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Effects of Betacyfluthrin + Imidacloprid OD (Solomon) against Major Plant Hoppers on Rice Ecosystem in Burdwan, West Bengal

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Abstract

The current study was conducted to evaluate the effects of three distinct levels of concentration of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD (Solomon) (45 g a.i. ha^{-1}, 60 g a.i. ha^{-1} and 75 g a.i. ha^{-1}) during *kharif* 2020 and 2021 against major plant hoppers of rice. White backed plant hopper (*Sogatella furcifera*) and Brown plant hopper (*Nilaparvata lugens*) were found as major plant hoppers on rice field. Solomon @ 75 g a.i. ha^{-1} was recorded significantly efficient against BPH and WBPH in both crop seasons (*kharif* 2020 and *kharif* 2021) with highest reduction over control (80.42% & 76.22% and 79.65% & 83.54%, respectively). A noticeably increased yield of rice grains was observed in case of Solomon @ 75 g a.i. ha^{-1} treatment than in control plot in *kharif* 2020 (73.78 q ha^{-1}) and *kharif* 2021 (68.03 q ha^{-1}). Although the natural enemy population in the plots that were treated with Solomon @ 10-30 g a.i. ha^{-1} had no significant negative impact than the untreated control and other treated plots.

Keywords: Bio-efficacy, BPH, Kharif, Rice, Treatment, WBPH

Introduction

Roughly half of all people on the world are dependent on rice (*Oryza sativa* L.), one of the most significant and vital cereal crops, for their main diet. Rice also helps rural communities by providing jobs and revenue. India cultivates 43 Mha of rice, producing 112 Mt of milled rice year with an average yield of 2.6 t ha^{-1}. The crop is grown in a wide range of environments, including hills and beaches. Over the years, rice production in India increased in such an extent that it hasn't just become self-sufficient but also produced enough to outsource the surplus, primarily, a *kharif* crop. In certain regions of the nation, it is grown all year round. West Bengal, Uttar Pradesh, Punjab, Odisha, Andhra Pradesh, Bihar and Chhattisgarh are the states that produce the most rice. In West Bengal, 14 among the 23 districts cultivate rice occupying over 45% of agricultural land. Among these districts, Burdwan (erstwhile) is aptly known as the "Rice Bowl of Bengal" as highest amount of rice per year is reaped from this district only (Adhikari *et al*., 2011).

Despite such spectacular figures in rice production, every year, Indian farmers who cultivate paddy suffer enormous financial losses. Numerous biotic and abiotic stressors, including pests, illnesses, poor soil fertility, heavy rainfall, water logging and weather patterns, contribute to the reduction in rice yield. Pests are thought to be one of the main factors restricting yield. In India, pests cause a 30% decrease in output (Sachan *et al*., 2006; Dhaliwal *et al*., 2010). Currently, 266 distinct species of herbivores - including non-arthropod taxa like rats - have been identified from rice habitats across the globe (Ali *et al*., 2017). Twenty of the more than 100 bug species that attack rice crops in India inflict financial harm (Basit and Bhattacharya, 2001). Numerous insect pest species are seldom encountered but do not result in financial losses; on the other hand, a small number of sucking insect species, including the BPH and WBPH, inflict considerable harm and are quite significant. The two most significant herbivorous insect pests on rice are the BPH, *Nilaparvata lugens* S. and WBPH, *Sogatella furcifera* H. which cause a significant damage on rice (Sogawa, 1994). It has also been reported that BPH and WBPH reduces the rice yield by 10-70% and 35-95%, respectively (Kumar *et al*., 2017). Both nymphs and adult insects can inject toxic saliva in plant vascular system leading plugging of bundle sheath. As a result in case of heavy infestation of these insects in *kharif* rice, hopper burn symptom is produced. They also can transmit virus to the plant during their feeding from one plant to others.

Article History

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Farmers mostly rely on use of chemical insecticide for management of pests of rice. Indiscriminate use of comparatively old aged chemicals presently are not so much effective as well as inviting insect resistance, resurgence, threat to natural enemies and residue problem. So, it is in need to evaluate the efficacy of newer molecules having unique mode of action to manage the said pest problems. Alternate better option will help our farmers to tackle BPH and WBPH in rice with more direct and indirect return. Hence, this trial was implemented to determine the effectiveness of various doses of the new insecticide Solomon against BPH and WBPH of paddy.

