Environment and Ecology 38 (2) : 161—166, April—June 2020
ISSN 0970-0420

Effect of Novel Insecticide Molecules in Mulberry on Reeling Parameters of Silkworm *Bombyx mori* L. Coccoons

M. P. Yeshika, K. G. Banuprakash, K. Murali Mohan, K. S. Vinoda

Received 25 January. 2020; Accepted 13 March 2020; Published on 3 April 2020

ABSTRACT

Effect of novel insecticides treated mulberry leaves on the reeling performance of silkworm *Bombyx mori* L. were studied. The cocoon filament length was longest in untreated control and in the insecticide treatments viz., dinotefuron 20 SG @ 0.25 g/l, dichlorovos 76 EC @ 2.63 ml/l at different time intervals of 10, 20, 30 days after spraying. Lowest filament length was recorded when flonicamid 50 WG sprayed @ 0.3 g/l and 20, 30 and 40 DAS. This was followed by azadirachtin 1% @ 1 ml/l recording shorter filament length at 40 DAS. However, at 10 and 20 DAS azadirachtin 1% @ 1 ml/l recorded longest cocoon filament which were at par with untreated control. At 10 DAS, filament denier across all the treatments was at par with each other except in the treatments dinotefuron 20 SG @ 0.12 g/l and dichlorovos 76 EC @ 2.63 ml/l. At 40 DAS, finer denier was observed in the treatments pymetrozine 50 WG @ 0.6 g/l and 0.3 g/l, flonicamid 50 WG @ 0.3 g/l and 0.15 g/l, dinotefuron 20 SG @ 0.12 g/l. In the remaining treatments, the filament denier was at par with untreated control. Azadirachtin 1% @ 2 ml/l recorded finer denier at 30 and 40 DAS. Buprofezin 25 SC @ 1 ml/l recorded coarse denier at par with control at 10, 20, 30 DAS, whereas denier was finer with the same treatment at 40 DAS. Among the various treatments, dinotefuron 20 SG @ 0.25 g/l has performed well with reference to the reeling parameters.

Keywords *B. mori,* Mulberry, Dinotefuron, Flonicamid, DDVP.

INTRODUCTION

The superiority of silk as a textile fiber has been recognized from the time immemorial and even today, no other fabric can match its lustre and elegance. Mulbarry being the sole food for silkworm *Bombyx mori* L. is infested by several pests. The insecticides applied for the management of mulberry pests have greater impact on silkworm rearing and subsequently on cocoon reeling parameters. Pesticide residues on mulberry leaves pose a severe threat to the silkworms, which in turn effect the silk quality (Yokoyama 1962). Field observations in India indicated loss of cocoon yield and quality of silk from silkworms fed on mulberry leaves sprayed with insecticides (Narasimhanna 1988). Silkworm being an insect is known to be very sensitive to insecticides, chemicals meant for insect pest control also affect the silkworms in terms of silk quality when they come in contact with the insecticides either directly or due to consumption of mulberry leaves treated with insecticides. Therefore, any application of insecticides on mulberry should be taken up very carefully. Sufficient waiting period has to be followed before harvest, so as to make leaves

M. P. Yeshika*, K. G. Banuprakash
Department of Sericulture, UAS, GKVK, Bangalore 560065, Karnataka, India

K. Murali Mohan
Department of Agricultural Entomology, UAS, GKVK, Bangalore 560065, Karnataka, India

K. S. Vinoda
Department of Silkworm Genetics & Breeding, College of Sericulture, Chintamani 563125, Karnataka, India
Email : yashikadechamma@gmail.com
*Corresponding author

safe for consumption by silkworms. Recommended and widely used insecticide, dichlorovos being a contact poison, has proven lethal against the silkworms if fed immediately after spraying. Therefore, leaves will be harvested only after 15 days of waiting or safety period. Pest management in mulberry sericulture is absolutely selective because silkworm cannot tolerate even sub-lethal doses of toxic compounds. In the light of above context, a study was initiated using different novel insecticides along with dichlorovos, has been notified for ban from import and manufacture with effective from January 2019 and complete ban from usage on all crops with effective from December 2020 (Anonymous 2016). Corresponding to the reeling parameters to silkworm like cocoon filament length and filament denier.

