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Residual Effect of Chemical Insecticides used Against Thrips on Cocoon and Reeling Parameters of Silkworm *Bombyx mori* L

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ABSTRACT: A study was conducted to evaluate the safety period and residual effect of chemical insecticides used against thrips through cocooning performance of silkworm *Bombyx mori* L. Insecticides were sprayed on mulberry at an interval of 25 (20 DAS), 30 (15 DAS) and 35(10 DAS) days after pruning. Among the treatments T2 (acetamiprid 20 SP @ 0.2 g / l) (82.78 %) recorded least cocooning per cent which was on par with T4 (acephate 75 SP @ 1 g/l) (88.04 %) most of the malformed cocoons and defective cocoons like flossy cocoon, double cocoon are obtained in T2 treated batch of silkworm. Acetamiprid recorded lowest cocoon weight (14.78 g/10 cocoons), shell weight (2.04 g/10 shells), pupal weight (12.74 g/10 pupae), cocoon shell ratio (13.84 %). Further Acetamiprid also recorded lowest reeling parameters like filament length (573 m), Non-breakable filament length (503.11 m), Filament weight (0.15 g), Denier (2.31).

Keywords: Silkworm, Cocoon, DAS, insecticides, acetamiprid.

INTRODUCTION

Quantitative and quanlitative characters of the mulberry leaves were affected due to thrips infestation, this had direct bearing on silkworm health and cocoon yield. Severe attack of thrips leads to different morpho-physiological changes in mulberry leaves. Thrips infestation lowers chlorophyll a/b ratio, carbohydrate (>16 %), protein (17.8 %) and moisture content (3.57 %) (Etebari *et al.,* 1998). Mulberry leaves fed to silkworms harvested from thrips infested mulberry garden causes reduced development, decreased larval progression and reduced cocoon yield. *Pseudodendrothrips mori* causes 12 per cent reduction in best cocoon weight (Das *et al.,* 1994). Being an insect silkworm is also sensitive to insecticides hence application of insecticides with high toxicity and prolonged residual effect in mulberry garden must be avoided. The mostly common route of pesticides has an impact on silkworm through host plants and the second most common route of pesticides exposure to silkworm by drifting of pesticides from nearby cultivated fields. Deterioration of different characteristics of silkworm occurs, such as delayed and uneven growth, weak body, light and small or uneven cocoons, shortened cocoon filament and uneven thickness of the filament, poor reel ability of cocoons, reduced number of eggs, production of abnormal eggs, *etc.,* contributed to economic yield loss. Mulberry leaves with permissible levels of pesticide residues must be used for feeding silkworms to overcome the adverse effect, Safety period must be followed which ranges from 3 to 110 days depending upon the insecticide used (Kuribayashi, 1988). Over 1.4 per cent of cocoon yield is reduced in sericulture due to pesticide imposition. Loss of cocoon yield was due to silkworms fed with insecticides sprayed mulberry leaves indiscriminately (Sik *et al.*, 1976). Hence, chemical insecticides for control of mulberry pests must be used very carefully (preferably using lower concentrations). Sufficient waiting period has to be followed before harvest, so as to make sure that leaves safe for consumption by silkworms.

MATERIALS AND METHOD

A. Experimental details
Crop : Mulberry
Variety : Victory-1 (V-1)
Spacing : (90 + 150) × 60 cm (paired row)
No. of treatment : 7
No. of replication : 3
Design : RCBD

Table 1: Treatment details.

Treatments	Details	Dosage
T_1	Buprofezin 25 SC	2 ml/l
T_{2_2}	Acephate 75 SP	1 g/l
T_3	Acetamiprid 20 SP	0.2 g/l
T_4	Imidacloprid 17.8 SL	0.3 ml/l
T_5	Fipronil 5 SC	2 ml/l
T_6	Dimethoate 30 EC	2 ml/l
T_7	Control (water spray)	-

The pesticides were sprayed on the foliage of mulberry using hand sprayer in the field. Treatments were imposed once on 25th, 30th and 35th days after pruning (DAP). Polythene sheet barrier was used to avoid drifting of pesticides from one treated plot to another while spraying.

