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Relative Efficacies of Insecticides Against Brown Plant Hopper (BPH), *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae) under Field Conditions

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Abstract: Brown plant hopper (BPH), *Nilaparvat lugens* (Stål), is the most important and notorious pest of rice crop. It causes huge yield losses and in case of sever attack "hopper burn" causes complete crop failure. Insecticides are the main tool for quick, reliable and feasible management of brown plant hopper. On the other hand, insecticides hit non-target fauna including predators and parasitoids which assist naturally to manage insect pests and are important part of biodiversity. This assay was designed to evaluate the effectiveness of some new chemistries against BPH and beneficial fauna in rice field. Eleven insecticides were tested in puddled transplanted rice for the year 2019-2020. Closer 240SC, Plenum 50WG, Telsta 20SC, Veyong Jin Teng 60WG and Momentum 50WG controlled the 62.28%, 61.28%, 41.78%, 21.05% and 22.96% BPH as compared to control after one week of application, respectively. Other insecticides such as Padan 4G, Actify 60WP, Feiniao 80WG, Buffer 25WP, Sitara 25WP and Atrasan Super 43WDG failed to produce effective results against BPH. Maximum yield produced by Plenum 50WG (4.15) followed by Closer 240SC (4.14), Telsta 20SC (3.88), Momentum 50WG (3.37), Veyong Jin Teng 60WG (3.14), Feiniao 80WG (2.68), Padan 4G (2.67), Actify 60WP (1.85), Atrasan Super 43WDG (1.84), Sitara 25WP (1.33), Buffer 25WP (1.27) and control (1.26 t/ha), respectively. Hence, the Closer 240SC, Plenum 50WG, Telsta 20SC, Veyong Jin Teng 60WG and Momentum 50WG proved effective for timely management of BPH and could be recommended for IPM programs.

Key words: Brown Planthopper · Insecticides · Management · Effectiveness · Rice

INTRODUCTION

Rice is the most important cereal crop serving as staple food to half of the world [1]. In Pakistan, it is cultivated on 11% of total cropped area. Kallar tract is famous for producing aromatic rice in the world. Rice is the second most important cash crop after cotton earning almost 2 billion US dollar annually [2]. Rice quality and quantity are equally important as it provides 21% of energy and 15% of protein of human need [1].

There are abiotic and biotic constraints in production of rice. Among abiotic constraints insect pests are of prime importance. Over 800 insect pest species have been recognized damaging either standing or stored rice [3]. There were 35 species including 10 serious one feeding on paddy in India were recorded [4]. Insect pests are responsible for more than 30 percent rice yield losses in Asia [5]. Among economically important insect pests, rice leaf folder [6], rice stem borers [7, 8] and rice plant hoppers [9] are of prime importance.

The brown plant hopper (BPH), *Nilaparvata lugens* (Stal) (Homoptera: Delphacidae), characterized by its large area migration, r-strategy life pattern and population outbreak and resurgence, is one of the most harmful insect pests in China and other rice growing countries in Asia [10-13]. BPH is a phloem feeder extracting nourishment directly from the plant. This induces complex plant responses, with direct and indirect deleterious effects including reduction in plant growth (root development, plant height and reproduction), wilting and leaf chlorosis [14-17]. Symptoms are collectively known as "hopper burn", a nonontagious disease also caused by other Plant hoppers and leaf hoppers including the sometimes coexisting white backed plant hopper,

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Sogatella furcifera. It has been estimated that rice consumption accounts for 20% of the world's calorific intake and single-season losses due to *N. lugens* during 1990/1991 in Thailand and Vietnam were calculated at $US 30 million [18, 19].

Pesticides are primary tool for pest management in IPM programs. These are cost-effective, reliable and short time control tactic. However, insecticides have undesirable impacts such as development of resistant biotypes, residual problem and lethal impact on non-target insect such as beneficial fauna including predators and parasitoids [9]. In contrast, use of selective insecticides that are less toxic to natural enemies than to pests should conserve natural enemy populations and the surviving natural enemies may suppress the pest populations, which in turn will reduce the rate of insecticide application. Keeping mind the idea of agro-ecosystem the research program was undertaken to investigate the effectiveness of different approaches of chemical and biological control against Brown Plant Hopper, *Nilaparvata lugens*.

