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D Sudha Rani

Scientist (Entomology),
Agricultural Research Station,
Vuyyuru, Krishna District,
Andhra Pradesh, India

P Mohana Rao

Scientist (Soil Science),
Agricultural Research Station,
Vuyyuru, Krishna District,
Andhra Pradesh, India

K Krishnamma

Principal Scientist
(Pl. Pathology), Agricultural
Research Station, Vuyyuru,
Krishna District,
Andhra Pradesh, India

Corresponding Author:**D Sudha Rani**

Scientist (Entomology),
Agricultural Research Station,
Vuyyuru, Krishna district,
Andhra Pradesh, India

Efficacy of chlorantraniliprole 625g/L FS (Lumivia) for the management of stem borer and leaf folder in direct seeded rice

D Sudha Rani, P Mohana Rao and K Krishnamma

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Abstract

The major production constraint of rice in enhancing productivity is due to attack by pests. Rice stem borer and leaf folder are considered as economic pests and influence the yield if proper timely management practices are not adopted. In case of severe pest incidences the usage of insecticides is inevitable. Among various modes of application of insecticides, seed treatment is mostly advantageous as it is required in small amount and offers control of target pests and ensuring the establishment of healthy and vigorous plants. Hence, studies on efficacy pertaining to Chlorantraniliprole 625g/L FS (lumivia) at different concentrations along with check chemicals viz., cartap hydrochloride 4G and untreated control were evaluate at Agricultural Research Station, Vuyyuru during *kharif*, 2019 and *rabi* 2019-2020 to assess the efficacy of various test chemicals against stem borer and leaf folder infesting direct sown rice. The experimental trial was laid out with seven treatments that were replicated four times and treatments were imposed as seed dresser and broadcasted as direct sown rice. The data on per cent dead hearts and per cent leaf folder damaged leaves at 30, 40, 50, 60 and 70 days after sowing were recorded for both rice variety (MTU 1061) and rice hybrid (28P67). The results revealed that, among various test chemicals the treatment T₄ (Chlorantraniliprole 625g/L FS @ 90 g a.i./ha) had registered highest per cent reduction of stem borer with 76.71 & 68.60 in *kharif* and *rabi* seasons of study period for rice variety. With respect to rice hybrid the per cent reduction of stem borer incidence over control was 78.19 & 65.09 per cent in *kharif* and *rabi*, 2019-2020, respectively. Similarly, the leaf folder damaged leaves were also recorded least in T₄ with 61.06 & 62.96 per cent reduction over control with respect to rice variety during *kharif* and *rabi*, 2019-2020, respectively, whereas the corresponding values for rice hybrid was 61.04 and 71.64 during *kharif* and *rabi* seasons, respectively. Hence, it can be concluded that chlorantraniliprole 625g/L FS @ 90 g a.i./ha (lumivia) is effective as seed dresser in suppressing stem borer and leaf folder in direct seeded rice with no phytotoxicity on rice crop and no adverse effects on natural enemies.

Keywords: Chlorantraniliprole, management, stem borer, direct seeded rice

1. Introduction

Rice, being the major crop constitutes about 52 per cent of the total food grain production and 55 per cent of total cereal production in our country (Kakde and Patel, 2014) ^[1]. In India, rice is grown in 43.86 million ha, the production level is 104.80 million tones and the productivity is about 2390 kg ha⁻¹. In Andhra Pradesh it is cultivated in an area of 38.09 lakh ha with a production of 127.24 lakh tons and 4234 kg ha⁻¹ productivity (www. India stat.com)². Insect-pests are the major constraints in enhancing the rice productivity, besides diseases and ²weeds (Behura *et al.* 2011) ^[3].

Approximately 21 per cent of the global production losses of rice are attributed to the attack of insect pests (Yarasi *et al.*, 2008) ^[4]. Globally, stem borer alone causes yield losses of 10 million tones and accounts 50 per cent of all insecticides usage in the rice field (Deka and Barthakur, 2010) ^[5]. Among stem borers, the yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae) is the dominant species in India and rice plants are most prone to stem borer infestation at the tillering and flowering stages. Stem borer inflicted 18 to 40% damage to the rice crop. The rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) earlier considered as a minor pest has gained the status of major pest with the widespread of high-yielding rice varieties and the accompanying changes in cultural practices (Teng *et al.* 1993) ^[6]. It was most widely spread and damage caused from 18.30 to 58.40 per

cent depending upon the stage of the crop at the time of infestation (Ramasamy and Jaliecksono 1996) [7]. Because of cultivating high yielding varieties year after year which are susceptible to pest attack insecticides remain as sole dependable weapon to the farmer in order to mitigate the insect population especially during epidemics. But among various modes of use of insecticides, seed treatment was the most appreciable method as for seed treatment only small amounts of pesticides are required compared to broadcast sprays which ensure no environmental risks and human hazards. Hence, a field trial was conducted at Agricultural Research Station, Vuyyuru, Andhra Pradesh, India during *khariif*, 2019 and *rabi*, 2019-2020 to evaluate the bioefficacy of Chlorantraniliprole 625g/L FS (Lumivia) as seed dresser in direct sown rice in suppressing the major pests incidence *i.e.*, stem borer and leaf folder.

2. Material and Methods

2.1 Experimental site

Field studies were carried out at Agricultural Research Station, Vuyyuru, Krishna district, Andhra Pradesh during

khariif, 2019 and *rabi*, 2019-2020 to evaluate the efficacy of test chemical Chlorantraniliprole 625g/L FS (Lumivia) at different concentrations in comparison to cartap hydrochloride. The experiment was laid out in RBD design with a plot size of 5 x 5 m including seven treatments which were replicated four times. Judicious fertilizer, inter cultivation and other agronomic practices were employed as per recommendations. Rice variety MTU 1061 and rice hybrid 28P67 which were prone to pest attack was used for experimentation. Direct sown (broadcasting) method was employed for cultivation with seed rate of 30 and 15 kg per hectare for rice variety and rice hybrid, respectively.

