Madras Agric. J., 97 (4-6): 164-167, June 2010
https://doi.org/10.29321/MAJ.10.100372

# Bioefficacy Evaluation of Bifenthrin 10EC against Major Pests of Rice

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**Field efficacy of bifenthrin 10EC at 25, 50 and 75g ai/ha was evaluated against rice stem borer *Scirpophaga incertulas* Walker, leaf folder *Cnaphalocrocis medinalis* Guenee and green leaf hopper *Nephotettix virescens* Distant along with two standard insecticides *viz.,* lambda cyhalothrin (Karate 5EC) and chlorpyriphos (Dursban 20EC) during Kuruvai and Navarai 2006 and Navarai, 2007 seasons at Annamalai University Experimental farm, Annamalainagar. Results revealed that bifenthrin 10EC @ 75g ai/ha was the most effective against tested insects followed by bifenthrin 10EC at 50 and 25g ai/ha. Other chemicals also proved effective than control.**

**Keywords:** Bioefficacy, biofenthrin, rice pests.

Rice (*Oryza sativa* Linn.) is one of the important food crops grown in our country. One of the major reasons for the low productivity of rice is the damage caused by insects. About 300 species of insects have been reported to attack rice crop, of which 20 were found to be major pests causing 21 to 51 per cent yield loss (Singh and Dhaliwal, 1994). Among the pests, the rice stem borer *Scirpophaga incertulas* (Walker) caused 38 to 80 % yield loss in late - planted rice crop (Lal, 1996), rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) causes 60 to 70 per cent leaf damage (Kushwaha and Singh, 1984). Green leafhopper, *Nephotettix virescens* (Dist.) often assumes serious status in several rice growing tracts of India due to its notorious nature of being a vector of 'Tungro' virus disease of rice besides causing leaf damage (Rai and Khan, 2002 ).

For the management of the above pests, although several effective insecticides are available, they are reported to cause resurgence and also not effective (Panda and Shi, 1989). Bifenthrin, a synthetic pyrethroid acting as contact and stomach poison had been field tested against cotton, grapes and chillies and found effective (Thulasiram *et al.,* 2005). To test the field efficacy of bifenthrin against the above mentioned pests of rice the following study was carried out.

## Materials and Methods

Three field trials were conducted at two different locations in randomized block design with five treatments and four replications. The first field trial was conducted at *Koilpathu*, *Sirkazhi* during *Navarai* season 2006 (December- March), with the rice variety ADT 43. The second and third field trial were conducted during Late *Kuruvai* (July-September) and *Navarai* season, 2007 (December – March) with CR 1009 and ADT36 variety respectively at Annamalai University experimental farm, Annamalainagar. Recommended agronomic practices were adopted except plant protection measures.

Three doses of bifenthrin10 EC (Talstar 10EC) *viz.,* 25, 50 and 75g ai/ha, lambda cyhalothrin (Karate 5 EC) 12.5 g ai/ha and chlorpyriphos (Dursban 20EC) @ 37.5g ai/ha were applied. The first application was done on 45 days after transplanting. The second spray was given on 10$^{th}$ day after the first application. Precount was taken one day before each application and the post counts were taken on I$^{st}$, 4$^{th}$ and 7$^{th}$ and 9$^{th}$ day after each application. The efficacy of insecticides were evaluated based on population level (GLH), leaf damage (leaf folder), dead heart and white ear (stem borer). The pest population and damage levels were assessed by the following methods.

Leaf folder: Leaf damage was estimated on 10 hills / plot and the per cent damage was calculated (Panda and Rath, 2004).

$$\text{Percent leaf damage} = \frac{\text{No. of infested leaves /10 hills}}{\text{Total No. of leaves / 10 hills}} \times 100$$

Green leaf hopper : The population of green leafhopper was estimated by net sweepings @ ten times/plot (Dyck and Pathak, 1974).

