**IMPACT OF FEEDING ABAMECTIN 1.9 % EC SPRAYED MULBERRY LEAVES ON COCOON AND FILAMENT TRAITS IN SILKWORM, *Bombyx mori* L.**

**ABSTRACT**

Chemical sprays have become an essential component of modern pest management strategies in agriculture. However, silkworms, (*Bombyx mori* L.) are highly sensitive to chemical residues, necessitating extensive research to identify compounds that are both effective against pests and safe for silkworm rearing. In this context, the present study was undertaken to assess the impact of feeding mulberry leaves sprayed with abamectin 1.9 % EC on the cocoon and filament characteristics of *B. mori*. The results of the study revealed that larvae fed with abamectin 1.9 % EC sprayed leaves at 20 days after spray (DAS) recorded highest cocoon weight (1.59 g), shell weight (0.325 g), cocoon shell ratio (19.98 %), Average filament length (1038.49 m), non-breakable filament length (1001.57 m), filament weight (0.298 g) and denier (2.52).

**Keywords:** Abamectin; mulberry; silkworm; cocoon; parental breeds.

**1. INTRODUCTION**

The silkworm, *Bombyx mori* L., a monophagous insect, feeds solely on mulberry leaves, which provide the essential nutrients required for its growth and development. The nutritional richness of mulberry foliage plays a crucial role in determining the health of the silkworm and the quality of the resulting cocoons (Mahadeva, 2011). The productivity of cocoons and the economic viability of silk farming are largely influenced by the quality and availability of mulberry foliage. However, due to its dense, green canopy, the mulberry plant is highly susceptible to various pests and pathogens. These infestations can severely hinder plant growth and significantly reduce leaf yield, which in turn affects silkworm health and silk production.

To combat these pests, farmers often resort to chemical pesticides. However, the chemical residue left on mulberry leaves can be harmful to silkworms, negatively impacting their development, cocoon quality and reproductive capacity (Bhosale & Kallapur, 1988). Therefore, it is essential to use pesticides cautiously and responsibly to protect the health and productivity of silkworms, while also keeping pest infestations in mulberry plantation under control. This approach not only secures cocoon production but also helps maintain ecological stability. In this context, a study was carried out to evaluate the effects of feeding mulberry leaves treated with abamectin 1.9 % EC on the cocoon and filament characters of *B. mori*.

**2. MATERIAL AND METHODS**

The experiment was conducted during the year 2023-2024, at the Department of Sericulture, UAS, GKVK, Bengaluru with well-established mulberry garden with V1 variety. The performance of parental breeds, namely PM, CSR2, FC1 and FC2 were reared to assess the impact of the chemical used in mulberry for management of thrips and mites.

The entire rearing room and appliances were disinfected by following standard procedure (Dandin & Giridhar, 2014). The rearing room was kept air tight for 24 hours and then the room was kept open and used for rearing. The chawki silkworms were reared on the leaves harvested from control plots while the third instar onwards the larvae were fed with mulberry leaves of treatment plots harvested at 15 and 20 DAS. A total of 150 larvae were transferred to each experimental tray in three replications after 30 minutes of initial feeding along with the mulberry leaves. In order to assess the impact of pesticide toxicity and to determine the post spray safety period of the on the cocoon and filament characters of silkworm, *B. mori* such as cocoon weight, shell weight, cocoon shell ratio, average filament length and non- breakable filament length, filament weight and denier in the parental breeds were observed and the data were analysed using Factorial- CRD for testing of significance by Fisher’s method of analysis of variance (Sundararaj et al., 1972). The level of significance used in the F-test was P = 0.05. The critical difference (CD) values were computed to compare significance of the treatments.

**Table 1: Treatment details**

|  |  |
| --- | --- |
|  **Treatments** |  **Description** |
|  T1 | PM (abamectin 1.9 % EC @ 0.75 ml/l at 15 DAS) |
|  T2 | CSR2 (abamectin 1.9 % EC @ 0.75 ml/l at 15 DAS) |
|  T3 | FC1 (abamectin 1.9 % EC @ 0.75 ml/l g/l at 15 DAS) |
|  T4 | FC2(abamectin 1.9 % EC @ 0.75 ml/l at 15 DAS) |
|  T5 | PM (abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS) |
|  T6 | CSR2(abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS) |
|  T7 | FC1(abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS) |
|  T8 | FC2(abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS) |
|  T9 | PM (control) |
|  T10 | CSR2 (control) |
|  T11 | FC1 (control) |
|  T12 | FC2 (control) |

 DAS: Days after spray; \* No chemical spray was used in the control treatment plots of mulberry for management of thrips and mites.

