**Evaluation of different bed disinfectants on economic traits of bivoltine hybrid mulberry silkworm (SK6×SK7) in Kishanganj district of Bihar**

**Abstract**

 The present experiment was carried out in the Kishanganj district of Bihar to assess the impact of various disinfectants on the bivoltine cross mulberry silkworm (SK6×SK7) reared on the C-2028 variety. The cross between SK6 and SK7 is considered a promising combination for silk production in East and North East region used for commercial silk production and egg production. Among the disinfectants tested, treating the mulberry silkworms with Vijetha @5g per square foot, half an hour before feeding, yielded the most favourable outcomes. This treatment resulted in higher measurements for parameters such as single cocoon weight (1.94 g), single shell weight (0.61 g), SR percentage (31.74%), filament length (987.7 m), NBFL (non-breakable filament length) (987.7 m), denier (2.56), raw silk filament weight (0.27 g), and renditta (2.90). In contrast, the control group exhibited lower values for these parameters. The results showed that Vijetha treatment had a positive impact on the quality and characteristics of the produced silk cocoons compared to the other disinfectants viz Labex, Sericillin, and Amla powder and the control group.

**Keywords: -** Bivoltine, Bed disinfectants, Post cocoon, Vijetha treatment

**Introduction**

 The silkworm larvae, scientifically known as *Bombyx mori* (L.), play a significant role in the economy by transforming leaf protein into silk. Due to silk's historical and global importance in industrial and commercial sectors, as well as its widespread application the silkworm has gained prominence as a valuable laboratory model (Hiware, 2001). Silk, often referred to as the "Queen of textiles," maintains its unparalleled position in the fibre industry, representing a remarkable natural resource for humanity. Among various silk types, mulberry silk stands out as the most crucial, contributing for up to 95% of the world's silk production (CSB, 2021). Large-scale rearing of silkworms with great care in both natural and controlled environments is carried out to scientifically produce cocoons, which serve as the raw material for silk manufacturing (Kamili et al., 2000). Silk, known globally as the "BIOSTEEL" for its unparalleled elegance, lustre, natural dye absorption, high absorbency, lightweight nature, soft texture, and remarkable durability. Silkworm, is responsible for spin this valuable silk fibre which makes it as a highly valuable insect to humanity, serving as a versatile material for various applications, both within the textile industry and beyond (Tsukada, 2005). Silk is a natural gift, and India is the world's second-largest producer after China, cultivating all four commercial types: Mulberry, Tropical Tasar, Temperate Tasar, Eri and Muga (CSB, 2018).

 The sericulture importance is underscored by the recent growth in silk production, with India recording a 6.37% increase in the financial year 2023-24, further setting its position as one of the world's leading silk producers (Amarnatha, et al. 2024). Around 72% of India's silk is mulberry silk, produced by the domesticated *Bombyx mori* silkworm, which feeds only on mulberry leaves (Lee, 1999). It is mainly reared indoors in Karnataka, Andhra Pradesh, Tamil Nadu, Jammu & Kashmir, West Bengal and Bihar. Bihar as a whole and Kishanganj in particular, is regarded as a non-traditional sericulture zone. In the state, the sericulture industry is already established itself on solid ground. Mulberry production in Bihar was 557 hectares in 2018-19, while mulberry raw silk production was 17 MT (CSB, Seri-states-profile-2019: Singh et al. (2023). The domesticated silkworm *(B. mori)* is vital for silk production but is highly sensitive to environmental, nutritional, and microbial factors, often leading to disease, mortality, and cocoon crop losses year-round (Shashidhar *et al*, 2018). Silkworms are prone to various infectious diseases, causing cocoon losses of 15–20 kg per 100 disease-free laying which is about 30% of total loss (Doreswamy *et al*., 2004). Once infected, controlling the disease is difficult, so prevention is crucial. Pathogens, including viruses, can be managed using cultural practices, and physical or chemical methods. Bed disinfectants help prevent contamination and disease spread in rearing areas (Selvakumar *et al*., 2002). Various bed disinfectants and methods have been developed to control silkworm diseases, playing a key role in successful cocoon production. This study examines their impact on the economic traits of silkworms (*Bombyx mori* L.).

**Materials and Methods**

The experiment was conducted at the Advance Centre on Sericulture, Kishanganj, Bihar, from March to June 2022. The bivoltine cross (SK6×SK7) was used to study the impact of bed disinfectants on commercial traits, with rearing carried out using standard methods until spinning.