B. Cocoon parameters

Cocooning percentage (%)

The cocooning percentage (CP) was calculated by using the formula,

$$CP = \frac{\text{Total number of cocoons formed}}{\text{Total number of larvae mounted for spinning}} \times 100$$

Cocoon weight (g / cocoon). A total of ten cocoons per replication in all treatments were selected randomly on fifth day after spinning and weighed separately. The average weight cocoon was computed as

$$\text{Cocoon weight (g/cocoon)} = \frac{\text{Total weight of cocoons (g)}}{\text{Total number of cocoons}} \times 100$$

Pupal weight (g/ pupae). The cocoons selected for recording average cocoon weight were cut open and the live pupae were weighed treatment and replication wise separately on the same day and the average pupal weight was calculated as below:

$$\text{Pupal weight (g/pupae)} = \frac{\text{Total weight of pupae}}{\text{Total number of pupae weighed}} \times 100$$

Cocoon shell weight (g/cocoon shell). The shells of cocoons were taken for recording the cocoon shell weight. Cocoon shell weight excluding pupae and exuviae were taken and the average shell weight was calculated separately for each treatment as given below

$$\text{Shell weight (g /cocoon shell)} = \frac{\text{Total weight of cocoon shell (g)}}{\text{Number of shells weighed}} \times 100$$

Cocoon shell ratio (%). Cocoon shell ratio (CSR) is the ratio of shell weight to cocoon weigh expressed in percentage and was calculated as,

$$\text{Cocoon shell ratio (\%)} = \frac{\text{Average weigh of cocoon shell (g)}}{\text{Average weigh of cocoon (g)}} \times 100$$

C. Reeling parameters

Average filament length (m). A sample of three cocoons was randomly drawn from each replication and cooked separately in boiling water for two to three minutes to soften the sericin layer. These cooked cocoons were reeled on an eprrouvette. The length of silk filament was determined using formula,

L= R × 1.125 m

Where,

L = Length of the silk filament (m)

R = Number of revolutions

1.125 m = Circumference of the reel

Non-breakable filament length (NBFL) (m). It represents the average length of raw silk filament from a cocoon that can be unwound from each cocoon without any breaks. It was calculated by the formula,

$$\text{Non-breakable filament length (m)} = \frac{\text{Total filament length (m)}}{1 + \text{Number of breaks}}$$

Filament weight (g). It was obtained by weighing the reeled silk filament of three cocoons from each replication in treatment. Later, the average was calculated to obtain average filament weight.

Filament Denier

Denier was calculated by the formula:

$$\text{Denier} = \frac{\text{Weight of the filament (g)}}{\text{Length of the cocoon filament (m)}} \times 100$$

D. Statistical analysis

The data was analysed statistically for the test of significance using Fisher method of analysis of variance as outlined by Sundaraaj *et al*. (1972). The population count and percentage values were subjected to square root and arc sine transformation, respectively. The interpretation of data was done using critical difference (CD) values. The Duncan's Multiple Range Test (DMRT) was conducted to compare the mean values among treatments was compared using CD value.

RESULTS AND DISCUSSION

The results and discussion on the research topic entitled **"Residual effect of chemical insecticides used against thrips through rearing performance of silkworm *Bombyx mori* L." co**nducted during 2021-22 at the Department of Sericulture, University of Agricultural Sciences, GKVK, Bangalore, are presented below and discussed in the light of earlier reports published.

(i) Effect of chemical insecticides on cocoon percentage (%). Cocooning percentage (%) of silkworms fed on mulberry leaves treated with chemical insecticides at different days after spraying exhibited significant difference among treatments.

At 10 DAS, the highest cocooning per cent was recorded in T7 (control) (97.08 %) followed by T6 (dimethoate 30 EC @ 2 ml / l) (96.22 %), T1 (buprofezin 25 SC @ 2 ml / l) (96.18 %), T3 (Fipronil 5 SC @ 2 ml / l) (95.63 %), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (94.61 %) and least was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (82.78 %) which was on par with T4 (acephate 75 SP @ 1 g / l) (88.04 %).

At 15 DAS, the highest cocooning per cent was recorded in T7 (control) (97.57 %) followed by T6 (dimethoate 30 EC @ 2 ml / l) (97.50 %), T1 (buprofezin 25 SC @ 2 ml / l) (96.93 %), T3 (Fipronil 5 SC @ 2 ml / l) (96.20 %), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (95.47 %) and least was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (85.57 %) which was on par with T4 (acephate 75 SP @ 1 g / l) (89.63 %).

