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EFFECT OF FEEDING ABAMECTIN 1.9 % EC SPRAYED MULBERRY LEAVES ON REPRODUCTIVE PERFORMANCE OF *Bombyx mori* L.

Shwetha G.V.*, Vinoda K.S., Gagana Sindhu S., Banuprakash K.G., Nikita Kankanawadi and Veenita M.K.

Department of Sericulture, College of Agriculture, University of Agricultural Sciences, Gandhi Krishi Vigyana Kendra, Bangalore, Karnataka-560065, India.

*Corresponding author E-mail: shwethagv74@gmail.com

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ABSTRACT

The silkworm, *Bombyx mori* L., being reared solely on mulberry, is highly sensitive for the chemical residues. Series of experiments have been carried out to identify an effective pesticide safer to silkworm. Abamectin 1.9 % EC is one such compound effective against thrips and mites in mulberry and safer for growth and productivity of *B. mori*. The present study aimed to evaluate the effect of feeding abamectin 1.9 % EC sprayed mulberry leaves on reproductive performance of parental breeds of *B. mori*. The observations revealed that the adults emerged from silkworm fed on abamectin 1.9 % EC sprayed leaves after 20 days post spray showed maximum pupation rate (98.29 %), pupal weight (1.27 g), laid maximum number of eggs (533.25 No./moth) with an egg recovery of (54.99 g/kg of cocoons), the maximum hatching percentage (97.06 %), weight of 100 eggs (57.86 mg), egg recovery (54.99 g/kg of cocoons) and minimum egg retention in the ovary (3.97 %), dead (2.29 %) and unfertilized eggs (0.63 %) were noticed in the treatment with 20 days after spray among the parental breeds.

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

Introduction

Globally, India stands second in silk production next only to the China and sericulture is an integral part of the rural economy in an agrarian country like India. Of the four kinds of silks produced in India, mulberry silk constitutes highest share of production and the silkworm *Bombyx mori* L., a completely domesticated species depends solely on mulberry leaf for its growth and development. Being a perennial and high biomass producing plant with lush green foliage throughout the year often leading to the breeding and multiplication of various pests. More than 300 insect and non-insect pests have been reported to damage the mulberry (Narayanaswamy *et al.,*1996).

Management of these Pest is imperative for sustained productivity of quality silk, which necessitates the use of pesticides. However, the pesticide leaves the residue on the leaf which adversely affect the silkworms, thus impairing their growth, productivity, cocoon quality and reproductive traits upon exposure because silkworm cannot tolerate even sublethal dose of toxic compound (Bhosale and Kallapur, 1988). To overcome this problem, a safe concentration of suitable pesticide and post spray waiting period should be followed for the leaf harvest (Yokoyama, 1962). Hence, it is imperative to handle pesticides with care and ensure their responsible use that would ensure safeguarding the health and well-being of the silkworms while effectively managing pests in mulberry plantations. The reproductive efficiency of silkmoth is essential for sustainable seed production and the overall success of sericulture. Keeping this in view, the present study was taken up to find out the impact of abamectin 1.9 % EC (@ 0.75 ml/l) sprayed mulberry leaves on reproductive performance of *B. mori.*

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, from second feed of 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 chemical on reproductive performance of *B. mori* silkmoth such as pupation rate, pupal weight, fecundity, egg retention in ovary, weight of 100 eggs, egg recovery, hatching, dead and unfertilized eggs 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

Treat-ments	Description
T_1	PM (abamectin 1.9 % EC @ 0.75 ml/l at 15 DAS)
T_2	CSR2 (abamectin 1.9 % EC @ 0.75 ml/l at 15 DAS)
T_3	FC1 (abamectin 1.9 % EC @ 0.75 ml/l g/l at 15 DAS)
T_4	FC2(abamectin 1.9 % EC @ 0.75 ml/l at 15 DAS)
T_5	PM (abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS)
T_6	CSR2(abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS)
T_7	FC1(abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS)
T_8	FC2(abamectin 1.9 % EC @ 0.75 ml/l at 20 DAS)
T_9	PM (control)
T_{10}	CSR2 (control)
T_{11}	FC1 (control)
T_{12}	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

Pupation rate (%)

The healthy pupa from all the cocoons in each replication of different treatments was recorded on the sixth day of spinning and the pupation rate was calculated using the formula,

$$\text{Pupation rate}\,(\%) = \frac{\text{Number of larvae pupated}}{\text{Number of larvae that spun the cocoons}} \times 100$$

Pupal weight (g)

The cocoons selected for recording cocoon and shell 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 computed as below:

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

Fecundity (No.)

