DOI: 10.15740/HAS/AU/12.TECHSEAR(5)2017/1446-1453 *Agriculture Update*
Volume **12** | TECHSEAR-5 | 2017 | 1446-1453
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RESEARCH ARTICLE :

Bio-efficacy of new insecticides against the management of leaf folder, *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae) in rice

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ARTICLE CHRONICLE :
Received :
15.07.2017;
Accepted :
30.07.2017

KEY WORDS :
Rice, Rice leaf folder, Acephate, Chlorantanili prole

SUMMARY : Studies on the different chemicals evaluated for their bio-efficacy against rice leaf folder revealed that, acephate 75 SP @ 675 g a.i ha^{-1} (92.30 % reduction with 0.14 larvae/ hill) followed by chlorantaniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} (91.75 % reduction with 0.15 larvae/ hill), flubendiamide 20 WDG @ 36 g a.i. ha^{-1} (90.10 % reduction) and indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} (88.46 % reduction) were found significantly superior in reducing the population of leaf folder larvae.Among the insecticides evaluated against per cent leaf damage, the lowest leaf damage was recorded in acephate 75 SP @ 675 g a.i ha^{-1} (63.15 % reduction with 5.74 % leaf damage), flubendiamide 20 WDG @ 36 g a.i. ha^{-1} (62.19 % reduction with 5.89 % leaf damage), chlorantaniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} (61.36 % reduction) and indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} (60.78 % reduction); besides recorded higher grain and fodder yield compared to rest of the treatments.Acephate 75 SP @ 675 g a.i ha^{-1} was found to be the best insecticide in getting highest net profit and cost benefit ratio with lower leaf folder infestation (Rs. 64,264, 1: 2.79). Other insecticides such as indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} (Rs. 62,037, 1: 2.65), flubendiamide 20 WDG @ 36 g a.i. ha^{-1} (Rs. 62,307, 1: 2.64) chlorantaniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} (Rs. 63,761, 1: 2.55), indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} (Rs. 54, 642, 1: 2.31) and spinosad 45 SC @ 48.60 ml a.i. ha^{-1} (55,103, 1: 2.28) were also recorded better cost benefit ratio and net profit.

How to cite this article : Vanitha, B.K., Ashok Kumar, C.T. and Vijay Kumar, L. (2017). Bio-efficacy of new insecticides against the management of leaf folder, *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae) in rice. *Agric. Update*, **12**(TECHSEAR-5) : 1446-1453; **DOI: 10.15740/HAS/AU/12.TECHSEAR(5)2017/1446-1453.**

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BACKGROUND AND OBJECTIVES

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50 per cent of the daily calorie intake (Khush, 2005). Approximately 52 per cent of the global production of rice is lost annually owing to the damage caused by biotic stress factors, of which 21 per cent is attributed to the attack of insect pests (Yarasi *et al.*, 2008). Rice is infested by more than 100 species of insects and mites and about 20 of them are considered to be major economic significance. Among the serious insect pests, rice leaf folder (RLF), *Cnaphalocrosis medinalis* (Guenee) and yellow stem borer (YSB), *Scirpophaga*

incertulas (Walker) are considered to be major lepidopteran pests causing significant yield loss. Rice leaf folder, earlier considered to be minor pests have gained the status of major pests with the wide spread cultivation of high yielding varieties and the accompanying changes in cultural practices. Leaf folder larva fastens the edges of the leaves, folded them longitudinally and feed on green matter. A damaged leaf produce white streaks, become membranous and ultimately reduces the photosynthetic activity of the plant. The extent of loss may extend upto 63 to 80 per cent depending on agro-ecological situations (Rajendran *et al.*, 1986).

In order to cope up with ever challenging insect pest problems in rice, the farmers need to have pest management practices. Apart from varietal technology, natural enemies and cultural methods, utilisation of insecticides is the most important and effective satisfactory tool available to the farmers. Chemical control is the only practical method for farmers to respond to an increasing leaf folder infestation during the growth of a crop as the leaf folders can attack the crop during any growth stage. Therefore, evaluation of new insecticide molecules and new formulations of older molecules is an important part in the management of this pest.

RESOURCES AND METHODS

A field experiment was carried out during *Kharif* 2011 at Zonal Agricultural Research Station (ZARS), V.C. Farm, Mandya to evaluate the efficacy of newer molecules against the rice leaf folder. Trial consisted of 11 treatments, including an untreated control (Table A) replicated thrice. The popular and susceptible variety Mandya Vijaya was used for the study. The 20-25 days old seedlings were transplanted in each treatment in blocks of 5 x 4m in three replications at 20x15 cm between rows and plants, respectively.

The first and second sprays were given when the crop was at 35 days and 60 days after planting. In each spray, the observation on per cent leaf damage and larval population were recorded.