MATERIALS AND METHODS

Field Experiment: The field experiment was carried out at the farm area of Shabeer Hussain of Moza Chakoka, Tehsil Minchinabad, District Bahawalnagar, Punjab, Pakistan. Experimental fields were located at 30.1622° N, 73.5653° E longitude and 157 m above sea level. The soil type is clay loam in texture having insufficient organic matter from 0.30 to 0.73%. The climate is a local steppe characterized by heavy monsoon rainfall from mid-June to mid-September. Highest rainfall received in July, August and September, scanty rainfall in winter from November to February and irregular rainfall in April. The highest average temperature in June (around 34°C) and lowest in January (around 12.5°C).

The population of rice brown plant hopper (*N. lugens* Stal.) (BPH) at this site was very high and these insects are regular pests of rice crop in this area [9]. Plant hoppers are responsible for more economic losses even crop failure in case of a severe attack. The seed of rice (*var.* 515) soaked for 24 hours in a plastic bucket, then taken out of the water and kept in a gunny bag. After 72 h, sprouted seeds of *var.* basmati 515 were broadcasted by hand in the nursery plots. The seedlings were transplanted in 1st week of July in both years. Diamonium phosphate (DAP), urea and nitrophos were applied at the rate of 133-85-62 (NPK Kg/ ha), respectively. DAP applied before transplanting as basal dose, urea applied in split doses with 1st dose after three weeks of transplanting, 2nd dose at tillering stage and last dose after 45-50 d of transplanting with nitrophos. All recommended agronomic practices were applied typically for rice production in Pakistan.

Experimental Design: Experiments was conducted at in the Kharif season (May to November 2019). The experiments were conducted in a randomized complete block design (RCBD) with 11 treatments for brown rice plant hopper with three replications. Each plot size was 4.38 m × 5.73m. Three blocks with described plot sizes were made each block representing a replication. Hence, there were 33 plots (11 × 3) were separately for white-backed and brown plant hopper. Plots were differentiated with 0.7 m distance to facilitate the cultural operations, irrigation and insecticide application. There were 15 rows with 20 plants in each plot. Insecticides used for evaluation were given in Table 2 (plant hoppers). Among selected treatment Padan 4%G (cartap hydrochloride), Sitara 25%WP (buprofezin) and Buffer 25%WP (buprofezin) are commonly used for pest management in rice including rice planthoppers. While Closer 240%SC, Plenum 50%WG, Telsta 20%SC, Veyong Jin Teng 60%WG, Momentum 50%WG, Actify 60%WP, Feiniao 80%WG and Atrasan Super 43%WDG are commonly used against plant hoppers.

Insecticides used on recommended doses as per label and were registered against insect pest tested and easily available in the market. As per the label, these insecticides were shown effective against tested insects. The doses of granular insecticides were weighed on electrical balance (NAPCO, 410 Japan) having an accuracy of 0.001mg. Granular insecticides were broadcasted with hand uniformly in 2 inches standing water. Liquid formulations were measured with syringes (5 ml capacity) and sprayed with a sprayer pump. All insecticides were applied above the economic threshold level (ETL) infestation level.

