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## Performance of chawki and late age rearing fed with same varieties for double hybrid (FC1×FC2) during spring (2019) under sub-tropical condition of Jammu (J&K)

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### Abstract

The study was conducted to know the performance of double hybrid (FC1×FC2) where chawki and late age rearing were fed with same varieties during spring (2019). Mature larval weight was significantly maximum in Vishala (55.02 g/10 larvae) and minimum in S-1635 (49.66 g/10 larvae). The ERR by number recorded among different varieties were significant statistically. The S - 1635 recorded more ERR by No. (8933.33) and least in Vishala (7300.00). The ERR by weight was highest in S - 146 (16.58 Kg) and showed significantly from other varieties & lowest in C-2038 (13.41 Kg). The pupation rate recorded non-significant differences with higher pupation rate recorded 92.67 per cent in S-146 & S-1635 and lowest in Vishala (90.33%). The single cocoon weight was found significant, Vishala recorded highest cocoon weight 2.05 g followed by S-146 (1.90 g) and lowest in C-2038 (1.80 g). The higher shell weight was observed 0.45 g in Vishala and lowest in G-4 (0.36 g). There was statistical significant variation in the shell ratio with highest shell ratio was recorded in Vishala (21.95%) followed by S-1635 (20.59 %) and lowest in G-4 (19.53 %). There was significant variation in the defective cocoon per centage with highest per cent was in Vishala (9.67%) followed by G-4 (9.33%) and lowest in S-146 & S-1635 (7.33%). The filament length was found significant; G-4 recorded highest filament length of about 1151 m followed by S-1635 (1117 m) and lowest in Vishala (936 m). The denier recorded significant, Vishala recorded lowest denier of about 2.78 followed by S-146 (2.91) and G-4 (2.92) and highest in C-2038 (3.06) and S-1635 (3.04). The renditta observed significant, C-2038 was recorded lowest renditta of about 2.50 followed by G-4 (2.67) and S-1635 (2.75) and highest in S-146 (3.00). The raw silk was significantly varied, C-2038 was recorded highest raw silk having 40.26 per cent (C-2038) followed by S-1635 (38.94%) and lowest in Vishala (35.03 %) and S-146 (33.74 %). Significantly varied reelability among different varieties, G-4 observed highest reelability having 83.67 per cent and lowest in S-1635 (74.10 %). According to the evaluation index, the mulberry varieties were shortlisted as S-146 having E.I value 51.61 followed by Vishala (51.54) and S-1635 (50.27) respectively.

**Keywords:** Double hybrid, mulberry varieties, chawki, late age, economic parameters, evaluation index

### Introduction

About 92.20 per cent of the silk produced in the world is obtained from mulberry silkworm *Bombyx mori* L. reared solely on mulberry leaves (*Morus* spp.). Leaf quality is an important parameter used for evaluation of varieties aimed at selection of superior varieties for rearing performance [44, 8]. Growth and development of silkworm *B. mori* L. is known to vary depending on the quality and quantity of mulberry leaf used as food source, which in turn indicated by commercial characteristics of cocoon crop [30, 42, 4, 29]. Superiority of different mulberry varieties used as food for silkworm larvae greatly affects the economy of sericulture industry [11]. Nutritive value of mulberry (*Morus* spp.) leaf is a key factor besides environment and technology adoption for better growth and development of the silkworms and cocoon production [33]. It is a confirmed fact that, leaf quality differs among mulberry varieties which in turn responsible for the difference in silkworm rearing performances [8]. Leaves of superior quality enhance the chances of good cocoon crop [34].

Silkworm, *B. mori* L. is a monophagous insect, feeding exclusively on the mulberry leaves (*Morus* spp.) and an important plant forming the backbone of sericulture industry. Silkworm is gregarious in habit and it grows ten thousand times in weight from hatching to seriposition. Single worm eats about 20 g of leaf throughout its larval life with 90 per cent of it in the last two instars to produce large quantity of silk. Different hybrids of silkworm differ in their nutritional requirements, body growth and cocoon parameters.

Feed consumption has a direct impact on larval weight, cocoon weight, silk production and number of eggs laid by a moth. Mulberry leaf quality is one of the key factors influencing the growth and development of silkworm, as the insect derives all the nutrients from mulberry leaf itself [3]. High commercial exploitation of *B. mori* L. has led to the evaluation of many silkworm races and mulberry varieties which has increased both silk production as well as mulberry leaf yield [2]. Successful rearing of silkworm depends on three major factors; mulberry leaf, environment and silkworm hybrid. Mulberry leaf solely contributes about 38.20 per cent towards successful rearing/quality cocoon production [14], besides environmental conditions which contributes about 37.00 per cent.

