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RESEARCH PAPER

Design and evaluation of eco-friendly mountages for the silkworm, *Bombyx mori* L.

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Abstract : The silkworm *Bombyx mori* L. ends its larval stage with construction of silken armour called 'cocoon'. The management of spinning larvae demands much care to maximize profit to the farmer, which necessitates manual picking of the ripened worms and provide proper anchorage to construct cocoons and the process is called as mounting. More than 40 % of the labour force is dedicated towards mounting (15 out of total 35 mandays/100 DFLs) that draws attention of the researchers striving hard to double farmer's income by designing self mounting cocooning structures. Though corrugated plastic mountages are available, they are suitable only for Bivoltine (BV) silkworms that have a notable crawling habit. Ourefforts to design and develop new eco-friendly self mounting structures for mounting both crossbreeds (CB) and BV silkwormsevolved four new type of mountages *viz.,* Spiral, Zig-zag, Square mountages made of bamboo and the Ribbon mountage. The lab tests of these mountages in comparison with the regular bamboo mountage and the plastic self mounting structures clearly indicated that the spiral mountages are comparable with the regular bamboo mountage with respect to various cocoon and reeling parameters among both CB (PM X CSR_2) and BV double Hybrid (FC_1 X FC_2). Also these are self mounting cocooning frames that reduce the cost on labour during ripe worm management.

Key Words : Mountages, Silkworm cocooning frames, Mounting, Self mounting structures

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INTRODUCTION

The silkworm, *Bombyx mori* L. is a holometabolous sericigenous insect that completes the larval stage in 28-30 days, passing four moults. The larvae attain maturity by about 7 days after fourth moult. At this stage, the silkworm stops feeding, the body becomes translucent, the silk glands are filled with liquid silk proteins and the worm starts spinning silken armour around its body for protection during its metamorphosis. However, this silken shell called 'cocoon' forms the most economical part for human being. Spinning is important for satisfying silkworm's physiological requirement by extruding amino acids from the body (Henry, 1984) in the form of silk thread. To exploit the commercial nature of these amino acids, the silkworms are domesticated and made to spin

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on an artificial substrate, the mountage that supports spinning.

The spinning of cocoons, a crucial part of silkworm rearing starts with the identification, collection (picking) and transfer of mature larvae to the cocooning frame, called 'Mountage' and the process is defined as 'mounting'. The time and method of mounting as well as the type of cocooning platform are the most important factors influencing the quality of cocoons, the raw silk yield and quality. Even a healthy silkworm crop yields poor quality cocoons if handled with improper mounting methods, spinning conditions, mounting density and poor type of mountages (Krishnaswami *et al*., 1973). Hence the anchorage used for supporting the spinning larvae play a vital role in determining quality of cocoons and price fixation at the cocoon market.

Mountage is a device for providing the platform for mature silkworms to spin cocoon (Singh, 1995 and Singh *et al.,* 2012). Several types of mountages areavailable in the field across globe*viz.,* Bamboo mountages, bottle brush mountages, rotary mountages, plastic corrugated self mounting structures etc., some of which are more popular (Kutsumata, 1975; Rajan *et al.,* 1996, 2000). Farmers also use different locally available materials like mulberry shoots, paddy straw, shoots of Mustard hay (*Brassica compestris*), *Indigoferaheterantha* shoots,*Pinusexcelsa* shootlets, and such other twigsin Kashmir for mounting silkworms (Sugun *et al.,* 2000; Rashid *et al.,* 2018). The available literature reveals 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). 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 while constructing the cocoon (Mathur and Qadri, 2010). 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). 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 BV breeds of silkworms. Further, the percentage of defective cocoons is more in these plastic mountages as inferred by the reelers. Uniformity in shape, size and compactness of the cocoon cannot be maintained or assured in the self mounting plastic mountages. The reelers using improved reeling machines offer lesser price for such cocoons harvested from plastic mountages as they experienced difficulty in unwinding of filament from cocoon shell due to mountage marks ultimately affecting reelability and quality of raw silk.Realizing the importance cocooning structures andinvestment on labour, efforts have been made at our centreduring 2017-19 to design new type of self mounting frames using locally available eco-friendly materials and determine their suitability in rearing the mulberry silkworm, *B. mori L.*

