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# Comparative Field Efficacy of Certain Insecticides against Paddy Leaf Folder Infestation

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

A field experiment which was conducted during *rabi,* 2016-17 and 2017-18 in the wetland farm of S.V. Agricultural College, Tirupati to evaluate the efficacy of certain insecticides against rice leaf folder in paddy variety, BPT-5204 revealed that, all the tested ten insecticides had significantly affected the larvae of *C. medinalis* and reduced the leaf damage over untreated control. The chlorantraniliprole proved as the most effective insecticide with the percentage of leaf damage as 4.95 followed by flubendiamide and monocrotophos with the damage percentage of

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5.44 and 5.53. The least effective insecticides were cartap hydrochloride 4 G (7.39%) followed by cartap hydrochloride 50 SP (7.33%) and acephate (7.19%) against paddy leaf folder damage.

*Keywords: Paddy; BPT-5204; leaf folder; C. medinalis; leaf damage; insecticides.*

## 1. INTRODUCTION

"Paddy, Oryza sativa (Linneaus) is the most important cereal food crop and one of the important human diets as carbohydrate source providing major source of the food energy for more than half of the human population of the world. "Paddy is Life" describes the importance of paddy in human diet. It is grown worldwide over an area of 153 million hectares with an annual production of more than 600 million tonnes" [1]. "In India, paddy is cultivated in an area of 43.19 million hectares with 110.15 million tonnes of production and 2550 kg $ha^{-1}$ of productivity" [2]. "In Andhra Pradesh, area under cultivation of paddy is approximately 2.10 million hectares with 12.00 million tonnes of production and 5702 kg $ha^{-1}$ of productivity. In Southern Agro-climatic zone of Andhra Pradesh (Chittoor, S.P.S. Nellore and Y.S.R. Kadapa districts), paddy crop is cultivated in an area of 0.16 million hectares with 1.32 milliion tonnes of production and 5722 kg $ha^{-1}$ of productivity during rabi, 2021-2022" [3].

"Paddy cultivation is commonly encountered by different biotic factors including insect pests like Yellow Stem Borer (YSB), pink stem borer, green leaf hoppers, leaf folder, brown planthoppers, gall midge, grasshoppers, gundhi bugs etc., which adversely affect its yield" [4]. "The yield losses caused by the insect pests in paddy was reported to the tune of 25 per cent" [5]. "Among the insect pests, YSB, Scirpophaga incertulas (Walker) was the major one accounting for 30-80 per cent yield loss followed by leaf folder, Cnaphalocrocis medinalis (Guenee) which causes 60 to 70 per cent leaf damage to paddy crop" [1]. As a result, sufficient precautions should be taken to manage resistance by using pesticides with diverse modes of action in a reasonable and alternative manner. By considering the above circumstance, the current experimental investigation was undertaken to demonstrate the bio-efficacy of newer insecticides with diverse mechanisms of action against rice leaf folder

## 2. MATERIALS AND METHODS

A field experiment was conducted during rabi, 2016-17 and 2017-18 in the Wetland Farm of S.V. Agricultural College, Tirupati to evaluate the efficacy of certain insecticides against rice leaf folder in a randomized block design with three replications. Thirty days old seedlings of rice variety, Samba mashuri (BPT-5204) was transplanted with a spacing of 15×10 cm in a plot of 20 sq.m and all agronomical practices recommended for the region were followed to raise the crop. There were ten treatments which comprised of carbofuran 3G @10 kg/acre, cartap hydrochloride 4G @ 8 kg/acre, acephate 75 SP @ 1.5 g/L, cartap hydrochloride 50 SP @ 2 g/L, chlorantraniiprole 18.5 SC @ 0.3 mL/L, chlorpyrifos 20 EC @ 2.5 mL/L, dichlorvos 76 EC @ 1 mL/L, flubendiamide 20 WDG @ 0.25 g/L, monocrotophos 36 SL @ 1.6 mL/L, profenofos 50 EC @ 2 mL/L and one untreated control. Each treatment was applied twice during the crop growing season at 40 and 60 days after transplanting.

