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Studies on Toxicological Effect of New Generation Insecticides Chlorantriniliprole, Flubendiamide Imidacloprid in Rearing Performance of Mulberry Silkworm, *Bombyx mori* L.

Sunil Kumar T.[1*], Ramakrishna Naika[1] and Kumar K. P.[2]

[1]Department of Sericulture, University of Agricultural Sciences, Gandhi Krishi Vignan Kendra (GKVK), Bengaluru-560065, Karnataka, India

[2]Department of Agricultural Entomology, University of Agricultural Sciences, Gandhi Krishi Vignan Kendra (GKVK), Bengaluru-560065, Karnataka, India

*Corresponding Author E-mail: sunilkesari24@gmail.com

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ABSTRACT

The toxicological studies on new generation insecticide Chlorantriniliprole, Flubendiamide Imidacloprid in rearing performance of Mulberry silkworm, Bombyx mori L. was carried out to find out waiting period for pesticides widely used by the farmers in mulberry growing areas were identified and sprayed to mulberry at an interval of 10, 15, 20, 25, 30 and 40days and fed to silkworms. Extended total larval duration was recorded in batches of silkworms fed on leaves sprayed with at [chlorantriniliprole (T1)- 15days after spray(DAS) (3^{rd} instar 86.90h, 4^{th} instar 127.90h, 5^{th} instar 231.75h), flubendiamide (T2) -10DAS(3^{rd} instar 86.15h, 4^{th} instar 127.04, 5^{th} instar 241.27h), imidacloprid (T3) -10DAS(3^{rd} 83.75h, 4^{th} 113.50h, 5^{th} 225.50h) and it was minimum in the batches of silkworm in T5(water spray) (3^{rd} 72.75h, 4^{th} 95.96h, 193.57h.)]. Disease incidence, cocoon yield, and denier recorded was least in[T1-15DAS(6.66%, 21.75g, 0.60.) T2-10 DAS (6.50%, 22.40g, 1.26.) T3-10 DAS (6.40%, 33.75g, 1.83.)].The rearing parameters viz., recorded in case of flubendiamide at 40DAS treatment and imidacloprid at 25 DAS were on par with the treatments dichlorvos.

Key words: *Bombyx mori, Mulberry, Silkworm, Disease, Chlorantriniliprole*

INTRODUCTION

Sericulture is an integral part of the rural economy in an agrarian country like India. India is the second largest silk producing country next only to China. Mulberry is the sole food of silkworm *Bombyx mori* L. and is infested by several pests. These pests affect the growth of mulberry and cause considerable damage to the plant and loss in the yield[1]. The insecticides applied for the control of mulberry pests have greater impact on silkworm. Pesticides leave residues on mulberry leaves which in turn affect the sensitive silkworm[2]. To overcome this problem, safe waiting period should be followed for leaf harvest[10]. Field observations in India indicated loss of cocoon yield from silkworms fed on mulberry leaves sprayed with insecticides[8].

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Exposure to the residue of pesticides in the mulberry leaves could affect growth and quality of economic characteristics of cocoons. Silkworm *B. mori L. is* highly sensitive to chlorantraniliprole (Coragen) and flubendiamide (Fame) are novel insecticide belonging to a potent class of anthranilic diamides, similarly neonicotinoid group Imidacloprid (Confidor) and OP's compound Dichlorvose (DDVP) that eliminates Lepidopteran insects. A little information is described about the anthranilic diamides effect on *B. mori L*. Although this insecticide is not used in mulberry fields, it can cause larval mortality and loss of cocoon production in sericulture farms near the areas where it isused[6]. In this context, it was thought necessary to investigate the toxicity effect of insecticides on performance of mulberry silkworm. Hence, it was proposed to undertake studies.

MATERIAL AND METHODS

The silkworms (PM × CSR2) were reared using V-1leaves. The larvae were provided with chopped mulberry leaves of required quantity and quality. After 30 minutes of initial feeding, 30 larvae were transferred to each experimental tray in four replications along with the mulberry leaves. The mulberry leaves sprayed with pesticides T1-Chlorantraniliprole 18.5 % SC (0.02%), T2-Flubendiamide 480 SC (0.05%), T3-Imidacloprid 17.80 % SL (0.05%), were sprayed to mulberry leaves at 10, 15, 20, 25, 30, 40 days interval and T4-Dichlorvos (0.2%) 76 % SC at 10day interval and T5- control with water spray, T6- untreated control leaves fed to silkworm from third instar onwards. The rearing and cocoon parameters like larval mortality (%) calculated by number of dead larvae/Total number of worms x 100. Total larval duration (h) was recorded by summation of third, fourth and fifth instars duration. Mature larval weight (g), Weight of ten randomly picked silkworms at fifth day of fifth instar was selected per each replication and the average of the same was calculated. Single cocoon weight (g), Ten cocoons were randomly picked from each replication of every treatment and weight was recorded on the fifth day of mounting. Individual cocoon weight was taken for 10 cocoons and average was calculated to obtain the mean cocoon weight[5].