At 20 DAS, the highest cocooning per cent was recorded in T7 (control) (98.00 %) followed by T6 (dimethoate 30 EC @ 2 ml / l) (97.83 %), T3 (Fipronil 5 SC @ 2 ml / l) (97.10 %), T1 (buprofezin 25 SC @ 2 ml / l) (96.93 %), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (96.70 %) and least was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (86.33 %) which was on par with T4 (acephate 75 SP @ 1 g / l) (90.20 %) (Table 2, Fig. 1). This might have due to variation in larval mortality and Effective rate of rearing (ERR %)

Similarly, according to Sik *et al*. (1976), the adverse effects of pesticide treatment account for more than 1.4% of the yield reduction in sericulture. Different pesticides were used in rice fields, fruit gardens, and olericulture, accounting for 49.4%, 21.2%, and 12.3% of the total.

Table 2: Effect of chemical insecticides on cocooning percentage (%).

Treatments		Cocooning percentage (%)		
		10 DAS	15 DAS	20 DAS
T_1	Buprofezin 25 SC @ 2 ml / l	96.18	96.93	96.93
T_2	Acetamiprid 20 SP @ 0.2 g / l	82.78	85.57	86.33
T_3	Fipronil 5 SC @ 2 ml / l	95.63	96.20	97.10
T_4	Acephate 75 SP @ 1 g / l	88.04	89.63	90.20
T_5	Imidacloprid 17.8 SL @ 0.3 ml / l	94.61	95.47	96.70
T_6	Dimethoate 30 EC @ 2 ml / l	96.22	97.50	97.83
T_7	Control (water spray)	97.08	97.57	98.00
F-test		*	*	*
S.Em. ±		0.568	0.668	0.403
CD @ 5 %		1.749	1.835	1.243

*Significant at 5%, DAS-Days after spraying

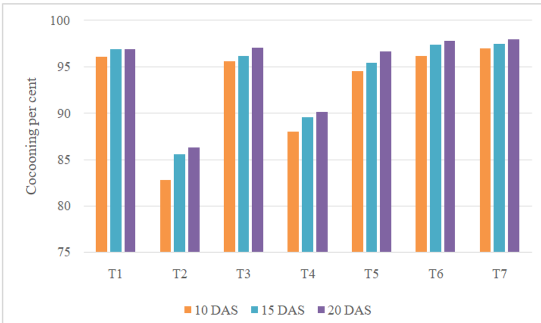

Fig. 1. Effect of chemical insecticides on cocooning percentage (%).

(ii) Residual toxicity symptoms exhibited by insecticide treated larvae on cocooning. Many of the pharate pupae obtained in the batch of silkworm fed on mulberry leaves treated with buprofezin (Plate 1), blackened pupae obtained in acephate (Plate 2) treated batch of silkworm and most of the malformed cocoons and defective cocoons like flossy cocoon, double cocoon are obtained in acetamiprid (Plate 3) treated batch of silkworm.

(iii) Cocoon shape and size spun by silkworms fed with selected insecticides. Cocoons produced by larvae fed on the mulberry leaves treated with T1 (buprofezin 25 SC@ 2 ml / l) were slightly spindle shaped and smaller than compared to control, in T2 (acetamiprid 20 SP @ 0.2 g / l) cocoons were more spindle and seen much smaller than control, in T3 (Fipronil 5 SC @ 2 ml / l) cocoons with yellowish tinge which was same as parent PM (Pure mysore) and in size cocoons were on par with T1 (buprofezin 25 SC @ 2 ml / l) and T2 (acetamiprid 20 SP @ 0.2 g / l), in T4 (acephate 75 SP @ 1 g / l) cocoons were spindle shaped and much smaller than previous three treatments, in T5 (imidacloprid 17.8 SL @ 0.3 ml / l) cocoon shape is similar to control *i.e.*, oval and also a mixture of spindle shape but smaller in size, in T6 (dimethoate 30 EC @ 2 ml / l) cocoons are oval in shape and bit smaller than control and in T7 (control) the obtained cocoons are oval in shape and are much uniform in size when compared to cocoons obtained in insecticide treated batches of silkworm (Plate).

