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Evaluation of bio-efficacy of different insecticides against white backed planthopper, *Sogatella furcifera* and their phytotoxic effects on rice

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Abstract
The present experiment was carried out to evaluate the efficacy of different insecticides against, *Sogatella furcifera* on rice at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Kharif* 2016-17. The result revealed that, the insecticides Buprofezin 25% SC @ 800 ml/ha (1.24) was best effective in reducing the population of white backed planthoppers followed by Imidacloprid 17.1% w/w SL @ 300 ml/ha (1.81), Thiamethoxam 25% WG @ 100 g/ha (2.01), Imidacloprid 17.1% w/w SL @ 250 ml/ha (2.16), Confidor 200 SL (Imidacloprid 17.8% w/w SL) @ 125 ml/ha (2.41) and Imidacloprid 17.1% w/w SL @ 200 ml/ha (2.59) were found effective in reduction of WBPH, respectively. The highest yield was obtained under treatment Buprofezin 25% SC @ 800 ml/ha (68.74 q/ha) which was followed by Thiamethoxam 25% WG @ 100 g/ha (66.06 q/ha) and Imidacloprid 17.1% w/w SL @ 300 ml/ha (62.05 q/ha). Furthermore, no phytotoxic effect was observed even in treatments imposed with imidacloprid 17.1% w/w SL @ 200 ml/ha, 300 ml/ha and 600 ml/ha.

Keywords: Bio-efficacy, insecticides, phytotoxicity, rice, white backed planthopper

Introduction

Rice (*Oryza sativa* L.) is the world's single most important crop belonging to the family of grasses, Graminae or Poaceae is most common cereal, serving as a stable food for approximately half of the global population. Over two billion people in Asia alone derive 80% of their energy needs from rice, which contains 80% carbohydrates, 7–8% protein, 3% fat and 3% fiber [4]. India is the largest rice growing country across the world having 43 million hectare area under this crop with production of 115 million tonnes of milled rice and average productivity of 2.7 tonnes per hectare [1, 2]. The average per hectare productivity in the country is relatively low as compared to other Asian countries due to heavy losses caused by biotic factors such as insect-pests [5]. In case of insects twenty insect species are economically significant although more than hundred insect species reported infesting this cereal [14]. Insect damage, especially due to brown planthopper, *Nilaparvata lugens* (Stal.), white-backed planthopper, *Sogatella furcifera* (Horvath.), yellow stem borer, *Scirpophaga incertulas* (Walker.), green leaf hopper, *Nephotettix nigropictus* (Distant.), leaf folder, *Cnaphalocrocis medinalis* (Guenee.) constitutes one of the major causes for the poor productivity of rice in India [15]. The average yield loss in rice have been accounted for 30% loss in stem borers, while plant hoppers 20%, gall midge 15%, leaf folder 10% and other pests 25%, respectively [9]. Sucking pests cause huge damage to rice by sucking plant sap, devitalizing plants and also act as vectors of several viral diseases [11]. Planthoppers such as brown planthopper, *Nilaparvata lugens* (Stal.) and white backed planthopper, *Sogatella furcifera* (Horvath) also infest the rice crop severely during tillering to panicle initiation stage. The brown planthopper (BPH) is one of the serious pests responsible for large-scale devastation of rice crop, causing yield losses amounting to as high as 60% [19, 10]. The white backed planthopper can cause 35-95 per cent yield loss in rice under favourable conditions [17].

It is thus imperative to protect rice crop effectively against ravages of insect pests. Pesticides are important tool of pest management but need to be used judiciously for averting their adverse effects on environment. To make pesticides environment-friendly, molecules with novel mode of action are being synthesized and marketed. Insecticides with novel mode of action, combination products and molecules with very low dosage requirement are available and can be used judiciously to avoid development of insecticide resistance in pests and minimize environmental contamination [3].

Materials and Methods

The experiment was laid out in randomized block design (RBD) with six treatments and one untreated control which were replicated thrice in Research Cum Instructional farm Department of Agronomy IGKV, Raipur (C.G.), under field conditions during *Kharif* 2016- 17 under rainfed condition with a variety of "Mahamaya" (a most popular variety grown by the farmers of Chhattisgarh) in 5m X 4m plot size with 20 c.m. X 20 c.m. spacing. The target pests were white backed planthopper, *Sogatella furcifera* (Horvath). For these sap feeders, the first application of test insecticide was carried out as and when, targeted insect were reached at ETL level. Sprayable solution was made with the 375-500 litre of water per hectare basis. Such insecticidal solution was sprayed with the either triple action or hollow cone nozzle spray.