2.2 Imposition of treatments

To evaluate efficacy of Chlorantraniliprole 625g/L FS (lumivia), a total of seven treatments including one test chemical cartap hydrochloride 4G and untreated control were imposed as seed treatment. The details of imposed treatments for rice variety and rice hybrid were presented in Table 1. The experimentation was carried out with rice variety and rice hybrid with same treatments simultaneously.

Table 1: Seed treatment details for pest management in direct sown rice

Treatment No	Treatment	Dose (g.i./ha)	Dose (g a.i./kg seed)		Formulation (ml/kg seed)	
			Variety	Hybrid	Variety	Hybrid
T ₁	: chlorantraniliprole 625g/L FS	67.5	2.25	4.5	3.6	7.2
T ₂	: chlorantraniliprole 625g/L FS	75.0	02.5	5.0	4.0	8.0
T ₃	: chlorantraniliprole 625g/L FS	82.5	2.75	5.5	4.4	8.8
T ₄	: chlorantraniliprole 625g/L FS	90.0	3.00	6.0	4.8	9.6
T ₅	: chlorantraniliprole 625g/L FS	180.0	6.00	12.0	9.6	19.2
T ₆	: cartap hydrochloride 4% G	750.0	-	-	18750 g	18750g
T ₇	: untreated control (water)	-	-	-	-	-

2.2.1 Methodology: Required quantity of chlorantraniliprole 625 g/L FS as per given dosage were measured and mixed with adequate water to make slurry sufficient to treat the seeds. Applied the slurry onto seeds in a plastic bag and shaken to coat seeds uniformly with insecticide slurry. Treated seeds were dried in shade prior to sowing.

2.3 Meteorological data

The data on weather parameters *viz.*, maximum temperature, minimum temperature, morning and evening relative humidity and rainfall data was recorded from Meteorological unit installed at Agricultural Research Station, Vuyyuru.

2.3.1 Data recording on pest incidence

The data on stem borer incidence in terms of per cent Dead Hearts (DH) was recorded from 20 hills per each plot at 30, 40, 50, 60 and 70 days after sowing.

$$\text{DH per cent} = \frac{\text{Total number of dead hearts in 20 hills}}{\text{Total number of tillers in 20 hills}} \times 100$$

Similarly, per cent number of leaf folder larvae per hill was observed per plot at 30, 40, 50, 60 and 70 days after sowing. The leaf folder damage was estimated using a rate scale (0-5) from randomly selected hills (Table 2). The leaf folder damage in leaves was calculated as per formulae hereunder at 30, 40, 50, 60 and 70 days after sowing.

$$\text{Per cent damaged leaves} = \frac{\text{Total number of damaged leaves in 20 hills}}{\text{Total number of leaves in 20 hills}} \times 100$$

The per cent reduction of stem borer and leaf folder damage in various treatments over control was calculated as per formulae hereunder.

$$\text{Per cent reduction over control} = \frac{C-T}{C} \times 100$$

Where C= pest incidence in control; T=pest incidence in treatment

Table 2: leaf damage scale for rice leaf folder

Scale	parameter
1	No damage/ scrapping on leaves/hill
2	10-30% damage on leaves/hill
3	30-50% damage on leaves/hill
4	50-80% damage on leaves/hill
5	>80% damage on leaves/hill

2.4 Influence on Natural enemies

The effect of various treatments (test chemicals) on natural enemies (spiders and mirid bugs) was recorded from 20 hills at 30, 50 and 70 days after sowing was recorded.

2.5 Phytotoxicity

The crop response or injury for yellowing, stunting, necrosis, epinasty, hyponasty were recorded in all the treatments and phytotoxicity rating was recorded basing on phytotoxicity scale (Table 3).

Table 3: Phytotoxicity scale based on crop injury

Scale	Crop injury (%)	Scale	Crop injury (%)
0	0	6	51-60
1	1-10	7	61-70
2	11-20	8	71-80
3	21-30	9	81-90
4	31-40	10	91-100
5	41-50		

2.6 Yield data

Plot-wise yields were also recorded after removing the two border rows from each plot and expressed in Kg ha⁻¹ and accordingly the yield advantage over control was retrieved.

2.7 Data analysis

The recorded data was transformed with suitable transformation method before analysis and subjected to analysis of variance. Significant differences in means were separated using Duncan's multiple range test (P= 0.05).

3. Results and discussions

3.1. Meteorological data

During the crop season *kharif*, 2019 the average maximum (33.6 °C) and minimum temperature (17.40 °C) was recorded during August and December, 2019 respectively. During *rabi*, 2019-2020 the maximum temperature was recorded in April 2020 (38.14 °C) and minimum temperature was recorded in January 2020 (15.52 °C). The highest rainfall was recorded in month September for *kharif*, 2019 and February for *rabi*, 2019-2020 with 228.3 and 13.21 mm, respectively (Table 4).

Table 4: Meteorological Data, Agricultural Research Station, Vuyyuru 2019-2020

Month and year	Temperature (°C)		Humidity (%)	Rainfall (mm)	Sunshine hrs
	Max	Min			
August 2019	33.68	21.14	60.45	146.5	6.2
September 2019	33.73	23.38	63.15	228.3	5.7
October 2019	32.72	22.88	63.94	43.4	6.8
November 2019	31.07	19.77	61.25	0.00	6.2
December 2019	29.61	17.14	55.14	0.00	7.2
January 2020	30.71	15.52	64.92	2.00	7.1
February 2020	33.24	16.37	51.78	13.21	7.1
March 2020	36.36	18.60	64.88	0.00	7.5
April 2020	38.14	23.41	51.27	5.10	8.9

3.2 Efficacy of chlorantraniliprole 625 g/L FS on incidence of major pests of rice during *kharif*, 2019

The efficacy of the test chemical, chlorantraniliprole 625 g/L FS as seed dresser on incidence of rice stem borer in terms of per cent dead hearts and incidence of leaf folder in terms of larval population and damaged leaves was recorded at 30, 40, 50, 60 and 70 days after sowing (DAS) in both rice variety and rice hybrid.

3.2.1 Influence of test chemical on incidence of rice stem borer

The incidence of rice stem borer in terms of dead hearts had ranged from 3.3 to 25.5 per cent in rice variety and 4.5 to 29.5 per cent in rice hybrid during *kharif*, 2019.