Stem borer : The per cent incidence of stem borer was calculated from 10 hills in each plot (Heinrichs *et al.,* 1981) at vegetative and tillering stages.

$$\text{Per cent dead heart} = \frac{\text{No. of dead hearts in infested hills}}{\text{Total No. of tillers observed in infested hills}} \times 100$$

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$$\text{Per cent white ear} = \frac{\text{No. of white ears in infested hills}}{\text{Total No. of tillers observed in infested hills observed}} \times 100$$

The data on green leaf hopper population, incidence of leaf folder and stem borer were analysed using FRBD and converted to corresponding angles (Snedecor and Cochran, 1967). The mean values were separated using DMRT (Gomez and Gomez, 1984).

## Results and Discussion

### *Effect on leaf folder*

Efficacy of bifenthrin 10EC after first spray during *Navarai* 2006 (Trial I) revealed that the incidence of leaf folder was significantly reduced in all the treatments compared to control. Bifenthrin10EC @ 75 g a.i./ha reduced the infestation to a minimum of 5.12%. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ ha and chlorpyriphos 20 EC @ 37.5 g a.i./ha recorded the infestation levels of 7.26 and 6.94 %, respectively 10 days after first spray. After the 10 days of second spray the incidence of leaf folder was minimum (1.69 %) at bifenthrin10 EC @ 75 g a.i./ha (Table 1).

During late *Kuruvai* 2006 (Trial II) after 10 days of first spray a mean incidence of leaf folder (8.98%) was recorded in bifenthrin 10 EC @ 75 g a.i./ha treated plots followed by bifenthrin10 EC @ 50 g a.i./ha and 25 g a.i./ha with the incidence levels of 10.40 and 12.41 %, respectively (Table 1).

During second spray after 10 of spray the mean incidence of leaf folder recorded 4.35% in bifenthrin10 EC @ 75 g a.i./ha treated plots, whereas 4.87 % and 5.75 % in bifenthrin10 EC @ 50 g a.i./ha and bifenthrin10 EC @ 25 g a.i./ha, respectively. The mean incidence of leaf folder recorded in control was maximum (26.39%) (Table 1).

