Pakistan J. Zool., vol. 45(4), pp. 929-933, 2013

Efficacy and Economics of Different Insecticides Against Stem Borers, *Scirpophaga incertulas* (Walker) in Rice Crop

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Abstract.- The present study on the efficacy of insecticides in reducing the infestation of rice stem borer, *Scirpophaga incertulas* (Walker) was conducted during 2008. The seed of rice (Cv. IRRI-6) was sown in the fourth week of June and transplanted in the fourth week of July. The distance between row to row and plant to plant was maintained at 20cm. The experiment had fourth treatments replicated four times in Randomized Complete Block Design. Pretreatment observation was taken 24 hrs before application of insecticides. At the time of harvest the number of filled grains and yield was recorded. The results obtained indicated that application of insecticides significantly ($P<0.05$) reduced the infestation of rice stem borer in rice crop compared with control treatment. After second application cartap hydrochloride was found most effective insecticide with the minimum percent infestation (4.37%) followed by carbofuran (7.08%), fipronil (8.68%) and control (38.53%). Application of insecticides also significantly ($P<0.01$) increased the filling of rice grain and yield of rice crop. The maximum cost: benefit ratio of 1: 50.3 was obtained with application of cartap hydrochloride followed by carbofuran (1: 26.45) and fipronil (1: 24.24).

Key words: *Oryza sativa*, pesticide, Lepidoptera.

INTRODUCTION

Rice, *Oryza sativa* L. is the second most important foreign exchange earning crop after cotton in Pakistan (Shafique and Ashraf, 2007). The rice export increased manifold during the recent years and a record export of 3.3 million tones, worth about Rs. 70 billion was made during 2005-2006. The country ranks 14th in terms of rice production and 6th in rice export to the world. In Pakistan, rice is grown under diverse climatic and edaphic conditions. There are two major rice growing regions in Pakistan. One of them includes Larkana and Jacobabad districts of Sindh and the adjoint district of Nasirabad of Balochistan. The other is located in North Eastern Punjab and comprises Gujranwala, Sheikhupura and Sialkot (PARC, 2006).

Amongst various constraints for good rice production, insect pests are very important. The hot and humid environment in which rice is grown is very conductive for proliferation of insects. The rice plant is attacked by more than 100 species of insects, 20 of them can cause serious economic loss (Pathak, 1977). Together they infest all parts of the plant at all growth stages. The major insect pests that cause significant yield losses are stem borer and defoliator species. The stem borers are generally considered the most serious pests of rice worldwide and are responsible for significant losses. The yellow stem borer, *Scirpophaga incertulas* is widely distributed throughout south and Southeast Asia including Pakistan (Pathak and Sexena, 1980; Mahar *et al*., 1985; Salim and Masih, 1987; Abro *et al*., 2003) and is the most destructive pest of rice crop in Sindh (Mahar *et al*., 1985).

Dead heart is produced when the insect attacks at vegetative stage, while white heads occur when the rice stem borer attack at the time of ear development (Mahmmod-ur-Rahman *et al.*, 2007). The larvae of rice stem borers, after hatching, bore into the stem of rice plant and cut out the food supply to the upper part of the affected stem, while rice plant compensates low percentage of dead hearts, but 1-3% loss of yield is expected for every percent of white ear head (Pathak *et al.*,

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0030-9923/2013/0004-0929 $ 8.00/0

1971).Yellow stem borer, *S. incertulas* is responsible for an annual loss of 10-15% of rice crop with local catastrophic outbreaks causing up to 60% damage (Catling and Islam, 1981; Daryaei, 2005). The larval stage of stem borers mostly remain concealed inside the stem and is difficult to control.

Pesticides are commonly used to manage rice pests. Use of insecticides has positive impact on rice production (Misra and Parida, 2004). Rice production is linearly correlated with insecticide use in rice. Application of insecticide (Padan) increased the paddy yield of Basmati-385 by 42.6 to 54.5% over control and cost benefit ratio of 1:7 to 1:14 was obtained (Khan *et al*., 2010). Since rice borers cause heavy loss to rice crop, therefore, present studies were conducted to evaluate efficacy of different insecticides against stem borers. The results of studies will provide information to the farming community for effective control of stem bores of rice in Sindh, Pakistan.

