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Bioefficacy of Commonly used Insecticides against Rice Brown Planthopper *Nilaparvata lugens* (Stål) in Nalgonda District of Telangana State, India

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Abstract

Studies on bio-efficacy of commonly used insecticides to brown planthopper BPH *Nilaparvata lugens* (Stål) population collected from Nalgonda district, Telangana, India were carried out during 2015. The results revealed that dinotefuran, acephate, monocrotophos and Dichlorvas recorded 100 percent mortality after 24 hours of insecticidal treatment followed by chlorpyriphos (98.8%), thiamethoxam (96.3%), ethiprole +imidacloprid (Glamore) (96.3%), pymetrozine (95%), imidacloprid (63.8%) and fipronil (61.3%). Buprofezin recorded least per cent mortality of 42.5. With the progression of time (48 and 72 hours after application of insecticides), the mortality of BPH nymphs increased in all the treatments. Dinotefuran, acephate, monocrotophos, Dichlorvas and chlorpyriphos are found to be highly effective against BPH, thiamethoxam, ethiprole +imidacloprid (Glamore) and pymetrozine are moderately effective and imidacloprid, fipronil and buprofezin failed to control BPH.

Key words: Bioefficacy, India, insecticides, Nalgonda, *Nilaparvata lugens,* rice

Introduction

Rice brown planthopper (BPH), *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) is the most important sucking insect pest attacking rice crop throughout the rice growing Asian countries today. Extensive yield losses have been reported from several states of the country (Basant *et al*., 2013; Chandana *et al*., 2015; Kalode and Viswanathan 1976; Sandeep *et al*., 2014). The emergence of BPH as a key pest was due to the suitable microclimate created by the cultivation of High Yielding Varieties and hybrids (Krishnaiah and Jhansi Lakshmi 2012). Both the nymphs and adults remain at the base of the rice plant and suck the sap from the phloem and xylem resulting in yellowing, wilting, drying up and death of the rice plant. Under field conditions, the damage spreads in a circular fashion and is termed as "hopper-burn". If timely control measures are not taken up, the entire field could be affected in a span of 15-20 days. In addition to direct feeding damage, BPH also transmits viral diseases like grassy stunt and ragged stunt (Ling 1977). Insecticides became the most sought after strategy for BPH management in spite of several draw backs such as development of insecticide resistance and resurgence (Baehaki *et al*., 2016; Matsumura *et al*., 2009; Nagata *et al*., 1979; Wang *et al*., 2008).

BPH has become a very serious problem causing severe yield losses in thousands of acres for the past 6-7 years in Nalgonda district of Telangana state in India due to the monoculturing of rice in extensive area, use of susceptible rice varieties, availability of irrigation water in addition to indiscriminate use of insecticides. Among the different groups of insecticides used against BPH, monocrotophos, acephate (organo-phosphates) imidacloprid, thiamethoxam, dinotefuran (neonicotinoids), buprofezin (insect growth regulator), pymetrozine (feeding inhibitor), and fipronil (phenyl pyrazole compounds) are important ones. There are many reports from the farmers, extension personnel and industry that there is a significant decline in the efficacy of neonicotinoids as well as buprofezin against BPH. However, there are no published reports on bioefficacy of insecticides in the Kampasagar area of Nalgonda district. In this context, the present study was undertaken to assess the bioefficacy of insecticides to BPH in Kampasagar area of Nalgonda district of Telangana state, India during 2015.

Materials and methods:

Collection and mass rearing of field populations of BPH

BPH populations were collected from farmers' fields in six villages of three mandals *viz*., Miryalaguda, Nidamanuru, Tripuraram of Nalgonda district of Telangana State during *kharif* 2015. Approximately 300 to 500 BPH nymphs and adults were collected from each village and a total of approximately 2500 insects were brought to Indian Institute of Rice Research (IIRR), Rajendranagar, Hyderabad, India. They were reared in IIRR greenhouse for 2 generations on 40 -50 day old rice plants of susceptible variety TN1. 7-9 days old nymphs from the culture were used for bioefficacy studies.

Insecticides:

Fresh and ready to use insecticide formulations were obtained from the manufacturing companies (Table 1). The test insecticides include three neonecotinoids viz., imidacloprid (Confidor 17.8 SL), thiamethoxam (Actara 25 WG) and dinotefuran (Osheen 20 SG); four organophoshates viz., monocrotophos (Monostar 36 SL), acephate (Starthene 75 WP), dichlorovas (Nuvan 76 EC) and chlorpyriphos (Dursban 20 EC); one phenyl pyrazole viz,. fipronil (Regent 5 SC). In addition, pymetrozine (Chess 25 WG), a pyridine azomethine compound, insect growth regulator cum chitin synthesis inhibitor, Buprofezin (Applaud 25 SC) and one combination product containing Ethiprole 40%+ Imidacloprid 40% (Glamore 80 WG) were also evaluated.