Per cent leaf damage :

The observation on per cent leaf damage was taken one day before spraying, 5 days, 10 days and 15 days after first and second spraying from 15 randomly selected hills in each treatment and replication. The percentage leaf damage was calculated as:

$$\text{\% leaf damage} = \frac{\text{Number of infested leaves}}{\text{Total number of leaves}} \times 100$$

Effect on larval population :

The observation on larval population was recorded one day prior to spraying, 1 day after spraying, 3 days after spraying and 5 days after spraying by counting the number of larvae in each hill and in each treatment separately.

The per cent leaf damage and the larval population in each treatment were subjected for ANOVA (Gomez and Gomez, 1984) and the means were compared by Tukey HSD test (Tukey, 1965). The percentage reduction of leaf damage over untreated control was calculated as:

$$\text{\% reduction over unteated control} = \frac{100 \times \text{\% leaf damage in treatment}}{\text{\% leaf damage in control}} - 100$$

The harvesting was done at physiological maturity. The grain and fodder (biomass) yields were recorded treatment wise. The data thus collected were subjected

Table A : Treatment details for the management of rice leaf folder, *C. medinalis*

Sr. No.	Treatments	Trade name	Dose ml or g/lt	Dose ml/g (a.i. ha^{-1})
1.	Chlorantraniliprole 18.5 SC	Corazen	0.25	41.62
2.	Chlorantraniliprole 18.5 SC	Corazen	0.20	33.30
3.	Flubendiamide 20 WDG	Takumi	0.20	36.00
4.	Flubendiamide 20 WDG	Takumi	0.15	27.00
5.	Flubendiamide 48 SC	Fame	0.05	21.60
6.	Indoxacarb 15.8 EC	Dhawagold	0.25	35.55
7.	Indoxacarb 14.5 SC	Avaunt	0.30	39.15
8.	Spinosad 45 SC	Tracer	0.12	48.60
9.	Acephate 75 SP	Asataf	1.0	675.0
10.	Quinalphos 25EC	Ekalux	2.0	450.0
11.	Untreated Control	-	-	-

to statistical analysis. In each treatment per cent additional grain yield over untreated control was calculated as:

$$\text{\% additional grain yield} = \frac{\text{\% damage in treatment} - \text{\% damage in control}}{\text{\% leaf damage in control}} \times 100$$

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Larval population :

First spray :

The larval population among the treatments a day before spray varied from 0.48 to 0.73 larvae/ hill. However, no significant difference was observed among the treatments (Table 1).

A day after spray, each treatment differed significantly with respect to the total larval population. Treatment acephate 75 SP @ 675 g a.i. ha^{-1} recorded significantly lower larval population (0.24 larvae per hill); this was followed by flubendiamide 20 WDG @ 27 g a.i. ha^{-1},chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1} and chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} recorded 0.35, 0.37 and 0.39 larvae per hill, respectively and these treatments were at par with each other. Further, flubendiamide 20 WDG @ 21.6 ml a.i. ha^{-1} and flubendiamide 20 WDG @ 36 g a.i. ha^{-1} recorded mean larval population of 0.43 and 0.48 larvae per hill, respectively and these two treatments were at par with indoxacarb 15.8 EC @ 35.5 ml a.i. ha^{-1}, indoxacarb 14.5 Sc @ 39.15 ml a.i. ha^{-1}, a check quinalphos 25 EC @ 450 ml a.i. ha^{-1} and spinosad 45 SC @ 48.6 ml a.i. ha^{-1} which recorded 0.51, 0.53, 0.53 and 0.56 larvae per hill, respectively and were at par with each other. However, the lowest larval population was recorded in untreated control (0.66 larvae per hill). There was no significant difference with respect to the larval population 3 days after spray.

On 5th day after spray all treatments differed significantly. The treatments acephate 75SP @ 675 g a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1}, indoxacarb 15.8 EC @ 35.5 ml a.i. ha^{-1}, flubendiamide

Table 1 : Bio-efficacy of newer insecticides against rice leaf folder, *C. medinalis* at Mandya, *Kharif* 2011