MATERIALS AND METHODS

The commercial cross breed PM × CSR_2 was used for the study which were fed with V_1 leaves. The larvae were provided with chopped mulberry leaves of required quantity and quality. At 3rd instar, after 30 minutes of initial feeding, 90 larvae were transferred to each experimental try in three replications along with the mulberry leaves. The design used was Completely Randomized Design. The mulberry leaves sprayed with insecticides viz., buprofezin 25 SC (Applaud), pymetrozine 50 WG (Chess), flonicamid 50 WG (Ulala), dinotefuran 20 SG (Osheen), azadirachtin 1% (Neemazol) and dichlorovos (Nuvan) were fed to silk worms separately as per schedule. The silkworms were fed with 10, 20, 30 and 40 DAS insecticides. The cocoons of different treatments were harvested and were subjected for the recling parameters viz., single cocoon filament length and filament denier.

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 :

$$L = R \times 1.125 \text{ m.}$$

Where, in L was length of the silk filament (m), R was number of revolutions and 1.125 m represented circumference of the eupprovette.

Silkworm filament denier was calculated by using the formula:

$$\text{Denier} = \frac{\text{Weight of silk filament (g)}}{\text{Length of silk filament (m)}} \times 9000$$

RESULTS AND DISCUSSION

Single cocoon filament length (m)

Single cocoon filament length recorded significant different among the four set of treatment where the

Table 1. Effect of insecticides on single cocoon filament length (m). *Significant at 5%, DAS –Days after spraying.

	Treatments	Filament length (m) 10 DAS	20 DAS	30 DAS	40 DAS
T_1	Buprofezin 25 SC @ 1 ml/l	652.67^{cd}	666.33^{cd}	654.00^{cdef}	664.00^{cd}
T_2	Buprofezin 25 SC @ 2 ml/l	614.67^{f}	619.67^{f}	615.00^{f}	620.00^{f}
T_3	Pymetrozine 50 WG @ 0.3 g/l	631.67^{ef}	634.67^{ef}	663.33^{cdef}	651.33^{de}
T_4	Pymetrozine 50 WG @ 0.6 g/l	697.67^{b}	686.33^{bc}	693.00^{abcd}	679.33^{c}
T_5	Flonicamid 50 WG @ 0.15 g/l	647.00^{cde}	687.00^{bc}	682.00^{abcde}	657.33^{d}
T_6	Flonicamid 50 WG @ 0.3 g/l	0.00^{g}	410.83^{g}	409.33^{gbcde}	374.00^{h}
T_7	Dinotefuron 20 SG @ 0.12 g/l	665.00^{c}	669.00^{cd}	672.33^{a}	668.00^{cd}
T_8	Dinotefuron 20 SG @ 0.25 g/l	722.67^{a}	716.33^{a}	728.00^{a}	705.33^{ab}
T_9	Azadirachtin 1% @ 1 ml/l	717.00^{a}	697.67^{ab}	637.00^{ef}	570.00^{g}
T_{10}	Azadirachtin 1% @ 2 ml/l	694.67^{b}	701.67^{ab}	706.00^{abc}	697.33^{b}
T_{11}	Dichlorovos 76 EC @ 1.32 ml/l	643.33^{dc}	647.67^{de}	643.33^{def}	636.33^{ef}
T_{12}	Dichlorovos 76 EC @ 2.63 ml/l (std check)	725.67^{a}	711.00^{ab}	704.00^{abc}	697.33^{b}
T_{13}	Untreated control	734.67^{a}	662.3^{ed}	718.67^{ab}	716.00^{a}
	F-test	*	*	*	*
	SEm ±	6.451	10.436	18.982	6.115
	CD at 5%	18.753	30.337	55.179	17.776

