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Non Target Effect of Ethiprole + Imidacloprid 80 WG on Predators of Rice Planthoppers

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Studies were conducted to evaluate ethiprole 40% + imidacloprid 40% - 80 WG as foliar application for its toxicity against spiders and mirid bugs of rice in Tamil Nadu Agricultural University, Coimbatore during 2006 - 2008. The higher dose of ethiprole 40% + imidacloprid 40% - 80 WG (125 g ha^{-1}) recorded 41.20 and 58.13 percent reduction of spiders and 35.74 and 56.21 percent reduction of mirid bugs over control during first and second trials, respectively. Whereas standard check, acephate 75 SP + endosulfan 35 EC (Tank mixture) @ 750 + 1000 g/ml ha^{-1} recorded higher reduction of 59.79 % and 61.00 % of spiders and 50.70 % and 78.75 % of mirid bugs over untreated control during first and second trials, respectively. A reduction in the population of mirid bugs and spiders was observed immediately after the application of insecticides. Though there was an initial set back in the population, it started increasing gradually in the ethiprole 40% + imidacloprid 40% - 80 WG treated plots. However, the population was found to be less when compared to untreated check. Hence ethiprole 40% + imidacloprid 40% - 80 WG treatments were found to be safer to the predators found in the rice ecosystem.

Key words: Ethiprole, Imidacloprid, spiders, mirid bugs, rice, safety

Rice crop is prone to severe yield losses by both abiotic and biotic stresses to an extent of 46.4 per cent out of which 26.7 per cent is due to insect pests (Jayaraj, 1996). There are over 70 pests infesting rice in India and 20 are of regular occurrence (Pathak, 1975). In India, losses incurred due to the different insect pests of rice is to the tune of 5,51,200 lakh rupees, which in turn comes out to 18.6 per cent of total loss. To combat these pests chemical insecticides are used as the frontline defense sources. Though, the over dependence and excessive use of chemical pesticides resulted in development of resistance to insecticides and resurgence of pests, destruction of natural enemies and pollution in environment (Pasalu *et al*., 2002), chemical control still forms the first line of defense against various insect pests of rice. In order to evolve effective and economic pest control, it is necessary to evaluate the new groups, new formulations and new insecticide combination of chemicals for their bio efficacy. While the use of insecticides remains an important component of integrated pest management (IPM), biological suppression of insect pests is also considered as an equally important tool. Hence, the protection and preservation of natural enemies of the pests are essential. Among the entomophages, spiders and mirids are very important in rice ecosystem. These natural enemies are exposed directly to insecticides during spraying, as well as to the left over insecticides on the crop.

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The recent novel insecticides are highly efficacious and remain in plant to defy the pests, thereby delaying the pest buildup. Ethiprole is one such insecticide being used to protect the rice crop from brown planthoppers, green leaf hoppers and white backed planthoppers. This insecticidal pyrazole compound acts on the GABA (gamma-amino-butyric acid) receptors of insects by blocking the passage of chloride ions, thereby causing disruption of the central nervous system (Cole *et al*. 1993). The mode of action of pyrazoles is similar to cyclodienes, and in general pyrazoles are highly specific to insects and are considered to have low toxicity against mammals (Arthur, 2002). On the other hand, of all the neonicotinoids the most studied and most understood one is imidacloprid 1 [(6-choloro-3-pyridinyl) methyl]-4-5-dihydro-N-nitro-1H-imidazol-2 amine. It's activity is nearly 10,000 folds higher than natural insecticide nicotine. The mode of action of all the neonicotinoids is the same and all are very specific binders of receptor protein, which is present on post synaptic membrane *i.e.* they are inhibitors of post synaptic receptor protein. In insects, imidacloprid specifically binds to the nicotinic acetylcholine receptors protein which is present only in the central nervous system. Imidacloprid entering into the insect body will not get easily ionized, but is readily transferred to the central nervous system and strongly interacts with the target site. Imidacloprid and other nicotinoids interact with the acetylcholine binding site of the nicotinic acetylcholine receptors as agonists, which causes excitation and eventually paralysis leading to death (Liu and Casida, 1993; Elbert *et al.,* 1998). With the above background, research work was carried out to evaluate the bioefficacy of ethiprole 40% + imidacloprid 40% - 80 WG against sucking pests of rice *viz*., green leaf hopper and brown plant hopper.