Sr. No.	Treatments	Dose ml or g/lt	Dose ml or g a.i./hac	Larval population								Mean	% reduction over untreated
				1 st spray				2 nd spray					
				1 DBS	1 DAS	3 DAS	5 DAS	1 DBS	1 DAS	3 DAS	5 DAS		
1.	Chlorantraniliprole 18.5 SC	0.25	41.62	0.68 (1.08)	0.39 (0.94)^{ab}	0.22 (0.84)	0.20 (0.83)^{a}	0.26 (0.87)^{a}	0.22 (0.85)^{a}	0.18 (0.82)^{a}	0.11 (0.78)^{a}	0.15	91.75
2.	Chlorantraniliprole 18.5 SC	0.20	33.30	0.55 (1.02)	0.37 (0.93)^{ab}	0.26 (0.87)	0.28 (0.88)^{ab}	0.44 (0.97)^{ab}	0.38 (0.94)^{ab}	0.31 (0.90)^{abc}	0.24 (0.86)^{a}	0.26	85.71
3.	Flubendiamide 20 WDG	0.20	36.00	0.64 (1.06)	0.48 (0.99)^{abc}	0.20 (0.83)	0.24 (0.85)^{a}	0.35 (0.92)^{ab}	0.24 (0.86)^{a}	0.20 (0.83)^{ab}	0.11 (0.78)^{a}	0.18	90.10
4.	Flubendiamide 20 WDG	0.15	27.00	0.48 (0.99)	0.35 (0.92)^{ab}	0.31 (0.89)	0.28 (0.87)^{ab}	0.47 (0.98)^{ab}	0.42 (0.96)^{ab}	0.38 (0.94)^{bc}	0.26 (0.87)^{a}	0.28	84.61
5.	Flubendiamide 48 SC	0.05	21.60	0.68 (1.08)	0.43 (0.97)^{abc}	0.24 (0.85)	0.28 (0.88)^{ab}	0.51 (1.00)^{ab}	0.40 (0.95)^{ab}	0.33 (0.91)^{abc}	0.24 (0.86)^{a}	0.26	85.71
6.	Indoxacarb 15.8 EC	0.25	35.55	0.57 (1.03)	0.51 (1.00)^{bc}	0.20 (0.83)	0.20 (0.83)^{a}	0.49 (0.99)^{ab}	0.38 (0.94)^{ab}	0.28 (0.88)^{abc}	0.22 (0.85)^{a}	0.21	88.46
7.	Indoxacarb 14.5 SC	0.30	39.15	0.61 (1.05)	0.53 (1.01)bc	0.22 (0.84)	0.24 (0.85)^{a}	0.33 (0.91)^{a}	0.24 (0.86)^{a}	0.18 (0.82)^{a}	0.15 (0.81)^{a}	0.20	89.01
8.	Spinosad 45 SC	0.12	48.60	0.73 (1.10)	0.56 (1.03)^{bc}	0.28 (0.87)	0.24 (0.86)^{ab}	0.31 (0.90)^{a}	0.24 (0.86)^{a}	0.15 (0.81)^{a}	0.13 (0.79)^{a}	0.19	89.56
9.	Acephate 75 SP	1.0	675.0	0.64 (1.06)	0.24 (0.86)^{a}	0.22 (0.84)	0.17 (0.82)^{a}	0.35 (0.92)^{ab}	0.22 (0.85)^{a}	0.15 (0.81)^{a}	0.11 (0.78)^{a}	0.14	92.30
10.	Quinalphos 25EC	2.0	450.0	0.57 (1.03)	0.53 (1.01)^{bc}	0.37 (0.93)	0.31 (0.89)^{ab}	0.60 (1.05)^{b}	0.55 (1.03)^{b}	0.40 (0.95)^{c}	0.31 (0.90)^{a}	0.31	82.96
11.	Untreated Control	-	-	0.62 (1.05)	0.66 (1.07)^{c}	0.70 (1.09)	0.77 (1.12)^{b}	0.88 (1.18)^{c}	1.02 (1.23)^{c}	2.18 (1.64)^{d}	2.86 (1.83)^{b}	1.82	--
S.E.±				NS	0.02	NS	0.05	0.02	0.02	0.02	0.03	--	--
C.D. (P=0.05)					0.08		0.16	0.07	0.06	0.06	0.10		

DBS- Day before spraying; DAS- Days after spraying; NS=Non-significant; figures in the parenthesis are √x+0.5 transformed values. Values in the column followed by common letters are non significant at P=0.05 as per Tukey's HSD test.

20 WDG @ 36 g a.i. ha^{-1} and indoxacarb 14.5 Sc @ 39.15 ml a.i. ha^{-1} recorded a significant lower population of 0.17, 0.20, 0.20, 0.24 and 0.24 larvae per hill, respectively and were at par with each other. However, acephate 75SP @ 675 g a.i. ha^{-1} proved to be best among all treatments (0.17 larva per hill). The next best treatments were spinosad 45 SC @ 48.6 ml a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 33.3 ml a.i. ha^{-1}, flubendiamide 20 WDG @ 27 g a.i. ha^{-1}, flubendiamide 20 WDG @ 21.6 ml a.i. ha^{-1}, and quinalphos 25 EC @ 450 ml a.i. ha^{-1} which recorded 0.24, 0.28, 0.28, 0.28, and 0.31 larvae per hill, respectively and were at par with each other. However, untreated control recorded the maximum larval population (0.77 larva per hill).

