Int. J. Agr. Ext. 11 (03) 2023. 269-274 DOI: 10.33687/ijae.011.03.4779

Available Online at EScience Press

International Journal of Agricultural Extension

ISSN: 2311-6110 (Online), 2311-8547 (Print)

https://esciencepress.net/journals/IJAE

EVALUATION OF DIFFERENT INSECTICIDES FOR THE SUPPRESSION OF RICE LEAF FOLDER AND THEIR IMPACT ON RICE YIELD UNDER FIELD CONDITION

[a]Muhammad Shahbaz*, [a]Azhar Mehmood, [a]Ghulam Farid, [b]Ahmad Nawaz, [c]Maimoona Mohiuddin, [d]Muhammad S. Kashif, [a]Muhammad T. Chaudhry, [e]Mushtaq Ali, [f]Ishtiaq Hassan, [f]Muhammad A. Ali

[a] *Directorate of agriculture (Farms Training & Adaptive Research) Sheikhupura, Pakistan.*
[b] *Pest Warning & Quality Control of Pesticides, Sheikhupura, Pakistan.*
[c] *Agriculture Extension Lahore, Pakistan.*
[d] *Agriculture Extension Faisalabad, Pakistan.*
[e] *Additional Directorate General of Agriculture (Farms and Training) Punjab, Pakistan.*
[f] *Directorate General of Agriculture (Extension & Adaptive Research) Punjab, Pakistan.*

ARTICLE INFO

Article History
Received: May 23, 2023
Revised: September 3, 2023
Accepted: October 21, 2023

Keywords
Insecticides
Rice Leaf folder
Yield
Pesticides
Fipronil
Chlorantraniliprole

ABSTRACT

The study was conducted at the Adaptive Research Farm in Sheikhupura, Punjab, Pakistan, over three crop seasons (Kharif-2020, 2021, and 2022). The goal was to assess both new and existing insecticides' effectiveness against leaf folders in rice crops. The results showed that all the experimental units treated with insecticides successfully reduced leaf folder damage and populations, with significant variations among them. Over three years, the insecticides Chlorantraniliprole, Flubendiamide, Fipronil, Gamma-cyhalothrin, and Lambda-cyhalothrin caused varying levels of pest mortality, ranging from 44.0% to 90.2%. Chlorantraniliprole had the most significant impact, with a mortality rate of 89.0% to 94.1%, followed by Flubendiamide (84.6% to 90.4%) and Fipronil (72.2% to 87.0%). Lambda-cyhalothrin had the lowest effect, with a mortality rate of 29.0% to 53.5% over the control treatment across all three years. The application of insecticides significantly improved grain yield, productive tillers, and paddy yield compared to the control. In terms of paddy yield, Chlorantraniliprole treatment had the highest production with yields of 4293.3, 3583.0, and 4540.0 kgha^{-1} in the years 2020, 2021, and 2022. It was followed by Flubendiamide (4166.7, 3566.7, and 4476.7 kgha^{-1}) and Fipronil (4030.3, 3483.3, and 4493.3 kgha^{-1}) for the respective years. The lowest paddy yield was observed in the check plot, with yields of 3650.0, 3200, and 3973.3 kgha^{-1} over the three consecutive crop seasons.

Corresponding Author: Muhammad Shahbaz
Email: shahbazssms2014@gmail.com

INTRODUCTION

Rice is a vital crop globally and is the second most important cereal after wheat. It's a staple food for about half of the world's population (Heinrichs *et al*., 2017). In Pakistan, fine rice varieties, particularly basmati rice, are renowned worldwide for their unique aroma. They make a substantial contribution to Pakistan's economy, accounting for 3.5% of the added value in agriculture and 0.7% of the national GDP. In 2021, Pakistan cultivated rice on 3.335 million hectares and produced 8.419 million tons (Government of Pakistan, 2021). Rice is a crucial food source for over a third of the world's

population (Murteza et al., 2008). In the realm of rice cultivation, notable and prevalent insect pests that lead to a decrease in rice harvest include white and yellow rice stem borers (*Scirpophaga incertulas* & *Scirpophaga innotata*), white-backed planthoppers (*Sogatella furcifera*), brown planthoppers (*Nilapervata lugens*), and leaf folders (*Cnaphalocrosis medinalis*). According to Vivek et al. (2009), these insects, along with gall midges, are recognized as common pests that afflict rice crops across Asia. Additionally, Heinrichs et al. (2017) have documented that more than a hundred insect species are known to target rice crops, with around twenty of them capable of inflicting substantial damage.

