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Studies on the impact of locally available mountages on cocoon quality of mulberry silkworm *Bombyx mori* L under Kashmir climatic conditions

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Abstract
The present study "Evaluation of Locally Available Mounting material for Spinning of Cocoons" was carried out at College of Temperate Sericulture, Mirgund, SKUAST-K during spring 2021. The ripe silkworms (*Bombyx mori* L.) were mounted for spinning cocoons on six different mounting materials, namely Plastic collapsible mountage (control), Mulberry shoot mountage, Dried grass mountage, Typha grass mountage, Maize straw mountage and Wicker willow shoot mountage. Among newly designed mountages Maize straw mountage recorded least larval mortality of 3 percent which was at par with plastic collapsible mountage (control) with the mortality percentage of 2 percent. Cocooning percentage was recorded maximum (97%) in case of Maize straw mountage which was at par with plastic collapsible mountages (control) with the value of 98 percent. During the course of present study Maize straw mountage was also found to record least defective cocoon percentage of 5 percent. Among newly designed mountages Maize straw mountage showed better results for most of the cocoon parameters *viz.*, single cocoon weight (1.8g), single shell weight (0.430g), cocoon shell percentage (23.8%), Silk productivity (6.14cg) and pupation rate (93.11%). From the studies conducted, it is inferred that maize straw can be used as an alternative mounting material for spinning cocoons by silkworm larvae with good success that sericulture farmers can get good renumeration for their produce.

Keywords: *Bombyx mori* L., mounting material, economic traits

Introduction
The spinning of cocoons is a crucial part of silkworm rearing, that starts with identification and collection (picking) of mature larvae and transferring them on to the cocooning structures, the process of which is defined as 'mounting'. The spinning larva utilizes 1-2% silk for making hammock on a good mounting material (Yokoyama, 1962) [13]. The mounting material used for spinning of cocoons must be easily available, economically viable and providing adequate space for cocooning (Tanaka, 1964) [11]. The relative impact of improved rearing techniques on larval behaviour and production of quality cocoons of mulberry silkworms has been worked out by a number of workers (Krishnaswami, 1978) [2] under tropical climatic conditions for multi-bivoltine breeds/ hybrids. Under the existing temperate climate of Kashmir, the prospective zone for bivoltine silkworm rearing, not much information is available regarding the impact of different locally available mounting material on cocoon yield.

At the end of fifth age silkworm larvae shrink in size, discharge soft light brown colored feaces and slowly stop feeding. Silkworms at this stage are called ripe worms or mature larvae and are ready to exude silk in the form of long thread for spinning of cocoons with the support of any hard object or hold fast called mountage. Thus the mountage or mounting material is the most important device that supports the silkworm larvae for spinning of cocoons comfortably (Singh *et al*., 2012) [7] and the process of transferring the mature larvae is called mounting (Shinde *et al*., 2012) [6]. Various types of mountages have been used in different countries and areas like rotary mountage in Japan (Rajan *et al*., 2000) [3], bottle brush mountage in Brazil (Singh *et al*., 1994) [8]. In China many types of mountages *viz.*, Umbrella type, centipede type, checker board type are being used at farmers level. All of them are fabricated from locally available materials which are economical and easily available (Sugun *et al*., 2000) [10]. The most common mountages used in India particularly in southern parts and North-west are bamboo chandrika, screen type bamboo mountage, plastic collapsible mountage and bamboo strip mountage (Haroon *et al*., 2001) [1].

Central Sericultural Research and Training Institute Mysore have developed different types of improved mountages to replace the traditional ones and the cocoons produced out of these have improved the reeling parameters (Sangappa *et al*., 2010) [5].

Material and Methods

The present investigation entitled "Evaluation of Locally Available Mounting material for Spinning of Cocoons" was carried out during spring 2021 in Division of Cocoon Crop Production at College of Temperate Sericulture, Mirgund.

Designing of new mountages

Mounting material was collected from different sources and allowed to dry for 8-10 days. Material was later on disinfected with 5% bleaching powder so as to remove contaminants and other infectious material. The mounting material was then interwoven into mats so as to create spaces for cocoon formation. The size of mountages were kept in line with the standard size of rearing tray. Five different mountages *viz.*, mulberry shoot mountages, dried grass mountages, typha grass mountages, maize straw mountages and wicker willow shoot mountages were designed with the help of local artisan for the investigation plate-1.