Assessment of Brown Planthopper (BPH) Infestation and Natural Enemy Populations: Data were recorded before 24 hours for pretreatment data recording. For post-treatment observations, data were recorded after 72 h and 7 d. Three rows were left as buffer zone and data were recorded from inner rows plants. Data were recorded randomly from five plants/ plot as follows:

- August (15-20 nymphs or adults/ plant)
- September (20-25 nymphs or adults/ plant) OR
- 8-10 nymphs or adults per net sweep

Table 1: List of insecticides generic name along with trade name given below

No. #	Treatment (Trade name)	Common Name	Dose / Acre
1.	Buffer 25%WP	Buprofezin	500 g
2.	Sitara 25%WP	Buprofezin	500 g
3.	Atrasan Super 43% WDG	Dinotefuran + chlorfenapyre	150 g
4.	Padan 4%G	Cartap hydrochloride	9 kg
5.	Actify 60%WP	Isoprocarb	240 g
6.	Feiniao 80%WG	Nitenpyram + pymetrozine	60 g
7.	Momentum 50%WG	Chlorfenapyre	150 g
8.	Closer 240%SC	Sulfoxaflor	150 ml
9.	Telsta 20%SC	Clothianidin	150 ml
10.	Veyong Jin Teng 60%WG	Dinotefuran + pymetrozine	100 g
11.	Plenum 50%WG	Pymetrozine	120 g
12.	Control	Water spray only	100 ml

Yield losses were recorded by taking a final yield of the whole plot.

Treatments for BPH: Treatments used in this experiment were given in table below with generic name along with trade name and recommended dose as per label.

Assessment of Yield: At the end of cropping season, whole plots were harvested to record the yield for each treatment. Unfilled grains were removed by using a pedestal fan. Rice stem borers, rice bug and rice leaf hopper were recorded very low. So, the damage made by these pest was not taken into consideration in this study. Moisture content of grains was determined with Riceter moisture meter found 21% while normally dry grains possess 14% moisture contents. Therefore, yield was adjusted to 14% moisture content.

$$Yield\ at\ 14\%\ moisture = \frac{Yield\ X\ 100 - Actual\ moisture}{100 - 14}$$

Data Analysis: Data recorded for yield and efficacy BPH were averaged for statistical analysis. Data relevant to infestation and yield fauna were analyzed using analysis of variance (ANOVA) with Statistix 8.1 software.

RESULTS

Efficacy of Insecticides Against BPH: All treatment performed differently against brown plant hopper. Closer 240 SC proved the best amongst all insecticides followed by Plenum 50 WG, Telsta 20 SC, Monentum 50 WG and Veyong Jin Teng 60 WG against brown planthopper. However, effectiveness increased with time interval from 72 hours to 7 d. Maximum efficacy at 7 d for Closer 240 SC, Plenum 50 WG, Telsta 20 SC, Monentum 50 WG and Veyong Jin Teng 60 WG was 62.28, 61.28, 41.78, 41.78, 22.96 and 21.05%, respectively. All other treatments including Feiniao 80 WG, Buffer 25 WP, Sitara 25 WP, Regent 80 WG, Atrasan super 43 WDG, Padan 4 G and Actify 60 WP were remained ineffective against brown planthopper. These insecticides were proved ineffective for both time periods i.e., 72 h and 7 d. Overall, all treatments were unable to produce desired effectiveness (≥ 80%) against brown planthopper as ompared to control treatment. However, Closer 240 SC, Plenum 50WDG and Telsta 20 SC suppressed the BPH population effectively at recommended dose rates.

Yield: Yields were recorded after harvesting, adjusted to 14% moisture level and converted into t/ha. Maximum yield (4.15 t/ha) recorded with Plenum 50 WG, followed by Closer 240%SC (4.14), Telsta 20%SC (3.88) (Figure 1). Whereas the minimum grain yield was recorded for control (0.1.26t/ha). In terms of yield, Plenum 50 WG and Closer 240 SC and Telsta 20 SC proved better among treatments

DISCUSSION

Previous report of BPH control with a novel chemical viz, suloxaflor, which at 100-75 g. a.i./ha was found to be effective for management of BPH under field condition [20]. Similar results on the efficacy of pymetrozine 50 WG against BPH and WBPH was earlier reported [21]. Good efficacy of dinotefuran against *N. lugens* was endorsed earlier [9].