A total of five disease free layings (DFL's) were randomly selected from each replication of all treatments and the number of eggs in each laying was counted and recorded as fecundity of individual moth.

Weight of 100 eggs (mg)

A total of 100 eggs were collected from each replication of all treatments and weighed separately and recorded as weight of 100 eggs (mg).

Egg retention in ovary (%)

The eggs retained in the ovary after 24 h of oviposition were counted from all the dissected silkmoths in each replication of different treatments and per cent egg retention was calculated using the formula,

$$\text{Egg retention}\,(\%) = \frac{\text{Number of eggs retained in the ovary}}{\text{Total number of eggs laid by moth} + \text{Number of eggs in ovary}} \times 100$$

Egg recovery (g/kg of cocoons)

The cocoons were stored in trays for moth emergence and the moths were allowed for selfing. The gravid females from each replication were collected and allowed for oviposition on loose egg sheets. The total number of eggs obtained from each replication among different treatments were weighed separately as per treatment and recorded as egg recovery.

Hatching (%)

The disease free layings that were used to record fecundity were considered and observing hatching percentage by using the formula,

$$\text{Hatching}\,(\%) = \frac{\text{Number of eggs hatched}}{\text{Total number of eggs/laying}} \times 100$$

Dead eggs (%)

The number of eggs that did not hatch and showed depression at the centre were counted in the same DFLs and recorded as dead eggs percentage by using the formula,

$$\text{Dead eggs}\,(\%) = \frac{\text{Number of dead eggs}}{\text{Number of eggs/laying}} \times 100$$

Results and Discussion

Pupation rate (%)

The rate of pupation showed significant difference among the parental breeds reared during the experiment. The multivoltine pure breed, PM showed the maximum pupation rate (99.14 %) while the bivoltine pure breed, CSR2 exhibited the minimum pupation rate of 93.34 per cent. The residual toxicity of the chemical exhibited notable influence on pupation rate when the silkworms were fed with abamectin 1.9 % EC @ 0.75 ml/l sprayed mulberry leaves harvested at different durations after spray. The rate of pupation was recorded much lower at 15 DAS (89.50 %), while it was higher in control (98.82 %), which was statistically on par with 20 DAS (98.29 %). A significant difference was observed regarding pupation among interaction between parental breeds and duration of spray. The multivoltine parental breed, PM was found to possess higher level of tolerance to withstand the toxicity of pesticide, which is reflected through higher pupation rate at both the safety periods (97.86, 99.57 %, respectively at 15 and 20 DAS) while the bivoltine parental breeds, both the pure breed and the hybrids showed higher sensitivity for the chemical toxicity that is observed in terms of low pupation rate (85.20, 88.11 and 86.82 %, respectively in CSR2, FC1 and FC2 at 15 DAS) (Table 2).

The survival rate of pupa in PMxNB4B2 was drastically affected by the hexachlorocyclohexane (HCH) treatment and it was lowered as time of application was advanced (Bhagyalakshmi *et al.*, 1995). Chen *et al.* (2023) observed that the treatment of larvae with a neonicotinoid insecticide, imidacloprid and thiamethoxam significantly reduced the pupation rate that decreased to 86.70 and 83.33 per cent, respectively even at sublethal concentrations compared to control group, indicating a marked negative impact of these neonicotinoid insecticides on the process of pupation. Tolfenpyrad is a broad-spectrum insecticide belonging to the pyrazole class. Exposure to tolfenpyrad can significantly reduce the pupation rate in silkworms to 51.6 per cent compared to the control group, due to its toxic effects inducing lethargy, reduced feeding, stunted growth and increased mortality rates before pupation (Wang *et al*., 2023).

