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Ingle Dipak Shyamrao
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

M Raghuraman
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Correspondence
Ingle Dipak Shyamrao
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Management of leaf folders, *Cnaphalocrocis medinalis* (Linnaeus) through conventional and newer insecticides in rice ecosystem of Varanasi region

Ingle Dipak Shyamrao and M Raghuraman

Abstract
An experimental trial was conducted during *Kharif* season of 2016-17 and 2017-18 at the Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to manage the leaf folder, *Cnaphalocrocis medinalis* (Linnaeus) through conventional and newer insecticides in rice. The leaf folder infestation varied from 4.07 to 9.21 per cent during both the year of investigation. Among the various insecticidal field evaluations against leaf folder, flubendiamide 20% WG @ 25 g a.i./ha was found best effective treatment against leaf folder followed by Chlorantraniliprole 18.5% SC @ 30 g a.i./ha, Lamda Cyhalothrin 5% EC @ 20 g a.i./ha, Fipronil 5% SC @ 50 g a.i./ha, Dinotefuran 20% SG @ 40 g a.i./ha, and Thiamethoxam 25% WG @ 25 g a.i./ha respectively during both *Kharif* season of 2016-17 and 2017-18. The highest mean grain yield 5.10 t/ha during 2016-17 and 4.77 t/ha during 2017-18 was recorded from the plots treated with Flubendiamide 20% WG @ 25 g a.i./ha. While the lowest mean grain yield 3.38 and 3.00 t/ha was harvested from the plots treated with Neem (Azadirachtin 0.15% EC) @ 4 ml/liter during *Kharif* 2016-17 and 2017-18, respectively.

Keywords: Bio-efficacy, rice pest, leaf folder, flubendiamide

Introduction

Purvanchal is one of the major rice growing tracts in Uttar Pradesh, India. In Asia, about two billion people obtained 60-70 per cent of their energy intake from rice and its products (Rai M. 2004) [13]. Rice occupies the largest area amongst all food crops in India. India ranks second in rice production globally and occupies an area of 44.00 million hectares producing 111.00 million tones with the productivity of 3.78 t/ha (Anonymous. 2016) [4]. West Bengal is the major producer of rice in India and Uttar Pradesh ranks second. In Uttar Pradesh, 4.55 million hectares was occupied by rice in India which produced 12.51 million tones with a productivity of 2.13 t/ha Among the various factors, insect pests are the main courses of the low yield of rice in India (Matteson, 2000 and Behura *et al.*, 2011) [10, 5]. Around 52 per cent of the worldwide production of rice is lost yearly due to the damage caused by biotic stress factors, of which 21 per cent is attributed by the attack of major insect pests (Yarasi *et al*., 2008) [16]. There was up to 25 per cent loss caused by insect damage in rice (Dhaliwal *et al.*, 2010) [7]. Yield losses due to rice leaf roller estimated 20-30 per cent every year (Prakash *et al.*, 2008). Use of insecticide has a positive impact on rice production (Mishra and Parida, 2004) [11]. Rice production is nearly correlated with insecticide use in rice. Application of insecticide increased the paddy yield of Basmati-385 by 42.6 to 54.5 per cent over control and cost benefit cost ratio of 1:7 to 1:14 was obtained (Khan *et al.*, 2010) [9]. Finally, rice leaf folder, *Cnaphalocrocis medinalis* (Guen.) was considered as pests of minor pests importance has increased in abundance in late 1980 and have become major pests in many parts of the world (Ahmed *et al.*,2010) [1]. An increase in leaf folder population could be attributed to the large scale cultivation of high yielding varieties, excessive use of nitrogenous fertilizers and continuous use of insecticides that created resistance against leaf folder. This insect attained the status of major pests during the last few years (Shah *et al.*, 2008) [15]. Keeping this in view, the present study was made to evaluate the different insecticides against leaf folder in rice ecosystem.