Cocoon yield (kg), cocoon yield per 100 worms reared in each replication was calculated to get cocoon yield. Shell weight (g), after taking cocoon weight, ten cocoons were cut open and the cocoon shell weight was recorded and the average was calculated to get the mean shell weight. Shell ratio (%), Shell ratio was calculated by shell weight / whole cocoon weight x 100. Silk filament length (m) five cocoons per replication were selected and each cocoon was reeled using Eupprovette and silk filament length was recorded. Filament length was calculated by the formula L= R ×1.125 m^4. The data was analysed statistically for the test of significance using Fisher's method of analysis of variance. The level of significance of F-test was at 5 per cent. The interpretation of data was done using critical difference (CD) values.

RESULTS AND DISCUSSION

Third instar larval duration (h): The third instar larval duration was significantly extended in the batch of silkworms fed on mulberry leaves sprayed with chlorantraniliprole at 15 DAS (86.90 h) followed by flubendiamide at 10 DAS (86.15 h) and imidacloprid at 10 DAS (83.75 h). The larval duration was minimum in batches of silkworms fed on leaves sprayed with imidacloprid at 40 DAS (70.00 h.). which was on par with the larval duration recorded in the batches of silkworms fed on mulberry leaves sprayed with dichlorvos, control with water spray and untreated control (74.62 h. 72.75 h.74.37 h, respectively). However, the third larval duration recorded in the batches of silkworms fed on mulberry leaves sprayed with imidacloprid at 25 DAS (75.25 h) and 30

DAS (72.00 h), flubendiamide at 30 DAS (79.55 h) and 40 DAS (74.75 h) were on par with standard check and control (Table. 1).

Fourth instar larval duration (h): The larval duration observed in fourth instar significantly varied among the treatments. Extended larval duration was noticed in the batch of silkworms fed on mulberry leaves sprayed with chlorantraniliprole at 15 DAS (127.90 h) followed by flubendiamide at 10 DAS (127.04 h) and imidacloprid at 10 DAS (113.50 h) The larval duration was minimum in batches of silkworms fed on leaves sprayed with Imidacloprid at 40 DAS (93.50 h) which was on par with the larval duration recorded in the batches of silkworm fed on mulberry leaves sprayed with dichlorvos, control with water spray (98.50 h and 95.96 h. respectively). However, the fourth instar larval duration recorded in the batches of silkworms fed on mulberry leaves sprayed with imidacloprid at 25 DAS (98.00 h) and 30 DAS (96.00 h), flubendiamide at 40 DAS (101.15 h) were on par with standard check and control (Table.1).

Fifth instar larval duration (h): Significant difference was observed with respect to fifth instar larval duration in first rearing. The larval duration was extended in the batch of silkworms fed on mulberry leaves sprayed with chlorantraniliprole at 15 DAS (231.75 h) followed by flubendiamide at 10 DAS (241.27 h) and imidacloprid at 10 DAS (225.50 h). The larval duration was minimum in batches of silkworms fed on leaves sprayed with imidacloprid at 40 DAS (190.75 h) which was on par with the larval duration recorded in the batches of silkworm fed on mulberry leaves sprayed with dichlorvos, control with water spray and untreated control (196.75 h, 193.57 h, 195.53 h, respectively). However, the fifth instar larval duration recorded in the batches of silkworms fed on mulberry leaves sprayed with imidacloprid at 25 DAS (201.50 h) and 30 DAS (194.50 h), flubendiamide at 40 DAS (202.37 h) were on par with standard check and control (Table.1). The extended larval instar duration might be due to presence of higher residue of insecticide in the initial days of spray and its effect decreases as the number of day's increases[5]. The larval period was extended slightly when the silkworm, *Bombyx mori* L. was fed with pesticides treated mulberry leaf[1]. The pesticide interferes with the release of the hormones essential for metamorphosis resulting in delaying of instar duration[11].

