INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 15, No. 2, p. 88-94, 2019
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Response of rice cultivars and insecticides against Rice stem borer (*Scirpophaga incertulus*) in Pakistan (Swat)

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Article published on August 30, 2019

Key words: Pakistan, Insecticides, Infestation, Rice varieties, Rice crops

Abstract

Rice is amongst the most vital food crops that provide an essential food for approximately half of the world's population. Rice crops are disposed to both biotic and abiotic stresses. Biotic stresses contain insect pests, fungus and herbicide toxicity. This study was conducted at Agricultural Research Institute (North) Mingora Swat, Khyber Pakhtun Khwa (Pakistan) in 2014 to determine the toxicity of Karate (Lambda Cyhlothrin 2.5g/l), Lorsban (Chlorpyrifos 500g/l), Talstar (Bifentnthrin 100g/l), Lannate (Methomyl 225g/l). Curacron (Profenofos 500g/l) were applied to rice varieties (*Oryza sativa)*, Basmati-385, JP-5, Fakhr-e-Malakand, Swat-1 and Dilrosh against rice stem borer, (*Scirpophaga incertulas*) and their effect on yield per hectare. In this study, the most resistant rice cultivar and effective insecticide against rice stem borer were investigated. Talstar Super resulted in to highest ranked in their efficacy against rice stem borer; as (3.7%) dead hearts while (7.5%) white hearts was recorded, which is significantly ($P < 0.05$) lower than control. Talstar with (52.71%) infestation was the most effective insecticide against rice stem borer followed by karate with (44.04%), Lorsbon (42.24%) and Lannate (41.70%). The lowest biological efficacy was recorded for Curacon (10.17%) significantly lower ($P < 0.05$) than the other tested varieties. The result also displayed the resistance of Swat-1, Basmiti-385 and Dilrosh to rice stem borer. This study made clear the Basmati-385 was the most susceptible variety against rice stem borer with lowest yield, JP-5 with (1688.3kg/ha) ranked first.

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Introduction

Rice is regarded as 2nd most essential food crop of Pakistan supporting food security for 50% of the global population. Worldwide, Approximately 90% of the land is rice cultivable in Asia, and about 2.5 billion people depends mainly on rice as main food source. Globally, per hectare yield of rice is lower in Pakistan as compared to other major rice producing countries. Improper management and damages by the pest insects are considered as one of the major causes of low yield generation of rice in Pakistan (Iram *et al.*, 2003, Jahn *et al.*, 2006). The abiotic factors proficiently implicate in the occurrences of pest, climatic factors and overindulge of insecticides application (Jahn *et al.*, 2005). Totally, 128 species of insects are in consideration of crop damage Out of these, 15 to 20 insect species are verified to economically important. Stem borers (SBs) are considered as crucial group of insect pests of rice. Rice stem borer (*Scirpophaga incertulas*) is known as monophagous rice pest. The destruction of the rising panicle subsequent in 'white head" signs causes by the larval Infestation during the reproductive growth period of rice. The larvae matures and then pupates after entering inside the stem via boring or tunneling. The damage due to rice borers increasing every year (Jiang *et al.*, 2005). Annually, around 25-30% yield loss owing to the stem borers in Pakistan (Inayatullah *et al.*, 1986). Stem borers consume comprehensive meta-morphisms.

The application of diverse insecticides of newer products is commonly used for conservatively control of rice stem borer (Khan and Khaliq, 1989). Nevertheless, In Pakistan, pests are controlled by granular and foliar formulations in the field. These synthetic insecticide chemicals can have wide spread environmental hazards as well as repeated insect pest recovery have developed resistance in insects with time. In spite of that, synthetic insecticides are still the most trusted way to control rice stem borer incidence (Bashir *et al.*, 2004). However, safe procedures to avoid these insecticides are emerging crops with its own resistant system against these insects (Ahmad *et al.*, 2011). Screening of rice germplasm with resistance capabilities and then injecting these properties into other commercial used varieties via sexual hybridization can attain these crops. Integrated pesticide management required the identification of such resistant genotype crops. In comparison to the non-resistant cultivars, less insect pests attack the plants, and more insecticidal application are imply to these resistant crops (Khan *et al.*, 2005). Insecticidal application along with natural varietal resistance of rice within proper scientific methods has been widely used globally for different insect attacks control and showed marked significance in rice production. As far research work on rice stem borer in Khyber Pakhtunkhwa is concerned, still scientific research is needed. Keeping in view the importance of rice and its infestation due to stem borer disease, the present research work was initiated with the following objectives.

