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Assessing the Impact of Self-Mounting Spiral Mountage on Silkworm Cocooning Behavior (*Bombyx mori* L.)

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Abstract - This study evaluates the effectiveness of a self-mounting spiral bamboo mountage for silkworm cocooning compared to traditional bamboo and plastic collapsible mountages. Key metrics analysed include larval density, cocooning percentage, cocoon count, weight, and defect rates. The traditional bamboo mountage exhibited the highest larval density and cocoon count. However, the self-mounting bamboo spiral mountage showed a high cocooning percentage (98.48%) and substantial cocoon weight, outperforming the plastic collapsible mountage. The spiral bamboo mountage also provided labour and time savings by facilitating natural larval crawling and efficient moisture absorption, critical for high-quality cocoon production. These findings highlight the bamboo spiral mountage as a viable and efficient alternative, optimising labour use and maintaining cocoon quality in sericulture.

Key Words: Self-mounting, spiral mountage, spinning, cocooning, labour efficiency

1. INTRODUCTION

Sericulture is the science and art of rearing silkworms for commercial production of raw silk and includes the operations which are required for the production of silk fiber. Silkworm rearing is an extensive month-long process starting from egg stage and terminating in adult laying eggs and attaining their natural death. During this course they pass through five larval instars intervened by four moults, cocoon spinning and pupal stage with whole lifespan of 40-55 days' duration (Arti Sharma *et al*., 2018). Towards the end of fifth instar during larval stage, the silkworms shrivel, release delicate yellowish green faeces and gradually quit feeding of leaves and such worms are called ripened larvae. Such mature silkworms construct their niche called 'cocoon' by encircling itself with long, break less silken fiber or filament made of proteins.

During cocoon construction stage, the ripened silkworms are collected manually and spread on special structures for spinning of the cocoons. Such process is termed as 'mounting'. The well-structured device that facilitates the mature larvae to spin cocoons is called mountage. Farmers often face economic losses due to low quality cocoons and silk yarn because of poor quality mountages, unscientific mounting methods and poor spinning conditions. Even a healthy silkworm crop produces poor quality cocoons realizing low returns due to poor mounting practices (Chandrakanth *et al.,* 2004). Silkworm mounting is one of the time bound labour intensive activity engaging maximum of total man days engaged during silkworm rearing and is considered as bottleneck for expanding the scale of silkworm rearing. The time of mounting of mature larvae has a vital influence on the quality of cocoons (Bandey and Amardev Singh, 2011).

The success of sericulture enterprise mostly depends on the timely availability of labour at the right time for different operations during silkworm rearing *viz*., disinfection of rearing house, harvesting mulberry leaves, bed cleaning, collecting the mature larvae *etc*. among which the picking and transferring the ripened worms on mountage demands more labour (> 40 %) than any other operation. To save time and labour different mounting methods are adopted by the farmers in India *viz*., Jobari (shoot shaking), self or natural mounting and manual mounting. It is estimated that the Jobari and self-mounting methods can save around 40 and 90 per cent of the labour

requirement, respectively. The self-mounting or natural mounting is an effective, time and labour saving and most rational method of utilizing the negative geotaxis of silkworms at the wandering stage (mature) (Kamimura *et al.*, 1996).

With this background, an experiment was conducted to evaluate the self-mounting spiral mountage for silkworm, *Bombyx mori* L. cocooning.

2. MATERIAL AND METHODS

2.1 Location and Experiment Details

The experiment was carried out at farmers' field (silkworm rearing houses) in Kolar and Chikkaballapur districts of Karnataka State, India. Total of thirty farmers were selected based on their rearing schedule and practices followed. The selected farmers procured young age silkworms (chawki worms) of the cross-breed PM×CSR2 of *B. mori L.* from the registered Chawki Rearing Center. The procured chawki worms were reared as per the standard procedure recommended by Dandin and Giridhar (2014). The rearing at each farmers' field was cautiously monitored. PM×CSR2 hybrid was selected because of its prominent presence in the region.

2.2 Self-mounting Spiral Mountage

The newly designed self-mounting spiral mountages measuring 2.5'×3' were fabricated with the help of local craftsmen using bamboo strips (Fig -1). The regular bamboo mountage and plastic collapsible mountages were also used to make the comparative study.

2.3 Treatment Details

Every selected farmer was provided with two mountages for each treatment.

