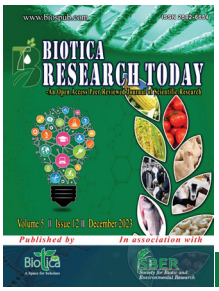
DOI: 10.54083/BioResToday/5.12.2023/837-843

Bio. Res. Today 2023, 5(12):837-843



Biotica Research Today

e-ISSN: 2582-6654

December, 2023

Article ID: RT1472 **Research Article**

Assessment of Certain Bed Disinfectants on Silkworm Rearing Performance of $FC_1 \times FC_2$ Bivoltine Double Hybrid

M. Parasuramudu*, K. Nandhini, Y. Praveen Reddy and U. Anil Kumar

Dept. of Sericulture, Sri Krishnadevaraya University, Anantapur, Andhra Pradesh (515 003), India

Corresponding Author

M. Parasuramudu

: parasuram723b@gmail.com

Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?

Parasuramudu *et al*., 2023. Assessment of Certain Bed Disinfectants on Silkworm Rearing Performance of $FC_1 \times FC_2$ Bivoltine Double Hybrid. *Biotica Research Today* 5(12), 837-843.

Abstract

Sericulture, a pivotal agro-based industry, significantly contributes to the socio-economic development of rural communities by creating substantial employment opportunities. However, the sector faces critical challenges, particularly the prevalence of silkworm diseases, which can result in considerable economic losses, with crop reductions of up to 20%, reported in India. This study investigates the efficacy of four bed disinfectants, *viz.*, Shakthi, Labex, Vijetha and Reshom Keet Oushadh (RKO) on the rearing performance of $FC_1 \times FC_2$ bivoltine silkworm hybrids. The experiment, conducted at Sri Krishna Devaraya University, involved applying the disinfectants during the 2nd to 5th instar stages and evaluating various parameters such as larval weight, shell weight, cocoon weight, pupation rate, effective rate of rearing (ERR), disease incidence and larval mortality. The results revealed that Vijetha was the most effective disinfectant, leading to the highest larval weight (4.37 g), shortest larval duration (23 days), superior cocoon (1.98 g) and shell weights (0.41 g). Additionally, Vijetha showed the highest pupation rate (85.67%) and ERR (91.00%) while significantly reducing disease incidence (3.00%) and larval mortality (4.67%). These findings highlight Vijetha as a highly effective disinfectant for improving silkworm rearing outcomes and managing diseases, making it a valuable tool for enhancing productivity in sericulture. However, the study underscores the importance of selecting appropriate bed disinfectants, particularly Vijetha, to maximize silk production and minimize losses due to disease.

Keywords: Bed disinfectants, Bivoltine, Cocoon, Hybrid, Rearing, Silkworm

Introduction

Sericulture, basically an agriculture-based cottage industry, encompasses the cultivation of host plants, the rearing of silkworms and the eventual production of silk. This industry plays a crucial role in rural economic development by providing significant employment opportunities to rural populations, requiring minimal investment while yielding substantial returns (Kapoor *et al.*, 2022). Silkworm is more prone to disease, leading to mortality among them and causing a reduction in cocoon yield throughout the year (Shashidhar *et al.*, 2018).

In India, the incidence of disease-related losses in cocoon crops has been documented to range between 15% and 20% (Selvakumar *et al.*, 2002; Balavenkatasubbaiah *et al.*, 2014; Shashidhar *et al.*, 2018). The management of silkworm diseases post-infection presents formidable obstacles underscoring the importance of disease prevention in sericulture. Because they are more successful than trying to treat or cure diseases after they manifest preventive measures are crucial. It is possible to prevent disease by using chemical agents' physical barriers and cultural practices.

One of the most important tactics for stopping infection and preventing the spread of pathogens is the use of bed disinfectants on raised beds. Infections from contaminated mulberry leaves or other environmental sources can occur while silkworm larvae are being raised (Baig *et al.*, 1990). Viral bacterial viral and fungal infections are among the many pathogens that can affect silkworms especially *Bombyx mori*. In the absence of specific preventive measures other than

Article History

RECEIVED on 12th September 2023 RECEIVED in revised form 24th December 2023 ACCEPTED in final form 30th December 2023

strict sterilization protocols the predominant commercial method of managing disease outbreaks at the moment is the mass culling of infected silkworm stocks to stop further spread (Acharya *et al.*, 2002). Nagarajan and Radha (1999) emphasized that maintaining disease levels below the economic threshold can enhance silk production by up to 25% without expanding the area under mulberry cultivation. Consequently, the application of bed disinfectants is gaining increasing importance in the successful production of cocoon crops (Surapwar *et al.*, 2019).