Materials and Methods

The investigation was executed at trial field of College of Agriculture, BCKV, East Bardhaman, West Bengal, India (Lat. 23.241087° and Long. 87.895847°) during late *kharif* 2020 and *kharif* 2021. At first seed bed preparation of Swarna variety rice (MTU 7029) was done. Following advised agronomic practises, rice crops were then transplanted in randomised block design (RBD) with four replications in individual 20 m^2 (5 m × 4 m) plots for each treatment. The number of treatments were six, *viz*., Solomon at 3 different concentrations (45 g a.i. ha^{-1}, 60 g a.i. ha^{-1} and 75 g a.i. ha^{-1}), Pymetrozine 50% WG (150 g a.i. ha^{-1}), Imidacloprid 17.8% SL (25 g a.i. ha^{-1}), untreated control. Three sprays @ 500 litre water ha^{-1} are given at 15 days interval starting first spray at 40 days. Two sprays @ 500 litre water ha^{-1} are given by using knapsack sprayer at 15 days interval starting first spray at 40 days after transplanting of rice in each treatment in each season.

During both trial seasons, observations on the populations of brown plant hopper and white backed plant hopper were made from randomly selected 10 hills which were tagged per duplicated plot one day prior to, seven days after and fourteen days following each treatment. Reduction over control (%) in population of BPH and WBPH were also worked out for each season. The impact of different concentrations of Solomon on available important natural enemy (Mirid Bugs and Spiders) was tested after each round spray in rice. Their populations were estimated by counting their total numbers from selected 10 hills $plot^{-1}$ at 1 day before and 7 DAS and 14 DAS for each treatment. The yield of rice $plot^{-1}$ of 20 m^2 at harvest was considered. The yield data thus obtained were expressed in q ha^{-1} which were analyzed statistically and has been presented. Appropriate statistical tests were followed for the analysis of all data. The methodology was followed by Sasmal *et al*. (2018).

Results and Discussion

The brown plant hopper, *Nilaparvata lugens* population $hill^{-1}$ before and after the insecticidal spray is presented in table 1 and table 2. During *Kharif* 2020 season 1 (Table 1), comparing the treated and untreated groups, it was found that all treatments considerably decreased the population of brown plant hoppers. However, Solomon @ 75 g a.i. ha^{-1} (T_3) was comparatively better than all the other treatments in reducing the BPH population after 7th and 14th day of application by recording 3.25 and 3.00 BPH $hill^{-1}$ (1st spray, Season 1) & 1.50 and 1.75 BPH $hill^{-1}$ (2nd spray, Season 1) with 80.42% reduction over the control plot, followed by Solomon @ 60 g a.i. ha^{-1} (T_2) which has found 2.93 and 3.00

Table 1: Bioefficacy of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD against Brown plant hopper, *N. lugens* (*Kharif*, 2020 Crop $season^{-1}$)

Treatment	Details	Dose (g a.i. ha^{-1})	1 DBS	Average no. of adult and nymphs $hill^{-1}$ at different days after insecticidal spray				PROC
				1st spray		2nd spray		
				7 DAS	14 DAS	7 DAS	14 DAS	
T_1	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	10	7.43	4.25 (2.28)	4.00 (2.23)	3.00 (2.00)	2.75 (1.93)	71.15
T_2	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l-1 OD	20	7.05	2.93 (1.98)	3.00 (2.00)	2.00 (1.72)	2.75 (1.93)	78.00
T_3	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	7.28	3.25 (2.03)	3.00 (2.00)	1.50 (1.57)	1.75 (1.64)	80.42
T_4	Pymetrozine 50% WG	150	7.93	3.00 (1.99)	3.00 (2.00)	2.00 (91.72)	2.75 (1.93)	77.84
T_5	Imidacloprid 17.8% SL	25	7.50	5.00 (2.45)	4.25 (2.28)	3.25 (2.05)	2.75 (1.93)	68.57
T_6	Control	-	7.70	10.00 (3.31)	12.00 (3.23)	12.25 (3.64)	14.25 (3.90)	-
CD				0.13	0.11	0.11	0.12	-
SEM				0.40	0.32	0.32	0.37	-

