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Evaluation of different fabricated mountages for various cocoon parameters of silkworm, *Bombyx mori* L.

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Abstract

The study was conducted to evaluate the performance of three fabricated self mountages *viz.,* spiral, square and zig-zag mountages on various cocoon parameters in comparision with ribbon, plastic collapsible and bamboo mountages by using two different silkworm hybrids *viz.,* the cross breed (CB) (PM x CSR_2) and the double hybrid (DH) (Krishnaraja). The results revealed that, the cocoon parameters *viz.,* single cocoon weight, cocoon shell weight, floss weight and cocoon shell ratio did not vary significantly except the pupal weight with respect to cross breed. Whereas, all the cocoon parameters showed non significant results in case of double hybrid. However, the relatively maximum cocoon weight was observed in spiral mountage (1.90 g) for CB and bamboo mountage (2.13 g) for DH; cocoon shell weight was higher in bamboo mountage (0.336 g) for CB and spiral mountage (0.498 g) for DH; the floss weight was found less in spiral mountage (0.350 mg) for CB and bamboo mountage (0.250 mg) for DH; cocoon shell ratio was recorded relatively higher in ribbon chandrike (19.46%) for CB and zig-zag mountage (26.10%) for DH; significantly higher pupal weight was observed in bamboo mountage (1.50 g) which was found on par with spiral mountage (1.49 g) for CB and it was found relatively higher in plastic and square mountage (1.50 g) for DH. Among the fabricated self mountages subjected for evaluation spiral mountage and zig-zag mountages were exhibited better performance as that of bamboo mountage.

Keywords: Self mounting structures, mountage, cross breed (CB) and double hybrid (DH)

1. Introduction

The silkworms are holometabolous sericigenous insects that complete the larval stage in about 23-27 days, where they undergo four moults. The larvae attain maturity within 7-8 days after fourth moult. At this stage silkworms stop feeding, their body becomes translucent, the silk glands are filled with silk proteins and the worms are ready for spinning, which is the most productive phase in silkworm rearing. Silkworm spins silken armour around its body for protection during its metamorphosis, which forms the most economical part for human being. Spinning is important for satisfying silkworm's physiological requirement by excreting amino acids from the body (Henry, 1984) [3].

The spinning of cocoons, which is also the nest for silkworms to metamorphosise into pupa, is a crucial part of silkworm rearing, that starts with identification and collection of mature larvae and transferring them on to the cocooning structures, the process of which is defined as 'mounting'. The time and method of mounting as well as the cocooning frame, otherwise called as 'mountage', are the most important factors influencing the quality of cocoons and thereby reflects on the raw silk yield and quality.

Mountage is a device for providing the platform for mature silkworms to spin cocoon. Several types of mountages are available at the field, some of which are more popular. Farmers use different locally available materials for fabricating such mountages. The studies reveal that the type of material used, design and fabrication of the mountage will decide the quality of the cocoon. In addition to support for spinning worms, the mountages should satisfy the requirements like, providing convenient and uniform space with suitable dimension for spinning good sized cocoons, discouraging formation of double cocoons and malformed cocoons, providing ventilation for drying up of the last excreta of the worm prior to spinning, enabling easy mounting and harvesting (Shinde *et al.*, 2012) [6]. Narrow space affects ventilation for spinning larvae and results in poor reelability of cocoons. Similarly more space results in wastage of silk in the form of floss to lay foundation by the silkworm for construction of cocoon (Mathur and Qadri, 2010) [4].

An improper use of mounting structure and lack of care during handling and management of mature silkworms results in formation of defective cocoons accounting to a loss of about 5 to 8 per cent of cocoon yield (Chandrakanth *et al.*, 2004) [1]. Thus, the quantity and quality of good cocoons depend largely upon the right selection and proper use of mountages during spinning of cocoons by the matured larvae.

A significant portion of investment during commercial rearing of silkworm, *B. mori* involves in the wages towards labour. Maximum number of labour is employed during spinning, to pick and mount the ripe worms on to mountages (approximately 15 mandays/100 DFLs out of a total of 35 mandays). Though several kinds of mountages are available, each one is coupled with its own disadvantages. More popularly used bamboo mountages are costly and cannot be used as self mounting structures. At present, the available self mounting plastic mountages are best suitable for bivoltine breeds of silkworms that too predominantly in seed cocoon formation. Further, it is difficult to maintain uniformity in shape, size and compactness of the cocoon in the self mounting plastic mountages. The reelers using improved reeling machines offer lesser price for the cocoons harvested from plastic mountages as they experienced that the cocoon shell has more moisture content which reduces the reelability and ultimately the raw silk quality. Realizing the importance of different cocooning structures and investment on labour, the study was undertaken to evaluate the cocoon parameters among the newly fabricated self mountages.