Better the quality of mulberry leaves greater are the possibilities of obtaining good cocoon crops. Since the production of good quality cocoons depends on providing good quality leaves to silkworm, the development of superior quality leaf has become one of the prime objectives in mulberry breeding programme. Different quality traits such as leaf moisture content, proteins, carbohydrates, nitrogen, amino acids and chlorophyll are responsible for leaf quality [7]. About 70 per cent protein of Silk is directly derived from mulberry leaves. The nutrient contents of mulberry leaves have a great effects on the growth of Silkworm, Cocoon crop and finally on raw-silk-yield. Worm health and cocoon characters are highly affected by quality and quantity of food [20, 35]. The efficiency of converting the ingested and digested food into body, cocoon and cocoon shell varies among the Silkworm breeds under the influence of mulberry varieties and season [1]. Keeping this background in mind the present study was envisaged to identify suitable mulberry varieties for commercial silkworm production under sub-tropical conditions of Jammu region.

## Material and Methods

### Location

The experiment trial was undertaken at Regional Sericultural Research Station (RSRS), Miran Sahib, Jammu. The rearing was conducted in lab to know the performance of double hybrid (FC1×FC2) reared on different mulberry varieties with chawki and late age were fed with same mulberry varieties during spring (2019).

### Collection of data

Suitable elite mulberry varieties viz., C-2038, S-146, Vishala, G-4 and S-1635 were used for the study and collected the data to know the rearing performance of double hybrid of silkworm from five varieties with three replications, each replication having 300 worms. The rearing performance of silkworms was collected at the stage of third instars onwards. For each variety details of the following economic parameters were recorded viz., larval weight, cocoon weight, shell weight, shell ratio, silk filament length and denier.

### Statistical analysis

The experimental data collected on various economic and yield parameters were subjected to Fisher's method of analysis of variance (ANOVA) as per methods outlined [17]. Critical difference (CD) was calculated wherever the 'F' test was found significant. The data are presented with the level of significance at 5 per cent. The data pertaining to economic traits viz., fifth age larval duration, total larval duration, pupation percentage, cocoon yield by ERR, cocoon weight, cocoon shell weight, cocoon shell percentage, average

filament length, denier, raw silk percentage, renditta, reelability and neatness was recorded. Evaluation Index was worked out as per the procedure suggested [26].

## Results

The rearing parameters was recorded where the varieties fed during chawki stage were continued the same varieties in late age rearing and recorded the following pre-cocoon and post-cocoon parameters on double hybrid (FC-1×FC-2) i.e. (CSR<sub>6</sub> × CSR<sub>26</sub>) × (CSR<sub>2</sub> × CSR<sub>27</sub>).

### Fifth instar larval duration (h)

The fifth instar larval duration was non significantly varied among different varieties and was recorded as 6 days for all the varieties (Table 1).

### Total larval duration (h)

There was non significant variation in the total larval duration with all the varieties and recorded total larval duration of about 25 days 5 h (Table 1).

### Mature larval weight (g)

Mature larval weight was significantly maximum when the FC-1×FC-2 worms were fed with leaves of variety, Vishala (55.02 g/10 larvae) followed by S - 146 (52.04 g/10 larvae), G-4 (51.86 g/10 larvae) and C-2038 (50.77 g/10 larvae). Whereas, significantly minimum mature larval weight was recorded in silkworm fed with leaves of S-1635 (49.66 g/10 larvae) and all the varieties showed statistically significant among each other (Table 1).

### Effective Rate of Rearing (ERR)

The ERR by number recorded among different varieties were significant statistically. The varieties S - 1635 recorded more ERR by No. (8933.33) followed by S - 146 (8722.22), C-2038 (8066.67), G-4 (7644.67) and least in Vishala (7300.00) (Table 1).

The ERR by weight (Kg) was recorded highest in the variety S-146 (16.58) and showed significantly from other varieties followed by S - 1635 (15.80), Vishala (14.17) & G-4 (13.54) & lowest was observed in C-2038 (13.41 Kg) (Table 1).

