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Relative Susceptibility of Different BPH, *Nilaparvata lugens* (Stal.) Populations of Chhattisgarh against Different Insecticides

M.G. Sable[1*] and D.K. Rana[2]

Department of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur- 492012, Chhattisgarh, India
**Corresponding author*

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A B S T R A C T

The experiment was conducted during Kh-2014 and Kh-2015 to study the relative susceptibility of different BPH populations against different insecticides *viz*. Imidacloprid 17.8SL, Dinotefuron 20SG, Acetamiprid 20SP, Acephate 75SP and Buprofezin 25SC. Among all the treatments, mortality of BPH glasshouse population 3 and 7 DAE of insecticides were found to be maximum in Dinotefuron 20SG during both the years, whereas mortality of different field populations of target locations varied greatly. Among all the populations checked for their susceptibility, Dhamatari population was found to be least susceptible to recommended doses of insecticides.

Introduction

Rice (*Oryza sativa* L.) is one of the major foods being consumed by world's population. India is largest producer of rice. In India Chhattisgarh state is known as 'Rice bowl' of the country, as rice is the principal crop of this state and about 70 percent of net sown area is covered under rice. Like other crops rice is also attacked by several insect pests. Among these brown planthopper *Nilaparvata lugens* (Stal.) is major sucking pest. The BPH causes direct damage to rice plant by sucking the plant sap. In addition to this, it also transmits several diseases like grassy stunt (Rivera *et al.*, 1966), ragged stunt (Ling, 1978) and wilted stunt viral disease of rice (Chen and Cheng, 1978). Popular varieties are almost susceptible to BPH and control is mostly dependent on insecticides (Alberto and Mou, 2016). Researcher have reported several problems caused by heavy reliability on chemicals targeted on BPH *viz*. resurgence, hormologosis, BPH resistance to insecticides, destruction of natural enemies and pollution etc.

Repeated use of insecticides causes resistance development in BPH. These chemicals will no longer effective against BPH, which leads to management failure and economic loss. There is need to investigate the promising chemicals in control of brown planthopper (Jhansi Lakshmi *et al.*, 2010). Keeping this in view, the present experiment was conducted.

Materials and Methods

This study was conducted at glasshouse during Kh-2014 and Kh-15. Recommended and popular chemicals among the farmers were selected for the study.

Insect collection

Adults of brown planthopper were collected from farmers' fields of four blocks representing Raipur and Dhamatari district each year. The insects were collected manually with the help of an aspirator from the base of rice plants and placed into plastic bottles covered with muslin cloth (Heong *et al*., 2010).

These collected insects were transported to glasshouse along with rice plant as a food in plastic bottles and released on fresh and cleaned TN1 plants in glasshouse at Raipur. These populations were reared separately. Newly hatched 1st and 2nd instar nymphs from this population was used to study the relative susceptibility towards different insecticide. The susceptible population of BPH which is being maintained in the glasshouse without any exposure to insecticides was used for comparison (Kushwaha, 2013).

Relative susceptibility of different populations of BPH

Three neonicotinoid compounds *viz.* Imidacloprid, Dinotefuron and Acetamiprid; one organophosphates, i.e. Acephate and one chitin synthesis inhibitor, Buprofezin has been used in the present study. Spray solutions of different insecticides were prepared as per the recommended doses. Healthy and well maintained 45 days old TN1 plants were used for the study. These plants were sprayed with spray solution up to run-off stage with the help of hand sprayer (Jhansi Lakshmi *et al*., 2006; Krishnaiah *et al*., 2004).

Sl. No.	Treatments	Dose (g or ml/ha)
1	Buprofezin 25 SC	800 ml
2	Acephate 75SP	667 gm
3	Dinotefuran 20SG	150 gm
4	Imidacloprid 17.8 SL	125 ml
5	Acetamiprid 20 SP	100 gm
	Control	

The spray deposits were allowed to dry in ambient conditions up to 24 hrs. The untreated plants were taken for comparison as control. Twenty BPH nymphs of first and second instar were released on these plants on next day and confined by inverted glass funnel to avoid escape. Observations on % mortality were recorded after 3 and 7 days of exposure (DAE). The experiment was conducted in CRD with six replications.