MATERIAL AND METHODS

A preliminary survey was conducted for collection of data regarding performance of existing mountages at farmer's field condition. A total of 120 farmers were contacted from four sericulturally important districts *viz.,* Kolar, Chikkaballapur, Bangalore Rural and Bangalore Urban where both Cross Breed and Bivoltine races are being commercially reared. The data was analyzed and based on the results, the new designs of the self mounting structures using locally available eco-friendly material were developed using CAD software. The new designed mountages were fabricated with the help of local artisans and the performance test of these new mountages was carried out during 2017-2019 at Department of Sericulture, College of Sericulture, Chintamani geographically located in the Eastern Dry Zone (Zone-5) of Karnataka state, India and lies between 13.40p N 78.06p E at an altitude of 865 m above MSL.

Designing new mountages :

Based on the information obtained from the data collection, three different mountages namely, spiral, square and zig-zag mountages of 6x4 size were designed using CAD software (Fig. A) and fabricated with the help of local artisan by using bamboo as raw material. Ribbon mountage (6x4) was prepared with the help of carpenter as indicated by Shivakumar *et al*. (2016).

The silkworm rearing was conducted using mulberry leaf harvested from well established mulberry garden with V-1 (Victory-1) variety established with aspacing of90 x 90 cm.At each rearing young age silkworms of 50 DFLs each of the CB (PM X CSR_2) and BV double hybrid, Krishnaraja[FC1(CSR_6 x CSR_{26}) X FC2 (CSR_2 x CSR_{27})] were procured from Registered Chawki Rearing Centres and reared separately according to the standard procedure recommended byDandin*et al.* (2003). The new self mounting structures *viz.,*Spiral mountage (T_1), Square mountage (T_2), Zig-Zagmountage (T_3) and Ribbon mountage (T_4) were placed over mounting net on the rearing bed for 90 minutes along with the self mounting plastic collapsible mountage (T_5, control 1) while manual mounting method *i.e.,* picking of ripened worms and mounting was followed for the regular bamboo mountage (T_6, Control 2).Three replications were maintained for all the treatments.The plastic mountages were joined together to make the size of 6x4.

The cocoons from each mountage were harvested separately on 5thand 7thday of spinning in CB and BV hybrid, respectively after ensuring complete formation of the cocoon. A bunch of 10 cocoons were collected randomly from each replication on the same day of harvesting and the observations regarding economically important cocoon parameters *viz.,* single cocoon weight (g), shell weight (g) and cocoon shell ratio (%) were recorded separately for eachtreatment. A sampleof 10 cocoons per replication were drawn randomly and stifled in a hot air oven at 80^{0}C temperature for 4 hours to ensure killing of pupa. Individual cocoons were test reeled following the standard procedure using an Epprouvette. The commercially important reeling traits*viz.,* Average filament length (AFL), Non-Breakable Filament Length (NBFL), Rawsilk recovery (Rawsilk %) and Denier were computed for both CB and BV as follows:

$$\text{AFL (m)} = \text{RX } 1.125$$

(where R=Number of Revolutions and 1.125 is the circumference of the Epprouvette)

$$\text{NBFL (m)} = \frac{\text{Total filament length (m)}}{1 + \text{Number of breaks}} \text{ x } 100$$

$$\text{Raw silk recovery (\%)} = \frac{\text{Weight of raw silk reeled (g)}}{\text{Weight of cocoon (g)}} \text{ x } 100$$

(The silk reeled from each cocoon was conditioned at 70^{0}C for 4 hours before weighing and the weight of cocoon refers to fresh weight).

$$\text{Denier} = \frac{\text{Weight of the filament (g)}}{\text{Weight of cocoon (g)}} \text{ x } 100$$

The data was analyzed following CRD.