### Pupation rate (%)

The pupation rate obtained from the mulberry varieties were fed with double hybrid recorded non - significant difference with higher pupation rate was recorded 92.67 per cent in S-146 & S-1635 followed by C-2038 (91.00%) and G-4 (90.67%). The lowest pupation was recorded in Vishala (90.33%) respectively (Table 1).

### Single cocoon weight (g)

The single cocoon weight was found significant differences among varieties, Vishala performed well during rearing which recorded highest cocoon weight 2.05 g followed by S-146 (1.90 g), G-4 (1.86 g) & S-1635 (1.81 g). The lowest cocoon weight was recorded in C-2038 (1.80 g) (Table 1).

### Single shell weight (g)

The cocoon obtained from the silkworm double hybrid recorded significant differences with different mulberry varieties with higher shell weight was observed 0.45 g in Vishala followed by S-146 (0.38 g). The lowest shell weight was recorded in G-4 (0.36 g) (Table 1).

### Shell ratio (%)

There was statistical significant variation in the shell ratio among the varieties, however the hybrid performed better

during rearing for the different varieties, of which highest shell ratio was recorded in Vishala (21.95 %) followed by S-1635 (20.59 %). The lowest shell ratio was recorded in G - 4 (19.53 %) (Table 1).

#### Defective cocoon (%)

There was significant variation in the defective cocoon *per cent* among all the varieties, however the varieties were recorded defective cocoons during rearing for the different varieties with highest *per cent* was in Vishala (9.67 %) followed by G-4 (9.33 %). The lowest defective cocoons were recorded in S-146 & S-1635 (7.33 %) (Table 1).

#### Post cocoon parameters recorded during chawki and late age feeding with same varieties

##### Average Filament length (m)

The filament length was found significantly among different varieties, G-4 was recorded highest filament length of about 1151 m followed by S-1635 (1117 m). The lowest filament length was recorded in Vishala (936 m) (Table 2).

##### Denier

The denier varied significantly among different varieties, Vishala which recorded lowest denier of about 2.78 followed by S-146 (2.91) and G-4 (2.92) respectively. The highest denier recorded in C-2038 (3.06) and S-1635 (3.04) respectively (Table 2).

#### Renditta

The renditta varied significantly among different varieties, C-2038 which was recorded lowest renditta of about 2.50 followed by G-4 (2.67) and S-1635 (2.75). The highest renditta recorded in S-146 (3.00) respectively (Table 2).

#### Raw silk (%)

The raw silk was significantly varied among different varieties, C-2038 was recorded highest raw silk having 40.26 *per cent* (C-2038) followed by S-1635 (38.94 %). The lowest raw silk *per cent* was recorded in Vishala (35.03 %) and S-146 (33.74 %) respectively (Table 2).

#### Reelability (%)

Significantly varied reelability among different varieties, G-4 observed highest reelability having 83.67 *per cent* followed by S-146 (82.00 %) and C -2038 (81.03 %) respectively. The lowest reelability was recorded in S-1635 (74.10 %) (Table 2).

#### Evaluation index for mulberry varieties used during chawki and late age rearing with same varieties

The mulberry varieties *viz.*, S-146, S-1635, G-4, Vishala and C-2038 were fed with double hybrid FC<sub>1</sub>×FC<sub>2</sub> during chawki stage and the same varieties were fed during late age rearing and according to the evaluation index, the mulberry varieties were shortlisted as S - 146 having E.I value 51.61 followed by Vishala (51.54) and S-1635(50.27) respectively (Table 3; Fig. 1).

**Table 1:** Economic parameters recorded during chawki and late age feeding with same varieties on double hybrid (FC<sub>1</sub>×FC<sub>2</sub>) silkworm, *Bombyx mori* L.

Variety	LD (D:h)	5 <sup>th</sup> LD (D:h)	LW (g.)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	DC (%)
				No.	Wt. (Kg)					
S -146	25.05	6.00	52.04	8722.22 (93.39)	16.58	1.90	0.38	20.41 (26.84)	92.67 (74.31)	7.33 (15.69)
S -1635	25.05	6.00	49.66	8933.33 (94.52)	15.80	1.81	0.37	20.59 (26.97)	92.67 (74.50)	7.33 (15.69)
G -4	25.05	6.00	51.86	7644.67 (87.44)	13.54	1.86	0.36	19.53 (26.21)	90.67 (72.41)	9.33 (17.77)
VISHALA	25.05	6.00	55.02	7300.00 (85.44)	14.17	2.05	0.45	21.95 (27.92)	90.33 (71.97)	9.67 (18.10)
C -2038	25.05	6.00	50.77	8066.67 (89.82)	13.41	1.80	0.37	20.54 (26.93)	91.00 (72.92)	9.00 (17.44)
CD @ 5 (%)	NS	-	0.43	0.003	0.59	0.04	0.01	0.57	NS	0.03
Sem±	0.006	NS	0.13	0.001	0.18	0.01	0.005	0.17	2.03	0.009
CV (%)	0.03	-	0.45	0.002	2.19	1.29	2.30	1.15	4.81	0.09