Similarly, among the silkworms affected by pesticides, some ones grow almost normally during the larval period but die in cocooning frames due to lack of cocooning ability or some ones carry out cocooning but die inside the cocoons. Furthermore, abnormal cocoons with abnormal cocoon shells, normal cocooning but giving poor silk reeling were observed (Kuribayashi, 1988). Cheng *et al*. (2019) reported that after treating the newly exuviated 3rd instar silkworm larvae continuously with low concentration of acetamiprid, the duration of each instar was prolonged and the body weight of moulting or mature larvae, cocoon weight, cocoon shell weight and cocoon shell ratio were all adversely affected. Under high concentration of acetamiprid, although the activity of superoxide dismutase (SOD) is activated, the activities ofcatalase (CAT) and glutathione peroxidase (GSH-Px) in silkworm larvae are both inhibited. Further he also reported that acetamiprid is high risk or ultra-high-risk grade poison to silkworm.

Plate 1. Effect of buprofezin 25 SC @ 2 ml / l on cocooning of silkworms.

Plate 2. Effect of acephate 75 SP @ 1 g / l on cocooning of silkworms.

Plate 3. Effect of acetamiprid 20 SP @ 0.2 g / l on cocooning of silkworms.

B. Effect of chemical insecticides on cocoon weight (g), shell weight (g), pupal weight (g) and cocoon shell ratio (%)

Cocoon weight (g) has shown significant difference among the different treatmentsand among different days after spraying. At 10 DAS, the highest cocoon weight was recorded in the T7 (control) (18.40 g /10 cocoons) followed by T6 (dimethoate 30 EC @ 2 ml / l) (18.04 g / 10 cocoons), T3 (Fipronil 5 SC @ 2 ml / l) (17.49 g / 10 cocoons) and lowest cocoon weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (14.78 g / 10 cocoons) which was on par with T4 (acephate 75 SP @ 1 g / l) (15.14 g / 10 cocoons).

At 15 DAS, the highest cocoon weight was recorded in the T7 (control) (18.77 g /10 cocoons) followed by T6 (dimethoate 30 EC @ 2 ml / l) (18.41 g / 10 cocoons), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (17.86 g / 10 cocoons) and lowest cocoon weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (15.03 g / 10 cocoons) which was on par with T4 (acephate 75 SP @ 1 g / l) (15.55 g / 10 cocoons).

At 20 DAS, the highest cocoon weight was recorded in the T7 (control) (19.02 g /10 cocoons) followed by T6 (dimethoate 30 EC @ 2 ml / l) (18.96 g / 10 cocoons), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (17.96 g / 10 cocoons) and lowest cocoon weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (15.24 g / 10 cocoons) which was on par with T4 (acephate 75 SP @ 1 g / l) (16.04 g / 10 cocoons).

Cocoon shell weight (g) was found significantly different among the treatments and among different days after spraying. At 10 DAS, the highest cocoon shell weight was recorded in the T7 (control) (2.62 g /10 shells) followed by T6 (dimethoate 30 EC @ 2 ml / l) (2.57 g / 10 shells), T3 (Fipronil 5 SC @ 2 ml / l) (2.52 g / 10 shells) and lowest cocoon shell weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (2.04 g / 10 shells) which was on par with T4 (acephate 75 SP @ 1 g / l) (2.22 g / 10 shells).

At 15 DAS, the highest cocoon shell weight was recorded in the T7 (control) (2.79 g /10 shells) followed by T6 (dimethoate 30 EC @ 2 ml / l) (2.59 g / 10 shells), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (2.61 g / 10 shells) and lowest cocoon shell weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (2.11 g / 10 shells) which was on par with T4 (acephate 75 SP @ 1 g / l) (2.28 g / 10 shells).

At 20 DAS, the highest cocoon shell weight was recorded in the T7 (control) (3.04 g /10 shells) followed by T6 (dimethoate 30 EC @ 2 ml / l) (2.83 g / 10 shells), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (2.76 g / 10 shells) and lowest cocoon shell weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (2.37 g / 10 shells) which was on par with T4 (acephate 75 SP @ 1 g / l) (2.55 g / 10 shells).

Pupal weight (g) was varied significantly among the treatments and among different days after spraying. At 10 DAS, the highest pupal weight was recorded in T7 (control) (15.78g /10 pupae) followed by T6 (dimethoate 30 EC @ 2 ml / l) (15.47 g / 10 pupae), T3 (Fipronil 5 SC @ 2 ml / l) (14.97 g / 10 pupae) and lowest pupal weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (12.74 g / 10 pupae) which was on par with T4 (acephate 75 SP @ 1 g / l) (12.92 g / 10 pupae).

