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Evaluation of bed disinfectants for improving rearing efficiency in $FC_1 \times FC_2$ Bivoltine double hybrid silkworms

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Abstract

Sericulture is a key agro-based enterprise that greatly supports rural livelihoods by offering significant employment opportunities. Nevertheless, the industry encounters major hurdles, particularly the widespread occurrence of silkworm diseases, which can lead to severe economic losses, including yield reductions of up to 20% in India. The present research evaluated the performance of four bed disinfectants-Shakthi, Labex, Vijetha, and Resham jyothi on $FC_1 \times FC_2$ bivoltine silkworm double hybrids. The experiment, carried out at Sri Krishna Devaraya University, involved applying bed disinfectants during the 2nd to 5th instar stages and assessing parameters such as larval and cocoon weights, shell weight, pupation rate, effective rate of rearing (ERR), disease incidence, and larval mortality. Among the tested disinfectants, Vijetha demonstrated superior effectiveness, yielding the highest larval weight (4.37 g), the shortest larval duration (23 days), and enhanced cocoon (1.98 g) and shell (0.41 g) weights. It also recorded the highest pupation rate (85.67%) and ERR (91.00%), along with the lowest disease incidence (3.00%) and larval mortality (4.67%). These results indicate that Vijetha is particularly effective in improving silkworm rearing performance and controlling diseases, thereby contributing to higher productivity in sericulture. The findings emphasize the importance of selecting suitable bed disinfectants, with Vijetha showing the greatest potential to boost silk yield and minimize disease-related losses.

Keywords: Bed disinfectants, bivoltine, cocoon, hybrid, rearing, silkworm

Introduction

Sericulture is a rural, agro-based cottage industry that integrates mulberry cultivation, silkworm rearing, and silk production. It plays a significant role in improving the rural economy by generating employment opportunities, requiring low investment, and offering high economic returns (Kapoor *et al.*, 2022) [3]. However, silkworms are highly susceptible to various diseases, which lead to considerable larval mortality and a decline in cocoon yield throughout the year (Shashidhar *et al.*, 2018) [18].

In India, disease outbreaks in silkworm crops cause annual losses ranging from 15% to 20% (Selvakumar *et al.*, 2002; Balavenkatasubbaiah *et al.*, 2014; Shashidhar *et al.*, 2018) [16, 12, 18]. Managing infections after they occur is challenging, making preventive measures essential to minimize losses. Disease prevention in sericulture typically involves the use of chemical disinfectants, physical barriers, and improved cultural practices.

Among these measures, the application of bed disinfectants is a critical strategy to prevent infections during the rearing process. Pathogens such as viruses, bacteria, and fungi may spread through contaminated leaves or rearing environments, particularly affecting *Bombyx mori* (Baig *et al.*, 1990) [10]. Without proper preventive interventions, controlling outbreaks often relies on culling infected stocks to stop disease transmission (Acharya *et al.*, 2002) [7]. Maintaining pathogen levels below the economic threshold has been shown to enhance silk productivity by up to 25% without expanding mulberry cultivation (Nagarajan and Radha, 1999) [6]. Therefore, the use of effective bed disinfectants is increasingly recognized as an important component of successful cocoon production (Surapwar *et al.*, 2019) [23].

This study focuses on assessing the performance of different bed disinfectants on the rearing efficiency of FC1×FC2 double hybrid silkworms, with the objective of improving disease management practices in sericulture.

Materials and methods

This research was carried out at the Postgraduate Department of Sericulture, Sri Krishna Devaraya University, Anantapur, Andhra Pradesh, to assess the influence of different bed disinfectants on the commercial characteristics and rearing performance of the bivoltine double hybrid silkworm FC1×FC2. The larvae in their second instar were procured from the Regional Sericultural Research Station, Anantapur. Rearing was conducted according to the standard procedures outlined by Benchamin and Nagaraj (1987)^[13] and continued until the spinning stage.

Treatment details

- **T₁:** Shakthi bed disinfectant applied at 5 g/ft² after bed cleaning, 30 minutes before feeding, from the second moult until just before spinning.
- **T₂:** Labex bed disinfectant applied at 5 g/ft² after bed cleaning, 30 minutes before feeding, from the second moult until just before spinning.
- **T₃:** Vijetha bed disinfectant applied at 5 g/ft² after bed cleaning, 30 minutes before feeding, from the second moult until just before spinning.
- **T₄:** Resham jyothi applied at 5 g/ft² after bed cleaning, 30 minutes before feeding, from the second moult until just before spinning.
- **T₅:** Control (no disinfectant applied).