**Observations recorded**

**Cocoon weight (g)**

A total of ten cocoons were selected randomly from each replication in all treatments on fifth day after spinning and weighed separately. The average weight of cocoons was computed as,

 Cocoon weight (g) $=\frac{Total weight of cocoons (g)}{Total number of cocoons weighed}$

**Cocoon shell weight (g)**

The cocoons were cut open, pupae and exuviae were separated and the average shell weight was computed separately for each treatment as below,

 Cocoon shell weight (g) $=\frac{Total weight of cocoon shells (g)}{Number of Shells weighed}$

**Cocoon shell ratio (%)**

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

 Cocoon shell ratio (%) $=\frac{Weight of cocoon shell (g)}{Total weight of cocoon (g)}$ × 100

**Average filament length (m)**

A sample of ten 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 eprouvette. 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)**

NBFL represents the average length of raw silk filament that can be unwound from a cocoon without any break. It was calculated by the formula,

 NBFL (m) $=\frac{Total filament length (m)}{1+Number of breaks}$

**Filament weight (g)**

The raw silk reeled from each cocoon was weighed separately replication wise from each treatment and the average was computed to obtain average filament weight.

**Denier**

The filament thickness was measure and expressed in terms of denier that was estimated by the formula:

 Denier $=\frac{Weight of the filament (g)}{Length of the filament (m)}$ × 9000

**3. RESULTS AND DISCUSSION**

**3.1 Cocoon weight (g)**

Cocoon is the economically valuable part in silkworm rearing and the average weight of ten randomly selected cocoons in each treatment was computed separately and expressed as single cocoon weight (g). A significant difference was observed for cocoon weight amongst the parental breeds reared in the experiment. The highest cocoon weight was recorded in bivoltine hybrid, FC2 (1.73 g) followed by FC1 (1.59 g), while the lowest cocoon weight was recorded in multivoltine breed, PM (1.24 g), which is the breed character. The duration of spray also found to have profound influence on cocoon weight when the silkworms were fed with abamectin 1.9 % EC (@ 0.75 ml/l) treated mulberry leaves harvested at different durations after

**Table 2: Cocoon weight, shell weight and cocoon shell ratio of parental breeds of silkworm, *B. mori* as influenced by feeding mulberry leaves treated with abamectin 1.9 % EC at different days after spray**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Cocoon weight (g)** | **Shell weight (g)** | **Cocoon shell ratio (%)** |
| **Breeds (B)** |
| B1: PM | 1.24 | 0.144 | 11.61 |
| B2: CSR2 | 1.49 | 0.333 | 22.31 |
| B3: FC1 | 1.59 | 0.338 | 21.23 |
| B4: FC2 | 1.73 | 0.388 | 22.43 |
| F-test | \* | \* | \* |
| S.Em± | 0.008 | 0.003 | 0.198 |
| CD 0.05 | 0.024 | 0.010 | 0.580 |
| **Safety period (S)** |
| S1: 15 DAS | 1.49 | 0.295 | 19.28 |
| S2: 20 DAS | 1.59 | 0.325 | 19.98 |
| S3: Control | 1.45 | 0.283 | 18.93 |
| F-test | \* | \* | \* |
| S.Em± | 0.007 | 0.002 | 0.171 |
| CD 0.05 | 0.021 | 0.084 | 0.558 |
| **Interaction (B×S)** |
| B1S1 | 1.21 | 0.139 | 11.55 |
| B1S2 | 1.32 | 0.158 | 12.01 |
| B1S3 | 1.19 | 0.135 | 11.29 |
| B2S1 | 1.46 | 0.323 | 22.05 |
| B2S2 | 1.57 | 0.361 | 22.97 |
| B2S3 | 1.43 | 0.313 | 21.91 |
| B3S1 | 1.57 | 0.332 | 21.17 |
| B3S2 | 1.67 | 0.367 | 21.91 |
| B3S3 | 1.52 | 0.315 | 20.62 |
| B4S1 | 1.71 | 0.383 | 22.35 |
| B4S2 | 1.79 | 0.412 | 23.02 |
| B4S3 | 1.68 | 0.368 | 21.92 |
| F-test | NS | NS | NS |
| S.Em± | - | - | - |
| CD 0.05 | - | - | - |