[*Mean of three replications; **Figures in the parenthesis are square root transformed values; DAS: Days after spray]

BPH hill^{-1} (1st spray, Season 1) & 2.00 and 2.75 BPH hill^{-1} (2nd spray, Season 1) with 78.00% reduction over control as compared to 10.00 and 12.00 BPH hill^{-1} (1st spray, season 1) & 12.25 and 14.25 BPH hill^{-1} (2nd spray, season 1) in the untreated control. Rest of the treatment follows T_2 are T_4 (Pymetrozine 50% WP @ 150 g a.i. ha^{-1}), T_1 (Solomon @ 45 g a.i. ha^{-1}) and T_5 (Imidacloprid @ 17.8 SL).

A similar trend was noticed during *Kharif* 2021 crop season 2 (Table 2), where in T_3 (Solomon @ 75 g a.i. ha^{-1}) again was considerably better than any other treatment in reducing the BPH population after 7th and 14th day of application by recording 3.75 and 3.73 BPH hill^{-1} (1st spray, Season 2) & 2.23 and 2.73 BPH hill^{-1} (2nd spray, Season 2) with 76.22% reduction than control plot, followed by T_2 (75.21%), T_4 (75.02%), T_1 (69.18%) and T_5 (64.92%).

Table 2: Bioefficacy of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD against Brown plant hopper, *N. lugens* (*Kharif*, 2021 Crop season-2)

Treatment	Details	Dose (g a.i. ha^{-1})	1 DBS	Average no. of adult and nymphs hill^{-1} at different days after insecticidal spray				PROC
				1st spray		2nd spray		
				7 DAS	14 DAS	7 DAS	14 DAS	
T_1	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	10	8.25	5.00 (2.45)	4.55 (2.35)	3.33 (2.07)	3.23 (2.04)	69.18
T_2	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	20	10.25	3.625 (2.15)	3.70 (2.17)	2.30 (1.81)	3.33 (2.08)	75.21
T_3	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	10.25	3.75 (2.17)	3.73 (2.17)	2.23 (1.80)	2.73 (1.93)	76.22
T_4	Pymetrozine 50% WG	150	9.75	3.75 (2.17)	3.68 (2.15)	2.53 (1.88)	3.10 (2.02)	75.02
T_5	Imidacloprid 17.8% SL	25	9.75	5.00 (2.44)	5.08 (2.46)	4.25 (2.28)	4.00 (2.23)	64.92
T_6	Control	-	9.2	12.00 (3.6)	12.5 (3.67)	13.50 (3.81)	14.25 (3.9)	-
CD				0.34	0.21	0.25	0.28	-
SEM				0.11	0.07	0.08	0.09	-

[*Mean of three replications; **Figures in the parenthesis are square root transformed values; DAS: Days after spray]

The population of WBPH, *S. furcifera* hill^{-1} before and after the insecticidal spray is presented in table 3 and table 4. During *Kharif* 2020 season 1 (Table 3), the population of WBPH was dramatically reduced by all of the treatments when compared to the untreated control group. However, Solomon @ 75 g a.i. ha^{-1} (T_3) was considerably better than any other treatment in reducing the WBPH population after 7th and 14th day of application by recording 2.43 and 1.75 WBPH hill^{-1} (1st spray, Season 1) & 2.00 and 2.58 WBPH hill^{-1} (2nd spray, Season 1) with 82.33% reduction over control, followed by Solomon @ 60 g a.i. ha^{-1} (T_2) which has found 2.93 and 2.38 WBPH hill^{-1} (1st spray, Season 1) & 2.28 and 2.50 WBPH hill^{-1} (2nd spray, Season 1) with 79.65% reduction over control as compared to 11.25 and 12.25 WBPH hill^{-1} (1st spray, season 1) & 13.25 and 12.75 WBPH hill^{-1} (2nd spray, Season 1) in the untreated control. Rest of the treatment follows T_2 are T_4 (Pymetrozine 50% WP @ 150 g a.i. ha^{-1}), T_1 (Solomon @ 45 g a.i. ha^{-1}) and T_5 (Imidacloprid @ 17.8 SL).