3.2.1.2 Rice variety: In rice variety MTU 1061 among various treatments, T₄ (chlorantraniliprole 625 g/L FS @ 90 g a.i./ha) had registered lowest stem borer incidence with only 5.4, 3.3, 3.8, 5.3 and 7.8 per cent dead hearts as against highest incidence in untreated control recording 18.4, 20.5, 21.5, 23.4 and 25.5 per cent at 30, 40, 50, 60 and 70 DAS, respectively. The next better treatment in suppressing per cent dead heart was found to be T₆ (cartap hydrochloride 4% G @ 750 g a.i./ha) with 7.5, 6.5, 6.5, 8.4 and 16.8 per cent dead hearts at 30, 40, 50, 60 and 70 DAS, respectively. The other treatments also exhibited better efficacy compared to untreated control and the chronological order in suppressing the borer incidence represents T₄>T₆>T₂>T₃>T₁>T₇ with 5.1, 9.1, 11.8, 12.1, 14.1 and 21.9 per cent, respectively (Table 5).

Table 5: Efficacy of chlorantraniliprole 625g/L FS against rice stem borer in terms of per cent dead hearts during *kharif*, 2019

Treatments	Rice variety					Rice Hybrid						
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average
T ₁	11.8 (20.09) ^c	12.5 (20.70) ^c	12.2 (20.44) ^c	15.5 (23.18) ^b	18.5 (25.47) ^b	14.1 (22.06) ^b	15.8 (23.42) ^c	13.8 (21.81) ^c	12.7 (20.88) ^b	14.6 (22.46) ^b	19.8 (26.42) ^b	15.3 (23.03) ^b
T ₂	10.5 (18.91) ^{bc}	9.3 (17.76) ^{bc}	8.5 (16.95) ^b	13.3 (21.39) ^b	17.5 (24.73) ^b	11.8 (20.09) ^b	14.3 (22.22) ^c	10.5 (18.91) ^{bc}	9.8 (18.24) ^b	10.8 (19.19) ^{ab}	20.5 (26.92) ^b	13.2 (21.30) ^b
T ₃	10.0 (18.43) ^b	7.8 (16.22) ^b	8.0 (16.43) ^b	15.1 (22.87) ^b	19.5 (26.21) ^b	12.1 (20.36) ^b	11.5 (19.82) ^{bc}	9.8 (18.24) ^b	8.7 (17.15) ^b	11.3 (19.64) ^{ab}	19.0 (25.84) ^b	12.1 (20.36) ^b
T ₄	5.4 (13.44) ^a	3.3 (10.47) ^a	3.8 (11.24) ^a	5.3 (13.31) ^a	7.8 (16.22) ^a	5.1 (13.05) ^a	5.3 (13.31) ^a	5.0 (12.92) ^a	4.5 (12.25) ^a	5.8 (13.94) ^a	8.5 (16.95) ^a	5.8 (13.94) ^a
T ₆	7.5 (15.89) ^{ab}	6.5 (14.77) ^b	6.5 (14.77) ^b	8.4 (16.85) ^a	16.8 (24.20) ^b	9.1 (17.56) ^b	6.8 (15.12) ^a	5.4 (13.44) ^a	5.1 (13.05) ^a	7.1 (15.45) ^a	10.4 (18.81) ^a	7.0 (15.34) ^a
T ₇	18.4 (25.40) ^d	20.5 (26.92) ^d	21.5 (27.62) ^d	23.4 (28.93) ^b	25.5 (30.33) ^c	21.9 (27.90) ^c	23.2 (28.79) ^d	25.8 (30.53) ^c	26.5 (30.98) ^c	28.0 (31.95) ^c	29.5 (32.90) ^c	26.6 (31.05) ^c
CD	3.55	3.04	2.58	4.01	3.42	5.15	4.08	3.22	3.98	4.3	5.04	2.68
CV	18.5	12.4	13.9	17.6	9.55	13.54	16.55	12.54	10.57	14.55	10.54	10.15

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test
Values in parenthesis are arc sine transformed values; DAS: Days After Sowing

3.2.1.3 Rice hybrid: In rice hybrid 28P67 also similar trend was observed with respect to efficacy of various treatments in reducing stem borer incidence as in case with rice variety. T₄ (chlorantraniliprole 625 g/L FS @ 90 g a.i./ha) had recorded significantly minimum per cent dead hearts compared to all other treatments and found on par to T₆ (cartap hydrochloride 4% G @ 750 g a.i./ha). The per cent incidence of stem borer in T₄ and T₆ were recorded as 5.3 & 6.8, 5.0 & 5.4, 4.5 & 5.1, 5.8 & 7.1 and 8.5 & 10.4 per cent dead hearts at 30, 40, 50, 60 and 70 DAS, respectively and considered as afforded with minimum borer incidence. The highest per cent dead hearts were recorded in untreated control with 23.2, 25.8, 26.5, 28.0 and 29.5 at 30, 40, 50, 60 and 70 DAS, respectively. The increasing order in efficacy (average per cent dead hearts) of various treatments represents T₄ (5.8) > T₆ (7.0) > T₂ (13.2) > T₃ (12.1) > T₁ (15.3) > T₇ (26.6) (Table 5).

3.2.2 Influence of test chemical on incidence of rice leaf folder in terms of larval population

The leaf folder infestation in terms of larval population per hill was recorded and the results inferred that all the test molecules exerted better suppression of the pest incidence over control. The larval population of leaf folder ranged from

0.0 to 7.5 and 0.8 to 7.2 number per hill in rice variety and rice hybrid, respectively. More or less all the treatments found on par to each other except T₁ (chlorantraniliprole 625 g/L FS @ 67.5 g a.i./ha) and T₇ (untreated control).

The average leaf folder population per hill was found to be less in T₄ and T₆ in both rice hybrid and rice variety with 2.3 and 1.5, respectively. The chronological order in suppressing leaf folder population was T₄ (1.5 & 2.3) > T₆ (2.1 & 3.5) > T₃ (2.5 & 4.6) > T₂ (3.3 & 5.0) > T₁ (4.1 & 5.5) > T₇ (6.1 & 6.6) (Table 6).