Second spray :

Similar trend was observed in the second spray. Among the treatments chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1}, indoxacarb 14.5 Sc @ 39.15 ml a.i. ha^{-1} and spinosad 45 SC @ 48.6 ml a.i. ha^{-1} recorded a significant lower larval population a day before second spray. The treatments acephate 75SP @ 675 g a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1}, flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1}, indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} and spinosad 45 SC @ 48.6 ml a.i. ha^{-1} recorded a significant lower larval population of 0.22, 0.22, 0.24, 0.24, and 0.24 larvae per hill, a day after spray and these treatments were followed by chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1}, indoxacarb 15.8 EC @ 35.5 ml a.i. ha^{-1}, flubendiamide 20 WDG @ 27.0 g a.i. ha^{-1}, and flubendiamide 20 WDG @ 21.6 ml a.i. ha^{-1} recorded 0.38, 0.38, 0.40, and 0.42 larvae per hill, respectively and were at par with each other; further, quinalphos 25 EC @ 450 ml a.i. ha^{-1} and an untreated control recorded 0.55 and 1.02 larvae per hill, respectively and differed significantly with each other.

Similar trend was observed third day after second spray in which the larval population varied between 0.15 to 2.18 larvae per hill. Among the treatments, a significant lower larval population was observed in acephate 75SP @ 675 g a.i. ha^{-1}, spinosad 45 SC @ 48.6 ml a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} and

Table 2 : Bio-efficacy of newer insecticides against rice leaf folder leaf damage at Mandya during *Kharif*, 2011

Sr. No.	Treatments	Dose ml or m/lt	Dose ml/g (a.i. ha^{-1})	Per cent leaf damage								Mean	% reduction over control
				1 st spray				2 nd spray					
				1 DBS	5 DAS	10 DAS	15 DAS	1 DBS	5 DAS	10 DAS	15 DAS		
1.	Chlorantraniliprole 18.5 SC	0.25	41.62	10.69 (19.08)	10.54 (18.94)	8.57 (17.00)	7.86 (16.27)^{ab}	7.28 (15.62)^{a}	6.53 (14.79)^{a}	4.59 (12.31)^{a}	4.18 (11.78)^{a}	6.02	61.36
2.	Chlorantraniliprole 18.5 SC	0.20	33.30	10.26 (18.66)	11.14 (19.47)	10.61 (19.01)	10.06 (18.49)^{bc}	11.50 (19.72)^{bc}	10.59 (18.92)^{bc}	8.68 (17.12)^{cd}	7.46 (15.84)^{c}	8.76	50.19
3.	Flubendiamide 20 WDG	0.20	36.00	10.39 (18.80)	10.98 (19.32)	8.98 (17.43)	7.63 (16.03)^{ab}	7.62 (16.00)^{ab}	6.80 (15.11)^{a}	4.52 (12.21)^{a}	4.15 (11.73)^{d}	5.89	62.19
4.	Flubendiamide 20 WDG	0.15	27.00	10.15 (18.58)	11.74 (19.99)	10.38 (18.79)	10.01 (18.42)^{bc}	13.04 (21.11)^{cd}	10.35 (18.70)^{bc}	9.23 (17.67)^{cd}	7.80 (16.21)^{c}	8.90	51.41
5.	Flubendiamide 48 SC	0.05	21.60	10.34 (18.76)	10.76 (19.07)	10.12 (18.55)	8.67 (17.12)^{abc}	14.83 (22.62)^{cd}	12.84 (20.95)^{c}	8.22 (16.65)^{bcd}	6.82 (15.11)^{bc}	7.74	56.93
6.	Indoxacarb 15.8 EC	0.25	35.55	11.59 (19.89)	10.38 (18.79)	9.03 (17.48)	7.99 (16.42)^{abc}	15.62 (23.21)^{cd}	12.78 (20.92)^{c}	7.65 (16.02)^{bcd}	6.79 (15.01)^{bc}	7.39	60.78
7.	Indoxacarb 14.5 SC	0.30	39.15	11.08 (19.41)	11.12 (19.46)	10.10 (18.52)	8.86 (17.29)^{abc}	8.48 (16.92)^{ab}	7.34 (15.70)^{ab}	6.53 (14.77)^{abc}	4.97 (12.86)^{ab}	6.91	55.64
8.	Spinosad 45 SC	0.12	48.60	10.50 (18.90)	10.67 (19.06)	10.01 (18.42)	8.62 (17.06)^{abc}	8.27 (16.70)^{ab}	7.59 (15.98)^{ab}	5.84 (13.97)^{ab}	4.85 (12.71)^{ab}	6.73	56.80
9.	Acephate 75 SP	1.0	675.0	9.69 (18.11)	9.53 (17.96)	8.60 (17.05)	7.46 (15.82)^{a}	7.20 (15.56)^{a}	6.48 (14.73)^{a}	4.45 (12.15)^{a}	4.03 (11.56)^{a}	5.74	63.15
10.	Quinalphos 25EC	2.0	450.0	11.06 (19.40)	10.66 (19.02)	10.71 (19.10)	10.48 (18.86)^{c}	16.51 (23.97)^{d}	14.31 (22.20)^{c}	10.17 (18.59)^{d}	9.22 (17.65)^{c}	9.85	46.98
11.	Untreated control	-	-	10.55 (18.95)	12.65 (20.77)	13.88 (21.85)	14.17 (22.10)^{d}	17.89 (25.01)^{d}	19.77 (26.39)^{d}	21.34 (27.49)^{e}	23.66 (29.09)^{d}	18.91	--
S.E.±				NS	0.84	0.44	0.48	0.84	0.72	0.61	0.60	--	--
C.D. (P=0.05)					-	-	1.42	2.50	2.12	1.82	1.79		