The result also derives support from the findings of a previous research concluding that pymetrozine 50 WG @ 350 g a.i./ha significantly superior in controlling BPH population [22]. It was also reported that Pymetrozine 50% WG (GSP sample) @ 300 and 400 g/ha and Pymetrozine 50% WG (Market sample) @ 300 g/ ha effectively controlled BPH followed by Imidacloprid 17.8% SL @ 125 ml/ha and Fipronil 5% SC @ 1500 ml/ha [23]. The research findings are also partly similar with the previous findings

Table 2: Efficacy of insecticides against BPH at 72 h and 7 d after application. Negative values indicate that insecticide has no control against BPH, instead BPH population increased after spray

	Number of BPH (adults/nymphs)				
Name of product	Pretreatment	72 h Post-treatment	7 d Post-treatment	Control of check (%) 72 h	Control of check (%) 7 d
Buffer 25%WP	69.33 ± 2.84	86.22 ± 11.36	105.22 ± 12.97	-24.04 ± 8.04 d	-43.74 ± 8.10 d
Sitara 25%WP	79.85 ± 4.83	106.67 ± 16.77	125.67 ± 18.52	-28.53 ± 9.94 d	-42.96 ± 12.14 d
Atrasan Super 43% WDG	85.59 ± 0.28	100.22 ± 4.03	127.67 ± 5.02	-21.56 ± 3.76 d	-37.08 ± 4.82 d
Padan 4%G	46.11 ± 2.00	49.44 ± 2.67	79.89 ± 4.40	-8.73 ± 4.09 d	-48.26 ± 4.36 d
Actify 60%WP	59.22 ± 7.42	66.56 ± 4.19	83.78 ± 12.27	-35.86 ± 18.35 d	-30.71 ± 19.43 d
Feiniao 80%WG	78.22 ± 1.07	81.00 ± 2.51	74.22 ± 7.00	-7.65 ± 3.04 d	-17.22 ± 6.69 d
Momentum 50%WG	72.07 ± 5.06	66.44 ± 4.56	49.44 ± 7.41	9.33 ± 9.95 c	22.96 ± 13.00 c
Closer 240%SC	85.81 ± 3.66	27.22 ± 9.87	18.67 ± 7.13	38.66 ± 8.20 a	62.28 ± 6.25 a
Telsta 20%SC	64.19 ± 3.23	45.67 ± 10.44	28.56 ± 12.79	23.18 ± 15.67 b	41.78 ± 19.27 b
Veyong Jin Teng 60%WG	73.04 ± 1.95	61.89 ± 6.17	57.56 ± 7.46	16.24 ± 5.84 c	21.05 ± 8.32 c
Plenum 50%WG	65.52 ± 1.83	34.33 ± 1.47	22.56 ± 1.67	35.42 ± 3.22 a	61.28 ± 2.91 a
Control	74.78 ± 7.26	109.00 ± 3.01	105 ± 6.67	-40.97 ± 10.53 d	-54.74 ± 13.63 d