Observations Recorded

Mature Larvae Weight (g)

A day before spinning, ten fully formed larvae were randomly selected and weighed from each replication.

The 5th Instar Larva's Duration (hours)

From the beginning of the first instar until 50% of the silkworms started to spin, the length of the larval stage was measured.

Effective Rate of Rearing (%)

The following formula was used to determine the Effective Rate of Rearing (ERR) (%), followed by Kumar *et al.* (2014)^[4],

$$\text{ERR} = \frac{\text{No. of cocoons harvested}}{\text{No. of larvae taken after 2 moults}} \times 100$$

Rate of Puberty (%)

Pupation was determined using the number of cocoons recovered and the number of healthy pupae found in each treatment.

Weight of Cocoon (g)

On the sixth day after spinning, about 10 cocoons were randomly chosen from each replication, followed by Kumar *et al.* (2014)^[4] and each one's weight was noted separately; and the cocoons' average weight was determined.

Weight of Shell (g)

10 randomly chosen cocoons from each replication were used to determine the shell weight and once the pupa was removed from the cocoons, the weight of the cocoon shell was noted.

Shell Ratio (%)

Using the following formula, the shell ratio was determined based on the weight of the corresponding cocoon shell:

$$\text{Shell ratio} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

Weight of Pupa (g)

Pupae extracted from ten randomly chosen cocoons in each replication were used to calculate pupal weight and each pupae weight was noted separately. The pupa's average weight was ascertained.

Disease Incidence (%)

During the rearing process, the total number of disease-infected and healthy larvae in each treatment was noted. The following formula was used to determine the diseases' percentage incidence, which was then reported as a percentage.

$$\text{Disease incidence} = \frac{\text{No. of diseased larvae}}{\text{Total No. of larvae}} \times 100$$

Larval Mortality (%)

Dead and diseased larvae are separated from healthy one and the larval mortality was counted daily and noted.

$$\text{Mortality (\%)} = \frac{\text{No. of dead larvae}}{\text{Total No. of larvae}} \times 100$$

Results and discussion

The experiment assessed the influence of four bed disinfectants—Shakthi, Labex, Vijetha, and Resham jyothi in comparison with an untreated control on the growth of fifth instar larvae of the bivoltine double hybrid (FC₁×FC₂) silkworm. Each disinfectant was applied at a rate of 5 g/ft², 30 minutes prior to feeding, from the third to the fifth instar stages.

Effect on Fifth Instar Larval Weight

Among the treatments, larvae reared on beds disinfected with Vijetha recorded the highest average weight (4.37 g/larva), followed by those treated with Shakthi (3.89 g/larva) and Labex (3.82 g/larva). The lowest weight was noted in the control group (3.72 g/larva) (Figure 1; Table 1). Although the differences were not very large, the use of Vijetha showed a consistent improvement in larval weight compared to other treatments.

Previous studies also support these findings. Manimegalai and Subramaniam (2000)^[5] reported a larval weight of 32.70 g per 10 larvae with Vijetha treatment, while Sivaprakasam (1999)^[21] observed a similar increase, recording 35 g per 10 larvae. An earlier report (Anonymous,

2002) ^[8] also highlighted that Vijetha improved larval weight, yielding 3.45 g per larva. Furthermore, Sujatha *et al.* (2007) ^[22] found that treatments with turmeric powder

enhanced larval weight significantly. The present results align with these observations, confirming that Vijetha is more effective than the other disinfectants tested.

Table 1: Effect of different bed disinfectants on the rearing performance of FC1×FC2 bivoltine double hybrid of mulberry silkworm (*Bombyx mori* L.)

Treatments	Weight of mature larvae (g)	Mean larval duration (days-hours)	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)	Pupa weight (g)	Pupation rate (%)	Effective Rate of Rearing (%)	Disease Incidence (%)	Larval Mortality (%)
T ₁ : Shakthi	3.89	23.05	1.93	0.40	20.65	1.53	78.33	83.67	4.67	10.33
T ₂ : Labex	3.82	23.16	1.92	0.41	21.25	1.51	72.67	78.00	6.00	14.00
T ₃ : Vijetha	4.37	23.00	1.98	0.41	20.68	1.57	85.67	91.00	3.00	4.67
T ₄ : Resham jyothi	3.79	23.20	1.86	0.39	21.10	1.47	69.33	73.67	7.67	14.33
T ₅ : Untreated control	3.72	24.10	1.83	0.38	20.60	1.45	55.00	64.33	15.67	18.33
significance	*	*	*	*	*	*	**	**	*	*
CD at 5%	0.156	0.18	NA	0.022	NA	NA	2.653	3.742	1.684	0.672
CV	3.321	4.01	4.665	4.694	4.52	5.67	9.645	10.672	7.17	7.54

