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Bio-efficacy of some novel insecticides against *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) on paddy

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Abstract
An experiment was carried out under field condition to study the bio-efficacy of novel insecticides against, *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) on paddy during *Kharif* season at the Agricultural Research farm of Institute of Agricultural Sciences, Banaras Hindu University (BHU), Varanasi, India. The average number of insects recorded one day prior to the spray was in a range of 10.33 to 12.00 / 10 hills. The overall mean of average number of insects per 10 hills after first insecticidal spray was shown in increasing order as: acetamiprid 20 SP @40g a.i/ha (6.06) < imidacloprid 17.8 SL @50ml a.i/ha (7.04)< difenthiuron 50 SC@300g a.i/ha (7.14) < fipronil 200 SC @ 50g a.i./ha (7.79) < fipronil 0.6GR @ 50g a.i./ha (8.45) < carbofuron 3 GR @ 750g a.i./ha (8.78) < lambda cyhalothrin 4.9 CS @12.5 a.i./ha (9.11). Similar trend was followed after second insecticidal spray with 3.13, 4.04, 4.80, 5.60, 5.80, 6.46 and 8.70 overall mean of insects per 10 hills, respectively. The fipronil 200SC was observed to be best and the plots treated by this chemical gave a yield of 5.67 kg/ plot, but the yield in kg per plot obtained from lambda cyhalothrin (5.53), acetamiprid (5.43) and imidacloprid (5.30), were statistically on par.

Keywords: Brown plant hopper, novel insecticides, *Nilaparvata lugens*, paddy, bio-efficacy

1. Introduction
Rice, *Oryza sativa* (Linnaeus) is one of the important cereal crops, being the staple food for more than 65 per cent of the world population [1]. It is cultivated in almost all the tropical, sub-tropical and temperate countries of the world. Almost 90 % of the rice is grown and consumed in Asia. It is used as a food for more than two billion people in developing countries of Asia [2]. The total rice growing area in the world is 153.9 million hectares with a production of 618 million tonnes of rough rice. It is the staple food crop of India, providing 30 per cent of caloric requirement for more than 70 per cent of Indian population. The area under cultivation is 35.46 million ha in *kharif* 2013. The rice production in India was 107 million tons in 2013 [3]. One of the major constraints of rice production and low productivity in India is the occurrence of insect pests at various stages of the crop growth. The rice plant is subject to attack by more than 100 species of insects and 20 of them can cause economic damage. Together they infest all parts of the plant at all growth stages, and a few transmit viral diseases [4]. There are sucking pests like Brown plant hopper (BPH) *Nilaparvata lugens* (Stål) v Rice gundhi bug, *Leptocorisa acuta* (Thunberg) which cause damage by sucking cell sap. The brown plant hopper (BPH) *Nilaparvata lugens* (Stål) is economic important pest and they damage plants directly by sucking the plant sap and by ovipositing in plant tissue causing plant wilting or hopper burn [5]. The green leaf hoppers cause browning of leaves. They are also known as vectors of rice transitory yellowing and rice yellowing dwarf disease. The rice gundhi bug sucks the sap from the peduncle, tender stem and milking grains making them to turn chaffy.
Insecticides have played and will play an important role in realizing yield potential of crops. In early seventies and eighties organophosphates like monocrotophos and acephate, Carbomate like carbaryl and fenobucarb and other derivatives like ethofenprox have been extensively used in India as well as other countries [6]. Nevertheless, these pests became resistant to these insecticides in Japan, Taiwan, China and Philippines, although the insecticide resistance has been reported to be in incipient stage in India [7, 8]. Judicious use of insecticides and alternation of chemicals with different mode of action are suggested to reduce insecticide resistance. So, the newer insecticide molecules with diversified mode of action against these pests will significantly play a vital role in the insecticide resistance management.

Keeping these conditions in view present study was focused on bio-efficacy of newer insecticides group along with the conventional insecticides against brown plant hopper, *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) of rice.

2. Materials and Methods

The experiment was conducted during the *kharif* season of 2014-15, at the Agricultural Research Farm, B. H. U., Varanasi. Field trial was laid out in Randomized Block Design (RBD) with 3 replications and 8 treatments including untreated control. The paddy variety Malviya Dhan-36 (mutant from variety of Masuri) was grown for this study. Twenty eight day old seedlings were transplanted in the experimental plots at a spacing of 20 × 15 cm. A field border of 1m was made along the length of the field. All the agronomic practices recommended for rice under Varanasi region were followed.