2. Materials and Methods

The effect of different mountages on cocoon parameters of silkworm, *Bombyx mori* L. were studied during 2017–2018. Well established V-1 (Victory-1) mulberry plants with 90 x 90 cm spacing were used for the silkworm rearing. 50 Disease Free Layings (DFLs) of each of young age silkworms of cross breed (PM X CSR_2) and bivoltine double hybrid, Krishnaraja {FC1 (CSR_6 x CSR_{26}) X FC2 (CSR_2 x CSR_{27})} were procured from Registered Chawki Rearing Centres for each rearing separately and they were reared by following the procedure recommended by Dandin *et al.* (2003) [2].

Treatment details: Six different mountages *viz.*, Spiral mountage (T_1), Square mountage (T_2) and Zig – Zag mountage (T_3) were newly designed and fabricated for the present study. Thalaghattapura Ribbon Chandrike (T_4), Plastic collapsible mountage (T_5) (Control 1) and Bamboo chandrike (T_6) (Control 2) were involved for analysis. Three replications were maintained for all the treatments.

The self mounting structures (T_1 – T_5) were placed over the silkworm rearing bed for a period of one and a half hours when the silkworms were at ripening stage. After one and a half hours, mountages were removed from the rearing bed whereas in T_6 manual mounting method *i.e.*, picking of ripened worms and mounting on to the mountages was practiced. The cocoons were harvested from each mountage on fifth and seventh day of spinning in cross breed and double hybrid, respectively which ensures complete cocoon formation. Then the cocoon parameters *viz.*, single cocoon weight (g), cocoon shell weight (g), pupal weight (g), floss weight (mg) and cocoon shell ratio (%) were recorded on the same day and statistically analysed by using Completely Randomized Design (Sundar Raj *et al.*, 1972) [9]. The mean data of two rearings was considered for the statistical analysis.

3. Results and Discussion

Single cocoon weight (g): The weight of single cocoon showed non significant difference among different mountages. However, for cross breed the cocoons harvested from spiral mountage (T_1) recorded maximum single cocoon weight than other mounting structures (1.80, 1.79, 1.71, 1.66 g for T_6, T_2, T_3 and T_4, respectively) and minimum cocoon weight was recorded from plastic mountage (1.62 g) (Table 1; Fig. 1). The same was also true when double hybrid was mounted on different types of mountages where higher cocoon weight was recorded in T_6 (Control 2) (2.13 g) and the least on T_3 (1.909 g) (Table 2; Fig. 1).

Several studies conducted to compare the single cocoon weight of different silkworm hybrids have evidenced the higher cocoon weight among bivoltine hybrids than cross breeds (Sharanyakumar Gowda, 2014) [5], which is more a breed character than the mountage. The present investigations also reflect a higher single cocoon weight in Krishnaraja, BV double hybrid than the cross breed, PM x CSR_2. Further, the non significant difference among the six treatments for single cocoon weight (T_1-T_4) clearly indicated that the new self mountages did not alter the cocoon weight in both cross breed and double hybrid and they can be readily utilized to mount any breed without compromising for cocoon weight.

Table 1: Effect of different mountages on various cocoon parameters of the cross breed, PM x CSR_2

Particulars	Single cocoon weight (g)	Cocoon shell weight (g)	Pupal Weight (g)	Floss Weight (mg)	Cocoon Shell Ratio (%)
T_1	1.90	0.326	1.49	0.350	17.79
T_2	1.79	0.315	1.40	0.361	17.34
T_3	1.71	0.327	1.28	0.358	19.04
T_4	1.66	0.330	1.27	0.392	19.46
T_5	1.62	0.261	1.35	0.355	16.67
T_6	1.80	0.336	1.50	0.355	18.38
F-test	NS	NS	*	NS	NS
SE. m ±	0.078	0.021	0.049	0.019	1.028
CD	0.336	0.090	0.151	0.083	4.439