\*Significant at 0.05; NS: Non-significant; DAS: Days after spray; The mentioned values represent the average of two rearing.

spray. The highest cocoon weight was observed at 20 DAS (1.59 g) while the control group showed least cocoon weight of 1.45 g. The interaction between parental breeds and timing of spray on cocoon weight showed no significant difference indicating the consistency of residual toxicity of the chemical across the parental breeds of *B. mori* silkworm with respect to cocoon weight (Table 2).

The silkworm breeds with different voltinism exhibit a noticeable variation in the cocoon weight, which is an inherent characteristic of the breed (Ashoka *et al.,* 2016) and the same has been reflected in the present study. The multivoltine though less productive, are known to have high intensity of sturdiness and can withstand the adverse rearing conditions compared to bivoltine (Kumaresan *et al*., 2012). The same is true even in the present study where the residual toxicity of the chemical had less effect on multivoltine, PM than the bivoltine breeds. Further, minimal impact of longer safety period may be attributed to gradual degradation of the molecules after certain period after spray while reducing the pest population and subsequent increase in the quality and productivity of mulberry plant and the silkworm. Hence, following a safe waiting period strictly before feeding the silkworms with mulberry leaves from chemical sprayed gardens is imminent as observed in the study conducted by Kariappa and Narasimhanna (1978) in their study that documented a significant improvement in larval and cocoon weight upon feeding silkworms on mulberry leaves treated with dimethoate @ 0.2 %.

**3.2 Shell weight (g)**

The shell weight of cocoons showed significant difference among the parental breeds. The highest shell weight was recorded in bivoltine hybrid, FC2 (0.388 g) and the lowest shell weight was observed in the multivoltine pure breed, PM (0.144 g). The safety duration after pesticide spray also had a significant impact on shell weight similar to that of cocoon. The highest shell weight was observed at 20 DAS (0.325 g), the lowest shell weight of 0.283 g was observed in control. The interaction between the shell weight of different breeds with the safety durations showed consistency as indicated by the non-significant results (Table 2).

The cocoon shell comprises the most important component of sericulture industry and has a direct impact on raw silk recovery. The variation in shell weight is also a breed characteristic as reported by (Ashoka *et al.,* 2016), which is also influence by several rearing and crop management practices. The pest and diseases management in mulberry, a sole food for silkworm, *B. mori* necessitates the use of chemicals and the varied toxicity level of these molecules interfere in the physiology of silk secretion and spinning and hence the weight and quality of the cocoon shell (Muthuswami *et al*., 2010). Feeding silkworm with buprofezin 25 SC (@ 1 ml/l) treated leaves harvested at 20, 30 and 40 DAS resulted in decline in the shell weight (Maria *et al*., 2000). However, feeding of silkworms with insecticide sprayed mulberry harvested after a safe waiting period showed a significant improvement with respect to shell weight (Kariappa and Narasimhanna, 1978).

**3.3 Cocoon shell ratio (%)**

A good cocoon shell ratio reflects good quality cocoons. Significant difference was observed across the parental breeds of silkworm and duration of spray. Among the parental breeds used in the experiment, the maximum cocoon shell ratio was recorded in bivoltine hybrid, FC2 (22.43 %) followed by bivoltine pure breed, CSR2 (22.31 %), while multivoltine pure breed, PM had the minimum shell ratio of 11.61 per cent. The duration of the spray also found to have profound influence on cocoon shell ratio when the silkworms were fed with abamectin 1.9 % EC @ 0.75 ml/l sprayed mulberry leaves harvested at different durations after spray. The highest cocoon shell ratio was recorded at 20 DAS (19.98 %) and it was least in control (18.93 %) during respective rearing periods. The interaction effects for cocoon shell ratio between parental breeds of silkworm and duration of the spray were found to be non-significant (Table 2).