Third moult (h): The duration of third moult was significantly high in the batch of silkworm fed on mulberry leaves sprayed with chlorantraniliprole at 15 DAS (30.52 h) followed by flubendiamide at 10 DAS (29.63 h) and imidacloprid at 10 DAS (28.40 h) The third moult duration was minimum in batches of silkworm fed on control with water spray (23.22 h). However, 40 DAS of flubendiamide (24.20 h) and imidacloprid at 25 DAS (24.65 h), 30 DAS (24.10 h) and 40 DAS (24.00 h) which was on par with the batches of silkworm fed on mulberry leaves sprayed with dichlorvos (23.90 h) and untreated control (23.84 h) (Table. 1).

Fourth moult (h): The batch of silkworms fed on mulberry leaves sprayed with chlorantraniliprole at 15 DAS recorded significantly higher fourth moult duration (30.75 h.) followed by flubendiamide at 10 DAS (31.25 h) and imidacloprid at 10 DAS (29.57 h.) The fourth moult duration was minimum in batches of silkworm fed on control with water spray (23.95 h). However, 40 DAS of flubendiamide (24.91 h) and imidacloprid at 25 DAS (26.26 h), 30 DAS (24.31 h) and 40 DAS (24.00 h) which is on par with the batches of silkworm sprayed with dichlorvos (24.89 h) and untreated control (24.12 h) (Table. 1). The results indicated that residual effect of insecticides resulted in delay in moulting. The production of deformed insects, resulting in inhibition of growth at high dose of insecticide toxicity had been reported in various insect species[2].

Table 1: Effect of insecticidal residue in mulberry on larval parameters of silkworm hybrid PM × CSR_2 (First rearing)

Treatments	Instar duration (h)			Moulting duration (h)	
	3rd instar	4th instar	5th instar	3rd moult	4th moult
T_1- (Chlorantraniliprole 0 .02 % spray.)					
10 DAS	0.00	0.00	0.00	0.00	0.00
15 DAS	86.90	127.90	231.75	30.52	30.75
20 DAS	84.05	126.75	229.47	29.70	30.30
25 DAS	83.22	121.57	222.02	29.00	30.00
30 DAS	82.92	114.32	218.64	28.00	29.80
40 DAS	80.52	101.35	202.10	27.00	29.20
T_2 – (Flubendiamide 0.05 % spray.)					
10 DAS	86.15	127.04	241.27	29.63	31.25
15 DAS	86.10	126.07	233.10	28.52	31.00
20 DAS	81.85	122.95	227.75	27.83	30.80
25 DAS	80.32	117.82	221.25	27.43	29.00
30 DAS	79.55	110.77	212.47	27.00	28.80
40 DAS	74.75	101.15	202.37	24.20	24.91
T_3-(Imidacloprid 0.05 % spray)					
10 DAS	83.75	113.50	225.50	28.40	29.57
15 DAS	81.50	108.25	220.75	28.00	29.45
20 DAS	80.75	105.50	210.50	27.80	28.27
25 DAS	75.25	98.00	201.50	24.65	26.26
30 DAS	72.00	96.00	194.50	24.10	26.13
40 DAS	70.00	93.50	190.75	24.00	25.10
T_4-Dichlorvos (Standard check)	74.62	98.50	196.75	23.90	24.89
T_5-Control with water spray.	72.75	95.96	193.57	23.22	23.95
T_6- untreated control	74.37	97.69	195.53	23.84	24.12
F-test	*	*	*	*	*
SE.m ±	2.05	1.26	4.72	1.01	1.10
CD at 5%	5.80	3.58	14.16	3.03	3.13

*DAS= Days after spray.

Disease incidence (%): The disease incidence differed significantly among different treatments. Maximum disease incidence was recorded in silkworm batches reared on mulberry leaves sprayed with chlorantraniliprole at 15 DAS (6.66 %.) followed by flubendiamide at 10 DAS (6.50 %.), imidacloprid at 10 DAS (6.40 %) and the least disease incidence was observed in the treatment imidacloprid at 40 DAS (4.50 %) which was on par with dichlorvos (6.00 %) (Table 2). It clearly indicated that incidence of disease is more during second rearing compared to first rearing which might be mainly because of favourable environmental condition for disease causing organisms during summer[7].