Pupal weight (g)

The pupa represents the developmental stage between the larva and the adult moth, during which significant physiological changes occur. The pupae were weighed replication wise and recorded the data. Pupal weight differs significantly among the parental breeds used in the study. The highest pupal weight was recorded in bivoltine hybrid, FC2 (1.34 g) and the multivoltine breed, PM had a lowest pupal weight (1.10 g). The pupal weight varied significantly when abamectin 1.9 % EC sprayed mulberry leaves were fed to the larvae at different spray intervals. The highest pupal weight was observed when the safety period was 20 DAS (1.27 g). The pupae weighed less in the control that weighed 1.17 g. The pupal weight of parental breeds and the safety duration after spray showed non-significant interactions among all treatments since the variation was consistent across the breeds (Table 2).

Table 2: Pupation rate and pupal weight 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	Pupation rate (%)	Pupal weight (g)
Breeds (B)		
B_1: PM	99.14	1.10
B_2: CSR2	93.34	1.16
B_3: FC1	95.04	1.25
B_4: FC2	94.61	1.34
F-test	*	*
S.Em±	0.468	0.008
$CD_{0.05}$	1.376	0.023
Safety period (S)		
S_1: 15 DAS	89.50	1.20
S_2: 20 DAS	98.29	1.27
S_3: Control	98.82	1.17
F-test	*	*
S.Em±	0.406	0.007
$CD_{0.05}$	1.191	0.020
Interaction (B×S)		
B_1S_1	97.86	1.08
B_1S_2	99.57	1.16
B_1S_3	100.00	1.06
B_2S_1	85.20	1.15
B_2S_2	96.98	1.22
B_2S_3	97.85	1.12
B_3S_1	88.11	1.24
B_3S_2	98.30	1.31
B_3S_3	98.72	1.21
B_4S_1	86.82	1.33
B_4S_2	98.30	1.38
B_4S3	98.70	1.30
F-test	*	NS
S.Em±	0.811	-
$CD_{0.05}$	2.383	-

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

Feeding silkworms with mulberry leaves treated with dimethoate (0.2 %) resulted in the highest pupal weight (Misra *et al*., 2003). However, Gayathri (2007) found no significant differences in pupal weight when methyl demeton, dimethoate, DDVP and azadirachtin were applied. In contrast, when larvae were fed with

pesticide treated mulberry leaves starting from the 4th instar, there was a significant increase in pupal weight as the days after the spray increased.

Fecundity (No.)

The moths of respective treatments were allowed for pairing replication wise and decoupled after four hours. The mated female moths were allowed to lay eggs for 24 hours to count the fecundity.

Fecundity, the total number of eggs laid by a gravid female moth, is an indicator of reproductive success and the overall productivity in sericulture. The parental breeds responded significantly different to the chemical toxicity with respect to fecundity. The bivoltine hybrid, FC2, recorded highest fecundity of 551.06 eggs/moth followed by FC1 (531.83 eggs/moth) whereas, least fecundity was reported in multivoltine pure breed, PM (495.26 eggs/moth) which is a breed characteristic. The residual toxicity of chemical sprayed to the host plant found to exhibit significant influence on the fecundity in different parental breeds of the silkworm, *B. mori*. The highest number of eggs were laid by the moths where the larvae were fed with abamectin 1.9 % EC sprayed mulberry leaves harvested after 20 days (533.25 eggs/moth) on par with control (539.34 eggs/moth) while it was least at 15 DAS (505.42 eggs/moth). There was no significant difference in the interaction between parental breeds and duration of spray concerning the fecundity (Table 3).

Table 3: Fecundity, egg retention in ovary and weight of 100 eggs of parental breeds of *B. mori* as influenced by feeding mulberry leaves treated with abamectin 1.9 % EC at different days after spray