3.2.3 Influence of test chemical on incidence of rice leaf folder in terms of per cent damage

The leaf folder damage also followed the analogous trend as in case with larval population. At 30 DAS the leaf folder damage in rice variety found to be below ETL in all treatments except control. At 40, 50, 60 and 70 DAS, the per cent leaf folder damaged leaves were recorded to be less in T₄ followed by T₆ confirming them as the best treatments with 4.3 & 5.3, 3.5 & 6.9, 8.5 & 9.3 and 5.8 & 6.9 per cent in rice variety, respectively. The corresponding values for T₄ and T₆ with respect to rice hybrid were 5.3 & 6.8, 6.8 & 7.9, 8.9 & 10.1 and 10.8 & 12.5 per cent respectively.

Table 6: Efficacy of chlorantraniliprole 625g/L FS on larval population of rice leaf folder/hill during *kharif*, 2019

Treatments	Rice variety					Rice Hybrid						
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average
T ₁	1.5 (1.22) ^a	3.4 (1.84) ^{bc}	5.3 (2.30) ^b	4.8 (2.19) ^{bc}	5.7 (2.39) ^{bc}	4.1 (2.02) ^b	3.8 (1.95) ^c	6.3 (2.51) ^{cd}	6.9 (2.63) ^d	4.3 (2.07) ^b	6.3 (2.51) ^b	5.5 (2.35) ^c
T ₂	0.9 (0.95) ^a	2.8 (1.67) ^{bc}	4.8 (2.19) ^b	3.7 (1.92) ^{ab}	4.3 (2.07) ^{ab}	3.3 (1.82) ^a	3.5 (1.87) ^c	5.4 (2.32) ^{bc}	6.0 (2.45) ^c	4.0 (2.00) ^b	6.0 (2.45) ^b	5.0 (2.24) ^b
T ₃	0 (0.0) ^a	1.3 (1.14) ^{ab}	3.5 (1.87) ^{ab}	3.5 (1.87) ^{ab}	4.0 (2.00) ^a	2.5 (1.58) ^a	3.0 (1.73) ^{bc}	5.3 (2.30) ^b	5.4 (2.32) ^{bc}	3.6 (1.90) ^b	5.5 (2.35) ^{ab}	4.6 (2.14) ^b
T ₄	0 (0.0) ^a	0 (0.0) ^a	1.8 (1.34) ^a	2.2 (1.48) ^a	3.6 (1.90) ^a	1.5 (1.22) ^a	0.8 (0.89) ^a	3.6 (1.90) ^a	3.1 (1.76) ^a	2.2 (1.48) ^a	2.0 (1.41) ^a	2.3 (1.52) ^a
T ₆	0 (0.0) ^a	1.1 (1.05) ^a	2.9 (1.70) ^a	2.4 (1.55) ^a	4.2 (2.05) ^{ab}	2.1 (1.45) ^a	1.8 (1.34) ^{ab}	4.4 (2.10) ^{ab}	4.8 (2.19) ^b	2.9 (1.70) ^{ab}	3.4 (1.84) ^a	3.5 (1.87) ^{ab}
T ₇	5.5 (2.35) ^b	5.4 (2.32) ^c	6.0 (2.45) ^b	6.3 (2.51) ^c	7.5 (2.74) ^c	6.1 (2.47) ^c	4.3 (2.07) ^c	7.8 (2.79) ^d	8.4 (2.90) ^e	5.3 (2.30) ^c	7.2 (2.68) ^b	6.6 (2.57) ^c
CD	1.38	1.15	0.69	0.57	0.27	0.81	0.44	0.32	0.18	0.29	1.04	0.45
CV	13.5	19.8	11.4	10.4	15.8	14.18	10.5	13.2	10.5	13.4	18.4	10.8

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test
Values in parenthesis are arc sine transformed values; DAS: Days After Sowing

The lowest average per cent damage leaves by leaf folder were registered with T₄ (4.4 & 6.7) followed by T₆ (5.7 & 8.0), T₃ (7.5 & 11.7), T₂ (8.7 & 12.4), T₁ (10.1 & 13.4) and T₇ (11.3 & 17.2) test chemicals in rice variety and rice hybrid during *kharif* 2019, respectively (Table 7).

3.3 Efficacy of chlorantraniliprole 625 g/L FS on incidence of major pests of rice during *rabi*, 2019-2020

The efficacy of the test chemical, chlorantraniliprole 625 g/L FS as seed dresser on incidence of rice stem borer in terms of per cent dead hearts and incidence of leaf folder in terms of larval population and damaged leaves was recorded at 30, 40, 50, 60 and 70 days after sowing (DAS) in both rice variety and rice hybrid.

3.3.1 Influence of test chemicals on incidence of rice stem borer

The incidence of rice stem borer in terms of dead hearts had ranged from 1.8 to 10.5 and 2.8 to 13.8 per cent in rice variety and rice hybrid, respectively during *rabi*, 2019-2020.

3.3.1.1 Rice variety: In rice variety among various treatments, the minimum per cent incidence of stem borer was recorded in T₄ (chlorantraniliprole 625 g/L FS @ 90 g a.i./ha) treated plots with 2.2, 1.8, 3.2, 4.3 and 2.1 per cent dead hearts followed by T₆ with 3.8, 2.7, 4.0, 5.6 and 3.8 per cent dead hearts as against highest per cent dead hearts in untreated control plots with 7.4, 8.7, 10.5, 9.8 and 6.8 per cent at 30, 40, 50, 60 and 70 DAS, respectively. The average per cent dead hearts during *rabi*, 2019-2020 was recorded less in T₄ and T₆ with 2.7 and 4.0 per cent dead hearts as against highest in untreated control (8.6%). Next to T₆ the plots treated with T₃ (5.3%) followed by T₂ (5.6%) and T₁ (6.3%) had recorded less average per cent dead hearts compared to control.