DBS- Day before spraying; DAS- Days after spraying; NS- Non significant; Figures in the parentheses are arcsine transformed values; Values in the column followed by common letters are non significant at P=0.05 as per Tukey's HSD test.

indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} which recorded a mean larval population of 0.15, 0.15, 0.18 and 0.18 larva per hill, respectively. However, all treatments recorded a significant lower larval population compared to untreated control which recorded higher larval population (2.86 larvae per hill).

Among the treatments which were evaluated for its efficacy on the larval population of *C. medinalis* acephate 75SP @ 675 g a.i. ha^{-1} (92.30), chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} (91.75) and flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} (90.10) recorded the higher per cent reduction over untreated control. The next best treatments which recorded higher per cent larval reduction were spinosad 45 SC @ 48.6 ml a.i. ha^{-1} (89.56), indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1}(89.01), indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} (88.46), flubendiamide 20 WDG @ 21.6 ml a.i. ha^{-1} (85.71), chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1} (85.71), and flubendiamide 20 WDG @ 27 g a.i. ha^{-1} (84.61). However, check quinalphos 25 EC @ 450 ml a.i. ha^{-1} also recorded lower per cent (82.96) larval reduction (Table 2).

Per cent leaf damage :

First spray :

The per cent leaf damage among the treatments a day before spray varied 9.69 to 11.59. However, no significant differences were observed among the treatments at 5 and 10 days after the spray (Table 2).

Fifteen days days after the first spray, each treatment differed significantly with respect to leaf damage. The treatment acephate 75 SP @ 675 g a.i. ha^{-1} recorded lower per cent of leaf damage (7.46); This was followed by flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} (7.63), chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} (7.86), indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1}(7.99), spinosad 45 SC @ 48.6 ml a.i. ha^{-1} (8.62), flubendiamide 48 SC @ 21.6 ml a.i. ha^{-1} (8.67) and indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} (8.86) and were at par with each other. These were followed by flubendiamide 20 WDG @ 27 g a.i. ha^{-1} and Chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1} recorded 10.01 and 10.06 per cent leaf damage, respectively and these were at par with indoxacarb 15.8 EC @ 35.50 ml a.i. ha^{-1}, spinosad 45 SC @ 48.60 ml a.i. ha^{-1}, flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1} and indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} and recorded 7.99, 8.62, 8.67 and 8.86 per cent leaf damage, respectively. Further, check quinalphos 25 EC @ 450.0 ml a.i ha^{-1} recorded 10.48 per cent leaf damage. However, untreated control recorded highest leaf damage of 14.17 per cent when compared to all other treatments.

Over all, acephate 75 SP @ 675 g a.i. ha^{-1} proved to be best among all the treatments with lower leaf damage of 7.46 per cent. The next best treatments were flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} and chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} which recorded 7.63 and 7.86 per cent leaf damage, respectively and were at par with each other.

Second spray :

Similar trend was observed in the second spray also. Among the treatments, chlorantraniliprole 18.5 SC @

Table 3 : Bio-efficacy of new insecticides against larval population and leaf damage of rice leaf folder, *C. medinalis* at Mandya during *Kharif* 2011

