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EVALUATION OF FLUBENDIAMIDE AGAINST BUDWORM, *HELICOVERPA ARMIGERA* (HUBNER) IN FCV TOBACCO

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Field experiments were conducted during 2009-10 and 2010-11 at the research farm of Central Tobacco Research Institute, Rajahmundry to test the bio-efficacy of a new molecule flubendiamide (Fame 480 SC) against budworm, *Helicoverpa armigera* on flue-cured Virgina tobacco. The results indicated that among the various dosages, flubendiamide 480 SC @ 0.012 and 0.024% recorded highest cured leaf yield of 1900 and 1920 kg/ha with lowest leaf damage as against 1690 and 1575 kg/ha in chlorpyriphos @ 0.05% and acephate 0.075% with significantly higher leaf damage, respectively. Studies on persistency showed that the persistent toxicity of flubendiamide was higher than chlorpyriphos and acephate. Studies on flubendiamide residues in cured leaf of tobacco showed that they were below detectable level (0.01ppm) when it was sprayed @ 0.012% and 0.024% even 7 days before harvest.

INTRODUCTION

Budworm, *Helicoverpa armigera* (Hubner) is one of the major insect pests of tobacco. It infests the crop during the grand growth period, feeds voraciously on the apical bud and bud leaves adversely affecting the growth of the plant resulting in considerable yield loss. In FCV tobacco the loss in green leaf and cured leaf was recorded to be up to 2891 and 426 kg/ha, respectively (Sreedhar *et al.*, 2005). Application of insecticides against the insect pests remains indispensable and economical to minimize the losses. Control of the pest with conventional insecticides requires repeated applications. Also the guidance residue levels (GRLs) of the recommended insecticides have been revised to a lower level by CORESTA (2008). Besides other adverse effects due to indiscriminate use of insecticides, the problem of insecticide residues in tobacco is the major cause of concern. In order to circumvent the problems, there is a need to replace the conventional insecticides with selective insecticides effective at low dose in tobacco. Flubendiamide, a benzene dicarboxamide, is a new class of insecticide having a new biochemical mode of action, affecting ryanodine receptors in insects and is highly effective at very low dose against broad spectrum of lepidopteran pests including resistance strains (Tohnishi *et al.*, 2005). Hence, flubendiamide is expected to provide the necessary protection against budworm, *H. armigera*, if needed to supplement the actions of other control components such as cultural, mechanical and biological in tobacco.

MATERIALS AND METHODS

The experiment was conducted in randomozied block design with three replications using flue-cured Virginia tobacco (*Nicotiana tabacum* L.) *cv* Siri at Central Tobacco Research Institute, Research Farm, Katheru for two seasons (2010 -2011). The gross plot size was 5.6 x 4.8 m and the net plot size was 4.0 x 3.6 m. Laboratory reared 8-day old budworm larvae were used for infesting at random 5 plants/plot, allowed to establish for 24 h and spraying was carried out with respective treatments. Foliar spray of insecticide flubendiamide (Fame 480 SC) @ 0.008%, 0.009%, 0.012% and 0.024% were evaluated in comparison with chlorpyriphos 20 EC @ 0.05% and acephate 75 SP @ 0.075% along with untreated control against budworm, *H. armigera*. Observations were recorded periodically on number of leaves damaged and per cent leaf area damaged. The data on per cent leaf area damaged were subjected to angular transformation. Yield data on cured leaf, bright leaf were collected and grade index was computed. The data were subjected to analysis of variance.

The persistent residual toxicity of insecticides used was studied by treating the

40-day old plants with respective insecticides and the leaves were used to study the residual persistent toxicity from 0 days till there is no mortality in that particular treatment at 24 h interval. Eight-day old *H. armigera* larvae (10 per replication) were released for each treatment and mortality was recorded after 24 h. All the six treatments were replicated thrice. The persistent residual toxicity was determined by slight modification of the method suggested by Pradhan (1967) and as used by Sarup *et al.* (1970) subsequently. Residue studies to evaluate the residues of flubendiamide and its metabolite des-iodo in tobacco and soil were conducted. The cured leaf samples were collected pick-wise from the treatments of flubendiamide 0.012, 0.024% and and untreated control. Soil samples were collected from these plots at final harvest. The samples were analysed by a validated HPLC-UV method at IIBAT, Padappai, Tamil Nadu. The method has a limit of quantification (LOQ) of 0.03 ppm for flubendiamide and its metabolite des iodo. The limit of detection (LOD) was 0.01 ppm for flubendiamide. Recovery studies in tobacco and the soil were conducted fortifying different concentrations of flubendiamide and its metaboloite @ 0.03, 0.15 and 0.30 ppm. The acceptable mean recovery percentage of flubendiamide in tobacco and soil was 89 ± 2.08 and 89 ± 1.00 at 0.03 ppm; 92 ± 1.53 and 90 ± 1.53 at 0.15 ppm and 91 ± 1.00 and 90 ± 2.00 at 0.30 ppm fortification levels, respectively. The metabolite des-Iodo has the recovery percentage 91 ± 1.00 and 90 ± 1.53 at 0.03 ppm; 92 ± 2.00 and 89 ± 1.15 at 0.15 ppm and 92 ± 0.58 and 90 ± 1.53 at 0.30 ppm fortification levels.