- To determine the most effective insecticide against rice stem borer and rice leaf folder.
- To evaluate the performance of different rice varieties against rice stem borer and rice leaf folder.

Materials and methods

Study area

Field experiment were conducted on the response of five cultivars of rice and five different insecticides against rice stem borer at Agriculture Research Institute (N) Mingora Swat in 2014 (Table 1).

Table 1. Variety Code and rice varieties in study plot.

S. No	Variety code	Rice variety
1	V1	Basmati-385
2	V2	JP-5
3	V3	Fakhr-e-Malakand
4	V4	Swat-1
5	V5	Dilrosh

Plot size

The 35-days old nursery of the variety was transplanted in plots of 4 x 6m². Distance between rows were 25cm. The experiments were laid out in randomized complete block design (RCBD) with two factors factorial design.

Investigated rice varieties and insecticides

For varietal Screening and insecticides evaluation against rice stem borer, seeds of the five varieties of

rice were obtained from rice section of Agricultural Research Institute (N) Swat. The insecticides were applied twice i.e. 25 days and 55 days interval after transplantation. Timely the insecticides were applied with 25 days (15th July) and 55 (15th August) day of transplantation. The following insecticides were applied to these varieties for analysis of stem borer infestation (Table 2).

Table 2. Common and trade names along with codes of various insecticides treatments.

S. No	Treatments	Trade Name	Common Name	Chemical Group	Dose
1	T1	Karate	Lambda-cyhalothrin	Pyrethroid	150ml /ha
2	T2	Lorsban	Chlorpyrifos	Organophosphate	150ml /ha
3	T3	Talstar	Bifenthrin	Pyrethroid	75g /ha
4	T4	Lannate	Methomyl	Carbomate	300g /acre
5	T5	Curacron	Profenofos	Organophosphate	250g /ha

Data collection, calculation and monitoring

The density of rice stem borer adults were monitored through installing light traps. The trap data was taken on weekly basis. Five plants were randomly selected from each plot and data damage percent of rice plants on the following parameters described below was studied (Table 3).

Table 3. Parameters and date of collection of data.

S. No	Parameter	Date
1	Healthy tiller + dead hearts	26 July, 2014
2	Healthy tiller + dead hearts	11 August, 2014
3	Healthy tiller + dead hearts	26 August, 2014
4	Healthy panicles + white heads	1 September, 2014
5	Healthy panicles + white heads	8 September, 2014

The data thus recorded and were converted into their respective parameters percentage by the following formula. Dead hearts (DH) percentage after booting stage:

$$DH\% = \frac{\text{No. of dead hearts}}{\text{Total No. of Tillers.}} \times 100$$

White heads percentage after milking stage,

$$WH\% = \frac{\text{No. of white heads}}{\text{Total No. of tillers with panicles .}} \times 100$$

First application of insecticides was on 27th July, 2014, followed by second application on 23rd August, 2014. All treatments were replicated four times. Biological efficacy the used treatment against rice stem borer was calculated through the following formula. By using Abbot Equation Percent (%) decrease over control = A-B/A x 100, A= White and dead hearts in control plot, B= White and dead hearts in treated plot. Yield data was recorded grains weight in gram, and further grain per plot were then converted intokg/ha.

Results and discussion

Varietal Resistance

Varietal resistance of different varieties to rice stem borers was investigated with no chemical addition. Results showed that the highest portion of dead hearts was noted in Fakhr-e-Malakand, whereas the lowest was found in Basmati-385 and Dilrosh (15.33%) (Table 4). In case of white head percent, the highest number was observed in Dilrosh (24.4%), while the minimum was of white head was registered in Basmati-385 (19.9%) (Table 4).

Table 4. Mean percent dead hearts and white head in different varieties of rice cultivars.

S. No	Varieties	Dead Hearts (%)	White Head (%)	Mean
1	Basmati-385	15.33	19.9	17.62
2	JP-5	16.27	22	19.14
3	Fakhr-e-Malakand	17.33	22.8	20.07
4	Swat-1	15.47	22.6	19.04
5	Dilrosh	15.33	24.4	19.87
Mean		15.95b	22.34a	

The result reveals the lowest mean dead hearts were recorded in plot treated with Talstar (0.6), similar with treatment Lannate (1.3) and Karate (1.3), which showed a significant difference with rest of treatments (Table 4.1). The highest dead hearts were recorded in Control plot (3.1) followed by Curacron (2.4) and Lorsban (1.6). Data depicted in table 4.1 showed that the lowest mean dead hearts was recorded in variety

JP-5 (1.0) which was statistically at par with variety Swat-1(1.3) and significant from remaining varieties. These are then followed by variety Basmati-385(1.8), Dilrosh (1.8) and Fakhr-e-Malakand (2.5).