Results and Discussion

Kharif 2014

The cumulative mortality of BPH nymphs was observed on 3 and 7 days after exposure (DAE) of insecticides.

Mortality of BPH 3 days after exposure

Among all the treatments, mortality of BPH glasshouse population, 3 DAE of insecticides was ranged from 0 to 37.50%. In Dinotefuron 20SG mortality of BPH was maximum (37.50%), which was significantly different from all the treatments. It was followed by Imidacloprid 17.8SL (28.33%) and Acetamiprid 20SP (24.17%) which were statistically at par with each other. Among the chemicals tested minimum mortality was observed in Buprofezin 25SC (5.00%). Average mortality of Arang population was ranged from 0.00 to 34.17 %. The population was most susceptible to Dinotefuron with maximum mortality (34.17%), while the lowest mortality was recorded in control (0.00%) followed by Buprofezin (4.17%). In Imidacloprid insect mortality was 21.67% which was at par with Acetamiprid 22.50% as shown in table 1.

Mortality of Abhanpur population was significantly higher in Dinotefuron (32.50%) than all the treatments. Minimum mortality was found in untreated control (0.00%) followed by Buprofezin (3.33%). BPH mortality in Imidacloprid and Acetamiprid was 19.17% which were statistically at par. Average mortality of Kurud population was ranged from 0.00 to 30.83%. The maximum insects were dead in treatment Dinotefuron (30.83%) followed by Imidacloprid (18.33%) and Acetamiprid (15.83%) which were at par with each other. Mortality in Acephate and Buprofezin was at par with each other *i.e.* 8.33% and 5.83% respectively.

In Dhamatari population the average mortality was ranged from 0.00 to 31.67%. Maximum mortality was recorded in Dinotefuron (31.67 %) followed by Acetamiprid (20.83%). Minimum mortality was recorded in control 0.00% and Buprofezin 1.67%. The average mortality found in Imidacloprid was 14.17%, which was least as compare to population of other locations.

Mortality of BPH 7 days after exposure (DAE)

Among all the treatments, mortality of BPH glasshouse population, 7 DAE of insecticides was ranged from 0.83 to 87.50%. In Dinotefuron 20SG mortality of BPH was maximum (87.50%), which was significantly different from all the treatments. It was followed by Buprofezin (85.83%), Imidacloprid 17.8SL (82.50%) and Acetamiprid 20SP (81.67%) which were statistically at par with each other. Among the chemicals tested, minimum mortality was observed in control (0.83%) followed by Acephate (75.83%) as shown in table 2.

Average mortality of Arang population was ranged from 1.67 to 82.50 %. The population was least susceptible to Acephate with minimum mortality (68.33%), while the highest mortality was recorded in Dinotefuron (82.50%). Average mortality in control was 1.67%.

Mortality of Abhanpur BPH population was significantly higher in Dinotefuron (80.83%) than all the treatments. Minimum mortality was recorded in untreated control (0.00%) followed by Acephate (67.50%). Mortality percentage in Buprofezin (73.33%), Acetamiprid (70.00%) and Imidacloprid (68.33%) was at par with each other. Average mortality of Kurud population was ranged from 0.00 to 79.17%. The population was highly susceptible to Dinotefuron (79.17%) followed by Buprofezin (70.83%). Minimum insect mortality was recorded in control 0.00%. Maximum BPH mortality in Dhamatari population was recorded in Dinotefuron (76.67 %), while it was minimum in control 0.00%. Remaining all the chemical treatments were at par with each other. Mortality in Imidacloprid was recorded to be minimum (56.67%) which was followed by Acephate (59.17%).