Treatments	Fecundity (No.)	Egg retention in ovary (%)	Weight of 100 eggs (mg)
Breeds (B)			
B_1: PM	495.26	3.64	54.83
B_2: CSR2	525.86	4.61	57.71
B_3: FC1	531.83	3.92	57.94
B_4: FC2	551.06	4.18	58.38
F-test	*	*	*
S.Em±	2.935	0.078	0.291
$CD_{0.05}$	8.617	0.230	0.855
Safety period (S)			
S_1: 15 DAS	505.42	4.53	55.25
S_2: 20 DAS	533.25	3.97	57.86
S_3: Control	539.34	3.77	58.53
F-test	*	*	*
S.Em±	2.542	0.068	0.252
$CD_{0.05}$	7.463	0.199	0.749
Interaction (B×S)			
B_1S_1	483.30	4.09	54.15
B_1S_2	498.23	3.51	55.10
B_1S_3	504.26	3.32	55.25
B_2S_1	504.91	5.07	55.14
B_2S_2	532.75	4.48	58.69
B_2S_3	539.93	4.29	59.29
B_3S_1	508.20	4.40	55.43
B_3S_2	540.65	3.80	58.79
B_3S_3	546.65	3.59	59.60
B_4S_1	525.30	4.57	56.27
B_4S_2	561.36	4.09	58.87
B_4S3	566.53	3.90	60.01
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

The higher residual concentration of the chemical compounds sprayed on host plant for management of pests and diseases are transferred to the tissues, particularly the gonadal tissues, accumulate there and do not degrade in the insect feeding on it. The accumulation of such toxic residues may bring about changes in the metabolism of reproductive cells. The insect growth regulators like novaluron may affect the hormone balance like juvenile hormone and ecdysteroids that are essential for egg production and maturation and lead to a decreased fecundity in the silkmoths (Santorum *et al.,* 2021). Feeding the silkworms with 0.05 % malathion showed significant reduction in the fecundity (319 eggs/moth) compared to low concentration (0.025 %) treatment (542 eggs/moth) and control group (549 eggs/moth) that was reported by Kuribayashi (1981). Similar results were also documented by Kumutha *et al*. (2013) in the breed, LxCSR2 where they reported reduced fecundity of 485±4.71 eggs/moth at a higher concentration (0.0005 %) of dichlorvos compared to lower concentration of 0.0001% (546±1.43 eggs/moth) and control group (547±4.12 eggs/moth). Exposure the silkworm strain, Jingsong X Haoyue to trace amount of acetamiprid (@ 0.01 mg/l) can affect the development of the oviduct in the silkworm, leading to decreased egg production (342±31 eggs/moth) compared to 539±22 eggs/moth in control group (Cheng *et al*., 2019).

The negative impact of pesticides can be mitigated by using the correct dosage and adhering to the proper spray duration, which may prevent any adverse effects on the reproductive performance of *B. mori*. Extending the safety period decreases residual toxicity, and reduced exposure time to effects of harmful residues thereby enhancing the reproductive traits. Patnaik *et al*. (2011) reported the fecundity of 426 eggs/moth in the untreated control group while the moths emerged from the cocoons spun by the silkworms fed on the leaves sprayed with a

neonicotinoid insecticide *viz.*, thiamethoxam @ 0.015% (388 and 430 eggs/moth) and clothianidin @ 0.0047 % (387 and 433 eggs/moth) at 14 and 21 days after treatment, respectively.

Egg retention in ovary (%)

The residual toxicity may have a profound influence on the egg laying behaviour of the gravid female moth. The gravid female moths were dissected after 24 hours of egg laying and the number of eggs retained in the ovary are counted that showed a significant variation among different treatments.

The multivoltine pure breed, PM showed the least number of egg retention in the ovary that was 3.64 per cent, while it was maximum in the bivoltine pure breed, CSR2 (4.61 %) followed by the bivoltine hybrid, FC2 (4.18 %). The residual toxicity of the chemical exhibited a notable impact on egg retention in ovary when the silkworms were fed with abamectin 1.9 % EC sprayed mulberry leaves harvested at different durations post spray. The highest egg retention percentage was recorded in 15 DAS schedule (4.53 %) and the least was in control (3.77 %) and 20 DAS (3.97 %). The interaction effects between breeds and the pesticide spray schedules did not exhibit any significant difference (Table 3).

Weight of 100 eggs (mg)

The egg weight reflects the health of developing embryo and decides the cocoon productivity in sericulture and is expressed in terms of weight of 100 eggs that showed significant difference among the parental breeds and different safety period post spray of the pesticide.

