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TOXICITY OF IMIDACLOPRID 17.8%SL AND TRIFLUMEZOPYRIM 10%SC TO RICE BROWN PLANTHOPPER *NILAPARVATA LUGENS*

E Priyadharshini, N Muthukrishnan*, B Vinothkumar, N Sathiah[1] and K Prabakar[1]

Department of Agricultural Entomology; Centre for Plant Protection Studies,
Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India
*Email: nmkrish@tnau.ac.in (corresponding author)

ABSTRACT

The rice brown planthopper *Nilaparvata lugens* (Stål.) is a threat to rice growers and it has developed resistance to many insecticides. Hence, newer molecules like triflumezopyrim 10%SC are available. Its toxicity has been investigated in this study, with four populations from Tamil Nadu along with imidacloprid 17.8%SL using rice seedling dip method. Lower LC$_{50}$ values of 0.538 ppm and 0.280 ppm were observed with the susceptible populations against imidacloprid 17.8%SL and triflumezopyrim 10%SC, respectively. LC$_{50}$ values were in range of 0.280-0.848 ppm for triflumezopyrim 10%SC indicating its superior toxicity. Nagapattinam population exhibited moderate resistance (15.36 folds) to imidacloprid 17.8%SL and low resistance (3.02 folds) to triflumezopyrim 10%SC.

Key words: *Nilaparvata lugens*, rice, triflumezopyrim 10%SC, imidacloprid 17.8%SL insecticide resistance, susceptibility, bioassay, seedling dip method, resistance ratio

Rice production amounts to 42% of food production and 45% of cereals production in India (Mohapatra, 2014; Kumar and Sharma, 2021). Rice is affected by a number of pests, and among these, brown planthopper (BPH) *Nilaparvata lugens* (Stal) causes typical hopper burn symptoms with a yield loss of about 40-70% (Anand et al., 2020), and in the 1960's it has become a major threat with the introduction of high yielding varieties and use of pesticides (Peshin, 2021). BPH has developed resistance to most of the earlier used insecticide molecules due to indiscriminate use leading to use of neonicotinoids and phenyl pyrazoles, as these effectively control pests like aphids, thrips, planthoppers and whiteflies (Bose et al., 2020). More than 25% in total global sales of insecticides are accounted for by the neonicotinoids, in particular against *N. lugens* (Ihara and Matsuda, 2018). The first of these, imidacloprid was developed against *N. lugens* in the early 1990s but after a decade, across Asia resistance to imidacloprid had been known (Bass et al., 2015; Matsumura et al., 2014). Continuous monitoring/ detection of insecticide resistance revealed resistance to sulfoxaflor 21.8%SC (Priyadharshini et al., 2020). Recently, new molecules that are analogous to neonicotinoids are introduced like triflumezopyrim 10%SC of mesoionic class that exhibits high potential against BPH with a unique mode of action which acts as a weak agonist at the orthosteric site of nAChRs and produces lethargic nature instead of excitatory symptoms produced by other neonicotinoids (Holyoke et al., 2016). The present study carried out during 2019-2020 aims to determine baseline toxicity and the existence of cross resistance to imidacloprid 17.8%SL and triflumezopyrim 10%SC against four populations of BPH from Tamil Nadu.

MATERIALS AND METHODS

The *N. lugens* collected from Coimbatore, Bhavani and Nagapattinam sites during 2019 were used, with >50 healthy female adults and 500 nymphs collected from the collar region using an aspirator or sweep nets. These were initially kept in mylar films filled with cut rice stems covered with muslin cloth on both sides. One to two days old female adults of these populations were used for the bioassay. A susceptible strain from the Paddy Breeding Station, TNAU, Coimbatore reared in the glasshouse was also used. The field collected populations were used as a starting culture reared on 10 days old TN-1 seedlings transplanted in plastic pots maintained at the Toxicology unit in glasshouse, TNAU, Coimbatore (11^{0}0'11"N, 76^{0}55'26"E); it was observed that 25-35 days old plants ideal for feeding and oviposition. These were mass cultured in the glasshouse (25± 1°C, 70-80% RH). Adults confined to the 35 to 45 days old potted plants were placed in plastic trays and kept in aluminium cages (Heinrichs, 1981). The stands were placed in trays with water to prevent ants. Adults were allowed to oviposit on 55 to 60 days old plants and freshly hatched nymphs were offered young seedlings. Continuous pure culture of the *N. lugens* was thus maintained. The bioassay were carried out with these using seedling dip method- IRAC method No. 5 (IRAC, 2009) and 10 days old rice seedling (TN-1) were used. Six concentrations of each insecticide replicated thrice were laid out in a completely randomized block design. Preliminary range-finding tests were done to fix the test dose causing 20-80% mortality approximately for constructing log-concentration-probit mortality (LCPM) lines. The test mortality was corrected against untreated mortality as per Abbott's formula (Abbott, 1925) and subjected to Finney's probit analysis to estimate the median lethal concentrations for the dose-mortality response (Finney, 1971). The resistance ratio (RR) was calculated by dividing the LC_{50} value of the field population by that of LC_{50} of the susceptible one (Baehaki et al*.,* 2017; Liao et al*.,* 2017).