Another similar trend was noticed during *Kharif* 2021 crop season 2 (Table 4), wherein T_3 (Solomon @ 75 g a.i. ha^{-1}) again had better effect comparatively from other treatment in reducing the WBPH population after 7th and 14th day of application by recording 2.20 and 1.83 WBPH hill^{-1} (1st spray, Season 2) & 1.53 and 2.23 BPH hill^{-1} (2nd spray, Season 2) with 83.54% reduction over control, followed by T_2 (82.06%), T_4 (81.64%), T_1 (72.27%) and T_5 (70.84%).

Observations on natural enemy population during the rice crop season *Kharif* 2020 and *Kharif* 2021 (Table 6 and Table 7) clearly revealed that before application of treatments and at 7 DAS and 14 DAS after each treatment, population of natural enemies, *viz*., spiders and mired bugs did not vary in various plots, signifying uniform establishment of the natural enemies in experimental plots. Thus, the natural enemy population in the Solomon @ 45-75 g a.i. ha^{-1} plots which were treated had no significant adverse impact when compared to the untreated control and other treatment plots.

Rice grain yield during *Kharif* 2020 crop season were recorded and grain yields from all insecticidal treatments were noticeably higher than those from the untreated control (Table 5). Solomon @ 75 g a.i. ha^{-1} (T_3) was recorded higher in case of yield than all the other treatments and reported the maximum yield of 73.78 q ha^{-1} followed by Solomon @ 60 g a.i. ha^{-1} (T_2) (71.77 q ha^{-1}), pymetrozine 50% WG @ 150 g a.i. ha^{-1} (T_4) (71.59 q ha^{-1}), Solomon @ 45 g a.i. ha^{-1} (T_1) (69.43 q ha^{-1}) and imidacloprid 17.8 SL @ 25 g a.i. ha^{-1} (T_5) (68.89 q ha^{-1}). The minimum yield of 60 q ha^{-1} was

Table 3: Bioefficacy of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD against White backed plant hopper, *S. furcifera* (*Kharif*, 2020 Crop season-1)

Treatment	Details	Dose (g a.i. ha^{-1})	1 DBS	Average no. of adult and nymphs $hill^{-1}$ at different days after insecticidal spray				PROC
				1st spray		2nd spray		
				7 DAS	14 DAS	7 DAS	14 DAS	
T_1	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	10	6.5	3.78 (2.18)	3.68 (2.15)	3.88 (2.20)	4.08 (2.25)	68.90
T_2	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	20	7.00	2.93 (1.98)	2.38 (1.83)	2.28 (1.81)	2.50 (1.87)	79.65
T_3	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	7.75	2.93 (1.98)	2.38 (1.83)	2.28 (1.81)	2.50 (1.87)	79.65
T_4	Pymetrozine 50% WG	150	7.5	2.48 (1.86)	2.60 (1.89)	2.50 (1.87)	2.60 (1.90)	79.45
T_5	Imidacloprid 17.8% SL	25	6.00	4.00 (2.23)	3.68 (2.16)	3.85 (2.20)	4.15 (2.27)	68.35
T_6	Control	-	7.25	11.25 (3.50)	12.25 (3.64)	13.25 (3.77)	12.75 (3.71)	0.04
CD				0.31	0.23	0.20	0.18	-
SEM				0.14	0.07	0.07	0.06	-

[*Mean of three replications; **Figures in the parenthesis are square root transformed values; DAS: Days after spray]

Table 4: Bioefficacy of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD against White backed plant hopper, *S. furcifera* (*Kharif*, 2021 Crop season-2

Treatment	Details	Dose (g a.i. ha^{-1})	1 DBS	Average no. of adult and nymphs $hill^{-1}$ at different days after insecticidal spray				PROC
				1st spray		2nd spray		
				7 DAS	14 DAS	7 DAS	14 DAS	
T_1	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	10	5.78	3.38 (2.09)	3.33 (2.07)	3.30 (2.07)	3.10 (2.02)	72.27
T_2	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	20	6.60	2.35 (1.83)	1.93 (1.71)	1.98 (1.73)	2.23 (1.79)	82.06
T_3	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	6.48	2.20 (1.77)	1.83 (1.68)	1.53 (1.59)	2.23 (1.79)	83.54
T_4	Pymetrozine 50% WG	150	6.58	2.30 (1.81)	2.30 (1.81)	2.13 (1.77)	1.95 (1.72)	81.64
T_5	Imidacloprid 17.8% SL	25	6.00	3.78 (2.18)	3.08 (2.02)	3.80 (2.19)	3.13 (2.03)	70.84
T_6	Control	-	7.25	9.00 (3.16)	12.25 93.64)	13.25 (3.77)	12.75 (3.71)	-
CD				0.26	0.24	0.13	0.12	
SEM				0.09	0.08	0.04	0.04	