At 15 DAS, the highest pupal weight was recorded in T7 (control) (15.96 g /10 pupae) followed by T6 (dimethoate 30 EC @ 2 ml / l) (15.76 g / 10 pupae), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (15.18 g / 10 pupae) and lowest pupal weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (12.94 g / 10 pupae) which was on par with T4 (acephate 75 SP @ 1 g / l) (13.25 g / 10 pupae).

At 20 DAS, the highest pupal weight was recorded in T7 (control) (16.08 g /10 pupae) followed by T6 (dimethoate 30 EC @ 2 ml / l) (15.89 g / 10 pupae), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (15.45 g / 10 pupae) and lowest pupal weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (13.03 g / 10 pupae) which was on par with T4 (acephate 75 SP @ 1 g / l) (13.49 g / 10 pupae).

Cocoon shell ratio (%) was found significantly different among the treatments and among different days after spraying. At 10 DAS, the highest cocoon shell ratio was recorded in T7 (control) (14.68 %) followed by T6 (dimethoate 30 EC @ 2 ml / l) (14.45 %), T3 (Fipronil 5 SC@ 2 ml / l) (14.43 %) and lowest cocoon shell ratio was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (13.84 %) which was on par with T4 (acephate 75 SP @ 1 g / l) (14.23 %).

At 15 DAS, the highest cocoon shell ratio was recorded in T7 (control) (14.92 %) followed by T6 (dimethoate 30 EC @ 2 ml / l) (14.81 %), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (14.67 %) and lowest cocoon shell ratio was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (14.07 %) which was on par with T4 (acephate 75 SP @ 1 g / l) (14.31 %).

At 20 DAS, the highest cocoon shell ratio was recorded in T7 (control) (15.95 %) followed by T6 (dimethoate 30 EC @ 2 ml / l) (15.67 %), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (15.57 %) and lowest cocoon shell ratio was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (14.91 %) which was on par with T4 (acephate 75 SP @ 1 g / l) (14.98 %) (Table 3).

Similarly, Yeshika *et al.* (2020) reported the *B. mori* L. cocoon characteristics were affected by new pesticide molecule residues found in mulberry leaves. The findings showed that untreated control had the highest single cocoon weight, pupal weight, and cocoon shell weight, which was on par with dichlorvos 76 EC, dinotefuran 20 SG, and pymetrozine 50 WG. Vassarmidaki *et al.* (2000) conducted a study to evaluate the effect of the insecticide buprofezin 25% WP (applaud) on silkworm *B. mori* L. The data revealed that, larvae fed (dipped in solution) on 3 different concentrations (0.5, 1, 2 g/litre) on 1st day of each instar caused mortality but larval duration of treated batches did not differ among the treatments. Whereas, the larval weight, cocoon weight, shells weight, sericin and fibroin content were different among treatments except for shell ratio. They also concluded that, supplementation of buprofezin to silkworm larvae affected the larval growth and cocoon parameters. Feeding silkworms with mulberry leaves harvested from dimethoate sprayed plots after safe waiting period showed a significant improvement in respect of larval weight, cocoon weight and shell weight as compared to the infested control (Kariappa and Narasimhanna 1978).

Table 3: Effect of chemical insecticides on cocoon weight (g), shell weight (g), pupal weight (g) and cocoon shell ratio (%).

Treatments	Cocoon parameters											
	10 DAS				15 DAS				20 DAS			
	Cocoon weight (g /10 cocoons)	Cocoon shell weight (g /10 shells)	Pupal weight (g/10 pupae)	Cocoon shell ratio (%)	Cocoon weight (g/10 cocoons)	Cocoon shell weight (g /10 shells)	Pupal weight (g /10 pupae)	Cocoon shell ratio (%)	Cocoon weight (g /10 cocoons)	Cocoon shell weight (g /10 shells)	Pupal weight (g /10 pupae)	Cocoon shell ratio (%)
T_1	17.31	2.48	14.68	14.29	17.35	2.59	14.79	14.46	17.63	2.71	15.28	15.38
T_2	14.78	2.04	12.74	13.84	15.03	2.11	12.94	14.07	15.24	2.37	13.03	14.91
T_3	17.49	2.52	14.97	14.43	17.49	2.55	14.93	14.57	17.62	2.76	14.99	15.45
T_4	15.14	2.22	12.92	14.23	15.55	2.28	13.25	14.31	16.04	2.55	13.49	14.98
T_5	17.17	2.50	14.81	14.37	17.86	2.61	15.18	14.67	17.96	2.76	15.45	15.57
T_6	18.04	2.57	15.47	14.45	18.41	2.59	15.76	14.81	18.96	2.83	15.89	15.67
T_7	18.40	2.62	15.78	14.68	18.77	2.79	15.96	14.92	19.02	3.04	16.08	15.95
F-test	*	*	*	*	*	*	*	*	*	*	*	*
S.Em. ±	0.105	0.024	0.004	0.012	0.048	0.041	0.028	0.022	0.053	0.033	0.128	0.014
CD @ 5 %	1.325	1.073	1.014	1.036	1.147	0.127	1.086	1.037	1.162	0.101	1.395	1.043