**Treatment details**

The treatments in the study were as follows:

* **T1**: Vijetha @ 5g/sq ft daily, applied after bed cleaning and 30 minutes before feeding, from 2nd moulting to pre-spinning.
* **T2**: Sericilin @ 5g/sq ft daily, applied similarly to T1.
* **T3**: Labex @ 5g/sq ft daily, applied similarly to T1.
* **T4**: Amla @ 5g/sq ft daily, applied similarly to T1.
* **T5**: Untreated control (no disinfectant used).

**Rearing techniques:**

 The experiment followed a completely randomized design (CRD) with five treatments and four replications using the bivoltine mulberry silkworm cross (SK6×SK7). Fifty disease-free laying (DFLs) were black-boxed in egg racks covered with black sheets at room temperature. Hatching rates reached 90–95%. Post-hatching, chopped tender mulberry leaves (C-2038 variety, 0.5 sq.cm) were sprinkled over the first instar larvae, which began feeding at the cut edges.

 Silkworms were fed four times daily. They underwent four moults, during which they stopped feeding, raised their heads, and changed colour. After the second moult, 300 third instar larvae per treatment were selected and reared in separate trays with four replications. Beds were uniformly sized, cleaned daily by hand, and disinfected with muslin cloth 30 minutes before feeding. Leaf quantity and size increased after each moult.

 Late instar larvae became sluggish, stopped feeding, turned transparent, and later became restless as they searched for support to spin cocoons. These were hand-picked and placed in Chandrika, where cocooning took 6–10 days. Pupation occurred within 2–3 days inside the cocoon. Cocoons were harvested on the 7th day, and 100 pupae were weighed. Fifty green cocoons were used to determine shell weight and ratio, then oven-dried at descending temperatures: 110°C (15 min), 100°C (30 min), 85°C (1 hr), 70°C (2 hrs), and 55°C (6 hrs). Finally, 150g of dried cocoons per treatment replication were set aside for post-cocoon analysis.

**Schedule for bed disinfectants:**

 From the 3rd to 5th instar, bed disinfectants were dusted daily at 5g/sq ft after cleaning and 30 minutes before feeding, using muslin cloth.

**Observations recorded**

**Single cocoon weight (gram):** Cocoon weight was recorded on the sixth day of spinning, when it's typically at its peak. The weight of a single cocoon was calculated by averaging the weight of 10 cocoons, measured in grams.

**Single shell weight (gram):** After removing the pupae, cocoons were cut open at one end, and shell weight was recorded. The average shell weight of 10 cocoons was taken and measured in grams.

**Cocoon shell ratio:** After deflossing and sorting, quality green cocoons were randomly selected for evaluation using a precise electronic balance (0.10 g sensitivity, 500–1000 g capacity). The assessment steps were:

* Cocoon examination was done 6–7 days after spinning.
* Cocoons were cut obliquely to avoid damaging the pupa.
* Ten male and ten female cocoons were separated.
* After calibrating the balance to zero, the total weight of ten male cocoons (with pupae) was recorded.
* Then, the shell weight of the same male cocoons was measured.
* The same procedure was repeated for female cocoons.
* Shell ratio was calculated separately for males and females.
* Finally, average cocoon weight, shell weight, and shell ratio were determined.

Table 1: Average shell weight cocoon weight measurement

|  |  |  |
| --- | --- | --- |
| Sex |  10 cocoon weight (gm) |  10 shell weight (gm) |
| Male  |  A |  B |
| Female  |  A1  |  B1 |
| Average  |  C = A+A1/2 |  D = B+B1/2 |

 Shell ratio is calculated by using the formulae;

 Weight of cocoon shell (D)

Shell ratio = -------------------------------- X 100

 Weight of cocoon (C)

**Filament length (m):** Oven-dried cocoons were cooked at 100°C before reeling. Using an Epprovate device, 10 cocoons were reeled to estimate the average filament length per cocoon in meters. Filament length was calculated using the following formula.

 Filament length (m) = number of revolutions in Epprovate X 1.125

**Non-breakable filament length (NBFL):**

It is a standard length of cocoon filament that can be unwound without breaking. It is calculated by taking average of five cocoon filament. Formula for calculating NBFL is,

 Filament length

 NBFL = -----------------------

 1 + Break

 (Anonymous, 2005)

**Denier:** Denier refers to silk filament thickness, calculated as (filament weight ÷ length) × 9000. The average filament weight, in grams, was measured from 10 randomly selected reeled filaments.