Per cent leaf folder damage was recorded one day before and at 5 days after insecticidal treatment by counting the number of damaged leaves/hill, from 10 randomly selected hills in each plot. Observations were similarly recorded at 10 and 15 days after treatment. The leaf folder damage (%) was calculated as follows:

Leaf folder damage = Damaged leaves per 10 hills / Total leaves per 10 hills * 100

## 3. RESULTS AND DISCUSSION

### 3.1 Evaluation of Certain Insecticides Against Paddy Leaf Folder Damage During rabi, 2016-17

#### 3.1.1 First insecticidal application

The initial percentage of paddy leaf damage ranged from 3.41 to 3.58 one day before the insecticidal application. At five DAA, it was evident from the Table 4 all the insecticides showed effectiveness against leaf folder damage over untreated control and were on par with each other in their efficacy showing chlorantraniliprole (3.56%) and cartap hydrochloride 4 G (3.88%) as highest and lowest efficacy against paddy leaf folder damage. The insecticides chlorantraniliprole followed by flubendiamide, chlorpyrifos, monocrotophos,

acephate, carbofuran, dichlorvos, flubendiamide, cartap hydrochloride 50 SP and cartap hydrochloride 4 G shows the decreasing order of efficacy against paddy leaf folder damage with percentages of 3.67, 3.85, 3.91, 3.92, 4.02, 4.06, 4.13, 4.29, 4.37 and 4.48 at ten DAA. At 15 DAA, with percentage damage of 3.82, chlorantraniliprole showed as superior one in efficacy followed by flubendiamide and monocrotophos with the leaf folder damage percentage of 4.17 and 4.27. The least effective insecticide was cartap hydrochloride 4G with the damage percentage of 5.29. The mean per cent leaf damage over untreated control was lowest in chlorantraniliprole (3.68%) followed by flubendiamide (3.88%) and monocrotophos (3.94%) while highest was recorded in cartap hydrochloride 4 G (4.55%) followed by cartap hydrochloride 50 SP (4.48%) and acephate (4.42%) treated plots (Table 1).

#### 3.1.2 Second insecticidal application

The pre treatment percentage leaf damage ranged from 4.23 to 10.71 and a significant difference was observed among the treatments including untreated control. With the lowest percentage of paddy leaf folder damage recorded in 4.27, chlorantraniliprole proved as the most effective insecticide at five DAA followed by flubendiamide and monocrotophos with the damage percentage of 4.63 and 4.67. The least effective insecticides were cartap hydrochloride 4 G (6.60%), cartap hydrochloride 50 SP (6.50%) and acephate (6.42%) which were on par with each other. The parallel on performance was recorded upto 15 DAA and also in the mean percentage leaf damage (Table 2).

After the two insecticidal applications, the cumulative mean per cent leaf damage indicated that the chlorantraniliprole was most effective with lowest leaf damage per cent of 4.05 followed by flubendiamide and monocrotophos as the next best treatments with the damage per cent of 4.39 and 4.46. The least effective treatment was cartap hydrochloride 4 G with leaf damage per cent of 5.90 followed by cartap hydrochloride 50 SP (5.83 %) and acephate (5.72 %) (Table 3).

### 3.2 Evaluation of Certain Insecticides against Paddy Leaf Folder Damage During rabi, 2017-18 First Insecticidal Application

The initial percentage of paddy leaf folder damage ranged from 4.49 to 4.66 one day before the first insecticidal application. It is evident from the Table 4 that the insecticides, chlorantraniliprole, chlorpyrifos, profenofos, monocrotophos, dichlorvos, carbofuran and acephate were in the order and on par with each other in their efficacy against leaf folder. The least effective one was cartap hydrochloride 4 G followed by cartap hydrochloride 50 SP and flubendiamide and showed no significant difference among the three insecticides in their efficacy at five DAA. At ten DAA, chlorantraniliprole followed by flubendiamide with the damage percentage of 4.90 and 5.08 represents the superior ones and were on par with each other in their efficacy. Without the significant difference, the insecticides cartap hydrochloride 4 G, cartap hydrochloride 50 SP and acephate with the damage percentage of 5.71, 5.60 and 5.51 showed the least ones in the increasing order of efficacy. At 15 days after insecticidal application, with less paddy leaf folder percentage damage chlorantraniliprole (5.14%) remained as superior one in efficacy followed by flubendiamide and monocrotophos as the next best treatments with the leaf folder damage percentage of 5.48 and 5.58. The least effective insecticide was cartap hydrochloride 4 G with the leaf folder damage percentage of 6.61 followed by cartap hydrochloride 50 SP (6.55%) and acephate (6.46%) with non significant difference. The mean per cent paddy leaf folder damage over untreated control was observed as lowest in chlorantraniliprole (4.91%) followed by flubendiamide (5.10%) and monocrotophos (5.16%) while highest was recorded in cartap hydrochloride 4 G (5.78%) followed by cartap hydrochloride 50 SP (5.70%) and acephate (5.64 %) treated plots (Table 4).