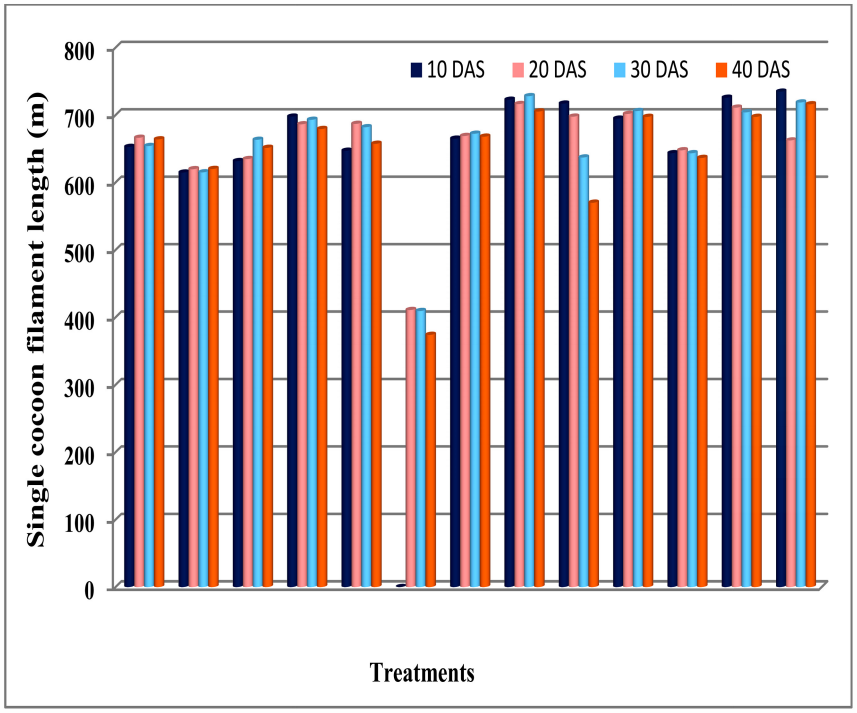

Fig. 1. Effect of insecticides on single cocoon filament length (m). T_1-Buprofezin 25 SC @ 1 ml/l, T_2-Buprofezin 25 SC @ 2 ml/l, T_3-Pymetrozine 50 WG @ 0.3 g/l, T_4-Pymetrozine 50 WG @ 0.6 g/l, T_5-Flonicamid 50 WG @ 0.15 g/l, T_6-Flonicamid 50 WG @ 0.3 g/l, T_7-Dinotefuron 20 SG @ 0.12 g/l, T_8-Dinotefuron 20 SG @ 0.25 g/l, T_9-Azadirachtin 1% @ 1 ml/l, T_{10}- Azadirachtin 1% @ 2 ml/l, T_{11}-Dichlorovos 76 EC @ 1.32 ml/l, T_{12}-Dichlorovos 76 EC @ 2.63 ml/l, T_{13}-Untreated control, DAS-Days after spraying.

silkworm batches were reared on the mulberry leaf treated with different insecticides on 10, 20, 30 and 40 DAS. The treatment untreated control recorded longest filament length (734.67 m) in the batches reared with leaves fed 10 DAS which was statistically at par with the filament length of dichlorovos 76 EC @ 2.63 ml/l (725.67 m), dinotefuron 20 SG @ 0.25 g/l (722.67 m) and azadirachtin 1% @ 1 ml/l (717 m). The shortest filament length was recorded in the treatment buprofezin 25 SC @ 2 ml/l (614.67 m). The other treatment recorded single cocoon filament length ranging from 643.33 to 697.67 m (Table 1). In the batches of silkworm fed with mulberry 20 DAS the range of filament length varied 716.33 to 410.83 m. The longest filament length in the treatment dinotefuron 20 SG @ 0.25 g/l (716.33 m) recorded was statistically at par with dichlorovos 76 EC @ 2.63 ml/l (standard check) (711 m)m, azadirachtin 1% @ 2 ml/l (701.67 m) and azadirachtin 1% @ 1 ml/l (697.67 m). These were followed by dinotefuron 20 SG @ 0.12 g/l (669 m) which was at par with buprofezin 25 SC @ 1 ml/l (666.33 m), untreated control (662.33 m) and dichlorovos 76 EC @ 1.32 ml/l (647.67 m). Filament length of 634.67 m was recorded by pymetrozine 50 WG @ 0.3 g/l which was at par with buprofezin 25 SC @ 2 ml/l (619.67 m). The shortest filament length was recorded in the treatment flonicamid 50 WG @ 0.3 g/l (410.83 m) (Table 1, Fig. 1).