**Table 1. Bioefficacy of bifenthrin 10 EC against leaf folder in rice ecosystem**

| Treatment | % Leaf damage | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Navarai* 2006 | | | | Late *Kuruvai* 2007 | | | | *Navarai* 2007 | | | |
| | I spray | | II spray | | I spray | | II spray | | I spray | | II spray | |
| | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS |
| Bifenthrin 10 EC 25 g ai/ha | 8.13 | 6.64 $^{ab}$ | 6.02 | 2.13 $^{a}$ | 14.86 | 12.41$^{ab}$ | 12.41 | 5.75 $^{a}$ | 10.41 | 8.52 $^{b}$ | 8.52 | 4.22 $^{b}$ |
| | (15.74) | (14.79) | (14.17) | (8.28) | (22.67) | (20.62) | (21.08) | (15.76) | (18.32) | (16.96) | (16.99) | (11.84) |
| Bifenthrin 10 EC 50 g ai/ha | 8.76 | 5.78 $^{a}$ | 5.11 | 1.83 $^{a}$ | 13.97 | 10.40 $^{a}$ | 10.40 | 4.87 $^{a}$ | 11.63 | 8.49 $^{b}$ | 8.49 | 3.94 $^{b}$ |
| | (16.41) | (13.89) | (13.03) | (7.62) | (21.94) | (18.81) | (19.68) | (14.89) | (19.93) | (16.90) | (16.91) | (11.31) |
| Bifenthrin 10 EC 75 g ai/ha | 8.42 | 5.12 $^{a}$ | 4.86 | 1.69 $^{a}$ | 13.41 | 8.98 $^{a}$ | 9.98 | 4.35 $^{a}$ | 12.67 | 7.31 $^{a}$ | 7.31 | 2.32 $^{a}$ |
| | (16.05) | (13.06) | (12.71) | (7.28) | (21.48) | (17.41) | (18.66) | (13.26) | (20.84) | (15.67) | (15.68) | (8.67) |
| Lambda cyhalothrin 5 EC | 8.74 | 7.26 $^{bc}$ | 6.31 | 2.77 $^{bc}$ | 14.28 | 14.22 $^{c}$ | 14.22 | 6.96 $^{b}$ | 9.92 | 8.33 $^{b}$ | 9.33 | 4.41 $^{b}$ |
| 12.5 g ai/ha | (16.39) | (15.60) | (14.53) | (9.50) | (22.19) | (22.27) | (22.09) | (16.97) | (18.20) | (17.38) | (15.68) | (12.10) |
| Chlorpyriphos 20EC | 8.17 | 6.94 $^{bc}$ | 6.67 | 3.06 $^{bc}$ | 13.21 | 15.31$^{cd}$ | 15.31 | 10.21 $^{c}$ | 10.52 | 9.33 $^{c}$ | 8.33 | 6.84 $^{c}$ |
| 37.5 g ai/ha | (15.78) | (15.26) | (14.95) | (10.01) | (21.31) | (23.03) | (22.68) | (12.62) | (18.92) | (17.78) | (18.33) | (15.15) |
| Control | 8.13 | 19.89 $^{d}$ | 19.28 | 21.91 $^{d}$ | 16.32 | 22.58 $^{e}$ | 22.58 | 26.39 $^{d}$ | 11.38 | 20.30 $^{d}$ | 20.30 | 16.97 $^{e}$ |
| | (15.73) | (26.47) | (26.03) | (27.91) | (22.71) | (28.31) | (22.34) | (24.89) | (19.70) | (26.78) | (16.76) | (24.32) |
| Mean | 8.39 | 8.60 | 8.04 | 5.48 | 14.10 | 13.97 | 13.97 | 9.75 | 11.09 | 10.48 | 10.48 | 6.45 |
| | (10.02) | (16.5) | (15.90) | (11.77) | (22.05) | (21.75) | (21.08) | (16.40) | (14.40) | (18.58) | (18.58) | (13.90) |
| **SEd** | | 0.768 | | 0.372 | | 0.852 | | 0.425 | | 0.304 | | 0.625 |
| **CD (p=0.05)** | | 1.547 | | 0.749 | | 1.702 | | 0.889 | | 0.643 | | 1.287 |

Figures in parentheses indicate arc sine transformed values; *Values are mean of four replications;
Values with different alphabets differ significantly by DMRT (p=0.05; DAS- Days after spray

During *Navarai* 2007 (Trial III) 10 days after first spray the mean incidence of leaf folder varied from a minimum of 7.31 % in bifenthrin10 EC @ 75 g a.i./ ha treated plots and the maximum of 20.30 % recorded in untreated control. After second spray the mean population of leaf folder recorded was 2.32% in bifenthrin10 EC @ 75 g a.i./ha treated plot. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ha recorded 4.41 % mean leaf damage whereas chlorpyriphos 20 EC @ 37.5 g a.i./ha recorded 6.84%. The maximum mean leaf damage of 16.97% was observed in control plots (Table 1).

### *Effect on stem borer*

Effect of bifenthrin 10EC after first spray during *Navarai* 2006 on the incidence of stem borer was studied both in vegetative and tillering stages of the crop. During the vegetative stage, 4.43 % dead heart and 7.82 % white ear were recorded in bifenthrin 20 EC @ 75 g a.i./ha treated plots. Bifenthrin10 EC @ 50 g a.i./ ha recorded 4.85 % dead heart and 8.50 % white ear and bifenthrin10 EC @ 25 g a.i./ ha recorded 5.45 % dead heart and 9.32 % white ear during vegetative and reproductive stage, respectively. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ ha recorded 5.77 % dead heart and 9.70 % white ear and chlorpyriphos 20 EC @ 37.5 g a.i./ha produced 8.16 % dead heart & 12.43% white ear whereas in control it was 12.47 % and 18.81 % dead heart and white ear, respectively (Table 2).