3.3.1.2 Rice hybrid: In rice hybrid also the plots treated with T₄ (chlorantraniliprole 625 g/L FS @ 90 g a.i./ha) had recorded significantly least per cent dead hearts with 3.2, 2.8, 3.8, 4.1 and 4.5 per cent at 30, 40, 50, 60 and 70 DAS, respectively. T₄ treated plots found to be on par with per cent dead hearts damage in T₆ treated plots with 4.3, 5.0, 4.8, 5.3 and 6.0 as against highest damage recorded in control (T₇)

with 8.7, 11.2, 13.8, 10.9 & 8.5 per cent at 30, 40, 50, 60 and 70 DAS, respectively. The average per cent dead hearts by stem borer during *rabi*, 2019-2020 was significantly lowest in

T₄ (3.7) followed by T₆ (5.1), T₃ (5.1), T₂ (5.7), T₁ (6.9) and T₇ (10.6) (Table 8).

Table 7: Efficacy of chlorantraniliprole 625g/L FS against rice leaf folder in terms of per cent damage during *kharif*, 2019

Treatments	Rice variety					Rice Hybrid						
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average
T ₁	3.5 (10.78)bc	9.5 (17.95) ^c	10.8 (19.19)c	13.8 (21.81)b	12.8 (20.96)b	10.1 (18.53)d	5.3 (13.31)d	11.3 (19.64)bc	15.4 (23.11)b	16.4 (23.89)b	18.4 (25.40)b	13.4 (21.47)b
T ₂	2.8 (9.63)b	8.5 (16.95) ^{bc}	7.5 (15.89)b	11.5 (19.82)ab	13.1 (21.22)b	8.7 (17.15)cd	4.1 (11.68)c	10.5 (18.91)b	14.2 (22.14)b	15.1 (22.87)b	17.9 (25.03)b	12.4 (20.62)b
T ₃	0 (0.0)a	8.0 (16.43) ^b	6.8 (15.12)b	12.1 (20.36)b	10.5 (18.91)b	7.5 (15.89)bc	3.8 (11.24)c	10.1 (18.53)b	13.4 (21.47)b	13.2 (21.30)b	18.1 (25.18)b	11.7 (20.00)b
T ₄	0 (0.0)a	4.3 (11.97)a	3.5 (10.78)a	8.5 (16.95)a	5.8 (13.94)a	4.4 (12.11)a	1.7 (7.49)a	5.3 (13.31)a	6.8 (15.12)a	8.9 (17.36)a	10.8 (19.19)a	6.7 (15.00)a
T ₆	0 (0.0)a	5.3 (13.31) ^{ab}	6.9 (15.23)b	9.3 (17.76)a	6.9 (15.23)a	5.7 (13.81)ab	2.9 (9.80)b	6.8 (15.12)a	7.9 (16.32)a	10.1 (18.53)a	12.5 (20.70)a	8.0 (16.43)a
T ₇	4.2 (11.83)c	10.5 (18.91) ^d	12.4 (20.62)c	15.1 (22.87)b	14.5 (22.38)b	11.3 (19.64)d	9.3 (17.76)e	15.2 (22.95)c	18.4 (25.40)c	20.5 (26.92)c	22.5 (28.32)c	17.2 (24.50)c
CD	1.21	4.01	2.54	3.11	3.57	2.89	1.15	2.89	3.17	1.47	2.09	2.15
CV	13.9	11.5	16.4	9.7	13.4	12.9	18.5	11.2	13.4	14.5	10.8	13.7

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test
Values in parenthesis are arc sine transformed values; DAS: Days After Sowing

Table 8: Efficacy of chlorantraniliprole 625g/L FS against rice stem borer in terms of per cent dead hearts during *rabi*, 2019-2020

Treatments	Rice variety					Rice Hybrid						
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average
T ₁	5.2 (13.18)b	4.8 (12.66)b	6.7 (15.00)d	8.8 (17.26)d	6.1 (14.30)b	6.3 (14.54)c	6.3 (14.54)bc	5.1 (13.05)b	6.3 (14.54)a	8.8 (17.26)d	7.8 (16.22)b	6.9 (15.23)b
T ₂	4.8 (12.66)b	4.3 (11.97)b	5.4 (13.44)c	8.1 (16.54)d	5.3 (13.31)b	5.6 (13.69)bc	5.1 (13.05)ab	4.0 (11.54)b	5.5 (13.56)a	7.4 (15.79)c	6.5 (14.77)ab	5.7 (13.81)a
T ₃	5.1 (13.05)b	4.0 (11.54)ab	5.1 (13.05)c	7.3 (15.68)cd	5.0 (12.92)b	5.3 (13.31)b	5.0 (12.92)ab	3.9 (11.39)ab	4.3 (11.97)a	6.0 (14.18)b	6.3 (14.54)ab	5.1 (13.05)a
T ₄	2.2 (8.53)a	1.8 (7.71)a	3.2 (10.30)ab	4.3 (11.97)ab	2.1 (8.33)a	2.7 (9.46)a	3.2 (10.30)a	2.8 (9.63)a	3.8 (11.24)a	4.1 (11.68)a	4.5 (12.25)a	3.7 (11.09)a
T ₆	3.8 (11.24)b	2.7 (9.46)a	4.0 (11.54)bc	5.6 (13.69)bc	3.8 (11.24)ab	4.0 (11.54)ab	4.3 (11.97)a	5.0 (12.92)b	4.8 (12.66)a	5.3 (13.31)b	6.0 (14.18)	5.1 (13.05)a
T ₇	7.4 (15.79)c	8.7 (17.15)b	10.5 (18.91)e	9.8 (18.24)e	6.8 (15.12)b	8.6 (17.05)c	8.7 (17.15)c	11.2 (19.55)c	13.8 (21.81)b	10.9 (19.28)e	8.5 (16.95)b	10.6 (19.00)b
CD	2.28	3.85	1.53	2.04	4.53	2.85	2.91	4.93	3.63	1.04	3.47	3.12
CV	18.54	12.71	14.7	13.5	11.8	14.3	14.3	10.4	9.7	12.5	10.4	11.5

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test
Values in parenthesis are arc sine transformed values; DAS: Days After Sowing