When the silkworms were fed with mulberry leaf 30 DAS of insecticide, the longest single cocoon filament length was recorded in dinotefuron 20 SG @ 0.25 g/l (728.00 m) which was at par with the highest filament length of untreated control (718.67 m), azadirachtin 1% @ 2 ml/l (706.00 m), dichlorovos 76 EC @ 2.63 ml/l (704.00 m), pymetrozine 50 WG @ 0.6 g/l (693.00 m), flonicamid 50 WG @ 0.15 g/l (682.00 m) and dinotefuron 20 SG @ 0.12

g/l (672.33 m).Buprofezin 25 SC @ 2 ml/l exhibited short filament length of 615 m which was statistically at par with buprofezin 25 SC @ 1 ml/l (654.00 m), pymetrozine 50 WG @ 0.3 g/l (663.33 m), azadirachtin 1% @ 1 ml/l (637.00 m) and dichlorovos 76 EC @ 1.32 ml/l (643.33 m) (Table 1, Fig. 1).

The single cocoon filament length varied from 374 to 716 m in the batches treated with mulberry leaves 40 DAS of insecticides. The longest filament length was exhibited by untreated control (716 m) which was statistically at par with dinotefuron 20 SG @ 0.25 g/l (705.33 m) . Azadirachtin 1% @ 2 ml/l and dichlorovos 76 EC @ 2.63 ml/l recorded the next best higher and statistically at par filament length of 697.33 m. Dinotefuron 20 SG @ 0.12 g/l recorded filament length of 668 m, which was statistically at par with pymetrozine 50 WG @ 0.6 g/l (679.33 m) and buprofezin 25 SC @ 1 ml/l (664 m). Flonicamid 50 WG @ 0.15 g/l recorded filament length of 657.33 m which was at par with pymetrozine 50 WG @ 0.3 g/l 651.33 m. The shortest single cocoon filament length was recorded in flonicamid 50 WG @ 0.3 g/l (374.00 m) (Table 1, Fig. 1).

Silkworm cocoon filament length was longest in untreated control and in the insecticide treatments viz., dinotefuron 20 SG @ 0.25 g/l, dichlorovos 76 EC @ 2.63 ml/l at different time intervals of 10, 20, 30 DAS. Lowest filament length was recorded in flonicamid 50 WG @ 0.3 g/l at 20, 30 and 40 DAS. This was followed by azadirachtin 1% @ 1 ml/l recording shorter filament length at 40 DAS. However, at 10 and 20 DAS azadirachtin 1% @ 1 ml/l recorded highest cocoon filament length at par with untreated control. Dinotefuron 20 SG is a third generation neonicotinoid with strong systemic and translaminar action. Upon ingestion, it acts on the nervous system of the insect and disrupts the normal functioning of nervous system by mimicking the functions of acetylcholine. This molecule is known to be effective on multiple sucking insects on crops and also known to be safer for non-sucking insects like silkworms (Ghosh et al. 2014).

Bandyopadhyay et al. (2005) noticed higher filament length with dichlorovos 0.1% and azadirachtin at 1% compared to other insecticides assessed. In another study where azadirachtin 0.15% EC showed higher silkworm cocoon filament length in comparison with other insecticides viz., emamectin benzoate, flubendiamide, abamectin and *Bacillus thuringiensis* (Kordy 2014). The similar trend was observed in the present investigation also.

Gayathri (2007) reported the adverse effects insecticides on cocoon filament length. Here, when fourth instar silkworms were fed with or ganophosphate insecticide, methyl demeton (0.05%), cocoon filament length was significantly lower than that of untreated control.