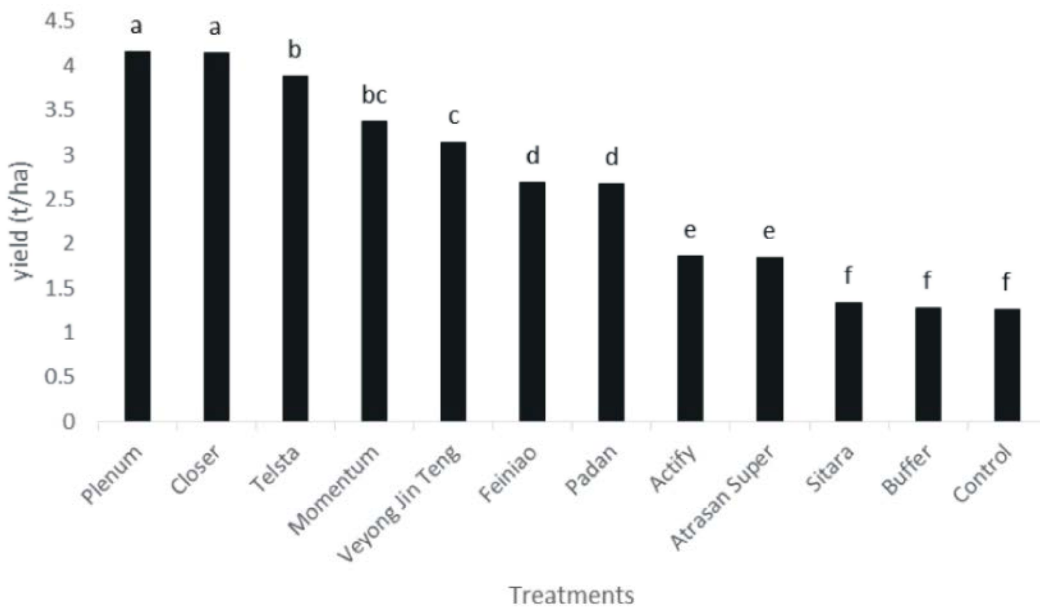

Fig. 1: Grain yield (t/ha) obtained after harvesting against treated and untreated plots

which reported that significantly low BPH population (1.40 and 1.60/hill) was observed with flonicamid 50 WG @ 150 g a.i. /ha and @ 75 g a.i. /ha with a reduction of 88.73 and 87.12% over untreated control, respectively [24]. The current findings also supported by the findings concluding that by the application of dinotefuran @ 600 g /ha the BPH population was reduced by 11.97 and 46.59 per cent at 70 and 85 DAT whereas, the same insecticide at 800 g a.i/ha exhibited a population reduction of 15.16 and 56.48 per cent at 70 and 85 DAT [25].

Dinotefuran 20 SG at 30 and 40 g a.i. /ha was proved to be effective against brown planthopper at 35 locations in India during 2009 [25]. The present study is in opposition with the findings reported that buprofezin (Applaud) was highly selective and effective at low rates against nymphs of N. lugens, S. furcifera and Nephotettix virescens (Distant) [26]. Buprofezin was effective against homopteran insect pests, such as planthopper with very low risks to environment and human beings. He further, stated that buprofezin was recently recommended as one of the alternatives for highly toxic organophosphorous insecticides for controlling important insects on rice and also cautioned that over use of buprofezin might induce resistance. To avoid development of resistance to buprofezin, the chemicals may be alternated with other effective molecules [27].

In recent years, the BPH has caused severe damage to rice plants in most east and south-east Asian countries [28]. Insecticides have been used extensively to control N. lugens, resulting in the development of resistance to many insecticides [29, 30, 31]. A mix of two unrelated insecticides may be more effective for managing insect pests than the alternate use of single insecticides [32], which reduced the amount of pesticides to the target insects and was an important strategy to suppress the resistance level [33, 34]. Thiamethoxam and chlorantraniliprole belong to different groups of insecticides and have different pesticidal mechanisms. Thiamethoxam has been used for controlling N. lugens for a long time and resulted in a gradual decrease of efficacy against the pest, with the resistance levels in Ningbo, Hangzhou and Shaoguan populations ranging from 9.4 to 15.8 fold compared with the susceptible strain [34, 35]. Furthermore, the BPH was not the target pest of chlorantraniliprole [36]. Chemical application contribute to increase the rice yield [37].

Buprofezin, a chitin synthesis inhibitor has been used continuously by the farmers in suppression of BPH for more than five years in areas around. Present results indicated that the population of BPH has acquired a high level of resistance to buprofezin. The observed variation in resistance level could be because of the selection pressures in these areas. Similar case is with imidacloprid, actify, fipronil and cartap which have lost efficacy against BPH.

CONCLUSION

Closer 240SC, Plenum 50WG and Telsta 20SC are still very effective against BPH and could be recommended for its management while Padan 4G, Sitara 25WP, Buffer 25WP and Actify 60WP are no more effective for BPH management. BPH has developed resistance against these chemicals at this recommended rate, so, these insecticides may not be recommended for BPH management.

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