(i) Assessment of pest population and grain yield

Observation on the population establishment of WBPH was recorded 1 day before first imposition and 3rd, 5th and 7th Days after each insecticide application from randomly selected 5 plants. The data on the pest incidence were subjected to statistical analysis by single factor ANOVA after making necessary transformation whenever required.

Grain yield/plot was recorded at harvest and it was converted into kg ha^{-1} for analysis and comparison. Net profit and cost benefit ratio was calculated by using following formula:

Net profit = Cost of increased yield over control - Cost of respective treatment

$$\text{B: C ratio} = \frac{\text{Net profit (Rs. ha}^{-1})}{\text{Cost of respective treatment (Rs. ha}^{-1})}$$

(ii) Assessment of phytotoxicity

The hills were sprayed with Imidacloprid 17.1% w/w SL @ 200 ml/ha, 300 ml/ha and 600 ml/ha to assess the occurrence of phytotoxicity. Observations of test insecticides were record on 10 plants randomly selected per plot. Count total number of leaves and leaves showing phytotoxic symptoms if any and work out the phytotoxicity percentage and apply phytotoxicity scale (0-10). Phytotoxicity like leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, leaf hyponasty, vein clearing, wilting and rosetting was recorded on the basis of scale: 0 Scale: No Phytotoxicity, 1-10% Phytotoxicity = 1 Scale, 11-20% Phytotoxicity = 2 scale…..91-100% Phytotoxicity = 10 scale at 1st, 3rd, 7th & 10th days after sprays as per the protocol of Central Insecticide Board and Registration Committee (C.I.B. and R.C). The per cent injury was calculated by using the formula:

$$\text{Percent leaf injury} = \frac{\text{Total grade points}}{\text{Max. grade x No. of leaves observed}}$$

Table 1: Leaf injury was assessed by visual ratings in a 0-10 Scale *i.e.*,

Scale/Score	Phytotoxicity (%)
0	No phytotoxicity
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

Results

(i) Bio-efficacy of different insecticides against white backed planthopper (*Sogatella furcifera*)

During the year of experimentation in general pest population was found low although in pre treatment observation the mean population of WBPH varied from 5.13 to 5.87 nymphs and adult/hill in different plots, which was homogenous and statistically non significant (Table 2).

In post treatment observation after three days, all the tested doses of insecticides showed significant differences over untreated control. Among the treatments, Buprofezin 25% SC @ 800 ml/ha (2.07) was proved to be most effective it was found at par with Imidacloprid 17.1% w/w SL @ 300 ml/ha (2.40) and significantly superior over Thiamethoxam 25% WG @ 100 g/ha (2.73), Imidacloprid 17.1% w/w SL @ 250 ml/ha (3.07), Confidor 200 SL (Imidacloprid 17.8% w/w SL) @ 125 ml/ha (3.40) and Imidacloprid 17.1% w/w SL @ 200 ml/ha (3.80). The maximum population of WBPH was found under the untreated control, which was 5.87 hoppers/hill (Table 2).

After five day of first spray, Buprofezin 25% SC @ 800 ml/ha again proved to be most effective reduction in WBPH population (1.40) nymph and adult per hills. Which was at par with Imidacloprid 17.1% w/w SL @ 300 ml/ha (1.87) but differed significantly from Thiamethoxam 25% WG @ 100 g/ha (1.93), Imidacloprid 17.1% w/w SL @ 250 ml/ha (2.00), Confidor 200 SL (Imidacloprid 17.8% w/w SL) @ 125 ml/ha (2.60) and Imidacloprid 17.1% w/w SL @ 200 ml/ha (2.87). The maximum population of WBPH was found under the untreated control *i.e.* 6.00 nymphs and adults/hill (Table 2).

Seven days After first spray, Buprofezin 25% SC @ 800 ml/ha again proved to be most effective in reduction in WBPH (0.93) nymph and adult per hills Followed by Imidacloprid 17.1% w/w SL @ 300 ml/ha (1.40), Thiamethoxam 25% WG @ 100 g/ha (1.53), Imidacloprid 17.1% w/w SL @ 250 ml/ha (1.87), Confidor 200 SL (Imidacloprid 17.8% w/w SL) @ 125 ml/ha (2.13) and Imidacloprid 17.1% w/w SL @ 200 ml/ha (2.27). The maximum population of WBPH was found under the untreated control *i.e.* 6.20 nymphs and adults/hill (Table 2).