Materials and Methods

Two season field experiments were conducted at Coimbatore district of Tamil Nadu to evaluate the effect of ethiprole 40% + imidacloprid 40% - 80 WG to natural enemies of rice. The experiments were carried out with the var. ADT 43 in plots of 5 x 5 m size in a randomized block design (RBD). In these experiments nine treatments were tested *viz.,* ethiprole 40 % + imidacloprid 40 % - 80 WG 62.5, 93.75 and 125 g ha^{-1}, ethiprole 10 SC @ 500 ml ha^{-1}, imidacloprid 200 SL @ 250 ml ha^{-1}, acephate 75 SP + endosulfan 35 EC (Tank mixture) @ 750 + 1000 g/ml ha^{-1}, imidacloprid 200 SL @ 125 ml ha^{-1}, thiamethoxam 25 WG @ 100 g ha^{-1} and untreated control, and were replicated three times. The treatments were imposed two times at active tillering stage in both the seasons at 14 days interval with pneumatic knapsack sprayer using spray volume of 500 liters ha^{-1}. Applications were made during morning hours to avoid photo oxidation of the insecticides.

Observation on the populations of spiders and mirids was recorded in ten randomly selected hills per plot before and 3, 7, 10 and 14 days after application. The corrected per cent reduction of pests over untreated check in the field population was worked out by using the formula given by Henderson and Tilton (1955). Pooled mean for two trials with two sprays were worked out for statistical analysis. The data on percentage were transformed into arc sine values and the population number into square root values. The data were subjected to ANOVA (Gomez and Gomez, 1984) and the mean values were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1951).

Results and Discussion

In the first experiment, the pretreatment population of spiders ranged from 7.33 to 8.67 per ten plants in different treatments (Table 1). After two rounds of spraying, the mean population of spiders per ten plants was the highest in untreated check (7.70 per ten plants). Lowest dose of ethiprole 40 % + imidacloprid 40 % - 80 WG @ 62.5 g ha^{-1} recorded 5.75 spiders per ten plants. Percent reduction over control indicated that ethiprole + imidacloprid 80 WG at higher concentration (125 g ha^{-1}) reduce the spider population up to 41.20 percent, whereas the standard check *viz*., acephate 75 SP + endosulfan 35 EC @ 750 + 1000 g/ml ha^{-1}, imidacloprid 200 SL at 250 g ha^{-1}, ethiprole 10 SC @ 500 ml ha^{-1} and thiamethoxam 25 WG @ 100 g ha^{-1} recorded 59.79, 44.07, 41.81 and 35.21 percent reduction of spiders over control, respectively in the first experiment, but in the second experiment ethiprole 40 % + imidacloprid 40 % - 80 WG @ 125 g ha^{-1} recorded 58.13 percent reduction of spiders over control and the standard checks *viz*., acephate 75 SP + endosulfan 35 EC (TM) @ 750 + 1000 g/ml ha^{-1}, imidacloprid 200 SL at 250 g ha^{-1}, ethiprole 10 SC @ 500 ml ha^{-1} and thiamethoxam 25 WG @ 100 g ha^{-1} recorded 61.00, 59.78, 57.14 and 53.14 percent reduction of spiders over control, respectively.

Table 1. Effect of ethiprole 40% + imidacloprid 40% - 80 WG on spiders in rice

Treatment	Number of spiders per ten hills									
		Mean					Mean			
	PTC	1st spray	2nd spray	Pooled	PRC	PTC	1st spray	2nd spray	Pooled	PRC
Ethiprole 40 % + Imidacloprid 40 % - 80 WG @ 62.5 g ha^{-1}	8.67	6.67 (2.68)^{b}	4.83 (2.31)^{c}	5.75	33.89	5.20	4.87 (2.32)^{b}	2.87 (1.84)^{b}	3.87	42.93
Ethiprole 40 % + Imidacloprid 40 % - 80 WG @ 93.75 g ha^{-1}	7.33	5.17 (2.38)^{h}	4.11 (2.15)^{e}	4.64	36.90	4.80	4.16 (2.16)^{d}	2.06 (1.60)^{c}	3.11	50.32
Ethiprole 40 % + Imidacloprid 40 % - 80 WG @ 125 g ha^{-1}	8.67	5.78 (2.51)^{e}	4.45 (2.22)^{d}	5.12	41.20	5.00	3.66 (2.04)^{f}	1.80 (1.52)^{d}	2.73	58.13
Ethiprole 10 SC @ 500 ml ha^{-1}	8.00	5.28 (2.40)^{g}	4.06 (2.14)^{e}	4.67	41.81	5.00	3.96 (2.11)^{e}	1.63 (1.46)^{e}	2.80	57.14
Imidacloprid 200 SL @ 250 ml ha^{-1}	8.67	5.56 (2.46)^{f}	4.17 (2.16)^{e}	4.87	44.07	5.50	4.84 (2.31)^{b}	0.93 (1.20)^{f}	2.89	59.78
Acephate 75 SP + Endosulfan 35 EC (TM) @ 750 + 1000 g/ml ha^{-1}	8.33	4.33 (2.20)^{i}	2.39 (1.70)^{f}	3.36	59.79	5.20	3.60 (2.02)^{f}	1.69 (1.48)^{de}	2.65	61.00
Imidacloprid 200 SL @ 125 ml ha^{-1}	8.33	6.17 (2.58)^{c}	5.28 (2.40)^{b}	5.73	31.50	5.10	3.90 (2.10)^{e}	2.87 (1.84)^{b}	3.39	49.11
Thiamethoxam 25 WG @ 100 g ha^{-1}	8.00	5.95 (2.54)^{d}	4.45 (2.22)^{d}	5.20	35.21	5.40	4.61 (2.26)^{c}	1.99 (1.58)^{c}	3.30	53.14
Untreated control	7.67	7.83 (2.89)^{a}	7.56 (2.84)^{a}	7.70	-	4.80	6.03 (2.56)^{a}	6.49 (2.64)^{a}	6.26	-