### 3.3 Second Insecticidal Application

A range of 5.67 to 12.71 percentage of paddy leaf folder damage was recorded as a pre treatment count which showed significant difference among all the treatments along with untreated control. The chlorantraniliprole proved as the most effective insecticide at five DAA with the lowest percentage of paddy leaf folder damage as 5.77 followed by flubendiamide and monocrotophos with the damage percentage of 6.12 and 6.16. The least effective insecticides were cartap hydrochloride 4 G (8.10%), cartap hydrochloride 50 SP (7.98%) and acephate (7.84%). The parallel trend was followed upto 15 DAA and also in the mean percentage leaf folder damage in the order of their efficacy (Table 5).

**Table 1. Effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis after first application during rabi, 2016-17**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 3.45 (10.70) | 3.64 (11.00)$^{abc}$ | 4.06 (11.63)$^{bcd}$ | 4.78 (12.63)$^{d}$ | 4.16 (11.77)$^{de}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 3.55 (10.86) | 3.88 (11.36)$^{c}$ | 4.48 (12.22)$^{f}$ | 5.29 (13.29)$^{e}$ | 4.55 (12.32)$^{f}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 3.44 (10.68) | 3.82 (11.27)$^{abc}$ | 4.29 (11.95)$^{def}$ | 5.16 (13.13)$^{e}$ | 4.42 (12.14)$^{f}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 3.51 (10.80) | 3.84 (11.30)$^{bc}$ | 4.37 (12.07)$^{ef}$ | 5.24 (13.23)$^{e}$ | 4.48 (12.23)$^{f}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 3.51 (10.79) | 3.56 (10.87)$^{a}$ | 3.67 (11.04)$^{a}$ | 3.82 (11.27)$^{a}$ | 3.68 (11.06)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 3.41 (10.65) | 3.61 (10.96)$^{ab}$ | 3.91 (11.40)$^{abc}$ | 4.34 (12.02)$^{bc}$ | 3.95 (11.47)$^{bc}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 3.45 (10.70) | 3.64 (11.00)$^{abc}$ | 4.13 (11.72)$^{cde}$ | 4.96 (12.86)$^{d}$ | 4.24 (11.88)$^{e}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 3.50 (10.77) | 3.62 (10.97)$^{ab}$ | 3.85 (11.32)$^{ab}$ | 4.17 (11.78)$^{b}$ | 3.88 (11.36)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 3.58 (10.90) | 3.63 (10.98)$^{ab}$ | 3.92 (11.42)$^{bc}$ | 4.27 (11.93)$^{bc}$ | 3.94 (11.45)$^{bc}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 3.54 (10.84) | 3.66 (11.03)$^{abc}$ | 4.02 (11.56)$^{bc}$ | 4.44 (12.17)$^{c}$ | 4.04 (11.59)$^{cd}$ |
| $T_{11}$ | Untreated control | - | 3.58 (10.90) | 4.93 (12.82)$^{d}$ | 6.96 (15.29)$^{g}$ | 8.94 (17.39)$^{f}$ | 6.94 (15.27)$^{g}$ |
| | **SE(m)** | | **-** | **0.12** | **0.12** | **0.09** | **0.07** |
| | **CD (P=0.05)** | | **-** | **0.35** | **0.36** | **0.27** | **0.21** |

Figures in parentheses are angular transformed values; DAA: Days After Application
The values followed by same letter did not differ significantly as per DMRT