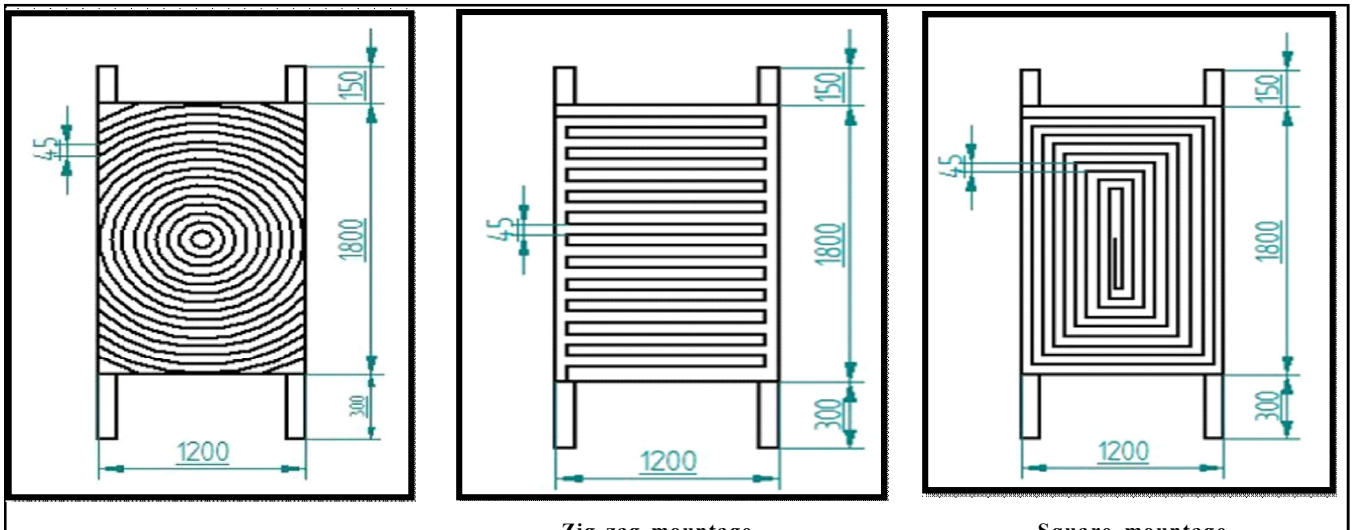

Fig. A: CAD designs of the new self mounting structures

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Design and fabrication of new mountages :

Most commonly used mountages in particularly in southern parts of India and West Bengal states are manual mounted bamboo chandrika, self mounting plastic collapsible mountage and bamboo strip mountage (Singh, 1995; Rajan *et al.,* 1996 and Haroon *et al.,* 2001) that was also true in the present study. The farmers indicated opined that though self mounting plastic mountages reduce the labour requirement during mounting their utility is limited to only BV silkworms. Further, the cocoons harvested from plastic mountages fetch up to Rs. 10-15 lesser per kg of green cocoons in the market, which is a huge compromise on cocoon cost. With this in view, three different designs of the mountages *viz.,* Spiral, Zig-zag and Square mountages were developed using CAD programming softwareand the bamboo tape supported by split bamboo reapers were used to fabricate the new designed mountages.CSR&TI, Mysore have developed different types of improved mountages to replace the traditional ones and the cocoons produced on these structures have improved reeling parameters (Sangappa *et al.,* 2010).

Evaluation of new mountages:

The new designed mountages were used during rearing of Cross breed and BV Double hybrid silkworm races-PM X CSR_2 and FC_1XFC_2, respectively.The ripened larvae were allowed to crawl onto the new self mounting structures for 90 minutes, theobservations recorded regarding various larval, cocoon and reeling parameters were recorded and the results have been discussed here under.