Values in parentheses are “x+0.5 transformed values, PTC – Pretreatment count, PRC – Percent reduction over control, TM – Tank mix
In a column means followed by a common letter are not significantly different by DMRT (P=0.05)

The population of mirids ranged from 5.33 to 6.33 per ten plants before treatment in the first experiment and 3.00 to 4.00 per ten plants before treatment in the second experiment (Table 2). In the first experiment, ethiprole 40 % + Imidacloprid 40 % - 80 WG at the lowest dose (62.5 g ha^{-1}) recorded mean mirid population of 3.94 per ten plants next to untreated check (5.75 per ten plants) after the two sprays in the first experiment. Ethiprole 40 % + imidacloprid 40 % - 80 WG @ 125 g ha^{-1} recorded 35.74 per cent reduction of mirid bugs and it was on par with ethiprole 40 % + imidacloprid 40 % - 80 WG @ 125 g ha^{-1} (32.46 %), ethiprole 10 SC @ 500 ml ha^{-1} (35.13 %), and thiamethoxam 25 WG @ 100 g ha^{-1} (34.97 %). Acephate 75 SP + endosulfan 35 EC @ 750 + 1000 g/ml ha^{-1} was most toxic to mired bugs and it registered more than 50 per cent reduction on mirids over untreated control. In the second experiment, all the treatments except ethiprole 40 % + imidacloprid 40 % - 80 WG @ 125 g ha^{-1} and thiamethoxam 25 WG @ 100 g ha^{-1} registered more than 50 per cent reduction over untreated control which could be due to unavailability of preybeing reduced significantly by insecticidal treatments. But acephate 75 SP + endosulfan 35 EC @ 750 + 1000 g/ml ha^{-1} treated plots registered as high as 78.75 percent reduction of mirids over untreated control.

The insecticides evaluated for toxicity against spiders and mirids in rice ecosystem showed that there was considerable decrease in spider population initially in all the treatments imposed on plants. Later it started increasing, but it was less than in untreated check. Results of the present research are in accordance with Iwaya and Tsuboi (1992), who stated that the toxicity of imidacloprid to spiders in rice fields was low. Imidacloprid had no significant effect on spiders but caused mortality in hemipteran predators (Lixin and Liang, 1995). Sun *et al.* (1996) reported that imidacloprid (10% SL) at 30 g a.i.ha^{-1} in rice was found to be highly safer to the spider communities. Jian *et al.* (1996), who suggested that imidacloprid displayed good selectivity between *N. lugens* and its natural enemies especially spider communities. In contrast Nagata *et al*. (1997) stated that diazinon, tenobucarb, carbaryl, dichlorvos and imidacloprid were toxic to spiders in cotton. According to Tanaka *et al*. (2000) and Manjunatha and Shivanna (2001), imidacloprid was toxic to predatory spiders and mirid bugs in rice ecosystem. Vanitha (2000) reported that predation rate of spiders was not affected when the spiders were allowed to feed on the prey treated with the nicotinyl compound, imidacloprid. Satheesan *et al.* (2002), who reported that no deleterious effect was observed on the populations of *C. lividipennis* and spiders in rice field applied with imidacloprid at 0.4 ml lit^{-1} of water. Imidacloprid at 0.2 kg a.i./ha was found to be quite promising both from the point of view of effectiveness against hoppers and safety to spiders, *Cyrtorhinus lividipennis* Reuter and *Paederus fuscipes* Curtis in rice ecosystem (Panda and Mishra, 1998). Widiarta *et al.* (2001) reported that the number of *Nephotettix virescens* (Distant) adults consumed by a lycosid spider, *Pardosa pseudoannulata* Boesenberg &