Total Larval Duration of FC1×FC2 Bivoltine Double Hybrid

In this study, the minimum larval duration was observed in the Vijetha-treated batches (23.00 days), followed by Shakthi-treated batches (23.05 days), while the untreated control group showed the longest duration (24.10 days) (Table 1). Similar findings were reported by Surapwar *et al.* (2019) ^[23], who assessed the impact of different bed disinfectants, including Vijetha, Labex, and Ankush, on multivoltine silkworm hybrids. Their results revealed that Vijetha applied at 5 g/ft² resulted in the shortest larval period (22.03 days), which was

statistically on par with Labex at 5 g/ft² (22.86 days). The untreated control had a notably longer larval duration of 24.43 days. Additionally, Swathi *et al.* (2014) ^[24] demonstrated that using hydrated lime powder at 5 g/ft², along with bundh powder after each moult, reduced the larval period to 25.23 and 25.22 days in *Bombyx mori* L. Likewise, Jawale and Tayade (1987) ^[2] reported shorter larval durations when silkworms were reared on leaves cleaned with cotton (24.41 days) and treated with turmeric powder. These results collectively indicate that proper use of bed disinfectants effectively shortens larval duration, thereby improving silkworm productivity.

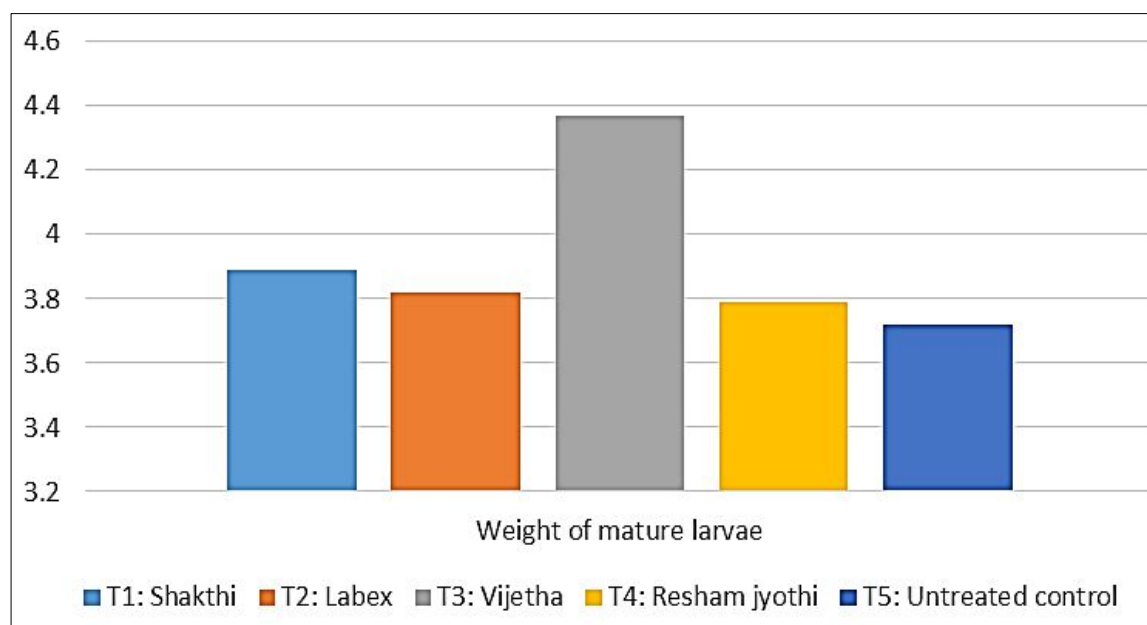


Fig 1: Weight of FC1×FC2 bivoltine double hybrid mature larva in grams

Cocoon Weight: The impact of various bed disinfectants on the double hybrid mulberry silkworm race [FC1×FC2] is presented in Table 1 and illustrated in Figure 2. The results showed that silkworms treated with Vijetha produced the heaviest cocoons, averaging 1.98 g. Treatments with Shakthi (1.93 g) and Labex (1.92 g) also enhanced cocoon weight compared to the untreated control, which recorded an average of 1.83 g.

