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IMPACT OF INSECTICIDE-INDUCED RESURGENCE ON BROWN PLANTHOPPER, *NILAPARVATA LUGENS* (STÅL) IN RICE

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ABSTRACT

The investigation on effect of the insecticide induced resurgence in rice brown planthopper, *Nilaparvata lugens* (Stal) was conducted under laboratory condition at ARS, Gangavathi during *Rabi*/Summer 2022-2023. In this experiment nine different group insecticides along with untreated control such of three replications and 10 treatments were used. The observation were recorded at day before spray and four consequent sprays revealed that among all the treatments, highest percent of resurgence in brown planthopper on rice was induced by the application of deltamethrin 11% EC (34.05%) and imidacloprid 17.8% SL(21.78%) with high *N. lugens* population compared to untreated control. Whereas the treatments *viz.*, triflumezopyrim 10% SC (-25.01%), Pymetrozine 50% WG (-23.77%), Dinotefuran 20% SG (-24.35%), fipronil 5% SC (-19.7%), buprofezine (-11.13%) 25% SC, carbofuran 3G (-23.04%) and acephate 75% SP (-24.51%) recorded no resurgence effect on brown planthopper population. Hence, resurgence causing insecticides should be avoid for management of brown planthopper.
***Keywords* :** Brown planthopper, insecticide, induced resurgence, rice, imidacloprid

Introduction

Brown planthopper (BPH), *Nilaparvata lugens* (Stal) (Hemiptera: Delphacidae), is a typical resurgent pest that threatens rice production during the post-green revolution period. It is considered the major yield limiting factor in all rice growing countries both in tropics and temperate regions (Krishnaiah, 2014). The BPH has become a major insect pest of rice in almost all rice growing tracts of India (Krishnaiah and Jhansilakshmi, 2012). The high population density of brown planthopper may result upto 60 per cent yield loss (Panda and Khush, 1995). Both nymphs and adults of the brown planthopper suck plant sap from phloem cells resulting in "hopper burn" symptoms and it can cover large circular patches in the rice fields under heavy pest pressure. In addition to direct damage, it is a vector for Rice Grassy Stunt Virus and Rice Ragged Stunt Virus. Farmers rely solely on insecticides for the management of brown planthopper but their repeated applications often result in problems such as induction of resurgence, development of resistance and residues on farm produce besides environmental concern. Detailed investigations have been made on insecticide induced resurgence of brown planthopper in rice (Chelliah and Heinrichs, 1980; Heinrichs *et al.*, 1982a; Heinrichs *et al.*, 1982b; Krishnaiah and Kalode, 1987) and reported that the suppression of natural enemies following intensive broad spectrum insecticidal application; the increased planthopper by repeated application of different groups of insecticides.

Material and Method

The study of insecticide induced resurgence in *Nilaparvata lugens* (Stal) was carried out at Agricultural Research Station (ARS), Gangavathi, Koppal district, Karnataka during *Rabi* 2022-23. and BPH as test insect in the experimentation. The following insecticides (Table1) were used as foliar

Test insect

Brown planthopper was reared on the one month old potted plants of the susceptible obtain large number of nymphs and adults of brown planthopper of uniform size and age rice variety, Taichung Native-1 (TN1) to sprays to study insecticide induced resurgence in rice brown planthopper.

Insecticide

Insecticides spraying solution were prepared from the commercial formulations by adding required quantities of water. Selected insecticide groups and insecticide doses were fixed as recommended by the Central Insecticide Board and Registration Committee (CIB& RC). Insecticides were applied four times at seven days intervals to the potted plants starting from 20 days after planting. The plants were sprayed with water alone in control. Insecticide treated potted plants were covered with cylindrical mylar film cages of 75 cm tall and 15 cm diameter and were maintained in a Glass house (Heinrichs *et al*., 1981).

Pot experiment

To study the insecticide induced resurgence in the pot experiment, variety BPT-5204 was sown in cement rings (120cm (Diametre) X 50cm (Height)) vcontaining soil and farm yard manure (FYM) in a ratio of 1:1. The rings were watered as and when needed. The 15-20 days old seedlings of BPT-5204 from cement rings were uprooted and transplanted in plastic pots (15 cm height and 11cm diameter).