The weight of 100 eggs was significantly higher in bivoltine hybrid, FC2 (58.38 mg) and least in multivoltine, PM (54.83 mg) which is probably due to the breed characteristic. The eggs laid by the moths that emerged from the larvae, fed on abamectin 1.9 % EC sprayed mulberry leaves harvested after 20 days post spray (57.86 mg/100 eggs) recorded significantly maximum weight with that of control (58.53 mg/100 eggs) compare to 15 DAS schedule that recorded significantly less weight (55.25 mg/100 eggs). There was no significant difference in the interaction between parental breeds and duration of spray concerning the weight of 100 eggs (Table 3).

The toxic effects of chemical residues may impair nutrient allocation or disrupt normal egg development, leading to smaller and less viable eggs laid by the moths when the silkworms are fed with leaves harvested from pesticide sprayed mulberry plants. In a study conducted by Cheng *et al.* (2019) the egg weight decreased in acetamiprid-treated group (0.524 mg/egg) compared to control group that weighed 0.580 mg/egg, which in line with the present investigations

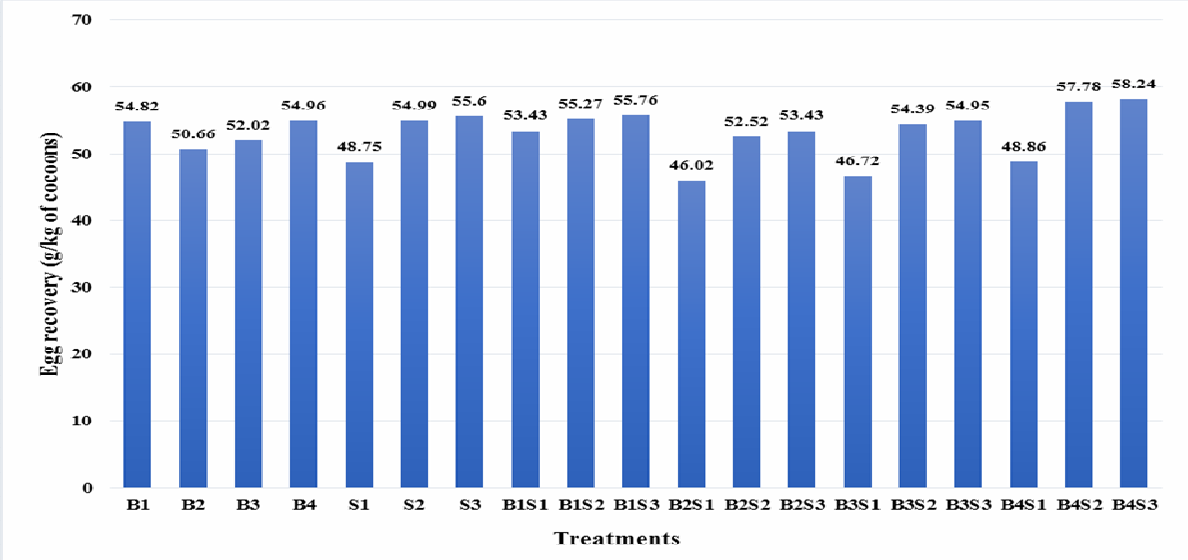

Fig. 1 : Egg recovery of parental breeds of silkworm, *B. mori* as influenced by feeding mulberry leaves treated with abamectin 1.9 % EC at different days after spray

B1: PM, **B2:** CSR2, **B3:** FC1, **B4:** FC2
S1: 15 DAS, **S2:** 20 DAS, **S3:** Control
B1S1: PM (15 DAS), **B1S2:** PM (20 DAS), **B1S3:** PM (Control)
B2S1: CSR2 (15 DAS), **B2S2:** CSR2 (20 DAS), **B2S3:** CSR2 (Control)
B3S1: FC1 (15 DAS), **B3S2:** FC1 (20 DAS), **B3S3:** FC1 (Control)
B4S1: FC2 (15 DAS), **B4S2:** FC2 (20 DAS), **B4S3:** FC2 (Control)
DAS: Days after spray
The mentioned value represents the average of two rearing

Egg recovery (g/kg of cocoons)