Materials and Methods

To determine the bio-efficacy of different insecticides against leaf folder in rice crop, a field experiment was conducted under randomized block design with ten treatments and three replications. Pretreatment observation was recorded one day before the application of insecticides, while post treatment observations were undertaken after 1st, 3rd, 7th and 14th days after spraying. The variety Swarna sub-1 was planted in a plot size of 5×4 m2 with a spacing of 20×15 m2 as per normal recommended agronomical practices. The knapsack sprayer and spray volume @ 500 l/ha used with hollow cone nozzle to impose the uniform spray of plant products in each treatment application. Observations were recorded by counting the number of healthy and damaged leaves from 10 randomly selected hills from each plot one day before application of treatments as pre-treatment observation followed by 1st, 3rd, 7th and 14th days after treatment application as post treatment observations. The per cent incidence of leaf folder was calculated as follows:

$$\text{Per cent Incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

In order to compare the response of different treatments on the grain yield, harvesting of grain was done and the yield obtained in the net plot of each treatment was recorded. The data on yield of grains were used to calculate the economic viability of each treatment. The cost of treatment, and spray material and labour required for application was calculated as per prevailing rates. Similarly, the income obtained from the sale of grains as per the market rate was also calculated for each treatment. The data, thus obtained were used to calculate the monetary returns and incremental cost benefit ratio.

Results and Discussion

The overall mean data of two sprays on the incidence of *C. medinalis* showed in Table 1 and 2 revealed that the overall mean per cent damage significantly differed among the treatments throughout the experimental periods of *Kharif* season of 2016-17 and 2017-18, respectively. The untreated control plot recorded 15.35 per cent and 16.60 per cent during 2016 and 2017. Treatment flubendiamide 20% WG @ 25 g a.i./ha was found to be best effective with lowest damage of 5.41% followed by Chlorantraniliprole 18.5% SC @ 30 g a.i./ha, Lamda- Cyhalothrin 5% EC @ 20 g a.i./ha, Fipronil 5% SC @ 50 g a.i./ha, Dinotefuran 20% SG @ 40 g a.i./ha, Thiamethoxam 25% WG @ 25 g a.i./ha, Acetamiprid 20 SP @ 35 g a.i./ha, Pymetrozine 50% WG @ 7.5 g a.i./ha, Carbofuran 3% G @ 75 g a.i./ha and Neem (Azadirachtin) 0.15% EC @ 4 ml/litre with overall mean of 5.83, 6.30, 6.64, 7.02, 7.44, 7.49, 8.11, 8.29 and 8.39 per cent respectively during *Kharif* 2016.

In *Kharif* 2017, Treatment flubendiamide 20% WG @ 25 g a.i./ha was also found to be best effective with lowest damage by leaf folder of 5.38% followed by Lamda- Cyhalothrin 5% EC @ 20 g a.i./ha, Chlorantraniliprole 18.5% SC @ 30 g a.i./ha, Fipronil 5% SC @ 50 g a.i./ha, Dinotefuran 20% SG @ 40 g a.i./ha, Thiamethoxam 25% WG @ 25 g a.i./ha, Acetamiprid 20 SP @ 35 g a.i./ha, Carbofuran 3% G @ 75 g a.i./ha, Pymetrozine 50% WG @ 7.5 g a.i./ha and Neem (Azadirachtin) 0.15% EC @ 4 ml/litre with overall mean of 5.60, 5.86, 6.81, 6.97, 7.07, 7.24, 8.02, 8.07 and 7.89 per cent respectively.

The highest grain yield of paddy was obtained in the Flubendiamide 20% WG insecticide treated plot and it was statistically most significant and superior followed by Chlorantraniliprole