This research aims to evaluate the comparative efficacy of various silkworm bed disinfectants on the rearing performance of the $FC_1 \times FC_2$ double hybrid, thereby contributing to the optimization of disease management practices in sericulture.

Materials and Methods

The current study was conducted at the PG Department of Sericulture, Sri Krishna Devaraya University, Anantapur, Andhra Pradesh, with the objective of evaluating the impact of various bed disinfectants on the commercial traits and rearing efficiency of the $FC_1 \times FC_2$ bivoltine double hybrid silkworm. The larvae, in their second moult, were sourced from the Regional Sericultural Research Station in Anantapur. Subsequently, they were reared following the standardized rearing protocol established by Benchamin and Nagaraj (1987), continuing through to the spinning stage.

Treatment Details

✓ T_1: Shakthi bed disinfectant (@ 5 g ft^{-2}) is applied once a day, following bed cleaning and half an hour before feeding from the second moult till before spinning.

✓ T_2: Daily application of Labex bed disinfectant (5g ft^{-2}) following bed cleaning and half an hour prior to feeding from the second moult until before spinning.

✓ T_3: Applying Vijetha bed disinfectant at a rate of 5 g ft^{-2} every day, following bed cleaning and half an hour prior to feeding from the second moult until before spinning.

✓ T_4: Reshom Keet Oushadh (RKO @ 5 g ft^{-2}) bed disinfectant is used daily after bed cleaning and before feeding for about an hour from the second moult until before spinning.

✓ T_5: Untreated control

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),

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

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) 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

In the present study, four different bed disinfectants namely, Shakthi, Labex, Vijetha and Reshom Keet Oushadh (RKO) along with control were used. The disinfectants were used @ 5 g ft^{-2} in each treatment and were applied half an hour before feeding on the silkworms from 3rd instar to 5th instar.

Effect of Various Disinfectants on 5th Instars Larval Weight of $FC_1 \times FC_2$ Bivoltine Double Hybrid

The results showed that substantially higher larval weight of fifth instar of double hybrid ($FC_1 \times FC_2$) was observed in T_3 (4.37 g $larvae^{-1}$) bed disinfected with Vijetha followed by T_1 (3.89 g $larvae^{-1}$) bed disinfected with shakthi, T_2 (3.82 g $larvae^{-1}$) disinfected with labex and least was observed in T_5 (3.72 g $larvae^{-1}$) in untreated control (Figure 1; Table 1). However slight improvement was observed in larval weight using bed disinfectant of Vijetha, shakthi and labex.

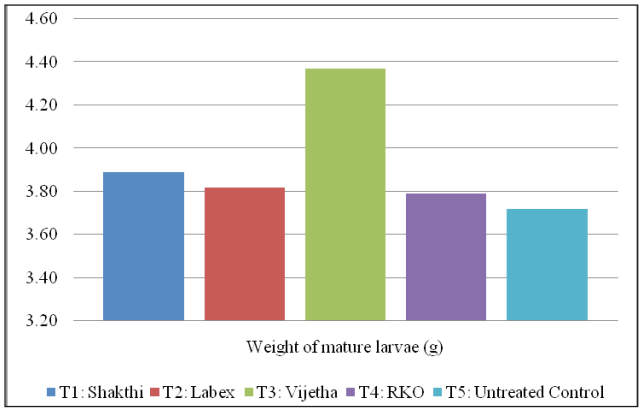


Figure 1: Weight of $FC_1 \times FC_2$ bivoltine double hybrid mature larva in grams

Manimegalai and Subramaniam (2000) documented a larval weight of 32.70 g per 10 larvae when treated with the Vijetha bed disinfectant. Similarly, Sivaprakasam (1999) observed a maximum larval weight of 35 g per 10 larvae under the same treatment conditions. Further supporting these findings, an anonymous study (Anonymous, 2002) reported that the use of Vijetha bed disinfectant resulted in a superior larval weight of 3.45 g per individual silkworm, demonstrating its efficacy compared to other disinfectants. Sujatha *et al.* (2007) noticed significantly increase in larval weight with larvae treated with turmeric powder. Similarly, in this experiment also slight improvement was noticed in Vijetha treated lots.