Among the insect pests that affect rice crops, the leaf folder stands out as a particularly concerning and significant threat due to its rapid capacity to harm the crop. Once these leaf folder larvae emerge, they can wreak havoc by folding and consuming numerous leaves, leading to substantial paddy losses, as noted by Bashir et al. (2004). In rice fields, the leaf folder larvae damage the crop by folding leaves using a sticky substance, scraping away the green leaf tissue, and leaving behind long, white, and see-through streaks on the leaf's surface. This process interferes with the plant's ability to carry out photosynthesis, ultimately resulting in reduced paddy yields. Padmavath et al. (2013) have similarly reported that rice leaf folder larvae fold the leaves and remove green tissue from within.

Leaf infestation by Cnaphalocrosis medinalis was observed at an overall rate of 25%, resulting in a significant 30% reduction in grain yield in the primary rice-growing areas of Punjab, as reported by Ahmad et al. in 2010. Similarly, Kulgagod et al. (2011) documented that rice leaf folders could lead to yield losses ranging from 5% to 25%. To combat this pest in rice fields, chemical insecticides are commonly used due to their effectiveness. However, rice growers frequently rely on traditional insecticides, which, when used regularly, have seen a decrease in their effectiveness due to the development of insecticide resistance. Additionally, the haphazard and inadequate use of these chemicals can disrupt the beneficial insect populations, including predators and parasites, within the rice fields. To manage rice pests, it is crucial to prioritize the use of selective insecticides that effectively target leaf folders while causing minimal harm to beneficial predators and parasites. Abro et al. (2013) noted that insecticides offer a fast, convenient, and cost-effective means of pest control but emphasized that their injudicious and indiscriminate use can lead to issues such as insecticide resistance, environmental contamination, residual toxicity, and harm to the beneficial fauna present in rice fields. To address these concerns, it is recommended to judiciously use insecticides with diverse modes of action, as suggested by Seni and Naik (2017), which may help mitigate the problem of insecticide resistance.

Given these circumstances, the study was designed to assess the effectiveness of both new and traditional insecticides in controlling the rice leaf folder and their subsequent effects on paddy yield across various agro-climatic conditions. Among these conditions, the Sheikhupura zone holds significance due to its unique cropping patterns and agricultural practices. This evaluation was carried out in diverse agro-climatic conditions, with a particular focus on the Sheikhupura zone, which is noteworthy for its specific crop cultivation practices and environmental factors.

MATERIALS AND METHODS

The field investigation was carried out at the Adaptive Research Farm in Sheikhupura, Punjab, Pakistan, consistently over the Kharif seasons of 2020, 2021, and 2022. During the first week of July, 30-day-old nursery plants of aromatic fine rice PK-1121 were transplanted, maintaining row spacing at 22.5 cm. Before the transplanting, essential inputs such as phosphatic, potash, and one-third of the nitrogenous fertilizers were applied. The remaining nitrogenous fertilizer was administered in two portions, first at 30 days and then at 55 days after transplanting. The plot size of 33x22 square feet was consistently upheld throughout the study period.

The experiment has six treatments including checks and is replicated thrice for each year. Treatments comprised of insecticides viz: Chlorantraniliprole, Flubendiamide, Fipronil, Gamma-cyhalothrin, and Lambda-cyhalothrin @ 50, 20, 500, 75 & 200 ml per acre were applied in respective plots against leaf folder at economic threshold level.