**Table 2. Effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis after second application during rabi, 2016-17**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 5.51 (13.58)$^{d}$ | 5.71 (13.83)$^{d}$ | 6.16 (14.37)$^{d}$ | 6.86 (15.19)$^{e}$ | 6.25 (14.47)$^{e}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 6.27 (14.50)$^{g}$ | 6.60 (14.89)$^{f}$ | 7.17 (15.53)$^{g}$ | 8.00 (16.43)$^{h}$ | 7.26 (15.63)$^{h}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 6.02 (14.21)$^{ef}$ | 6.42 (14.67)$^{f}$ | 6.88 (15.21)$^{f}$ | 7.76 (16.17)$^{g}$ | 7.02 (15.36)$^{g}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 6.16 (14.37)$^{fg}$ | 6.50 (14.77)$^{f}$ | 7.06 (15.41)$^{fg}$ | 7.94 (16.37)$^{h}$ | 7.17 (15.53)$^{h}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 4.23 (11.87)$^{a}$ | 4.27 (11.93)$^{a}$ | 4.41 (12.13)$^{a}$ | 4.58 (12.36)$^{a}$ | 4.42 (12.14)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 4.87 (12.75)$^{c}$ | 5.05 (12.98)$^{c}$ | 5.36 (13.39)$^{c}$ | 5.79 (13.93)$^{c}$ | 5.40 (13.44)$^{c}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 5.84 (13.98)$^{e}$ | 6.03 (14.22)$^{e}$ | 6.51 (14.79)$^{e}$ | 7.36 (15.74)$^{f}$ | 6.63 (14.93)$^{f}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 4.55 (12.32)$^{b}$ | 4.63 (12.43)$^{b}$ | 4.86 (12.74)$^{b}$ | 5.21 (13.20)$^{b}$ | 4.90 (12.79)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 4.65 (12.45)$^{b}$ | 4.67 (12.49)$^{b}$ | 4.95 (12.86)$^{b}$ | 5.30 (13.31)$^{b}$ | 4.97 (12.89)$^{b}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 5.03 (12.96)$^{c}$ | 5.15 (13.12)$^{c}$ | 5.51 (13.58)$^{c}$ | 5.94 (14.11)$^{d}$ | 5.54 (13.61)$^{d}$ |
| $T_{11}$ | Untreated control | - | 10.71 (19.10)$^{h}$ | 11.87 (20.15)$^{g}$ | 13.19 (21.30)$^{h}$ | 14.57 (22.44)$^{i}$ | 13.21 (21.31)$^{i}$ |
| | **SE(m)** | | 0.08 | 0.09 | 0.08 | 0.05 | 0.05 |
| | **CD (P=0.05)** | | 0.23 | 0.26 | 0.23 | 0.16 | 0.14 |

*Figures in parentheses are angular transformed values; DAA: Days After Application*
*The values followed by same letter did not differ significantly as per DMRT*

**Table 3. Cumulative effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis during rabi, 2016-17**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 4.48 (12.22)$^{d}$ | 4.68 (12.49)$^{d}$ | 5.11 (13.07)$^{d}$ | 5.82 (13.96)$^{f}$ | 5.20 (13.19)$^{e}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 4.91 (12.80)$^{f}$ | 5.24 (13.24)$^{f}$ | 5.82 (13.96)$^{g}$ | 6.64 (14.94)$^{i}$ | 5.90 (14.06)$^{h}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 4.73 (12.56)$^{ef}$ | 5.12 (13.08)$^{f}$ | 5.58 (13.67)$^{f}$ | 6.46 (14.72)$^{h}$ | 5.72 (13.84)$^{g}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 4.84 (12.70)$^{ef}$ | 5.17 (13.14)$^{f}$ | 5.72 (13.83)$^{fg}$ | 6.59 (14.88)$^{i}$ | 5.83 (13.97)$^{h}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 3.87 (11.34)$^{a}$ | 3.92 (11.41)$^{a}$ | 4.04 (11.60)$^{a}$ | 4.20 (11.83)$^{a}$ | 4.05 (11.61)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 4.14 (11.74)$^{bc}$ | 4.33 (12.01)$^{c}$ | 4.63 (12.43)$^{c}$ | 5.06 (13.00)$^{d}$ | 4.68 (12.49)$^{c}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 4.64 (12.44)$^{de}$ | 4.84 (12.71)$^{e}$ | 5.32 (13.34)$^{e}$ | 6.16 (14.37)$^{g}$ | 5.44 (13.49)$^{f}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 4.02 (11.57)$^{ab}$ | 4.13 (11.72)$^{b}$ | 4.36 (12.05)$^{b}$ | 4.69 (12.51)$^{b}$ | 4.39 (12.10)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 4.11 (11.70)$^{bc}$ | 4.15 (11.76)$^{b}$ | 4.44 (12.16)$^{b}$ | 4.78 (12.63)$^{c}$ | 4.46 (12.19)$^{b}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 4.28 (11.94)$^{c}$ | 4.40 (12.11)$^{c}$ | 4.76 (12.61)$^{c}$ | 5.19 (13.17)$^{e}$ | 4.79 (12.64)$^{d}$ |
| $T_{11}$ | Untreated control | - | 7.14 (15.50)$^{g}$ | 8.40 (16.84)$^{g}$ | 10.07 (18.51)$^{h}$ | 11.75 (20.05)$^{j}$ | 10.08 (18.51)$^{i}$ |
| | **SE(m)** | | 0.09 | 0.07 | 0.08 | 0.04 | 0.04 |
| | **CD (P=0.05)** | | 0.28 | 0.22 | 0.24 | 0.13 | 0.13 |

