EFFECTS OF NEW GENERATION INSECTICIDES ON THE INFESTATION OF STEM BORERS AND YIELD OF RICE

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ABSTRACT

The study was conducted from September 2019 to December 2020 to know the effects of the new generation insecticides, Virtako 40WG (Chlorantraniliprole and Thiamethoxam) and Coragen 18.5SC (Chlorantraniliprole) on the infestation of rice yellow stem borer (*Scirpophaga incertulas*) and dark headed stem borer (*Chilo suppressalis*) and yield of rice. The insecticides with concentrations 0.1, 0.5, 2, 10, 50 and 200 ppm were applied along with an untreated control. Rice plants were cultivated in the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. All doses of the insecticides resulted significantly lower level of plant infestation. Virtako 40WG and Coragen 18.5SC at concentrations of 200 ppm showed the lowest levels of dead heart (3.0% and 2.0%, respectively) and white head (2.7% and 2.2%, respectively) symptoms. All the doses of the insecticides produced significantly the higher yield of rice compared to untreated control and the dose 200 ppm produced the highest yield.

Keywords: Aman rice, *Chilo suppressalis,* Coragen 18.5SC, *Scirpophaga incertulas,* Virtako 40WG.

INTRODUCTION

Rice is the highest consumed cereal crop in Bangladesh occupying more than 80% of the acreages (Ullah & Tuhin 2018). Bangladesh ranks the 3rd in production, 4th in area and 6th in per hectare yield of rice (Schneider & Asch 2020). The geographical, climatic and edaphic conditions of Bangladesh are favorable for year-round rice production. However, in Bangladesh, the average yield of rice is about 3.2 t ha^{-1} (BBS 2020) which is very low compared to other rice growing countries of the world, like China (6.3 t ha^{-1}), Japan (6.6 t ha^{-1}) and Korea (6.30 t ha^{-1}) (Akondo *et al.* 2020).

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Insect pests are the major constraint for successful rice production. Rice plants are infested by various insect pests from seedlings to harvest. The estimated loss of rice in Bangladesh due to insect pests and diseases was about 1.5 to 2.0 million tons (Magunmder *et al.* 2013). The lepidopteran insects, rice yellow stem borer (*Chilo suppreselis*) and dark headed stem borer (*Scirphophaga incertulus*) are the major chewing pests of rice plant that cause up to 20% yield loss (Rahman *et al.* 2014). The particular symptom of stem borer attack is called dead heart and white head, due to infestations at tillering and grain filling stages, respectively. The extent of rice yield losses due to yellow stem borer has been estimated as 50-90% if timely control measure is not taken (Baruah & Dutta 2020). Various chemical insecticides also have been recommended to control the insect pest of rice. The new generation insecticides diamide products have broad spectrum effects, which are widely used against stem borers of rice (Sparks & Nauen 2015). Therefore, the present study was undertaken to assess the effects of two new generation insecticides, Virtako 40WG and Corahen 18.5SC on the infestation of stem borers in the rice field and yield of rice.

MATERIALS AND METHODS

Study site and duration: The study was conducted during September 2019 to December 2020 in the field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. The rice variety Gopalbhog was cultivated in the experimental plots in two consecutive Aman seasons of the years 2019 and 2020.

Experimental design and rice cultivation: The experiment was conducted following randomized complete block design having plot size of 2.0 m × 2.0 m. The spacing between block to block and plot to plot was 0.5 m. The experiment was comprised of seven treatments (six doses of insecticides and untreated control) with three replications. After collecting the seeds from BSMARU farm, the seedlings were raised in the experimental field and then twenty-four days old seedlings were transplanted on first September in well puddled plots. Each plot had 9 rows and each row had 9 hills having five seedlings in each. Fertilizers were applied according to Fertilizer Recommendation Guide (FGR 2018: N-120 kg ha^{-1}, P-26 kg ha^{-1}, K-50 kg ha^{-1}). Irrigation and weeding were done according to necessity.

