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Resistance to Diamide Insecticides in Stem Borers of Rice in Bangladesh

Nazmus Sakib, Md Ruhul Amin, Md Shamim Hossain and AKM Aminul Islam[1]

Department of Entomology, [1]Department of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
E-mail: mramin@bsmrau.edu.bd

***Abstract*:** The study was conducted from September 2019 to December 2020 to know the efficacy of the diamide products, namely Virtako 40 WG (Chlorantraniliprole + Thiamethoxam) and Coragen 18.5 SC (Chlorantraniliprole) against rice yellow stem borer (*Scirpophaga incertulas*) and dark headed stem borer (*Chilo suppressalis*). Larvae of the stem borers were collected from four locations of Bangladesh, and then the diamide products with the concentrations of 0.1, 0.5, 2, 10, 50 and 200 ppm were applied along with untreated control to know the mortality of the larvae at 96 hours after treatments. Diamide products showed differing mortality effects on the larvae based on different concentrations. After the application of Coragen 18.5 SC, the highest rate of mortality of larvae of *S. incertulas* and *C. suppressalis* at the four locations were 55.0 to 68.8% and 51.4 to 59.5%, respectively with the concentration of 200 ppm. In Virtako 40 WG, also the concentration of 200 ppm showed the highest mortality of the larvae of the four locations ranging from 60.6& to 71.3% in *S. incertulas* and 59.8 to 70.9% in *C. suppressalis*. The LC_{95} value of the Coragen 18.5 SC ranged from 337.2 to 494.6 ppm for *S. incertulas* and 435.2 to 557.0 ppm for *C. suppressalis.* LC_{95} value of Virtako 40 WG ranged from 312.1 to 488.1 ppm for *S. incertulas* and 405.6 to 514.0 ppm for *C. suppressalis*.

***Keywords*:** *Chilo suppressalis*, Coragen 18.5 SC, Mortality, *Scirpophaga incertulas,* Virtako 40 WG

Rice is the staple food for more than three billion people in developing countries of Asia (Deepa 2020). It is the highest consumed cereal crop occupying more than 80% of the acreages in Bangladesh (Ullah and Tuhin 2018). The annual production of rice in Bangladesh is 35.3 million tons covering an area of 11.8 million hectares of land (BBS 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 (Akando et al 2020). The infestation of the insect pests, stem borers is the major constraint for rice production, which cause up to 20% yield loss (Rahman et al 2004). Management of stem borers in rice field of Bangladesh is solely relied on chemical insecticides, and the diamide products have been using for a decade. The diamide insecticides exhibited selective activity against Lepidopteran insects and showed significant reduction of the abundance and infestation of stem borers in rice field. Now-a-days, repeated use of diamide products with recommended concentrations did not show satisfactory result against yellow stem borer and dark headed stem borers. Farmers of Bangladesh are applying higher doses of diamide products in the rice field, thus creating disruptions of the rice ecosystem. Understanding the susceptibility of insect populations to insecticides plays a key role in insecticide resistance management and for developing new strategies for pest control. Considering this, the study was done to know the resistance of diamide products, Virtako 40 WG (Chlorantraniliprole and Thiamethoxam) and Coragen 18.5% SC (Chlorantraniliprole) in yellow stem borer *Scirpophaga incertulas* and dark headed stem borer *Chilo suppressalis* of rice through the assessment of the mortality rate of the larvae of the pests.

MATERIAL AND METHODS

The study was conducted during September 2019 to December 2020 in the Laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh**.** Egg masses of yellow stem borer *Scirpophaga incertulas* and dark headed stem borer *Chilo suppressalis* were collected from four different locations of Bangladesh (Table 1).

Cut-stem bioassays against stem borers with different treatments: Eggs and larvae of the stem borers were reared in the laboratory at 25 ± 2°C in dark at 70% relative humidity providing fresh stems of rice plants. The rice stems were collected from insecticide treatment free rice field of BSMRAU at the tillering stage and cut into 5-6 cm long pieces. Then the cut pieces were treated with the diamide products Virtako 40 WG (chlorantraniliprole + thiamethoxam) and Coragen 18.5 SC (chlorantraniliprole)

separately at 0.1, 0.5, 2, 10, 50 and 200 ppm concentrations. Ten fifth-instar larvae of *S. incertulas* and five of *C. suppressalis* were taken for each replication of the treatments. The larvae with five pieces of treated rice stems were placed in glass jars, and the opening of the jars was closed using cloth. The experiment was conducted following completely randomized design. Experiments of both of the diamide products were constituted with seven treatments (six doses and control) and three replications. Control treatment did not receive any diamide products.