2.4 Observations Recorded

a. Number of worms on mountage: The self-mounting spiral mountage and plastic collapsible mountages were placed on the silkworm rearing bed when 50 per cent of silkworms attained maturity and were allowed to crawl on the mountage. Parallelly, the ripened silkworms were collected manually and spread on the regular bamboo, here the larval density was maintained @ 50-55 worms per square foot. In case of self mountages, the number of larvae self-mounted after 150 minutes of mounting time was counted and recorded.

b. Density of worms (No./ sq.ft.): The density of self-mounted silkworms on mountage was computed by counting the number of larvae crawled on the mountage per square foot area.

c. Cocooning percentage (%): The per cent cocooning is the ratio of number of worms that constructed the cocoon to the total number of worms mounted on the cocooning structure.

d. Total number of cocoons (No./ mountage): The silkworms were allowed to construct cocoons on respective mountages and the cocoon harvesting was carried out manually on the fifth day of spinning. The total cocoons harvested from each mountage at each farmers' field were recorded separately for different treatments.

e. Weight of cocoons per mountage (g/ mountage): The cocoons harvested from each mountage were weighed using the Digital Weighing Scale separately for each treatment immediately after the harvesting on the fifth day of spinning.

f. Per cent defective cocoons (%): The percentage of defective cocoons is the ratio of the number of defective cocoons to the total number of cocoons harvested from the mountage.

g. Number of cocoons per litre (No./ litre): The good cocoons harvested from each mountage were filled in one litre glass jar and the total number of cocoons in the jar was counted for the number of cocoons per litre.

2.5 Data Analysis

The experiment was carried out under Completely Randomized Design (CRD) as per the methods outlined by Sundar Raj *et al.* (1972).

T1	Self-mounting Spiral Mountage
T2	Plastic Collapsible Mountage
T3	Regular Bamboo Mountage

Fig -1: Cocooning on self-mounting spiral mountage

3. RESULTS AND DISCUSSION

Among the three treatments, the maximum number of CB larvae were observed on the regular bamboo mountage (215.60 worms/ mountage) where the mature worms were manually mounted. Amongst self-mounting structures, the number of larvae self-mounted on the bamboo spiral mountage was significantly higher (195.16 worms/ mountage) than plastic mountage (189.23 worms/ mountage) (Table -1). The mature larvae were collected and mounted manually which might have resulted in the highest number of larvae on regular bamboo mountage than self-mounting structures.

Similar results were reported by Vinoda *et al.* (2021) where they reported that higher number of larvae from self-mounting spiral mountage when compared to plastic collapsible mountage among self-mounting structures. The intricately woven bamboo spiral mountage might have provided better anchorage for the silkworm to crawl when compared to the plastic collapsible mountage allowing a greater number of larvae on the self-spiral mountage. The Thalaghattapura ribbon chandrike, a self-mounting type showed higher mounting capacity of larvae followed by regular bamboo mountage as reported by Shivakumar *et al.* (2016).

The density of worms on the different types of mountage varied significantly, the highest being observed on regular bamboo mountage (41.23 worms/ sq.ft.) while bamboo spiral mountage had 32.67 worms/ sq.ft. and the least was counted on plastic collapsible mountage (27.81 worms/sq.ft.) (Table -1).

The ripened silkworms were collected and mounted on the regular bamboo mountage following the recommended package of practices (Dandin *et al*., 2003) that mentioned the optimum density of ripe larvae to be maintained for better spinning at 40-50 worms/ sq.ft. and that might be a reason for the highest density of larvae (Benchamin, 1995). However, the new spiral mountage performed better among the self mountage due to better anchorage and enough spinning area just like the regular bamboo mountage compared to the plastic collapsible mountage Sahana *et al*. (2020a). The higher density of the larvae on the mountage does change the microclimate, which in turn affects pupation and fecundity, hence it is very important to maintain the optimum density of silkworm larvae on the mountage (Vemananda Reddy *et al*., 2004). The studies conducted by Vinoda *et al.* (2021) reported a higher density of larvae on self-mounting spiral mountage when compared to plastic collapsible mountage among self-mounting structures.

A significant difference was noticed concerning the cocooning percentage in silkworms mounted on different types of mountage. The highest cocooning percentage of 98.48 was recorded on self-mounting spiral mountage on par with regular bamboo mountage (96.76%) and it was least on plastic collapsible mountage (95.59%) (Table -1). Comparatively better cocooning percentage of CB silkworms on self-mounting structures is indicative of the suitability of the new spiral mountage for rearing of cross breed silkworms. The present-day CB hybrids are developed by crossing PM with improved bivoltine breeds like CSR, which might have contributed towards the crawling habit of silkworms similar to that of bivoltine. The results obtained in the present study follow similar trends with Sahana *et al*. (2020a), who revealed that the cocooning percentage was high on self-mounting spiral mountage when compared with that of plastic collapsible mountage for both the silkworm hybrids. Sakthivel (2019) and Chandrakanth *et al.* (2004) observed higher number of cocooning in regular bamboo mountage than in plastic collapsible mountage similar to the present investigation. The cocooning percentage was higher in plywood-made mountage compared to plastic collapsible mountage which could be due to the mounting material (Ahmad Ibrahim *et al.*, 2015).

