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EFFICACY OF BENZPYRIMOXAN 10SC AGAINST RICE PLANTHOPPERS

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ABSTRACT

The efficacy of foliar application of benzpyrimoxan 10SC @ 50, 75, 100, 125 and 150 g a.i./ ha besides the insecticidal checks imidacloprid 17.8SL @ 25 g a.i./ ha and buprofezin 25SC @ 187.5 g a.i./ ha was evaluated against the brown planthopper (BPH) *Nilaparvata lugens* (Stal.) and the white backed planthopper (WBPH) *Sogatella furcifera* (Horvath) on rice during kharif 2017 and 2018 at the Punjab Agricultural University, Ludhiana. Experimental design consisted of random blocks in three replications. Two years data revealed that benzpyrimoxan 10SC @ 100 g a.i./ ha is significantly superior against the *N. lugens* and *S. furcifera* complex. Benzpyrimoxan 10SC @ 100 g a.i./ ha gave significantly higher yield (34.17 q/ ha) than its lower doses but was statistically at par with its higher doses. Non-significant differences in number of spiders/ hill among treated plots and untreated check at 10- and 15-DAS indicated the safety of benzpyrimoxan.

Key words: Rice, *Nilaparvata lugens*, *Sogatella furcifera*, benzpyrimoxan, imidacloprid, buprofezin, efficacy, spiders, safety, yield

Rice (*Oryza sativa* L.) is a major cereal crop, and among the biotic stresses affecting rice, insect pests are the major ones (Makkar and Bentur, 2017). The brown planthopper *Nilaparvata lugens* (Stal.) (BPH) and the white backed planthopper *Sogatella furcifera* (Horvath) (WBPH) are the two most important sucking pests causing economic damage under north-Indian conditions (Singh et al., 2002; Suri and Makkar, 2018a and b). The nymphs as well as adults suck plant sap from phloem and occasionally from xylem. Planthoppers often cause enormous draining of phloem sap resulting in drying of plants in circular patches called 'hopper-burn' (Horgan, 2009; Suri and Makkar, 2018a,b; Fahad et al., 2021) and hence the yield loss (Catindig et al., 2009). Planthoppers are amenable to control with insecticides but the indiscriminate and frequent use of insecticides has led to the problems like insecticide resistance and resurgence (Krishnaiah et al., 2006). Several insecticides have been reported effective against hoppers (Krishnaiah et al., 2004; Wang et al., 2008; Suri et al., 2012), but at the same time the reports on development of resistance (Nagata et al., 1979; Krishnaiah et al., 2006), resurgence (Krishnaiah et al., 2006; Dhakal and Poudel, 2020; Fahad et al., 2021), elimination of natural predators and environmental pollution (Balakrishna and Satyanarayana, 2013) have also emerged due to indiscriminate use of insecticides.

In view of documented evidences on the development of resistance in *N. lugens* and *S. furcifera* against neonicotinoids like imidacloprid and buprofezin (Krishnaiah et al., 2006; Gorman et al., 2008; Wang et al., 2008; Lakshmi et al., 2010; Matsmura and Morimura, 2010; Ling et al., 2011; Basanth et al., 2013; Su et al., 2013; Garrood et al., 2016) search for safer and effective insecticides is important. Since, benzpyrimoxan has a unique chemical structure which contains benzyloxy and cyclic acetal groups on pyrimidine moiety (5-(1,3-dioxan-2-yl)-4-[4-(trifluoromethyl) benzyloxy] pyrimidine), it can be a potential alternative for planthoppers control in near future. Thus, the present study was conducted to evaluate efficacy of benzpyrimoxan against *N. lugens* and *S. furcifera*, its relative safety towards spiders and impact on marketable yield.

MATERIALS AND METHODS

Experiments for evaluating efficacy of benzpyrimoxan 10SC were conducted at the Entomological Research Farm, Punjab Agricultural University, Ludhiana (30°90'N,75°80›E, 247 masl) during kharif 2017 and 2018. The nursery of variety Pusa Basmati 1121 was sown in well prepared seed beds of 5 x 1 m in unsprayed conditions following the recommended agronomic practices of PAU (Anonymous, 2017). Thirty days old seedlings were transplanted in randomized block design with three replications. Two seedlings/ hill were transplanted in a plot size of 100 m^2 with 1 m replication border and 0.5 m treatment border between the plots, on July 11 and July 18, respectively during the two years. The plant to plant and row to row distance was maintained at 0.15 and 0.20 m, respectively. The individual experimental plots were separated by bunds and water channels to ensure prevention of water movement from one plot to another. Urea was applied @ 0.100 t/ ha in two equal splits i.e. 3 and 6 weeks after transplanting (Anonymous, 2017). Altogether, there were eight treatments including benzpyrimoxan 10SC @ 50, 75, 100, 125, 150 g a.i./ ha, besides insecticidal checks imidacloprid 17.8SL @ 25 g ai/ ha, buprofezin 25SC @ 187.5 g a.i./ ha, and an untreated control. Additionally, benzpyrimoxan 10SC @ 200 and 250 g a.i./ ha was evaluated for phytotoxicity. Insecticides were applied on the basis of economic threshold level on September 1 and 15, 2017 and September 22, 2018 using 250-300 l/ ha.