Spinning Larval characters:

The number of larvae mounted after 90 minutes, per cent cocooning, good cocoon percentage was better on new self mounting spiral mountage compared to the most popularly used plastic ones. A total of 488 and 278 larvae, respectively of cross breed and Krishnaraja were mounted on to the spiral mountage and successfully spun the cocoons (99.50 and 99.15 %, respectively in cross breed and Krishnaraja) out of which 459 (94.49%) and 257 (93.39 %) were good cocoons respectively in the two hybrids. The per cent defective cocoons were comparatively less in the spiral mountage among both the breeds (5.51 and 6.61 %, respectively in cross breed and Krishnaraja. The plastic mountage recorded least number of larvae mounted (166 No./mountage) in Krishnaraja with the least cocooning percentage of 97.74 that yielded the least number of good cocoons (150 cocoons/mountage). The regular bamboo mountage had percentage of defective cocoons (66cocoons/mountage). Interestingly, in the present experiment, the cross breeds also crawled onto the new mountages building a hope for their utility in rearing of cross breeds silkworms of *B. mori* L (Table 1 and Fig. 1).

Table 1: Influence of different mountages on various parameters of spinning larvae Cocoon traits of the Cross Breed and Bivoltine Double Hybrid (Krishnaraja)

Treatments	Total larvae mounted (No./mountage)		Cocooning (%)		Good cocoons (No./mountage)		Defective cocoons (No./mountage)	
	Cross Breed	Krishnaraja	Cross Breed	Krishnaraja	Cross Breed	Krishnaraja	Cross Breed	Krishnaraja
T_1	488	278	99.52	99.15	459 (94.49)	257 (93.39)	27 (5.51)	18 (6.61)
T_2	282	278	99.17	98.92	265 (94.81)	248 (89.97)	15 (5.19)	27(10.03)
T_3	394	285	99.31	99.05	364 (93.10)	262 (92.96)	27 (6.90)	20 (7.04)
T_4	138	178	99.01	98.86	130 (95.42)	162 (91.95)	6 (4.58)	14 (8.05)
T_5	212	166	97.91	97.74	191 (91.96)	150 (92.84)	17 (8.04)	12 (7.16)
T_6	682	546	99.27	98.78	638 (94.15)	474 (87.83)	40 (5.85)	66 (12.17)
F-test	**	**	**	**	**	**	**	**
SE. m ±	17.85	15.62	0.18	0.12	17.49	15.61	5.06	6.35
CD	77.10	67.47	0.80	0.53	75.56	67.44	21.85	27.43

✓ ** significant at 1%
✓ The values are the mean of two rearings
✓ The average mounting duration of worms (T_1-T_5) is 90 minutes and T_6 is manual mounted
Values in the parenthesis indicate percentage values

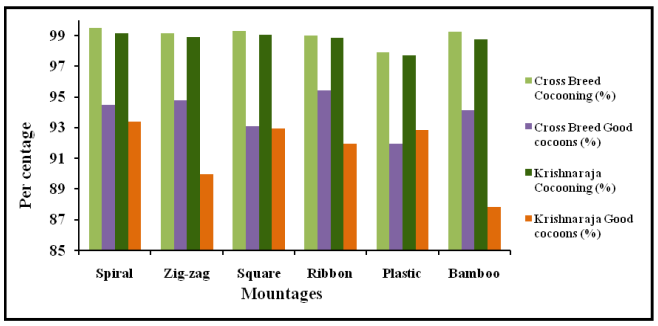

Fig. 1: Influence of different mountages on cocooning of cross breed and BV double hybrid (Krishnaraja)

