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Field efficacy of newer insecticides against leaf folder (*Cnaphalocrocis medinalis* Gn.) in rice

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Abstract
Rice (*Oryza Sativa* L.) is one of the most important cereal crops grown in India. Beside yellow stem borer, rice leaf folder (*Cnaphalocrocis medinalis* Gn.) is another new emerging important insect pest in rice. In recent years, leaf folders which were of minor importance have gained significant pest status, resulting in significant crop damage and production loss. The present experiment was conducted at the Rice Research Farm, BAU, Ranchi to evaluate the efficacy of different insecticides against rice leaf folder. All treatments were significantly superior to the control. Among all the ten treatments after first spray, lowest leaf damage was recorded in flubendiamide 240 SC + thiacloprid 240 SC (Belt Expert) @ 250 ml/ha (0.61%) and it remained statistically at par with flubendiamide 240 SC + thiacloprid 240 SC @ 200 ml/ha (1.01%) followed by flubendiamide 480 SC @ 50 ml/ha (1.58%) as compared to control (7.26%). In the second and third spray the lowest leaf damage was also recorded in flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha with (1.66%) and (2.11%) as compared to control (9.07%) and (12.07%) respectively. Highest grain yield of 46.50 q/ha and maximum B: C ratio (6.2:1) were recorded in the plot received three sprays of flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha.

Keywords: Rice, leaf folder, leaf damage, insecticides, bio efficacy

Introduction
The constant surge in global population has resulted in an ever-increasing demand for food grain production. Rice (*Oryza sativa* L.) is one of the important cereal crops grown worldwide. It is the staple food and primary source of nutrition for more than half of the world's population. In the state of Jharkhand, rice production and productivity are 4988.06 thousand tone and 2971 kg per hectare, respectively (Anonymous, 2018) [1]. Rice is a high energy food and play vital role in national food security. It contains high carbohydrates 77.84 per cent and low fat about 2.0 to 2.5 per cent. It is also a good source of thiamine, riboflavin and niacin including eight essential amino acids (Prakash *et al*., 2007) [2]. But the surmounting infestation of pests has been threatening rice yields. The rice crop is a perfect target for a variety of insect pests starting from the time of sowing till the crop is harvested. Beside yellow stem borer, rice leaf folder (*Cnaphalocrocis medinalis* Gn.) is another new emerging important insect pest in rice. Once thought to be minor pests, leaf folders have become a major problem in recent years, causing serious crop damage and loss of production. Larva of leaf folder folds rice leaf through silken threads, live within the leaf folds and feed the chlorophyll content of leaf resulting in formation of white streaks on the outer side of leaf. In case of severe infestation of this pest, vigour of the plant is lost thus leading to significant reduction in yield. Among the pest management tools, Chemical control is an integral and essential part of pest management strategy. It is important to mention here that about thirty popular chemical pesticides are on the verge of banned and prohibition in use. Hence there is an urgent need to evaluate field bio efficacy of newer molecules of chemical insecticides. Therefore, the present investigation was undertaken to generate the required information for the welfare of farming communities.

Materials and Methods
The study was conducted in *Kharif* 2018 in the Rice research farm of Birsa Agricultural University, Ranchi, Jharkhand. IR-64, an early maturing rice variety was selected for this study.

The major aim of this experiment was to study the effect of chemical insecticidal treatments on the incidence of leaf folder in rice. There were 11 insecticidal treatments were taken including the control. The sprays were given to the rice crop thrice, at 30, 50 and 80 DAT (days after transplanting). The observations were recorded at 4, 7 and 14 days after application of insecticides in each spray as per cent leaf damage (%LD) per ten hills. All the insecticides under the study were applied as foliar spray and granular application was also made. The experimental design used was Randomized block design and the treatments were replicated thrice.

The per cent leaf damage was calculated as follows

$$\text{Per cent leaf damage (\%LD)} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \text{x } 100$$

Results and discussion

Before spray

The leaf folder infestation in terms of leaf damage symptom (% LD) values were calculated before the application of treatments. The range of leaf folder infestation before spray was observed to be from 5.38 to 6.80 per cent. The data was examined closely and it was deduced from the data that the infestation was uniformly distributed. No significant difference was observed among the experimental units.