Plate 1: Newly designed mountages used during the course of the study

Experiment details

The experiment was conducted to evaluate locally available mounting material for spinning of cocoons during spring 2021.The treatments were subjected to Completely Randomized Design (CRD) with the following six treatments and each treatment with three replications.

Treatment details

Treatment	Type of Mountage	Scientific Name	Local Name
T_1	Plastic collapsible mountage	_	_
T_2	Mulberry shoots	*Morus spp.*	Tullange
T_3	Dried grass	*Oryza sativa*	Dhaneyghas
T_4	Typha grass	*Typha angustifolia* L.	Pech
T_5	Maize straw	*Zea mays* L.	Makai
T_6	Wicker willow shoots	*Salix rubra* L.	Veer

Target crop: Silkworm (*Bombyx mori* L)
Silkworm hybrid: CSR_2 x CSR_4

Observations recorded

1. **Cocooning (%):** It was calculated as per the following formula:

$$\text{Cocooning (\%)} = \frac{\text{Number of cocoons formed}}{\text{Number of worms mounted}} \times 100$$

2. **Cocoon Crop weight per mountage (g):** The harvested cocoons were weighed on seventh day of spinning and average weight was calculated for each mountage which was expressed in grams per mountage.
3. **Number of good and defective cocoons per mountage:** The harvested cocoons were segregated into good and defective cocoons and the number of good and defective cocoons were counted separately from each mountage. The average number was calculated for each mountage

which was expressed as number per mountage.

4. **Weight of good and defective cocoons per mountage (g):** The segregated good and defective cocoons were weighed separately on seventh day of spinning for each mountage and the average weight was calculated for each mountage which was expressed as grams per mountage.
5. **Floss weight (mg):** In each mountage 10 male and 10 female cocoons were randomly selected and floss was removed and the individual cocoon floss was weighed and recorded. The average was calculated to get the mean floss weight which was expressed in milligrams.
6. **Single cocoon weight (g):** Ten male and 10 female cocoons were selected randomly from each mountage and were weighed individually. The average weight was calculated to compute the single cocoon weight which was expressed in grams.
7. **Single shell weight (g):** The cocoons utilized for computing single shell weight were cut open and pupa was removed. The cocoon shell was weighed individually and then the average was calculated to get the mean cocoon shell weight which was expressed in grams.
8. **Cocoon Shell (%):** It is the ratio between the cocoon shell weight and the cocoon weight and was calculated as:

$$\text{Cocoon Shell (\%)} = \frac{\text{Weight of cocoon Shell (g)}}{\text{Weight of cocoon (g)}} \times 100$$

9. **Pupation rate (%):** This was recorded by calculating the number of viable pupae obtained out of total number of cocoons harvested and was calculated as:

$$\text{Pupation rate (\%)} = \frac{\text{Number of viable pupae obtained}}{\text{Total Number of cocoons harvested}} \times 100$$

Results and Discussion

Unspun larvae (%)

Statistical analysis of the data revealed that there exists significant differences with regard to unspun larval percentage. Among the evaluated mountages Plastic collapsible mountage (control) recorded least unspun larvae of 2 percent which was at par with Maize straw mountage with an unspun larval percentage of 3 percent. The unspun larval percentage recorded by other treatments include: Typha grassmountage (4%), Wicker willow shootmountage (5%). Dried grassmountage (5%) and Mulberry shootmountage (6%) (Table-1). The findings are very much in line with the results of Singh *et al.*, (2002) [9] who reported comparative lower unspun larval percentage in plastic collapsible mountages by the tune of 2 percent.

Cocooning (%)

Significant difference was observed among treatments with regard to cocooning percentage. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (98%) cocooning percentage which was at par with Maize straw mountage with cocooning percentage of 97 percent. The cocooning percentage recorded by other treatments include: Typha grassmountage (96%), Wicker willow shootmountage (95%). Dried grass mountage (95%) and Mulberry shootmountage (94%) (Table-2). The results of this study correlate with the findings of Singh *et al.*, (2002) [9] who recorded highest number of cocoons per mountage on plastic collapsible mountages (9686).