Application of insecticides and observation of infestations: The experimental plots were monitored at weekly intervals and the infestation of the stem borers were

observed carefully. On the incidence of the infestation, two insecticides namely Virtako 40WG and Coragen 18.5SC were applied to rice plots separately using 0.1, 0.5, 2, 10, 50 and 200 ppm doses. The insecticides were applied at 4th and 10th weeks after transplanting. Information of the applied insecticides are presented in Table 1.

Data collection on the infestation levels: Data on the infestation level (dead heart and white head symptoms) were collected after 7, 14 and 21 days after spraying (DAS) insecticides. To collect data, systematic sampling method was followed for each treatment and replication. Therefore, 9 hills were selected from each plot and the total number of tillers and number of infested tillers of each hill were counted and then the infestation level was calculated into percentage.

Harvesting of the crop: The crop was harvested at full maturity when 80-90% of the grains were turned into straw color. The harvested crop was bundled separately, properly tagged and brought to threshing floor. The grains were dried, cleaned and weighed for individual plot and adjusted to a moisture content of 12%. The grain of each plot was separately measured using a balance and then converted to t ha^{-1}.

Data analysis: Data on infestation levels of stem bores and rice yield were analyzed using one-way analysis of variance followed by Tukey's HSD posthoc Test (at 5% level of significance). The analyses were performed using IBM SPSS 20.0.

RESULTS

The applied insecticides showed statistically significant differences in terms of the infestation of the stem borers (dead heart and white head). All the concentrations of Virtako 40WG resulted significantly lower level of dead heart and white head symptoms compared to control. The dead heart symptoms in the first and second season ranged from 2.5 to 17.8% and 3.4 to 20.7%, respectively. The mean results of the two seasons varied from 3.0 to 19.3% (Table 2). The white head symptoms in the first and second years ranged from 3.2 to 22.4% and 2.4 to 16.4%, respectively, and the mean results of the two seasons varied from 2.7 to 19.5% (Table 2).

Table 1. Insecticides used for controlling rice yellow stem borer and dark headed stem borer

Trade name	Common name	Chemical subgroup	Mode of entry	Recommended dose
Virtako 40WG	Chlorantraniliprole and Thiamethoxam	Diamide	Systemic + contact	200 ppm
Coragen 18.5SC	Chlorantraniliprole	Diamide	Systemic + contact	200 ppm

All tested concentrations of Coragen 18.5SC revealed significantly lower level of dead heart and white head symptoms compared to control. The dead heart symptoms in the first and second year ranged from 1.9 to 19.7% and 2.0 to 18.8%, respectively. The mean deal heart symptom of the two seasons varied from 2.0 to 19.3% (Table 3). The white head symptoms in the first and second year ranged from 2.4 to 18.8% and 2.0 to 17.5%, respectively. The mean results of the two seasons varied from 2.2 to 18.2% (Table 3).

The Virtako 40WG treated plots at different concentrations showed significantly higher yield compared to control. The yield of rice in the first year (2019) and second year (2020) ranged from 2.89 to 3.25 t ha^{-1} and 2.95 to 3.22 t ha^{-1}, respectively. The mean results of the two seasons varied from 2.92 to 3.24 t ha^{-1} (Table 4). The yield of the different concentrations of Virtako 40WG insecticide treated plots over control varied from 1.39 to 12.5%. The highest yield was obtained from 200 ppm treated plots.

The yield of Coragen 18.5SC at different concentrations was presented in Table 5. It was found that the concentrations of the Coragen 18.5SC resulted significantly higher yield compared to control. The yield of rice in the first and second years ranged from 2.87 to 3.22 t ha^{-1} and 2.92 to 3.21 t ha^{-1}, respectively. The mean results of the two seasons varied from 2.89 to 3.22 t ha^{-1} (Table 5). The yield increase in the treated plots over control varied from 3.96 to 15.83%. The highest yield was obtained from 200 ppm treatment.