*Figures in parentheses are angular transformed values; DAA: Days After Application The values followed by same letter did not differ significantly as per DMRT*

**Table 4. Effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis after first application during rabi, 2017-18**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 4.53 (12.29) | 4.77 (12.62)$^{ab}$ | 5.29 (13.30)$^{bcd}$ | 6.09 (14.29)$^{d}$ | 5.39 (13.42)$^{d}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 4.64 (12.44) | 5.02 (12.94)$^{c}$ | 5.71 (13.83)$^{e}$ | 6.61 (14.90)$^{f}$ | 5.78 (13.91)$^{f}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 4.52 (12.27) | 4.94 (12.84)$^{bc}$ | 5.51 (13.57)$^{de}$ | 6.46 (14.73)$^{ef}$ | 5.64 (13.73)$^{e}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 4.59 (12.37) | 4.97 (12.88)$^{bc}$ | 5.60 (13.68)$^{e}$ | 6.55 (14.83)$^{f}$ | 5.70 (13.82)$^{ef}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 4.58 (12.36) | 4.68 (12.50)$^{a}$ | 4.90 (12.78)$^{a}$ | 5.14 (13.10)$^{a}$ | 4.91 (12.80)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 4.49 (12.23) | 4.73 (12.56)$^{ab}$ | 5.13 (13.09)$^{b}$ | 5.64 (13.74)$^{bc}$ | 5.17 (13.14)$^{b}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 4.53 (12.29) | 4.77 (12.62)$^{ab}$ | 5.36 (13.38)$^{cd}$ | 6.27 (14.50)$^{de}$ | 5.47 (13.52)$^{d}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 4.57 (12.34) | 4.74 (12.58)$^{ab}$ | 5.08 (13.02)$^{ab}$ | 5.48 (13.54)$^{b}$ | 5.10 (13.05)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 4.66 (12.46) | 4.75 (12.59)$^{ab}$ | 5.15 (13.11)$^{bc}$ | 5.58 (13.66)$^{bc}$ | 5.16 (13.13)$^{b}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 4.62 (12.42) | 4.79 (12.64)$^{abc}$ | 5.25 (13.25)$^{bc}$ | 5.76 (13.89)$^{c}$ | 5.27 (13.27)$^{c}$ |
| $T_{11}$ | Untreated control | - | 4.66 (12.46) | 6.04 (14.23)$^{d}$ | 8.35 (16.79)$^{f}$ | 10.62 (19.02)$^{g}$ | 8.34 (16.78)$^{g}$ |
| | **SE(m)** | | **-** | 0.10 | 0.09 | 0.08 | 0.04 |
| | **CD (P=0.05)** | | **-** | 0.29 | 0.27 | 0.26 | 0.12 |

*Figures in parentheses are angular transformed values; DAA: Days After Application*
*The values followed by same letter did not differ significantly as per DMRT*