The pot experiment was laid out in a Completely Randomized Design (CRD) with 10 treatments including untreated control. Each treatment consisted of two pots with three replications that were maintained and kept in separate meshed pots to avoid drift in the experiment. The insecticide groups and insecticide doses mentioned in Table 1. were fixed as recommended by the Central Insecticide Board and Registration Committee (CIB& RC). A total of four applications at seven days intervals were done for each treatment. The sprays were taken early morning. The method of application was foliar spray by using a hand sprayer. After each insecticide spray, the hand sprayer was washed thoroughly and rinsed twice with water before the next treatment application.

Table 1: Brown planthopper resurgence due to repeated application of different insecticides in rice during *Rabi* 2022-23

Treatments	Insecticides	Formulation	
		Active ingredient (*g.a.i*/ha)	**Dosage (g or ml/ha)**
T1	Acephate 75 SP	750	1000
T2	Carbofuran 3G	750	25000
T3	Deltamethrin 11EC	15	150
T4	Buprofezin 25SC	200	800
T5	Imidacloprid 17.8SL	25	125
T6	Fipronil 5 SC	75	1500
T7	Dinotefuran 20SG	40	200
T8	Pymetrozine 50WG	150	300
T9	Triflumezopyrim 10SC	25	235
T10	Untreated control	-	-

The observations recorded on nymphs and adults of BPH were counted from four randomly selected hills per pot in pot experiment at one day before spray and at six days after each spray of insecticides (before initiation of each spray) (Heinrichs *et al*., 1981).. To minimize the error while sampling the mean of BPH was calculated.

Percent of resurgence

$$\text{Percent resurgence} = \left\{\frac{\text{Ts} \times \text{Cf}}{\text{Cs} \times \text{Tf}} - 1\right\} \times 100$$

Where, T_F = Infestation in the treated plot during the first count, T_S = Infestation in the treated plot during subsequent count, C_F = Infestation in the untreated check plot during the first count, C_S = Infestation in the untreated check plot during subsequent count. The percent of resurgence was calculated by using the formula given by Regupathy and Dhamu, (2001) (Positive value – Resurgence, Negative value – No resurgence).

Statistical Analysis

Data collected on brown plantoppers from the experiments were subjected to transformation (square root) values and then analyzed using analysis of variance technique (ANOVA) (Gomez and Gomez, 1984) in CRD. Means were compared by Duncan's Multiple Range Test (DMRT) (Duncan, 1955) using the SPSS 21.0 statistical software package.

Results and Discussion

Effect of repeated application of different group of insecticide on *N. lugens* population

The effect of insecticide induced resurgence in rice brown planthopper revealed that population of *N. lugens* was more or less evenly distributed before the imposition of insecticides among the treatment plots (79.23 to 80.87 hoppers per four hills) (Table 2). Later, at different insecticides sprays at seven days interval the population of *N. lugens* was varied among different treatments. The treatments deltamethrin and imidacloprid showed higher population of *N. lugens* across four different sprays when compared with other treatments. The deltamethrin 11% EC @ 30 g a.i per ha treated plot were recorded higher number of BPH count in fourth spray (215.53 hoppers/four hills) followed by third spray (144.00 hoppers hills), second spray (176.20 hoppers/four hills) and first spray (110.30 hoppers/ four hills). The treatment imidacloprid plot also observed highest *N. lugens* population in fourth spray (148.93 hoppers/four hills) followed by third spray (144.00 hoppers hills), second spray (131.40 hoppers/hills) and first spray (91.23 hoppers/four hill) (Table 2). Whereas in buprofezine followed by carbofuran and acephate treatments were noticed lower number of *N. lugens* population when compared with untreated control and found moderately effective in control of BPH. In other treatments such as triflumezopyrim followed by pymetrozine, dinotefuran, fipronil were recorded least *N. lugens* population and found effective in control of BPH.