A better mounting capacity BV silkworms was reported by Shivakumar *et al.* (2016) on self mounting Thalaghattapura ribbon chandrike. In the present study, an intricately woven bamboo spiral in the new mountage might have anchored the silkworms better than plastic mountages allowing more number of larvae to crawl. The per cent cocooning is a parameter computed by considering total cocoons formed on each mountage against the total larvae mounted. The number of worms that did not spin cocoons was higher on plastic mountage leading to reduced percentage of cocooning. Chandrakanth *et al.* (2004) also reported highest percentage of cocooning in bamboo mountage compared to plastic ones. The dried parts of different plants like shoot of *Indigoferaheterantha*, *Pinusexcelsa* Paddy straw, *etc*., can be readily used without compromising the cocooning percentage in BV double hybrid FC_1XFC_2 that works out to be very cheap and easily available (Rashid *et al.,* 2018). The apo-geotrophic nature of silkworm could also be one of the reasons for higher numberof larvae and cocoons on spiral mountage than other self mounting structures. The varied number of defective cocoons depends on the material and structure of the cocooning frame (Tazima, 1972). The number of defective cocoons was very less on self mounting shindi branches than plastic mountages (Shinde *et al.,* 2012) and the absorbent nature of the natural substrate probably reduced the number of defective cocoons like urinated ones. The type of material used to design mounting structure played a significant role in determining cocoon and rawsilk quality in the silkworm, *B. mori* L. (Naphade *et al.,* 2011; Datta *et al.,* 2007; Chikkanna *et al.,* 2009 and Pandey *et al.,* 2007).

Cocoon characters:

The important cocoon parameters directly associated with price of cocoons in commercial sericulture aresingle cocoon weight (g) shell weight (g), and cocoon shell ratio (%). The type of mountage did not show any significant difference among the cocoon characters of both the silkworm hybrids.

The cocoon weight on new spiral mountage (1.90 g/cocoon in cross breed and 2.00 g/cocoon in Krishnaraja) was higher than that on self mounting plastic mountage (1.62 g/cocoon for cross breed and 1.96 g/ cocoon for Krishnaraja) (Fig. 2). The shell weight recorded highest in the new self mounting designs (0.33 and 0.50 g/cocoon, respectively for cross breed and Krishnaraja on new spiral mountage) compared to plastic mountage (0.261 g/cocoon for cross breed and 0.454 g/ cocoon for Krishnaraja).A least cocoon shell ratio of 16.67 % was recorded on plastic mountage that was

Table 2: Effect of different mountages on various cocoon parameters of the Cross Breed and Bivoltine Double Hybrid (Krishnaraja)

Treatments	Single cocoon weight (g)		Shell weight (g)		Cocoon shell ratio (%)	
	Cross breed	Krishnaraja	Cross breed	Krishnaraja	Cross breed	Krishnaraja
T_1	1.90	2.00	0.33	0.50	17.79	25.14
T_2	1.79	1.99	0.32	0.48	17.34	24.37
T_3	1.71	1.90	0.33	0.50	19.04	26.10
T_4	1.66	1.92	0.33	0.49	19.46	25.45
T_5	1.62	1.96	0.26	0.45	16.67	22.50
T_6	1.80	2.13	0.34	0.47	18.38	22.89
F-test	NS	NS	NS	NS	NS	NS
SE. m ±	0.078	0.055	0.021	0.015	1.028	0.831
CD	0.336	0.236	0.090	0.067	4.439	3.590

✓ * significant at 5%; ** Significant at 1%; NS- Non Significant
✓ The values are the mean of two rearings
✓ The cocoons weight and shell weight are average of 10 random samples per replication

higher in other new type of self mounting structures (Fig. 2). However, there was no significant difference among the new self mounting structures and the regular bamboo mountages available in the field for single cocoonweight, shell and the cocoon shell ratio indicating their suitability for use at farmer's field level (Table 2).