Prior to second application of insecticides pre-treatment population again estimated. Which was found statically uniform, range between 4.27 to 5.13 WBPH/hill. The similar

trend was also observed in second spray at 3, 5 and 7 days after spray during the year 2016 (Table 2).

(ii) Impact on grain yield and cost benefit ratio

After the application of insecticides the economics of experimentation was worked out, which indicates that all the tested insecticides were performed better than that to untreated control. The highest yield was obtained under treatment Buprofezin 25% SC @ 800 ml/ha (68.74 q/ha) followed by Thiamethoxam 25% WG @ 100 g/ha (66.06 q/ha), Imidacloprid 17.1% w/w SL @ 300 ml/ha (62.05 q/ha), Confidor 200 SL (Imidacloprid 17.8% w/w SL) @ 125 ml/ha (61.29 q/ha), Imidacloprid 17.1% w/w SL @ 250 ml/ha (56.46 q/ha) and Imidacloprid 17.1% w/w SL @ 200 ml/ha (55.09 q/ha), respectively. The lowest yield was obtain in untreated control plot *i.e.* 51.89 q/ha (Table 3).

Among the tested insecticides net return varied between Rs. 22177.5 (Buprofezin 25% SC @ 800 ml/ha) to Rs. 2454 (Imiadcloprid 17.1 % w/w SL @ 200 ml/ha). Similar result about benefit cost ratio was observed. The highest and the lowest value of benefit cost ratio was obtained with Buprofezin 25% SC @ 800 ml/ha (8.56) and Imiadcloprid 17.1 % w/w SL @ 200 ml/ha (1.09) respectively (Table 3).

(iii) Phytotoxicity

The results of field experiments with rice crop indicated that there were no phytotoxic effects of the tested insecticides (Imidacloprid 17.1% w/w SL @ 200 ml/ha, Imidacloprid 17.1% w/w SL @ 300 ml/ha and Imidacloprid 17.1% w/w SL @ 600 ml/ha). The insecticide were observed for the phytotoxic symptoms like injury to the leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, leaf hyponasty, vein clearing, wilting and rosetting in leaves when sprayed on rice crop along with the scale of phytotoxicity. The observations on 1st, 3rd, 5th, 7th and 10 days after spraying indicated that all the tested insecticides did not cause any phytotoxic effects on rice crop.

Table 2: Population of white backed planthoppers in pre-treatment and post treatment observations during *Kharif* 2016.

Nymph and adult population of white blacked planthopper/hill											
			1st spray				2nd spray				
S.N.	Treatment	Dose/ha (g or ml)	Pre-treatment	Post treatment			Pre-treatment	Post treatment			Overall mean
				3 DAS	5 DAS	7 DAS		3 DAS	5 DAS	7 DAS	
T_1	Imidacloprid 17.1% w/w SL	200 ml/ha	5.67 (5.40)	3.80 (4.46)	2.87 (3.91)	2.27 (3.50)	4.87 (5.02)	2.53 (3.69)	2.27 (3.50)	1.80 (3.15)	2.59
T_2	Imidacloprid 17.1% w/w SL	250 ml/ha	5.40 (5.27)	3.07 (4.02)	2.00 (3.31)	1.87 (3.21)	4.27 (4.72)	2.27 (3.50)	2.07 (3.33)	1.67 (3.04)	2.16
T_3	Imidacloprid 17.1% w/w SL	300 ml/ha	5.87 (5.48)	2.40 (3.59)	1.87 (3.21)	1.40 (2.82)	4.67 (4.92)	1.87 (3.20)	1.80 (3.13)	1.53 (2.90)	1.81
T_4	Imidacloprid 17.8% w/w SL	125 ml/ha	5.27 (5.22)	3.40 (4.21)	2.60 (3.74)	2.13 (3.41)	5.07 (5.11)	2.40 (3.60)	2.20 (3.45)	1.73 (3.08)	2.41
T_5	Buprofezin 25% SC	800 ml/ha	5.87 (5.47)	2.07 (3.35)	1.40 (2.82)	0.93 (2.36)	4.33 (4.75)	1.53 (2.94)	0.87 (2.30)	0.67 (2.07)	1.24
T_6	Thiamethoxam 25% WG	100 g/ha	5.47 (5.31)	2.73 (3.82)	1.93 (3.26)	1.53 (2.94)	4.53 (4.86)	2.20 (3.46)	2.00 (3.29)	1.67 (3.04)	2.01
T_7	Untreated control	-	5.80 (5.45)	5.87 (5.48)	6.00 (5.55)	6.20 (5.65)	5.13 (5.15)	5.33 (5.24)	5.53 (5.35)	5.60 (5.36)	5.76
	SE(m)		0.276	0.258	0.216	0.236	0.227	0.215	0.216	0.256	
	CD at 5%		N/S	0.387	0.444	0.299	N/S	0.455	0.477	0.658	

Note: Figure in parenthesis is square transformed value. DAS- Days after spray.