Table 1: Effect of different mountages on spinning percentage of mulberry silkworm (*Bombyx mori* L.) under temperate climatic conditions of Kashmir

Treatment	No. of larvae per mountage	Unspun larvae (No./mountage)	Unspun larvae (%)
Plastic collapsible mountage	250	5.0^{c}	2^{c}
Mulberry shoot mountage	250	15.0^{a}	6^{a}
Dried grass mountage	250	12.5^{ab}	5^{ab}
Typha grass mountage	250	10.0^{b}	4^{b}
Maize straw mountage	250	7.5^{bc}	3^{bc}
Wicker willow shoot mountage	250	12.5^{ab}	5^{ab}
C.D ($p \leq 0.05$)	-	2.93	1.95

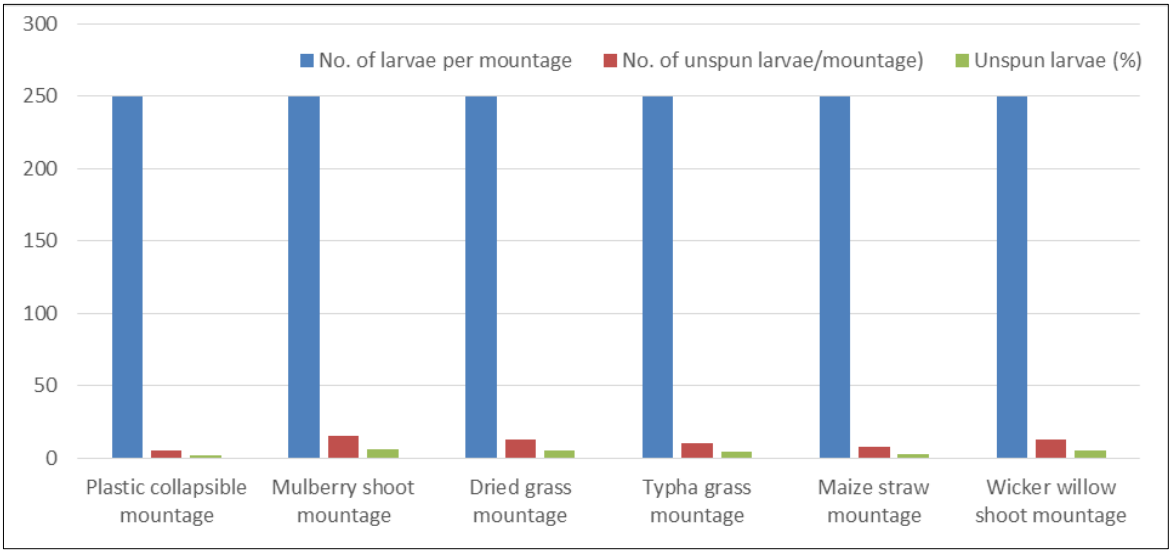

Fig 1: Effect of different mountages on spinning percentage of mulberry silkworm (*Bombyx mori* L.) under temperate climatic conditions of Kashmir

Cocoon crop weight

Statistical analysis of the data revealed that there exists significant differences with regard to cocoon crop weight. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (445.0g) cocoon crop weight which was at par with Maize straw mountage with the cocoon crop weight of 436.0 grams. The cocoon crop weight recorded by other treatments include: Wicker willow shootmountage (403.0g), Typha grass mountage (384.0g), Mulberry shoot mountage (376.0g) and Dried grass mountage (356.0g) (Table-2).

Table 2: Effect of different mountages on cocooning percentageof mulberry silkworm (*Bombyx mori* L.) under temperate climatic conditions of Kashmir

Treatment	No. of cocoons (No./mountage)	Cocooning (%)	Cocoon crop weight (g / mountage)
Plastic collapsible mountage	245.0^{a}	98^{a}	445.0^{a}
Mulberry shoot mountage	235.0^{c}	94^{c}	376.0^{c}
Dried grass mountage	237.5^{bc}	95^{bc}	356.0^{d}
Typha grass mountage	240.0^{b}	96^{b}	384.0^{c}
Maizestraw mountage	242.5^{ab}	97^{ab}	436.0^{a}
Wicker willow shoot mountage	237.5^{bc}	95^{bc}	403.0^{b}
C.D ($p \leq 0.05$)	2.66	1.95	12.3

