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Population Incidence and Efficacy of Chemical Control against Rice Leaffolder (*Cnaphnalocrocis medinalis* Guenee) (Pyralidae: Lepidoptera)

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Authors' contributions

This work was carried out in collaboration between all authors. All the authors of this experiment designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BA and MR supervised the whole study. All authors read and approved the final manuscript.

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ABSTRACT

Rice leaffolder has become a serious pest in the last two decades. It causes up to 50 to 70 percent leaf damage and consequently up to 46 percent yield losses in case of severe infestation. A field experiment was conducted at Rice Research Institute, Kala Shah Kaku Punjab Pakistan in which population incidence of rice leaffolder and efficacy of different insecticides evaluated. Population observed form end August to termination of Kharif season. Highest population of rice leaffolder was recorded in September and October. Insecticides, proved, viz., Karate 2.5EC (Lambda cyhalothrin) @ 160ml 86.65%, Pravo 10EC (fipronil +lambda cyhalothrin) @ 300 ml 85.25%, Hoopoe 4G (cartap hydrochloride) @ 9 kg 85.85, Oncol 3G (Benfuracarb) @8 Kg 89.53%, Mover Plus 4.3G (cartap hydrochloride) @ 4.5 Kg 82.77%, Star 4G (cartap hydrochloride) @ 9 kg 78.40%, Padan 4G(cartap

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hydrochloride) @ 9 kg 86.83%, Virtako 0.6G (thiamethoxam + chlorantraniliprole) @ 4 kg 72.05%, Ferterra 0.4G (Chlorantraniliprole) @ 4 kg 91.21%, Paidan 8G (Cartap hydrochloride) 8 kg 84.18% effective. Insecticide treatedplots yielded higher than the control. Highest 3.62 t/ha was recorded with Hoopoe 4G and lowest with Star 4G 2.99 t/ha as compared to 1.95 t/ha of control. All treatments were statistically at par with each other but significantly different from control. In case of yield benefits, 34.78 percent to 46.27 percent increase was recorded. All the treatments were proved statistically at par against beneficial fauna.

Keywords: Cnaphalocrocis medinalis; population incidence; weather interaction; chemical control.

1. INTRODUCTION

Rice is among one of the utmost significant staple food cereal crops and is widely cultivated in different parts of the world. It is the most important energy source solely as half of the global human population feeds on it [1]. So rice was vital that Asian famines were predicted in 1980's [2] and this menace was deterred through Green Revolution and development of high yielding varieties. Green revolution increased the crop productivity significantly. The production of rice in South Asia, after Green revolution, augmented from 47 million tons in 1950-52 to 161.5 million tons during 1996-98 [3]. Prodigious developments were made in areas of irrigated rice producing 72% of total rice production on the globe and will endure exceptionally important [1]. The rice leaffolder (RLF) was a minor or sporadic pest in the historical perspective in numerous Asian countries. However, now it has gained momentum as one of the most important insect pests and become a main menace to rice cultivation in tropical and subtropical Asia. It has been reported that severe infestation of this pest causes 60% to 70% leaf damages [4], resulting insurmountable yield losses [5]. These losses may go upto 80% in terms of yield [6].Approximately 52% losses of rice global production are due to biotic stress factors, of which insect pest are responsible for 21% damages [7].

Even though insect pests have been held as a significant force in paddy cultivation over the centuries, incidence of pest eruptions have augmented with the change of pest complications, in the past four decades [8]. The damage, in this case, is done by the immature stage of RLF i.e., larvae. Larvae feed on leaf tissues of paddy. The second instar folds the leaf longitudinally to form a tube and starts scrapping the green matter inside it, which impedes photosynthetic activity. Its damage can be seen in paddy fields as white streaks of feeding appears on leaves of plants in damaged areas and these white patches are can be clearly seen from distance [9].

Unfortunately, pest complications augmented with the amplification of irrigated rice production, which included enhanced investments such as pesticides. In particular, intensification in insecticide use lead outbreaks of secondary pests, which were of minor significance in the past such as rice leaffolder (*Cnaphalocrocis medinalis Gn*.) [10]. The escalated use of insecticides against the increasingly large secondary pest lead to other problems, especially induced pest resistance [11]. Furthermore, insecticide poisoning have also grow into a serious issue [12] and substances used to overcome the rice pests have induced insecticide resistance in vectors which causes diseases in humans and propagate in inundated fields [13].