**Table 5. Effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis after second application during rabi, 2017-18**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 6.95 (15.29)$^{d}$ | 7.20 (15.57)$^{d}$ | 7.74 (16.15)$^{d}$ | 8.54 (16.99)$^{e}$ | 7.83 (16.25)$^{e}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 7.71 (16.12)$^{f}$ | 8.10 (16.53)$^{g}$ | 8.80 (17.26)$^{g}$ | 9.68 (18.13)$^{h}$ | 8.86 (17.32)$^{i}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 7.40 (15.78)$^{e}$ | 7.84 (16.26)$^{f}$ | 8.40 (16.85)$^{f}$ | 9.38 (17.83)$^{g}$ | 8.54 (16.99)$^{g}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 7.60 (16.00)$^{f}$ | 7.98 (16.41)$^{fg}$ | 8.64 (17.09)$^{g}$ | 9.61 (18.06)$^{h}$ | 8.74 (17.20)$^{h}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 5.67 (13.78)$^{a}$ | 5.77 (13.89)$^{a}$ | 6.00 (14.18)$^{a}$ | 6.27 (14.50)$^{a}$ | 6.01 (14.19)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 6.31 (14.55)$^{c}$ | 6.53 (14.81)$^{c}$ | 6.94 (15.27)$^{c}$ | 7.47 (15.86)$^{c}$ | 6.98 (15.32)$^{c}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 7.22 (15.59)$^{e}$ | 7.47 (15.86)$^{e}$ | 8.04 (16.47)$^{e}$ | 8.98 (17.44)$^{f}$ | 8.16 (16.60)$^{f}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 5.99 (14.17)$^{b}$ | 6.12 (14.33)$^{b}$ | 6.45 (14.71)$^{b}$ | 6.89 (15.22)$^{b}$ | 6.49 (14.75)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 6.08 (14.28)$^{b}$ | 6.16 (14.37)$^{b}$ | 6.58 (14.86)$^{b}$ | 6.97 (15.31)$^{b}$ | 6.57 (14.85)$^{b}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 6.48 (14.75)$^{c}$ | 6.65 (14.94)$^{c}$ | 7.10 (15.46)$^{c}$ | 7.63 (16.04)$^{d}$ | 7.13 (15.48)$^{d}$ |
| $T_{11}$ | Untreated control | - | 12.71 (20.89)$^{g}$ | 13.89 (21.88)$^{h}$ | 15.68 (23.33)$^{h}$ | 17.43 (24.67)$^{i}$ | 15.67 (23.32)$^{j}$ |
| | **SE(m)** | | 0.07 | 0.05 | 0.06 | 0.03 | 0.03 |
| | **CD (P=0.05)** | | 0.22 | 0.16 | 0.17 | 0.09 | 0.09 |

*Figures in parentheses are angular transformed values; DAA: Days After Application*
*The values followed by same letter did not differ significantly as per DMRT*

**Table 6. Cumulative effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis during rabi, 2017-18**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 5.74 (13.86)$^{d}$ | 5.99 (14.16)$^{d}$ | 6.52 (14.79)$^{d}$ | 7.32 (15.69)$^{e}$ | 6.61 (14.89)$^{e}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 6.18 (14.39)$^{g}$ | 6.56 (14.84)$^{g}$ | 7.26 (15.63)$^{g}$ | 8.14 (16.58)$^{h}$ | 7.32 (15.70)$^{i}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 5.96 (14.13)$^{ef}$ | 6.39 (14.64)$^{f}$ | 6.95 (15.29)$^{f}$ | 7.92 (16.34)$^{g}$ | 7.09 (15.44)$^{g}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 6.09 (14.29)$^{fg}$ | 6.47 (14.74)$^{fg}$ | 7.12 (15.47)$^{g}$ | 8.08 (16.51)$^{h}$ | 7.22 (15.59)$^{h}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 5.13 (13.09)$^{a}$ | 5.22 (13.21)$^{a}$ | 5.45 (13.50)$^{a}$ | 5.70 (13.81)$^{a}$ | 5.46 (13.51)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 5.40 (13.43)$^{bc}$ | 5.63 (13.73)$^{c}$ | 6.03 (14.22)$^{c}$ | 6.56 (14.83)$^{c}$ | 6.07 (14.27)$^{c}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 5.88 (14.03)$^{de}$ | 6.12 (14.32)$^{e}$ | 6.70 (15.00)$^{e}$ | 7.63 (16.03)$^{f}$ | 6.81 (15.13)$^{f}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 5.28 (13.29)$^{ab}$ | 5.43 (13.48)$^{b}$ | 5.76 (13.89)$^{b}$ | 6.18 (14.40)$^{b}$ | 5.79 (13.93)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 5.37 (13.40)$^{b}$ | 5.46 (13.51)$^{b}$ | 5.86 (14.01)$^{b}$ | 6.28 (14.51)$^{b}$ | 5.86 (14.01)$^{b}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 5.55 (13.63)$^{c}$ | 5.72 (13.83)$^{c}$ | 6.18 (14.39)$^{c}$ | 6.70 (15.00)$^{d}$ | 6.20 (14.41)$^{d}$ |
| $T_{11}$ | Untreated control | - | 8.68 (17.14)$^{h}$ | 9.97 (18.40)$^{h}$ | 12.02 (20.28)$^{h}$ | 14.03 (21.99)$^{i}$ | 12.00 (20.27)$^{j}$ |
| | **SE(m)** | | **0.07** | **0.05** | **0.06** | **0.04** | **0.03** |
| | **CD (P=0.05)** | | **0.22** | **0.14** | **0.18** | **0.13** | **0.08** |