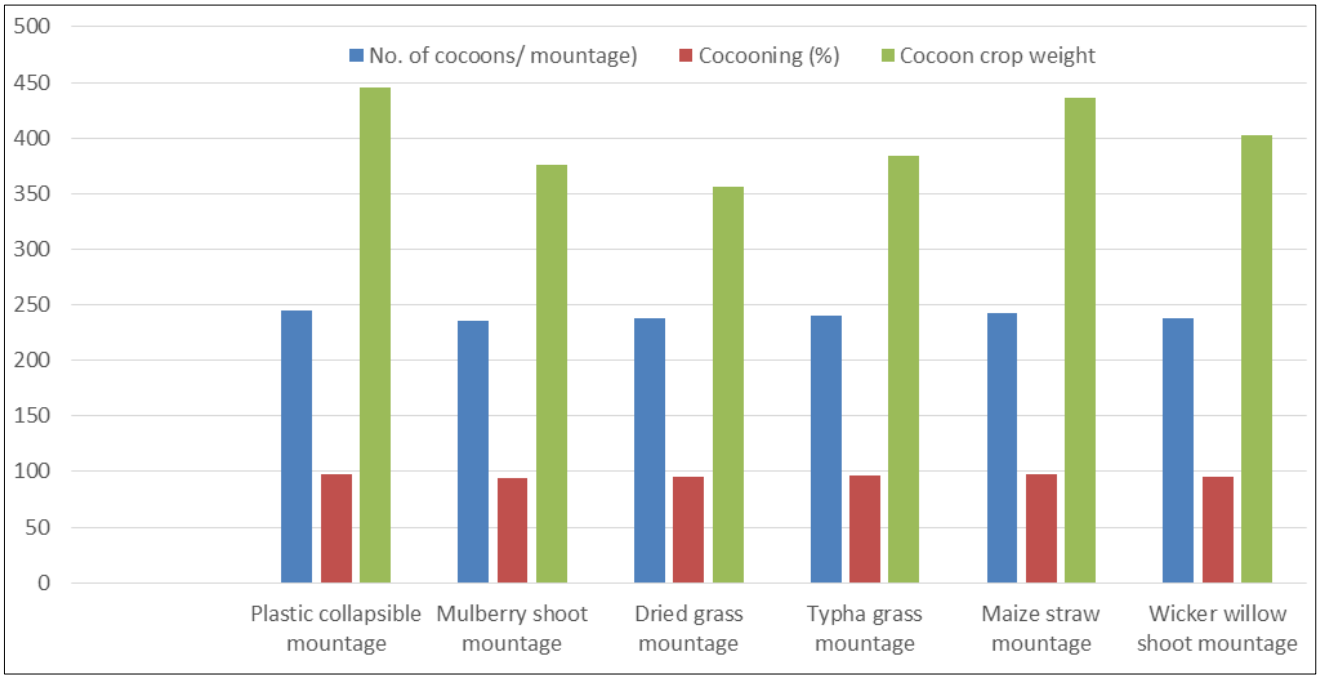

Fig 2: Effect of different mountages on cocooning percentage of mulberry silkworm (*Bombyx mori* L.) under temperate climatic conditions of Kashmir

Good cocoon (%)

Statistical analysis of the data revealed that there exists significant differences with regard to good cocoon percentage. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (94%) good cocoon percentage which was at par with Maize strawmountage with the good cocoon percentage 92 percent. The good cocoon percentage recorded by other treatments include: Typha grass mountage (90%), Wicker willow shoot mountage (89%). Dried grass mountage (87%) and Mulberry shoot mountage (84%) (Table-3).

Weight of good cocoon

Statistical analysis of the data revealed that there exists significant differences with regard to good cocoon weight. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (446.0g) good cocoon weight followed by Maize straw mountage with the good cocoon weight of 414.0 grams. The good cocoon weight recorded by other treatments include: Wicker willow shoot mountage (377.4g), Typha grass mountage (360.0g), Mulberry shoot mountage (336.0g) and Dried grass mountage (325.0g) (Table-3).

Defective cocoon (%)

Statistical analysis of the data revealed that there exists significant differences with regard to defective cocoon percentage. Among the evaluated mountages Plastic collapsible mountage (control) recorded least defective cocoon of 4 percent which was at par with Maize straw mountage with defective cocoon percentage of 5 percent. The defective cocoon percentage recorded by other treatments include: Typha grass mountage (6%), Wicker willow shoot mountage (7%). Dried grass mountage (8%) and Mulberry shoot mountage (10%) (Table-4). Tazima, (1972) also reported increase or decrease in the number of defective cocoons varies depending on the material and structure of the cocooning frame.