*Significant at 5%, DAS-Days after spraying

T1-Buprofezin 25 SC @ 2 ml / l ; T2- Acetamiprid 20 SP @ 0.2 g / l ; T3- Fipronil 5 SC @ 2 ml / l; T4- Acephate 75 SP @ 1 g/ l; T5- Imidacloprid 17.8 SL @ 0.3 ml / l; T6- Dimethoate 30 EC @ 2 ml / l; T7- Control (water spray)

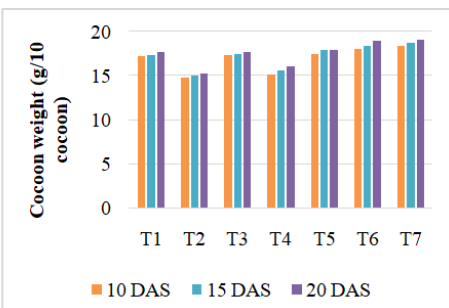

Fig. 2. Effect of chemical insecticides on cocoon weight.

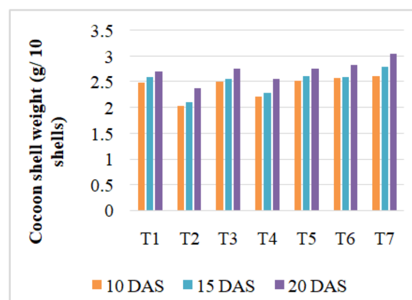

Fig. 4. Effect of chemical insecticides on cocoon shell weight.

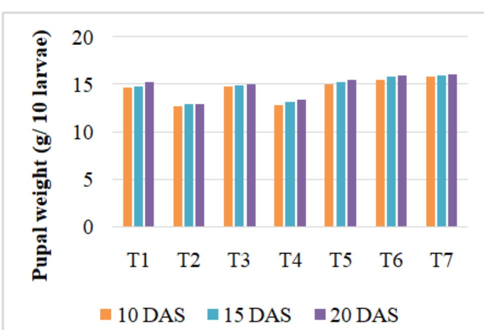

Fig. 3. Effect of chemical insecticides on pupal weight.

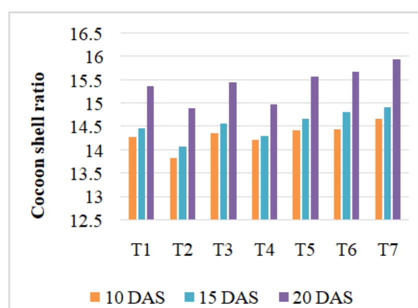

Fig. 5. Effect of chemical insecticides on Cocoon shell ration

C. Effect of chemical insecticides on cocoon filament length (m), non-breakable filament length (m), filament weight (g) and denier

Cocoon filament length exhibited significant difference among different treatments for different days after spraying. At 10 DAS, the longest filament length was recorded in T7(control)(732 m) followed by T6 (dimethoate 30 EC @ 2 ml / l) (715 m), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (681 m) and lowest filament length was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (573 m) which was on par with T4 (acephate 75 SP @ 1 g / l) (593 m).

At 15 DAS, the longest filament length was recorded in T7 (control) (741.33 m) followed by T6 (dimethoate 30 EC @ 2 ml / l) (719.33 m), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (684.67 m) and lowest filament length was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (575.33 m) which was on par with T4 (acephate 75 SP @ 1 g / l) (595.33 m).