2.1 Plant Protection

In the present experiment, pests were monitored at regular intervals and when pest population/ damage reached the economic threshold level, insecticides *viz*., acetamiprid 20 SP @40g a.i/ha, imidacloprid 17.8 SL @50ml a.i/ha, difenthiuron 50 SC@300g a.i/ha, fipronil 200 SC @ 50g a.i./ha, fipronil 0.6GR @ 50g a.i./ha, carbofuron 3 GR @ 750g a.i./ha, lambda cyhalothrin 4.9 CS @12.5 a.i./ha, were sprayed as per the schedule laid out in two sprays and an untreated control was maintained. First spray was applied after 60 days after transplanting (DAT) and second spray after 75 DAT.

2.2 Preparation of Spray Solution

The insecticidal spray solution of desired concentration as per each treatment was freshly prepared every time at the experimental site just before the start of spraying operation. A measured required quantity of insecticide was mixed with a little quantity of water and stirred well, after which the remaining quantity of water was added to obtain the required concentration of the spray fluid. In case of soluble concentrates the required quantities were first taken and mixed with a little quantity of water to dissolve and then the remaining quantity of water was added to obtain desired concentration and stirred well. In case of granular formulations were mixed with sand and applied to the three plots of treatment in three replications were treated at a time.
All the sprays were given during the evening hours. A hand compression sprayer was used for imposing the treatments @ 500 l/ha. All the plants in a treatment were sprayed thoroughly to the point of runoff with the spray fluid to cover all the parts. The sprayer and accessories are thoroughly washed before changing insecticide and also rinsed with the spray fluid of the chemical to be applied next.
The number of motile (adult and nymphs) stages of Brown plant hoppers (BPH) on all the 10 hills was recorded at one day prior to insecticidal application and 1st, 3rd, 7th and 14th day after application. The total count was averaged and expressed in per hill basis.

2.3 Statistical analysis

The ANOVA of data recorded was made for the insect pests under study and the calculated 'F' was compared with tabulated 'F' at 5 % level of significance. The significance of difference between treatments was judged by CD at 5 % level of significance.
The yield data in each treatment was recorded separately and subjected to statistical analysis to test the significance of mean yield variation in different treatments. The per cent increase in yield over control in various treatments was calculated by using the following formula.

$$\text{\% increase of yield in treatment over control} = \frac{\text{Yield in treatment - Yield in control}}{\text{Yield in control}} \text{ X } 100$$

3. Result and discussion

3.1 First spray

The results on the impact of insecticidal treatments after first insecticidal spray are shown in Table 2 and Fig1. The average number of insects recorded one day prior to the spray was in a range of 10.33 to 12.00 / 10 hills (Table 2).
Average number of insects recorded per 10 hills at 1st days after spray (DAS), 3rd DAS, 7th DAS and 14th DAS was lowest in plots treated with Acetamiprid (8.50, 6.50, 3.60 and 5.63, respectively). Acetamiprid was on par, with imidacloprid & Difenthiuron at 1st DAS, with Difenthiuron (7.43) at 3rd DAS, with Imidacloprid (4.40) at 7th DAS and significantly differed from the rest of the insecticidal treated plots. At 1st days after spray (DAS) and 3rd DAS, the highest average number of insects was recorded on Carbofuron (11.16 and 9.10 per 10 hills, respectively), but 7th DAS and 14th DAS, the highest average number of insects was recorded on Lambda cyhalothrin (7.87 and 9.83 per 10 hills, respectviely) (Table 2)
The observations on 7th days after spray showed that the average number of insects recorded per 10 hills was lowest by Imidacloprid was on par with Difenthiuron (5.10) (Table 2).
The average number of insects per 10 hills during 14th day after treatment by fipronil 200SC and fipronil 0.6GR was 7.83 and 7.17, respectively. Difenthiuron (7.27) was not significantly different from imidacloprid (6.60) and fipronil 0.6GR (7.17). Fipronil 200SC (7.83) did not differed significantly from the average number of insects observed in fipronil 0.6GR (7.17), difenthiuron (7.27) and Carbofuron, (7.40), treated plots (Table 2).
The overall mean of average number of insects per 10 hills after first insecticidal spray was shown in increasing order as: acetamiprid (6.06) < imidacloprid (7.04)< difenthiuron (7.14) < fipronil 200 SC (7.79) < fipronil 0.6GR (8.45) < carbofuron (8.78) < lambda cyhalothrin (9.11) (Table 2).