Table 2: Effect of insecticidal residue in mulberry on disease incidence (%), larval mortality (%) and ERR (%) of silkworm hybrid PM X CSR_2 (First rearing)

Treatments	Disease incidence (%)	Cocoon yield (g/100 cocoon)	Denier
T_1- (Chlorantraniliprole 0.02% spray.)			
10 DAS	0.00	0.00	0.00
15 DAS	6.66	21.75	0.60
20 DAS	6.00	35.50	0.82
25 DAS	5.90	46.90	1.10
30 DAS	5.55	68.97	1.40
40 DAS	5.00	119.00	1.60
T_2 – (Flubendiamide 0.05% spray.)			
10 DAS	6.50	22.40	1.26
15 DAS	6.30	31.25	1.46
20 DAS	6.10	42.50	1.53
25 DAS	5.80	49.25	1.90
30 DAS	5.40	87.25	2.00
40 DAS	4.90	138.50	2.21
T_3 (Imidacloprid 0.05% spray)			
10 DAS	6.40	33.75	1.83
15 DAS	5.50	46.50	1.95
20 DAS	5.00	70.75	2.04
25 DAS	4.96	136.25	2.18
30 DAS	4.90	137.75	2.21
40 DAS	4.50	139.00	2.28
T_4-Dichlorvos (Standard check)	6.00	136.00	2.29
T_5-Control with water spray.	5.50	149.75	2.39
T_6- untreated control	5.80	144.75	2.30
F-test	*	*	*
SE. m ±	0.70	2.09	0.08
CD at 5%	1.99	5.92	0.22

**DAS= Days after spray.*

Cocoon yield (g): Significantly high cocoon yield was observed in silkworm batches fed on mulberry leaves from control with water spray (149.75 g) followed by untreated control (144.75 g) and standard check (136.00 g). However, the cocoon yield in the treatment imidacloprid at 40 DAS was 139.00 g and flubendiamide at 40 DAS was 138.50 g which were on par with the cocoon yield obtained from the treatment dichlorvos (136.00 g). Further significantly less cocoon yield was recorded in silkworm batches reared on leaves obtained from chlorantraniliprole spray at 15 DAS (21.75 g). However, the cocoon yield recorded in the batches of silkworms fed on mulberry leaves sprayed with imidacloprid at 25 DAS (136.25 g) and 30 DAS (137.75 g), flubendiamide at 40 DAS (138.50 g), were on par with standard check and untreated untreated control (Table.2).Increased cocoon weight might be mainly due to the increased larval weight and other positive larval characters. There was change in the body weight due to the consumption of treated leaves[3].

Denier: The denier was significantly high (2.39)in the cocoon obtained from the batches of silkworms fed with leaves from the treatment control with water spray followed by untreated control (2.30), standard check (2.29), imidacloprid at 40 DAS (2.28), flubendiamide at 40 DAS (2.21). chlorantraniliprole at 40 DAS (1.60) and the minimum denier recorded was (0.60) in treatment chlorantraniliprole at 15 DAS. However, the denier recorded in the batches of silkworms fed on mulberry leaves sprayed with imidacloprid at 25 DAS (2.18) and 30 DAS (2.21), flubendiamide at 40 DAS (2.21), were on par with standard check and untreated control (Table.2) this might be because of the residual effect of chlorantraniliprole insecticide, poor quality leaves and residue problems in rearing[9].

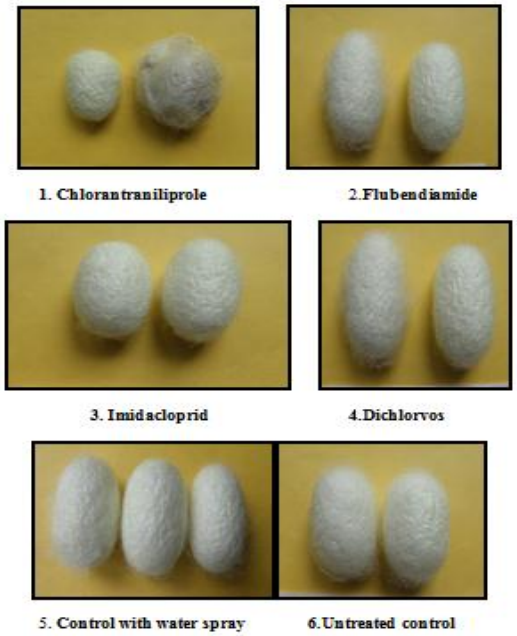

Fig. 1: Effect of Insecticidal residue in mulberry at 40th days after spray on Cocoon parameter

CONCLUSION

The present study clearly indicated that the chemical chlorantraniliprole had negative effects on rearing performance even at 40 DAS. This clearly indicated that whenever the chlorantraniliprole is used in crops near to mulberry garden there is a need to suggest waiting period of more than 40 days for use of mulberry leaf to silkworm rearing. Other chemical alternate to chlorantraniliprole can be recommended with lesser waiting period as evidenced from the experiment. The rearing parameters *viz.* recorded in case of flubendiamide at 40DAS treatment and imidacloprid at 25 DAS were on par with the treatments dichlorvos, control with water spray and untreated control.

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