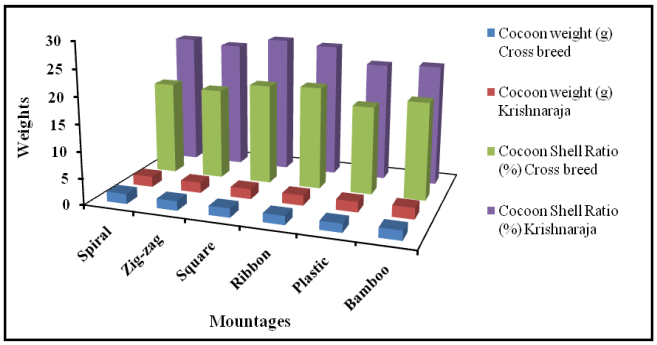

Fig. 2 : Influence of different mountages on the cocoon weight (g) and cocoon shell ratio (%) of cross breed and BV double hybrid, Krishnaraja

Cocoon shell weight is one of the important quality parameters largely influenced by type, material and structure of mountages used at the spinning stage (Singh *et al.,* 1994), which is more a breed character than the mountage (Sharanyakumar Gowda, 2014). The plastic collapsible mountages if not maintained properly, would increase the spinning space leading to wastage of silk in the form of floss, resulting in reduced shell weight and cocoon shell ratio. The same is also true in the present investigation where the plastic mounting frames have recorded lower cocoon and shell weight as well as shell ratio for both cross breed and the double hybrid. Hence, even though the durability of new mounting structures are yet tobe understood, their self mounting ability definitely plays paramount role in doubling the seri-farmer's incomeby remarkebaly reducing the cost on labour. Rashid *et al.* (2018) also found similar results while using different self mounting materials to rear BV double hybrid FC_1XFC_2. Shivakumar *et al.* (2016), recorded relatively higher cocoon shell ratio of 18.34 % on ribbon chandrike than bamboo mountage (18.22 %) for BV double hybrid. Shindi/Date sugar branches showed better results with respect to various economic parameters like cocoon and shell weight, shell ratio, *etc.* compared to plastic mountage (Shinde *et al.,* 2012).

Reeling characters:

The ideal mountages provide congenial conditions for the larvae to exude silk proteins in such a way that the filament is strong enough to enable unwinding continuously. The quality of rawsilk filament is largely influenced by the reeling traits like length of the cocoon filament, non-breakable filament length, rawsilk recovery and the filament denier.

The new mountages varied significantly with respect to the filament length only in cross breed silkworms. The longest filament was reeled from the cocoons spun on new self mounting Zig-zag (890.51m/cocoon) and spiral (885.58 m/cocoon) mountage in cross breed and spiral mountage (1155.65 m/cocoon) while the shortest filament was reeled on plastic mountage (862.51and 1102.91m/ cocoonfor cross breed and Krishnaraja, respectively). The non-breakable filament length (NBFL) varied greatly among different mountages when used for mounting the

Table 3: Effect of different mountages on various reeling parameters of the Cross Breed and Bivoltine Double Hybrid (Krishnaraja)

Treatments	Filament length (m/cocoon)		Non breakable filament length (m/cocoon)		Raw silk recovery (%)		Denier	
	Cross Breed	Krishnaraja	Cross Breed	Krishnaraja	Cross Breed	Krishnaraja	Cross Breed	Krishnaraja
T_1	885.58	1155.65	322.50	449.56	14.85	18.81	2.80	2.83
T_2	890.51	1146.91	313.80	436.10	16.40	18.28	2.90	2.86
T_3	883.70	1149.13	309.71	430.27	15.26	19.60	2.61	2.87
T_4	877.65	1102.91	311.92	434.75	16.38	19.11	2.71	2.88
T_5	862.51	1146.35	305.11	428.83	15.84	18.68	2.62	2.81
T_6	862.27	1181.68	312.46	441.28	14.71	17.55	2.70	2.78
F-test	**	NS	NS	*	NS	NS	**	NS
SE. m ±	5.086	19.853	3.814	4.115	0.699	0.691	0.032	0.043
CD	21.969	85.761	16.474	12.681	3.020	2.985	0.139	0.186