Table 1: Details of insecticides used in the study

S.No	Common Name	Trade Name and formulation	Chemical group	Manufacturing company
1	Imidacloprid	Confidor 17.8 SL	Neonicotinoid	M/s Bayer Crop Sciences Limited, Mumbai
2	Thiamethoxom	Actara 25 WG	Neonicotinoid	M/s Syngenta India Limited, Mumbai
3	Dinotefuron	Osheen 20 SG	Neonicotinoid	PI Industries Limited, Mumbai
4	Ethiprole 40% + Imidacloprid 40%	Glamore 80 WG	Combination product	M/s Bayer Crop Sciences Limited, Mumbai
5	Chlorpyriphos	Dursban 20 EC	Organophosphate	M/s Dow Chemical International Private Limited, Mumbai
6	Monocrotophos	Monostar 36 SL	Organophosphate	M/s Swal Corporation Limited, Mumbai
7	Dichlorvos	Nuvan 76 EC	Organophosphate	M/s Insecticides (India) Limited, Delhi
8	Acephate	Starthene75 WP	Organophosphate	M/s Swal Corporation Limited, Mumbai
9	Buprofezin	Applaud 25 SC	Insect growth regulator	M/s Rallis India Limited, Mumbai
10	Fipronil	Regent 5 SC	Phenyl pyrazole	M/s Bayer Crop Sciences Limited, Mumbai
11	Pymetrozine	Chess 25 WG	M/s Syngenta India Limited, Mumbai	M/s Syngenta India Limited, Mumbai

Toxicity tests for bioefficacy of insecticides

The tests were carried out under controlled greenhouse conditions at a temperature of 30±5^{0} C and RH of 60±5%, following the methodology standardized by Jhansi Lakshmi *et al*., 2001a, 2001b. To assess the efficacy of insecticides, all the insecticides tested were used at recommended doses as detailed in Table 2. The insecticides were diluted to the required concentrations with tap water and sprayed on 40 day old potted rice plants with the help of fine atomizer up to runoff stage. Tap water spray without any insecticide served as control. The spray deposits were allowed to dry in ambient conditions. Twenty 7-9 day old BPH nymphs were confined to the treated plants with mylar cages. Observations on BPH mortality were recorded after 24, 48 and 72 hours of release of nymphs. The insects that were unable to move when touched with camel hair brush were considered as dead insects (Tabashnik *et al*., 1990). Per cent mortalities were computed and after suitable transformations, the data were statistically analyzed as completely randomized block design (CRBD) according to Cochran and Cox (1957). Treatment means were separated by Duncan's Multiple Range Test (DMRT).

Results and discussion

Results pertaining to the efficacy of insecticides on the third instar nymphs of BPH are presented in the Table 2. Eleven insecticides significantly reduced the BPH population compared to control after 24 hours of application. Acephate was the most effective in reducing BPH nymphal population (97.5% mortality) followed by monocrotophos (95.0%), chlorpyriphos (93.8%), dinotefuron (92.5%) and dichlorvos (91.3%). Pymetrozine (77.5% mortality) , thiamethaxom (77.5%) and ethiprole 40% + Imidacloprid 40% 80 WG (glamore) (67.5%) were next in the order. Fiproil, imidacloprid and buprofezin recorded very low mortality of 37.5, 30 and 13.8 percent respectively.

Table 2. Bio-efficacy of insecticides against Nalgonda BPH population

S.No.	Treatments	Dose g or ml of formulation /l water	Mortality of BPH nymphs (%)		
			1 DAS	2 DAS	3 DAS
1	Imidacloprid	0.5 ml/l	30 (33.1)c	48.75 (44.23)e	63.75 (53.00)c
2	Thiamethoxom	0.5 g/l	77.5(61.83)b	90(72.11)cd	96.25(80.27)b
3	Dinotefuron	0.4 g /l	92.5(76.43)ab	100(89.96)a	100(89.96)a
4	Ethiprole 40% + Imidacloprid 40%	0.25 g/l	67.5(55.29)bc	93.75(79.66)c	96.25(82.12)b
5	Chlorpyriphos	2 ml/l	93.75(79.66)a	98.75(86.73)b	98.75(86.73)ab
6	Monocrotophos	2 ml/l	95(78.89)a	100(89.96)a	100(89.96)a
7	Dichlorvos	1 ml/l	91.25(73.2)ab	98.75(86.73)b	100(89.96)a
8	Acephate	1 g/l	97.5(83.5)a	100(89.96)a	100(89.96)a
9	Buprofezin	2 ml/l	13.75(21.68)d	31.25(33.89)f	42.5(40.64)d
10	Fipronil	2 ml/l	37.5(37.69)c	52.5(46.42)e	61.25(51.50)c
11	Pymetrozine	1.7 g/l	77.5(61.83) b	87.5(69.36)d	95(80.25)b
12	Control		0(0) e	0 (0)g	0 (0) e