[*Mean of three replications; **Figures in the parenthesis are square root transformed values; DAS: Days after spray]

achieved by the untreated control. Thus, percent increase in yield over control during *Kharif* 2020 crop season was as high as 22.96% in T_3, 19.61% in T_2, 19.31% in T_4, 15.71% in T_1 and 14.81% in T_5. Similarly, during *Kharif* 2021 crop season, Solomon @ 75 g a.i. ha^{-1} (T_3) was found the maximum yield (68.03 q ha^{-1}) and 39.03% yield increase over control, followed by T_2 (65.61 q ha^{-1} and 34.08%), T_4 (64.56 q ha^{-1} and 31.95%), T_1 (60.43 q ha^{-1} and 23.51%) and T_5 (55.13 q ha^{-1} and 12.66%) (Table 5). The lowest yield of 48.93 q ha^{-1} was achieved by the untreated control. The results clearly showed that T_3, T_2 and T_4 were on par in yield and better than rest of the treatments.

Table 5: Influence of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD and other insecticides on yield of Rice (*Kharif*, 2020 Crop season-1) and (*Kharif*, 2021 Crop season-2)

Treatments	Details	Dose (g a.i. ha^{-1})	*Kharif*, 2020		*Kharif*, 2021	
			Grain Yield (q h^{a-1})	Increase in yield over control (%)	Grain Yield (q ha^{-1})	Increase in yield over control (%)
T_1	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	10	69.43	15.71	60.43	23.51
T_2	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	20	71.77	19.61	65.61	34.08
T_3	Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	73.78	22.96	68.03	39.03
T_4	Pymetrozine 50% WG	150	71.59	19.31	64.56	31.95
T_5	Imidacloprid 17.8% SL	25	68.89	14.81	55.13	12.66
T_6	Control	-	60.00	-	48.93	-
CD			7.42	-	4.26	-
SEM			2.44	-	1.40	-

[*Mean of three replications]

Table 6: Influence of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD and other test insecticides on natural enemies population of Rice ecosystem (*Kharif*, 2020 Crop season-1)

Treatments	Dose (g a.i. ha^{-1})	*Mean no. of Natural enemies per 10 hills									
		Mirid Bug					Spiders				
		1st application			2nd Application		1st application			2nd Application	
		1 DBA	7 DAA	14 DAA	7 DAA	14 DAA	1 DBA	7 DAA	14 DAA	7 DAA	14 DAA
Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l-1 OD	10	1.25 (1.49)	2.00 (1.73)	2.00 (1.72)	2.50 (1.85)	2.50 (1.85)	2.00 (1.72)	3.50 (2.09)	3.00 (1.98)	3.50 (2.09)	8.75 (3.03)
Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	20	1.75 (1.62)	2.00 (1.72)	1.75 (1.65)	2.25 (1.74)	2.50 (1.85)	3.00 (1.99)	4.00 (2.20)	3.25 (2.05)	3.25 (2.04)	10.50 (3.38)
Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	1.50 (1.57)	1.50 (1.57)	1.75 (1.65)	2.25 (1.79)	2.25 (1.74)	1.50 (1.57)	2.50 (1.85)	3.75 (2.16)	5.00 (2.40)	10.00 (3.27)
Pymetrozine 50% WG	150	1.50 (1.57)	2.25 (1.80)	1.75 (1.65)	2.25 (1.85)	2.50 (1.85)	2.00 (1.72)	2.75 (1.90)	3.50 (2.10)	3.00 (1.83)	11.00 (3.46)
Imidacloprid 17.8% SL	25	1.75 (1.65)	1.75 (1.65)	2.00 (1.72)	2.50 (1.85)	2.50 (1.85)	2.00 (1.72)	3.00 (1.98)	3.25 (2.05)	2.75 (1.83)	12.75 (3.68)
Control	-	1.50 (1.57)	2.00 (1.72)	1.75 (1.65)	2.00 (1.72)	2.25 (1.74)	2.50 (1.85)	3.00 (1.99)	2.75 (1.91)	3.25 (2.03)	10.50 (3.23)
S.Em ±		-	-	-	-	-	-	-	-	-	-
CD (P=0.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[*Mean of three replications; NS = Non-significant; Figures in parenthesis are (X+0.5) square root transformed values; DBA = Days Before Application; DAA = days after application]