Weight of defective cocoons

Statistical analysis of the data revealed that there exists significant differences with regard to weight of defective

cocoons. Among the evaluated mountages Plastic collapsible mountage (control) recorded least defective cocoon weight of 19.50 grams which was at par with Maize straw mountage with defective cocoon weight of 22.75 grams. Weight of defective cocoon recorded by other treatments include: Typha grass mountage (24.0g), Wicker willow shoot mountage (25.76g). Dried grass mountage (29.50g) and Mulberry shoot mountage (40.75g) (Table-4).

Table 3: Effect of different mountages on formation of good cocoons

Treatment	Good cocoons (No./mountage)	Good cocoon (%)	Weight of good cocoons(g /mountage)
Plastic collapsible mountage	235^{a}	94^{a}	446.0^{a}
Mulberry shoot mountage	210^{d}	84^{d}	336.0^{d}
Dried grass mountage	217^{c}	87^{c}	325.0^{d}
Typha grass mountage	225^{b}	90^{b}	360.0^{cd}
Maize straw mountage	230^{ab}	92^{ab}	414.0^{b}
Wicker willow shoot mountage	222^{bc}	89^{bc}	377.4^{c}
C.D ($p \leq 0.05$)	5.98	2.48	27.08

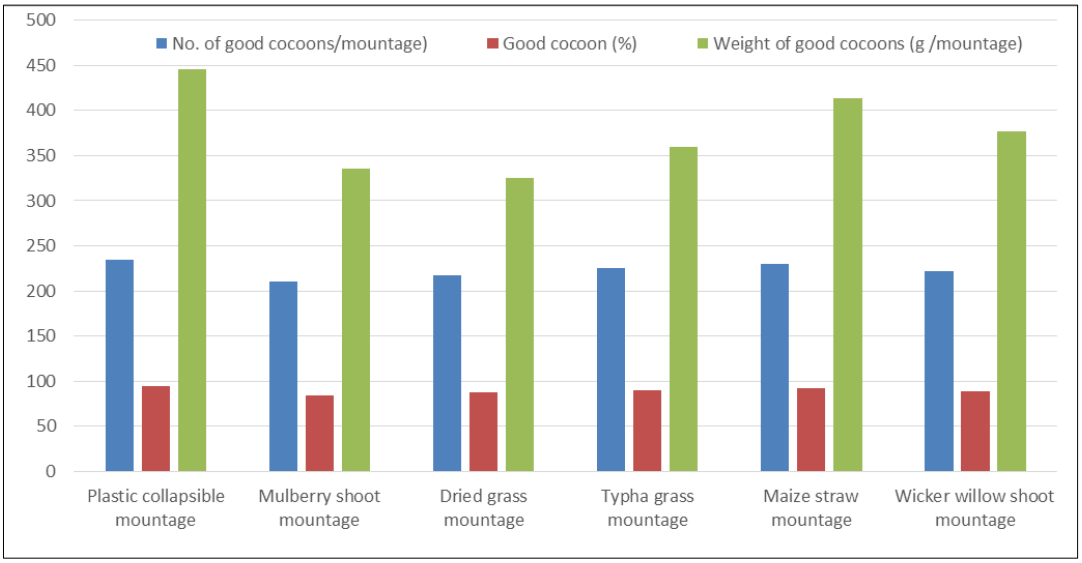

Fig 3: Effect of different mountages on formation of good cocoons

Table 4: Effect of different mountages on formation of defective cocoons

Treatment	Defective cocoons (No./ mountage)	Defective cocoon (%)	Weight of defective cocoons (g /mountage)
Plastic collapsible mountage	10^{d}	4^{d}	19.5^{d}
Mulberry shoot mountage	25^{a}	10^{a}	40.75^{a}
Dried grass mountage	20^{b}	8^{b}	29.5^{b}
Typha grass mountage	15^{cd}	6^{c}	24.0^{c}
Maize straw mountage	12.5^{d}	5^{cd}	22.75^{cd}
Wicker willow shoot mountage	16^{c}	7^{bc}	25.76^{c}
C.D ($p \leq 0.05$)	2.62	1.97	3.45