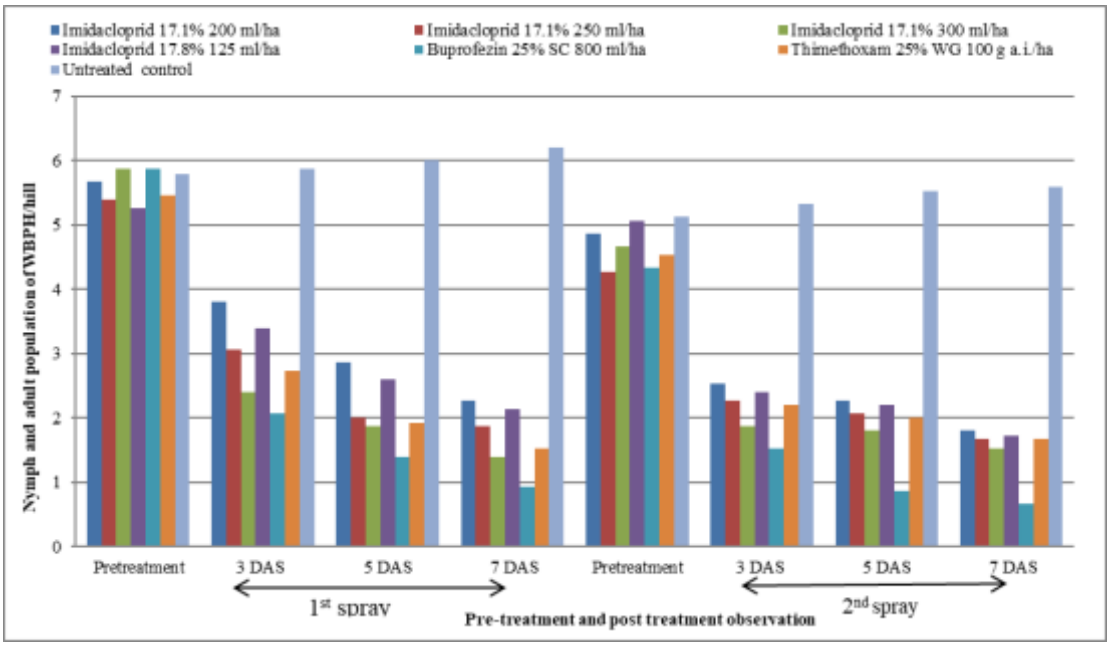

Fig 1: Population of white backed planthoppers in pre-treatment and post treatment observations

Table 3: Impact of different insecticides on grain yield in rice during *Kharif* 2016.

S. N.	Treatment	Dose/ha (g or ml)	Yield (q/ha)	Increase yield over control (q/ha)	Price of increased yield over control (Rs/ha)	Cost of chemical and labour (Rs/ha)	Net Return	B:C ratio
T1	Imidacloprid 17.1% w/w SL	200 ml/ha	55.09	3.2	4704	2250	2454	1:1.09
T2	Imidacloprid 17.1% w/w SL	250 ml/ha	56.46	4.57	6717.9	2312.5	4405.4	1:1.90
T3	Imidacloprid 17.1% w/w SL	300 ml/ha	62.05	10.16	14935.2	2423	12512.2	1:5.11
T4	Imidacloprid 17.8% w/w SL	125 ml/ha	61.29	9.4	13818	2047.5	11770.5	1:5.75
T5	Buprofezin 25% SC	800 ml/ha	68.74	16.85	24769.5	2592	22177.5	1:8.56
T6	Thiamethoxam 25% WG	100 g/ha	66.06	14.17	20829.9	2240	18589.9	1:8.29
T7	Untreated control	-	51.89	-	-	-	-	-