3.2 Second spray

Impact of insecticidal treatments on *N. lugens* in terms of average insects per 10 hills after second spray is shown in Table 3 and Fig. 1. One day before the spray, the average number of insects was observed in the range of 6.27 to 16.60 / 10 hills (Table 3).
At 1st DAS, 3rd DAS, 7th DAS and 14th DAS, Acetamiprid treated plots recorded a lowest counts of 4.80, 3.57, 1.43 and 2.73 BPH per 10 hills, respectively, and next lowest average number of insects per 10 hills was recorded from Imidacloprid treated plots (5.67, 4.27, 2.23 and 3.97). Highest number of insects per 10 hills were observed from Lambda cyhalothrin treated plots (9.33, 8.47, 8.00 and 9.00 at 1st DAS, 3rd DAS, 7th DAS and 14th DAS, respectively) during (Table 3).
The average number of insects per 10 hills observed at 7th DAS in plots treated with Imidacloprid (2.23), Difenthiuron (3.10), and Fipronil (3.83), was statistically at par. However, plots treated with Corbofuron 3G (4.33), Fipronil 0.6GR (5.00) and Carbofuron3G (4.33), Fipronil 200SC do not differ significantly in number of insects observed (Table 3).
The overall mean population of BPH per 10 hills after second insecticidal spray in increasing order was: Acetamiprid (3.13) < Imidacloprid (4.04) < Difenthiuron (4.80) < Fipronil 200

SC (5.60) < Carbofuron (5.80) < Fipronil 0.6GR (6.46) < Lambda cyhalothrin (8.70) (Table 3).

3.3 Influence of insecticidal treatments on paddy yield

The insecticides employed to reduce insect damage indirectly helps to increase the yield of the crop. The Fipronil 200SC was observed to be best and the plots treated by this chemical gave a yield of 5.67 kg/ plot, but the yield in kg per plot obtained from Lambda cyhalothrin (5.53), Acetamiprid (5.43) and Imidacloprid (5.30), were statistically at par. In control plot the yield was 3.43 Kg per plot. This clearly shows that all insecticidal treatments gave good results when compared with control.

The per cent increase over control by Fipronil 200SC (65.21) treated plot was best among all insecticidal treatments and remaining insecticidal treatments on the basis of per cent increase over control were observed to be in following order: Fipronil 200SC (65.21)>Lambda cyhalothrin(61.32)> Acetamiprid (58.41) > Imidacloprid (54.52) > Carbofuron 3G (51.60) > Difenthiuron(47.72) > Fipronil 0.6GR (43.83) (Table 4)

Table 1: Details of various insecticidal treatments and their source of supply

S. No.	Technical name	Trade name	Formulation	Dose (a.i./ha)
1	Difenthiuron 50 SC	PEGASUS	50 SC	300
2	Imidacloprid 17.8 SL	VICTOR	17.8 SL	40
3	Fipronil 200SC	REGENT	200 SC	50
4	Acetamiprid 20 SP	PERMIT(TM)	20 SP	40
5	Fipronil 0.6 GR	REGENT	0.6 GR	50
6	Lambda cyhalothrin 4.9 CS	DABANG	4.9% CS	12.5
7	Carbofuran 3G	FURADAN	3G	750
8	Untreated Control	-	-	

* Mean of three replications

Table 2: Effect of insecticidal treatments against *N. lugens* after 1st insecticidal spray

