	10.97 (3.38)	0.33 (0.91)	1.47 (1.40)	2.17 (1.59)	6.27 (2.60)	0.43 (0.96)	0.97 (1.21)	1.47 (1.40)	0.43 (0.96)	1.69	83.87
T_5	Buprofezin25% SC+Multineem (300ppm)	100ml a.i./ha+1.25L/ha	16.27 (4.09)	0.67 (1.08)	1.93 (1.56)	4.17 (2.15)	6.97 (2.73)	0.87 (1.17)	1.47 (1.40)	2.23 (1.65)	0.83 (1.15)	2.39	77.19
T_6	Imidacloprid17.8%SL+Multineem (300ppm)	17.5 mi a.i./ha+1.25l/ha	18.37 (4.26)	0.20 (0.84)	0.83 (1.15)	1.57 (1.42)	5.33 (2.41)	0.37 (0.93)	0.70 (1.09)	1.13 (1.27)	0.30 (0.89)	1.30	87.59
T_7	Multineem(300ppm azadirachtin)	2.5L/ha.	16.77 (4.06)	10.10 (3.24)	7.46 (2.81)	5.10 (2.37)	7.17 (2.76)	0.93 (1.20)	1.80 (1.52)	2.30 (1.67)	1.07 (1.25)	4.49	57.15
T_8	CONTROL		14.10 (3.80)	12.15 (3.56)	13.17 (3.69)	13.10 (3.69)	10.10 (3.26)	11.40 (3.45)	8.20 (2.95)	8.57 (3.01)	7.20 (2.77)	10.48	
	SE(m) ±		0.373	0.108	0.106	0.147	0.065	0.046	0.041	0.064	0.054		
	CD 5%		NS	0.32	0.32	0.44	0.19	0.14	0.12	0.19	0.16		

Figures in parentheses are (X + 0.5) square root transformed values DBS: Days before spraying DAS: Days after spraying NS: Non significant

Table 3: Effect of different insecticides against brown plant hopper (BPH) during *Kharif* 2017

Tr no.	Treatments	Dose (g or ml a.i./ha)	Mean population of brown plant hopper (nymphs and adults/hill)									Mean	Reduction over control (%)
			First spray					Second spray					
			1DBS	3DAS	7DAS	10DAS	15DAS	3DAS	7DAS	10DAS	15DAS		
T_1	Flonicamid 50%WG	75	6.73 (2.64)	0.93 (1.17)	1.33 (1.35)	2.23 (1.65)	2.87 (1.83)	0.57 (1.03)	1.37 (1.36)	1.40 (1.38)	2.03 (1.59)	1.59	84.65
T_2	Buprofezin 25% SC	200	4.87 (2.27)	3.77 (2.06)	1.70 (1.48)	2.23 (1.65)	3.07 (1.89)	0.60 (1.05)	1.57 (1.44)	1.97 (1.55)	2.20 (1.64)	2.16	79.15
T_3	Imidacloprid 17.8%SL	35	4.40 (2.17)	0.43 (0.96)	1.03 (1.23)	1.63 (1.46)	2.46 (1.71)	0.37 (0.93)	1.03 (1.24)	1.17 (1.29)	2.50 (1.72)	1.32	87.71
T_4	Flonicamid50%WG+Multineem (300 ppm)	37.5 g a.i./ha+1.25l/ha	5.83 (2.45)	0.63 (1.05)	1.13 (1.27)	1.87 (1.52)	2.57 (1.75)	0.43 (0.97)	1.27 (1.33)	1.33 (1.32)	1.73 (1.49)	1.37	86.77
T_5	Buprofezin25%SC+ Multineem (300ppm)	100ml a.i./ha+1.25L/ha	5.30 (2.40)	1.27 (1.32)	1.80 (1.51)	2.80 (1.81)	3.43 (1.98)	0.77 (1.11)	1.90 (1.55)	1.83 (1.53)	2.57 (1.75)	2.04	80.30
T_6	Imidacloprid17.8%SL+Multineem(300ppm)	17.5 mi a.i./ha+1.25l/ha	6.93 (2.71)	0.27 (0.87)	0.87 (1.16)	1.03 (1.23)	2.40 (1.69)	0.23 (0.86)	0.60 (1.05)	0.87 (1.17)	2.30 (1.64)	1.07	89.65
T_7	Multineem(300ppm azadirachtin)	2.5L/ha.	6.47 (2.59)	4.33 (2.20)	3.93 (2.10)	3.17 (1.90)	3.73 (2.06)	2.33 (1.68)	2.03 (1.59)	1.98 (1.56)	3.20 (1.92)	3.08	70.27
T_8	Control		9.90 (3.20)	8.33 (2.97)	8.83 (3.05)	8.93 (3.07)	10.10 (3.26)	11.00 (3.39)	10.67 (3.34)	11.23 (3.41)	13.83 (3.79)	10.36	
	SE(m) □		0.314	0.099	0.089	0.088	0.053	0.055	0.071	0.11	0.074		
	CD 5%		NS	0.29	0.27	0.26	0.16	0.16	0.21	0.34	0.22		

Figures in parentheses are (X + 0.5) square root transformed values DBS: Days before spraying DAS: Days after spraying NS: Non significant

4. Conclusion

Results from the present experimental study revealed that the pre-mix formulation of imidacloprid 17.8%SL @17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha proved to be superior in controlling the plant hoppers of rice i.e. WBPH and BPH among all other treatments. Imidacloprid 17.8%SL @ 17.5 ml a.i./ha + multineem (300ppm) @ 1.25l/ha, imidacloprid 17.8%SL @ 35g a.i./ha, flonicamid 50%WG @ 37.5g a.i./ha + Multineem (300ppm) @ 1.25 l/ha and flonicamid 50% WG @ 75g a.i./ha were the best treatments during the period of investigation.

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