RESULTS AND DISCUSSION

Baseline toxicity data of imidacloprid 17.8%SL and triflumezopyrim 10%SC against *N. lugens* adult females were expressed in terms of median lethal concentration (LC_{50}); the order of resistance was observed to be- Coimbatore > Bhavani > Nagapattinam (Table 1). The LC_{50} value was 0.538 ppm for the TNAU susceptible population which is in accordance with Gorman et al. (2008). The susceptibility remains unaltered with TNAU susceptible population. Maximum LC_{50} value (8.265 ppm) was observed in the Nagapattinam population; LD_{50} for imidacloprid for the susceptible strain was 0.6 mg/ l which was maintained for 130 generations without exposure to insecticides (Garrood et al., 2017). The insect resistance declines and susceptibility increases over succeeding generations under continuous mass culturing in laboratory conditions. The field population developed moderate to high resistance for imidacloprid 17.8%SL during the last decade (Liu and Han, 2006). Basanth et al. (2013) reported Kathalagere *N. lugens* population developed resistance (8.90 folds) to imidacloprid 17.8%SL, while a resistance ratio of 13.42 folds was reported by Khan et al. (2020). Imidacloprid resistance is due to the enhanced activity of P450 monooxygenases detoxification (Wen et al., 2009). In the present study, Nagapattinam population displayed low to moderate level of resistance. A similar trend of higher resistance to imidacloprid 17.8%SL was seen in WBPH populations collected from the Nagapattinam region (Surya Raj et al., 2020).

The Nagapattinam population exhibited higher resistance to older molecules compared to newer neonicotinoid, triflumezopyrim 10%SC- the values were: Bhavani (0.688 ppm) and Coimbatore (0.570 ppm). LC_{50} value with third instar nymphs fixed by rice stem dipping bioassay method was 0.042 mg/l to triflumezopyrim 10%SC (Zhang et al., 2020); field populations exhibited a low level of resistance (1.3-7.3 fold) to triflumezopyrim 10%SC (Liao et al., 2020). In the present study, *N. lugens* exhibited less resistance (RR 2.03- 3.02 folds). The unique action of triflumezopyrim 10%SC which has a distinct chemotype might increase the susceptibility to *N. lugens* and very effective in managing *N. lugens* population resistant to other neonicotinoids (Baehaki et al., 2018). The reliable baseline data assessed for newer insecticide molecules would be more useful for field resistance monitoring studies and as well for further applications (Tang et al., 2013).

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Table 1. Baseline toxicity of neonicotinoids to *N. lugens*

Population	Insecticide	χ^2	LC_{50} (ppm)	Fiducial limits LL	Fiducial limits UL	LC_{95} (ppm)	Fiducial limits LL	Fiducial limits UL	RR
Susceptible	Imidacloprid	0.145	0.538	0.485	0.596	1.704	1.217	2.387	-
	Triflumezopyrim	0.073	0.280	0.253	0.310	0.879	0.623	1.240	-
Coimbatore	Imidacloprid	0.115	2.784	2.629	2.948	5.303	4.400	6.392	5.17
	Triflumezopyrim	0.367	0.570	0.520	0.625	1.614	1.203	2.166	2.03
Bhavani	Imidacloprid	0.043	4.893	4.741	5.049	6.966	6.303	7.698	9.09
	Triflumezopyrim	0.071	0.688	0.633	0.749	1.791	1.334	2.404	2.45
Nagapattinam	Imidacloprid	0.094	8.265	8.034	8.503	11.414	10.310	12.637	15.36
	Triflumezopyrim	0.098	0.848	0.787	0.914	1.980	1.496	2.621	3.02

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