NS- Non Significant; * significant at 5%

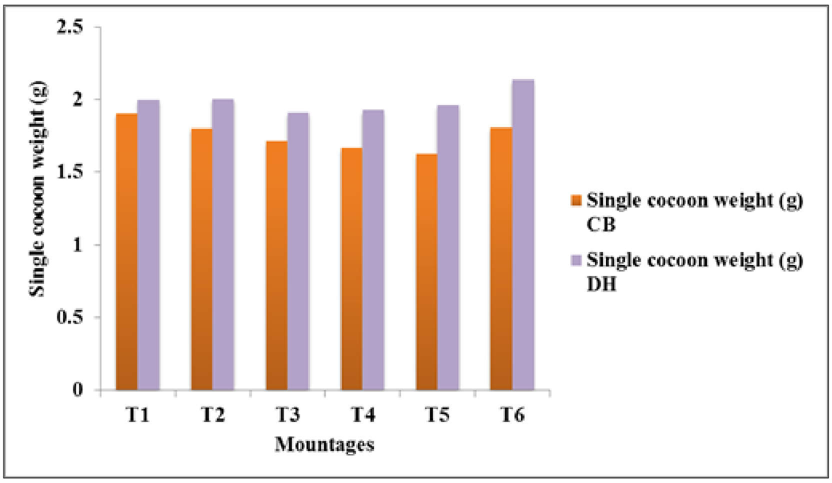

Fig 1: Single cocoon weight for PM x CSR_2 (CB) and Krishnaraja (DH) as influenced by different mountages

Cocoon shell weight (g): The cocoon shell weight did not vary significantly among different treatments when used to mount both CB and the DH. However, T_6 (Control 2) (0.336 g) showed relatively maximum cocoon shell weight than T_4 (0.330 g), T_3 (0.327 g), T_1 (0.326 g), T_2 (0.315 g) and T_5 (Control 1) (0.261 g) for CB (Table 1; Fig. 2). The T_1 recorded higher shell weight of 0.498 g followed by T_3 (0.496 g), T_4 (0.487 g), T_2 (0.483 g), T_6 (0.468 g) and T_5 (0.454 g) for DH (Table 2; Fig.2).

Cocoon shell weight is one of the important quality parameters that is largely influenced by type, material and structure of mountages used at spinning stage of silkworms (Singh *et al.*, 1994) [8]. The plastic collapsible mountages if not maintained properly, would increase the spinning space leading to wastage of silk while cocoon is constructed by the larvae leading to reduced cocoon shell weight. The same is also true in the present investigation, where the plastic mounting frames have recorded lower shell weight for both CB and the DH.

Pupal weight (g): The significant difference in pupal weight was recorded only for the cocoons spun by CB silkworms, which was significantly higher in T_6 (Control 2) (1.50 g) on par with T_1 (1.49 g) and T_2 (1.40 g) while it was least in T_4 (1.27 g), T_3 (1.28 g) and T_5 (Control 1) (1.35 g) in CB (Table 1; Fig. 3). Though there was a difference in pupal weight among different mountages for the double hybrid, it was found non significant. The T_6 (Control 2) (1.644 g) recorded relatively higher pupal weight than T_5 (Control 1) (1.50 g), T_2 (1.50 g), T_1 (1.47 g), T_4 (1.42 g) and T_3 (1.39 g) (Table 2; Fig. 3).

Table 2: Effect of different mountages on various cocoon parameters of the Double Hybrid, Krishnaraja

Particulars	Single cocoon weight (g)	Cocoon shell weight (g)	Pupal Weight (g)	Floss Weight (mg)	Cocoon shell Ratio (%)
T_1	1.99	0.498	1.47	0.260	25.14
T_2	2.00	0.483	1.50	0.252	24.37
T_3	1.90	0.496	1.39	0.257	26.10
T_4	1.92	0.487	1.42	0.267	25.45
T_5	1.96	0.454	1.50	0.278	22.50
T_6	2.13	0.468	1.64	0.250	22.89
F-test	NS	NS	NS	NS	NS
SE. m ±	0.055	0.015	0.055	0.014	0.831
CD	0.236	0.067	0.238	0.062	3.590