Note: LD-Larval duration; D-days; H-hours; LW- Larval weight; ERR- effective rate rearing; PR- pupation rate; SCW- Single cocoon weight; SSW- Single shell weight; SR – Shell ratio; PR-Pupation rate; DC- defective cocoon; NS- Non Significance; Values in parentheses are statistically transformed

**Table 2:** Post cocoon parameters recorded during chawki and late age feeding with same varieties on double hybrid (FC<sub>1</sub>×FC<sub>2</sub>) silkworm, *Bombyx mori* L.

Variety	AFL (mtrs)	Denier	Renditta	Raw Silk (%)	Reelability (%)
S -146	1026.00	2.91	3.00	33.74 (35.49)	82.00 (64.94)
S -1635	1117.00	3.04	2.75	38.94 (38.59)	74.10 (59.38)
G -4	1151.00	2.92	2.67	37.81 (37.92)	83.67 (66.13)
Vishala	936.00	2.78	2.88	35.03 (36.27)	79.49 (63.04)
C -2038	986.00	3.06	2.50	40.26 (39.36)	81.03 (64.15)
CD @ 5 (%)	8.68	0.10	0.09	0.05	2.26
Sem±	2.72	0.03	0.03	0.01	0.70
CV (%)	0.45	1.95	1.95	0.07	1.93

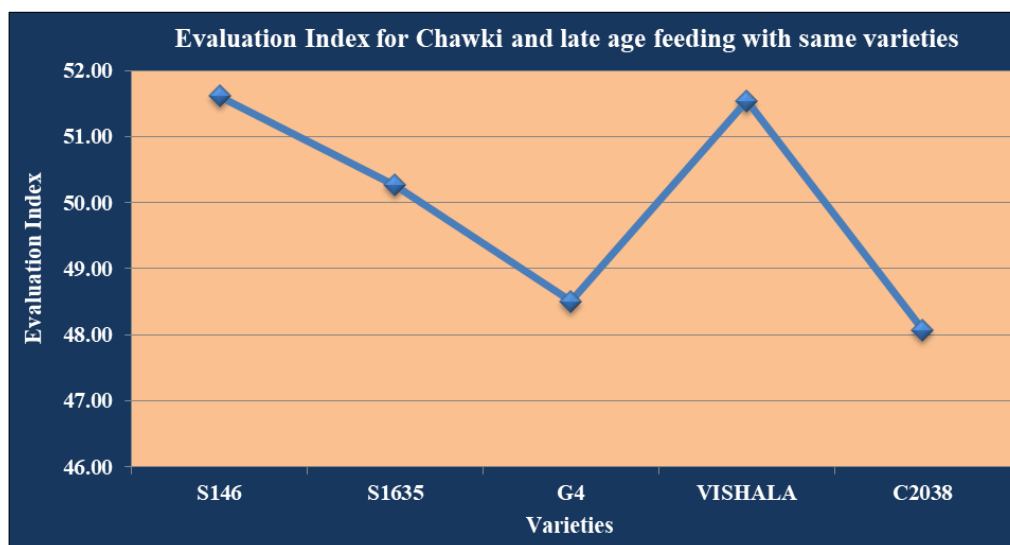
Note: AFL-Average filament length; Values in parentheses are statistically transformed

**Table 3:** Evaluation index for economic parameters recorded during chawki and late age feeding with same varieties on double hybrid (FC<sub>1</sub>×FC<sub>2</sub>) silkworm, *Bombyx mori* L. during spring season (2019-20)

Variety	LW (g.)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	DC (%)	AFL (mtr)	Denier	Renditta	Raw Silk (%)	Reelability (%)	Average
		No.	Wt. (Kg)											
S146	50.84	58.49	63.26	51.50	48.68	47.74	60.71	39.29	48.08	47.17	62.49	37.41	55.31	51.61
S1635	38.97	61.53	57.77	42.85	45.86	49.82	60.71	39.29	58.23	58.66	49.48	56.58	33.72	50.27