Sr. No.	Treatments	Dose ml or g/lt	Dose ml/g (a.i. ha^{-1})	Ist spray		IInd spray		Mean larval population	Mean % leaf damage
				Larval population (5 DAS)	% Leaf damage (15 DAS)	Larval population (5 DAS)	% Leaf damage (15 DAS)		
1.	Chlorantraniliprole 18.5 SC	0.25	41.62	0.20	7.86	0.10	4.18	0.15	6.02
2.	Chlorantraniliprole 18.5 SC	0.20	33.30	0.28	10.06	0.17	5.46	0.22	7.76
3.	Flubendiamide 20 WDG	0.20	36.00	0.24	7.63	0.11	4.15	0.17	5.89
4.	Flubendiamide 20 WDG	0.15	27.00	0.28	10.01	0.19	5.13	0.23	7.57
5.	Flubendiamide 48 SC	0.05	21.60	0.28	8.67	0.13	4.76	0.20	6.71
6.	Indoxacarb 15.8 EC	0.25	35.55	0.20	7.99	0.10	4.23	0.15	6.11
7.	Indoxacarb 14.5 SC	0.30	39.15	0.24	8.86	0.15	4.97	0.19	6.91
8.	Spinosad 45 SC	0.12	48.60	0.24	8.62	0.13	4.85	0.18	6.73
9.	Acephate 75 SP	1.0	675.0	0.17	7.46	0.10	4.03	0.13	5.74
10.	Quinalphos 25EC	2.0	450.0	0.31	10.48	0.22	6.05	0.26	8.26
11.	Untreated Control	-	-	0.77	14.17	2.86	17.0	1.81	15.58

DBS- Day before spraying; DAS- Days after spraying

41.62 ml a.i. ha^{-1}, acephate 75 SP @ 675 g a.i. ha^{-1} recorded significant lower leaf damage a day before the second spray.

Five days after second spray, the treatments *viz.*, acephate 75 SP @ 675 g a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} and flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1}, recorded a significant lower leaf damage of 6.48, 6.53 and 6.80 per cent, respectively. These were followed by indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} and spinosad 45 SC @ 48.60 ml a.i. ha^{-1} which recorded 7.34 and 7.59 per cent leaf damage, respectively and were at par with each other.; further, flubendiamide 20 WDG @ 27 g a.i. ha^{-1} and chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1} recorded leaf damage of 10.35 and 10.59 per cent, respectively. The treatments indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1}, flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1}, and a check insecticide quinalphos 25 EC @ 450.0 ml a.i ha^{-1} recorded 12.78, 12.84 and 14.31 per cent leaf damage and were at par with each other. However, higher leaf damage was recorded in untreated control (19.77 %), which significantly differed from all other treatments.

Ten days after second spray, significant lower leaf damage of 4.45, 4.52 and 4.59 per cent was recorded in acephate 75 SP @ 675 g a.i. ha^{-1}, flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} and chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1}, respectively. The next best treatment was spinosad 45 SC @ 48.60 ml a.i. ha^{-1} which recorded 5.84 per cent leaf damage and it was at par with indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} which recorded 6.53 per cent leaf damage. The treatments indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1}, flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1}, recorded 7.65 and 7.82 per cent leaf damage and they were at par with flubendiamide 20 WDG @ 27 g a.i. ha^{-1} which recorded 9.23 per cent leaf damage. Quinalphos 25 EC @ 450.0 ml a.i ha^{-1}, a check recorded 10.17 per cent leaf damage, whereas control recorded 21.34 per cent leaf damage and both were significantly differed from each other.

As of 10 days after second spray, lower leaf damage was recorded in acephate 75 SP @ 675 g a.i. ha^{-1}, flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} and chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1}, with per cent leaf damage of 4.03, 4.15 and 4.18, respectively and were at par with spinosad 45 SC @ 48.60 ml a.i. ha^{-1} and indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} which recorded 4.85 and 4.97 per cent leaf damage, respectively. These were followed by indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} and flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1}, which recorded 6.79 and 6.82 per cent leaf damage and are at par with each other. Among the treatments, significantly higher per cent leaf damage (9.22) was recorded in check quinalphos 25 EC @ 450.0 ml a.i ha^{-1} which was found superior over control. Whereas, the maximum leaf damage of 23.66 per cent was observed in control (Table 2).

Among the insecticides which were evaluated against per cent leaf damage of *C. medinalis*, acephate

Table 4 : Effect of new insecticides against grain and biomass yield, *Kharif* 2011