Table 2. Effect of ethiprole 40% + imidacloprid 40% - 80 WG on mirids in rice

Treatment	Number of mirids per ten hills									
		Mean					Mean			
	PTC	1st spray	2nd spray	Pooled	PRC	PTC	1st spray	2nd spray	Pooled	PRC
Ethiprole 40 % + Imidacloprid 40 % - 80 WG @ 62.5 g ha^{-1}	5.33	4.44 (2.22)^{d}	3.50 (2.00)^{b}	3.97	22.28	3.50	2.34 (1.69)^{c}	1.54 (1.43)^{b}	1.94	45.51
Ethiprole 40 % + Imidacloprid 40 % - 80 WG @ 93.75 g ha^{-1}	5.67	4.45 (2.22)^{d}	2.89 (1.84)^{e}	3.67	32.46	3.00	2.01 (1.58)^{e}	0.88 (1.17)^{e}	1.45	52.65
Ethiprole 40 % + Imidacloprid 40 % - 80 WG @ 125 g ha^{-1}	6.00	4.28 (2.19)^{e}	3.11 (1.90)^{d}	3.70	35.74	3.30	2.04 (1.59)^{e}	0.90 (1.18)^{e}	1.47	56.21
Ethiprole 10 SC @ 500 ml ha^{-1}	5.67	4.33 (2.20)^{e}	2.72 (1.79)^{f}	3.53	35.13	3.60	2.31 (1.68)^{c}	1.06 (1.25)^{d}	1.69	53.99
Imidacloprid 200 SL @ 250 ml ha^{-1}	6.33	4.11 (2.15)^{f}	2.72 (1.79)^{f}	3.42	43.70	4.00	2.56 (1.75)^{b}	1.02 (1.23)^{d}	1.79	56.01
Acephate 75 SP + Endosulfan 35 EC (TM) @ 750 + 1000 g/ml ha^{-1}	6.00	3.61 (2.03)^{g}	2.06 (1.60)^{g}	2.84	50.70	3.40	0.99 (1.22)^{f}	0.48 (0.99)^{f}	0.74	78.75
Imidacloprid 200 SL @ 125 ml ha^{-1}	5.67	4.56 (2.25)^{c}	3.06 (1.89)^{d}	3.81	29.88	3.00	2.16 (1.63)^{d}	1.05 (1.24)^{d}	1.61	47.40
Thiamethoxam 25 WG @ 100 g ha^{-1}	6.33	4.67 (2.27)^{b}	3.22 (1.93)^{c}	3.95	34.97	3.60	2.34 (1.69)^{c}	1.13 (1.28)^{c}	1.74	52.62
Untreated control	6.00	6.17 (2.58)^{a}	5.33 (2.41)^{a}	5.75	-	3.20	3.41 (1.98)^{a}	3.10 (1.90)^{a}	3.26	-

Values in parentheses are “x+0.5 transformed values, PTC – Pretreatment count, PRC – Percent reduction over control, TM – Tank mix
In a column means followed by a common letter are not significantly different by DMRT (P=0.05)

Strand, which was exposed to imidacloprid treated rice seedlings for the last 24 h before experiment was significantly lower than that on untreated ones. Ethiprole 10 SC at 25 g a.i. ha^{-1} was found to be the least toxic to C. lividipennis and recorded relatively more predators in treated plots (Kumaran *et al.,* 2009).

In present experiment, all the insecticide treatments exhibited their influence on spiders and mirids. These predators might be exposed to insecticides by several routes *viz*., direct uptake after exposure, uptake of residues by contact with contaminated surface of vegetation and oral uptake by feeding on contaminated prey. Since, the insecticides may express the same effect on predators, which they exert on pests; mortality of predators due to insecticides is unavoidable in modern agriculture. But, in this experiment relatively more number of predators were recorded, when they were treated with lower doses of insecticides. So, the selection of insecticides which is highly selective to pests and judicious dose that will exert little impact on predators is vital. Employing the pesticides which are relatively harmless to spiders could increase the effectiveness of natural predation and thus reduce the population of insect pests in rice ecosystem. Phenyl pyrazole compound ethiprole and neonicotinoid compound imidacloprid combination can be included in the spray schedule of rice to manage the plant and leaf hoppers.

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