MATERIALS AND METHODS

The experiment was conducted in the experimental area of Rice Research Institute Dokri, during the year 2008, to determine the comparative efficacy of different insecticides against stem borer in rice crop. The seed (cv. IRRI-6) was sown on 21-06-2008 and the crop was transplanted in field on 20-07-2008. The distance between row to row and plant to plant was 20 cm. The agronomic practices were carried out as usual. All the insecticides used in this study were obtained from the local market in the sealed condition. The recommended doses of granular insecticides were weighed on electronic balance, the recommended dose of (Regent 4.95 EC) was measured with auto filler pipette and mixed with 250g of urea and broadcasted to the assigned plots uniformly. The design of experiment was Randomized Complete Block Design (RCBD) with four replications and four treatments. The size of each treatment was 9x9 meters. The insecticides used were: Cartap hydrochloride (Hoopoe 4G® applied @ 9kg/acre; Carbofuran (Furadan 3G® applied @ 8kg/acre); Fipronil (Regent 4.95EC® applied @ 480ml/acre) and control.

Pre-treatment observation was taken 24 hours before the application of insecticides which was 35 days after transplantation of crop. At that time infestation had began and dead hearts were seen in some hills. The post treatment observation was taken 10 days after the application of insecticides and dead hearts were counted. At that time egg masses of stem borer were also seen on green leaves of rice crop. Second application of insecticide was made after 20 days of first application.

There were 25 lines per treatment, seven lines on each side were left as buffer and observations were taken from the inner lines of treatment to avoid the drifting effect of pesticides. Ten hills were observed per treatment, selected at random and dead hearts were counted. Before the harvest of crop, white ear heads were also counted in the same manner. Similarly, at the time of harvest 10 hills were selected at random and the grain of 10 tillers from each hill was counted and the numbers of filled and unfilled grain were recorded. The yield data were recorded from one square meter (25 plants) area of the crop per treatment, selected at random. All the data recorded were subjected to analysis of variance and means were compared by LSD test.

RESULTS

Infestation of hills

Application of insecticides was effective in decreasing the infestation of rice stem borer, *S. incertulas* in rice. The infestation of rice hills was significantly reduced after first ($F= 5.999$; $DF = 3,9$; $P<0.05$) and second ($F= 5.74$, $DF= 3,9$; $P<0.05$) application of insecticides. The level of infestation was similar in insecticide applied treatments, which was 72.5% compared with 92.5% in control treatment after first application of insecticides. Infestation of rice stem borer decreased after second application and minimum infestation (67.5%) was recorded in cartap hydrochloride and carbofuran applied treatments followed by fipronil (77.5%) and control (92.5%) (Table I).

Infestation of tillers (dead hearts)

Insecticides significantly decreased the infestation of tillers after first ($F= 13.958$, $DF=3, 9$, $P<0.01$) and second ($F = 136.87$, $DF= 3,9$, $P<0.01$)

application of insecticides. After first application the minimum infestation (7.05%) was recorded in cartap hydrochloride applied treatment, followed by fipronil (8.17%), and carbofuran (8.45%) compared with control (13.94%). Second application of insecticides decreased the infestation of rice stem borer in rice crop. The minimum (4.37%) infestation of tillers was recorded in Cartap hydrochloride applied treatment followed by carbofuran (7.08%) and fipronil (8.68%) compared with control (38.53%) (Table I).

Table I.- Infestation (%) of rice hills and tillers after application of insecticides.