Sr. No.	Treatments	Dose ml/g (a.i. ha^{-1})	Grain yield			% Increase over control	Biomass			% Increase over control
			Plot basis (kg/20m^2)	Hectare basis (q/ha)	Tons /ha		Plot basis (kg/20m^2)	Hectare basis (q/ha)	Tons /ha	
1.	Chlorantraniliprole 18.5 SC	41.62	11.83^{a}	59.15 ^{a}	5.91	64.07	13.53^{b}	67.65 ^{a}	6.76	27.64
2.	Chlorantraniliprole 18.5 SC	33.30	10.23^{de}	51.15 ^{de}	5.11	41.88	12.35^{abc}	61.75 ^{abc}	6.17	16.50
3.	Flubendiamide 20 WDG	36.00	11.45^{ab}	57.25 ^{ab}	5.72	58.80	13.10^{ab}	65.50 ^{ab}	6.55	23.58
4.	Flubendiamide 20 WDG	27.00	9.25^{f}	46.25 ^{f}	4.62	28.29	12.42^{abc}	62.10 ^{abc}	6.21	17.16
5.	Flubendiamide 48 SC	21.60	9.66^{ef}	48.30 ^{ef}	4.83	33.98	12.30^{abc}	61.50 ^{abc}	6.15	16.03
6.	Indoxacarb 15.8 EC	35.55	11.28^{abc}	56.40 ^{abc}	5.64	56.44	13.82^{a}	69.10 ^{a}	6.91	30.37
7.	Indoxacarb 14.5 SC	39.15	10.47^{cde}	52.35 ^{cde}	5.23	45.21	11.63^{bcd}	58.15 ^{bcd}	5.81	9.71
8.	Spinosad 45 SC	48.60	10.64^{bcd}	53.20 ^{bcd}	5.32	47.57	11.46^{bcd}	57.30 ^{bcd}	5.73	8.11
9.	Acephate 75 SP	675.0	11.74^{a}	58.70 ^{a}	5.87	62.82	12.46^{abc}	62.30 ^{abc}	6.23	17.54
10.	Quinalphos 25EC	450.0	8.35^{g}	41.75 ^{g}	4.17	15.81	10.80^{cd}	54.00 ^{cd}	5.40	1.88
11.	Untreated Control	--	7.21^{h}	36.05 ^{h}	3.60	--	10.60^{d}	53.00 ^{d}	5.30	--
S.E.±			0.15	0.79	--	--	0.32	1.62	--	--
C.D. (P=0.05)			0.47	2.35			0.95	4.78		

DBS- Day before spraying; DAS- Days after spraying; Values in the column followed by common letters are non significant at P=0.05 as per Tukey's HSD test.

75 SP @ 675 g a.i. ha^{-1}, flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} and chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} recorded 63.15, 62.19 and 61.36 per cent reduction of leaf damage over untreated control, respectively. Further, indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1}, spinosad 45 SC @ 48.60 ml a.i. ha^{-1} and indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} recorded per cent reduction of 60.78, 56.80 and 55.64, respectively. However, the check quinalphos 25 EC @ 450.0 ml a.i ha^{-1} recorded lower per cent leaf damage (46.98) compared to all other treatments (Table 2 and 3).

Grain yield :

Significantly higher grain yield of 59.15 and 58.70 q ha^{-1} was recorded in chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} and acephate 75 SP @ 675 g a.i. ha^{-1} with 64.07 and 62.82 per cent increase over control. The next best treatment was flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} which recorded 57.25 q ha^{-1} grain yield which resulted in 58.80 per cent yield increase over control and was at par with indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} and spinosad 45 SC @ 48.60 ml a.i. ha^{-1} which recorded 56.40 and 53.20 q ha^{-1} grain yield and per cent increase of 56.44 and 47.57, respectively. These were followed by indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} which recorded 52.35 q ha^{-1} grain yield and found at par with chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1} and flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1} which recorded 51.15 and 48.30 q ha^{-1} grain yield, respectively. These were followed by flubendiamide 20 WDG @ 27.0 g a.i. ha^{-1} which recorded grain yield of 46.25 q ha^{-1} which significantly differ from all other treatments. A check, quinalphos 25 EC @ 450.0 ml a.i ha^{-1} recorded 41.75 q ha^{-1} grain yield with 15.81 per cent increase over control and differed significantly with control (36.05 q ha^{-1}) (Table 4).

Biomass yield :

Significant differences were observed among the treatments with respect to the plant biomass yield (Table 4). The treatment indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} recorded higher biomass yield (69.10 q ha^{-1}) with 30.37 per cent increase over control and chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} recorded 67.65 q ha^{-1} and these two treatments were at par with each other. The next best treatment was flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} with 65.50 q ha^{-1} biomass (23.58 % increase over untreated control) and was at par with chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1}, flubendiamide 20 WDG @ 27.0 g a.i. ha^{-1}, flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1} and acephate 75 SP @ 675 g a.i. ha^{-1} with 61.75, 62.10, 61.50 and 62.30 q ha^{-1}, respectively. These were followed by indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} and spinosad 45 SC @ 48.60 ml a.i. ha^{-1} recorded biomass of 58.15 and 57.30 q ha^{-1} and per cent increase over control was 9.71 and 8.11, respectively. Significantly lower yield of 54.00 q ha^{-1} was recorded in check, quinalphos 25 EC @ 450.0 ml a.i ha^{-1} with only 1.88 per cent increase over untreated control; remaining treatments, indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} and spinosad 45 SC @ 48.60 ml a.i. ha^{-1} recorded lower plant biomass and were at par with control (Table 4).