✓ * significant at 5%; ** Significant at 1%; NS- Non Significant
✓ The values are the mean of two rearings
✓ The AFL, NBFL, Raw silk recovery (%) and Denier are the average of 10 random samples per replication

BV double hybrid, Krishnaraja but not for cross breed. The longest NBFL was recorded on new self mounting spiral mountage (322.50, 449.56 m/cocoon, respectively for cross breed and Krishnaraja) compared to plastic ones (305.11, 428.83m/cocoon, respectively for cross breed and Krishnaraja). The percent recovery of rawsilk and the filament denier was not much affected by the type of cocoonage used in mounting of the double hybrid whereas the recovery of rawsilk in cross breed was highest from the cocoons spun on the new self mounting structures on spiral and zig-zag mountages (2.80 %) against the least on plastic mountage (2.62 %). All these quality parameters of rawsilk have been better in new spiral mountage when compared to both the controls (self mounting plastic mountage and the bamboo chandrika) (Table 3).

Several studies across the globe that used different cocoonages have reported similar observations with regard to reeling characters silk cocoons.The natural plant parts such as mango twigs (Naphade *et al.,* 2010), paddy straw and semi dried eucalyptus leaves (Pandey *et al.,* 2006), twigs of *Indigofera heterantha* and *Pinus excela* (Rashid *et al.* 2018) serve as better alternatives to plasticmountages and are abundant in nature reducing the cost of cocoon production. Besides other factors, the type of mountage, mounting methods and the mounting material used plays a paramount role in determining the quality of cocoons (Tazima, 1972; Periasamy and Radhakrishna, 1987; Geetha Devi *et al.,*1990; Haroon *et al.,* 2001; Rashid *et al.,* 2018).

Conclusion:

An enormous quantity of water evaporates from the larval body once it attains maturity and starts spinning. Hence, they need proper ventilation to maintain quality of cocoon and rawsilk. As in the new self mounting structures, an ideal mountage provides enough space and good aeration for the spinning larvae upon placing on the rearing bed thereby adding to the quality of cocoon and rawsilk (Rashid *et al.,* 2018). Further, the larvae need proper grip to lay foundation during construction of cocoon, which is effectively available in spiral mountage because the material used is bamboo tape. Thus, the present investigation inferred that the bamboo spiral mountages can serve as best alternative to plastic mountage while rearing bivoltine silkworms and a new hope has arouse for their utility in rearing cross breeds more economically.

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REFERENCES

Chandrakanth, K. S., Srinivasa Babu, G. K., Dandin, S. B., Mathur, V. B. and Mahadevamurthy, T. S. (2004). Development of improved mountages. *Indian Silk,* **43** (5) : 07-12.

Chikkanna, G. S., Singh, V. A. and Quadri, S. M. H. (2009). Qualitative and improvement in terms of economic gain by using two different types of mountages for silkworm cocoon. *Green Farming,* **2** (14): 1014-1016.

Dandin, S.B., Jayanth Jayaswal and Giridhar, K. (2003). *Handbook of Sericulture Technologies,* Central Silk Board, Bangalore, pp. 284.

Geetha Devi, R. G., Himantharaj, M. T., Vindya, G. S. and Mathur, V. B. (1990). Can Plastic collapsible mountage replaces the bamboo mountages. *Indian Silk,* **10** : 26-28.

Henry, J. (1984). *An introduction to Entomology*. Ninth Edition, Entomological Dept., Cornell University, pp. 188.

Katsumata, F. (1975). *Text book on Tropical Sericulture* (111 Edn). Japanese Overseas Co-operation Volunters, Tokyo, Japan, pp. 503-519.

Krishnaswami, S., Narasimhanna, M. N., Suryanarayana, S. K. and Kumararaj, S. (1973). *Manual on Sericulture –2,* FAO, Rome, pp. 131.