18.5% SC, Pymetrozine 50% WG and Thiamethoxam 25% WG during both the year of study. In terms of investments in crop production, as the labour and spraying charges were similar in each treatment and hence application cost of insecticides were taken into account for comparison, the highest cost (Rs. 6720) was incurred in the treatment Carbofuran 3% G followed by Dinotefuran 20% SG (Rs. 5920). The lowest cost of treatment was found in Lamda-Cyhalothrin 5% EC (Rs. 2684) followed by Neem (Azadiractin 0.15% EC) (Rs. 3120) and Thiamethoxam 25% WG (Rs. 3320). These results are in agreement with Sandhu and Dhaliwal (2016) [14] who reported that Fame 480 SC (Flubendiamide 39.35%) an anthranilic diamide group, was effective than Fipronil 0.3 G (Reagent) and cartap hydrochloride 4% G. However, Bhanu and Reddy (2008) [6] reported that the two formulations of Flubendiamide *viz.*, flubendiamide 20 WDG @ 25 g a.i./ha and flubendiamide 48 SC @ 24 g a.i./ha were effectively controlled the leaf folder. Flubendiamide 20 WDG @ 25 g a.i./ha and Flubendiamide 48 SC @ 24 g a.i./ha were effective controlling leaf folder and recorded higher grain yields as earlier reported by Anonymous (2005 & 2006) [3]. The results obtained with flubendiamide 20 WDG @ 25 g a.i./ha were agreement with the findings of Gowda J. 2005.

However in the present study, the Flubendiamide 20% WG @ 25 g a.i./ha was most

effective against leaf folder in low land rice crop. The order of efficacy of each treatment along with the test of significance is depicted below: Flubendiamide 20% WG < Chlorantraniliprole 18.5% SC < Lambda-cyhalothrin 5% EC < Fipronil 5% SC < Dinotefuran 20% SG < Thiamethoxam 25% WG < Acetamiprid 20% SP < Pymetrozine 50% WG < Carbofuran 3% G, Neem (Azadiractin 0.15% EC), respectively.

Conclusion

Thus on the basis of present finding, it may be concluded that Flubendiamide 20% WG @ 25 g a.i./ha was found best effective against leaf folder followed by Chlorantraniliprole 18.5% SC @ 30 g a.i./ha. The yield was found to be high in Flubendiamide 20% WG @ 25 g a.i./ha followed by Chlorantraniliprole 18.5% SC @ 30 g a.i./ha treated plot. However, all the insecticidal treatments recorded significantly lower incidence than the untreated control

Table 1: Effect of insecticidal treatments against *C. medinalis* in rice ecosystem during *Kharif* 2016-17.