Treatment	First application		Second application	
	Hills	Tillars	Hills	Tillars
$T_{1=}$ Cartap hydrochloride 4G	72.5± 9.57 a	7.05± 1.00 a	67.5± 9.57 a	4.37± 3.79 a
T2= Carbofuran3G	72.5± 9.57 a	8.45± 1.61 a	67.5± 9.57 a	7.08± 1.40 a
T3= Fipronil4.95EC	72.5± 9.57 a	8.17± 1.66 a	77.5± 9.57 a	8.68± 0.72 a
T_4 =Control	92.5± 5.00 b	13.94± 1.85b	92.5± 5.00 b	38.53± 4.31b

Mean ± SD followed by same letters are not significantly (P<0.05) different from each other by LSD method.

Table II.- Percent white ear heads and grain filling in rice after application of insecticides.

Treatments	White earheads	Grain filling
T_1 Cartap hydrochloride 4G	1.00 ± 0.10 a	98.71 ± 0.19 c
T_2 Carbofuran3G	1.98 ± 0.53 b	98.15 ± 0.29 b
T_3 Fipronil 4.95EC	2.35 ± 0.71 b	97.98 ± 0.21 b
T_4 Control	8.18 ± 0.13 c	95.14 ± 0.37 a

Mean ± SD followed by same letters are not significantly (P<0.05) different from each other by LSD method.

Filled rice grains

Application of insecticides affected the filling of rice grains in rice crop. There was significant (F=148.84; DF= 3, 9, P<0.01) effect of application of insecticides on filling of rice grains. The maximum (98.7%) grains were filled in cartap hydrochloride applied treatment compared with other treatments and control (Table II).

Application of insecticides reduced the white ear heads in rice significantly (F = 234.98; DF= 3,9, P<0.01). The minimum white ear heads (1%) were observed in cartap hydrochloride applied plot, followed by carbofuran (1.98 %) and fipronil (2.35%) compared with control (8.18%) (Table II).

Yield

The maximum yield was obtained from rice crop treated with cartap hydrochloride followed by carbofuran and fipronil (Table III). Application of insecticides significantly (F= 42.686, DF=3, 9, P<0.01) increased yield compared with control treatment. The maximum cost: benefit ratio of 1: 50.3 was obtained with application of cartap hydrochloride followed by carbofuran (1: 26.45) and fipronil (1: 24.24) (Table IV).

Table III.- Yield of rice crop/m^2 and acre in kgs after application of insecticides.

Treatments	Yield of rice (kgs/m^2)	Yield per acre (kgs) (Fresh weight)	Adjusted weight *Kgs/ acre
T_1=Cartap hydrochloride 4G	2.22 ± 0.25 c	89001±1039.2	5663.6
T_2 =Carbofuran3G	1.67 ± 0.11 b	6700 ± 476.1	4263.6
T_3 =Fipronil 4.95EC	1.56 ± 0.12 b	6250 ± 500	3977.3
T_4 =Control	0.77 ± 0.13 a	3100 ± 458	1972.7

Mean ± SD followed by same letters are not significantly (P<0.05) different from each other by LSD method

* Since freshly harvested grain contains approximately 22% moisture, whereas, normally dry grain has moisture content of 14%; therefore, yield was adjusted according to the following formula:

$$\frac{\text{Fresh yield x dry grain moisture}}{\text{Fresh grain moisture}} = \frac{8900 \times 14}{22} = 5663.6 \text{ kgs}$$

DISCUSSION

Rice stem borer is serious pest of rice causing more than 38% infestation of rice tillers. Application of insecticides significantly reduced the infestation of stem borers in rice crop, and cartap hydrochloride significantly increased the filling of rice grains and increased the yield of rice crop compared with other insecticides.

There are many studies reported in literature on the effect of insecticides in reducing infestation

Table IV.- Cost benefit analysis.