These observations are consistent with earlier research. Manimegalai and Subramaniam (2000) ^[5] documented a maximum cocoon weight of 1.63 g using Vijetha, while Sivaprakasam (1999) ^[21] reported a similar value of 1.6 g. Likewise, Anonymous (2002) ^[8] found that Vijetha treatment resulted in the largest cocoon weight of 1.684 g, and Kapoor *et al.* (2022) ^[3] confirmed similar trends in their study.

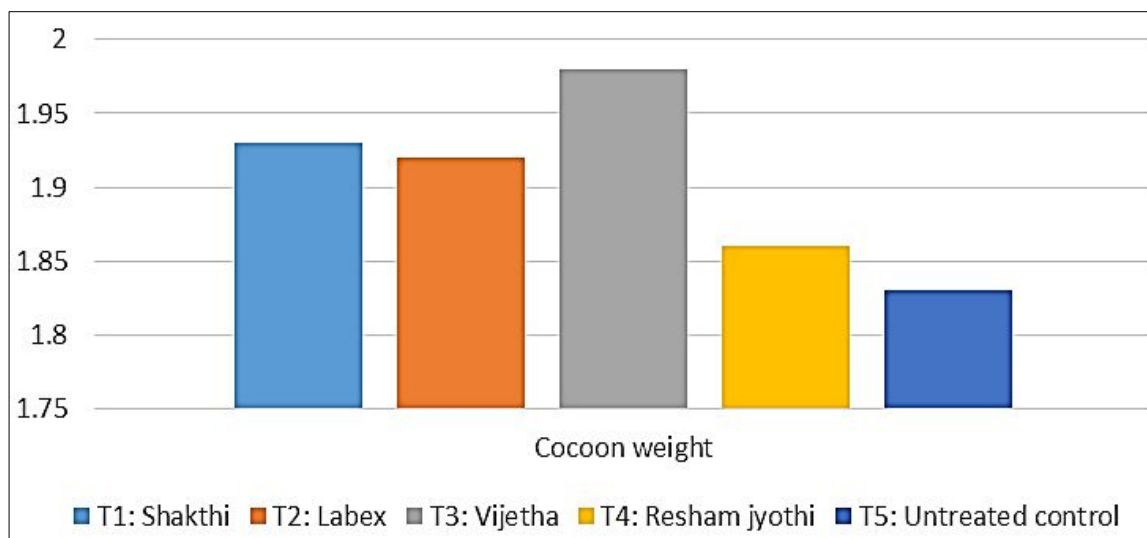


Fig 2: FC1×FC2 bivoltine double hybrid single cocoon weight in grams

Cocoon Shell Weight

The influence of various bed disinfectants on cocoon shell weight followed a pattern similar to their effect on total cocoon weight. In the untreated control group, the average shell weight was recorded at 0.38 g. Treatments with disinfectants resulted in noticeable improvements, with cocoons exposed to Vijetha achieving the highest shell weight of 0.41 g. Labex and Shakthi treatments also showed positive outcomes, producing shell weights of 0.41 g and 0.40 g, respectively (refer to Table 1 and Figure 3).

Comparative findings from earlier studies support these results. Manimegalai and Subramaniam (2000) ^[5] reported a maximum shell weight of 0.24 g, while Sivaprakasam (1999) ^[21] observed 0.20 g. Similarly, Anonymous (2002) ^[8] documented a maximum value of 0.285 g for double hybrid mulberry silkworms treated with Vijetha disinfectant. The present study also demonstrated an increase in shell weight with Vijetha treatment, consistent with observations reported by Kapoor *et al.* (2022) ^[3].