RESULTS AND DISCUSSION

Perusal of data (Table 1) shows that during both the years all the treatments gave significantly better protection than control from budworm damage at 4, 8 and 15 days after spray (DAS). The number of leaves damaged by *H. armigera* was least (1.00) in flubendiamide 0.024% followed by flubendiamide 0.012% (1.16) which were significantly less than all the other treatments. Among the treatmenets at 4 DAS the number of leaves damaged were highest (9.83) in acephate 0.075% which was on a par (8.83) with chlorpyriphos 0.05% and lower doses i.e., 0.008 & 0.009% of flubendiamide (10.16 and 8.50). The same trend was recorded at 8 and 15 DAS. Leaf area damaged by *H. armigera* was significantly less in all the treatments than control at all the observations during 2009-10 (Table 2). The damage was least (2.40%) in flubendiamide 0.024% followed by flubendiamide 0.012% (2.90) and was on a par with each other. The damage was significantly less in these two treatments than all others. Similar trend was observed at 8 and 15 DAS. During 2010-11 the per cent leaf area damaged in acephate (16.90, 19.40 & 22.60) and chlorpyriphos (16.60, 19.36 & 20.20) was on a par with that of untreated control (24.80, 26.60 & 30.26) at 4, 8 and 15 DAS which was higher than other treatments. The leaf area dameged in the lower doses (0.008% & 0.009%) of flubnedimide was on a par with acephate and chlorpyriphos during both the seasons.

Data on yield parameters revealed that all the treatments recorded significantly higher cured leaf and bright leaf yield and better grade index than that of untreated control. Highest cured leaf yield (1920 kg/ha) was recorded in flubendiamide 0.024% followed by flubendiamide 0.012% (1900 kg/ha) which was significantly higher than all the other treatments (Table 3). Acephate recorded the lowest (1575 kg/ha) cured leaf yield which was on a par with the remaining treatments. The highest bright leaf yield (966 kg/ha) was recorded in flubendiamide 0.024% followed by its lower dose 0.012% (960 kg/ha) which was significantly higher than all other treatments except flubendiamide 0.009% (855 kg/ha). The overall grade index was highest (1416) in flubendiamide 0.024% and was on a par (1400) with flubendiamide 0.012% which was significantly superior to all other treatments.

Studies on persistent toxicity of insecticides to *H.armigera* on FCV tobacco showed that the treatments of flubendiamide 0.024% and 0.012% resulted in cent per cent mortality up to 8 days after treatment (DAT) and their toxicity was very high (98.6 & 92.6%) up to 10 DAT. Lower doses of flubendiamide (0.008% and 0.009%), chlorpyriphos (0.005%) and acephate (0.075%) recorded cent per cent mortality only up to 2 DAT. The period of persistence was the highest (18 days) for flubendiamide at 0.024 and 0.012%,

Table 1: Field efficacy of flubendiamide against tobacco budworm, *H.armigera* - (Mean number of leaves damaged)

Treatments	4 Days after spray			8 Days after spray			15 Days after spray		
(% a.i.)	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
Flubendiamide 0.008	10.00	10.33	10.16	12.33	12.67	12.50	14.33	14.00	15.50
Flubendiamide 0.009	8.33	8.67	8.50	10.00	11.33	10.66	12.00	12.67	14.81
Flubendiamide 0.012	1.00	1.33	1.16	1.00	1.33	1.16	1.00	1.33	1.16
Flubendiamide 0.024	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Chlorpyriphos 0.05	8.67	9.00	8.83	11.67	12.00	11.83	15.00	14.67	14.83
Acephate 0.075	9.00	10.67	9.83	12.67	11.00	12.33	15.00	15.33	15.16
Control	16.60	18.33	17.46	20.67	19.80	20.23	24.00	28.00	26.00
SEm±	**2.32**	**2.38**		**2.57**	**2.87**		**2.84**	**2.76**	
CD (P=0.05)	**7.10**	**7.20**		**7.81**	**8.60**		**8.60**	**8.40**	

Table 2: Evaluation of flubendiamide against tobacco budworm, *H. armigera*- (Mean per cent leaf area damaged)