**Table 2. Bioefficacy of bifenthrin 10 EC against stem borer in rice ecosystem**

| Treatment | % Leaf damage | | | | | |
|---|---|---|---|---|---|---|
| | *Navarai* 2006 | | Late *Kuruvai* 2007 | | *Navarai* 2007 | |
| | Mean % DH (at 50 DATP)* | Mean % WE (at harvest)* | Mean % DH (at 50 DATP)* | Mean % WE (at harvest)* | Mean % DH (at 50 DATP)* | Mean % WE (at harvest)* |
| Bifenthrin 10 EC 25 g ai/ha | 5.45$^{bc}$ | 9.32$^{b}$ | 4.21$^{b}$ | 8.95$^{b}$ | 5.9$^{b}$ | 8.1$^{b}$ |
| | (13.50) | (17.77) | (11.84) | (17.40) | (14.05) | (16.53) |
| Bifenthrin 10 EC 50 g ai/ha | 4.85$^{ab}$ | 8.50$^{ab}$ | 3.13$^{ab}$ | 8.04$^{a}$ | 4.8$^{a}$ | 7.2$^{a}$ |
| | (12.72) | (16.95) | (10.19) | (16.47) | (12.65) | (15.56) |
| Bifenthrin 10 EC 75 g ai/ha | 4.43$^{a}$ | 7.82$^{a}$ | 2.22$^{a}$ | 7.79$^{a}$ | 4.3$^{a}$ | 6.4$^{a}$ |
| | (12.15) | (16.23) | (8.56) | (16.20) | (11.96) | (14.65) |
| Lambda cyhalothrin 5 EC 12.5 g ai/ha | 5.77$^{c}$ | 9.70$^{b}$ | 5.80$^{c}$ | 9.30$^{b}$ | 6.6$^{b}$ | 9.5$^{c}$ |
| | (13.89) | (18.14) | (13.93) | (17.75) | (13.68) | (17.95) |
| Chlorpyriphos 20EC 37.5 g ai/ha | 8.16$^{d}$ | 12.43$^{c}$ | 6.76$^{c}$ | 11.81$^{b}$ | 7.8$^{c}$ | 10.7$^{c}$ |
| | (16.59) | (20.64) | (16.20) | (20.29) | (16.21) | (19.09) |
| Control | 12.47$^{e}$ | 18.81$^{d}$ | 9.25$^{d}$ | 15.59$^{c}$ | 11.2$^{d}$ | 16.8$^{d}$ |
| | (20.67) | (25.76) | (17.70) | (23.25) | (19.55) | (24.19) |
| **SEd** | 0.910 | 0.500 | 0.540 | 0.600 | 0.770 | 1.640 |
| **CD (p=0.05)** | 1.940 | 1.070 | 1.150 | 1.200 | 0.640 | 1.360 |

Figures in parentheses indicate arc sine transformed values ; Values are mean of four replications; Values with different alphabets differ significantly by DMRT (p=0.05; DAS- Days after spray ; DATP – Days after transplanting ; DH – Dead heart; E — White ear

During *Kuruvai* 2007, the mean per cent incidence of dead heart in bifenthrin10 EC @ 75 g a.i./ ha treated plots was 2.22% and 7.79% white ear followed by bifenthrin10 EC @ 50 g a.i./ha (3.13% dead heart and 8.04% white ear) and bifenthrin10 EC @ 25 g a.i./ha (4.21% dead heart and 8.95% white ear). The maximum incidence recorded in control was 9.25% dead heart and 15.59% white ear (Table 2).