Treatments	Cost per acre (Rs)	Yield (kg)	Yield (Maunds)	Increase in yield over control (Maunds)	Value (Rs)	Cost: benefit ratio
T_1 = Cartap hydrochloride 4G	1100	5663.6	141.6	92.3	55380.0	1: 50.3
T_2 = Carbofuran3G	1300	4263.6	106.6	57.3	34380.0	1: 26.45
T_3 = Fipronil 4.95EC	1240	3977.3	99.4	50.1	30060.0	1: 24.24
T_4 = Control	-	1972.7	49.3	-	-	-

Means followed by same letters are not significantly (P<0.05) different from each other by LSD method.

of rice stem borer. Karthikeyan and Purushothaman (2000) reported application of carbosulfan significantly reduced dead hearts caused by rice stem borer, *S. incertulas* in rice crop and increased the yield. Rath (2001) determined efficacy of insecticides against rice stem borer and observed that performance of fipronil was at par with carbofuran granules. Wakil *et al*. (2001) evaluated the efficacy of five different Lorsban (chlorpyrifos), Decis-D (deltamethrin+dimethoate), Nurelle-D (cypermethrin+chlorpyrifos), Thimet (phorate) and Furadan (carbofuran)) as sprayable and granular insecticides in controlling rice stem borer and leaf folder on the rice variety Basmati-385. Furadan granular application proved to be the best in controlling the attack of stem borer and leaf folder as well as better yield per acre, while among sprayable insecticides, Nurelle-D proved better for the control of these pests. The Furadan application gave the maximum yield of 1527 kg/acre with cost benefit ratio of 1:6.67. Salijoqi *et al*. (2002) determined efficacy of fipronil and other insecticides against rice stem borer and found that cartap hydrochloride was most effective in reducing rice stem borer infestation followed by fipronil and carbofuran. The highest yield (tones ha^{-1}) was obtained from Padan 4G treated plots, followed by Regent 300 EC; Regent 300 EC mixed with fertilizer and Furadan 3G compared to untreated plots. Jena (2004) tested four new insecticides, imidacloprid, ethofenprox [etofenprox], fipronil (at 0.01%) and carbosulfan (at 0.02%), as seedling root dip treatment against the yellow stem borer, *S. incertulas* along with chlorpyrifos. Fipronil was found promising in controlling the pest as well as increasing rice grain yield. Imidacloprid and carbofuran were next in the order of effectiveness.

The highest yield increase was also recorded for cartap hydrochloride followed by fipromil and carbofuran treated plots. Panda *et al.* (2004) evaluated fipronil at various dose levels against rice stem borer and observed that its application significantly reduced dead hearts and produced more tillers and higher grain yields. Prasad *et al.* (2005, 2007) determined efficacy of insecticides in controlling rice stem borer and found that cartap hydrochloride followed by chlorpyriphos, fipronil and carbofuran were most effective in controlling stem borer infestation and increasing crop yield. Crop yield (24.39 quintals ha^{-1}) was highest with fipronil 0.4 G at 0.075 kg a.i. ha^{-1}. The economic analysis of different insecticidal treatments indicated that chlorpyrifos 10 G at 0.75 kg a.i. ha^{-1}, with an average marginal benefit cost ratio of 4.07 was most effective and economically profitable against yellow stem borer. Mahal *et al*. (2006) reported that integration of one application of cartap hydrochloride 4G at 1.0 kg a.i. ha^{-1} 30 days after transplanting with weekly tagging of Tricho cards *Trichogramma chilonis* (Ishii) and *T. japonicum* Ashmead at 20000 /0.4 ha each during the crop season was the most effective approach in reducing the leaf folder and stem borer incidence. It gave higher grain yield than the untreated control and non-IPM farmers' fields and also showed maximum cost benefit ratio (1:5.08) as against the recommended three applications of cartap hydrochloride 4G (1:1.81).

The results obtained indicated that application of insecticides significantly (P<0.05) reduced the infestation of rice stem borer in rice crop compared with control treatment. After second application cartap hydrochloride was found most effective insecticide with the minimum percent infestation

(4.37%) followed by carbofuran (7.08%), fipronil (8.68%) and control (38.53%). Application of insecticides also significantly ($P<0.01$) increased the filling of rice grain and increased the yield of rice crop.

Cartap hydrochloride (Hoopoe) was comparatively better insecticide which significantly reduced rice stem borer infestation and increased rice yield compared with other insecticides.

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(Received 1 December 2012, revised 15 May 2013)