Information regarding the leaf folder population was gathered both before and after the application of insecticides. This data encompassed the effectiveness of the insecticides in percentage (%), the density of productive tillers per square meter (m^2), the number of grains per panicle, and the weight of one thousand grains (g). To determine paddy yield, each experimental

unit was harvested, threshed, and individually weighed, with the grain yield then converted into kilograms per hectare (kg ha^{-1}). The field was regularly monitored to assess the Economic Threshold Level (ETL) of C. medinalis, and the number of folded leaves per plant was observed. Annually, ten plants were randomly selected from each plot, and the average data regarding the number of larvae or folded leaves per plant, both before and a week after treatment application, were recorded.

The collected data underwent analysis of variance, and the means were compared using the Least Significant Difference test (LSD) at a significance level of 5%, as outlined by Steel et al. (1997). Assessments of leaf folder damage per plant and the efficacy of the insecticides in percentage were conducted using the following formulas:

$$\text{Leaf folder damage/plants} = \frac{\text{Number of damaged leaves alongwith larvae}}{\text{number of plants assessed}}$$

$$\text{Efficacy of insecticides (\%)} = \frac{C - T}{C} \text{ X } 100$$

[C= leaf folder population in control plot T= leaf folder population in the treated plot]

Percent increase in yield over control was calculated by the following equation:

$$\text{Percent yield increase/decrease} = \frac{Yt - Yc}{Yt} \text{ X } 100$$

[Yc= paddy yield in control plot Yt= paddy yield in the treated plot]

RESULTS AND DISCUSSION

The effectiveness of various insecticides in controlling rice leaf folder infestation is presented in Table 2, clearly demonstrating a significant reduction in leaf folder infestation compared to the untreated plot (control). The selected insecticides led to a substantial decrease of 90.2%, 86.0%, 80.7%, 73.0%, and 44.0% over the control on average over three years. Data collected before the application of insecticides showed leaf damage by leaf folder per plant ranging from 2.05 to 2.46, 2.30 to 2.43, and 2.03 to 2.56 during the study years in 2020, 2021, and 2022, as detailed in Table 1. This damage rate aligns with Kumar et al.'s (2010) findings of 2.37% leaf folder damage under field conditions.

Post-treatment data, collected one week after the insecticidal spray, is presented in Table 2. The results indicated that the check plot had the highest infestation of leaf folder per plant (3.0, 3.196, and 3.833), while the least damage was found in the Chlorantraniliprole treatment (0.333, 0.436, and 0.233), followed by Flubendiamide (0.466, 0.556, and 0.366), and fipronil (0.833, 0.536, and 0.50) treated plots, resulting in reduction percentages of 89.0%, 86.3%, and 94.1%, 85.0%, 82.6%, and 90.4%, and 72%, 83.0%, and 87.0% in the years 2020, 2021, and 2022, respectively. The varying levels of significance among the percent decrease over control of the tested insecticides in controlling the leaf folder agree with the findings of Wakil et al. (2001) and Bhanu et al. (2008).

Table 1. Pre-treatment data of rice leaf folder infestation per plant during the study years 2020-2022.

Treatments	Rice Leaf folder infestation per plant		
	2020	2021	2022
T_1	2.053 c	2.307	2.030 c
T_2	2.110 c	2.366	2.133 bc
T_3	2.350 ab	2.310	2.366 abc
T_4	2.216 bc	2.300	2.566 a
T_5	2.466 a	2.430	2.433 abc
T_6	2.130 bc	2.400	2.466 ab
LSD (P≤ 0.05)	0.233	NS	0.433