*Figures in parentheses are angular transformed values; DAA: Days After Application*
*The values followed by same letter did not differ significantly as per DMRT*

**Table 7. Effect of insecticide treatments on the incidence of rice leaf folder, C. medinalis after during rabi, 2016-17 and rabi, 2017-18 (Pooled data)**

| Sl.No. | Treatment | Dosage | Pre treatment leaf damage (%) | Leaf damage (%) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 5 DAA | 10 DAA | 15 DAA | Mean |
| $T_1$ | Carbofuran 3 G | 10.0 kg/acre | 5.11 (13.06)$^{d}$ | 5.33 (13.35)$^{d}$ | 5.81 (13.95)$^{e}$ | 6.57 (14.85)$^{f}$ | 5.91 (14.06)$^{e}$ |
| $T_2$ | Cartap hydrochloride 4 G | 8.0 kg/acre | 5.54 (13.62)$^{g}$ | 5.90 (14.06)$^{g}$ | 6.54 (14.82)$^{h}$ | 7.39 (15.78)$^{i}$ | 6.61 (14.90)$^{i}$ |
| $T_3$ | Acephate 75 SP | 1.5 g/L | 5.34 (13.37)$^{ef}$ | 5.75 (13.88)$^{f}$ | 6.27 (14.50)$^{g}$ | 7.19 (15.55)$^{h}$ | 6.40 (14.66)$^{g}$ |
| $T_4$ | Cartap hydrochloride 50 SP | 2.0 g/L | 5.47 (13.52)$^{fg}$ | 5.82 (13.96)$^{fg}$ | 6.42 (14.67)$^{h}$ | 7.33 (15.71)$^{i}$ | 6.52 (14.80)$^{h}$ |
| $T_5$ | Chlorantraniliprole 18.5 SC | 0.3 mL/L | 4.50 (12.24)$^{a}$ | 4.57 (12.34)$^{a}$ | 4.75 (12.58)$^{a}$ | 4.95 (12.86)$^{a}$ | 4.76 (12.60)$^{a}$ |
| $T_6$ | Chlorpyrifos 20 EC | 2.5 mL/L | 4.77 (12.62)$^{bc}$ | 4.98 (12.90)$^{c}$ | 5.33 (13.35)$^{c}$ | 5.81 (13.95)$^{d}$ | 5.38 (13.41)$^{c}$ |
| $T_7$ | Dichlorvos 76 EC | 1.0 mL/L | 5.26 (13.26)$^{de}$ | 5.48 (13.54)$^{e}$ | 6.01 (14.19)$^{f}$ | 6.89 (15.22)$^{g}$ | 6.13 (14.33)$^{f}$ |
| $T_8$ | Flubendiamide 20 WDG | 0.25 g/L | 4.65 (12.46)$^{ab}$ | 4.78 (12.63)$^{b}$ | 5.06 (13.00)$^{b}$ | 5.44 (13.48)$^{b}$ | 5.09 (13.04)$^{b}$ |
| $T_9$ | Monocrotophos 36 SL | 1.6 mL/L | 4.74 (12.58)$^{bc}$ | 4.80 (12.66)$^{b}$ | 5.15 (13.12)$^{b}$ | 5.53 (13.60)$^{c}$ | 5.16 (13.13)$^{b}$ |
| $T_{10}$ | Profenofos 50 EC | 2.0 mL/L | 4.92 (12.81)$^{c}$ | 5.06 (13.00)$^{c}$ | 5.47 (13.53)$^{d}$ | 5.94 (14.11)$^{e}$ | 5.49 (13.55)$^{d}$ |
| $T_{11}$ | Untreated control | - | 7.91 (16.34)$^{h}$ | 9.18 (17.64)$^{h}$ | 11.05 (19.41)$^{i}$ | 12.89 (21.04)$^{j}$ | 11.04 (19.41)$^{j}$ |
| | **SE(m)** | | **0.08** | **0.04** | **0.06** | **0.04** | **0.03** |
| | **CD (P=0.05)** | | **0.24** | **0.11** | **0.17** | **0.11** | **0.09** |