NS- Non Significant

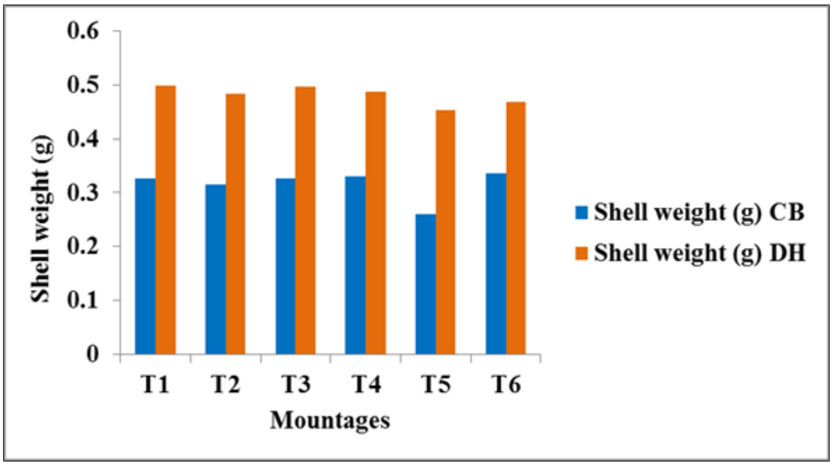

Fig 2: Cocoon shell weight (g) for PM x CSR_2 (CB) and Krishnaraja (DH) as influenced by different mountages

The proteins accumulated in the larval body are diverted for accumulation of silk proteins in the silk gland as well as gonad development (Tazima, 1972) [10]. It is well understood from several experiments that the bivoltine silkworms consume more food than multivoltines and the multivoltine x bivoltine hybrids that might contribute to the higher cocoon, shell and pupal weight, which is clearly reflected in the present investigation. There was a low pupal weight in CB on zig-zag and plastic mountage than other cocooning frames as well as in DH. Shinde *et al.* (2012) [8], from their experiments also revealed such variation in the pupal weight in cross breeds when the cocooning frames were changed during spinning stage of the larvae.

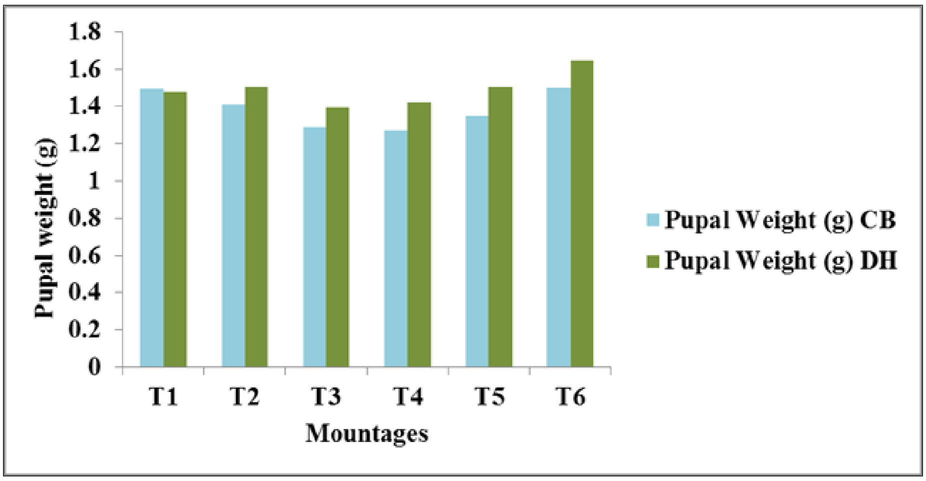

Fig 3: Pupal weight for PM x CSR_2 (CB) and Krishnaraja (DH) as influenced by different mountages

Cocoon floss weight (mg): The floss is the outermost layer that adds to the total cocoon weight. The floss weight did not show significant difference in both CB and DH. A higher floss weight was recorded in T_4 (0.392 mg) followed by T_2 (0.361 mg), T_3 (0.358 mg), T_5 (Control 1) and T_6 (Control 2) (0.355 mg) and the lower weight was in T_1 (0.350 mg) for cross breed (Table 1; Fig.4) and in case of double hybrid T_5 (Control 1) (0.278 mg) recorded higher floss weight followed by T_4 (0.267 mg), T_1 (0.260 mg), T_3 (0.257 mg), T_2 (0.252 mg) and it was low in T_6 (Control 2) (0.278 mg) (Table 2; Fig.4).

The CB had significantly high floss content, which is a racial character. Normally the bivoltine and univoltine races have less floss than the multivoltine breeds.The quantity of floss varies according to silkworm races and design of the cocooning frame (Yokoyama, 1962) [12]. However, relatively higher floss content on ribbon mountage and the plastic collapsible mountage compared to other types could be due to the plastic material used to design the mountages that is non-absorbent.