Treatments	Dose (g a.i./ha)	Mean per cent damage per 10 hills												
		First spray						Second spray						Overall mean
		1 DBS	1 DAS	3 DAS	7 DAS	14 DAS	Mean	1 DBS	1 DAS	3 DAS	7 DAS	14 DAS	Mean	
Acetamiprid 20 SP	35	10.58* (18.97)**	10.10 (18.52)	6.70 (14.98)	8.19 (16.63)	8.51 (16.96)	8.37 (16.77)	8.40 (16.84)	8.31 (16.75)	5.10 (13.04)	5.85 (13.99)	7.20 (15.55)	6.61 (14.83)	7.49 (15.80)
Carbofuran 3% G	750	11.75 (20.03)	9.60 (18.05)	7.41 (15.80)	8.89 (17.35)	9.64 (18.08)	8.88 (17.32)	9.89 (18.32)	9.22 (17.66)	5.30 (13.31)	7.60 (15.99)	8.68 (17.13)	7.70 (16.02)	8.29 (16.67)
Chlorantraniliprole 18.5% SC	30	10.74 (19.12)	8.49 (16.93)	4.83 (12.68)	5.71 (13.82)	7.01 (15.34)	6.51 (14.69)	7.10 (15.45)	6.87 (15.18)	3.32 (10.49)	4.34 (12.01)	6.03 (14.20)	5.14 (12.97)	5.83 (13.83)
Dinotefuran 20% SG	40	11.17 (19.51)	9.96 (18.38)	6.46 (14.71)	6.95 (15.28)	7.97 (16.40)	7.83 (16.18)	8.00 (16.43)	7.24 (15.59)	4.97 (12.86)	5.58 (13.65)	7.06 (15.39)	6.21 (14.37)	7.02 (15.28)
Fipronil 5% SC	50	11.23 (19.57)	9.76 (18.19)	5.89 (14.03)	6.70 (14.98)	7.78 (16.20)	7.53 (15.85)	7.50 (16.16)	7.10 (15.44)	4.17 (11.77)	4.82 (12.66)	6.88 (15.21)	5.74 (13.77)	6.64 (14.81)
Flubendiamide 20% WG	25	10.26 (18.67)	7.65 (16.06)	4.41 (12.11)	5.21 (13.17)	6.72 (15.01)	5.99 (14.08)	7.35 (15.72)	6.64 (14.92)	3.14 (10.20)	3.94 (11.43)	5.61 (13.69)	4.83 (12.56)	5.41 (13.32)
Lamda Cyhalothrin 5% EC	20	10.57 (18.96)	9.11 (17.55)	5.40 (13.44)	6.35 (14.58)	7.14 (15.50)	7.00 (15.26)	7.25 (15.61)	7.01 (15.34)	3.74 (11.14)	5.06 (12.99)	6.61 (14.89)	5.60 (13.59)	6.30 (14.43)
Neem (Azadiractin 0.15% EC)	4 ml/lit.	11.14 (19.49)	10.71 (19.10)	7.64 (16.03)	8.35 (16.80)	8.97 (17.41)	8.91 (17.33)	9.00 (17.45)	8.66 (17.10)	6.66 (14.96)	7.24 (15.60)	8.95 (17.39)	7.87 (16.26)	8.39 (16.80)
Pymetrozine 50% WG	7.5	10.65 (19.03)	10.99 (19.35)	8.11 (16.53)	8.55 (16.99)	9.19 (17.63)	9.21 (17.62)	9.30 (17.74)	7.76 (16.18)	5.62 (13.70)	6.66 (14.94)	8.02 (16.44)	7.01 (15.31)	8.11 (16.47)
Thiamethoxam 25% WG	25	11.34 (18.75)	10.31 (18.72)	6.96 (15.30)	7.53 (15.91)	8.31 (16.74)	8.27 (16.66)	8.50 (16.94)	7.83 (16.25)	4.64 (12.43)	6.10 (14.28)	7.84 (16.26)	6.60 (14.80)	7.44 (15.73)
Control	Water spray	10.51 (18.90)	12.04 (20.28)	13.40 (21.46)	13.90 (21.88)	14.60 (22.34)	13.48 (21.49)	14.85 (22.65)	15.45 (23.13)	16.72 (24.12)	17.55 (24.75)	19.15 (25.94)	17.21 (24.48)	15.35 (22.99)
C.D. (0.05%)	--		0.60	0.63	0.68	0.65	--	--	0.55	0.62	0.64	0.67	--	--
SE (m)±	--		0.20	0.21	0.22	0.21	--	--	0.18	0.21	0.21	0.22	--	--

*Mean of three replications, **Figures in the parenthesis are Angular transformed values, DBS- Days before spray DAS- Days after spray

Table 2: Effect of insecticidal treatments against *C. medinalis* in rice ecosystem during *Kharif* 2017-18