Treatments	Dose (g a.i./ha)	Avg. no. of adult & nymphs /10 hills one day before spray	Avg. no. of adults & nymphs per 10 hills at different days after 1st insecticidal spray				
			1 DAS	3 DAS	7 DAS	14 DAS	Overall Mean
Difenthiuron 50 SC	300	10.67* (3.41)**	8.77 (3.12)bac	7.43 (2.90)b	5.10 (2.46)cb	7.27 (2.87)dbc	7.14 (2.84)
Imidacloprid 17.8 SL	50	11.33 (3.51)	9.37 (3.21)ca	7.77 (2.95)cb	4.40 (2.32)b	6.60 (2.75)b	7.04 (2.81)
Fipronil 200SC	50	10.33 (3.36)	9.60 (3.25)dc	8.00 (2.99)dbc	5.73 (2.59)dc	7.83 (2.97)fcde	7.79 (2.95)
Acetamiprid 20 SP	40	10.47 (3.38)	8.50 (3.08)a	6.50 (2.73)a	3.60 (2.14)a	5.63 (2.57)a	6.06 (2.63)
Fipronil 0.6GR	50	11.67 (3.55)	10.87 (3.44)fe	8.90 (3.14)fde	6.86 (2.80)e	7.17 (2.85)cb	8.45 (3.06)
Lamda cyhalothrin 4.9CS	12.5	11.00 (3.46)	9.97 (3.31)ecd	8.77 (3.12)ed	7.87 (2.97)gef	9.83 (3.29)g	9.11 (3.17)
Corbofuran 3G	750	12.00 (3.60)	11.60 (3.54)gef	9.10 (3.17)gef	7.00 (2.82)fe	7.40 (2.89)ebcd	8.78 (3.11)
Control		11.27 (3.50)	12.13 (3.62)hg	13.67 (3.83)h	14.97 (3.99)h	16.00 (4.12)h	13.61 (3.89)
C.D.		-	0.15	0.17	0.18	0.17	-
SE(m)		-	0.04	0.05	0.06	0.05	-

* Mean of three replications, ** Figures in the parenthesis are Square root transformed values, DAS – Days after spray,
In the column the values followed by more than one alphabets do not differ significantly.

Table 3: Effect of insecticidal treatments against *N. lugens* after 2nd insecticidal spray

Treatments	Dose (g a.i./ha)	Avg. no. of adult & nymphs /10 hills one day before spray	Avg. no. of adults & nymphs per 10 hills at different days after 2nd insecticidal spray				
			1 DAS	3 DAS	7 DAS	14 DAS	Overall Mean
Difenthiuron 50 SC	300	7.87* (2.97)**	6.33 (2.70)cb	5.00 (2.44)cb	3.10 (2.02)c	4.77 (2.39)c	4.80 (2.40)
Imidacloprid 17.8 SL	50	7.10 (2.84)	5.67 (2.58)b	4.27 (2.29)ba	2.23 (1.79)b	3.97 (2.22)b	4.04 (2.23)
Fipronil 200SC	50	8.27 (3.04)	7.37 (2.89)def	6.13 (2.67)d	3.83 (2.19)d	5.07 (2.46)ecd	5.60 (2.55)
Acetamiprid 20 SP	40	6.27 (2.69)	4.80 (2.40)a	3.57 (2.13)a	1.43 (1.55)a	2.73 (1.92)a	3.13 (2.00)
Fipronil 0.6GR	50	8.03 (3.00)	7.80 (2.96)f	7.00 (2.82)fde	5.00 (2.44)fe	6.03 (2.65)f	6.46 (2.72)
Lamda cyhalothrin 4.9CS	12.5	10.27 (3.35)	9.33 (3.21)g	8.47 (3.07)gf	8.00 (3.00)g	9.00 (3.16)g	8.70 (3.11)
Corbofuran 3G	750	8.00 (2.99)	7.53 (2.92)ef	6.37 (2.71)ed	4.33 (2.30)ed	4.97 (2.44)dc	5.80 (2.59)
Control		16.60 (4.19)	17.10 (4.25)h	18.27 (4.38)h	19.33 (4.50)h	21.60 (4.75)h	19.08 (4.47)
C.D.		-	0.16	0.18	0.17	0.16	-
SE(m)		-	0.05	0.06	0.05	0.05	-

* Mean of three replications, ** Figures in the parenthesis are Square root transformed values, DAS – Days after spray,

Table 4 Impact of insecticidal treatments on paddy yield

Treatments	Dose (g a.i./ha)	*Yield (kg/plot)	Yield (tonnes/ha)	% Increase over control
Difenthiuron 50 SC	300	5.07 *	4.22	47.72
Imidacloprid 17.8 SL	50	5.30	4.41	54.52
Fipronil 200SC	50	5.67	4.72	65.21
Acetamiprid 20 SP	40	5.43	4.52	58.41
Fipronil 0.6GR	50	4.93	4.11	43.83
Lambdacyhalothrin 4.9CS	12.5	5.53	4.61	61.32
Carbofuran 3G	750	5.20	4.33	51.60
Control	-	3.43	2.86	-
C.D.	-	0.41	-	-
SE(m)	-	0.13	-	-

In the column the values followed by more than one alphabet do not differ significantly.