Discussions

In the present study, Buprofezin 25% SC @ 800 ml/ha was most effective and superior over the other insecticidal treatments, after first and second spray. The second best insecticide was Imidacloprid 17.1% w/w SL @ 300 ml/ha followed by Thiamethoxam 25% WG @ 100 g/ha and Imidacloprid 17.1% w/w SL @ 250 ml/ha. These results are in close concurrence with the results obtained in the study of [16] reported that the overall mean efficacy of Ethiprole @ 0.05 kg. a.i./ha (77.69%) and Buprofezin @ 0.20 kg a.i./ha (76.73) being on par recorded highest reduction of WBPH population and remained significantly superior over all the other treatments. However, in the present investigation are in conformity with those of [7] reported that the Buprofezin 25% SC was most effective against BPH and WBPH, followed by Thiamethoxam 25% WG and Imidacloprid 17.8% w/w SL. [20] reported that Buprofezin was effective against homopteran insect pests, such as planthopper with very low risks to environment and human beings. [13] reported that the Imidacloprid 200 SL, Endosulfan 35 EC, Quinalphos 25 EC and Cartap hydrochloride 4G significantly reduced white backed planthopper population at booting stage.

Present finding are in agreement with [6] who also reported that Buprofezin 1.0 ml/l. registered its superiority over rest of the treatment by recording lowest hopper population and higher grain yield followed by Acephate 75 SP @ 1g/l and Thiamethoxam 25 WG @ 0.3 g./l., respectively. The next best treatment in the order of efficacy against the hopper population included Acetamipride 20 SP @ 0.2 g./l., Imidacloprid 17.8 SL @ 1ml/l. Buprofezin 25 SC @ 1.0 ml/l recorded highest net profit of Rs 66,128.13/ha which was followed by Acephate 75 SP @ 1g/l (Rs. 64,120.63/ha) and Thiamethoxam 25 WG @ 0.3 g./l (Rs 62,345.63/ha). Present findings are [12] evaluated that the Imidacloprid 17.1% @ 60 g.a.i./ha was effective in reducing plant hopper and leaf hopper population. The pooled mean population (two consecutive seasons) of BPH, WBPH and GLH was recorded as 0.78, 0.60 and 0.60 per hill respectively. The insecticidal treatments were found safe to the non target invertebrates like Spider, coccinellids and rove beetles. Furthermore no phototoxic effect was observed even in treatments imposed with Imidacloprid 17.1% SL @ 60,120 and 240 g.a.i./ha. [18] also evaluated that the Pymetrozin 50% WG (GSP sample) @ 300 and 400 g/ha and Pymetrozin 50% WG (Market Sample) @ 300 g/ha effectively control the BPH, GLH and WBPH pest followed by Imidaclopride 17.8% SL @ 125 ml/ha and Fipronil 5% SC @ 1500 ml/ha. There are no phytotoxic symptoms on paddy crop are found and no adverse effect on natural enemies were recorded due to application of treatments. Earlier, [8] evaluated that the efficacy of different doses of lancer gold (Acephate 50% + Imidacloprid 1.8% SP) *i.e.* 800, 1000 and 1200 g/ha and 2000 g/ha (only for phytotoxicity test) along with three checks against major insect pest of rice. Among the different doses of lancer gold, 1200 and 1000 g/ha were found effective over to Acephate 75 SP, Imidacloprid 17.1 SL and Chlorpyriphos 50+cypermethrin 5 EC in controlling population of brown plant hopper, green leaf hopper, stem borer and rice leaf folder and also gave significantly higher grain yield than other treatments. Highest grain yield of 3610 and 3471 kg/ha was recorded in lancer gold (Acephate 50% + Imidacloprid 1.8 % SP) @ 1200 g/ha and it is statistically at par with lancer gold @ 1000 g/ha. However, the maximum cost benefit ratio of 1:18.65 was obtained in lancer gold @ 1000 g/ha due to low cost of treatment. Lancer gold (Acephate 50% + Imidacloprid 1.8% SP @ 2000 g/ha did not cause any visual phytotoxic symptoms on the crop.

Conclusion

Thus, the present study revealed that all the tested insecticides were effective for WBPH management but among the insecticides Buprofezin 25% SC @ 800 ml/ha proved to be most effective insecticide to reduce the population of WBPH nymph and adult per hill followed by Imidacloprid 17.1% w/w SL @ 300 ml/ha, Thiamethoxam 25% WG @ 100 g/ha and Imidacloprid 17.1% w/w SL @ 250 ml/ha were found effective in reduction of WBPH, respectively. The studies on phytotoxic effects clearly indicated that the Imidacloprid 17.1% w/w SL did not cause phytotoxicity on rice upto 10 days in any form (injury to leaf chlorosis, leaf tips burning, leaf necrosis, leaf epinasty, leaf hyponasty, vein clearing, wilting of plants and rosetting) even spray @ 600 ml/ha and all the doses of tested insecticides were safe to the rice crop.

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