3.3.2 Influence of test chemical on incidence of rice leaf folder in terms of larval population

The larval population of leaf folder ranged from 0.0 to 7.3 and 0.0 to 6.4 number per hill in rice variety and rice hybrid, respectively. Among various treatments, T₄ (chlorantraniliprole 625 g/L FS @ 90 g a.i./ha) had recorded minimum per cent dead hearts at 30, 40, 50, 60 and 70 DAS with 0.0, 0.0, 2.4, 1.8 & 3.3 per cent in rice variety and with 0.0, 0.0, 0.0, 1.9, 2.8 & 0.9 per cent in rice hybrid, respectively. The decreasing order of efficacy in suppressing the average leaf folder population in rice variety and rice hybrid represents T₄ (1.5 & 0.9) > T₆ (2.0 & 1.7) > T₃ (3.2 & 2.4) > T₂ (3.6 & 2.6) > T₁ (4.0 & 2.8) > T₇ (4.7 & 3.8) (Table 9).

3.3.3 Influence of test chemical on incidence of rice leaf folder in terms of per cent damage

The leaf folder incidence in terms percent damage leaves also represented the similar trend in case with various treatments imposed. At 30 DAS, the damage per cent was nil both in case with rice hybrid and rice variety. At 40 DAS the damage was nil in T₄ and T₆ in rice variety whereas, at 40 and 50 DAS

the damage was nil in T₃, T₄ and T₆ representing efficacy in reducing the pest incidence.

The average per cent damaged leaves in rice variety recorded to be lowest in T₄ (3.0 & 1.9) and found on par to T₆ (3.6 & 2.8) followed by least damage recorded in T₃ (5.5 & 3.7), T₂ (6.0 & 4.1), T₁ (7.0 & 4.8) and highest damage recorded in T₇ (8.1 & 6.7) with respect to rice variety and rice hybrid, respectively (Table 10).

3.4 Efficacy of test chemicals (cumulative mean) in terms of per cent reduction over control

The pooled mean in terms of per cent reduction over control of stem borer and leaf folder in both rice variety and rice hybrid was calculated for both the seasons.

3.4.1 Rice stem borer: During the season *kharif*, 2019 the order of efficacy of various chemicals with respect to per cent dead hearts represents T₄ (76.71 & 78.19) > T₆ (58.44 & 73.68) > T₃ (44.74 & 54.51) > T₂ (46.12 & 50.37) > T₁ (35.61 & 42.48) in rice variety and rice hybrid, respectively. During *rabi*, 2019-2020 similar trend was observed as in case with

khariif 2019 and among various treatments the highest per cent reduction was recorded in T4 followed by T6, T3, T2 and T1 with 68.60, 53.48, 38.37, 34.88 & 26.74 and 65.09, 51.88,

51.88, 46.22 & 33.94 per cent in rice variety and rice hybrid, respectively (Table 11).

Table 9: Efficacy of chlorantraniliprole 625g/L FS on larval population of rice leaf folder during *rabi*, 2019-2020

Treatments	Rice variety					Rice Hybrid						
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average
T ₁	0 (0.0)	4.1 (2.02)bc	5.4 (2.32)ab	3.8 (1.95)cd	6.5 (2.55)b	4.0 (2.00)	0 (0.0)	0 (0.0)	3.5 (1.87)b	4.8 (2.19)c	5.9 (2.43)cd	2.8 (1.67)c
T ₂	0 (0.0)	3.7 (1.92)a	5.0 (2.24)ab	3.5 (1.87)c	6.0 (2.45)b	3.6 (1.90)	0 (0.0)	0 (0.0)	3.2 (1.79)ab	4.3 (2.07)bc	5.3 (2.30)cd	2.6 (1.61)bc
T ₃	0 (0.0)	2.8 (1.67)a	4.9 (2.21)a	3.0 (1.73)bc	5.4 (2.32)b	3.2 (1.79)	0 (0.0)	0 (0.0)	2.8 (1.67)a	4.0 (2.00)b	5.0 (2.24)c	2.4 (1.55)b
T ₄	0 (0.0)	0 (0.0)	2.4 (1.55)a	1.8 (1.34)a	3.3 (1.82)a	1.5 (1.22)	0 (0.0)	0 (0.0)	0 (0.0)a	1.9 (1.38)a	2.8 (1.67)ab	0.9 (0.95)a
T ₆	0 (0.0)	0 (0.0)	3.1 (1.76)a	2.2 (1.48)ab	4.5 (2.12)ab	2.0 (1.41)	0 (0.0)	0 (0.0)	2.4 (1.55)a	2.8 (1.67)ab	3.4 (1.84)b	1.7 (1.30)b
T ₇	0 (0.0)	5.2 (2.28)c	6.5 (2.55)b	4.3 (2.07)d	7.3 (2.70)b	4.7 (2.17)	0 (0.0)	3.5 (1.87)	3.9 (1.97)b	5.3 (2.30)c	6.4 (2.53)d	3.8 (1.95)c
CD	NS	0.44	0.84	0.31	0.61	0.55	NS	NS	0.24	0.47	0.37	0.36
CV	-	12.4	18.4	13.71	15.4	14.97	-	-	12.5	13.8	9.7	12.0

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test
Values in parenthesis are square root transformed values; DAS: Days After Sowing

Table 10: Efficacy of chlorantraniliprole 625g/L FS against rice leaf folder in terms of per cent damage during *rabi*, 2019-2020