Note: Figures in parenthesis are arcsine transformed values

Figures in a column followed by same letter are not significantly different at P=0.05

Two days after application, dinotefuran, acephate and monocrotophos recorded 100 percent mortality of BPH nymphs, followed by dichlorvos and chlorpyriphos which recorded 98.5 percent mortality. The combination product ethiprole 40% + imidacloprid 40% 80 WG (Glamore), thiamethaxom and pymetrozine showed 93.8, 90 and 77.5 percent mortality respectively. Fiproil, imidacloprid and buprofezin recorded 52.5, 48.8 and 31.3 per cent mortality, respectively. With the progression of time after application of insecticides, the mortality of BPH nymphs increased in all the treatments. Seventy two hours after treatment, dinotefuran, acephate, monocrotophos and Dichlorovas recorded 100 percent mortality, followed by thiamethoxam (96.3%), chlorpyriphos (98.8%), ethiprole 40+imidacloprid 40 80 WG (glamore) (96.3%), pymetrozine (95%), imidacloprid (63.8%) and fipronil (61.3%). Buprofezin recorded least per cent mortality of 42.5%. Mortality of BPH nymphs in buprofezin treatment after 96 and 120 hours after release was 62.5% and 81.3% respectively.

Earlier workers reported that, among the neonicotinoids, imidacloprid treatment resulted in 100% mortality within 24 hours or even earlier (Krishnaiah *et al*., 2004) while in the present study, only 64% mortality was observed even after 3 days of exposure. Even though, thiamethoxam exhibited 96% mortality after 3 days of exposure, the effectiveness was much lower compared to the previous studies (Jhansi Lakshmi *et al*., 2010a). Thus, both these neonicotinoids have been found far less effective against Nalgonda BPH during 2015. Dinotefuran is a new neonicotinoid compound which was introduced into Indian market in 2012. It was quite effective against BPH in the field condition (Ghosh *et al*., 2014). During 2015, the insecticide showed good degree of effectiveness against Nalgonda BPH population (93- 100% mortality).

Monocrotophos and acephate were extensively used against BPH throughout India including Nalgonda district, though their use has been replaced by application of neonicotinoids. These two insecticides were found to maintain their efficacy against BPH population from Nalgonda with 97.5 -100% nymphal mortality. Monocrotophos is also known for its quick knock down effect and longer persistence on plant (Jhansi lakshmi *et al*., 2010a; Krishnaiah *et al*., 1982a and b; Randeep *et al*. 2016). In the present study, results related to chlorpyriphos use are in conformity with the findings of Krishnaiah and Buchain (1987) and Kharbade *et al*. (2015) who reported that chlorpyriphos application was highly effective against BPH though it is generally used against stem borer. Dichlorvos recorded 91-100% BPH nymphal mortality after 24-72 hrs of exposure. Dichlorvos is also not commonly used for BPH control, but for the past 3-4 years, farmers have been using this insecticide in combination with monocrotophos with good results mainly due to its quick knock down effect even though it lacks persistence.

Fipronil has been under use in rice ecosystem in India since 2001. This compound is slow acting (Randeep *et al*., 2016) and requires 3 days to express its full potential. The present study revealed that fipronil was less effective against BPH than in earlier reports (Krishnaiah *et al*., 2004). Pymetrozine is a new molecule whose mode of action is still not well understood and is being used in rice ecosystem against BPH since 2012 (Jhansi Lakshmi *et al*., 2010a). The insecticide does not result in direct killing of BPH, but die due to starvation caused by their inability to feed on treated plants due to very high anti-feedant activity of the molecule (He *et al*., 2011). In the present study, pymetrozine retained its normal efficacy (90% mortality) against BPH (Kiran Kumar 2016).

Buprofezin is a slow acting insecticide requiring 3 days to exhibit its full potential. The previous results indicated buprofezin could kill all the exposed BPH within three days (Krishnaiah *et al*, 1996 and 2008; Shashank *et al*., 2012). However, in the present study, it could exhibit only 43% mortality even after 3 days exposure revealing a failure to control BPH.

The combination product Glamore exhibited moderate degree of effectiveness (67.5% -96.3% mortality) to Nalgonda population of BPH in opposition toearlier report by, Jhansi lakshmi *et al*. (2010b) who observed 100% mortality after 24 hrs and PT (Persistent toxicity) value of 2826.

Dinotefuran, acephate, monocrotophos and Dichlorovas thiamethoxam, chlorpyriphos, ethiprole 40+imidacloprid 40 80WG (glamore), pymetrozine recorded good bioefficacy against Nalgonda BPH population whereas imidacloprid, fipronil and buprofezin recorded low per cent mortality of BPH and failed to control the BPH.

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