At 20 DAS, the longest filament length was recorded in T7 (control) (742 m) followed by T6 (dimethoate 30 EC @ 2 ml / l) (725 m), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (690 m) and lowest filament length was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (578 m) which was onpar with T4 (acephate 75 SP @ 1 g / l) (600.67 m). The variations in the cocoon filament length could be due to the differed quality of cocoons obtained in respective treatments.

Non-breakable filament length (NBFL) (m) recorded significantly difference among the treatments and among different days after spraying. At 10 DAS, the longest NBFL was recorded in T7 (control) (701.33 m) followed by T6 (dimethoate 30 EC @ 2 ml / l) (693.11 m), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (650.33 m) and the lowest NBFL was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (503.11 m) which was on par with T4 (acephate 75 SP @ 1 g / l) (604.67 m).

At 15 DAS, the longest NBFL was recorded in T7 (control) (701.67 m) followed by T6 (dimethoate 30 EC @ 2 ml / l) (698.67 m), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (654.67 m) and the lowest NBFL was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (544.78 m) which was on par with T4 (acephate 75 SP @ 1 g / l) (561.33 m).

At 20 DAS, the longest NBFL was recorded in T7 (control) (721.33 m) followed by T6 (dimethoate 30 EC @ 2 ml / l) (701.33 m), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (690 m) and the lowest filament length was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (548.67 m) which was on par with T4 (acephate 75 SP @ 1 g / l) (576.33 m).

Filament weight (g) was recorded significantly difference among treatments and among different days after spraying. At 10 DAS, the highest filament weight was recorded inT7 (control) (0.26 g) followed by T6 (dimethoate 30 EC @ 2 ml / l) (0.25 g), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (0.22 g) and the lowest filament weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (0.15) which was on par with T4 (acephate 75 SP @ 1 g / l) (0.17).

At 15 DAS, the highest filament weight was recorded in T7 (control) (0.27 g) followed by T6 (dimethoate 30 EC @ 2 ml / l) (0.26 g), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (0.23 g) and lowest filament weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (0.16 g) which was on par with T4 (acephate 75 SP @ 1 g / l) (0.18 g).

At 20 DAS, the highest filament weight was recorded in T7 (control) (0.28 g) followed by T6 (dimethoate 30 EC @ 2 ml / l) (0.27 g), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (0.24 g) and the lowest filament weight was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (0.17 g) which was on par with T4 (acephate 75 SP @ 1 g / l) (0.19 g).

Denier showed significantly difference among treatments and among different days after spraying. At 10 DAS, denier was high in T7 (control) (2.63) followed by T6 (dimethoate 30 EC @ 2 ml / l) (2.61), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (2.60) and finest denier was recorded inT2 (acetamiprid 20 SP @ 0.2 g / l) (2.31) which was on par with T4 (acephate 75 SP @ 1 g / l) (2.48).

At 15 DAS, denier was high in T7 (control) (2.64) followed by T6 (dimethoate 30 EC @ 2 ml / l) (2.63), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (2.62) and finest denier was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (2.35) which was on par with T4 (acephate 75 SP @ 1 g / l) (2.49).

At 20 DAS, denier was high in T7 (control) about 2.67 followed by T6 (dimethoate 30 EC @ 2 ml / l) (2.66), T5 (imidacloprid 17.8 SL @ 0.3 ml / l) (2.64) and finest denier was recorded in T2 (acetamiprid 20 SP @ 0.2 g / l) (2.42) which was on par with T4 (acephate 75 SP @ 1 g / l) (2.50) (Table 4).

Similarly, Yeshika *et al*. (2020) studied the effect of novel insecticides treated mulberry leaves on the reeling performance of silkworm *Bombyx mori* L. The cocoon filament length was longest in untreated control and the lowest filament length was recorded in flonicamid 50 WG 0.3 g/l sprayed @ 20, 30 and 40 DAS. At 10 DAS, filament denier across all the treatments was on par with each other except in the treatments dinotefuron 20 SG @ 0.12 g/l and dichlorvos 76 EC @ 2.63 ml/l.

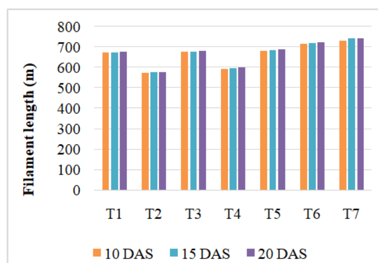

Fig. 6. Effect of chemical insecticides on filament length.