Filament denier (D)

The values pertaining to the denier which was recorded by the effect of different insecticides when they were fed at different intervals of DAS were found significant in all the four batches of rearing. The coarse denier at 10 DAS was found in dinotefuron 20 SG @ 0.25 g/l (2.61) which was found statistically at par with the treatments like untreated control (2.57), pymetrozine 50 WG @ 0.6 g/l (2.56), azadirachtin 1% @ 2 ml/l (2.53), buprofezin 25 SC @ 2 ml/l (2.51), buprofezin 25 SC @1 ml/l (2.50) and pymetrozine 50 WG @ 0.3 g/l (2.45). However, dinotefuron 20 SG @ 0.12 g/l (2.23) has exhibited the finest denier. Dichlorovos 76 EC @ 2.63 ml/l (standard check) had yielded coarse filament (2.61) which was found to be statistically at par with all the other treatments, except flonicamid 50 WG @ 0.15 g/l (2.13) and flonicamid 50 WG @ 0.3 g/l (2.07) when the silkworms were reared in the batches treated with 20 DAS of insecticides (Table 2, Fig. 2)

Azadirachtin 1% @1 ml/l (2.59) was the most coarse filament given among all the treatments, when the silkworms were reared with mulberry leaves treated with 30 DAS of insecticides. The fine denier was found in flonicamid 50 WG @ 0.3 g/l (1.94) and azadirachtin 1% @ 2 ml/l (2.18). Similarly azadirachtin 1% @ 1 ml/l (2.60) has given coarse denier among the 40 DAS of insecticide batches. This was found at par with buprofezin 25 SC @ 1 ml/l (2.55), dinotefuron 20 SG @ 0.25 g/l (2.51), pymetrozine 50 WG @ 0.3 g/l (2.48), untreated control (2.47) and buprofezin 25 SC @ 2 ml/l (2.38). The finest denier among the

Table 2. Effect of insecticides on denier (D). *Significant at 5%. DAS - Days after spraying.

	Treatments	Denier			
		10 DAS	20 DAS	30 DAS	40 DAS
T_1	Buprofezin 25 SC @ 1 ml/l	2.50^{abc}	2.28^{cdef}	2.51^{ab}	2.09^{e}
T_2	Buprofezin 25 SC @ 2 ml/l	2.51^{ab}	2.52^{abc}	2.41^{abc}	2.38^{abcd}
T_3	Pymetrozine 50 WG @ 0.3 g/l	2.45^{abc}	2.50^{abc}	2.27^{bc}	2.48^{abc}
T_4	Pymetrozine 50 WG @ 0.6 g/l	2.56^{ab}	2.51^{abc}	2.41^{abc}	2.19^{de}
T_5	Flonicamid 50 WG @ 0.15 g/l	2.44^{bcd}	2.13^{ef}	2.45^{abc}	2.25^{cde}
T_6	Flonicamid 50 WG @ 0.3 g/l	0.00^{e}	2.07^{f}	1.94^{d}	2.24^{cde}
T_7	Dinotefuron 20 SG @ 0.12 g/l	2.23^{d}	2.22^{def}	2.37^{abc}	2.32^{bcde}
T_8	Dinotefuron 20 SG @ 0.25 g/l	2.61^{a}	2.58^{ab}	2.43^{abc}	2.51^{ab}
T_9	Azadirachtin 1% @ 1 ml/l	2.33^{bcd}	2.46^{abcd}	2.59^{a}	2.60^{a}
T_{10}	Azadirachtin 1% @ 2 ml/l	2.53^{ab}	2.51^{abc}	2.18^{cd}	2.23^{cde}
T_{11}	Dichlorovos 76 EC @ 1.32 ml/l	2.25^{cd}	2.33^{bcde}	2.34^{abc}	2.55^{ab}
T_{12}	Dichlorovos 76 EC @ 2.63 ml/l (std check)	2.36^{bcd}	2.61^{a}	2.40^{abc}	2.41^{abcd}
T_{13}	Untreated control	2.57^{ab}	2.43^{abcd}	2.55^{ab}	2.47^{abc}
	F-test	*	*	*	*
	SEm ±	0.099	0.133	0.103	0.088
	CD at 5%	0.287	0.387	0.299	0.256

batch was found in buprofezin 25 SC @ 1 ml/l (2.09) which was at par with pymetrozine 50 WG @ 0.6 g/l (2.19), azadirachtin 1% @ 2 ml/l (2.23), flonicamid 50 WG @ 0.3 g/l (2.24), flonicamid 50 WG @ 0.15