 Filament weight (g)

 Denier = ---------------------------- X 9000

 Filament length (m)

 (Anonymous, 2005; Marks and Robinson, 1976)

**Raw silk filament weight:** It is the silk weight obtained after the reeling.

**Renditta:** Renditta is value derive from litre of cocoon required to produce 1 kg of silk. Calculated by using formula;

 Good green cocoon weight

 Rendita = -----------------------------

 Silk weight (Manual JICA CSB, 2003)





**Plate 1: Bed disinfectants used in experiment**

**Result and Discussion**

**Single cocoon weight:**

In bivoltine race (table 2) the maximum single cocoon weight (1.94 g) was noted in T1 (Vijetha bed disinfectant application @ 5g/sq. ft. half an hour before feeding followed by T2 (application of Sericilin @ 5 g/sq. ft., 1.88 g). Suggestively lowermost single cocoon weight was observed in control conditions (1.66 g).

These findings are in agreement with earlier studies of Manimegalai et al. (1999) reported that the Vijetha treatment recorded the highest single cocoon weight (1.63 g). Similarly, Anonymous (2002) also observed that Vijetha resulted in the maximum single cocoon weight (1.684 g) compared to other disinfectants. Swathi et al. (2014) noted the highest cocoon weight of 1.96 g under the treatment involving daily hydrated lime dust application at a rate of 5 g/sq ft, combined with the application of bundh dust after each moult. Studies by Singh (2012) also reported an increase in cocoon weight compared to untreated controls. Furthermore, the findings of Shashidhar et al. (2018), Surapwar et al. (2019), and Narasimhanna et al. (1975) were consistent with the current results.

**Single shell weight:**

The results shown in (table 2) regarding bivoltine race discovered that the maximum single shell weight (0.61 g) was recorded in T1 ((Vijetha bed disinfectant application @ 5g/ sq. ft. half an hour before feeding daily) followed by T2 (application of Sericilin @ 5g/sq. ft., 0.53 g). However, minimum single shell weight (0.38 g) was recorded in untreated control.

These results align with previous findings. Anonymous (2002) reported that Vijetha recorded the highest single shell weight (0.285 g) compared to other disinfectants. Similarly, Swathi et al. (2014) observed the highest shell weight (0.330 g) with the daily hydrated lime powder application after each moult. Shashidhar et al. (2018) found that the combined use of Ankush, Vijetha Green, and slaked lime powder as a bed disinfectant was effective in controlling silkworm diseases and resulted in a higher shell weight (0.340 g). Surapwar et al. (2019) also reported that applying Vijetha at 5 g/sq ft, half an hour before resuming feeding after each moult, produced the maximum single shell weight.

**Cocoon shell ratio (SR%):**

The results presented in (table 2) regarding bivoltine race revealed that the highest cocoon shell ratio (31.74 %) was recorded in T1 (application of Vijetha @ 5 g/ sq. ft. half an hour before feeding daily) followed by T2 (application of Sericilin @ 5 g/sq. ft., 30.96 %). However, minimum cocoon shell ratio (26.14 %) was recorded in untreated control.

The results are in line with those of Surapwar et al. (2019), who reported that the application of Vijetha bed disinfectant at 5 g/sq ft resulted in the highest cocoon shell ratio compared to the control. Jadhav and Salunke (1995) recorded the highest shell percentage in mulberry silkworms when the rearing bed was treated with a mixture of lime and paraformaldehyde in a 98:2 ratio. Supporting findings were also reported by Baig et al. (1993), Sivaprakasam (1999), Jawale and Tayade (1987), and again by Jadhav and Salunke (1995), who documented improved shell ratios using various bed disinfectants.

**Table 2: Post cocoon parameters of bivoltine silkworm race (SK6 X SK7) on application of different bed disinfectants**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatments  | Single cocoon weight (g)  | Single Shell Weight (g)  | SR (%)  | Filament length (m)  | NBFL (m)   | Denier  | Raw Silk filament Weight (g)  | Renditta  |
| T1- Vijetha  | 1.94  | 0.61  | 34.29 (31.74\*)  | 987.7  | 987.70  | 2.56  | 0.27  | 2.90  |
| T2- Sericilin  | 1.88  | 0.53  | 33.81 (30.96)  | 978.3  | 978.30  | 2.68  | 0.28  | 3.33  |
| T3- Labex  | 1.81  | 0.48  | 33.20 (29.98)  | 970.7  | 970.70  | 2.75  | 0.29  | 3.39  |
| T4- Amla  | 1.79  | 0.42  | 30.98 (26.49)  | 946.5  | 833.7  | 2.83  | 0.29  | 3.47  |
| T5- Control  | 1.66  | 0.38  | 30.75 (26.14)  | 918.3  | 697.3  | 2.93  | 0.30  | 3.53  |
| SE m (±)  | 0.03  | 0.02  | 0.88  | 8.3  | 15.3  | 0.02  | 0.00  | 0.06  |
| CD at 5%  | 0.10  | 0.05  | 2.65  | 25.0  | 46.3  | 0.05  | 0.01  | 0.19  |
| CV%  | 3.63  | 6.59  | 6.06  | 1.7  | 3.4  | 1.17  | 2.10  | 3.88  |