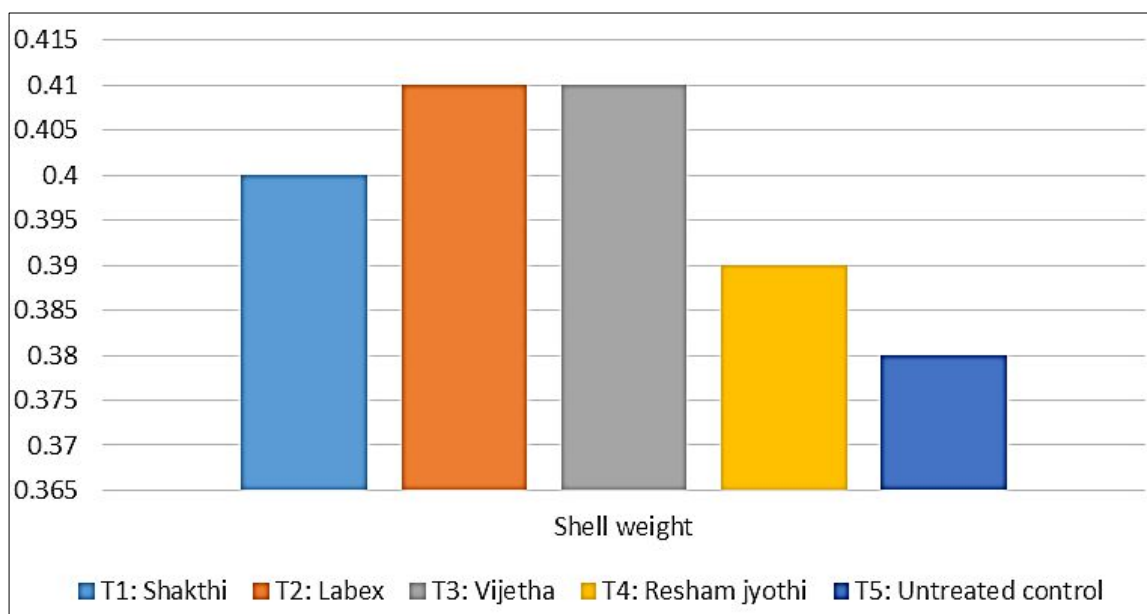


Fig 3: FC1×FC2 bivoltine double hybrid cocoon shell weight in grams

Cocoon Shell Ratio: The application of different bed disinfectants had a significant effect on the cocoon and shell weights of the FC1×FC2 hybrid, as indicated in Table 1 and Figure 4. Labex treatment achieved the highest shell ratio at 21.25%, while Shakthi recorded the lowest at 20.65%, which was nearly equal to the control value of 20.60%. The Vijetha disinfectant produced a shell ratio of 20.68%. Statistical analysis confirmed that these differences were

highly significant at the 0.01% level. Previous investigations have also reported variability in shell ratio with Vijetha application; Manimegalai and Subramaniam (2000) ^[5] documented a ratio of 15%, and Sivaprakasam (1999) ^[21] reported 16%. Findings by Kapoor *et al.* (2022) ^[3] further support these observations, suggesting that Vijetha use generally contributes to an improved cocoon shell ratio.

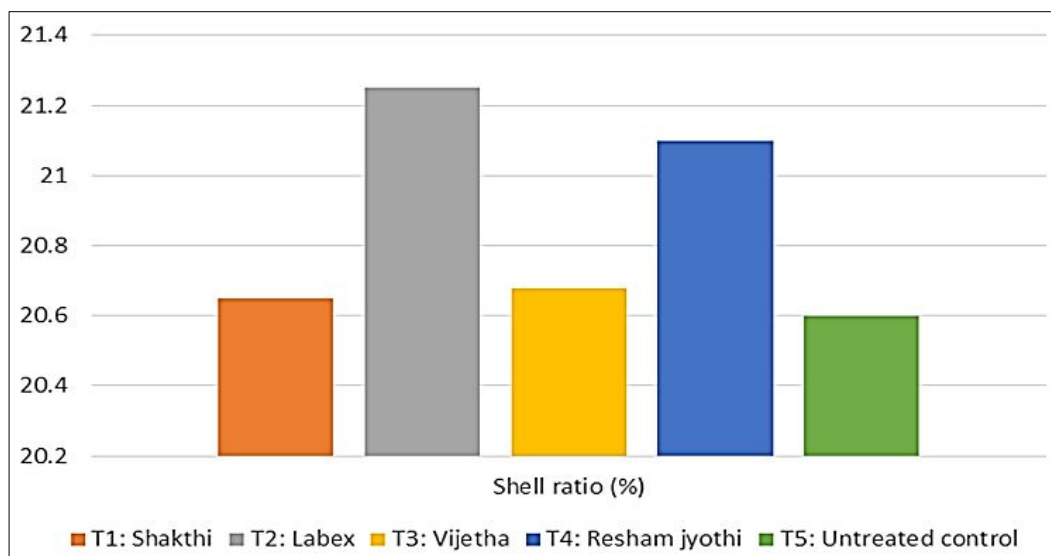


Fig 4: FC1×FC2 bivoltine double hybrid cocoon shell ratio%

Effect on Pupation Rate

The pupation rate was notably influenced by the application of different bed disinfectants on fifth instar larvae of the FC1×FC2 hybrid. The highest pupation rate was observed in the batch treated with Vijetha, reaching 85.67%, followed by Labex with 72.67%. Shakthi-treated batches recorded a pupation rate of 78.33%, while Resham jyothi treatment resulted in the lowest among the disinfectants at 69.33%. The control group exhibited the least pupation rate at 55.00% (Table 1). Similar observations were made by Shashidhar *et al.* (2018) [18], who assessed the impact of various dosages of bed disinfectants on double hybrid