G4	49.94	42.95	41.84	47.50	43.03	37.66	42.86	57.14	62.03	48.06	45.32	52.41	59.87	48.51
VISHALA	65.73	37.99	46.23	66.47	67.51	65.55	39.89	60.11	38.04	35.69	56.24	42.16	48.45	51.54
C2038	44.51	49.04	40.90	41.68	44.92	49.24	45.84	54.16	43.62	60.42	36.47	61.44	52.66	48.07

Note: LW- Larval weight; ERR- effective rate of rearing; PR- pupation rate; SCW- Single cocoon weight; SSW- Single shell weight; SR – Shell ratio; DC- Defective cocoon; AFL – average filament length; Values in parentheses are statistically transformed



**Fig 1:** Evaluation index for economic parameters recorded during chawki and late age feeding with same varieties on double hybrid (FC<sub>1</sub>×FC<sub>2</sub>) silkworm, *Bombyx mori* L. during spring season (2019)

## Discussion

### Mature larval weight (g)

Mature larval weight was significantly maximum when the FC-1×FC-2 worms were fed with leaves of variety, Vishala (55.02 g/10 larvae) followed by S-146 (52.04 g/10 larvae), G-4 (51.86 g/10 larvae) and C-2038 (50.77 g/10 larvae). Whereas, significantly minimum mature larval weight was recorded in silkworm fed with leaves of S-1635 (49.66 g/10 larvae) and all the varieties showed statistically significant among each other. The variation in larval weight may be due to the difference in nutritional composition of the leaf. Larval weight was maximum during fifth instar. This may be due to maximum food consumption and growth rate during fifth instar. The present results are comparable with the findings, who observed significant differences in weight of larvae when the silkworm larvae were fed on mulberry varieties viz., Kanav-2, Kosen, LM-1, LM-2, Mysore Local, S-30, S-36, S-41 and S-54<sup>[41]</sup>. The nutritive quality of leaves Tr-10 and MR-2 varieties were found superior, as larvae fed on these two varieties have shown higher values larval weight<sup>[40]</sup>. The evaluation of seven mulberry genotypes suggested that SKM-27 recorded the highest larval weight (52.59 g)<sup>[19]</sup> and also results observed better larval growth with different mulberry varieties<sup>[23, 43]</sup>.

### Effective Rate of Rearing (ERR)

The ERR by number recorded among different varieties were significant statistically. The varieties S-1635 recorded more ERR by No. (8933.33) followed by S-146 (8722.22), C-2038 (8066.67), G-4 (7644.67) and least in Vishala (7300.00). The ERR by weight was recorded highest in the variety S-146 (16.58 Kg) and showed significantly from other varieties followed by S - 1635 (15.80), Vishala (14.17) & G-4 (13.54) & lowest was observed in C-2038 (13.41 Kg).

Krishnaswami *et al.* (1970) observed that Berhampore variety was better than Kosen and Mandalaya with regard to effective rate of rearing and mean cocoon weight<sup>[23]</sup>. The varieties S-36, RFS- 135 and C-776 are equally good in their leaf yield

and cocoon yield<sup>[37]</sup>. Further, the observations recorded in Karnataka that K2 was superior to Mysore local for realizing gain in all cocoon characters<sup>[24]</sup> and the observations revealed that S1 mulberry variety showed distinct varietal effect on all economic cocoon characters<sup>[38]</sup> and advocated the standard rearing technologies<sup>[21, 22]</sup>. The results reported that yield/10,000 larvae by weight was maximum in genotypes SKM-27 and SKM-48 which occupied 3<sup>rd</sup> and 4<sup>th</sup> rank as their performance<sup>[19]</sup>.

### Pupation rate (%), Single cocoon weight (g), Single shell weight (g) and Shell ratio (%)

The pupation rate obtained from the mulberry varieties were fed with double hybrid recorded non - significant difference with higher pupation rate recorded 92.67 per cent in S-146 & S-1635 followed by C-2038 (91.00 %), G-4 (90.67). The lowest pupation was recorded in Vishala (90.33 %) respectively. The single cocoon weight was found significant differences among varieties, Vishala performed well during rearing which recorded highest cocoon weight 2.05 g followed by S-146 (1.90 g), G-4 (1.86 g) & S-1635 (1.81 g). The lowest cocoon weight was recorded in C-2038 (1.80 g). The cocoon obtained from the silkworm double hybrid recorded significant differences with different mulberry varieties with higher shell weight was observed 0.45 g in Vishala followed by S-146 (0.38 g). The lowest shell weight was recorded in G-4 (0.36 g).