Kharif 2015

Mortality of BPH 3 days after exposure

Among all the treatments, mortality of BPH glasshouse population, 3 DAE of insecticides was ranged from 0 to 34.17% during Kh-2015. In Dinotefuron 20SG mortality of BPH was maximum (34.17%), which was significantly different from all the treatments. It was followed by Imidacloprid 17.8SL (31.67%) (Table 3).

Table.1 Mortality (%) of different BPH populations 3 days after exposure (Kh-2014)

Treatment No.	**Insecticide name**	**Dose (ml or gm/ha)**	**Glasshouse**	**Arang**	**Abhanpur**	**Kurud**	**Dhamatari**
1	Imidacloprid 17.8SL	125 ml	28.33 (32.33)[b]	21.67 (27.96)[b]	19.17 (26.24)[b]	18.33 (25.62)[b]	14.17 (22.38)[c]
2	Dinotefuron 20SG	150 gm	37.50 (37.99)[a]	34.17 (35.99)[a]	32.50 (35.00)[a]	30.83 (33.90)[a]	31.67 (34.39)[a]
3	Acetamiprid 20SP	100 gm	24.17 (29.63)[b]	22.50 (28.57)[b]	19.17 (26.24)[b]	15.83 (23.66)[b]	20.83 (27.43)[b]
4	Acephate 75SP	667 gm	15.83 (23.71)[c]	13.33 (21.75)[c]	11.67 (20.33)[c]	8.33 (17.12)[c]	9.17 (18.01)[d]
5	Buprofezin 25SC	800 ml	5.00 (12.17)[d]	4.17 (11.28)[d]	3.33 (10.39)[d]	5.83 (12.01)[c]	1.67 (7.22)[e]
6	Control	-	0.00 (4.05)[e]	0.00 (4.05)[e]	0.00 (4.05)[e]	0.00 (4.05)[d]	0.00 (4.05)[e]
		SEm±	1.72	1.47	1.22	1.97	1.40
		CD(0.05)	4.96	4.24	3.53	5.69	4.06

(Values in parenthesis are arc sign transformed values)

Table.2 Mortality (%) of different BPH populations 7 days after exposure (Kh-2014)

Treatment No.	Insecticide name	Dose (ml or gm/ha)	Glasshouse	Arang	Abhanpur	Kurud	Dhamatari
1	Imidacloprid 17.8SL	125 ml	82.50 (65.86)[ab]	72.50 (59.01)[ab]	68.33 (56.51)[ab]	65.83 (54.72)[bc]	56.67 (49.18)[b]
2	Dinotefuron 20SG	150 gm	87.50 (71.50)[a]	82.50 (65.96)[a]	80.83 (64.65)[a]	79.17 (63.47)[a]	76.67 (61.62)[a]
3	Acetamiprid 20SP	100 gm	81.67 (65.38)[ab]	71.67 (58.23)[ab]	70.00 (57.23)[ab]	59.17 (50.62)[c]	63.33 (53.38)[b]
4	Acephate 75SP	667 gm	75.83 (61.33)[b]	68.33 (56.72)[b]	67.50 (56.21)[b]	56.67 (49.33)[c]	59.17 (50.79)[b]
5	Buprofezin 25SC	800 ml	85.83 (68.93)[ab]	76.67 (62.04)[ab]	73.33 (59.81)[ab]	70.83 (57.80)[ab]	61.67 (52.14)[b]
6	Control	-	0.83 (5.63)[c]	1.67 (7.22)[c]	0.00 (4.05)[c]	0.00 (4.05)[d]	0.83 (5.63)[c]
		SEm±	2.61	2.81	2.90	2.22	2.78
		CD(0.05)	7.52	8.14	8.36	6.40	8.02

(Values in parenthesis are arc sign transformed values)

Table.3 Mortality (%) of different BPH populations 3 days after exposure (Kh-2015)