silkworm rearing under the subtropical conditions of Jammu. Their findings indicated that the application of Vijetha and lime disinfectants at 100% and 75% concentrations yielded better performance in parameters such as larval weight, effective rate of rearing (ERR), cocoon weight, shell ratio, shell weight, pupation rate, filament length, denier, renditta, and reelability compared to lower concentrations (0%, 20%, and 50%). These results are consistent with the observations of Kapoor *et al.* (2022) [3], supporting the conclusion that Vijetha treatment enhances pupation rate and other economic traits.

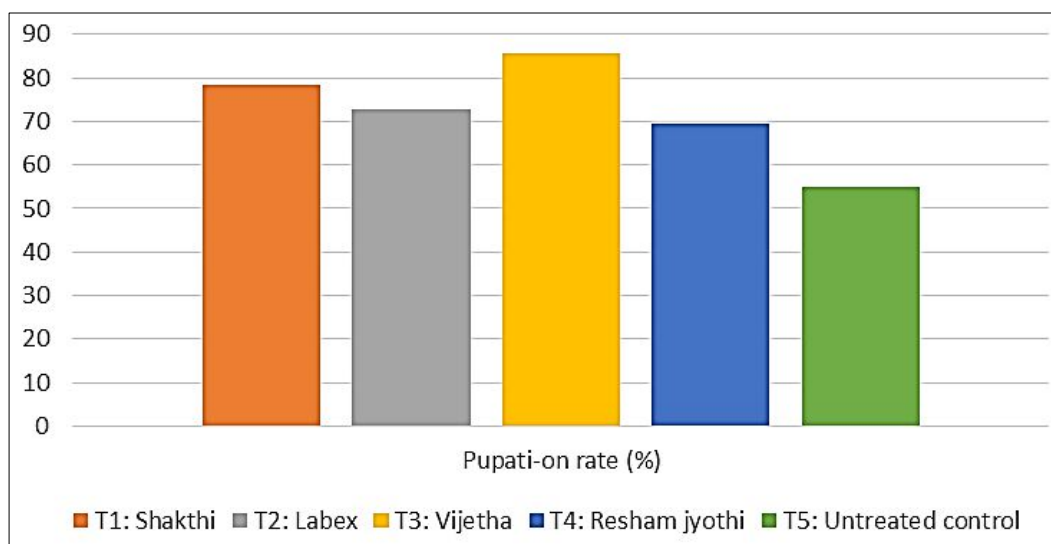


Fig 5: FC1×FC2 bivoltine double hybrid Pupation %

Effective Rate of Rearing

The Effective Rate of Rearing (ERR) indicates the percentage of larvae that successfully form cocoons. In the present study, the highest ERR (91.00%) was achieved with the use of the Vijetha bed disinfectant, whereas the control group showed a much lower ERR of 64.33% (Kapoor *et al.*, 2022) [3]. Treatments with Shakthi and Labex recorded ERRs of 83.67% and 78.00%, respectively, as shown in Table 1 and Figure 6. These differences were statistically significant at the 0.001% level. Similar findings were

reported by Venkataramana *et al.* (2002) [25], who observed a marked improvement in ERR with Vijetha and Resham Jyothi compared to untreated batches. Swathi *et al.* (2014) [24] also noted that control groups consistently exhibited the lowest ERR values relative to those treated with various disinfectants. Earlier studies by Narasimhanna *et al.* (1975) [14], Baig *et al.* (1993) [11], and Sharma *et al.* (1994) [17] further corroborate the present results, confirming the beneficial effects of disinfectant application on silkworm rearing performance.