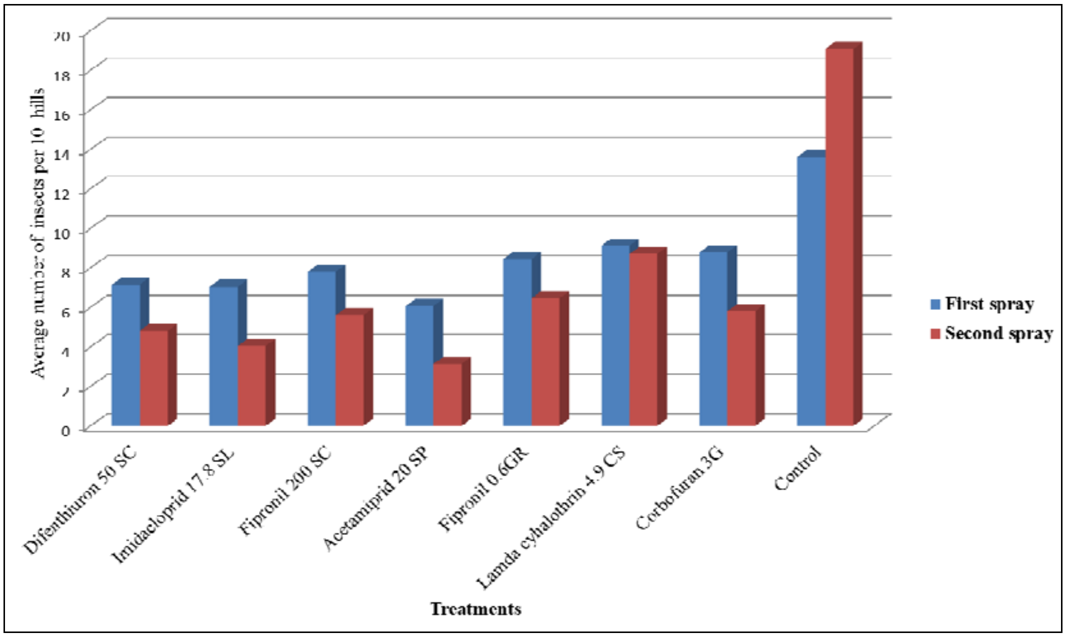

Fig 1: Response of insecticidal treatments against *N. lugens* on paddy

4. Discussion

In the present study, Acetamiprid was most effective and superior over the other insecticidal treatments, after first and second spray. The second best chemical was Imidacloprid of neonicotinoid followed by Difenthiuron and Fipronil 200SC & Fipronil 0.6GR of phenyl pyrazoles. These results are in close concurrence with the results obtained in the study of [9] who reported that Acetamiprid was found to be effective compared to Imidacloprid. [10] showed that Imidacloprid was found to be effective when compared with fipronil for management of BPH. Fipronil 200SC proved to be effective than Carbofuran and Lambda cyhalothrin.

The performance of the treatments are in the order of: Acetamiprid 20 SP @40g a.i/ha,> Imidacloprid 17.8 SL @50ml a.i/ha> Difenthiuron 50 SC@300g a.i/ha >Fipronil 200SC @ 50g a.i./ha > Fipronil 0.6% GR @ 50g a.i./ha> Carbofuran 3 GR @ 750g a.i./ha and >Lambda cyhalothrin 4.9 CS @12.5 a.i./ha. [11] reported that the treatment Fipronil 200 SC @ 50 g a.i./ha was the most effective and significantly superior over all other treatments in reducing BPH population and also Fipronil 0.6GR was also effective in suppressing the population of BPH next to fipronil 200SC. [12] found application of granular fipronil was more pronounced in restricting the plant hopper population to a minimum level at its peak activity period. In the present studies Carbofuran was also effective in suppressing the population of BPH next to fipronil [13]. who reported the efficacy of carbofuran against BPH and they have attributed the effectiveness of this insecticide due to its systemic and persistent activity.

The investigation made on the impact of insecticidal treatments on yield revealed that the highest yield of rice (4.72 tones/ha) was obtained in a treatment with Fipronil 200 SC @ 50g a.i. /ha and this treatment recorded 65.21 per cent increase in yield over control. These results are in strong accordance with [14], who reported that Fipronil was found promising in controlling the pest as well as increasing rice grain yield.