In the post-Green Revolution era the much emphasis was led on the sustainability and efficiency [1,14] instead of further amplification of costly inputs, particularly insecticides. In integrated pest management the main task is to make natural non-chemical controls jointly more effective, so the need for chemical control could be minimized in other case it may exacerbate some pest problems, could also be ecologically injurious and may result into un resolvable problems for farmers' focused oncautious use of insecticides [15].

The objective of the study is to observe the incidence of rice leaffolder, to evaluate the efficacy of the available insecticides against rice leaffolder, and economic benefits/losses to the farmers of these practices and insecticides.

2. MATERIALS AND METHODS

The present study was conducted to observe the leaffolder incidence, chemical control and its economic benefits (Table 3) to the farmer. The experiment was carried out at experimental area

at Rice Research Institute Kala Shah Kaku Punjab, Pakistan during the kharif season 2017 and 2018. The nursery was sown in 1st week of June and transplanted after one month. The light trap fixed for collection of adults had four parts i.e. collection bottle, funnel molded lid, a bulb of 100W as light source and a top lid to cover it from unexpected rainfall. Potassium cyanide was used to kill the insect pests trapped in the collection chamber. Killing bottles were substituted manually and trapped moths were identified and calculated.

The number of treatments was eleven including ten insecticides and one control Table 1. Treatments include both granule and sprayable formulations. The detail of these treatments is as given under:

The treatments were applied at economic threshold level. The granules were applied through broadcasting and knapsack sprayer was used for application of sprayable formulations. The post treatment data was collected 72 hours and one week after the application of insecticides. The treatments were applied in three replications and experiment was conducted in randomized complete block design. Plot size was 24" × 18" ft. The percent infestation was recorded according to the formula given as below:

$$\frac{Infested\ leaves}{Total\ leaves} X \frac{Infested\ hills}{Total\ hills} X\ 100$$

Effect on beneficial fauna was also recorded using the formula given:

Survival Percentage=

$$\frac{Pretreatment\ number\ of\ beneficial\ insects}{\text{Post}-treatment\ number\ of\ beneficial\ insects} X\ 100$$

All agrotechnical measures, water and fertilizers were applied according to the recommended schedule for paddy. The yield data was obtained at the time of harvesting. The data were subjected to analysis of variance and the means were compared by least significant difference (LSD) at 5% probability level.

3. RESULTS AND DISCUSSION

Population incidence of rice leaffolder (Fig. 1) first recorded in first week of September in 2017, then it continued to increase till 1st week of October. In the month of October, highest number of catches was recorded. After that catches were dropped till the end of season. In the year 2018, RLF catches were started in last week of August, then continued to increase till 3rd week of September. RLF catches declined in the 4th week of September and continues to escalate till highest number of adults were captured in 2nd week of October, after that population strength continuously dropped till the end of Kharif season. In this year 2017, RLF showed comparatively stable and continuous high population while in 2018Ftwo peaks of activity in 3rd week of September and 2nd week of October.

Our findings (Fig. 1) are in partial accordance with Ram et al. [16] who also observed activity peak of rice leaffolder in the 2nd fortnight of September. However, our observations are in complete accordance with Khan and Ramamurthy [17] and Khan et al., [18]who reported its peak activity in the month of October. These interpretations are not in agreement with the former finding of Kumar et al. [19], Kaul et al. [20] and Alvi et al. [21] who described the peak activity of *C. medinalis* from mid of August to the end of September.

It is apparent from the Table 2 that the results were significantly different as compared to control treatment. Among potential insecticides, Pravo (10EC) proved most effective (3.50 c) followed by Hoopoe 4G (5.55 bc), Padan 4G (5.69 bc), Star 4G (5.73 bc), Karate 2.5EC (5.74 bc), Mover Plus 4.3G (6.40 bc), Oncol 3G (7.99 bc), Virtako 0.6G (8.66 b), Paidan 8G (8.76 b) and Ferterra 0.4G (8.86 b). All the insecticides were at par against rice leaffolder in case of percent efficacy with respect to control.