The data regarding yield parameters, presented in Table 3, showed significant results when compared with the check plot. The effect of insecticides on paddy yields, compared to the check, was statistically significant for the treatments under consideration for three years. The percentage increase or decrease in yield over the check is presented in Table 4, illustrating that all insecticidal treatments significantly outperformed the untreated plots. Chlorantraniliprole outperformed all treatments, yielding the highest paddy yield of 4293.3 kg ha^{-1}, which was 17.6%, 11.9%, and 14.2% higher than the check plot in 2020, 2021, and 2022, respectively. Flubendiamide

and fipronil ranked 2nd and 3rd among the tested insecticides, yielding 4166.7, 3566.7, and 4476.7 and 4030.0, 3483.3, and 4493.3 kg ha^{-1} paddy yield in three consecutive years. Over the three-year study, the highest average paddy yield of 4138.8 kg ha^{-1} was achieved with Chlorantraniliprole, followed by Flubendiamide (4077.0 kg ha^{-1}) and fipronil (4002.0 kg ha^{-1}), representing increases of 14.7%, 13.0%, and 10.9% over the control, respectively. The lowest yield, 3607.7 kgha^{-1}, was recorded in check plot. These results are consistent with Kakde et al. (2019), Soomro et al. (2020), and Karthikeyan et al. (2011), who reported that selective insecticides improved grain yield and that fipronil was particularly effective among the tested insecticides.

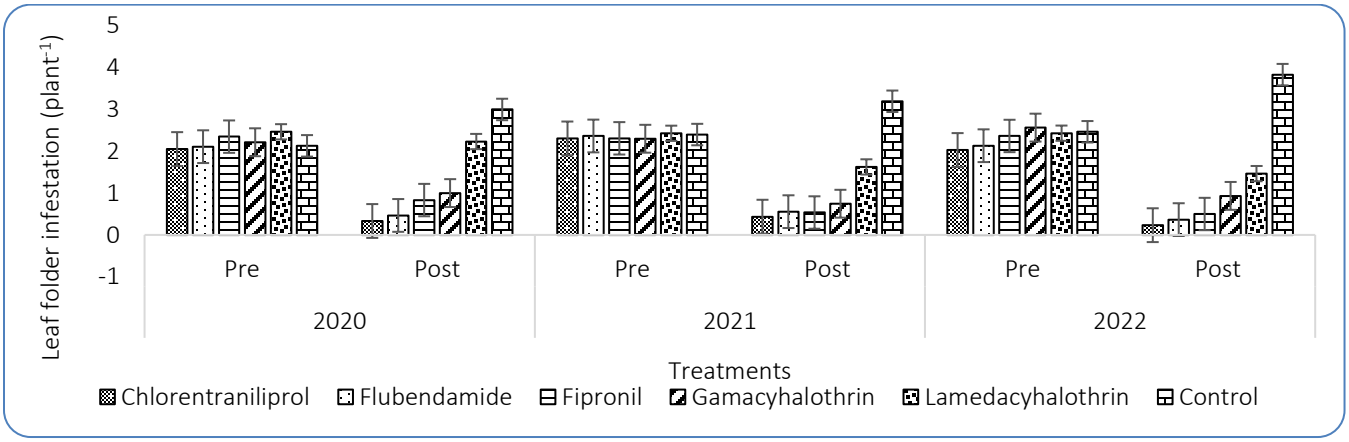

Figure 1. Leaf Folder infestation (plant^{-1}).