Total Larval Duration of $FC_1 \times FC_2$ Bivoltine Double Hybrid

Minimum larval duration was observed in T_3: Vijetha treated lots (23.00 days) followed by T_1: Shakthi treated lots (20.05 days) and maximum (22.10 days) in untreated control (Table 1). Surapwar *et al.* (2019) conducted a study to evaluate the effects of various bed disinfectants, *viz.*, Vijetha, Labex, and Ankush, on the larval duration of multivoltine silkworm hybrids. The disinfectants were applied at a dosage of 4 g ft^{-2}, half an hour before feeding resumed after each moulting and @ 5 g ft^{-2} under the same conditions. The results indicated that the shortest larval duration, 22.03 days, was achieved with Vijetha @ 5 g ft^{-2}, which was statistically comparable to the larval duration of 22.86 days observed with Labex @ 4 g ft^{-2}. In contrast, the untreated control group exhibited a significantly longer larval duration of 24.43 days. Similarly, Swathi *et al.* (2014) found that the application of hydrated lime powder @ 5 g ft^{-2}, combined with bundh powder after each moult, resulted in a larval duration of 25.23 and 25.22 days, respectively, in *Bombyx mori* L. Moreover, Jawale and Tayade (1987) observed a reduced larval duration in silkworms reared on leaves cleaned with cotton (24.41 days) and in those treated with turmeric powder. These findings underscore the importance of appropriate disinfectant application in minimizing larval duration, thereby potentially enhancing overall silkworm productivity. Likewise, in this experiment reduction of total larval duration was noticed when the bed disinfectants were applied.

Cocoon Weight

The effects of various bed disinfectants on the double hybrid mulberry silkworm race [$FC_1 \times FC_2$] are summarized in table 1 and illustrated in figure 2. The data indicate that the highest average cocoon weight of 1.98 g was achieved with the Vijetha disinfectant, while the average weights for the Shakthi and Labex treatments were 1.93 g and 1.92 g, respectively. These values were considerably higher compared to the control group's average cocoon weight of 1.83 g. Specifically, Manimegalai and Subramaniam (2000) reported a highest single cocoon weight of 1.63 g with the Vijetha treatment and Sivaprakasam (1999) observed a similar weight of 1.6 g for a single cocoon treated with Vijetha. In comparison to other disinfectants, Anonymous (2002) found that the Vijetha treatment yielded the largest single cocoon weight of 1.684 g. These findings are corroborated by the results of Kapoor *et al.* (2022), who also reported similar outcomes.

Table 1: Effect of different bed disinfectants on the rearing performance of $FC_1 \times FC_2$ 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: Reshom Keet Oushadh	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

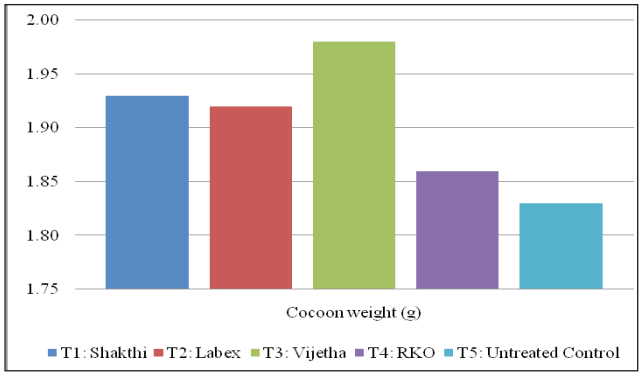


Figure 2: $FC_1 \times FC_2$ bivoltine double hybrid single cocoon weight in grams

Cocoon shell weight

The impact of bed disinfectants on cocoon shell weight mirrors their effect on overall cocoon weight. In the control group, the average cocoon shell weight was 0.38 g. Notably, significant improvements were observed in shell weight for cocoons treated with the Vijetha disinfectant (T_3), which yielded shell weights of 0.41 g. Similarly, cocoons treated with Labex and Shakthi disinfectants exhibited shell weights of 0.41 g and 0.40 g, respectively (as shown in Table 1 and Figure 3). For comparison, the control group had a shell weight of 0.38 g. Some previous studies provide additional context. Manimegalai and Subramaniam (2000) reported a maximum shell weight of 0.24 g, Sivaprakasam (1999) reported 0.20 g and Anonymous (2002) documented a maximum shell weight of 0.285 g for double hybrid mulberry silkworms treated with Vijetha disinfectant. In this experiment also the same trend of increase in shell weight in Vijetha treated lots were observed. Kapoor *et al.* (2022) also reported similar findings, reinforcing the observed trends.