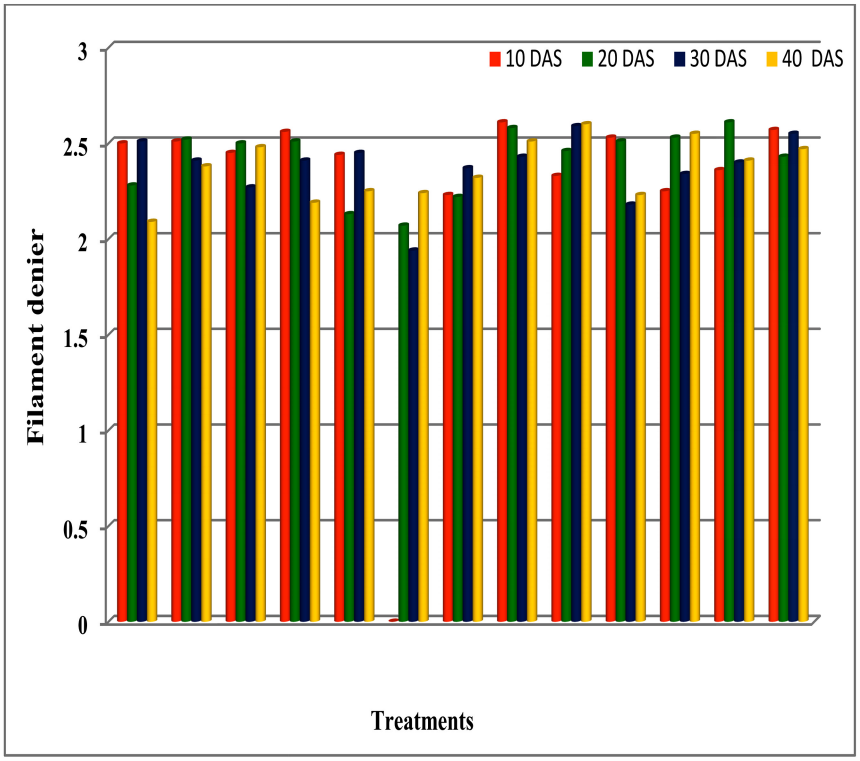

Fig. 2. Effect of insecticides on denier (D). T_1-Buprofezin 25 SC @ 1 ml/1, T_2- Buprofezin 25 SC @ 2 ml/l, T_3-Pymetrozine 50 WG @ 0.3 g/l, T_4-Pymetrozine 50 WG @ 0.6 g/l, T_5-Flonicamid 50 WG @ 0.15 g/l, T_6-Flonicamid 50 WG @ 0.3 g/l, T_7-Dinotefuron 20 SG @ 0.12 g/l, T_8-Dinotefuron 20 SG @ 0.25 g/l, T_9-Azadirachtin 1% @ 1 ml/l, T_{10}-Azadirachtin 1% @ 2 ml/l, T_{11}-Dichlorovos 76 EC @ 1.32 ml/l, T_{12}-Dichlorovos 76 EC @ 2.63 ml/l, T_{13}-Untreated control, DAS-Days after spraying.

g/l (2.25) and dinotefuron 20 SG @ 0.12 g/l (2.32) which possessed similar finer denier (Table 2, Fig. 2).

At 10 DAS, filament denier across all the treatments was at par with each other except in the treatments dinotefuron 20 SG @ 0.12 g/l and dichlrovos 76 EC @ 2.63 ml/l. Similar trend was noticed at 20 DAS and 30 DAS. At 40 DAS, finer denier was observed in the treatments pymetrozine 50 WG @ 0.6 g/l and 0.3 g/l, flonicamid 50 WG @ 0.3 g/l and 0.15 g/l, dinotefuron 20 SG @ 0.12 g/l. In the remaining treatments, the filament denier was at par with untreated control. Azadirachtin 1% @ 2 ml/l recorded finer denier at 30 and 40 DAS. In contrast these observation, Bandyopadhyay et al. (2005) reported higher denier value of 2.5 when silkworms were fed with azadirachtin 1500 ppm and 300 ppm treated leaves. However, this study suggested decrease in denier among other insecticides viz., monocrotophos, acephate and dichlorovos.