Table 4.1. Mean stem borer infestation, dead hearts (DH) in various rice cultivars after application of different insecticides application (26 July, 2014).

Insecticides	Varieties					Mean dead hearts
	Basmati-385	Fakhr-e-Malakand	Swat-1	Dilrosh	JP-5	
Karate	0.8	1.8	1.0	2.3	0.8	1.3 bc
Lorsban	1.3	2.5	1.0	2.3	1.0	1.6 b
Lannate	2.5	1.8	1.0	1.0	0.3	1.3 bc
Curacron	2.3	4.0	2.0	2.5	1.3	2.4 a
Talstar	0.3	1.3	0.5	0.5	0.5	0.6 c
Control	3.8	4.0	2.5	2.5	2.5	3.1 a
Means	1.8 b	2.5 a	1.3 bc	1.8 b	1.0 c	

Treated Plots

Five insecticides namely karate. Lorsban, Lannate, Talstar and Curacron, were applied. The five rice varieties were Basmati-385, Fakhr-e-Malakand, Swat-1, Dilrosh and JP-5. The table 4.1 represent the following results of data taken on 26th July 2014.

Comparison of varieties and insecticides results

Data presented in table 4.2 showed the highest dead hearts were noted in Control plot (3.6) followed by Curacron (3.3) and Lorsban (2.3), and lowest dead hearts in plot treated with Talstar (1.5) was statistically similar with Lannate (2.2) and Karate treatment (2.2). The result reveals the lowest mean dead hearts was observed in variety JP-5 (1.7) which was statistically at par with variety Swat-1(2.3), followed by variety Basmati-385(2.7), Dilrosh (2.7) and Fakhre-Malakand (3.1) (Table 4.2). It is reported that chemical against infestation with mix treatment including chemical and bioactive compounds can highly be effective against the infested disease which is considerable accepted as first decrease in environmental pollution and second the bioactive may also be related to specific system that enhance the yield of that particular sample.

Table 4.2. Mean rice stem borer infestation and dead hearts (DH) in various rice cultivars after different insecticides application (11 August, 2014).

Insecticides	Varieties					Mean dead hearts (DH)
	Basmati-385	Fakhr-e-Malakand	Swat-1	Dilrosh	JP-5	
Karate	2.8	2.5	2.3	2.3	1.0	2.2bc
Lorsban	2.3	3.0	1.5	3.0	1.5	2.3 b
Lannate	3.0	3.5	1.5	2.0	1.0	2.2bc
Curacron	4.0	3.8	3.0	3.3	2.3	3.3a
Talstar	1.3	2.5	1.3	1.5	1.0	1.5c
Control	3.0	3.5	4.3	4.0	3.3	3.6a
Means	2.7 ab	3.1 a	2.3 bc	2.7ab	1.7c	

The lowest dead hearts were observed in plot treated with Talstar (2.5) followed by Curacron (2.7). The mean infestation under karate was found to be (2.8) and in Lorsban (2.9) followed by Lannate (3.0) (Table 4.3). The highest dead hearts were recorded in Control plot (4.4) that was free from chemicals. Data in table 4.3 further illustrated that the lowest mean dead hearts was recorded in variety JP-5 (1.9) followed by variety Dilrosh (3.1). The mean infestation in variety swat-1 was found to be (3.3) the highest infestation was recorded in variety Fakhr-E- Malakand that was (3.7). The interaction of Varieties and Insecticides was found non-significant. The infestation recorded in Bsmati-385 was found to be (3.1).