In this experiment Betacyfluthrin + Imidacloprid was evaluated for the first time in rice for controlling sucking pests especially hoppers. Scanty literatures have been observed on this chemical control. Although, few researchers have reported the effectiveness of this product against different sucking pests in various crops. Patel and Yadav (2018) reported the higher efficacy of this two combined product against sucking pests of wheat. This research supports the present investigation against sucking pests of rice. Singh *et al.* (2020) also reported the greater efficacy of Betacyfluthrin + Imidacloprid in green gram against sucking pests in Madhya Pradesh. Another study in cowpea also shown the highest

Table 7: Influence of Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD and other test insecticides on natural enemies population of Rice ecosystem (*Kharif*, 2021 Crop season-2)

Treatments	Dose (g a.i. ha^{-1})	*Mean no. of Natural enemies per 10 hills									
		Mirid Bug					Spiders				
		1st application			2nd Application		1st application			2nd Application	
		1 DBA	7 DAA	14 DAA	7 DAA	14 DAA	1 DBA	7 DAA	14 DAA	7 DAA	14 DAA
Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	10	1.75 (1.64)	2.00 (1.72)	2.00 (1.72)	2.25 (1.78)	2.50 (1.87)	5.50 (2.50)	6.50 (2.73)	5.00 (2.40)	5.00 (2.45)	6.50 (2.73)
Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	20	1.25 (1.47)	1.25 (1.47)	2.00 (1.47)	2.50 (1.85)	2.75 (1.93)	5.75 (2.58)	7.00 (2.82)	6.50 (2.73)	5.25 (2.48)	5.50 (2.52)
Betacyfluthrin 90 g l^{-1} + Imidacloprid 210 g l^{-1} OD	30	1.75 (1.65)	2.00 (1.72)	1.50 (1.72)	2.00 (1.72)	2.50 (1.86)	5.50 (2.54)	6.75 (2.76)	6.25 (2.69)	5.00 (2.41)	5.00 (2.45)
Pymetrozine 50% WG	150	2.00 (1.72)	2.00 (1.72)	2.00 (1.72)	2.00 (1.72)	3.00 (1.99)	6.750 (2.75)	3.75 (2.17)	4.25 (2.28)	4.00 (2.20)	5.50 (2.54)
Imidacloprid 17.8% SL	25	2.50 (1.85)	1.50 (1.53)	2.25 (1.54)	2.25 (1.78)	2.50 (1.85)	4.50 (2.28)	6.25 (2.67)	4.75 (2.39)	3.00 (1.99)	5.75 (2.59)
Control	-	1.50 (1.57)	1.75 (1.60)	2.25 (1.60)	2.25 (1.78)	2.50 (1.87)	6.00 (2.63)	5.50 (2.54)	5.50 (2.53)	4.50 (2.33)	6.00 (2.62)
S Em±		-	-	-	-	-	-	-	-	-	-
CD (P= 0.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[*Mean of three replications; NS = Non-significant; Figures in parenthesis are (X+0.5) square root transformed values; DBA = Days before application; DAA = Days after application]

efficacy of this product against sucking pests compared to other treated plots and untreated plot (Reddy *et al*., 2018). So all these previous works proved that Betacyfluthrin + Imidacloprid have a good efficacy against sucking pests and in our study we found the same but in rice crop.

Conclusion

This study provides important details of different group of chemicals and their effectiveness in rice against sucking pests particularly hoppers. To combat sucking pests of rice, we may recommend using a pre mixture of betacyfluthrin 90 g l^{-1} + imidacloprid 210 g l^{-1} OD (Solomon), taking into account field bio-efficacy, yield and relative safety to natural enemies.

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