Treatments	Rice variety					Rice Hybrid						
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	Average
T ₁	0 (0.0)	2.1 (8.33)b	8.8 (17.26)bc	10.2 (18.63)bc	13.8 (21.81)c	7.0 (15.34)	0 (0.0)	0 (0.0)a	4.8 (12.66)bc	8.8 (17.26)bc	10.4 (18.81)b	4.8 (12.66)bc
T ₂	0 (0.0)	1.5 (7.03)b	7.2 (15.56)b	9.8 (18.24)b	11.5 (19.82)b	6.0 (14.18)	0 (0.0)	0 (0.0)a	4.1 (11.68)bc	7.4 (15.79)ab	9.1 (17.56)b	4.1 (11.68)b
T ₃	0 (0.0)	1.5 (7.03)b	6.8 (15.12)b	8.5 (16.95)b	10.8 (19.19)b	5.5 (13.56)	0 (0.0)	0 (0.0)a	3.5 (10.78)bc	6.3 (14.54)ab	8.5 (16.95)b	3.7 (11.09)b
T ₄	0 (0.0)	0 (0.0)a	3.5 (10.78)a	4.3 (11.97)a	7.1 (15.45)a	3.0 (9.97)a	0 (0.0)	0 (0.0)a	0 (0.0)a	4.3 (11.97)a	5.0 (12.92)a	1.9 (7.92)a
T ₆	0 (0.0)	0 (0.0)a	4.3 (11.97)a	5.7 (13.81)a	7.9 (16.32)a	3.6 (10.94)a	0 (0.0)	0 (0.0)a	2.4 (8.91)b	5.4 (13.44)ab	6.3 (14.54)a	2.8 (9.63)ab
T ₇	0 (0.0)	3.3 (10.47)c	10.5 (18.91)c	12.4 (20.62)c	14.5 (22.38)d	8.1 (16.54)	0 (0.0)	3.4 (10.63)b	5.9 (14.06)c	10.4 (18.81)c	13.8 (21.81)c	6.7 (15.00)c
CD	NS	1.34	2.84	2.07	1.87	2.03	NS	3.54	4.54	3.97	2.14	3.55
CV	-	18.5	11.8	9.8	15.4	13.9	-	12.9	17.45	9.54	11.44	10.69

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test
Values in parenthesis are arc sine transformed values; DAS: Days After Sowing

Table 11: Efficacy of chlorantraniliprole 625g/L FS on incidence of rice stem borer in terms of per cent reduction over control

Treatments	<i>Khariif</i> , 2019				<i>rabi</i> , 2019-2020			
	Rice variety		Rice hybrid		Rice variety		Rice hybrid	
	%DH	% ROC	Per cent DH	% ROC	%DH	% ROC	%DH	% ROC
T ₁	14.1 (22.06) ^b	35.61	15.3 (23.03) ^b	42.48	6.3 (14.54) ^c	26.74	6.9 (15.23) ^b	33.94
T ₂	11.8 (20.09) ^b	46.12	13.2 (21.30) ^b	50.37	5.6 (13.69) ^{bc}	34.88	5.7 (13.81) ^a	46.22
T ₃	12.1 (20.36) ^b	44.74	12.1 (20.36) ^b	54.51	5.3 (13.31) ^b	38.37	5.1 (13.05) ^a	51.88
T ₄	5.1 (13.05) ^a	76.71	5.8 (13.94) ^a	78.19	2.7 (9.46) ^a	68.60	3.7 (11.09) ^a	65.09
T ₆	9.1 (17.56) ^b	58.44	7.0 (15.34) ^a	73.68	4.0 (11.54) ^{ab}	53.48	5.1 (13.05) ^a	51.88
T ₇	21.9 (27.90) ^c	-	26.6 (31.05) ^c	-	8.6 (17.05) ^c	-	10.6 (19.00) ^b	-
CD	5.15		2.68		2.85		3.12	
CV	13.54		10.15		14.3		11.5	

3.4.2 Leaf folder in terms of damaged leaves: The highest per cent reduction of leaf folder larval population over control during *khariif*, 2019 was recorded in T₄ treated plots (61.06) followed by T₆, T₃, T₂ and T₁ with 49.55, 33.62, 23.00 and 10.61 per cent in rice variety. The corresponding values in

case with rice hybrid represents T₄ (61.04) > T₆ (53.48) > T₃ (31.97) > T₂ (27.91) > T₁ (22.09). For the season *rabi*, 2019-2020 similar trend was recorded and the decreasing order of efficacy in suppressing the larval population represents T₄ (62.96 & 71.64) > T₆ (55.55 & 58.21) > T₃ (32.09 & 44.77)

>T₂ (25.92 & 38.88) >T₁ (13.58 & 28.35) in rice variety and rice hybrid, respectively (Table 12).

3.5 Influence of various treatments on natural enemies population

The population of predatory spiders and mirid bugs were recorded from each plot and the mean population inferred that there is no significant difference among various treatments and all are found on par to each. It was apparent from the results that, the application of test chemical chlorantraniliprole 625 g/L FS at various doses did not exerted any adverse effects to natural enemies at both *kharif* and *rabi* seasons under study period of 2019-2020.

4. Phytotoxicity

The results revealed that chlorantraniliprole 625 g/L FS @ 90 and 180 g a.i ha⁻¹ have not exhibited any phytotoxic symptoms like leaf injury on tips and leaf surface, wilting,

leaf vein clearing, necrosis, epinasty and hyponasty in any of the doses and treatments tested in rice crop. chlorantraniliprole 625 g/L FS was tested for phytotoxicity at all the doses during *kharif*, 2019 and *rabi*, 2019-2020 and was also proven safe to rice crop during entire crop season.

5. Efficacy of various treatments on yield

The yield from various treated plots was recorded and converted in to Kg/ha. Among various treatments evaluated the highest yield was recorded in T₄ and T₆ with 4580 & 4490 and 4925 & 4800 kg/ha as against lowest yield with 2750 & 2950 in untreated control during *kharif*, 2019 season with respect to rice variety and rice hybrid, respectively. During *rabi*, 2019-2020 the highest yields were realized in plots treated with T₄ and T₆ in both rice variety and rice hybrid with 3420 & 3385 and 3250 & 3150 kg/ha, respectively (Table 13). This is for kind intimation that the yield was low in *rabi*, 2019-2020 due to lockdown effect (insufficient laborer).