During *Navarai* 2007, control plots recorded 11.2% dead heart and 16.80% white ear symptoms. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ha and chlorpyriphos 20 EC @ 37.5 g a.i./ha recorded 6.60%, 7.80 % dead heart and 7.8, 10.7% white ear, respectively. Bifenthrin10 EC @ 75 g a.i./ha recorded minimum level of incidence at 4.30 % dead heart and 6.40 % white ear (Table 2).

***Effect on green leafhopper***

Effect of bifenthrin10 EC against green leaf hopper after 10 days of first spray in Navarai 2006 season revealed that bifenthrin10 EC @ 75 g a.i./ha recorded a minimum of 4.00/net sweep followed by bifenthrin10 EC @ 50 g a.i./ha treated plot (4.50) and bifenthrin10 EC @ 25 g a.i./ha (4.50) treated plot. The mean population levels of GLH recorded in chlorpyriphos 20 EC @ 37.5 g a.i./ha and lambda cyhalothrin 5 EC @ 12.5 g a.i./ha were 5.25 and 4.75, respectively. The maximum mean incidence was recorded in control (7.25) (Table 3).

During second spray after 10 days of treatment, bifenthrin10 EC @ 75 a.i./ ha recorded a lower level of GLH population (2.50/net sweep) followed by bifenthrin10 EC @ 50 a.i./ha and bifenthrin10 EC @ 25 g a.i./ ha with 3.50 and 4.75 GLH/sweep respectively. The mean population of GLH recorded was 5.00 and 5.50 in lambda cyhalothrin and chlorpyriphos respectively. The maximum population recorded in control was 9.25 GLH/sweep where the mean population was 5.25 GLH/ sweep hill (Table 3).

The mean incidence of green leafhopper after 10 days of first spray during late *Kuruvai* 2007, was maximum (9.75) in untreated control. The mean population was reduced (5.00) in bifenthrin10 EC @ 75 g a.i./ha treated plots. Bifenthrin10 EC @ 50 g a.i./ ha and bifenthrin10 EC @ 25 g a.i./ ha recorded 6.50 and 7.00/ sweep, respectively. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ha and chlorpyriphos 20 EC @ 37.5 g a.i./ ha recorded 8.25 GLH/sweep. After 10 days of second spray the control recorded at maximum level of mean GLH incidence (13.75). Lambda cyhalothrin 5 EC @ 12.5 g a.i./ha recorded 6.25 GLH and chlorpyriphos 20 EC @ 37.5 g a.i /ha recorded 7.50 GLH. Bifenthrin10 EC @ 25 g a.i./ha recorded 5.75 GLH followed by bifenthrin10 EC @ 50 g a.i./ha (5.50). The lowest mean population was recorded in bifenthrin10 EC @ 75 g a.i./ha with the population of 3.00 sweep (Table 3).

In the third trial during *Navarai* 2007, the mean population of GLH after 10 days of first spray recorded maximum in the control (9.25) and all the insecticide treated plots were significantly superior over control. Bifenthrin10 EC @ 75 g a.i./ha recorded low GLH population (4.75) followed by bifenthrin10 EC @ 50 g a.i./ha and bifenthrin10 EC @ 25 g a.i./ha. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ha recorded the mean population of 6.75 and the chlorpyriphos recorded with 7.75 GLH. After 10 days of second spray bifenthrin10 EC @ 75 g a.i./ha showed the mean population of 3.50 GLH whereas control was 11.75 GLH. Bifenthrin10 EC @ 50 g a.i./ha (3.75) and bifenthrin10 EC @ 25 g a.i./ha (4.00) were also significantly reduced the population of GLH. Lambda cyhalothrin 5 EC @ 12.5 g a.i./ha recorded 4.75 GLH and chlorpyriphos was 5.00 GLH/sweep (Table 3).