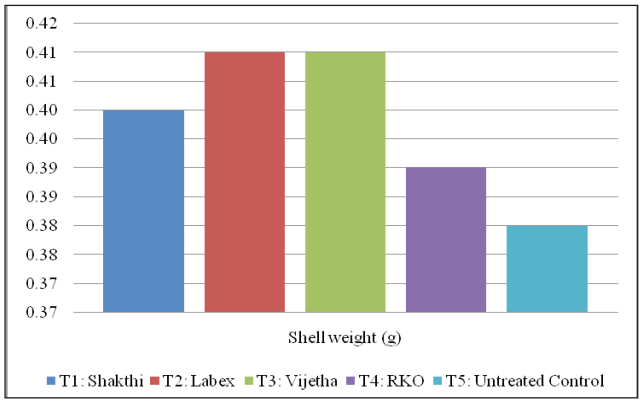


Figure 3: $FC_1 \times FC_2$ bivoltine double hybrid cocoon shell weight in grams

Cocoon Shell Ratio

The application of various bed disinfectants significantly influenced both cocoon and shell weights in the $FC_1 \times FC_2$ hybrid (as detailed in Table 1 and Figure 4). Among the treatments, the Labex disinfectant yielded the highest shell ratio at 21.25%, whereas the Shakthi disinfectant produced the lowest shell ratio of 20.65%, compared to 20.60% in the control group. The Vijetha disinfectant resulted in a shell ratio of 20.68% (as illustrated in Figure 7). These differences were statistically significant at the 0.01% level. Previous studies have also noted varying shell ratios with Vijetha treatment. Manimegalai and Subramaniam (2000) reported a shell ratio of 15%, while Sivaprakasam (1999) observed a ratio of 16%. Similarly, Kapoor *et al.* (2022) reported comparable findings, supporting the observed trends. These results confirms higher cocoon shell ratio with the usage of Vijetha disinfectant.

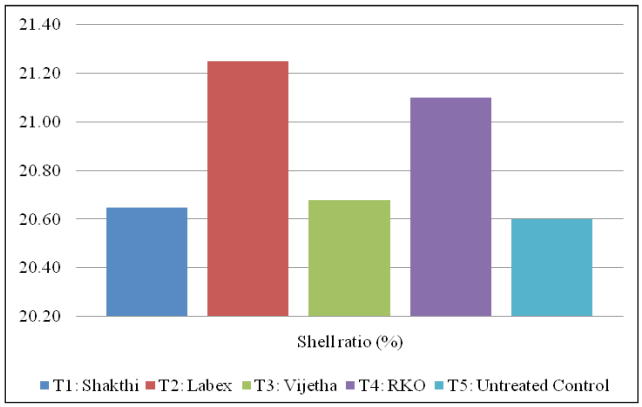


Figure 4: $FC_1 \times FC_2$ bivoltine double hybrid cocoon shell ratio %

Effect on Pupation Rate

The pupation rate was impacted by the effects of various bed disinfectants on the fifth instar larvae in $FC_1 \times FC_2$, as well as the cocoon weight, shell weight and shell ratio (Kapoor *et al.*, 2022). The results revealed that highly significant pupation rate was recorded in the batch dusted with Vijetha showed highest pupation rate (85.67%) followed by labex (72.67%) and among treatments least pupation rate (69.33%) was recorded in the population derived from disinfectant Resham Keet Oushadh, respectively and least was recorded in control (55.00%). Concomitantly, a pupation rate of 78.33% was recorded for cocoons treated with the Shakthi bed disinfectant (as presented in Table 1). Shashidhar *et al.* (2018) investigated the effects of sub-optimal dosages of bed disinfectants on the performance of double hybrid silkworm rearing ($FC_1 \times FC_2$) under Jammu's subtropical climate. Likewise, in this experiment similar results have been observed (Figure 5). Their study revealed that, compared to other dosages (0%, 20% and 50%), the application of Vijetha and Lime disinfectants at concentrations of 100% and 75% yielded superior outcomes across various parameters, including larval weight, effective rate of rearing (ERR), cocoon