Brown planthopper resurgence

The repeated application of different groups of insecticides sprays on BPH resurgence study revealed that highest positive percent of resurgence were observed in deltamethrin treated pot followed by imidacloprid treated pot in comparison with untreated control. The mean of percent resurgence of four sprays showed high percent of resurgence observed in deltamethrin followed by imidacloprid when compared with untreated control. The highest percent of resurgence were noticed in deltamethrin treated pot (96.08%) followed by imidacloprid pot (52.91%) during third spray when compared with different sprays. Subsequently, during second spray also were recorded 52.55 per cent resurgence in deltamethrin and 37.54 per cent resurgence in imidacloprid treated pot. Least negative percent of resurgence were recorded in triflumezopyrim followed by pymetrozine, dinotefuran, fipronil, buprofezine, carbofuran and acephate (Fig. 1).

By considering the above investigated data clearly indicated that deltamethrin 11% EC and imidacloprid 17.8% SL can create a comeback in the BPH population across four different sprays. The increased population in deltamethrin and imidacloprid treatments caused positive percent of resurgence. The major reason for resurgence of brown planthopper in rice was destruction of natural enemies (Heinrichs *et al*., 1982 a&b) and alteration in plant nutritional status (Wu *et al*., 2003). The destruction of natural enemies and changes in the nutritional and biochemical elements of the host plant may be linked to the resurgence generated by deltamethrin 11% EC and imidacloprid 17.8% SL in the field. The current findings in these studies agree with the findings research work conducted by Rao *et al*. (2016), Venkatreddy *et al.* (2015) and Kumar and Rao (2021), Uddin *et al.* (2020).

In general, synthetic pyrethroids breakdown quickly in direct sunlight, usually within a few days of application, functioning as a sub-lethal dose for the target pest, and thus are ineffective against rice BPH in control, instead triggering resurgence (Rehman *et al*., 2014). Thus, the flareup of BPH produced by synthetic pyrethroids in the field was most likely due to a combination of natural enemy suppression, host plant compatibility through adjustments in nutritional and biochemical contents, and reproductive enhancement.

Conclusion

The results obtained from the pot experiment in the present investigation revealed that insecticide induced resurgence in the populations of *N. lugens* is due to a combination of factors such as selective destruction of natural enemies and an indirect effect through favorable changes in the nutritional quality of rice plant towards the growth of BPH. To avoid the insecticide induced resurgence of the target pests and the outbreak of secondary pests, pesticides must be properly screened against all of the important insect pests before being recommended for use in a rice ecosystem.

Table 2 : Effect of different insecticides on brown plant hopper in rice at different sprays in pot during *Rabi/* Summer 2022-23