It is evident from the Table 2 that control operations increased paddy yield significantly. Maximum yield recorded in Hoopoe 4G 3.62 tonnes per hectare followed by Padan 4G 3.41 t/ha, Mover Plus 4.3G 3.25 t/ha, Paidan 8G 3.15 t/ha, Ferterra 0.4G 3.11 t/ha, Oncol 3G 3.09 t/ha, Pravo 10EC 3.06 t/ha, Karate 2.5EC 3.05 t/ha, Virtako 0.6G 3.02 t/ha and Star 4G 2.99 t/ha.

Our findings are similar to those of Bhanu et al., [22] who reported the significant control of rice leaffolder infestation and increase in grain yield over check. Chakraborty and Deb [23] also reported the significant control of rice leaffolder by fipronil. Our studies are similar to that of Iqbal [24] who reported the very effective control of rice leaffolder by Padan 4G. Kulagod [25] found cartap hydrochloride very effective for controlling

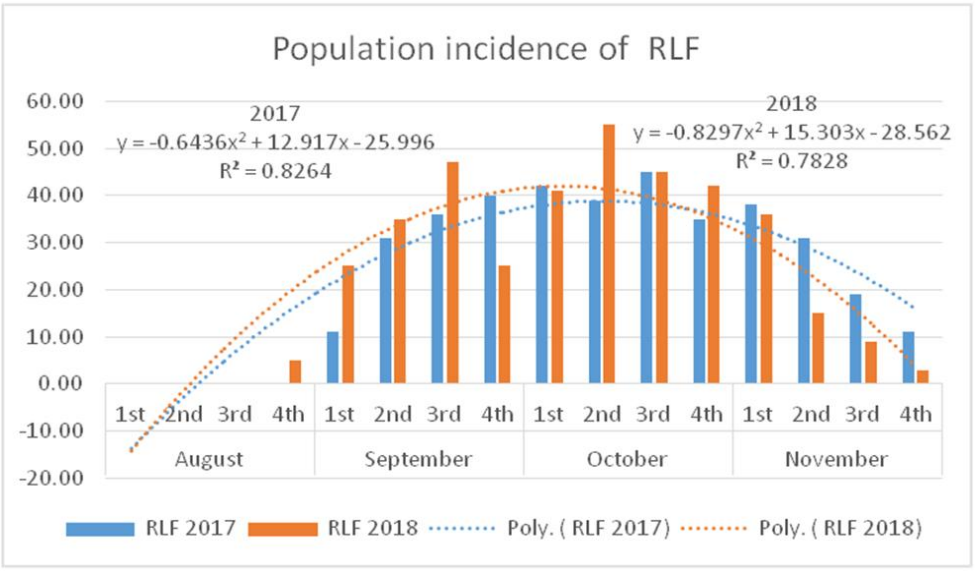

Fig. 1. Population incidence of rice leaffolder during 2017 and 2018

Table 1. Treatments included in the experiment for efficacy against Rice Leaffolder during 2017 and 201 at experimental area Rice Research Institute, Kala Shah Kaku

Treatments	Trade name	Common name	Dose/ acre
1.	Karate 2.5EC	Lambda cyhalothrin	160ml
2.	Pravo 10EC	Fipronil +lambda cyhalothrin	300ml
3.	Hoopoe 4G	Cartap hydrochloride	9kg
4.	Oncol 3G	Benfuracarb	8kg
5.	Mover Plus 4.3G	Cartap hydrochloride	4.5kg
6.	Star 4G	Cartap hydrochloride	9kg
7.	Padan 4G	Cartap hydrochloride	9kg
8.	Virtako 0.6G	Thiamethoxam + chlorantraniliprole	4kg
9.	Ferterra 0.4G	Chlorantraniliprole	4kg
10.	Paidan 8G	Cartap hydrochloride	8kg
11.	Control	Water spray only	-

Table 2. Post- treatment average relative progression in infestation (mean number) of rice leaffolder for the two years