Treatment No.	Insecticide name	Dose (ml or gm/ha)	Glasshouse	Arang	Abhanpur	Kurud	Dhamatari
1	Imidacloprid 17.8SL	125 ml	31.67 (34.47)[ab]	17.50 (24.90)[b]	16.67 (24.34)[b]	12.50 (21.04)[b]	11.67 (19.74)[b]
2	Dinotefuron 20SG	150 gm	34.17 (36.03)[a]	33.33 (35.51)[a]	30.83 (33.96)[a]	29.17 (32.96)[a]	28.33 (32.43)[a]
3	Acetamiprid 20SP	100 gm	26.67 (31.35)[b]	16.67 (24.19)[b]	14.17 (22.38)[b]	8.33 (16.94)[b]	15.83 (23.71)[b]
4	Acephate 75SP	667 gm	17.50 (24.90)[c]	9.17 (17.83)[c]	8.33 (17.12)[c]	4.17 (11.28)[c]	6.67 (14.65)[c]
5	Buprofezin 25SC	800 ml	10.83 (19.62)[d]	3.33 (10.39)[d]	2.50 (8.80)[d]	2.50 (8.80)[c]	0.00 (4.05)[d]
6	Control	-	0.00 (4.05)[e]	0.00 (4.05)[e]	0.00 (4.05)[e]	0.00 (4.05)[d]	0.00 (4.05)[d]
		SEm±	1.19	1.58	1.37	1.62	1.62
		CD(0.05)	3.35	4.45	3.95	4.56	4.55

(Values in parenthesis are arc sign transformed values)

Table.4 Mortality (%) of different BPH populations 7 days after exposure (Kh-2015)

Treatment No.	Insecticide name	Dose (ml or gm/ha)	Glasshouse	Arang	Abhanpur	Kurud	Dhamatari
1	Imidacloprid 17.8SL	125 ml	80.83 (64.49)[a]	58.33 (50.10)[bc]	51.67 (46.24)[c]	47.50 (43.85)[bc]	42.50 (40.97)[c]
2	Dinotefuron 20SG	150 gm	83.33 (66.44)[a]	79.17 (63.27)[a]	77.50 (62.06)[a]	77.50 (62.06)[a]	75.83 (60.94)[a]
3	Acetamiprid 20SP	100 gm	79.17 (63.27)[ab]	62.50 (52.61)[b]	66.67 (55.05)[b]	51.67 (46.24)[b]	54.17 (47.68)[b]
4	Acephate 75SP	667 gm	75.83 (60.94)[b]	61.67 (52.07)[b]	51.67 (46.26)[c]	43.33 (41.44)[c]	48.33 (44.32)[bc]
5	Buprofezin 25SC	800 ml	82.50 (65.86)[a]	54.17 (47.68)[c]	56.67 (49.14)[c]	46.67 (43.73)[bc]	41.67 (40.47)[c]
6	Control	-	0.00 (4.05)[c]	0.00 (4.05)[d]	1.67 (7.22)[d]	0.83 (5.63)[d]	2.50 (8.80)[d]
		SEm±	1.20	1.15	1.33	1.14	1.42
		CD(0.05)	3.37	3.23	3.84	3.20	3.98

(Values in parenthesis are arc sign transformed values)

Mortality of Abhanpur population was significantly higher in Dinotefuron (30.83%) than all the treatments. Minimum mortality was found in untreated control (0.00%) followed by Buprofezin (2.50%). BPH mortality in Imidacloprid and Acetamiprid was 16.67% and 14.17% respectively.

Average mortality of Kurud BPH population was ranged from 0.00 to 29.17%. The maximum population was dead in treatment Dinotefuron (29.17%) followed by Imidacloprid (12.50%) and Acetamiprid (8.33%) which were at par with each other. Mortality in Acephate and Buprofezin was at par with each other i.e. 4.17% and 2.50% respectively.

In Dhamatari population, among the treatments, average mortality was ranged from 0.00 to 28.33%. Maximum mortality was recorded in Dinotefuron (28.33%) followed by Acetamiprid (15.83%). Minimum mortality was recorded in control and Buprofezin 0.00%. The results in Imidacloprid and Acetamiprid were at par with each other.