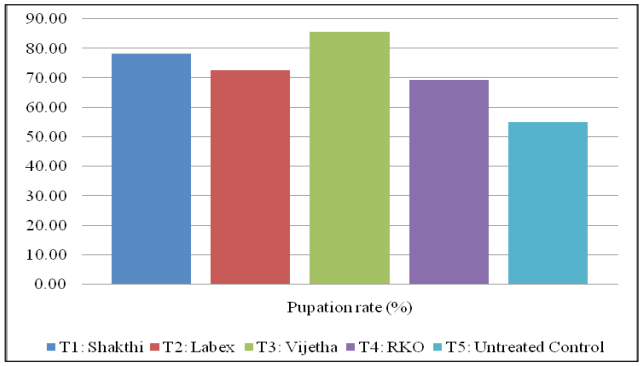


Figure 5: $FC_1 \times FC_2$ bivoltine double hybrid pupation %

weight, shell ratio, shell weight, pupation rate, filament length, denier, renditta and reelability. These findings are corroborated by Kapoor *et al.* (2022), who reported similar results, further validating the observed trends.

Effective Rate of Rearing

The Effective Rate of Rearing (ERR) represents the proportion of larvae that successfully spin cocoons. Notably, an improvement of 91.00% in ERR was observed in the population treated with the Vijetha bed disinfectant, compared to a 64.33% ERR in the control group (Kapoor *et al.*, 2022). In contrast, ERRs of 83.67% and 78.00% were recorded for cocoons treated with the Shakthi and Labex disinfectants, respectively (Table 1; Figure 6). The values were highly significant at 0.001%. Venkataramana *et al.* (2002) reported that the significant improved effective rate of rearing (ERR) with the use of Vijetha and Resham Jyothi bed disinfectants as comparison to the control. Swathi *et al.* (2014) also recorded lowest effective rate of rearing in control as compared to other bed disinfectant used silkworms rearing. The results were also supported by the works of Narasimhanna *et al.* (1975), Baig *et al.* (1993) and Sharma *et al.* (1994).

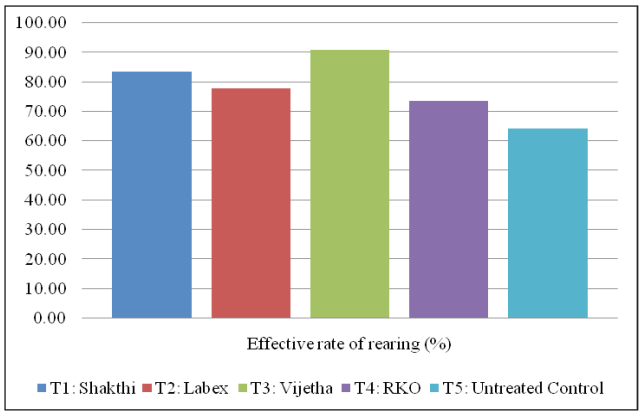


Figure 6: Effective rate of rearing % of $FC_1 \times FC_2$ bivoltine double hybrid

Disease Incidence

The impact of various bed disinfectants on disease incidence was evaluated in the experiment involving bivoltine double hybrid silkworms ($FC_1 \times FC_2$) (Figure 7). The treatment with Vijetha bed disinfectant (T_3) exhibited the lowest disease incidence at 3.00%, followed by the Shakthi disinfectant (T_1), which recorded a disease incidence of 4.67% (Singh *et al.*, 2023). The highest incidence of disease was observed in the untreated control group (T_5), with a rate of 15.67%. Samson (2000) identified several bed disinfectants with notable efficacy against silkworm diseases, including RKO, Vijetha, Resham Jyothi and Suraksha. Additionally, Anonymous (2002) reported that Vijetha was associated with the lowest disease incidence at 5.47% compared to other disinfectants. Manimegalai and Subramaniam (2000) and Surapwar *et al.* (2019) found that the application of turmeric powder combined with chalk powder, along with Vijetha, resulted in a 63.16% reduction in grasserie infection. Moreover, Singhvi *et al.* (2004) and Surapwar *et al.* (2019) emphasized the effectiveness of bed disinfectants such as