Observation and calculation of the mortality of larvae: Mortality data of the larvae of the stem borers were recorded at 96 hours after treatment (HAT). Number of dead larvae inside of each glass jar was counted and calculated into percentage. The mortality data at different doses of insecticides were corrected using control mortality according to Schneider-Orelli (1947).

$$\text{Corrected mortality (\%)} = \frac{\text{Treatment mortality (\%)} - \text{Control mortality (\%)}}{\text{100- Control mortality (\%)}} \times 100$$

Statistical analysis: The toxic effects of the insecticides on the larvae were analyzed following Probit statistic through the dose-mortality response at 95% fiducial confidence intervals, and the LC_{50} and LC_{95} values with their fiducial limits were estimated. The analyses were performed using IBM SPSS 20.0.

Table 1. Geographic locations of the regions of Bangladesh from where the egg masses of yellow stem borer and dark headed stem borer were collected

Name of the location	Latitude	Longitude
Gazipur	24.0	90.42
Tangail	24.25	89.91
Kishoregonj	24.43	90.78
Bogura	24.84	89.37

RESULTS AND DISCUSSION

The corrected mortality rates of the larvae of *S. incertulas* of the four locations at different treatment concentrations of the diamide products are presented in Table 2. The mortality rates of the larvae of different locations among the treatment concentrations of Coragen 18.5 SC and Virtako 40 WG showed differences. The mortality of the larvae of Gazipur, Tangail, Kishoregonj and Bogura among the treatments of Coragen 18.5 SC ranged from 10.6 to 68.8, 10.6 to 61.9, 17.8 to 60.0 and 11.3 to 55.0%, respectively. The mortality of larvae with of Virtako 40 WG ranged from 10.0 to 71.3, 12.1 to 69.4, 10.0 to 65.0 and 10.6 to 60.6%, respectively at Gazipur, Tangail, Kishoregonj and Bogura, respectively. Mortality rate of *S. incertulas* larvae of the four locations was the highest at 200 ppm concentration of both diamide products (Table 2). The toxicity of the Coragen 18.5% SC on the larvae of *S. incertulas* at Tangail, Gazipur, Kishoregonj and Bogura showed the LC_{50} and LC_{95} values ranging from 125.2 to 227.1 and 337.2 to 494.6 ppm, respectively (Table 3). Due to the application of Virtako 40 WG LC_{50} and LC_{95} against the larvae of *S. incertulas* at these four locations ranged from 115.7 to 213.4 and 312.1 to 488.1 ppm, respectively (Table 3). Due to different concentrations of Coragen 18.5 SC and Virtako 40 WG the mortality of the larvae of *C. suppressalis* of different locations varied (Table 4). The mortality rates of the larvae of Gazipur, Tangail, Kishoregonj and Bogura among the doses of Coragen 18.5 SC ranged from 16.1 to 59.5, 10.8 to 51.4, 10.3 to 52.4 and 6.3 to 57.5%, respectively. In contrast, the mortality rates of the larvae of Gazipur, Tangail, Kishoregonj and Bogura among the treatments of Virtako 40 WG ranged from 20.6 to 70.9, 11.1 to 66.7, 13.6 to 65.0, 12.3 to 59.8%, respectively. Mortality rate of the larvae of all the four locations was the highest at 200 ppm concentration irrespective of the diamide products.

The toxic effects of the Coragen 18.5 on the larvae of *C. suppressalis* at Tangail, Gazipur, Kishoregonj and Bogura showed the LC_{50} and LC_{95} values varying from 159.6 to 256.6 and 435.2 to 557.0 ppm, respectively. In case of the toxic

Table 2. Effects of different concentrations of Coragen 18.5 SC and Virtako 40 WG on the corrected mortality rate (%) of *Scirpophaga incertulas* larvae collected from different locations of Bangladesh

Treatment concentration (ppm)	Coragen 18.5 SC				Virtako 40 WG			
	Gazipur	Tangail	Kishoregonj	Bogura	Gazipur	Tangail	Kishoregonj	Bogura
200	68.8	61.9	60.0	55.0	71.3	69.4	65.0	60.6
50	45.0	40.6	39.4	38.1	53.1	40.0	40.6	46.9
10	30.6	26.9	33.1	32.5	35.0	30.0	31.3	32.5
2	25.0	18.8	21.9	23.8	26.3	21.3	25.6	23.1
0.5	20.0	13.1	16.3	18.1	19.3	15.6	20.0	18.9
0.1	10.6	10.6	17.8	11.3	10.0	12.1	10.0	10.6