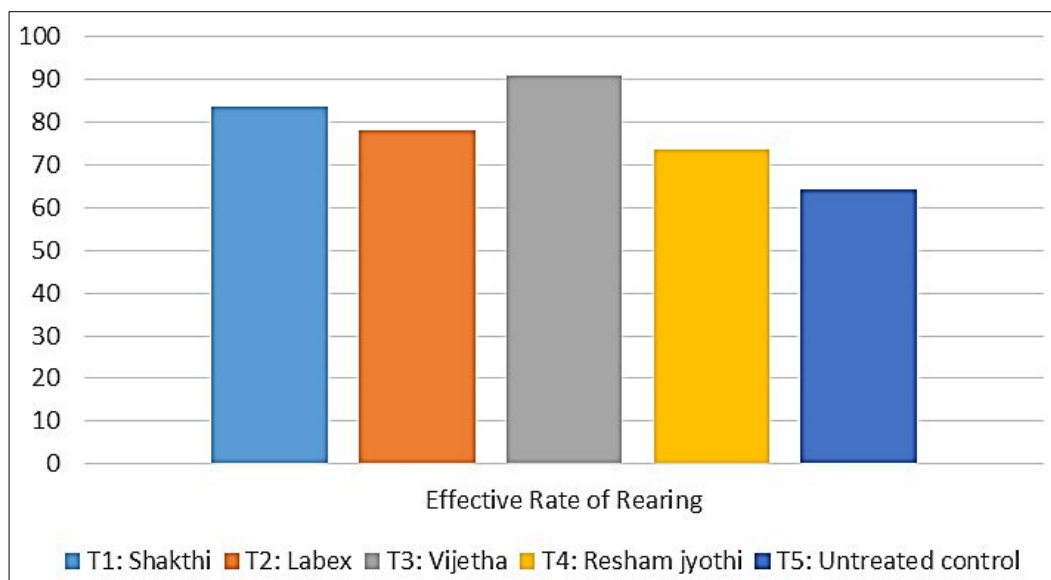


Fig 6: Effective Rate of Rearing % bivoltine double hybrid

Disease Incidence: The study assessed how different bed disinfectants influence disease occurrence in bivoltine double hybrid silkworms (FC1×FC2) (Figure 7). Among the treatments, the Vijetha disinfectant (T₃) recorded the lowest disease incidence at 3.00%, followed by Shakthi (T₄), which showed 4.67% (Singh *et al.*, 2023) ^[19]. In contrast, the untreated control group (T₅) exhibited the highest disease incidence, reaching 15.67%. Previous research by Samson (2000) ^[15] highlighted several disinfectants, including RKO, Vijetha, Resham Jyothi, and Suraksha, as highly effective against silkworm diseases. Similarly, Anonymous (2002) ^[8]

reported that Vijetha demonstrated the lowest disease incidence (5.47%) compared to other tested products. Furthermore, Manimegalai and Subramaniam (2000) ^[5] and Surapwar *et al.* (2019) ^[23] observed that using turmeric powder combined with chalk powder, along with Vijetha, reduced grasserie infection by 63.16%. Additionally, Singhvi *et al.* (2004) ^[20] and Surapwar *et al.* (2019) ^[23] confirmed that disinfectants like RKO, Resham Jyothi, and Vijetha effectively shield Tasar silkworms from pathogenic attacks. Overall, Vijetha consistently minimized the spread of diseases in treated batches.

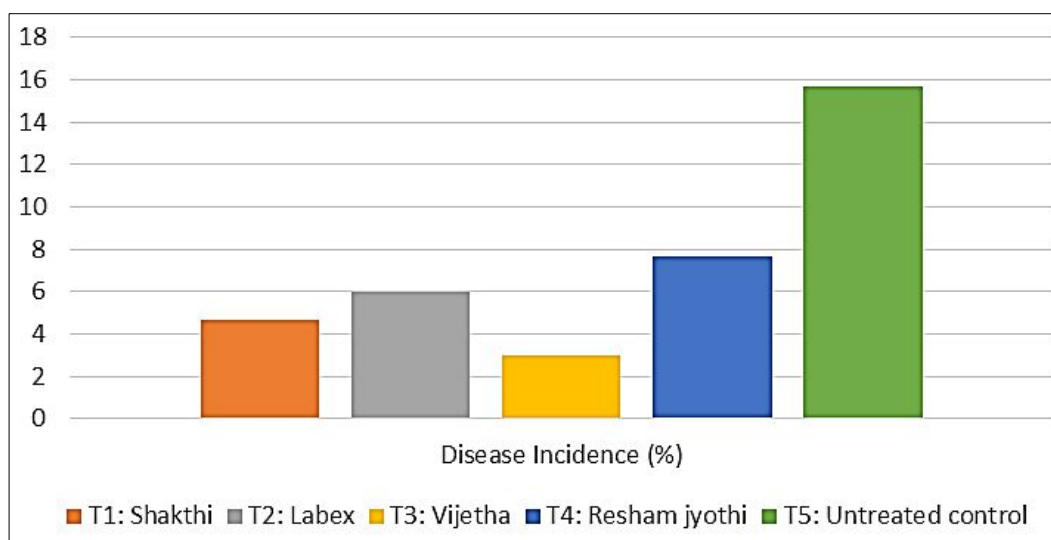


Fig 7: Disease Incidence % during the rearing performance of bivoltine double hybrid