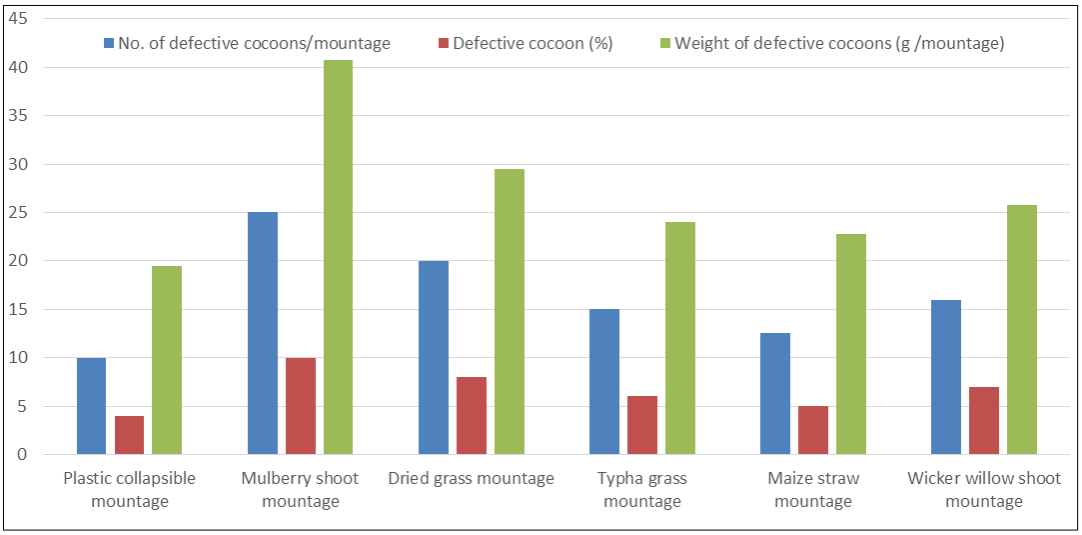

Fig 4: Effect of different mountages on formation of defective cocoons

Single cocoon weight

Statistical analysis of the data revealed that there exists significant differences with regard to single cocoon weight. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (1.9g) single cocoon weight which was at par with Maize straw mountage with single cocoon weight of 1.8 grams. The single cocoon weight recorded by other treatments include: Wicker willow shoot mountage (1.7g), Typha grass mountage (1.6g), Mulberry shoot mountage (1.6g) and Dried grass mountage (1.5g) (Table-5). The results are in conformity with the results of Singh *et al.*, (2002) [9] who reported that the single cocoon weight was maximum in plastic collapsible mountages (1.41g) and paddy straw cocoonage (1.39g). The results are also supported by the findings of Rajan and Datta (1996) [4] who reported that cocoon shell weight is largely influenced by type, material and structure of mountages used at spinning stage of silkworms.

Single shell weight

Statistical analysis of the data revealed that there exists significant differences with regard to single shell weight. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (0.460g) single shell weight which was at par with Maize straw mountage with single shell weight of 0.430 grams. The single shell weight recorded by other treatments include: Typha grass mountage (0.372g), Wicker willow shoot mountage (0.370g), Dried grass mountage (0.350g) and Mulberry shoot mountage (0.341g) (Table-5).

Shell (%)

Statistical analysis of the data revealed that there exists significant differences with regard to shell percentage. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (24.2%) shell percentage which was at par with Maize straw mountage with shell percentage of 23.8 percent. The shell percentage recorded by other treatments include: Dried grass mountage (23.3%), Typha grass mountage (23.2%), Wicker willow shoot mountage (21.7%) and Mulberry shoot mountage (21.3%) (Table-5). The findings are in conformity with the results of Singh *et al.*, (2002) [9] who reported that the shell (%) was maximum in plastic collapsible mountages (18.08%) and paddy straw cocoonage (17.89%).

Pupation rate (%)

There was non-significant effect of the treatments on the pupation rate. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (94.21%) pupation rate followed by Maize straw mountage with pupation rate of 93.11 percent. The pupation rate recorded by other treatments include: Dried grass mountage (92.43%), Typha grass mountage (91.25%), Mulberry shoot mountage (88.32%) and Wicker willow shoot mountage (85.35%) (Table-5).