Treatments	Dose (g a.i./ha)	Mean per cent damage per 10 hills														
		First spray						Second spray						Overall mean	Grain yield (t/ha)	
		1 DBS	1 DAS	3 DAS	7 DAS	14 DAS	Mean	1 DBS	1 DAS	3 DAS	7 DAS	14 DAS	Mean		2016	2017
Acetamiprid 20 SP	35	11.38* (19.70)**	10.05 (18.47)	6.73 (15.02)	7.21 (15.56)	7.42 (15.79)	7.85 (16.21)	7.60 (15.99)	6.80 (15.10)	5.29 (13.29)	6.70 (15.00)	7.68 (16.09)	6.62 (14.87)	7.24 (15.54)	4.20	3.96
Carbofuran 3% G	750	11.42 (19.74)	11.15 (19.49)	7.76 (16.16)	8.08 (16.50)	9.05 (17.49)	9.01 (17.41)	9.10 (17.55)	7.78 (16.18)	5.53 (13.59)	7.00 (15.34)	7.83 (16.24)	7.03 (15.33)	8.02 (16.37)	3.62	3.33
Chlorantraniliprole 18.5% SC	30	9.22 (17.67)	8.85 (17.29)	5.28 (13.27)	6.23 (14.44)	6.79 (15.10)	6.79 (15.02)	6.40 (14.64)	5.85 (13.98)	3.77 (11.17)	4.65 (12.43)	5.40 (13.44)	4.92 (12.75)	5.86 (13.89)	4.80	4.50
Dinotefuran 20% SG	40	10.31 (18.72)	9.80 (18.23)	6.60 (14.94)	7.05 (15.38)	7.32 (15.69)	7.69 (16.06)	7.65 (16.05)	6.62 (14.90)	5.14 (13.09)	5.78 (13.90)	7.46 (15.85)	6.25 (14.43)	6.97 (15.25)	4.00	3.77
Fipronil 5% SC	50	11.48 (19.79)	10.71 (19.10)	6.03 (14.20)	6.96 (15.30)	7.19 (15.54)	7.72 (16.02)	7.50 (15.88)	6.50 (14.76)	4.48 (12.21)	5.60 (13.67)	6.99 (15.33)	5.89 (13.99)	6.81 (15.01)	3.77	3.52
Flubendiamide 20% WG	25	9.46 (17.90)	8.51 (16.95)	4.73 (12.54)	5.58 (13.65)	6.16 (14.35)	6.24 (14.37)	6.25 (14.47)	5.75 (13.87)	3.40 (10.62)	4.20 (11.82)	4.98 (12.88)	4.58 (12.30)	5.38 (13.34)	5.10	4.77
Lamda Cyhalothrin 5% EC	20	11.68 (19.97)	9.49 (17.93)	5.82 (13.95)	6.34 (14.57)	6.85 (15.16)	7.12 (15.40)	7.00 (15.33)	6.03 (14.20)	4.18 (11.78)	5.11 (13.05)	6.37 (14.62)	4.07 (13.41)	5.60 (14.41)	3.45	3.13
Neem (Azadiractin 0.15% EC)	4 ml/lit.	11.75 (20.03)	10.92 (19.28)	7.15 (15.50)	7.95 (16.38)	8.66 (17.11)	8.67 (17.07)	9.21 (17.66)	8.32 (16.75)	5.37 (13.39)	6.18 (14.38)	8.56 (17.01)	7.11 (15.38)	7.89 (16.23)	3.38	3.00
Pymetrozine 50% WG	7.5	11.12 (19.47)	11.04 (19.39)	7.97 (16.39)	8.18 (16.61)	9.27 (17.71)	9.11 (17.52)	9.71 (18.14)	7.50 (15.89)	5.75 (13.86)	6.80 (15.12)	8.02 (16.44)	7.02 (15.33)	8.07 (16.43)	4.60	4.36
Thiamethoxam 25% WG	25	9.78 (18.21)	9.55 (17.99)	6.96 (15.28)	7.29 (15.65)	8.04 (16.46)	7.96 (16.34)	8.51 (16.95)	6.97 (15.30)	4.91 (12.79)	5.28 (13.27)	7.56 (15.95)	6.18 (14.32)	7.07 (15.33)	4.37	4.13
Control	Water spray	10.64 (19.03)	12.00 (20.25)	13.49 (21.53)	14.68 (22.51)	15.80 (23.41)	13.99 (21.92)	16.00 (23.57)	17.31 (24.57)	18.68 (25.59)	19.77 (26.38)	21.10 (27.33)	19.21 (25.96)	16.60 (23.94)	3.05	2.69
C.D. (0.05%)	--	--	0.62	0.65	0.69	0.64	--	--	0.53	0.56	0.60	0.63	--	--	--	--
SE (m)±	--	--	0.20	0.22	0.23	0.21	--	--	0.17	0.19	0.20	0.21	--	--	--	--

*Mean of three replications, **Figures in the parenthesis are Angular transformed values, DBS- Days before spray DAS- Days after spray

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