**Table 3. Bioefficacy of bifenthrin 10 EC against green leaf hopper in rice ecosystem**

| Treatment | No of GLH/sweep* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Navarai* 2006 | | | | Late *Kuruvai* 2007 | | | | *Navarai* 2007 | | | |
| | I spray | | II spray | | I spray | | II spray | | I spray | | II spray | |
| | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS | Pre count | 10 DAS |
| Bifenthrin 10 EC 25 g ai/ha | 5.75 | 4.50 [a] | 4.50 | 4.75 [c] | 9.00 | 7.00 [b] | 7.00 | 5.75 [b] | 7.00 | 6.50 [b] | 6.50 | 4.00 [a] |
| | (2.39) | (2.11) | (2.11) | (2.17) | (2.64) | (2.54) | (2.54) | (198) | (2.64) | (2.54) | (2.54) | (1.98) |
| Bifenthrin 10 EC 50 g ai/ha | 5.75 | 4.50 [a] | 4.50 | 3.50 [b] | 9.50 | 6.50 [b] | 6.50 | 5.50 [b] | 6.50 | 6.25 [b] | 6.25 | 3.75 [a] |
| | (2.39) | 2.11) | (1.98) | (1.55) | (2.54) | (2.49) | (2.49) | (1.92) | (2.54) | (2.49) | (2.49) | (1.92) |
| Bifenthrin 10 EC 75 g ai/ha | 6.00 | 4.00 [a] | 4.00 | 2.50 [a] | 8.00 | 5.00 [a] | 5.00 | 3.00 [a] | 5.25 | 4.75 [a] | 4.75 | 3.50 [a] |
| | (2.44) | (1.98) | (1.98) | (1.55) | (2.28) | (1.92) | (2.17) | (1.85) | (2.28) | (2.17) | (2.17) | (1.85) |
| Lambda cyhalothrin 5 EC | 6.00 | 4.75 [b] | 4.75 | 5.00 [c] | 8.25 | 8.25 [c] | 8.25 | 6.25 [bc] | 7.00 | 6.75 [b] | 6.75 | 4.75 [ab] |
| 12.5 g ai/ha | (2.44) | (2.17) | (2.17) | (2.33) | (2.64) | (2.59) | (2.59) | (2.17) | (2.64) | (2.59) | (2.59) | (2.17) |
| Chlorpyriphos 20EC | 5.75 | 5.25 [bc] | 5.25 | 5.50 [cd] | 9.25 | 8.25 [c] | 8.25 | 7.50 [bc] | 6.00 | 7.75 [bc] | 7.75 | 5.00 [bc] |
| 37.5 g ai/ha | (2.39) | (2.28) | (2.28) | (2.33) | (2.44) | (2.78) | (2.59) | (2.22) | (2.44) | (2.78) | (2.78) | (2.22) |
| Control | 5.50 | 7.25 [d] | 7.25 | 9.25 [e] | 7.75 | 9.75 [d] | 9.75 | 13.75 [d] | 5.50 | 9.25 [c] | 9.25 | 11.75 [d] |
| | (2.33) | (2.68) | (2.68) | (3.03) | (2.33) | (3.03) | (3.03) | (2.11) | (2.33) | (3.02) | (3.03) | (3.27) |
| Mean | 5.79 | 5.04 | 5.04 | 5.25 | 8.62 | 7.46 | 7.46 | 6.80 | 6.20 | 6.86 | 6.86 | 5.45 |
| | (2.40) | (2.22) | (2.18) | (2.19) | (2.48) | (2.56) | (2.57) | (2.24) | (2.17) | (2.03) | (2.57) | (2.24) |
| **SEd** | | 0.312 | | 0.375 | | 0.252 | | 0.710 | | 0.396 | | 0.412 |
| **CD (p=0.05)** | | 0.633 | | 0.776 | | 0.510 | | 1.439 | | 0.806 | | 0.831 |

Figures in parentheses are square root transformed values;*Values are mean of four replications; Values with different alphabets differ significantly by DMRT (p=0.05); DAS-Days after spray

The superior performance of bifenthrin may be attributed to its long persistence and rapid penetration into the plant tissues. In addition, bifenthrin is a contact and stomach poison. The larvae might have been exposed to both actions. Bifenthrin was more effective than chlorpyriphos and lambda cyhalothrin and they were in accordance with the findings of Misra *et al*. (1998).