The next best treatment was Lambda cyhalothrin 4.9CS @12.5ml a.i./ha which recorded 4.61 tones/ha yield with 61.32 per cent increase over control and next best treatment was Acetamiprid 20 SP@ 40g a.i./ha in which 4.52 tonnes/ha yield with 58.41 per cent increase over control was obtained. Among the granular application Carbofuran gave highest yield (4.33 tones/ha) and per cent increase (51.60%) over control. The untreated control recorded lowest of 2.86 tones/ha yield of rice. These results are in strong accordance with [14] who reported the fipronil treated plot produced more yield than Imidacloprid. This was probably due to the better control of insects leading to less infestation and reduced losses in yield.

While in the present investigation, it was reported that Acetamiprid, Imidacloprid and Difenthiuron were restricted to show an effective results for sucking pests only, which keep the Fipronil 200SC, Lambda cyhalothrin and Acetamiprid in front line regarding control of pest complex.

5. Conclusion
Acetamiprid and Imidacloprid were found to be most effective against *N. lugens,* in reducing the population, but the yield was found to be high in Fipronil 200 SC treated plots followed by Lambda cyhalothrin and Acetamiprid. Among all insecticides a low yield was recorded in plots treated with Fipronil 0.6GR treatments but the yield was significantly higher than untreated control. All above mentioned insecticides can be incorporated in integrated pest management practices as they showed persistent toxic effects and gave an effective control of the brown plant hopper of paddy and also improved the yield.

6. Reference

1. Mathur KC, Reddy PR, Rajamali S, Moorthy BTS. Integrated pest management of rice to improve productivity and sustainability. *Oryza,* 1999; 36(3):195-207
2. Khush GS, Brar DS. Biotechnology for rice breeding: Progress and Potential impact. Proceeding of the 20th Session of the International Rice Commission, Bangkok, 2002. 23th -26th July.
3. Anonymous. State of Indian Agriculture 2012-13 Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, New Delhi, 2013.
4. Pathak MD, Khan ZR. Insect pests of rice. International Rice Research Institute, P.O box 933, 10999, Manila, Philippines, 1994, 1-17.
5. Turner R, Song YH, Uhm KB. Numerical model simulations of brown planthopper *Nilaparvata lugens* and white-backed planthopper *Sogatella furcifera* (Homoptera: Delphacidae) migration. Bull Ent Res. 1999; 89:557-68.
6. Jhansi Lakshmi V, Krishnaiah NV, Katti G, Pasalu IC, Vasantabhanu K. Development of insecticide resistance in rice brown planthopper and whitebacked planthopper in Godavari delta of Andhra Pradesh. *Indian Journal of Plant Protection.* 2010; 38(1):35-40.
7. Sarupa M, Krishnaiah NV, Reddy DDR. Assessment of insecticide resistance in field population of Rice Brown Planthopper, *Nilaparvata lugens* (Stal) in Godavari Delta, (A.P.). India. Indian Journal of Plant Protection. 1998; 26(1):80-82.
8. Padmakumari AP, Sarupa M, Krishnaiah NV. Status of insecticide resistance in rice brown planthopper, *Nilaparvata lugens* (Stal)- A review. Agricultural Reviews. 2002; 23(4):262-271.
9. Rakshit Roshan D, Raju SVS. Relative efficacy of Acetamiprid +Fipronil combination against BPH (*N. lugens*) and GLH (*N. virscens*) in rice. Journal of pure &applied Microbiology. 2016, 10.
10. Firake DM, Karnatak AK. Comparative bio efficacy of insecticides against major sucking pests of rice. Journal of Insect science. 2010; 23(1):38-43.
11. Paidi Satyanarayana, Raghuraman M, santeshwari. Bio efficacy of Phenyl Pyrazole against Brown Planthopper, *Nilaparvata lugens* in Rice. Trends in Biosciences. 2014; 7(14):1660-1663.
12. Dash D, Mishra PR, Sarangi PK. Compatibility of varietal resistance with chemical controls against rice brown planthopper, *Nilaparvata lugens* (Stal.). Environment and Ecology. 2008; 26(3A):1260-1262.
13. Jena, Mayabini. Efficacy of new insecticides as seedling root dip treatment against yellow stem borer in rabi rice. Ind. J of Plant Protec. 2004; 32(2):37-39.