The incidence of *N. lugens*, *S. furcifera* and predatory spiders (*Lycosa* sp., and *Tetragnatha* sp.) was recorded on 10 randomly selected hills/ plot in each replication one day before treatment (BT) and 3, 7, 10, and 15 days after spray (DAS) and presented as mean number/ hill following the standard methodology (Heinrichs et al., 1981). The data on mean number of hoppers before and after the treatment was used to calculate % reduction over control (PROC) as per the following formula (Henderson and Tilton, 1955): reduction over control (PROC) = $\frac{1-[\text{Ta x Cb}] \text{ x } 100}{[\text{Tb x Ca}]}$, where

Ta: Population after treatment in treated plot; Tb: Population before treatment in treated plot; Ca: Population after treatment in control plot; and Cb: Population before treatment in control plot. The observations for phytotoxicity were recorded on the basis of epinasty, hyponasty, necrosis, vein clearing and wilting on 0-100% scale at 1, 3, 5, 7 and 10 DAS where 0 meant 'no phytotoxicity' and 100 meant 'death of plant'. The data on mean number of planthoppers/ hill were transformed using square root transformation. The treatment means were analysed through a randomized block design using ANOVA and were separated by least significant difference (LSD, p=0.05) (Gomez and Gomez, 1984) using CPCS1 software.

RESULTS AND DISCUSSION

All insecticidal treatments proved significantly superior than the untreated check in controlling the *N. lugens* and *S. furcifera* infesting rice. Pretreatment incidence of *N. lugens* varied from 17.4 to 17.7 hoppers/ hill and the differences were non-significant (Table 1). Significant reduction was recorded after 3, 7, 10 and 15 days of insecticide application; at 3 DAS, benzpyrimoxan 10SC @ 150 g a.i./ ha recorded the least incidence (6.17 hoppers/ hill) followed by benzpyrimoxan 10SC @ 125 and 100 g a.i./ ha (6.30 and 6.45 hoppers/ hill), however, the three were statistically at par with each other but significantly superior to

Table 1. Field efficacy of benzpyrimoxan 10SC against *N. lugens* and *S. furcifera* on rice

Treatment	Dose/ ha g a.i.	Dose/ ha Formulation in ml	Mean no. of *N. lugens*/ hill Before treatment	3 DAS	7 DAS	10 DAS	15 DAS	Mean no. of *S. furcifera*/ hill Before treatment	3 DAS	7 DAS	10 DAS	15 DAS
Benzpyrimoxan 10SC	50	500	17.5	11.03 (3.46)d	9.82 (3.27)d	10.67 (3.38)d	12.63 (3.66)d	5.07	3.93 (2.22)b	3.73 (2.17)d	4.58 (2.36)d	5.87 (2.62)c
Benzpyrimoxan 10SC	75	750	17.4	9.47 (3.22)c	7.58 (2.90)c	8.97 (3.12)c	10.17 (3.29)c	5.10	3.72 (2.17)b	3.18 (2.04)c	3.92 (2.22)c	5.28 (2.51)bc
Benzpyrimoxan 10SC	100	1000	17.5	6.45 (2.71)ab	3.72 (2.16)a	4.92 (2.42)a	6.80 (2.77)a	5.18	2.70 (1.92)a	1.80 (1.70)a	2.07 (1.75)a	3.15 (2.04)a
Benzpyrimoxan 10SC	125	1250	17.7	6.30 (2.68)ab	3.53 (2.11)a	4.87 (2.41)a	6.72 (2.76)a	5.15	2.65 (1.91)a	1.77 (1.66)a	2.07 (1.75)a	3.07 (2.02)a
Benzpyrimoxan 10SC	150	1500	17.6	6.17 (2.66)a	3.45 (2.09)a	4.78 (2.39)a	6.67 (2.75)a	5.03	2.65 (1.91)a	1.75 (1.66)a	2.02 (1.74)a	3.07 (2.02)a
Imidacloprid 17.8SL	25	140	17.6	7.10 (2.83)b	5.05 (2.45)b	6.48 (2.72)b	8.32 (3.03)b	5.25	3.75 (2.18)b	2.33 (1.82)b	3.12 (2.03)b	5.23 (2.49)b
Buprofezin 25SC	187.5	750	17.5	10.53 (3.35)cd	3.87 (2.20)a	4.62 (2.37)a	6.12 (2.66)a	5.00	3.87 (2.21)b	1.93 (1.71)a	2.22 (1.79)a	3.63 (2.15)a
Untreated control	--	--	17.6	20.20 (4.58)e	22.47 (4.83)e	25.23 (5.10)e	27.90 (5.35)e	5.07	5.75 (2.60)c	6.88 (2.80)e	7.93 (2.99)e	9.30 (3.21)d
LSD (p=0.05)			NS	(0.16)	(0.15)	(0.20)	(0.19)	NS	(0.08)	(0.10)	(0.08)	(0.12)