S.#	Treatments	Common Name	Pre-treatment	Post-treatment	% Efficacy with respect to control	Yield t/ha
T_1	Karate 2.5EC	lambda cyhalothrin	4.76 a	5.74 bc	86.65 a	3.05 a
T_2	Pravo 10EC	fipronil + lambda cyhalothrin	2.50 a	3.50 c	85.25 a	3.06 a
T_3	Hoopoe 4G	cartap hydrochloride	4.46 ab	5.55 bc	85.85 a	3.62 a
T_4	Oncol 3G	Benfuracarb	6.75 a	7.99 bc	89.53 a	3.09 a
T_5	Mover Plus 4.3G	cartap hydrochloride	5.18 ab	6.40 bc	82.77 a	3.25 a
T_6	Star 4G	cartap hydrochloride	4.96 ab	5.73 bc	78.40 a	2.99 a
T_7	Padan 4G	cartap hydrochloride	4.66 ab	5.69 bc	86.83 a	3.41 a
T_8	Virtako 0.6G	thiamethoxam + chlorantraniliprole	6.10 ab	8.66 b	72.05 a	3.02 a
T_9	Ferterra 0.4G	Chlorantraniliprole	7.55 a	8.86 b	91.21 a	3.11 a
T_{10}	Paidan 8G	cartap hydrochloride	6.67 a	8.76 b	84.18 a	3.15 a
T_{11}	Control	water spray only	6.16 ab	18.59 a	0.00 b	1.95 b
		LSD	Non-significant	4.77	24.83	0.9551
		CV				18.31

Table 3. Economics of rice leaffolder control operations over untreated plot average of two years

S.#	Treatment	Yield/ha	Percent increase in yield over control
T_1	Karate 2.5EC	3.05	36.07
T_2	Pravo 10EC	3.06	36.27
T_3	Hoopoe 4G	3.62	46.13
T_4	Oncol 3G	3.09	36.89
T_5	Mover Plus 4.3G	3.25	40.00
T_6	Star 4G	2.99	34.78
T_7	Padan 4G	3.41	42.82
T_8	Virtako 0.6G	3.02	35.43
T_9	Ferterra 0.4G	3.11	37.30
T_{10}	Paidan 8G	3.15	38.10
T_{11}	Control	1.95	0.00

Table 4. Impact of different insecticides on beneficial fauna prevailing in rice ecosystem

S.#	Treatment	Pre-Treatment	Post-Treatment	Survival Percentage
T_1	Karate 2.5EC	3.05	1.2 b	63.38 bc
T_2	Pravo 10EC	3.06	0.87 b	60.47 bc
T_3	Hoopoe 4G	3.62	0.93 b	62.82 bc
T_4	Oncol 3G	3.09	1.07 b	57.64 bc
T_5	Mover Plus 4.3G	3.25	0.87 b	57.88 bc
T_6	Star 4G	2.99	0.73 b	54.34 c
T_7	Padan 4G	3.41	1.00 b	66.63 bc
T_8	Virtako 0.6G	3.02	1.00 b	64.87 bc
T_9	Ferterra 0.4G	3.11	0.80 b	57.22 bc
T_{10}	Paidan 8G	3.15	0.80 b	63.97 c
T_{11}	Control	1.95	4.67 a	225.59 a
		NS	LSD=0.4954	LSD=11.931
			CV=22.96	CV=12.33

NS=non-significant, CV=coefficient of variance, LSD=Least significant difference

rice leaffolder. The effectiveness of monomehypo and cartape hydrochloride was also found significant as compared to control similar to our studies by Kulagod 2013 [25]. Farooq et al. [26] also reported the extensive use of cartap hydrochloride, fipronil and lambda-cyhalothrin by farmers' community in Sheikhupura Gujranwala region in Pakistan due to the effectiveness of these chemicals against rice leaffolder [27].

It is evident from the Table 3 that rice leaffolder causes significant yield losses ranging from 35 to 46 percent to the paddy. Maximum yield increase recorded in Hoopoe 4G 46.13 percent followed by Padan 4G 42.82%, Mover Plus 4.3G 40.00%, Paidan 8G38.10%, Ferterra 0.4G 37.30%, Oncol 3G 36.89%, Pravo 10EC 36.27%, Karate 2.5EC 36.07, Virtako 0.6G 35.43% and Star 4G 34.78%.

4. CONCLUSION

Rice leaffolder population found highest in the months of September and October and chemicals are very effective to suppress the leaffolder outbreaks. Chemical control produced results within a short time effectively and ensures a healthy crop production. The chemical control of the pest imparts a subsequent increase in paddy yield. The new chemistry insecticides are also comparatively safe against beneficial fauna.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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