First spray

The first insecticidal spray was given at 30 DAT and the effect of insecticidal spray on the leaf folder population was studied. The % LD data was collected for all the treatments. A diligent study of the overall mean % LD (per cent damaged leaves) per 10 hills values (Table 1) showed that the treatment which recorded the least damage by leaf folder was flubendiamide 240 SC + thiacloprid 240 SC @ 250ml/ha with 0.61% LD which was at par with the treatment flubendiamide+ thiacloprid 240 SC @ 200 ml/ha which showed 1.01% LD followed by flubendiamide 480 SC @ 50 ml/ha (1.58% LD). First two treatments proved to be superior over the other treatments in controlling leaf folder at 30 DAT stage. However, the highest incidence of damaged leaves per cent (7.26) was received in case of control.

Second spray: The second application of insecticides was given at 50 DAT and subsequently the damage leaf data was collected. The overall mean % DL values following the second spray revealed in Table 1 that again, the treatments flubendiamide 240 SC + thiacloprid 240 SC @ 250ml/ha (2.11) and flubendiamide + thiacloprid 240 SC @ 200 ml/ha (2.30) were at par with each other and were significantly superior to all other in reducing the level of leaf folder attack in the vegetative stage of the rice crop. It is followed by granules of fipronil 0.3GR @ 12 kg/ha (2.36) and chlorpyriphos 20 EC @ 2 lit/ha (2.69).

Third spray

The third application of insecticide was planned so as to counter the effect of leaf folder in the reproductive stage, hence given at 80 DAT. At this point of time, the crop had already transitioned from vegetative stage and entered into the beginning of the reproductive stage. Combining that with the effect of two previous insecticidal sprays, the % DL recorded was lower as compared to the previous instances on an average. The mean % DL after third application was studied carefully (Table 1) and it indicated that the treatment flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha showed the least incidence of leaf folder (2.11) which was at par with flubendiamide 240 SC + thiacloprid 240 SC @ 200ml/ha (2.74) and chlorpyriphos 20 EC @ 2 lit/ha (2.87). Hence first two treatments were consistent in proving to be the superior treatments. In all the three cases, control was noticed to be receiving the maximum level of pest attack in terms of leaf damage whereas all the other treatments performed significantly better than the control.

Influence of insecticidal treatment on paddy yield

The results shown in **Table 1** revealed that the highest grains yield of rice (46.50 q/ha) was obtained when combination insecticide flubendiamide 240 SC + thiacloprid 240 SC @250 ml/ha was applied as foliar spray which was at par with chlorpyriphos 20 EC @ 2lit/ha applied at 50 DAT (44.00 q/ha), fipronil 0.3 GR @ 12 kg/ha followed by two foliar spray of chlorpyriphos 20 EC @ 2l/ha (43.70 q/ha) applied at 50 DAT, flubendiamide 240 SC + thiacloprid 240 SC @ 200 ml/ha (42.40 q/ha) applied at 30 DAT and flubendiamide 480 SC @ 50 ml/ha (40.80 q/ha) followed by rynaxypar 20 SC @150 ml/ha (39.70 q/ha) applied at 50 DAT.

The above findings were more or less found to be in agreement with the experimental findings of Sandhu and Dhaliwal (2016) whose results showed that, fame (flubendiamide 480 SC) @50 ml/ha proved to be better option for management of two major pests of rice i.e. stem borer and leaf folder. Singh (2018) found that chemical insecticide, rynaxypyr 20 SC was found best to control the infestation of stem borer and leaf folder. Prasad *et al*., (2018) [3] revealed that the chemical insecticides, dinetofuron 20 SG @ 200g/ha and rynaxpyr 20 SC @150ml/ha were highly effective in suppression of the major pest species including leaf folder infesting rice. All these findings of the earlier workers are almost in the line of the results of the present studies.

Table 1: Effects of certain chemical insecticides on the incidence of leaf folder infesting rice