Table 3. Toxic effects of different concentrations of Coragen 18.5 SC and Virtako 40 WG on the larvae of *Scirpopgaga incertulas* collected from different locations of Bangladesh

Location	Insecticide	LC_{50} (Lower limit-Upper limit)	LC_{95} (Lower limit-Upper limit)	Slope±SE	χ^2 (df)
Gazipur	Coragen 18.5 SC	125.2 (117.8-353.3)	337.2 (258.5-429.0)	-0.4±0.2	49.3 (38)
	Virtako 40 WG	115.7 (103.9-323.9)	319.0 (270.0-430.1)	-0.4±0.2	47.8 (38)
Tangail	Coragen 18.5 SC	151.1 (115.3-290.5)	385.0 (267.1-543.3)	-1.2±0.2	56.2 (38)
	Virtako 40 WG	131.9 (117.4-219.9)	380.6 (261.9-563.9)	-0.3±0.2	53.3 (38)
Kishoregonj	Coragen 18.5 SC	138.3 (117.6-328.3)	386.6 (262.3-569.8)	-0.3±0.2	52.7 (38)
	Virtako 40 WG	122.5 (109.5-227.8)	312.1 (275.3-584.7)	-0.1±0.1	56.5 (38)
Bogura	Coragen 18.5 SC	227.1 (114.9-362.6)	494.6 (366.0-707.1)	-0.2±0.2	54.0 (38)
	Virtako 40 WG	213.4 (189.2-333.2)	488.1 (365.7-649.8)	-0.3±0.2	49.3 (38)

Concentrations are expressed as ppm. Figures in parentheses indicate the range

Table 4. Effects of different concentrations of Coragen 18.5 SC and Virtako 40 WG on percent mortality rate of *Chilo suppressalis* larvae collected from different locations of Bangladesh

Treatment concentration (ppm)	Coragen 18.5 SC				Virtako 40 WG			
	Gazipur	Tangail	Kishoregonj	Bogura	Gazipur	Tangail	Kishoregonj	Bogura
200	59.5	51.4	52.4	57.5	70.9	66.7	65.0	59.8
50	45.8	32.4	39.2	42.5	52.5	50.0	45.9	43.1
10	32.5	24.2	26.4	31.3	41.9	38.8	32.5	29.7
2	26.9	21.6	23.3	27.5	31.1	25.0	24.4	21.7
0.5	21.4	13.1	15.6	13.8	26.1	19.4	16.1	18.9
0.1	16.1	10.8	10.3	6.3	20.6	11.1	13.6	12.3

Table 5. Toxic effects of different concentrations of diamide products on the larvae of *Chilo suppressalis* collected from different locations of Bangladesh

Location	Insecticide	LC_{50} (Lower limit-Upper limit)	LC_{95} (Lower limit-Upper limit)	Slope±SE	χ^2 (df)
Gazipur	Coragen 18.5 SC	159.6 (142.5-362.0)	435.2 (289.5-564.3)	1.3±0.2	7.7 (22)
	Virtako 40 WG	149.7 (121.1-275.3)	405.6 (207.6-501.1)	-1.3±0.2	8.7(22)
Tangail	Coragen 18.5 SC	171.9 (103.3-405.4)	455.6 (281.4-565.5)	-1.2±0.2	10.8 (22)
	Virtako 40 WG	154.7 (106.1-369.4)	430.9 (203.8-591.9)	-1.2±0.2	6.2 (22)
Kishoregonj	Coragen 18.5 SC	244.1 (136.91-357.2)	545.0 (384.4-664.2)	-1.1±0.2	8.9 (22)
	Virtako 40 WG	211.5 (143.2-366.0)	508.9 (398.5-685.4)	-1.2±0.2	7.1 (22)
Bogura	Coragen 18.5 SC	256.7 (144.9-387.8)	557.0 (312.9-703.9)	-0.9±0.2	19.1 (22)
	Virtako 40 WG	247.7 (140.3-361.0)	514.0 (390.0-669.1)	-1.2±0.2	7.6 (22)

Concentrations are expressed as ppm. Figures in parentheses indicate the range

effects of Virtako 40 WG on the larvae of *C. suppressalis* collected from those four locations, the LC_{50} and LC_{95} values ranged from 149.7 to 247.7 and 405.6 to 514.0 ppm, respectively (Table 5).