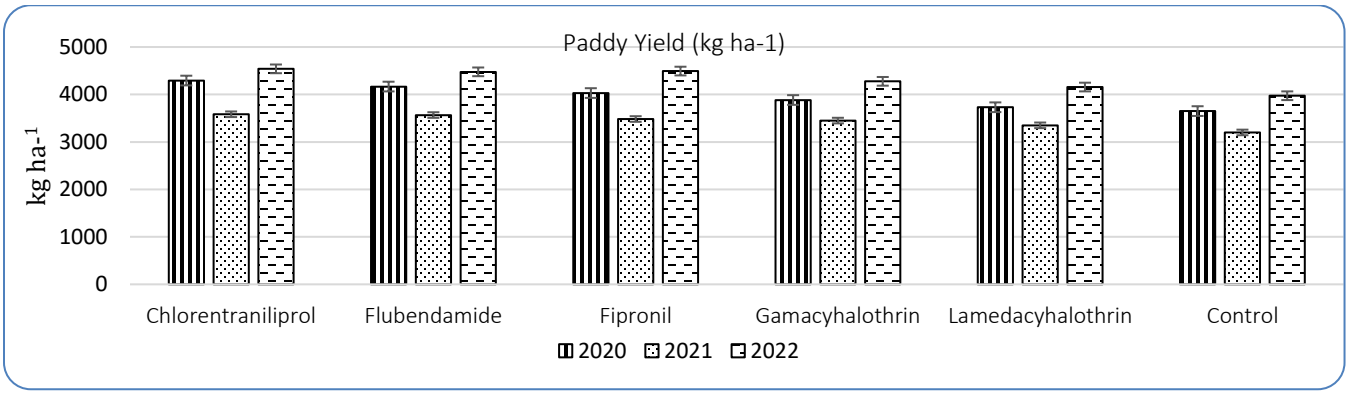

Figure 2. Paddy yield (Kg ha $^{-1}$).

Table 2. Post-treatment data of rice leaf folder infestation per plant and efficiency of insecticides used during study years 2020-2022.

Treatments	2020		2021		2022	
	No of folded leaves /plant	Efficacy % Age	No of folded leaves /plant	Efficacy % Age	No of folded leaves /plant	Efficacy % Age
T1	0.333 e	89	0.436 c	86.3	0.233 c	94.1
T2	0.466 de	84.6	0.556 c	82.6	0.366 c	90.4
T3	0.833 cd	72.2	0.536 c	83.0	0.500 c	87.0
T4	1.000 c	66.6	0.746 c	76.6	0.933 b	75.6
T5	2.233 b	29.0	1.626 b	49.0	1.466 b	53.5
T6	3.000 a		3.196 a		3.833 a	
LSD (P≤ 0.05)	0.43		0.57		0.38	

Table 3. Data on different yield attributes of rice crops during the study years 2020-2022.

Treatments	No. of fertile tillers m^{-2}			Grains/panicle			1000 grain weight (g)		
	2020	2021	2022	2020	2021	2022	2020	2021	2022
T_1	398.3a	377.3a	317.6a	110.6a	110.3 a	118.3 a	22.16a	21.56 a	26.00a
T_2	397.3a	366.3bc	302.6b	106.0 b	107.0a	111.0 b	21.53 a	20.90b	24.90b
T_3	369.3b	376.6a	302.6b	98.0 c	109.6a	113.6 ab	20.43b	21.93a	26.00a
T_4	366.6b	368.6 b	280.6c	97.6 c	107.6 a	103.0 c	20.16b	19.96c	24.70b
T_5	350.0c	365.33bc	274.3c	93.3 d	102.0 b	102.0c	18.60 c	19.13d	24.43b
T_6	330.0d	361.0 c	259.0d	88.0 e	89.6 c	98.6 c	17.83 c	18.26e	21.70c
LSD (P≤ 0.05)	10.62	7.26	9.32	4.19	4.57	7.01	0.95	0.58	0.75

Table 4. Data on paddy yield during the study years 2020-2022.

Treatments	Paddy Yield (kg ha^{-1})					
	2020		2021		2022	
	Yield	% increase/ Decrease	Yield	% increase/ Decrease	Yield	% increase/ Decrease
T1	4293.3 a	17.6	3583.3 a	11.9	4540.0 a	14.2
T2	4166.7 b	14.1	3566.7 ab	11.4	4476.7 a	12.6
T3	4030.0 c	11.9	3483.3 bc	8.8	4493.3 a	13.0
T4	3883.3 c	6.3	3450.0 c	7.8	4276.7 b	7.6
T5	3730.7 d	2.2	3350.0 d	4.6	4156.7 b	4.6
T6	3650.0 e	-	3200.0 e	-	3973.3 c	-
LSD (P≤ 0.05)	100.36	96.36	104.91			

CONCLUSION

The study demonstrated the significant effectiveness of various insecticides in reducing rice leaf folder infestation compared to the control group. Over three years, these selected insecticides achieved a substantial reduction in leaf folder population, with Chlorantraniliprole standing out as the most effective. This effectiveness in controlling leaf folder infestation translated into a significant increase in paddy yield, further confirming the positive impact of the insecticides on crop productivity. These findings align with previous research, emphasizing the importance of judicious insecticide use and the selection of effective insecticides for pest management, highlighting the potential for higher crop yields in rice cultivation.