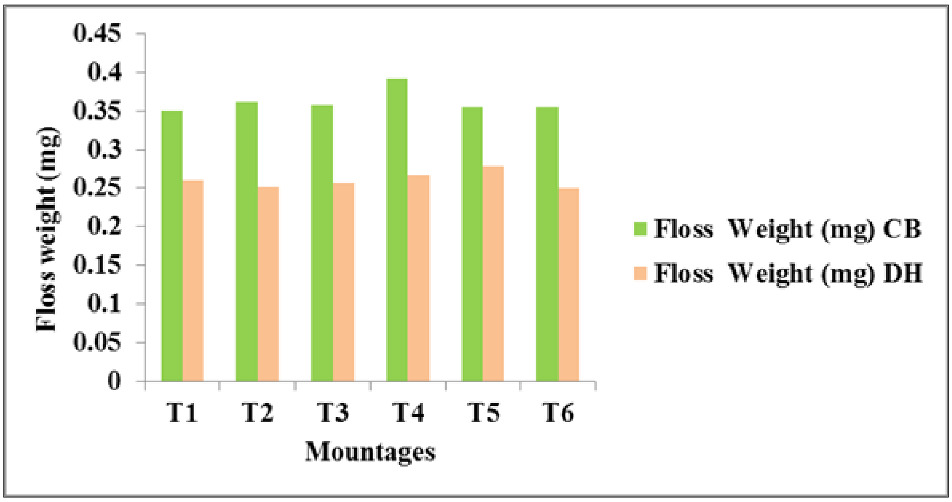

Fig 4: Floss weight for PM x CSR_2 (CB) and Krishnaraja (DH) as influenced by different mountages

Cocoon Shell Ratio (%): The cocoon shell ratio was not significant for both CB and DH among the different mountages used in the experiment. The per cent cocoon shell ratio was relatively higher on T_4 (19.46%) followed by T_3 (19.04%), T_6 (Control 2) (18.38%), T_1 (17.79%), T_2 (17.34%) and T_5 (Control 1) (16.67%) for CB (Table 1; Fig.5) and T_3 (26.10%) followed by T_4 (25.45%), T_1 (25.14%), T_2 (24.37%), T_6 (Control 2) (22.89%) and T_5 (Control 1) (22.50%) in case of DH (Table 2; Fig.5).

A comparable cocoon shell ratio found among new mountages and the controls for both the breeds depicted that these mountages may be utilized in ripened worm management without any compromise for cocoon quality. In line with the present observations, Shivakumar *et al.* (2016) [7], also recorded relatively higher cocoon shell ratio of 18.34 per cent for ribbon chandrike than bamboo mountage (18.22%).

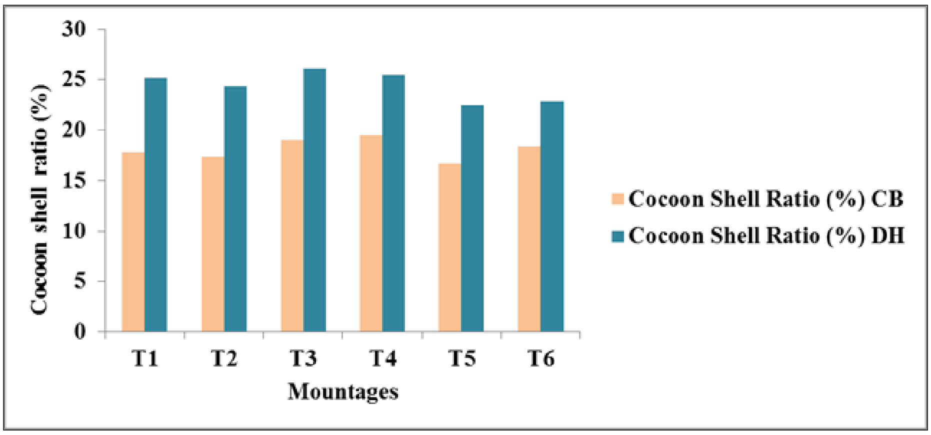

Fig 5: Cocoon shell ratio for PM x CSR_2 (CB) and Krishnaraja (DH) as influenced by different mountages

4. Conclusion
The present study communicating that, among the different mountages evaluated, the self mounting structures like spiral mountage and zig-zag mountages were exhibiting more or less similar results with that of the bamboo mountage for single cocoon weight, cocoon shell weight, cocoon shell ratio, cocoon floss weight and pupal weight. Therefore, these mountages can be recommended for field trials, as they reduce the drudgery of labour who are required requirement for picking and mounting of ripened silkworms.

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