Larval Mortality

The findings of the study showed that the application of the Vijetha bed disinfectant (T₃) resulted in the lowest larval mortality rate of 4.67% (Singh *et al.*, 2023) ^[19]. The next lowest mortality was observed with the Shakthi disinfectant (T₁), which recorded 10.33%. The untreated control group (T₅) exhibited the highest mortality at 18.33% (Figure 8).

Comparable outcomes were reported by Dhirwani *et al.* (2015) ^[1], who observed mortality rates as low as 1% with Amla and 4% with Tulsi when testing various plant-based disinfectants, including Neem, Amla, Haldi, Ber, and Tulsi, against RKO and other chemical agents. These observations are in agreement with the findings of Ayandokun *et al.* (2017) ^[9] and Balavenkatasubbaiah *et al.* (2014) ^[12].

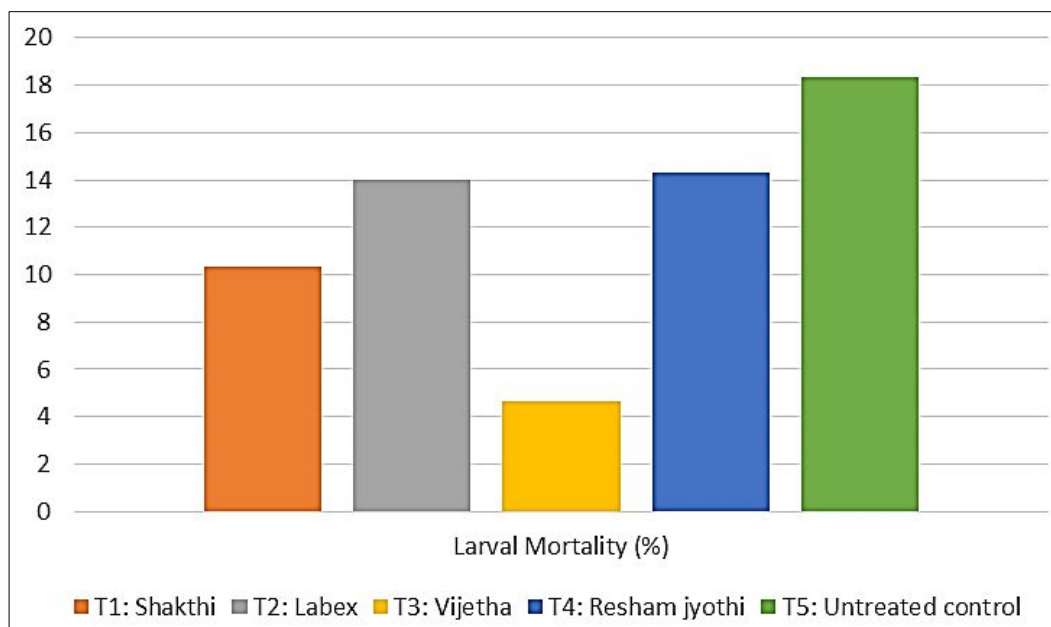


Fig 8: FC1×FC2 bivoltine double hybrid larval mortality % during the experiment

Conclusion

Sericulture is often hindered by silkworm diseases, which can cause severe production losses. The present study assessed the effectiveness of four bed disinfectants-Shakthi, Labex, Vijetha, and Resham jyothi on the performance of FC1×FC2 bivoltine silkworm hybrids. Applications were carried out from the second moult to fifth instar stages, and parameters such as larval weight, cocoon weight, shell weight, pupation rate, effective rate of rearing (ERR), disease incidence, and larval mortality were examined. Among the tested products, Vijetha proved to be the most efficient, resulting in notable increases in larval and cocoon traits, as well as the highest pupation rate and ERR. Furthermore, it effectively minimized disease occurrence and larval mortality. These findings emphasize the importance of using bed disinfectants to create favorable rearing conditions. In particular, the superior results of Vijetha indicate its potential to enhance disease management and improve silk yield, offering significant advantages for sericulture practices.

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