Table 5: Effect of different mountages on commercial cocoon parameters of *Bombyx mori.* L

Treatment	Single cocoon weight (g)	Single shell weight (g)	Shell (%)	Pupation rate (%)
Plastic collapsible mountage	1.9^{a}	0.460^{a}	24.2^{a}	94.21^{a}
Mulberry shoot mountage	1.6^{bc}	0.341^{b}	21.3^{c}	88.32^{d}
Dried grass mountage	1.5^{c}	0.350^{b}	23.3^{b}	92.43^{b}
Typha grass mountage	1.6^{bc}	0.372^{b}	23.2^{b}	91.25^{c}
Maize straw mountage	1.8^{ab}	0.430^{ab}	23.8^{ab}	93.11^{b}
Wicker willow shoot mountage	1.7^{b}	0.370^{b}	21.7^{c}	85.35^{e}
C.D ($p \leq 0.05$)	0.1	0.066	0.5	0.74

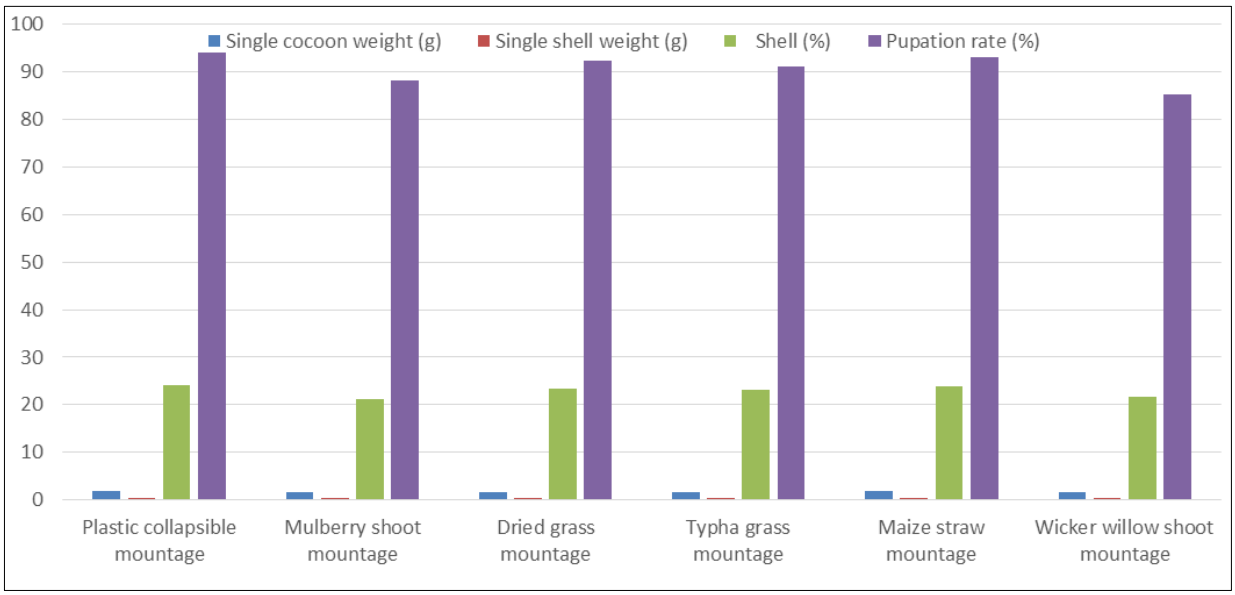

Fig 5: Effect of different mountages on commercial cocoon parameters of *Bombyx mori.* L

Floss weight

There was non-significant effect of the treatments on the floss weight. Among the evaluated mountages Plastic collapsible mountage (control) recorded least floss weight 0.252 milligrams followed by Wicker willow shoot mountage with floss weight of 0.253 milligrams. Floss weight recorded by other treatments include: Maize straw (0.257mg), Mulberry shoot mountage (0.262mg), Dried grass mountage (0.267mg)

and Typha grass mountage (0.278mg) (Table-6). The results are in agreement with the findings of Yokoyama, (1962) [13] who reported that the quantity of floss (non reelable silk) varies according to silkworm races and design of the cocooning frame.

Silk productivity

Statistical analysis of the data revealed that there exists significant differences with regard to silk productivity. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (6.57cg) silk productivity which was at par with Maize straw mountage with silk productivity of 6.14 centigrams. The silk productivity recorded by other treatments include: Typha grass mountage (5.31cg), Wicker willow shoot mountage (5.28cg), Dried grass mountage (5.00cg) and Mulberry shoot mountage (4.87cg) (Table-6).