The organophosphate insecticide, methyl demeton cause adverse effect on cocoon shell ratio when fourth instar silkworm are fed with the treated leaves (Gayathri, 2007). Patnaik *et al.* (2011) reported increased shell ratio of 17.35 per cent over control when the silkworms were fed with a neonicotinoid insecticide, thiamethoxam (0.015 %) treated mulberry leaves. The novel insecticide like chlorantraniliprole belonging to ryanoid class found to have residual effect in silkworms even after 15 DAS and resulted in construction of poor-quality cocoons (Sunil Kumar *et al*., 2016). However, as evidenced in the studies conducted previously the cocoon parameters *viz.,* cocoon weight, shell weight, pupal weight and cocoon shell ratio recorded higher at 20 DAS compared to 15 DAS (Kalpana, 2022), even in the present study which clearly indicates that a significant reduction in the residual toxicity when the safety period was increased, thus leading to improvement in larval and cocoon characters.

**Table 3: Average and non- breakable filament length of parental breeds of silkworm, *B. mori* as influenced by feeding mulberry leaves treated with abamectin 1.9 % EC at different days after spray**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Average filament length (m)** | **Non-breakable filament length (m)** |
| **Breeds (B)** |
| B1: PM | 538.96 | 503.10 |
| B2: CSR2 | 1175.86 | 1117.90 |
| B3: FC1 | 1096.50 | 1041.38 |
| B4: FC2 | 1232.47 | 1171.49 |
| F-test | \* | \* |
| S.Em± | 4.916 | 6.858 |
| CD 0.05 | 14.434 | 20.136 |
| **Safety period (S)** |
| S1: 15 DAS | 1012.55 | 959.89 |
| S2: 20 DAS | 1038.49 | 1001.57 |
| S3: Control | 981.80 | 913.94 |
| F-test | \* | \* |
| S.Em± | 4.257 | 5.939 |
| CD 0.05 | 12.500 | 17.438 |
| **Interaction (B×S)** |
| B1S1 | 537.50 | 502.02 |
| B1S2 | 553.87 | 525.59 |
| B1S3 | 525.52 | 481.70 |
| B2S1 | 1183.27 | 1124.61 |
| B2S2 | 1209.75 | 1170.42 |
| B2S3 | 1134.56 | 1058.68 |
| B3S1 | 1103.10 | 1047.41 |
| B3S2 | 1130.54 | 1093.04 |
| B3S3 | 1055.85 | 983.69 |
| B4S1 | 1226.35 | 1165.53 |
| B4S2 | 1259.81 | 1217.24 |
| B4S3 | 1211.27 | 1131.72 |
| F-test | NS | NS |
| S.Em± | - | - |
| CD 0.05 | - | - |

\*Significant at 0.05; NS: Non-significant; DAS: Days after spray; The mentioned values represent the average of two rearing.

**3.4 Average filament length (m)**

The average filament length showed significant difference among parental breeds of silkworm. The longest filament length was recorded in the bivoltine hybrid, FC2 (1232.47 m) and the multivoltine pure breed, PM had the shortest filament length (538.96 m). These results highlight that breed significantly influences filament length, with bivoltine parental breeds showing the longest filaments and multivoltine pure breed PM the shortest. The duration of the spray also significantly affected the average filament length when the silkworms were fed with abamectin 1.9 % EC @ 0.75 ml/l sprayed mulberry leaves during different intervals of spray. The longest filament length was observed at 20 DAS (1038.49 m) and the control had shorter filament length (981.80 m). There was no significant difference in the interaction between the breeds and the timing of the spray regarding filament length, indicating that the influence of spray duration on filament length was consistent across different breeds (Table 3).

The residual effect of insecticides resulted in construction of poor quality cocoons, especially thin shelled ones and thus the silk production and hence there was a marked reduction in the silk filament length upon feeding the pesticide sprayed mulberry leaves to the silkworms (Roxelle *et al*., 2013; Anitha, 2015 and Sunil Kumar *et al*., 2016). However, the filament length exhibited a significant increase with reduced levels of toxicity that necessitates the careful harvesting of the leaves after the specified safety period as evidenced in the present study.

**3.5 Non-breakable filament length (m)**

A significantdifference was noticed for non-breakable filament length difference among the parental breeds used in the study. The bivoltine hybrid, FC2 exhibited the longest non-breakable filament length (1171.49 m) and the multivoltine pure breed, PM had the shortest non-breakable filament length (503.10 m). The safety duration after pesticide spray also had a significant impact on non-breakable filament length. The longest non-breakable filament length was observed at 20 DAS (1001.57 m) while it was shorter in control (913.94 m). The interaction between the parental breeds and duration of spray regarding non-breakable filament length was found to be non-significant, indicating that the influence of safety duration on filament length was consistent across silkworm breeds (Table 3).