The findings of the present study showed that the recommended dose (200 ppm) of the diamide products, Coragen 18.5 SC and Virtako 40 WG revealed variations in the mortality of the larvae collected from different geographic locations and due to the use of insecticides in different patterns. The highest mortality rates of the larvae of *S. incertulus* at the recommended dose (200 ppm) of Coragen 18.5 SC and Virtako 40 WG were 68.8% and 71.3%, respectively. The highest mortality rates of the larvae of *C. suppressalis* at the recommended dose (200 ppm) of Coragen 18.5 SC and Virtako 40 WG were 59.5 and 70.9%, respectively. The results of the recommended dose of the diamide products indicated that the efficacy of the insecticides against the stem borers was poor. Richardson et al (2020) reported high resistance to diamide products in Lepidopteran insects. Population of *C. suppressalis* collected from different geographic locations of China depicted low level of resistance to Chlorantraniliprole (Gao et al 2013). A six years study by Ahmad and Gull (2017) showed that the Chlorantraniliprole revealed low level of resistance in the larvae of *Spodoptera litura.* Nozad-Bonab et al (2021) showed that the LC_{50} value of Chlorantraniliprole was 0.02 (0.002-0.03) and LC_{90} was 0.28 (0.17–0.61) on lepidopteran larvae. But our study showed higher levels of LC_{50} and LC_{90} values which indicated that the recommended dose of the diamide products did not remain sufficiently toxic to the larvae of the stem borers.

CONCLUSION

The bioassay data of rice stem borers, collected from different locations of Bangladesh, revealed low levels of mortality with the recommended dose (200 ppm) of the tested diamide products. According to the current findings, Coragen 18.5 SC at the recommended dose revealed 55.0% to 68.8% mortality of *S. incertulas,* and 51.4 to 59.9% of *C. suppressalis*. The Virtako 40 WG at the recommended dose exerted 60.6% to 71.3% mortality of *S. incertulas* and 59.8 to 70.9% of *C. suppressalis* larvae.

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REFERENCES

Ahmad M and Gull S 2017. Susceptibility of armyworm *Spodoptera litura* (Lepidoptera: Noctuidae) to novel insecticides in Pakistan. *The Canadian Entomologist* **149**: 649-661.

Akondo MRI, Hossain MB, Akter SE and Islam MM 2020. Growth and yield performance of BINA released six promising aman rice varieties of Bangladesh. *Asian Plant Research Journal* **6**: 18-25.

BBS (Bangladesh Bureau of Statistics) 2020. *Statistical Yearbook 2020.* Ministry of Planning, Government of the People's Republic of Bangladesh.

Deepa 2020. Rice: The Staple Diet of Half the World. Online article published in Owlcation. https://owlcation.com/agriculture/Rice-The-Staple-Diet-of-Half-the-World.

Gao C, Yao R, Zhang Z, Wu M, Zhang S and Su J 2013. Susceptibility baseline and Chlorantraniliprole resistance monitoring in *Chilo suppressalis* (Lepidoptera: Pyralidae). *Journal of Economic Entomology* **106**: 2190-2194.

Nozad-Bonab Z, Hejazi MJ, Iranipour S, Arzanlou M and Biondi A 2021. Lethal and sublethal effects of synthetic and bio-insecticides on *Trichogramma brassicae* parasitizing *Tuta absoluta*. *Plos one* **16**: e0243334.

Rahman MT, Khalequzzaman M and Khan MAR. 2004. Assessment of infestation and yield loss by stem borers on variety of rice. *Journal of Asia-Pacific Entomology* **7**: 89-95.

Richardson EB, Troczka BJ, Gutbrod O, Davies TGE and Nauen R 2020. Diamide resistance: 10 years of lessons from lepidopteran pests. *Journal of Pest Science* **93**: 911–928.

Schneider-Orelli O 1947. Entomologisches Praktikum: Einführung in die land- und forstwirtschaftliche Insektenkunde. Sauerländer Aarau, Germany.

Ullah MJ and Tuhin IJ 2018. Response of local and modern T-aman rice varieties to drought stress. *Journal of Experimental Biosciences* **9**: 21-26.