Buprofezin 25 SC @ 1 ml/l recorded coarse denier at par with control at 10, 20, 30 DAS. However denier was finer with the same treatment at 40 DAS. Similar to results witnessed at 40 DAS during the present investigation, feeding of buprofezin 25% WP treated leaves resulted in decline in denier as compared to control as reported by Maria et al. (2000) .

CONCLUSION

The filament length was longest in untreated control and in the insecticide treatments viz., dinotefuron 20 SG @ 0.25 g/l and dichlorovos 76 EC @ 2.63 ml/l at different time intervals of 10, 20, 30 DAS. Lowest filament length was recorded in flonicamid 50 WG @ 0.3 g/l at 20, 30 and 40 DAS. Azadirachtin 1% @ 1 ml/l recording shorter filament length at 40 DAS. Dinotefuron molecule is known to be effective on multiple sucking insects on crops and also known to be safer for non-sucking insects like silkworms and azadirachtin is an effective eco-friendly insecticide. Silk filament denier in the silkworm batch treated with the mulberry leaves 10 DAS has recorded coarse denier in dinotefuron 20 SG @ 0.25 g/l (2.61) and the finest denier was recorded in the batches treated with flonicamid 50 WG @ 0.3 g/l. On 20 DAS the silkworm batches reared recorded coarse denier in the treatment dichlorovos 76 EC @ 2.63 ml/l (2.33) and flonicamid 50 WG @ 0.3 g/l recorded the finer denier of 2.07. At 30 DAS, the batches fed with mulberry leaves exhibited coarse denier of 2.18 in the azadirachtin 1% @ 1 ml/l and the finer denier was recorded in the treatment flonicamid 50 WG @ 0.3 g/l (1.94). In the silkworm batch treated with the mulberry leaves 40 DAS,the coarse denier was recorded in azadirachtin 1% @ 1 ml/l (2.60) and the finer denier was recorded in the batches treated with pymetrozine 50 WG @ 0.6 g/l (2.19). Flonicamid is known to act on insects also as a repellent along with its action on stylet penetrations. Due to its repellent action the silkworms exhibited lesser reeling parameters when compared to other treatments. Since dinotefuron 20 SG @ 0.25 g/l and azadirachtin 1% @ 1 ml/l are performing well with respect to reeling parameters they can be used as an effective novel molecules to replace DDVP in sericulture.

REFERENCES

Anonymous (2016) The gazette of India. Sec 3 (11) : 8.

Bandyopadhyay UK, Santhakumar MV, Saratchandra B (2005) Role of insecticides and botanicals in regulating whitefly *(Dialeuropora decempuncta)* incidence and their influence on some economic traits of silkworm (*Bombyx mori* L.). Ann Pl Prot Sci 13 (1) : 48—53.

Gayathri M (2007) Studies on tukra and powdery mildew diseases in mulberry and their impact on the growth and development of silkworm, *B. mori.* MSc (Agric) thesis. Angrau Bapatla, pp 42—112.

Ghosh A, Samantha A, Chatterjee ML (2014) Dinotefuron, a third generation neonicotinoid insecticide for management of rice brown planthopper. Afr J Agric Res 9 (8) : 750—754.

Kordy AM (2014) Residual effect of certain pesticides on the mulberry silkworm (*Bombyx mori* L.). Middle East J Appl Sci 4 (3) : 711—717.

Maria EV, Paschalis CH, Sergios K (2000) Effects of Applaud on the growth of silkworm (Lepidoptera : Bombycidae). J Ecol Ent 93 (2) : 290—292.

Narasimhanna MN (1988) Manual on silkworm egg production. CSB, Bangalore, pp 146.

Yokoyama T (1962) Synthesized Science of Sericulture. Japan, pp 39—46.