The parental breeds assessed in the study included both multivoltine and bivoltines and a noticeable difference was observed among them for egg recovery that was highest in bivoltine hybrid, FC2 (54.96 g/kg of cocoons) followed by multivoltine pure breed, PM (54.82 g/kg of cocoons) while it was least in bivoltine pure breed, CSR2 (50.66 g/kg of cocoons). Among the duration of post spray significantly higher egg recovery (54.99 g/kg of cocoons) was observed when the silkworms were fed with abamectin 1.9 % EC sprayed mulberry leaves harvested 20 DAS compare to shorter safety period of 15 DAS (48.75 g/kg of cocoons) and it was on par with control (55.60 g/kg of cocoons). The interaction effect between parental breeds and the safety period was significant to notice in the present study. The multivoltine pure breed, PM was found to possess high level of tolerance to withstand the toxicity of the chemical, which was reflected through higher egg recovery at both the safety periods (53.43 and 55.27 g/kg of cocoons, respectively at 15 and 20 DAS) while the bivoltine parental breeds, both the pure breed and hybrids showed higher sensitivity for the chemical residues that was reflected through low egg recovery of 46.02, 46.72 and 48.86 g/kg of cocoons, respectively in CSR2, FC1 and FC2 at 15 DAS, which is probably the breed characteristic (Fig. 1).

Hatching (%)

A good seed in sericulture is the one which has higher percentage of hatched eggs in a laying. The hatching percentage showed significant difference among the parental breeds, different safety periods and their interactions and it was found highest in multivoltine breed, PM (97.75 %) and least in the bivoltine hybrid, FC1 (95.80 %). Amongst the safety durations, the highest per cent hatching was recorded in the treatment with the safety duration of 20 DAS (97.06 %) and least in 15 DAS (95.46 %). The breeds showed notable interaction with the toxicity of chemical used in the study. The highest hatching percentage was recorded in PM at longer safety period of 20 DAS (98.21 %) the lowest was observed in the bivoltine hybrid, FC1 (94.62 %) at 15 DAS (Table 4).

The hatching percentage of eggs improved as the safety period was extended while spraying chemicals during pest management in mulberry, the sole food plant of silkworm, *B. mori*. Further, the multivoltines are hardier than bivoltines due to their inherent genetic potential and the same has been observed in the present investigation. The current observations are in line with findings of Patnaik *et al*. (2011) that reported a better hatching percentage in the eggs laid by moths that emerged from thiamethoxam @ 0.015% (96.11 and 98.12 %, respectively at 14 and 21 DAS) and clothianidin @ 0.0047% (96.64 and 97.46 %, respectively at 14 and 21 DAS) treated groups when the safety period was extended to 21 DAS.

A higher concentration of dichlorvos (@ 0.0005 %) significantly reduced egg hatchability to 79.67 %, whereas at a lower concentration (0.0001 %) Kumutha *et al.* (2013) recorded a higher per cent hatching of 91.86 per cent comparable with control group (93.39 %). Similar observations were made by Qian *et al*. (2020) were highest hatching percentage was reported in low concentration treatment (0.001 g/l) of pyriproxyfen, (94.48 %) that was comparable with the control (98.47 %) and the least were in high concentration (@ 1 g/l) treatment group (89.43 %).

Table 4: Hatching, dead eggs and unfertilized eggs of parental breeds of *B. mori* as influenced by feeding mulberry leaves treated with abamectin 1.9 % EC at different days after spray