Table 2. Effect of different concentrations of Virtako 40WG on the infestation of rice stem borer in Aman rice field

Treatment (ppm)	Dead heart (%)			White head (%)		
	1st season (2019)	2nd season (2020)	Mean	1st season (2019)	2nd season (2020)	Mean
200	2.5 ± 0.2g	3.4 ± 0.1g	3.0 ± 0.3	3.2 ± 0.2g	2.4 ± 0.2g	2.7 ± 0.2
50	6.6 ± 0.2f	7.6 ± 0.2f	7.1 ± 0.3	8.6 ± 0.2f	6.8 ± 0.2f	7.7 ± 0.5
10	9.1 ± 0.1e	11.6 ± 0.1e	10.4 ± 0.7	12.8 ± 0.1e	9.4 ± 0.1e	11.1 ±1
2	9.4 ± 0.0d	14.8 ± 0.2d	12.1 ± 1.5	16.2 ± 0.1d	11.1 ± 0.1d	13.7 ± 1.5
0.5	13.2 ± 0.1c	16.0 ± 0.1c	14.6 ± 0.8	19.5 ± 0.1c	13.4 ± 0.1c	16.5 ± 1.8
0.1	15.9 ± 0.1b	18.3 ± 0.4b	17.1 ± 0.7	20.7 ± 0.2b	14.8 ± 0.2b	17.8 ± 1.7
Control	17.8 ± 0.1a	20.7 ± 0.1a	19.3 ± 0.8	22.4 ± 0.1a	16.6 ± 0.1a	19.5 ± 1.7

Each datum represents the mean of three replicates. Means followed by the same letters within a column are not significantly different (Tukey's HSD, $p \leq 0.05$).

Table 3. Effect of different concentrations of Coragen 18.5SC on the infestation of rice stem borer in Aman rice field

Treatment (ppm)	Dead heart (%)			White head (%)		
	1st season	2nd season	Mean	1st season	2nd season	Mean
200	1.90.2g	2.00.1g	2.00.0	2.40.1g	2.00.2g	2.20.0
50	6.70.1f	5.70.1f	6.20.1	7.30.2f	5.70.1f	6.50.1
10	11.20.1e	11.10.1e	11.20.0	10.70.0e	9.20.1e	9.90.0
2	14.50.1d	12.10.1d	13.30.1	13.70.1d	11.20.1d	12.50.0
0.5	16.50.2c	13.90.1c	15.20.1	14.40.1c	12.60.2c	13.50.2
0.1	17.90.2b	15.70.1b	16.80.1	15.80.1b	16.10.1b	15.90.0
Control	19.70.1a	18.80.1a	19.30.0	18.80.1a	17.50.1a	18.20.1

Each datum represents the mean of three replicates. Means followed by the same letters within a column are not significantly different (Tukey's HSD, $p \leq 0.05$).

Table 4. Effect of different concentrations of Virtako 40WG on the yield of Aman rice

Treatment (ppm)	Yield (t ha^{-1})			Yield increase over control (%)
	1st season (2019)	2nd season (2020)	Mean	
200	3.25a	3.22a	3.24	12.5
50	3.20a	3.18a	3.19	10.76
10	3.11a	3.1a	3.11	7.98
2	3.09b	3.05b	3.07	6.59
0.5	3.00b	2.98b	2.99	3.81
0.1	2.89c	2.95c	2.92	1.39
Control	2.84c	2.93c	2.88	-

Means followed by the same letters within a column are not significantly different (Tukey's HSD, $p \leq 0.05$).