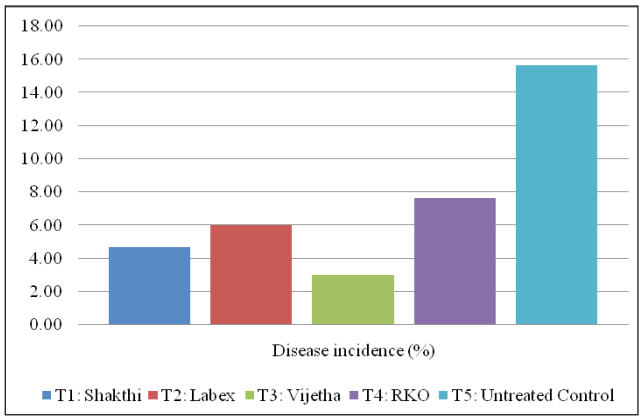


Figure 7: Disease incidence % during the rearing performance of $FC_1 \times FC_2$ bivoltine double hybrid

TKO, Resham Jyothi and Vijetha in protecting Tasar silkworms from pathogen invasion. Likewise, Vijetha could able to prevent the prevalence of diseases spread in treated lots.

Larval Mortality

The results revealed, that considerably lowest mortality (4.67%) was seen in the treatment T_3 *i.e.*, application of bed disinfectant Vijetha (Singh *et al.*, 2023), followed by treatment T_1 shakthi (10.33%). The significantly highest motility (18.33%) was observed in treatment T_5 *i.e.*, untreated control (Figure 8). Dhirwani *et al.* (2015) noticed while conducting experiment to evaluate the various plant-based disinfectants such as Neem, Amla, Haldi, Ber, Tulsi compared with RKO and other chemical disinfectant and found that larval mortality was nearly 1% and 4% with Amla and Tulsi. The results were also supported by the works of Ayandokun *et al.* (2017) and Balavenkatasubbaiah *et al.* (2014).

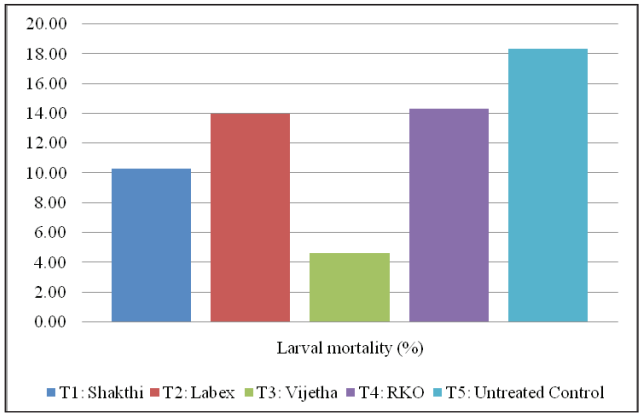


Figure 8: $FC_1 \times FC_2$ bivoltine double hybrid larval mortality (%) during the experiment

Conclusion

Sericulture faces significant challenges due to silkworm diseases, which can lead to substantial crop losses. This study evaluated the efficacy of four bed disinfectants, *viz.*, Shakthi, Labex, Vijetha and Reshom Keet Oushadh (RKO), on the rearing performance of $FC_1 \times FC_2$ bivoltine silkworm hybrids. The disinfectants were applied from the 2nd to 5th instar stages and various parameters were assessed, including larval weight, shell weight, cocoon weight, pupation rate,

effective rate of rearing (ERR), disease incidence and larval mortality. Vijetha emerged as the most effective disinfectant, demonstrating significant improvements in larval weight, shell weight and cocoon weight. It also led to the highest pupation rate and ERR while reducing disease incidence and larval mortality. These results underscore the critical role of bed disinfectants in optimizing silkworm rearing conditions. Specifically, Vijetha's superior performance highlights its potential as a valuable tool in managing diseases and enhancing silk production, suggesting that its use could substantially benefit sericulture practices.

Acknowledgements

Authors would like to acknowledge the Vice Chancellor, Sri Krishnadevaraya University for providing us the lab facilities.

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