These results are in parallel to the findings, who evaluated the feed quality of 25 mulberry varieties utilizing two popular silkworm races viz., the crossbreed PM×CSR2 and PM×NB4D2 with significant differences observed among them. Significant differences were observed for cocoon weight when the larvae were fed on different mulberry varieties<sup>[40]</sup>. The observations reported that, the silkworm growth and cocoon characters were optimum when the leaves of V-1, V-4 and S-36 were fed to the larvae<sup>[18]</sup>.

There was statistical significant variation in the shell ratio among the varieties, however the hybrid performed better

during rearing for the different varieties, of which highest shell ratio was recorded in Vishala (21.95 %) followed by S-1635 (20.59 %). The lowest shell ratio was recorded in G-4 (19.53 %). There was significant variation in the defective cocoon *per centage* among all the varieties, however the varieties were recorded defective cocoons during rearing for the different varieties with highest *per cent* was in Vishala (9.67 %) followed by G-4 (9.33 %). The lowest defective cocoons were recorded in S-146 & S-1635 (7.33 %).

The evaluation of three improved Japanese mulberry cultivars *viz.*, Ichinose, Goshierami and Kokuso - 27 for nutritional potential by feeding experiments. The feeding of Ichinose leaves resulted in higher weight of matured larvae and improvement of economic traits of cocoon such as cocoon and shell weight and silk percentage as compared to other two varieties [10]. The studies on the interaction of different silkworm breeds with different mulberry varieties. The varieties S30, S36 and S54 registered high cocoon and shell weight, and silk percentage whereas cocoon melting was very low with S54 [16, 15]. Data pertaining to the rearing parameters *viz.*, larval weight, ERR, single cocoon weight, shell weight and cocoon shell ratio revealed that except larval duration (which differed significantly among the four genotypes) the other parameters were non-significant [25].

The evaluation of feed quality of 25 mulberry varieties utilizing two popular silkworm races *viz.*, the crossbreed PM×CSR2 and PM×NB4D2. Significant differences were observed for all the characters *viz.*, larval weight, survival rate, cocoon weight, shell weight, shell ratio, average filament length and filament denier, when the larvae were fed on different mulberry varieties [40]. Studied the efficiency of six varieties of mulberry leaves namely V-1, DD, S-36, S-41, Mysore Local and Khurda Local under laboratory condition. It was found that, maximum shell weight was in V1 and S36 and V-1 varieties of mulberry leaves are recommended for feeding in order to achieve better silk yield [6].

### Post cocoon parameters

The filament length was found significantly among different varieties, G-4 was recorded highest filament length of about 1151 m followed by S-1635 (1117 m). The lowest filament length was recorded in Vishala (936 m). When the chawki and late age worms were fed with same varieties, the denier varied significantly among different varieties, Vishala which recorded lowest denier of about 2.78 followed by S-146 (2.91) and G-4 (2.92) respectively. The highest denier recorded in C-2038 (3.06) and S-1635 (3.04) respectively. The renditta varied significantly among different varieties, C-2038 which was recorded lowest renditta of about 2.50 followed by G-4 (2.67) and S-1635 (2.75). The highest renditta recorded in S-146 (3.00) respectively.

When the chawki and late age worms were fed with same varieties, the raw silk was significantly varied among different varieties, C-2038 was recorded highest raw silk having 40.26 *per cent* (C-2038) followed by S-1635 (38.94 %). The lowest raw silk *per cent* was recorded in Vishala (35.03 %) and S-146 (33.74 %) respectively. Significantly varied reelability among different varieties, G-4 observed highest reelability having 83.67 *per cent* followed by S-146 (82.00 %) and C-2038 (81.03 %) respectively. The lowest reelability was recorded in S-1635 (74.10 %).