Treatments	Hatching (%)	Dead eggs (%)	Unfertilized eggs (%)
Breeds (B)			
B_1: PM	97.75	1.59	0.64
B_2: CSR2	95.97	3.17	0.85
B_3: FC1	95.80	3.36	0.82
B_4: FC2	96.46	2.69	0.83
F-test	*	*	*
S.Em±	0.038	0.035	0.021
$CD_{0.05}$	0.110	0.103	0.060
Safety period (S)			
S_1: 15 DAS	95.46	3.46	1.07
S_2: 20 DAS	97.06	2.29	0.63
S_3: Control	96.97	2.36	0.66
F-test	*	*	*
S.Em±	0.033	0.030	0.017
$CD_{0.05}$	0.950	0.092	0.052
Interaction (B×S)			
B_1S_1	96.99	2.17	0.82
B_1S_2	98.21	1.23	0.54
B_1S_3	98.06	1.35	0.57
B_2S_1	95.09	3.82	1.07
B_2S_2	96.51	2.76	0.71
B_2S_3	96.30	2.93	0.76
B_3S_1	94.62	4.12	1.24
B_3S_2	96.40	2.97	0.61
B_3S_3	96.38	2.97	0.63
B_4S_1	95.12	3.70	1.16
B_4S_2	97.13	2.19	0.67
B_4S3	97.14	2.18	0.66
F-test	*	*	*
S.Em±	0.065	0.061	0.036
$CD_{0.05}$	0.191	0.182	0.105

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

Dead eggs (%)

The quality of a laying is considered as poor if the percentage of dead eggs is more in a laying. There was a significant influence of breeds, safety period and their interaction with respect to dead eggs percentage observed in the present study using the chemical, abamectin 1.9 % EC sprayed @ 0.75 ml/l for management of thrips and mites in mulberry while cultivating the food plant of silkworm, *B. mori*.

Among the four different parental breeds of *B. mori*, significantly lowest percentage of dead eggs was observed in multivoltine breed, PM (1.59 %) that was highest in bivoltine hybrid, FC1 (3.36 %) followed by bivoltine breed, CSR2 (3.17 %). The duration of the spray significantly influenced the percentage of dead eggs when the silkworms were reared on abamectin 1.9 % EC (@ 0.75 ml/l) sprayed mulberry leaves harvested at different safety periods, the lowest percentage of dead eggs was recorded in the batch reared with 20 DAS (2.29 %) treatment that was comparable with control (2.36 %), while it was highest in the treatment with 15 DAS (3.46 %). Interaction between parental breeds and the time of the leaf harvest from the treatment plot showed significant variation in the per cent dead eggs, indicating the contribution of both breed and chemical toxicity on the per cent dead eggs in a laying (Table 4).

Unfertilized eggs (%)

The significant difference was observed concerning to the percentage of unfertilized eggs among the parental breeds, safety duration and the interactions. The highest percentage of unfertilized eggs was found in bivoltine pure breed, CSR2 (0.85 %), while it was lowest in the multivoltine breed, PM (0.64 %). The duration of spray significantly affected the percentage of unfertilized eggs that was lowest at 20 DAS (0.63 %) on par with the control (0.66 %), while the highest was recorded at 15 DAS (1.07 %). Interaction between parental breeds and the time of the leaf harvest from the treatment plot showed significant variation in the per cent unfertilized eggs (Table 4).

Kumutha *et al*. (2013) reported maximum rate of unfertilized eggs in the treatment with higher concentration @ 0.005% neem pesticide (12.85 %) and @ 0.0005 % dichlorvos compared to (8.94 %) and control (2.77 %) and lower concertation of dichlorvos @ 0.0001 % and Vijay neem @ 0.001 % (3.20 and 5.70 %, respectively). Cheng *et al.* (2019) observed low rate of unfertilized eggs in the acetamiprid-treated group (8 %) comparable with control group (5 %) suggesting that low concentration of chemical (acetamiprid) may not significantly impact the fertilization process and probably does not interfere directly with the reproductive mechanisms involved in fertilization process. Similar observations were reported in the present study where the extended safety period showed improved hatchability and reduced number of unfertilized and dead eggs.

Conclusion

The study on the impact of abamectin 1.9 % EC on the reproductive performance of silkworm, revealed its dual role in effectively managing thrips and mites in mulberry cultivation while safeguarding the grainage parameters of *B. mori*. The selected molecule abamectin 1.9 % EC @ 0.75 ml/l was found safer to parental breeds of silkworm when the leaves are used at 20 DAS, which was reflected through the maximum fecundity, hatching %, egg weight, egg recovery and minimum number of eggs retained in the ovary, per cent dead and unfertilized eggs. This suggests that spraying abamectin 1.9 % EC, judiciously can be a viable option for pest management in mulberry cultivation without compromising the reproductive performance of silkworm *B. mori*.

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