Treatment No.	Treatments	Dose of formulated product (Per ha)	DL% before spray	Mean DL% after 1st spray	Mean DL% after 2nd spray	Mean DL% after 3rd spray	Grain yield (q/ha)
T_1*	Fipronil 0.3 GR (First spray) + chlorpyrifos 20 EC (2nd & 3rd Spray)	12 Kg+2 lit	4.59 (12.34)	4.38 (12.05)	2.36 (8.72)	2.87 (9.74)	43.70
T_2	Chlorpyrifos 20 EC	2 lit	3.47 (10.71)	3.15 (10.16)	2.69 (9.42)	3.31 (10.42)	44.00
T_3	Fipronil 80 WG	65 gm	3.67 (11.03)	3.25 (10.36)	5.33 (13.33)	6.54 (14.79)	38.00
T_4	Dinetofuran 20SG	200 gm	4.96 (12.85)	4.78 (12.56)	5.87 (14.00)	6.91 (15.13)	36.00
T_5	Flubendiamide 480 SC	50 ml	1.58 (6.81)	1.25 (6.41)	2.81 (9.64)	4.26 (11.82)	40.80
T_6	Imidacloprid 17.8 SL	200 ml	5.04 (12.92)	4.60 (12.33)	5.54 (13.58)	7.11 (15.44)	36.60
T_7	Flubendiamide 240 SC+ Thiacloprid 240 SC	200 ml	1.01 (5.68)	0.86 (5.24)	2.30 (8.69)	2.74 (9.51)	42.40
T_8	Flubendiamide 240 SC +Thiacloprid 240 SC	250 ml	0.61 (4.37)	0.26 (2.85)	1.66 (7.27)	2.11 (6.05)	46.50
T_9	Rynaxypyr 20 SC	150 ml	2.84 (9.68)	2.50 (9.03)	4.65 (12.44)	6.05 (14.22)	39.70
T_{10}**	Fipronil 0.3 GR	12 kg	4.91 (12.79)	4.60 (12.37)	5.46 (13.48)	7.12 (15.45)	36.20

T_{11}	Control	-	7.26 (15.61)	6.70 (14.96)	9.07 (17.51)	12.07 (20.32)	29.00
	SEm (±)		(0.0.91)	(0.68)	(0.64)	(0.52)	(2.08)
	CD (P=0.05)		NS	(2.02)	(1.92)	(1.56)	(6.18)
	CV (%)		(11.09)	(11.32)	(10.71)	(7.85)	(9.10)

Figures under parentheses are angular transformed values,
NS – Not significant
T_1*- Granules of fipronil 0.3GR @ 12 kg/ha were applied at 30DAT followed by foliar spray of chlorpyrifos 20EC @ 2 lit/ha at 50 DAT and 80 DAT (days after transplanting).
T_{10}**- Granules of fipronil 0.3 GR @12kg/ha were applied only at 30 DAT.

Economics of chemical insecticidal treatments used against leaf folder in rice: A perusal of results (Table 2) showed that flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha applied as foliar sprays at 30, 50 and 80 DAT on the standing crop in field realized the highest net profit of Rs. 18,087/ha with maximum benefit cost ratio 6.2:1 followed by flubendiamide 240 SC + thiacloprid 240 SC @ 200 ml/ha giving rise to the net profit of Rs. 13,430/ha with B:C ratio of 5.0:1 and rynaxypar 20 SC @ 150 ml/ha giving rise to net profit of Rs. 10,070/ha with B:C ratio 3.6:1 in the present studies.

Table 2: Economics of certain chemical insecticides used against leaf folder in rice

Tr. No.	Treatments	Yield of Rice grain (q/ha)	Increase in yield over Untreated control (%)	Additional gain in yield over Control (q/ha)	Price of additional yield (Rs.) over untreated control	Additional cost of pest control (Rs. /ha)	Net profit (Rs/ha)	Benefit cost ratio
T_1*	Fipronil 0.3 GR (First spray) + chlorpyrifos 20 EC (2^{nd} & 3^{rd} Spray)	43.70	50.68	14.70	17640	4060	13580	3.3:1
T_2	Chlorpyrifos 20 EC	44.00	51.72	15.00	18000	4120	6200	1.5:1
T_3	Fipronil 80 WG	38.00	31.03	9.00	10800	2965	7835	2.6:1
T_4	Dinetofuran 20SG	36.00	24.13	7.00	8400	2410	5990	2.4:1
T_5	Flubendiamide 480 SC	40.80	40.68	11.80	14160	4300	9860	2.2:1
T_6	Imidacloprid 17.8 SL	36.60	26.20	7.60	9120	2560	6560	2.5:1
T_7	Flubendiamide 240 SC+ Thiacloprid 240 SC	42.40	46.20	13.40	16080	2650	13430	5.0:1
T_8	Flubendiamide 240 SC+ Thiacloprid 240 SC	46.50	60.34	17.50	21000	2912	18087	6.2:1
T_9	Rynaxypyr 20 SC	39.70	36.89	10.70	12840	2770	10070	3.6:1
T_{10}**	Fipronil 0.3 GR	36.20	24.82	7.20	8640	2380	6260	2.6:1
T_{11}	Control	29.00	-	-	-	-	-	-

T_1*- Granules of fipronil 0.3GR @ 12 kg/ha were applied at 30DAT followed by foliar spray of chlorpyrifos 20EC @ 2 lit/ha at 50 DAT and 80 DAT (days after transplanting).
T_{10}**- Granules of fipronil 0.3 GR @12kg/ha were applied only at 30 DAT.

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