Data values pooled mean of two years based on counts on 10 hills/ replication; DAS-Days after insecticide spray; Figures in parentheses after sq. root transformations the checks, imidacloprid and buprofezin (7.10 and 10.53 hoppers/ hill, respectively) and benzpyrimoxan 10SC @ 50 and 75 g a.i./ ha (11.03 and 9.47 hopper/ hill, respectively). Seven days after the application, benzpyrimoxan 10SC @ 100, 125 and 150 g a.i./ ha (3.72, 3.53 and 3.45 hoppers/ hill, respectively) were found equally effective against *N. lugens* and the latter three were also at par with buprofezin 25 SC @ 187.5 g a.i./ ha (3.87 hoppers/ hill) indicating relatively slow mode of action of buprofezin. A similar trend was observed at 10 DAS and 15 DAS where benzpyrimoxan 10SC @ 150 g a.i./ ha recorded the lowest *N. lugens* incidence (4.78 and 6.67 hoppers/ hill, respectively) and was found equally effective to its lower doses @ 100 (4.92 and 6.80 hoppers/ hill, respectively), 125 g a.i./ ha (4.87 and 6.72 hoppers/ hill, respectively) and buprofezin (4.62 and 6.12 hoppers/ hill, respectively). Satoh et al. (2021) also reported remarkable activity of benzpyrimoxan against nymphs of rice planthoppers, including strains resistant to existing insecticides. Asai et al. (1983) and Ghosh et al. (2013) also reported the slow action of buprofezin in controlling the *N. lugens*.

Before spray, *S. furcifera* incidence among the various treatments plots varied from 5.00 to 5.25 hoppers/ hill without any significant differences amongst all. However, a significant reduction was recorded after 3, 7, 10 and 14 days of insecticidal application. Benzpyrimoxan 10SC @ 150 g a.i./ ha recorded the least incidence (2.65 hoppers/ hill) followed by benzpyrimoxan 10SC @ 100 and 125 g a.i./ ha (2.70 and 2.65 hoppers/ hill, respectively), the three being statistically at par with each other but significantly superior to all other treatments. Seven days after the application of insecticides, benzpyrimoxan 10SC @ 100, 125 and 150 g a.i./ ha (1.80, 1.77 and 1.75 hoppers/ hill, respectively) were found equally effective, and the latter three were also at par with buprofezin 25SC@ 187.5 g a.i./ ha (1.93 hoppers/ hill). A similar trend was observed at 10 and 15 DAS where benzpyrimoxan 10SC @ 150 g a.i./ ha recorded the least incidence, and was found equally effective to its lower doses @ 100 (2.07 and 3.15 hoppers/ hill, respectively), 125 g a.i./ ha (2.07 and 3.07 hoppers/ hill, respectively) and buprofezin (2.22 and 3.63 hoppers/ hill, respectively).