Treatments	4 Days after spray			8 Days after spray			15 Days after spray		
(% a.i.)	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
Flubendiamide 0.008	12.93	14.96	13.89	15.66	16.00	15.83	16.80	16.60	16.70
	(5.12)	(6.67)		(7.20)	(7.66)		(8.14)	(8.00)	
Flubendiamide 0.009	8.96	12.46	10.71	10.50	14.20	12.35	12.42	16.00	14.21
	(3.90)	(5.12)		(4.30)	(6.10)		(5.10)	(7.88)	
Flubendiamide 0.012	2.90	4.12	3.51	2.98	4.20	3.59	2.98	4.20	3.59
	(0.92)	(0.94)		(1.70)	(0.94)		(1.70)	(1.60)	
Flubendiamide 0.024	2.40	2.86	2.63	2.40	2.88	2.64	2.40	2.88	2.64
	(0.78)	(0.90)		(0.78)	(0.91)		(0.78)	(0.91)	
Chlorpyriphos 0.05	11.94	16.60	14.27	12.98	19.36	16.17	16.70	20.64	18.67
	(4.86)	(8.16)		(5.22)	(10.02)		(8.04)	(14.88)	
Acephate 0.075	12.17	16.90	14.53	14.86	19.40	17.13	18.64	22.60	20.62
	(5.12)	(8.24)		(6.58)	(10.04)		(9.94)	(15.48)	
Control	20.64	24.80	22.72	24.60	26.60	25.65	28.16	30.26	29.21
	(14.88)	(18.40)		(18.20)	(20.00)		(23.80)	(26.86)	
SEm±	**2.46**	**2.66**		**2.84**	**3.16**		**2.98**	**3.20**	
CD (P=0.05)	**7.50**	**8.20**		**8.60**	**9.60**		**9.10**	**9.66**	

Figures in parentheses are original treatment means

Table 3: Evaluation of flubendiamide against *H. armigera* – (Mean yield (2009-2011)

Treatments (% a.i.)	Cured leaf (kg/ha)	Bright leaf (kg/ha)	Grade index
Flubendiamide 0.008	1695	815	1189
Flubendiamide 0.009	1700	855	1225
Flubendiamide 0.012	1900	898	1400
Flubendiamide 0.024	1920	912	1416
Chlorpyriphos 0.05	1690	826	1200
Acephate 0.075	1575	685	1190
Control	1350	580	960
SEm±	52	41	59
CD (P=0.05)	154	119	182

whereas it was 16 days for flubendiamide 0.009% and 12 days for flubendiamide 0.008%, chlorpyriphos 0.05% and acephate 0.075%. The mean persistent toxicity (PT) as well as persistent toxicity index (PTI) was highest for flubendiamide 0.024% (78.60 & 1414.80) followed by flubendiamide 0.012% (76.81 & 1382.58). The lowest PT (61.77) and PTI (741.24) were recorded for acephate 0.075%. The order of relative persistent toxicity was flubendiamide 0.024% > flubendiamide 0.012% > flubendiamide 0.009%> flubendiamide 0.008%> chlorpyrifos 0.05%> acephate 0.075%.

The residue studies showed that in all the leaf samples of tobacco (pick 1- pick 6) treated with flubendiamide 0.012 and 0.024%, the residues of flubendiamide were below detectable levels i.e. 0.01 ppm. Flubendiamide in the soil samples collected from these treated plots was also below detectable levels. Even in the first pick of tobacco leaf which was treated with flubendiamide @ 0.012 and 0.024% before 7 days of harvest, the residues were below detectable level, indicating that the safe preharvest interval (PHI) for flubenidamide in FCV tobacco can be 7 days.

From the experimental results based on the leaf damage due to *H. armigera*, yield data, persistent toxicity studies and residue analysis of cured tobacco leaf, it can be inferred that flubendiamide 480 SC @ 0.012% can be used to effectively control budworm, *H. armigera* in FCV tobacco. Effectiveness of flubendiamide against lepidopterous borers in general and *H. armigera* in particular was reported in various crops (Tohnishi *et al.*, 2005; Masanori *et al.*, 2005 Lakshminarayana and Rajashri, 2006; Ebbinghaus *et al.*, 2007; Ameta and Kumar, 2008; Kumar and Shivaraju, 2009 ; Tatagar *et al.*, 2009; Deshmukh *et al.*, 2010; Thilagam *et al*, 2010; Tohinshi *et al.*, 2010; Ameta *et al.*, 2011; Kanwar *et al.*, 2012). The present studies are in confirmity with the previous studies and indicated that flubendiamide can be deployed for management of budworm, *H. armigera* in flue- cured tobacco.

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Table 4: Persistent residual toxicity of flubendiamide on FCV tobacco against *H. armigera*

Treatments	Per cent mortality (Days after treatment)											P	PT	PTI
(% a.i.)	0	1	2	4	6	8	10	12	14	16	18	20			
Flubendiamide 0.008	100	100	100	90.0	74.2	49.4	20.6	8.2	0	-	-	-	12	67.80	813.60
Flubendiamide 0.009	100	100	100	98.6	90.6	70.2	46.8	26.6	10.0	4.8	0	-	16	64.28	1028.48
Flubendiamide 0.012	100	100	100	100	100	100	92.6	78.4	48.8	18.4	6.8	0	18	76.81	1382.58
Flubendiamide 0.024	100	100	100	100	100	100	98.6	80.8	50.6	24.7	10.0	0	18	78.60	1414.80
Chlorpyrifos 0.05	100	100	100	82.5	60.0	40.0	20.5	7.5	0	-	-	-	12	63.81	765.72
Acephate 0.075	100	100	100	80.8	56.6	36.6	16.6	3.6	0	-	-	-	12	61.77	741.24

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