In the present study, the efficacy of bifenthrin10 EC was evaluated against stem borer 50 days after transplanting for recording the dead heart incidence and for recording the level of white ear incidence at the time of harvest. The superior performance of bifenthrin10 EC @ 75 g a.i./ha evidenced by reducing the incidence of dead heart and white ear and the results are in accordance with Tej Kumar (2001).

In the field trials, application of bifenthrin10 EC @ 75 g a.i./ha was the most effective against GLH followed by bifenthrin10 EC @ 50 g a.i./ha and bifenthrin10 EC @ 25 g a.i./ha and there was significant differences between treatments and control. GLH population was reduced during the cropping period in the treatments and there was successive reduction in GLH population from I and II sprays. This may be due to the stability of the product as described by Misra and Parida (2004) in acephate treated rice crop.

## References


Dyck, V.A. and Pathak, M.D. 1974. Preliminary summary of methods used in sampling insects. *Int. Rice Res. Conf.* 1974. IRRI, Philippines, *Ann. Report, IRRI,* Philippines

Snedecor, G.W. and Cochran, W.G. 1967. Statistical methods. Oxford and IBH Publ. Co., Calcutta, p.539.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for Agricultural Research. John Wiley and Sons, New York, p.680.

Heinrichs, E.A., Chelliah, S., Valencia, M.B., Arceo, M.B., Fabellar, L.T., Aquino, G.B. and Pickin, S. 1981. Manual for testing insecticides in rice. IRRI, Los Banos, Laguna, Philippines, p.134.

Kushwaha, K.S. and Singh, R. 1984. Leaf folder (LF) outbreak in Haryana. *Int. Rice. Res. Newsl.,* **9**: 20.

Lal, O.P. 1996. Recent Advances in Entomology, (Ed). Lal, O.P. APC Publications Pvt. Ltd. New Delhi, p.392.

Mishra, B.K., Senapati, B. and Mishra, P.R. 1998. Chemical control of rice leaf folder, *Cnaphalocrosis medinalis* (Guenee) in Orissa, *J. Insect Sci.,* **11**: 137-140.

Misra, H.P. and Parida, R.K. 2004. Efficacy of combination insecticides on rice gall midge and hoppers. *Pl. Protec. Bull.*, **56**: 27-28.

Panda B.M. and Rath, K.L. 2004. Efficacy of some new insecticides on the incidence of Leaf folder, *Cnaphalocrocis medinalis* Guenee infesting rice. *Ann. Pl. Protec. Sci.,* **12**: 59-62.

Panda, S.K. and Shi, N. 1989. Carbofuran induced rice leaf folder resurgence. *IRRN*., **14**:58.

Rai, A.K. and Khan, M.A. 2002. Light trap catch of rice insect pest, *Nephotettix virescens* (Distant) and its relation with climatic factors. *Ann. Pl. Protec*. *Sci*., **10**: 17-22.

Singh, J. and Dhaliwal, G.S. 1994. Insect pest management in rice: A perspective, In: Dhaliwal, G.S. and Ramesh Arora (eds.). Trends in Agricultural Pest Management. Commonwealth Publisher, New Delhi, India, 56-112.

Tej Kumar, S. 2001. Efficacy of Cartap hydrochloride for the control of major insects of rice. *Pestology*, **25**: 27-28.

Thulasiram, B.V., Patil, M., Bheemanna, M. and Hanchinal, S.G. 2005. Bioefficacy of Bifenthrin(Talstar) 10 EC against chilli insect pests in irrigated ecosystem. *Pestology*, **29**: 17-19.


Received: February 24, 2010; Accepted: June 4, 2010