**Filament Length (FL):**

The results presented in (table 2) regarding bivoltine race revealed that the maximum filament length (987.7 m) was recorded in T1 (application of Vijetha @ 5 g/ sq. ft. half an hour before feeding daily) followed by T2 (application of Sericilin @ 5 g/sq. ft., 978.3 m). However, minimum filament length (918.3 m) was recorded in untreated control.

To date, no studies have specifically examined the effect of the disinfectants Vijetha and Labex on the larval weight of silkworms, as investigated in the present study. However, Jawale and Tayade (1987) reported the longest filament length in silkworms treated with paraformaldehyde. Similarly, Jagannatha (1996) observed significantly increased filament length following the application of formalin chaff and a combination of lime and Dithane M. The findings of Manimegalai and Subramaniam (1999), Anonymous (2002), Kuntamalla (2007), Swathi et al. (2014), and Shashidhar et al. (2018) also appear to be consistent with the filament length results reported in the present study.

**Non-Breakable Filament Length (NBFL):**

The results presented in (table 2) regarding bivoltine race revealed that the maximum non-breakable filament length (987.7 m) was recorded in T1 (application of bed disinfectant Vijetha @ 5 g/ sq. ft. half an hour before feeding daily) followed by T2 (application of Sericilin @ 5 g/sq. ft., 978.3 m). Minimum non-breakable filament length (697.3 m) was recorded in untreated control.

The findings of the present study are in accordance with earlier research. Jawale and Tayade (1987) reported the longest non-breakable filament length in silkworms treated with paraformaldehyde. Similarly, Jagannatha (1996) observed a significantly greater non-breakable filament length with the use of formalin chaff and a combination of lime and Dithane M. The results reported by Manimegalai and Subramaniam (1999), Anonymous (2002), Swathi et al. (2014), and Shashidhar et al. (2018) also appear to support the present findings regarding non-breakable filament length. Notably, the current investigation is the first to explore the effect of the disinfectants Vijetha and Labex on the larval weight of silkworms, as no prior studies have addressed this specific aspect.

**Denier:**

The results presented in (table 2) regarding bivoltine race revealed that the minimum denier (2.56) was recorded in T1 (application of Vijetha @ 5g/ sq. ft. half an hour before feeding daily) followed by T2 (application of Sericilin @ 5g/sq. ft., 2.68). Significantly higher denier (2.93) was recorded in untreated control. Singh et al. (2023) reported in multivoltine race the result showed that significantly minimum denier (2.54) was observed in treatment T3 i.e., application of bed disinfectants Labex @ 5g/sq. ft. ½ an hour before feeding.

**Raw silk filament weight:**

The results presented in (table 2) regarding bivoltine race revealed that the minimum raw silk filament weight (0.27 g) was recorded in T1 (application of bed disinfectant Vijetha @ 5g/ sq. ft. half an hour before feeding daily) followed by T2 (application of bed disinfectant Sericilin @ 5g/sq. ft., 0.28 g). Significantly higher raw silk filament weight (0.30 g) was recorded by untreated control.

The present findings are consistent with those of Sharanyakumar Gowda (2014), who reported improved denier values when bed disinfectants were applied at the recommended dosage, particularly with 100 percent or fully recommended applications.

**Renditta:**

The results presented in (table 2) regarding fo bivoltine race revealed that the lowest renditta (2.90) was recorded in T1 (application of bed disinfectant Vijetha @ 5g/ sq. ft. half an hour before feeding daily) followed by T2 (application of bed disinfectant Sericilin @ 5g/sq. ft., 3.33). The highest renditta (3.53) was recorded in untreated control.

No previous studies have examined the effect of the disinfectants Vijetha and Labex on the renditta of bivoltine silkworm races, making the present investigation a novel contribution in this area.

**Conclusion**

The study found that applying Vijetha bed disinfectant at 5 g/sq. ft, half an hour before feeding after each moult, significantly improved post-cocoon traits in bivoltine silkworms. It led to higher cocoon and shell weights, better shell ratio, longer filament and NBFL, and lower denier and renditta. These parameters are considered highly desirable in the silk reeling and processing industry.

Thus, using Vijetha at this dosage and timing is recommended to enhance the biological and economic performance of bivoltine silkworms in Kishanganj district, Bihar.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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