Mortality of BPH 7 days after exposure

Among all the treatments, mortality of BPH glasshouse population, 7 DAE of insecticides was ranged from 0.0 to 83.33%. In Dinotefuron 20SG mortality of BPH was maximum (83.33%), it was followed by Buprofezin 82.50% and Imidacloprid 17.8SL (80.83%), which were statistically at par with each other. Minimum mortality was observed in control 0.00% as shown in table 4.

Average mortality of Arang population was ranged from 0.00 to 79.17%. The population was least susceptible to Buprofezin (54.17%), while the highest mortality was recorded in Dinotefuron (79.17%). Mortality of Abhanpur BPH population was ranged from 1.67 to 77.50%. Maximum insect mortality was found in Dinotefuron (77.50%) and minimum mortality was recorded in untreated control (1.67%).

The maximum Kurud BPH population was dead in treatment Dinotefuron (77.50%) followed by Acetamiprid (51.67%), while minimum insect mortality was recorded in control 0.83%. Maximum mortality of BPH Dhamatari population was recorded in Dinotefuron (75.83%), followed by Acetamiprid (54.17%), while it was minimum in control 2.50%.

Various scientists have reported fluctuating results on the susceptibility of BPH against various insecticides. Chau (2007) reported that Imidacloprid 10WP, Imidacloprid 700WG, Buprofezin 10WP, Fipronil 5SC, Etofenprox 10EC were only effective when they were used at higher dosages than recommended rate. While Yanhua *et al*. (2008) reported that most BPH populations were susceptible to Buprofezin before 2004. However, substantially higher levels of resistance (up to 28-fold) were found in most of the rice fields in China after 2004.

In India Jhansi Lakshmi *et al*., (2010c) reported that the resistance ratios in BPH against neonicotinoid insecticides are at high levels. During 2006, BPH in Godavari delta of Andhra Pradesh exhibited increased order of resistance to Neonicotinoids. Similarly Basanth *et al*., (2013) investigated susceptibility of BPH population of Gangavati, Kathalagere, Kollegala, Soraba and Mandya. They reported that all the field populations differed in their susceptibility to insecticides. In general, Soraba and Mandya populations were more susceptible to insecticides compared to Gangavati and Kathalagere populations. The populations from Gangavati, Kathalagere and Kollegala exhibited higher resistance to some of the old insecticides and low resistance to new molecules.

The extreme situation is observed in west Godavari region of Andhra Pradesh, India where BPH have developed resistance to greater extent. In current study it was found that the highly reliable and mostly adopted systemic insecticides are being failed to control the pest. The monopoly of neonicotinoid in rice ecosystem leads to sever problem. The Dinotefuron is the third generation neonicotinoid, it was not experienced previously by the insect more frequently and hence it has shown superior results. Being highly effective against all the life stages of BPH, Dinotefuron shows its superiority in both the years. The insecticides Imidaclopride and Buprofezin were not giving acceptable results at current recommended doses.

Insects like Aphids, Jassids and Whiteflies in which overlapping generations with short life cycle are there, the problem of insecticide resistance is common. BPH is not exception for that, due to short life cycles and high fecundity the chances of insecticide resistance are more. Due to high selection pressure exerted by systemic insecticide, BPH evolves resistance to insecticides. Generally insects become resistant to insecticides by directly excretion of the chemicals, by detoxification or changed site of action. Due to quick knock down effect Imidacloprid was the first priority of farmer to control the pest but results shown less efficacy against BPH of some locations. From current studies it is clear that the farmers are totally dependent on one group i.e. neonicotinoids. Whatever may be reasons i.e. inadequate information by chemical dealers or mouth to mouth publicity by famers it is dominant group in selected area. Rotation of chemicals is the advice by scientist, which is totally washed out at ground level by farmers because of risk bearing ability. Chemicals which have good margin on selling are only promoted by retailers. To guarantee global food security for continuing population expansion it is crucial to control the different insect pests that harm rice crop (Normile, 2008). So in due course of time insecticide resistance management policy makers should compulsorily consider the traders and retailers of BPH prone area.

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