Raw silk percentage

Statistical analysis of the data revealed that there exists significant differences with regard to raw silk percentage. Among the evaluated mountages Plastic collapsible mountage (control) recorded maximum (16.97%) raw silk percentage which was at par with Maize straw mountage and Typha grass mountage with raw silk percentage of 16.28 and 16.26 percent respectively. The raw silk percentage recorded by other treatments include: Dried grass mountage (15.18%), Wicker willow shoot mountage (15.10%) and Mulberry shoot mountage (15.08%) (Table-6).

Table 6: Effect of different mountages on silk productivity

Treatment	Floss weight (mg)	Silk productivity(cg)	Rawsilk (%)
Plastic collapsible mountage	0.252	6.57^{a}	16.97^{a}
Mulberry shoot mountage	0.262	4.87^{b}	15.08^{b}
Dried grass mountage	0.267	5.00^{b}	15.18^{b}
Typha grass mountage	0.278	5.31^{b}	16.26^{ab}
Maize straw mountage	0.257	6.14^{a}	16.28^{a}
Wicker willow shoot mountage	0.253	5.28^{b}	15.10^{b}
C.D ($p \leq 0.05$)	NS	0.490	1.08

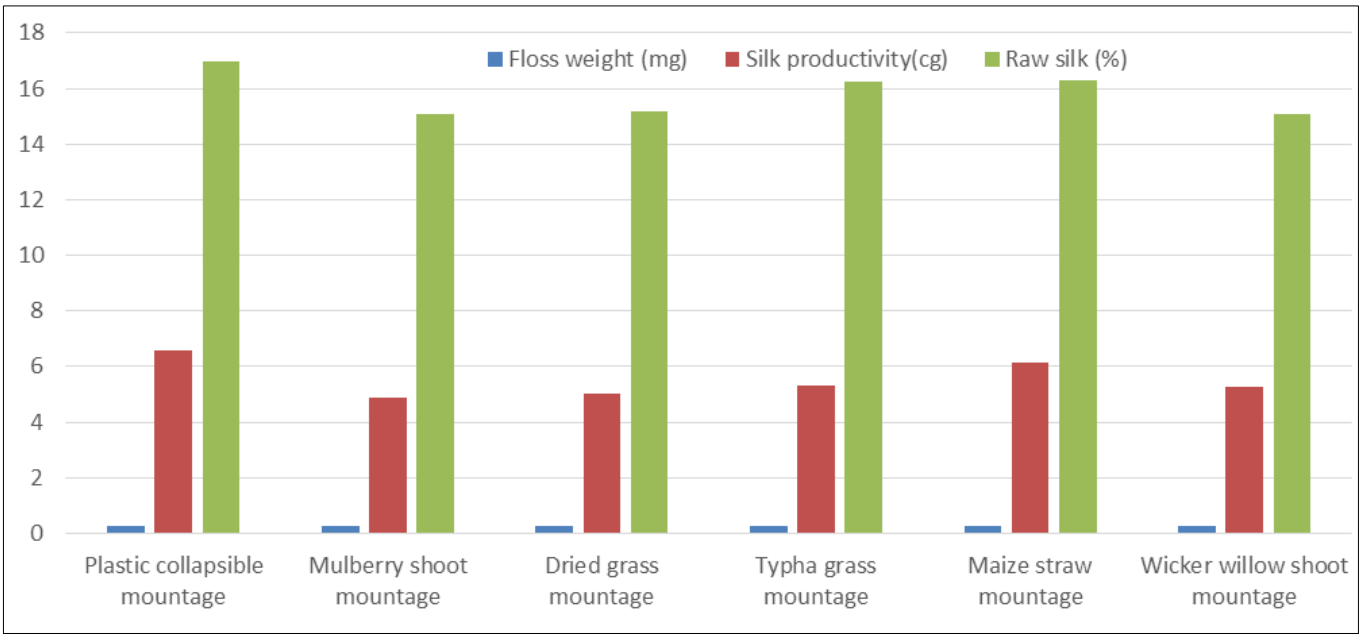

Fig 6: Effect of different mountages on silk productivity

Cocoon crop weight was recorded maximum (445.0g) in case of Plastic collapsible mountages which was at par with that of Maize straw mountages with a cocoon crop weight of 436.0 grams. The results are in conformity with the results of Singh *et al.*, (2002) [9] who reported that cocoon crop weight was higher in plastic collapsible mountages (13.960kg). The cocoon crop weight recorded by other treatments include: Wicker willow shoot mountage (403.0g), Typha grass mountage (384.0g), Mulberry shoot mountage (376.0g) and Dried grass mountage (356.0g).

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