The regular bamboo mountage recorded the highest number of cocoons (206.28 cocoons/ mountage). Among self-mounting structures, the highest number of cocoons were harvested from self-mounting spiral mountage (190.34 cocoons/ mountage) and the least from plastic collapsible mountage (183.54 cocoons/ mountage) (Table -1). The adequate space provided by the self-mounting spiral mountage, longer duration of mounting and better aeration/ventilation available for the silkworm encourages comfortable spinning on the new spiral mountage resulting in increased number of cocoons which is also supported by the findings of Sahana *et al.* (2020b).

The cocoons harvested from each treatment were weighed and the total weight of cocoons spun on different types of mountages varied significantly. A significantly highest cocoon weight was recorded on regular bamboo mountage for both the hybrids (369.39g/ mountage) followed by bamboo spiral mountage (349.86g/ mountage). The corrugated plastic mountage yielded in 309.70g cocoons per mountage (Table -1). The quality of cocoons is often influenced by the type and structure of mountage (Shinde *et al*., 2012; Chandrakanth *et al*., 2004). The raw material used in designing the spiral mountage and the regular mountage is bamboo strips, which absorb

the moisture and provide ambient conditions for the silkworms spin better cocoons.

The highest percentage of defective cocoons was observed on plastic collapsible mountage, which was 6.52 per cent. The higher percentage of defective cocoons in the plastic mountage may be due to misshape, poor maintenance and the non-absorbent nature of the mountage (Sakthivel, 2019 and Sahana *et al.*, 2020b).

The number of cocoons per litre is an indirect indicator of the quality of cocoons. The number of cocoons filled in a 1000ml cylindrical vessel was counted and recorded separately for each treatment. The number of cocoons per litre varied significantly on the different mounting structures. The least number of cocoons per volume litre were counted on self-mounting spiral mountage (75.06 cocoons/ litre), which is on par with that on regular bamboo mountage (76.00 cocoons/ litre) and the highest number of cocoons per litre were counted on plastic collapsible mountage (78.16 cocoons/ litre) (Table -1). The least number of cocoons per litre in the present study indicates that the self-mounting spiral mountage is more suitable for use in sericulture. The observations of the present investigation are on par with Vinoda *et al*. (2021) who recorded the least number of cocoons per litre in both CB and Krishnaraja hybrids.

The relation of the cocoon yield attributes among the different treatments was also studied (Table -2). In self mountage (T_1) total worms on the mountage have a positively significant association with density (r = 0.6232), per cent of cocooning (r = 0.6778), the total number (r = 0.6493) and weight of cocoons (r = 0.7147), as total worms increase with the increase in the total number of cocoons there is a significant increase in the number (r = 0.6492) and weight of good cocoons (0.6405) with the decrease in the number (r = -0.1515) and weight (-0.1590) of the defective cocoons. The total number of cocoons has a positive association with the total number of good cocoons and the weight of good cocoons and a negative association with defective cocoons. In case of plastic mountage (T_2) we can find a similar association with total worms and density of worms (r = 0.7451) on the mountage along with cocooning percentage (r = 0.5129). Even though there is a positive association among the total worms with per cent cocooning, the total number (r = 0.5300) and weight of cocoons (0.4965), also total number and weight of cocoons with number (r = 0.2534) and weight of good cocoons (r = 0.1531) they are less significant in the plastic mountage and it also has a positive association with number (r = 0.0525) and weight (r = 0.2195) of defective cocoons indicating that there is increase in the number of defective cocoons along with total number of cocoons. The number of cocoons per mountage shows a negative association with the number (r = -0.2648) and weight (r = -0.4604) of good cocoons and a positive association with number (0.4261) and weight (r = 0.4496) of defective cocoons and weight of total cocoons in the plastic mountage also follows similar trend and has negative association with number and weight of good cocoons. The total worms in regular bamboo mountage (T_3) have a positive association with the density of cocoons (r = 0.6012) and per cent of cocooning (r = 0.5980). The total number of cocoons has a positive association with density (r = 0.5131) and per cent of cocooning (r = 0.5831) and the total weight of cocoons also follows the similar trend. Whereas, total weight (r = 0.7593) and number (r = 0.7887) and weight (r = 0.9650) of good cocoons have positively significant correlation with total number of cocoons, number (r = -0.2206) and weight (r = -0.2511) of defective cocoons has negative association with total number of cocoons indicating the decrease in the number of defective cocoons with increase in the number of cocoons in the mountage.