Effects of different insecticides on rice stem borer infestation

Data pertaining to the borer infestation is depicted in table 4.4. Statistical analysis of the data showed that the lowest white heads were recorded in plot treated

with Talstar (3.2). The infestation in plots karate and Lannate were found statistically similar (3.3), followed by Lorsban (3.4). The infestation in plot treated with Curacron was found (4.3). The highest infestation caused by rice stem borer was recorded in control plot that was (5.4). Data in Table 4.4 also confirmed that the lowest mean white heads were recorded in variety JP-5 (2.4) followed by swat-1, Fakhr-e-Malakand and Dilrosh (3.7) and (4.6) while the highest infestation was recorded in Basmati-385 that was (4.3). Statistical analysis of the data showed that interaction between varieties and insecticides (V x I) was recorded non-significant. Our results Support previous studies, demonstrate the expression of insecticides resistance rice varieties that can provide season-long protection from the natural infestation of insect pests. The present study observed significant reduction in infestation of the rice stem borer disease in first trail of insecticide, which increased in the second trail. Moreover, the insecticides application had also increased significantly filling of rice grain and rice yield.

Data presented in table 4.5 disclosed the mean white heads occurrence. Statistical analysis of the data confirmed that lowest white heads were recorded in plot treated with Talstar (5.3). The infestation in plots sprayed with Lorsban was found (5.8), followed by karate (5.9). While in those plots treated with chemical Lannate showed 6.4 mean infestations. Highest infestation (11.2) was recorded in control plot in which no chemicals were applied. The lowest mean white head were recorded in variety JP-5 (6.0) followed by variety Basmati-385 (6.9). Statistical analysis of the parameters showed that the mean infestation in variety Dilrosh was found to be followed by Swat-1. While the highest infestation was recorded in variety Fakhr-E- Malakand that was (Table 4.5). Previous studies determine the effect of insecticides on egg parasitoid of yellow stem borer of rice crop, considered combine application of insecticides as control strategy IPM program to give higher and efficient parasitism for YSB egg parasitoids.

Table 4.4. Mean rice stem borer infestation and white head in various rice cultivars after different insecticides application (1 September, 2014).

Insecticides	Varieties					Mean white heads
	Basmati-385	Fakhr-e-Malakand	Swat-1	Dilrosh	JP-5	
Karate	2.8	3.8	4.0	3.3	2.5	3.3b
Lorsban	4.0	3.3	2.8	6.0	0.8	3.4b
Lannate	4.0	3.8	5.0	2.8	1.0	3.3b
Curacron	4.5	5.3	4.0	5.8	2.0	4.3ab
Talstar	4.5	1.8	2.0	3.8	3.8	3.2b
Control	6.3	5.8	4.5	6.3	4.3	5.4a
Means	4.3a	3.9a	3.7ab	4.6a	2.4b	

Table 4.5. Mean rice stem borer infestation and white head in various rice cultivars after different insecticides application (8 September, 2014).

Insecticides	Varieties					Mean white heads
	Basmati-385	Fakhr-e-Malakand	Swat-1	Dilrosh	JP-5	
Karate	5.3	8.5	7.0	4.8	4.0	5.9b
Lorsban	6.0	9.0	3.8	4.8	5.5	5.8b
Lannate	7.0	5.8	8.5	6.0	4.5	6.4b
Curacron	7.5	4.0	9.8	9.5	5.5	7.3b
Talstar	6.3	7.0	3.8	5.8	3.8	5.3b
Control	9.3	10.5	11.8	12.0	12.5	11.2a
Means	6.9a	7.5a	7.4a	7.1 ba	6.0a	

Effects of rice varieties and insecticides on mean yield

Table 4.6 showed that in variety Basmati-385 the insecticide Talstar was found effective and gives significantly highest mean yield of (2326.4kg/hac) followed by Karate (1934.8kg/hac), Lannate (1844.8kg/hac), Lorsban (1834.8kg/ha) and Curacron (1794.8kg/ha). Significantly lowest mean yield was recorded in control plot (1335.8kg /ha). Similarly in variety Fakhr-e-Malakand the insecticide Talstar was found effective and gives significantly highest mean