Table 5 : Cost economics of rice leaf folder management by insecticides at Mandya, *Kharif* 2011

Sr. No.	Treatments	Trade name	Dose ml/g (a.i. ha^{-1})	Yield (q/ha)		Gross returns (Rs.)	Cost involved (Rs./ha)		Total cost (Rs.)	Net profit (Rs.)	C : B ratio
				Grain	Biomass		Leaf folder management	Other expenditure			
1.	Chlorantraniliprole 18.5 SC	Corazen	41.62	59.15	67.65	88725	2464	22500	24964	63761	1: 2.55
2.	Chlorantraniliprole 18.5 SC	Corazen	33.30	51.15	61.75	77292	1980	22500	24480	52812	1: 2.15
3.	Flubendiamide 20 WDG	Takumi	36.00	57.25	65.50	85887	1080	22500	23580	62307	1: 2.64
4.	Flubendiamide 20 WDG	Takumi	27.00	46.25	62.10	70992	810	22500	23310	47682	1: 2.05
5.	Flubendiamide 48 SC	Fame	21.60	48.30	61.50	73552	675	22500	23175	50377	1: 2.15
6.	Indoxacarb 15.8 EC	Dhawagold	35.55	56.40	69.10	85412	874	22500	23375	62037	1: 2.65
7.	Indoxacarb 14.5 SC	Avaunt	39.15	52.35	58.15	78222	1080	22500	23580	54642	1: 2.31
8.	Spinosad 45 SC	Tracer	48.60	53.20	57.30	79187	1584	22500	24084	55103	1: 2.28
9.	Acephate 75 SP	Asataf	675.0	58.75	62.30	87277	513	22500	23013	64264	1: 2.79
10.	Quinalphos 25EC	Ekalux	450.0	41.75	54.00	63725	720	22500	23220	40505	1: 1.74
11.	Untreated control	-	-	36.05	53.00	56140	-	22500	22500	33640	1: 1.49

* Price of paddy grains = Rs. 1300.00 per quintal; Price of fodder = Rs. 1750.00 per ton.

Cost economics of leaf folder management :

The results on cost economics revealed that acephate 75 SP @ 675 g a.i. ha^{-1} registered the highest net profit of Rs. 64,264 ha^{-1}. This was followed by chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1}, flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1}, indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1}, spinosad 45 SC @ 48.60 ml a.i. ha^{-1}, indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1}, flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1} and flubendiamide 20 WDG @ 27.0 g a.i. ha^{-1} recorded Rs. 63,761, 62,307, 62,037, 55,103, 54, 642, 52,812, 50,377 and 47,682 per ha^{-1}, respectively. Likewise, quinalphos 25 EC @ 450.0 ml a.i ha^{-1} recorded Rs. 40,505 (Table 5).

Similarly, the highest cost benefit ratio (1: 2.79) was recorded in acephate 75 SP @ 675 g a.i. ha^{-1} followed by indoxacarb 15.8 EC @ 35.55 ml a.i. ha^{-1} (1: 2.65), flubendiamide 20 WDG @ 36.0 g a.i. ha^{-1} (1: 2.64), chlorantraniliprole 18.5 SC @ 41.62 ml a.i. ha^{-1} (1: 2.55), indoxacarb 14.5 SC @ 39.15 ml a.i. ha^{-1} (1: 2.31), spinosad 45 SC @ 48.60 ml a.i. ha^{-1} (1: 2.28), chlorantraniliprole 18.5 SC @ 33.30 ml a.i. ha^{-1} (1:2.16), flubendiamide 48 SC @ 21.60 ml a.i. ha^{-1} (1: 2.15) and flubendiamide 20 WDG @ 27.0 g a.i. ha^{-1} (1: 2.05). However, quinalphos 25 EC @ 450.0 ml a.i ha^{-1} recorded low cost benefit ratio (1: 1.74) among the treatments (Table 5). In general, the cost benefit ratio also depends upon the type of the chemical, dosage and cost of the chemical formulation (Dash and Mukherjee, 2004 and Mathur *et al.,* 1999).

Suresh *et al.* (2011) reported the superiority of flubendiamide 480 SC @ 0.2 ml/l with 4.60 per cent damaged leaves at 5 days after spray. Ten days after the application of flubendiamide, maintained lowest per cent damaged leaves and was at par with spinosad 45 SC @0.2 ml/l, indoxacarb 14.5 SC @ 0.5 ml/l and fipronil 5 FS @ 2.5 ml/l.Karthikeyan *et al.* (2008) observed significantly least leaf folder damage in spinosad @ 54 g. a.i. ha^{-1}. Nalini *et al*. (2008) reported Cartap hydrochloride 50 SP and spinosad 2.5 SC were effective against rice leaf folder and resulted in 96.27 and 95.63 per cent larval mortality.Javaregowda and Naik (2005) also reported that flubendiamide 20 WDG (RIL-038) is an effective chemical for the management of paddy stem borer and leaf folder.

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