4. CONCLUSION

The experimental results show that the regular bamboo mountage outwits the self-mounting mountages. But the self-mounting bamboo spiral mountage has its own advantages which could positively impact the B:C ratio by not only reducing labour involvement but also reducing the operational time of mounting worms to the mountage. The corrugated plastic collapsible mountage though provides good ventilation for the silkworms while spinning, it cannot absorb excess moisture developed on the mountage. Whereas, the bamboo spiral mountage avoids the issue very effectively by absorbing the moisture and helps in spinning good quality cocoons on par with regular bamboo mountage.

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Table -1: Cocooning parameters in different types of mountages

Particulars	No. of silkworms per mountage	Larval density (No./ sq.ft.)	Cocooning percentage	No. of cocoons per mountage	Weight of cocoons per mountage (g)	No. of defective cocoons	Defective cocoon percentage	No. of cocoons per litre
T_1	195.16	32.67	98.48	190.34	349.86	11.26	5.65	75.06
T_2	189.23	27.81	95.59	183.54	309.7	12.25	6.52	78.16
T_3	215.6	41.23	96.76	206.28	369.39	11.85	5.74	76
SEm±	1.97	0.33	0.48	4.634	5.88	0.314	0.21	0.36
F-test	**	**	**	**	**	NS	NS	**
CD	5.54	0.94	1.37	13.04	16.56	-	-	1.02

** - Significant @ 1%; NS - Non-significant
The values in the table are average of two rearings taken up by selected thirty farmers

Table -2: Relationship among the cocoon yield attributes of Cross Breed in different mountages

T_1 - Self mountage									
Particulars	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Total worms (No./mountage) (X_1)	1.000								
Density (Sq. ft./mountage) (X_2)	0.623*	1.000							
Percent of cocooning (X_3)	0.677*	0.616*	1.000						
Total number of cocoons (X_4)	0.649*	0.512	0.515*	1.000					
Total cocoons wt. (X_5)	0.714**	0.689*	0.691*	0.612**	1.000				
No. of good cocoons (X_6)	0.694*	0.702**	0.722**	0.676*	0.690**	1.000			
Weight of good cocoons (X_7)	0.640*	0.735**	0.633*	0.545*	0.523*	0.492**	1.000		
No. of defective cocoons (X_8)	0.151	0.175	0.226	-0.150	-0.243	-0.278	-0.129	1.000	
Wright of defective cocoons (X_9)	0.159	0.340	0.094	-0.002	-0.036	-0.262	-0.043	0.293**	1.000
T_2 – Plastic collapsible mountage									
Particulars	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Total worms (No./mountage) (X_1)	1.000								
Density (Sq. ft./mountage) (X_2)	0.745**	1.000							
Percent of cocooning (X_3)	0.512*	0.623*	1.000						
Total number of cocoons (X_4)	0.530*	0.649**	0.579*	1.000					
Total cocoons wt. (X_5)	0.496*	0.477*	0.439*	0.504*	1.000				
No. of good cocoons (X_6)	0.253	0.031	0.309	-0.264	0.572*	1.000			
Weight of good cocoons (X_7)	0.153	0.136	0.241	-0.460	0.790**	0.656*	1.000		
No. of defective cocoons (X_8)	0.052	0.279	0.566	0.426	-0.065	0.016	0.200	1.000	
Wright of defective cocoons (X_9)	0.219	0.119	0.597*	0.449	0.297	0.109	0.064*	0.659**	1.000
T_3 – Regular bamboo mountage									
Particulars	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Total worms (No./mountage) (X_1)	1.000								
Density (Sq. ft./mountage) (X_2)	0.601**	1.000							
Percent of cocooning (X_3)	0.598**	0.593**	1.000						
Total number of cocoons (X_4)	0.504	0.513	0.583**	1.000					
Total cocoons wt. (X_5)	0.598*	0.522	0.510	0.759**	1.000				
No. of good cocoons (X_6)	0.597*	0.506	0.427	0.625*	0.788**	1.000			
Weight of good cocoons (X_7)	0.517	0.722**	0.328	0.504	0.965**	0.815**	1.000		
No. of defective cocoons (X_8)	0.125	0.098	0.228	-0.220	-0.166	-0.114	-0.310	1.000	
Wright of defective cocoons (X_9)	0.170	0.111	0.257	-0.251	-0.060	-0.093	-0.090	0.929**	1.000

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