Mathur, V. B. and Qadri, S.M.H. (2010). *Manual on Mountages, Mounting and Harvesting Technology for Quality Cocoon Production*.CSR & TI, Mysore, pp. 23.

Naphade, S.T., Hiware, C.J. and Avhad, S.B. (2010). Development of improved mountage using mango plant twigs during lack of sufficient number or absence of mountages on field for silkworm cocoons. *Rec. Res. In Sci. & Tech.,* **2**(7): 5-8.

Pandey, R. K., Khan, M. A., Dhar, A. and Chauhan, S. S. (2006). Performance of different locally available plant materials for mounting of silkworms, pp.190-193. In: *Proceedings of regional seminar on Prospects and problems of sericulture as an economic enterprise in North West India*. Nov. 11&12.

Panday, R. K., Khan, M. A., Bindroo, B. B., Dhar, A. and Chauhan, S. S. (2007). Plant shoot mountages of north-western India. *Researchgate,* **46** : 4-5.

Periasamy, K. and Radha Krishnan, S.(1987). Design of a new type of mountage and assessment of its advantages over the conventional bamboo mountage. *Sericologia,* **17**(1): 35-44.

Rajan, R. K., Tamio Inokuchi and Datta, R.K.,(1996). Manual on mounting and harvesting technology. JICA bivoltine sericulture technology development Project, CSR&TI Mysore. Jawalamukhi Job press, Bangalore, pp.22.

Rajan, R. K., Himantha Raj, M. T. and Singh, G. B. (2000). Rotary mountage and its advantages. *Indian Silk,* **39**(4): 4-6.

Rashid, H., Gulzar Ahmad Khan, Babulal and Ghosh, M. K. (2018). Field Evaluation of Different Locally Available Mounting Materials for Their Suitability under Hilly Areas of Kashmir. *Int.J.Cur.Mic. and Appl.Sci.,* **7** (6) : 1597-1605.

Sangappa, S., Bhanuprakash, R., Srinivasa, G. and Dandin, S. B. (2010). Impact of different types of mountages on raw silk production and quality. *Nippon Silk Gakkaishi,* **18**:15-19.

Sharanyakumar Gowda, Y. K.(2014). The performance of double hybrids of silkworm, *Bombyxmori* L. in Central Dry Zone of Karnataka. M. Sc. (Seri.) Thesis, UAS, Bangalore, India.

Shinde, K. S., Avhad, S. B., Jamdar, S. V. and Hiware, C. J. (2012). Comparative studies on the performance of mountages on cocoon quality of *Bombyxmori* L. *Trends in Life Sciences,* **1** : 8-11.

Shivakumar, C., Prasad, N. R., Katti, S. R. and Gupta, K. N. N. (2016). Ribbon chandrike-A mechanized cocoon harvester. *Indian Silk,* **7** (8) : 141-145.

Singh, G. B., Rajan, R. K., Inokuchi, T., Himantharaj, M. T., Meenal, A. and Datta, R. K. (1994). Studies on the use of plastic bottle brush mountages for silkworm mounting and its effect on cocoon characters and reelability. *Indian J. Seric.,* **33** (1) : 95-97.

Singh, G. B. (1995). Silkworm mountages. *Indian Silk,* **4** (1) : 13-16.

Singh, G. B., Chandrakanth, K. S., Vijayakumari, K. M. and Qadri, S.M.H.(2012). Impact of mountages in different seasons on cocoon yield and reeling parametres of bivoltine silkworm, *Bombyx mori* L. *Green farming,* **3** (1) : 69-73.

Sugun, R., Chandrakala, M. V. and Katti, S. R. (2000). Types of mountages practiced in Chinese sericulture. *Bull. Indian Acad. Seric.,* **4** (1) : 82-84.

Tazima, Y. (1972). *Handbook of silkworm rearing* (Translated in 1997), Central Silk Board, Bombay, India,pp. 193.