Table 12: Efficacy of chlorantraniliprole 625g/L FS on incidence of rice leaf folder in terms of per cent reduction over control

Treatments	<i>Kharif</i> , 2019				<i>rabi</i> , 2019-2020			
	Rice variety		Rice hybrid		Rice variety		Rice hybrid	
	%LFDL	% ROC	%LFDL	% ROC	%LFDL	% ROC	%LFDL	% ROC
T ₁	10.1 (18.53)d	10.61	13.4 (21.47)b	22.09	7.0 (15.34)	13.58	4.8 (12.66)bc	28.35
T ₂	8.7 (17.15)cd	23.00	12.4 (20.62)b	27.91	6.0 (14.18)	25.92	4.1 (11.68)b	38.88
T ₃	7.5 (15.89)bc	33.62	11.7 (20.00)b	31.97	5.5 (13.56)	32.09	3.7 (11.09)b	44.77
T ₄	4.4 (12.11)a	61.06	6.7 (15.00)a	61.04	3.0 (9.97)	62.96	1.9 (7.92)a	71.64
T ₆	5.7 (13.81)ab	49.55	8.0 (16.43)a	53.48	3.6 (10.94)	55.55	2.8 (9.63)ab	58.21
T ₇	11.3 (19.64)d	-	17.2 (24.50)c	-	8.1 (16.54)	-	6.7 (15.00)c	-
CD	2.89		2.15		2.03		3.55	
CV	12.9		13.7		13.9		10.69	

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test

values in parenthesis are arc sine transformations;%LFDL: per cent leaf folder damaged leaves;%ROC: Per cent reduction over control

Table 13: Efficacy of chlorantraniliprole 625g/L FS on rice yield (kg/ha)

Treatments	<i>kharif</i> , 2019				<i>rabi</i> , 2019-2020			
	Rice variety		Rice hybrid		Rice variety		Rice hybrid	
	Yield (kg/ha)	Yield advantage over control	Yield (kg/ha)	Yield advantage over control	Yield (kg/ha)	Yield advantage over control	Yield (kg/ha)	Yield advantage over control
T ₁	3950c	43.6	4018c	36.2	3050d	41.86	2955b	47.7
T ₂	3940c	43.2	4010c	35.9	3040d	41.39	2930b	46.5
T ₃	4080b	48.3	4210b	42.7	3205c	49.06	3050b	52.5
T ₄	4580a	66.5	4925a	66.9	3420a	59.06	3250a	62.5
T ₆	4490a	63.3	4800a	62.7	3385b	57.44	3150a	57.5
T ₇	2750d	-	2950d	-	2150e	-	2000c	-
CD	88.7		78.2		110.4		124.8	
CV	14.7							

Mean with same letter are not significantly different at 5% level by Duncan's Multiple Range test

The research trials by Sachan *et al.* (2018) [8] pronounced that among various insecticides application of chlorantraniliprole 18.5 SC @ 150ml/ha and chlorantraniliprole 0.4%G @ 10 Kg/ha had registered significant efficacy in reducing stem borer incidence in basmai rice. Similarly the studies by Arvind and Rajpoot (2017) [9] inferred that application of Coragen 20% @ 150ml/ha was most effective in reducing per cent dead hearts (4.15-4.65) and per cent white ears(5.70-6.25) as against highest in case with untreated control with 15.05-16.25 and 25.30-28.65 per cent dead hearts and white ears, respectively.

6. Conclusions

Among the various treatments evaluated for efficacy against stem borer and leaf folder infesting rice as seed dresser the treatment T₄ (chlorantraniliprole 625 g/L FS @ 90 g a.i. /ha) had recorded significantly lowest per cent dead hearts, minimum leaf folder larval population and least per cent leaf folder damaged leaves in both rice variety and rice hybrid during *kharif*, 2019 and *rabi*, 2019-2020. The treatment T₄ was found on par to T₆ in many cases in suppressing the stem borer and leaf folder damage. From the results, it is inferred that, chlorantraniliprole 625 g/L FS @ 90 g a.i. /ha (lumivia) was effective in suppressing the stemborer and leaf folder

infestation up to 70 DAS if used as seed dresser in direct seeded rice with no harm to natural enemies and no phytotoxicity on rice crop.

7. References

1. Kakde AM, Patel KG. Seasonal incidence of rice yellow stem borer (*Scirpophaga incertulas* Wlk.) in relation to conventional and Sri Methods of planting and its correlation with weather parameters. J. Agric and Vet Science. 2014; 7(6):5-10.
2. www. Indiatat.com. Ministry of Agriculture. 2014-15. Government of India. <http://www.Indiatat.com>
3. Behura N, Sen P, Kar MK. Introgression of yellow stem borer (*Scirpophaga incertulas*) resistance gene, into cultivated rice (*Oryza* sp.) from wild spp. Indian Journal Agriculture Science. 2011; 81:359-62.
4. Yarasi B, Sadumpati V, Immanni CP, Vudem DR, Khareedu VR. Transgenic rice expressing *Allium sativum* leaf agglutinin (ASAL) exhibits highlevel resistance against major sap-sucking pests. BMC Plant Biology. 2008; 8:102-115.
5. Deka S, Barthakur S. Overview on current status of biotechnological interventions on yellow stem borer, *Scirpophaga incertulas* (Lepidoptera: Crambidae) resistance in rice. Biotechnol Adv. 2010; 28(1):70-81.
6. Teng PS, Heong KL, Keith M. Advances in tropical rice pest management research. In: New frontiers in rice research (Eds.: K. Muralidharan and E. A. Siddiq). Directorate of Rice Research, Hyderabad, India, 1993, 255
7. Ramasamy C, Jaliecksono T. Inter country comparison of insect and disease losses. In: Rice Research in Asia: Progress and Priorities. (Eds.: R.E.R.W. Evanson, W. Herdt and M. Hossain), CAB International and IRRI, Philippines, 1996, 26.
8. Sachan SK, Kashyap AK, Ritesh Sharma, Verma KD, Singh HR. Efficacy of some novel insecticides against yellow stem borer, *Scirpophaga incertulas* (Walker) In Basmati Rice. Journal of Pharmacognosy and Phytochemistry 2018; SP1:195-197.
9. Arvind KS, Rajpoot SKS. Efficacy of commercially available insecticides and botanicals against yellow stem borer (*Scirpophaga incertulas*, Walker) of rice. Bulletin of Environment, Pharmacology and Life Sciences. 2017; 6(3):11-13.