Table 5. Effect of different concentrations of Coragen 18.5SC on the yield of Aman rice

Treatment (ppm)	Yield (t ha^{-1})			Yield increase over control (%)
	1st season (2019)	2nd season (2020)	Mean	
200	3.22a	3.21a	3.22	15.83
50	3.18b	3.17ab	3.18	14.35
10	3.14c	3.11bc	3.13	12.59
2	3.06d	3.04c	3.05	9.71
0.5	2.95e	2.96d	2.95	6.11
0.1	2.87e	2.92de	2.89	3.96
Control	2.70f	2.85e	2.78	-

Means followed by same letter within a column are not significantly different (Tukey's HSD, $p \leq 0.05$).

DISCUSSION

The new generation insectcides Virtako 40WG is a 1:1 composition of Chlorantraniliprole and Thiamethoxam, whereas Coragen 18.5SC contains only Chlorantraniliprole. Thiamethoxam and Chlorantraniliprole show systemic action when the insecticides are applied to soil but their foliar application reveal contact poison on insects. Chlorantraniliprole is responsible for activating the ryanodine receptors and stimulating calcium ion release from muscle cells causing paralysis and death. On the other hand, Thiamethoxam disrupts the nervous system due to its ingestion or penetration into the insect body through cuticle. In the present study, yellow stem borer and dark headed borer showed lower level of infestation in insecticide treated plots compared to control plots because the applied insecticides exerted toxic effect on insect body, and resulted in reduced abundance and infestation. Several research findings suggested that Chlorantraniliprole was very effective against the infestation of rice stem borers. For example, Sachan *et al.* (2018) observed that application of Chlorantraniliprole18.5SC @ 150 ml ha^{-1} was an effective treatment in reducing the stem borer infestation and producing higher grain yield. Sarao and Cheema (2014) reported that Chlorantraniliprole (Ferterra) @ 40 g a.i. ha^{-1} significantly reduced the dead heart and white ear head infestation in rice.

In the present study, yield of rice varied between the two seasons, between the insecticides having different concentrations. Environmental factors may have influenced the growth of rice and interrupted the population buildup of the stem borers and their infestation. Environmental factors affect the activity of the insecticide and influence mortality level of the larvae and their infestation. The crop loss due to the stem borers in the previous seasons and indiscriminate use of insecticides may have influenced the abundance and infestation of the borers and development of insecticide resistance. Resistance to insecticides was reported by Shafiq *et al.* (2002), Venkateswarlu *et al.* (2005) and Sahoo *et al.* (2007). Intensive and injudicious application of insecticides for a long time, there has become driving force for target pests namely yellow stem borer and dark headed stem borer of rice to develop resistance.

In the year 2022, Bangladesh applied 37422 Mt pesticides of which 14750 Mt were insecticides (Mazed *et al*. 2022). Major portion of the insecticides is applied in the rice field specially for controlling stem borers, leaf roller and brown plant hopper. The stem borers infest rice plants throughout the country in the three seasons (aus, aman and boro) of rice. That is why stem borers are the serious concern of the rice growers in Bangladesh. The farmers frequently spray insecticides without examining

the recommended dose of the chemical, level of pest infestation, growth stages of crop and pest, weather conditions and beneficial activities of natural enemies in the field. The haphazard and unmethodical applications of chemical insecticides often create resistance in the insects to insecticides.

In this study, different doses of Virtako 40WG and Coragen 18.5SC showed varied level of dead heart and white head symptoms. But the observed dead heart and white head levels at the recommended dose of Virtako 40WG were 3.0±0.3 and 2.7±0.2%, respectively. The results obtained from the recommended dose of Coragen 18.5SC were 2.0±0.0 and 2.2±0.0%, respectively. Baskaran *et al.* (2013) applied Virtako 40WG to control stem borers in rice field and reported mean dead heart and white head symptoms of 2.90% and 2.55%, respectively. The findings of the present study indicated that the applied insecticides kept the infestation level below economic threshold level but needed repeated applications. Berefit cost ratio (BCR) for the management of these pests of rice using there two new generation insecticides needed to be calculated after comparative efficacy of these two chemicals.

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