Thus, all three higher doses of benzpyrimoxan 10SC @ 100, 125 and 150g a.i./ ha proved at par in suppressing planthoppers, and lower dose 100 g a.i./ ha) may be considered ideal for managing both *N. lugens* and S. *furcifera*. Imidacloprid 17.8SL @ 25 g a.i./ ha was found inferior to benzpyrimoxan 10SC @ 100, 125 and 150g a.i./ ha and buprofezin 25SC @ 200 g a.i./ ha in controlling *N. lugens* and *S. furcifera*. These results corroborate the findings of Ghosh et al. (2013) and Satoh et al. (2021). Data in Table 2 reveal non-significant differences among the treatment plots w.r.t pretreatment number of spider/ hill. The number of spiders at 3 and 7 DAS in benzpyrimoxan 10SC @ 100 g a.i./ ha was significantly lower than untreated check registering a short decline in spiders' number following the spray of test insecticide. Roy and Chakraborty (2021) also

Table 2. Effect of benzpyrimoxan 10SC on spiders and yield

Treatment	Dose/ ha g a.i.	Dose/ ha Formulation in ml	Before treatment	3 DAS	7 DAS	10 DAS	15 DAS	Yield (q/ ha) 2017	Yield (q/ ha) 2018	Yield (q/ ha) Pooled
Benzpyrimoxan 10SC	50	0.47	0.45 (1.20)^{b}	0.48 (1.21)^{c}	0.52 (1.23)^{a}	0.57	500	31.77	31.23	31.50^{d}
Benzpyrimoxan 10SC	75	0.48	0.43 (1.20)^{b}	0.45 (1.20)^{bc}	0.48 (1.22)^{a}	0.53	750	33.43	31.57	32.50^{c}
Benzpyrimoxan 10SC	100	0.48	0.42 (1.19)^{ab}	0.47 (1.21)^{c}	0.52 (1.23)^{a}	0.55	1000	34.50	33.83	34.17^{a}
Benzpyrimoxan 10SC	125	0.47	0.37 (1.17)^{ab}	0.43 (1.20)^{bc}	0.47 (1.21)^{a}	0.53	1250	34.67	34.10	34.38^{a}
Benzpyrimoxan 10SC	150	0.48	0.35 (1.16)^{a}	0.37 (1.17)^{a}	0.45 (1.20)^{a}	0.50	1500	34.77	34.00	34.38^{a}
Imidacloprid 17.8SL	25	0.48	0.37 (1.17)^{ab}	0.40 (1.18)^{ab}	0.48 (1.22)^{a}	0.52	140	33.13	33.77	33.45^{b}
Buprofezin 25SC	187.5	0.48	0.45 (1.20)^{b}	0.47 (1.21)^{c}	0.52 (1.23)^{a}	0.53	750	34.50	34.03	34.27^{a}
Untreated control	--	0.47	0.53 (1.24)^{c}	0.55 (1.24)^{d}	0.57 (1.26)^{b}	0.58	--	28.83	29.83	29.33^{e}
LSD (p=0.05)			NS	(0.03)	(0.02)	(0.03)	NS	1.43	0.88	0.91

Data pooled means for two years; DAS: Days after insecticide spray; Figures in parentheses after sq. root transformation recorded a short-term decline in predator populations after application of insecticides but reported subsequent gradual increase within a week. However, after the first week of spray, a gradual increase of spiders' number in benzpyrimoxan 10SC @ 100 g a.i./ ha (0.55/ hill at 10 DAS) was observed which was at par with untreated check (0.58/ hill at 10 DAS). Similarly, at 15 DAS the differences in spider population were non-significant among treatment plots. These results corroborate the findings of Satoh et al. (2021) on pollinators and beneficial arthropods.

Maximum yield was obtained with benzpyrimoxan 10SC @ 150 g a.i./ ha (34.77 q/ ha) during 2017 and benzpyrimoxan 10SC @ 125 g a.i./ ha (34.10 q/ ha) during 2018; but statistically at par with yield in plots treated with benzpyrimoxan 10SC @ 100 g a.i./ ha (34.50 and 33.83 q/ ha during 2017 and 2018, respectively) (Table 2). During 2018 the maximum yield was observed in benzpyrimoxan 10SC @ 125 g a.i./ ha (34.10 q/ ha) which was statistically at par with benzpyrimoxan 10SC @ 100 and 150 g a.i./ ha (and 34.00 q/ ha, respectively). The pooled yield data also showed a similar trend, with maximum grain yield being in benzpyrimoxan 10SC @ 150 g and 125 g a.i./ ha (34.38 q/ ha each). which was statistically at par with benzpyrimoxan 10SC @ 100 g a.i./ ha (34.17 q/ ha) and buprofezin 25SC (34.27 q/ ha) but significantly better than lower doses of benzpyrimoxan 10SC, imidacloprid 17.8SL (33.45 q/ ha) and untreated check (28.83 q/ ha). No crop phytotoxicity was observed in benzpyrimoxan 10SC doses viz., 50, 100, 125, 150, 200 and 250 g a.i./ ha.

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