**Table 4: Filament weight and Denier of parental breeds of silkworm, *B. mori* as influenced by feeding mulberry leaves treated with abamectin 1.9 % EC at different days after spray**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Filament weight (g)** | **Denier**  |
| **Breeds (B)** |
| B1: PM | 0.123 | 2.06 |
| B2: CSR2 | 0.331 | 2.53 |
| B3: FC1 | 0.316 | 2.59 |
| B4: FC2 | 0.361 | 2.63 |
| F-test | \* | \* |
| S.Em± | 0.004 | 0.035 |
| CD 0.05 | 0.011 | 0.103 |
| **Safety period (S)** |
| S1: 15 DAS | 0.282 | 2.44 |
| S2: 20 DAS | 0.298 | 2.52 |
| S3: Control | 0.268 | 2.39 |
| F-test | \* | \* |
| S.Em± | 0.003 | 0.031 |
| CD 0.05 | 0.010 | 0.090 |
| **Interaction (B×S)** |
| B1S1 | 0.122 | 2.04 |
| B1S2 | 0.132 | 2.15 |
| B1S3 | 0.115 | 1.98 |
| B2S1 | 0.331 | 2.52 |
| B2S2 | 0.349 | 2.60 |
| B2S3 | 0.312 | 2.48 |
| B3S1 | 0.316 | 2.58 |
| B3S2 | 0.333 | 2.65 |
| B3S3 | 0.300 | 2.56 |
| B4S1 | 0.359 | 2.63 |
| B4S2 | 0.379 | 2.70 |
| B4S3 | 0.343 | 2.55 |
| F-test | NS | NS |
| S.Em± | - | - |
| CD 0.05 | - | - |

\*Significant at 0.05; NS: Non-significant; DAS: Days after spray; The mentioned values represent the average of two rearing.

**3.6 Filament weight (g)**

The filament weight varied significantly among the parental breeds used in the experiment. The highest filament weight was recorded in the bivoltine hybrid, FC2 (0.361 g) followed by bivoltine pure breed, CSR2 (0.331 g) while it was least in multivoltine pure breed, PM (0.123 g). The spray schedule also significantly influenced the filament weight when the larvae were fed with abamectin 1.9 % EC sprayed mulberry leaves at different duration after spray. The heaviest filament weight was observed at 20 DAS (0.298 g). The least weight was found in control, where no spray was carried out (0.268 g). The interaction between parental breeds and duration of the spray concerning filament weight were found to be non-significant, indicating that the influence of spray duration on filament weight was consistent across all parental breeds used in the experiment (Table 4).

**3.7` Denier**

The denier is a unit of measurement used to express the thickness and it is essential in the textile industry to know the fineness of silk threads. For denier, significant difference was observed across the parental breeds used in the study. The lowest denier was observed in the multivoltine pure breed, PM (2.06) and the highest was recorded in the bivoltine hybrid, FC2 (2.63) followed by FC1 (2.59). The duration of the spray also showed significant impact on denier when the silkworms were fed with abamectin 1.9 % EC @ 0.75 ml/l sprayed mulberry leaves harvested at different durations after spray. The highest denier was recorded 20 DAS (2.52) and the lowest was observed in control (2.39). There was no significant difference observed among the interaction between parental breeds and safety duration concerning denier (Table 4).

Feeding on a organophosphate insecticide, buprofezin 25% WP treated leaves resulted in decline in denier compared to control as reported by Maria *et al*. (2000). Buprofezin 25 % WP is a growth regulator that acts on chitin synthesis mechanism and hence disrupts the growth and development of the insects. Such molecules found to have residual toxicity for a longer period that is exhibited by noticing a coarse denier at 10, 20 and 30 DAS whereas finer denier was observed with increased safety period *i.e.,* at 40 DAS (Yeshika *et al.,* 2020).

**Conclusion:**

The study demonstrated that abamectin 1.9 % EC @ 0.75 ml/l effectively controls thrips and mites in mulberry without harming silkworm cocoon quality when leaves are used 20 days after spraying. At this interval, silkworms showed improved cocoon weight, shell weight, cocoon shell ratio, filament length, filament weight and denier, indicating the chemical safe integration into sericulture with proper application dose and timing.

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