REFERENCES

Abro G.H., Syed T.S., Shah A.H., Cui J., Sattar M., Awan M. S. 2013. Efficacy and economics of different insecticides against stem borers, in rice crop. Pakistan Journal of Zoology, 45(4): 929-933.

Ahmad H., Khan R.B., Sharma D., Jamwal V.V.S., Gupta S., 2010. Seasonal incidence, infestation and trap catches of Cnaphalocrocis medinalis in rice. Annals of Plant Protection Sciences, 18(2):38-383.

Government of Pakistan. 2021. Pakistan Economic Survey. Ministry of Food, Agriculture and Livestock Federal Bureau of Statistics, Islamabad, Pakistan.

Bashir K., Tayyab H., Tahira F., Zakia L., Mehdi S.A., Sheikh R., 2004. Field evaluation and risk assessment of transgenic indica basmati rice. Molecular Breeding,13: 301-312.

Bhanu K.V. and Reddy P. S. 2008. Field evaluation of of certain newer insecticides against rice insects' pests. Journal of Applied Zoological Research, 19 (1): 11-14.

Chakraborty K. and Deb D.C. 2011. Extent of suppression of leaf folder population by some selected insecticides in the field of scented local paddy cultivar. International Journal of Plant, Animal and Environmental Sciences, 1: 142-149.

Heinrichs E.A., Nwiliene F.E., Stout M.J.,Hadi B.U.R., and Frietas T. 2017. Rice insect pests and their management. Cambridge: Burleigh Dodds Science publishing. p277.

Kakde A.M., Patel K.G., 2019. Yield performance of different insecticides against rice yellow stem borers. Journal of Rice Research, 7(1): 203.

Karthikevan K., S. Jacob and S.M. Parushothaman. 2011. Evaluation of insecticides and bio-rationals

against yellow stem borer and leaf folder on rice crop. Journal of Agriculture Science, 24(2): 244-246

Kulgagod S.D., Hegade M., Nayak G.V., Vastrad A.S., Hugar P.S. 2011. Evaluation of insecticides and bio rational against yellow stem borer and leaf folder in rice crop. Karnataka journal of Agricultural Science, 24 (2): 244-246.

Morteza N., Y. Nicknejad, H. Pirdeshti, D.B. Tari, S. Nasiri. 2008. Growth, yield and yield traits of rice varieties in rotation with clover, Potato, Canola and cabbage in North of Iran. Asian Journal of Plant Sciences, 7(5): 495-499.

Padmavath Ch., Katti I.G., Padmakumari A.P., Voleti S.R., Subba L.V. 2013. The effect of leaffolder Cnaphalocrocis medinalis injury on the plant physiology and yield loss in rice. Journal of Applied Entomology, 137(4): 249-256

Soomro A.S., Mazari S. N., Hulio M.H., Soomro J.A., Junejo G. Q. 2020. Efficacy of different insecticides against rice leaf folder under field conditions. International Journal of Applied Sciences and Biotechnology, 8 (2): 211-215

Seni A. and Naik B.S. 2017. Efficacy of some insecticides against major insect pests of rice. Journal of Entomological and Zoological Studies, 5(4):1381-1385

Sharma P.K., Srivastava A., 2008. Evaluation of different insecticides for control of leaf folder. Agriculture Science Digest, 28: 277-279.

Steel R.D., Torrie J.H. and Dicky D.A., 1997. Principles and procedures of statistics. A biometrical approach 3rd Ed. McGraw Hill Book international Co., Singapur: p204-207.

Wakil W., M. Hussain, R. Akbar and A. Gulzar. 2001. Evaluation of different insecticides against rice stem borer and rice leaf folder. Pakistan Journal of Agriculture Sciences, 38: 49-50.

Vivek., 2009. Integrated Pest management (IPM) in rice. http://agropedia.iitk.ac.in.contentintegrated-pest management-rice.