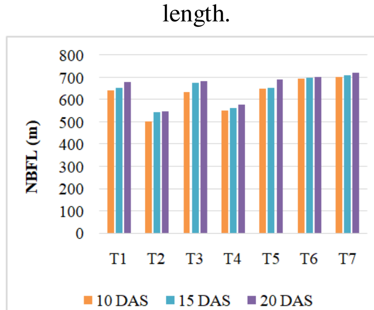

Fig. 7. Effect of chemical insecticides on NBFL.

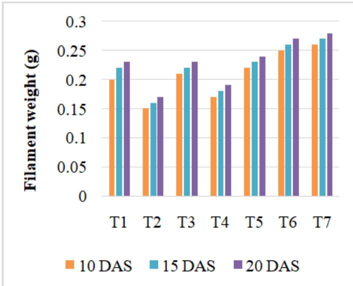

Fig. 8. Effect of chemical insecticides on filament weight.

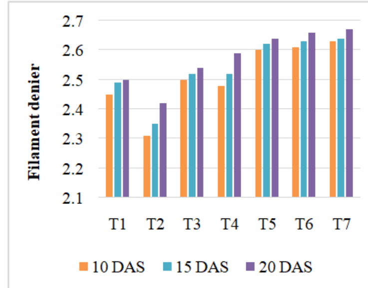

Fig. 9. Effect of chemical insecticides on filament denier.

Table 4: Effect of chemical insecticides on cocoon filament length (m), non-breakable filament length (m), filament weight (g) and denier.

Treatments	Reeling parameters											
	10 DAS				15 DAS				20 DAS			
	Filament length (m)	NBFL (m)	Filament weight (g)	Denier	Filament length (m)	NBFL (m)	Filament weight (g)	Denier	Filament length (m)	NBFL (m)	Filament weight (g)	Denier
T_1	673.67	643.11	0.20	2.45	674.67	651.33	0.22	2.52	677.67	677.67	0.23	2.59
T_2	573.00	503.11	0.15	2.31	575.33	544.78	0.16	2.35	578.00	548.67	0.17	2.42
T_3	675.00	635.17	0.21	2.50	677.33	677.33	0.22	2.52	681.67	681.56	0.23	2.54
T_4	593.00	552	0.17	2.48	595.33	561.33	0.18	2.49	600.67	576.33	0.19	2.50
T_5	681.00	650.33	0.22	2.60	684.67	654.67	0.23	2.62	690.00	690	0.24	2.64
T_6	715.00	693.11	0.25	2.61	719.33	698.67	0.26	2.63	725.00	701.33	0.27	2.66
T_7	732.00	701.33	0.26	2.63	741.33	710.67	0.27	2.64	742.00	721.33	0.28	2.67
F-test	*	*	*	*	*	*	*	*	*	*	*	*
S.Em. ±	0.577	0.236	0.004	0.009	0.828	0.282	0.003	0.007	0.696	0.357	0.005	0.015
CD @ 5 %	1.779	0.726	0.011	0.028	2.551	0.868	0.029	0.022	2.144	1.099	0.010	0.045

*Significant at 5%, DAS-Days after spraying

T1-Buprofezin 25 SC @ 2 ml / l ; T2- Acetamiprid 20 SP @ 0.2 g / l ; T3- Fipronil 5 SC @ 2 ml / l ; T4- Acephate 75 SP @ 1 g/ l ; T5- Imidacloprid 17.8 SL @ 0.3 ml / l; T6- Dimethoate 30 EC @ 2 ml / l; T7- Control (water spray)

CONCLUSIONS

Acetamiprid belongs to neonicotinoid group of chemicals which shows systemic and translaminar action and it is also belongs to broad-spectrum insecticide, which is mainly used to control sucking pests but it also shows its effect on biting and chewing type of insects hence its residue on mulberry leaves showed adverse effect on silkworm performance with toxicity symptoms some ones grow almost normally during the larval period but die in cocooning frames due to lack of cocooning ability or some ones carry out cocooning but die inside the cocoons. Furthermore, abnormal cocoons with abnormal cocoon shells, normal cocooning but giving poor silk reeling *etc.* From this study it is suggested that fipronil and dimethoate had a reasonably good safety period of 15 days and resulted in better cocoon parameters.

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