The studies on disease free eggs of silkworm hybrids MY1×CSR2 were utilized. The treatments were V-1, Kanva-2, BER-1, BER-779, Mizosava, A-1, S-30, S-34, S-36, and S-54. Observations on the different economic traits of silkworm,

*B. mori* L. were taken. Larval weight varied in the range of 33.77 g to 40.67 g. Variety V-1 (40.67 g), Larval duration was observed in the range of 21.04 days to 22.28 days. Variety BER-1 (21.04 days), Single cocoon weight 1.664 g to 1.863 g. The highest single cocoon weight was V-1 (1.863 g), Single shell weight 0.297 g to 0.364 g. Maximum shell weight V-1 (0.364 g), Shell percentage 17.60 per cent to 19.82 *per cent*. Maximum yield variety V-1 (18.63 Kg), was observed significantly superior, Cocoon filament length in the range of 680.00 m to 836.66 m. Longest filament length variety V-1 (836.66 m). These findings will help the sericulturists in finding suitable variety for getting more economic returns from silkworm rearing. It is observed that V-1 is becoming popular in Marathwada region [31].

Differences in silk quality parameters between the accessions might be due to difference in the nutritional contents in leaves of different accessions and larval duration during fifth instar. These results are in conformity with the findings, who reported significant differences in all the characters *viz.*, cocoon weight, shell weight, shell ratio, average filament length and filament denier, when the larvae were fed on different mulberry varieties [40]. The food quality influences the weight of the cocoon, silk yield and physicochemical properties of silk thread. The evaluation of seven mulberry genotypes through bioassays and reported that the highest filament length was recorded in Ichinose (1206 m) [19]. The results reported that, higher amino acids and protein content are of particular importance to the silkworm larvae because of their active utilization for the synthesis of silk protein [39].

The bioassays conducted on silkworm hybrid N×YB and reported maximum cocoon yield/ 10,000 larvae by weight in CCB9 (19.93 Kg) followed by CCB5 (19.91 Kg). While maximum shell ratio was found in CCB3 (17.49 %) followed by CCB4 (16.90 %) and maximum non-breakable filament length in CCB8 (857 m) followed by CCB3 (843 m) [9]. A critical evaluation study comprising five mulberry varieties *viz.*, S1708, MS5, C10, C6 and M5 was conducted for their leaf quality through silkworm moulting and rearing using crossbreed (PM×NB<sub>4</sub>D<sub>2</sub>) silkworms. Results revealed that, in moulting tests, silkworm larvae reared on S1708 mulberry leaves recorded highest larval weight (25.03 mg) and moulting ratio (84.96 %) and lowest larval weight (17.04 mg) and moulting ratio (71.06 %) recorded in silkworms reared on C6 leaves during II moult. Silkworms reared on S1708 leaves recorded highest larval weight (39.08 mg), cocoon weight (1.90 g), shell weight (0.41 g), shell percentage (21.66 %), filament length (957.57 mts), reelability (86.88 %), renditta (6.06), denier (2.08) and E.R.R (88.31 %), whereas lower larval weight (26.20 g), cocoon weight (1.30 g), shell weight (0.19 g), shell percentage (16.18 %), filament length (722.60 mts), reelability (56.12 %), renditta (8.30), denier (2.62) and E.R.R (78.86 %) were observed in C6 mulberry leaves [28].

### Evaluation index for mulberry varieties used during chawki rearing and late age rearing

The mulberry varieties *viz.*, S-146, S-1635, G-4, Vishala and C-2038 were fed with double hybrid FC1×FC2 during chawki stage and the same varieties were fed during late age rearing and according to the evaluation index, the mulberry varieties were shortlisted as S-146 having E.I value 51.61 followed by Vishala (51.54) and S-1635 (50.27) respectively.

Mulberry (*Morus* spp.) is an important plant forming the backbone of sericulture as it is the only food for silkworm. Due to its importance in silk producing areas, multiple varieties of mulberry have been developed suited to different

agro climates and topographies. The observations reported that due to heterozygous nature of mulberry, variability is high <sup>[13]</sup> and variations in characters have also been reported <sup>[12]</sup>. According to multiple character analysis, evaluation index formed a good tool for determining the superiority of mulberry varieties. They however advocated the inclusion of feeding response to give the holistic results <sup>[27, 32]</sup>.

Seven mulberry varieties recorded mean evaluation index (E.I.) values of >50 ranging from 50.01 to 60.29, whereas, control (Sujanpur) scored E.I. value of 35.10 only. Three mulberry varieties, S-146 (60.29), Tr- 8 (52.42) and Tr-10 (52.17) recorded average E.I. value >52 for all the characters under sub-tropical conditions <sup>[36]</sup>.

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