Tr. No	Treatment	Dose (g a.i/ha)	Population of brown planthoppers/four hills)									
			Before spray	1st Spray	% Resur -gence	2nd Spray	% Resur -gence	3rd Spray	% Resur -gence	4th Spray	% Resur -gence	Mean % resurgence
T_1	Acephate 75% SP	750	79.23 (8.93)	56.43 (7.55)[ef]	-25.91	35.90 (6.03)[f]	-39.25	25.10 (5.06)[e]	-18.09	21.30 (4.67)[e]	-14.81	-24.51
T_2	Carbofuran 3% G	750	79.50 (8.94)	58.40 (7.67)[e]	-23.59	41.73 (6.50)[e]	-31.76	25.33 (5.08)[e]	-28.88	23.23 (4.87)[e]	-7.93	-23.04
T_3	Deltamethrin 11% EC	15	80.30 (8.99)	110.30 (10.53)[a]	42.89	176.20 (13.29)[a]	52.55	196.53 (14.04)[a]	30.65	215.53 (15.83)[a]	10.12	34.05
T_4	Buprofezin 25% SC	200	79.63 (8.95)	60.47 (7.81)[e]	-21.01	55.87 (7.51)[d]	-11.78	45.83 (6.81)[d]	-3.89	42.07 (6.52)[d]	-7.86	-11.13
T_5	Imidachloprid 17.8% SL	25	80.87 (9.02)	91.23 (9.58)[b]	17.35	131.40 (11.48)[b]	37.54	144.00 (12.02)[b]	28.39	148.93 (13.54)[b]	3.83	21.78
T_6	Fipronil 5% SC	75	79.53 (8.95)	69.57 (8.37)[d]	-9.01	33.10 (5.80)[f]	-54.57	25.30 (5.08)[e]	-10.45	24.00 (5.30)[e]	-4.77	-19.70
T_7	Dinotefuran 20% SG	40	80.40 (8.99)	57.70 (7.63)[e]	-25.35	28.17 (5.35)[g]	-53.38	20.63 (4.60)[f]	-14.18	19.63 (4.85)[e]	-4.47	-24.35
T_8	Pymetrozine 50% WG	150	79.90 (8.97)	51.77 (7.23)[f]	-32.60	23.17 (4.86)[h]	-57.27	19.47 (4.47)[f]	-1.54	18.67 (4.84)[e]	-3.69	-23.77
T_9	Triflumezopyrim 10% SC	25	79.90 (8.97)	40.47 (6.40)[g]	-47.31	21.80 (4.72)[h]	-48.56	18.33 (4.34)[f]	-1.47	17.33 (4.44)[e]	-5.08	-25.61
T_{10}	Untreated control	-	79.37 (8.94)	76.30 (8.76)[c]	-	79.90 (8.97)[c]	-	68.20 (8.29)[c]	-	67.93 (8.27)[c]	-	
S.Em (±)			0.09	0.08		0.08		0.07		0.19		
CD @ 1%			NS	0.36		0.32		0.29		0.77		

*Figure in parenthesis are square root transformed value; NS-Non significant
In a column, means followed by a common letter are not significantly different at p=0.05 as per DMRT

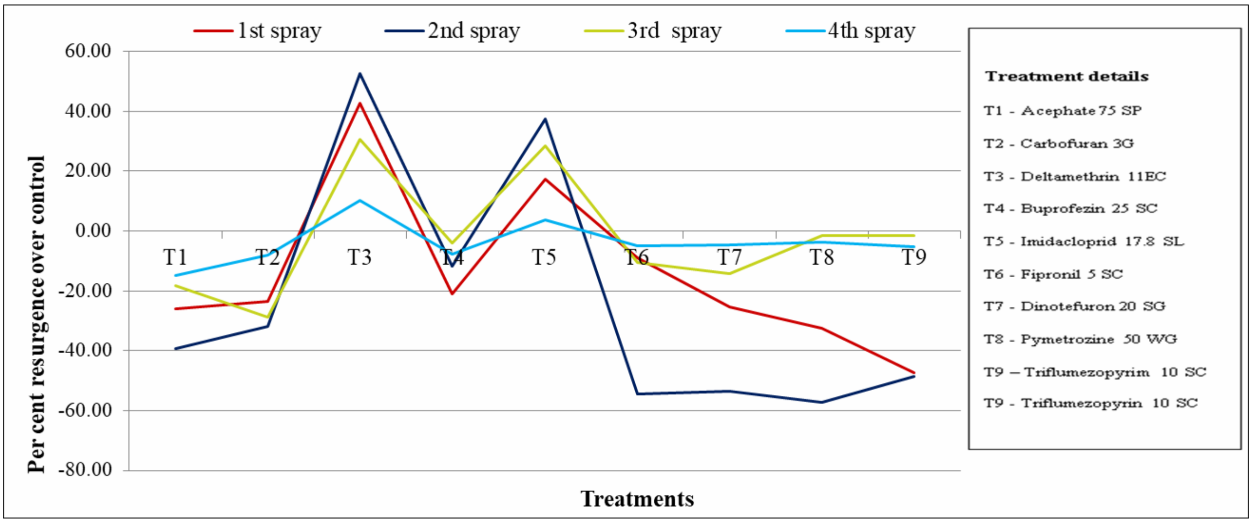

Fig. 1 : Different insecticide sprays showing brown planthopper resurgence during *Rabi*/ Summer 2022-23 (Pot Experiment)

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