yield of (2323.3kg/hac) followed by Karate (2070.0kg/hac), Lorsban (2061.8kg/ha), Lannate (1910.4kg/hac), and Curacron (1747.3kg/ha). Significantly lowest mean yield was recorded in control plot (1424.0kg/ha). The mean yield of Karate and Lorsban were significantly similar but significantly different from Talstar and control plot. In variety Swat-1 the insecticide Talstar was found effective and gives significantly highest mean yield of (2126.3kg/hac) followed by Karate (1876.7kg/hac), Lorsban (1722.8kg/ha), Curacron (1722.5kg/hac), and Lannnate (1702.4kg/ha). Significantly lowest mean yield was recorded in control plot (1422.0kg /ha). The mean yield of Karate and Lorsban were significantly similar but significantly different from Talstar and control plot. In variety JP-5 the insecticide Talstar was found effective and gives significantly highest mean yield of (2478.0kg/hac) followed by Karate (2132.5kg/hac), Lorsban (2166.8kg/ha), Lannate (2027.3kg/hac), and Curacron (1877.3kg/ha). Significantly lowest mean yield was recorded in control plot (1688.3kg /ha). In variety Dilrosh-97 the highest mean yield was found in plot Talstar (2415.6kg/ha), followed by Curacron (2253.3kg/ha). The mean yield of Lorsban, Lannate and karate was recorded (1911.3kg/ha), (1733.3) and (1620.0kg/ha) respectively. The lowest mean yield was recorded in control plot (1394.3kg/ha) in which no chemicals were applied. Data present in table 4.6 also illustrate the overall mean of rice varieties. The highest overall yield mean was recorded in Talstar (2333.9) followed by Lorsban (1929.5kg/ha), Karate (1926.8kg/ha), Curacron (1879.0kg/ha) and Lannate (1843.6kg/ha). The lowest overall mean of yield was recorded in control plot (1452.9kg/ha). The overall mean yield of all varieties were similar and significantly different from those plots in which Talstar was applied. These results are in line with (Bux *et al*., 2013), who reported that lowest grain yield was found in plots where no chemical applied. The rest of rice genotypes were intermediate in tolerance or susceptibility to the attack of stem borers. In case of varieties JP-5 produced the higher grain yield of rice followed by Swat-1, Basmati-385, and Dilrosh, while lower grain yield of rice was recorded in Fakhr-e- Malakand.

Table 4.6. Effect of different insecticides on the mean yield (kg/hac) of various varieties of Rice.

Treatments	Basmati-385	Fakhr-e-Malakand	Swat-1	JP-5	Dilrosh-97	Mean
Karate	1934.8 b	2070.0 b	1876.7 b	2132.5 b	1620.0 bc	1926.8 b
Lorsban	1834.8 b	2061.8 b	1722.8 bc	2116.8 b	1911.3 b	1929.5 b
Curacron	1794.8 b	1747.3 c	1722.5 bc	1877.3 cd	2253.3 a	1879.0 b
Lannate	1844.8 b	1910.4 bc	1702.4 c	2027.3 bc	1733.3 b	1843.6 b
Talstar	2326.4 a	2323.3 a	2126.3 a	2478.0 a	2415.6 a	2333.9 a
Control	1335.8 c	1424.0 d	1422.0 d	1688.3 d	1394.3 c	1452.9 c
LSD	384.5	250.37	172.12	215.15	329.54	184.78

Effects of different insecticides on biological efficacy

Data consisting in table.4.7 shows illustrate the percent biological efficacy of different treatments applied karate, Lorsban, Lannae, Curcorn, Talstar, Means table of the data were calculated and manipulated for result. Plots received chemical Talstar showed highest (52.71%) biological efficacy followed by Karate, Lorsbon and Lannate (44.04%), (42.24%) and (41.70%). While the lowest biological efficacy showed by Curacon (10.17%). Plots that were untreated with chemicals showed highest mean infestation of (5.54).

Table 4.7. Biological efficacy of various insecticide against rice stem borer in five different rice cultivars.

Treatments	Infestation Mean White heads +Dead hearts	Biological Efficacy (%)
Karate	3.10	44.04
Lorsban	3.20	42.24
Lannate	3.23	41.70
Curacron	3.99	27.98
Talstar	2.62	52.71
Control	5.54	

Conclusions

On the basis of above facts revealed following findings:

- Talstar have shown the most prominent results in prevention of stem borer infestation.
- The rice type, Basmati-385 variety is highly effective due to the application of insecticides. High infestation of stem borer was recorded in cultivars in control plots.
- Talstar had positive effect in yield of rice crop in all cultivars. The rice JP-5 had comparatively high production yield rate. On the basis of the results of the present study, we recommend that, Talstar should be applied to rice varieties for effective management of stem borer infestation.
- The Variety JP-5 will be recommended for cultivation in Swat area of Pakistan for higher yield and lowest stem borer infestation.

Acknowledgment

We are also thankful to all our respected teachers and dear friends for their support during Lab work in Agriculture Research Institute (N) in Mingora Swat.

Author's contribution

All authors contributed critically and equally to the draft and gave final approval for publication in the supervision of Mr. Saif Ullah, and have no any conflict of interest

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