*Figures in parentheses are angular transformed values; DAA: Days After Application*
*The values followed by same letter did not differ significantly as per DMRT*

After the two insecticidal applications, the cumulative mean per cent leaf folder damage indicated that the chlorantraniliprole showed most effective with lowest leaf folder damage per cent of 5.46 followed by flubendiamide and monocrotophos as the next best treatments with the paddy leaf folder damage per cent of 5.79 and 5.86. The least effective treatment was cartap hydrochloride 4 G with paddy leaf folder damage per cent of 7.32 followed by cartap hydrochloride 50 SP (7.22%) and acephate (7.09%) (Table 6).

### 3.4 Efficacy of Insecticides against Paddy Leaf Folder Damage During rabi, 2016-17 and 2017-18 (Pooled Data)

The results presented in the Table 7 indicated that all the tested insecticides had significantly low infestation of paddy leaf folder. The initial percentage of paddy leaf folder damage ranged from 4.50 to 7.91 one day before the insecticidal application. At 15 DAA, the chlorantraniliprole proved as the most effective insecticide with the percentage of paddy leaf folder damage as 4.95 followed by flubendiamide and monocrotophos with the damage percentage of 5.44 and 5.53. The least effective insecticides were cartap hydrochloride 4 G (7.39%) followed by cartap hydrochloride 50 SP (7.33%) and acephate (7.19%) against paddy leaf folder damage percentage (Table 7).

The results which were presented in the Tables 1 to 7 revealed that, all the treatments had significant control of paddy leaf folder damage over untreated control. Chlorantraniliprole @ 0.3 mL $L^{-1}$ was found most effective insecticide against paddy leaf folder infestation followed by flubendiamide, monocrotophos and chlorpyrifos while cartap hydrochloride 4 G @ 8 kg $acre^{-1}$ was found to be least effective. The results of the present investigation were in conformity with the findings of Reddy et al. [6] who reported that Chlorantraniliprole 0.4% GR with 1.56 % damaged leaves was found significantly superior over control in reducing the incidence of leaf folder and the least effective was Chlorpyrifos 10% GR with 2.83 % damaged leaves. The application of Bifenthrin 10 EC (1.36%) and was followed by Fipronil 5% SC (1.39%), Acephate 75 SP (1.44%), Thiamethoxam 25% WG (1.5%), carbosulfan 25 EC (1.50%), Cartap hydrochloride 50 (1.55%) proved effective in minimizing the paddy leaf folder as per the findings of Wagh et al. [7] . Sabitha et al. [8] reported that “the treatment Chlorantraniliprole 18.5 SC (0.3 g/l) (per cent leaf folder damage: 3.29) worked best against leaf folder and this insecticide was on par to both of its mixtures with fungicides-azoxystrobin (per cent leaf folder damage: 3.02, per cent reduction over control: 92.91) and difenoconazole (per cent leaf folder damage: 3.85, per cent reduction over control: 90.63)”. According to the reports of Srinivas et al. [9], it was discovered that “chlorpyrifos and thiamethoxam were the most effective insecticides, causing 4.11% and 4.10% leaf damage, respectively”. Surekha et al. [10] reported that “among the different chemicals tested, 5 treatments viz., tetraniliprole (8.71%), chlorantraniliprole (8.89%), cartap hydrochloride (9.23%), tetraniliprole + (tebuconazole + trifloxystrobin) (9.27%) and tetraniliprole + (azoxystrobin + Difenoconazole) (9.96%) recorded lowest incidence compared to control (20.90%) and were proved to be effective against leaf folder”.

## 4. CONCLUSION

The efficacy of certain insecticides against *C. medinalis* during rabi, 2016-17 and 2017-18 revealed that, all the tested insecticides had significantly affected the larvae of *C. medinalis* and reduced the leaf damage over untreated control. The chlorantraniliprole proved as the most effective insecticide with the percentage of leaf damage as 4.95 followed by flubendiamide and monocrotophos with the damage percentage of 5.44 and 5.53. The least effective insecticides were cartap hydrochloride 4 G (7.39%) followed by cartap hydrochloride 50 SP (7.33%) and acephate (7.19%) against paddy leaf folder damage.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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