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Study on economic traits of bivoltine silkworm hybrids on V_1 mulberry variety of *Morus alba*

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Abstract
The present investigation was undertaken during August to December 2017-18 to study on economic traits of bivoltine silkworm hybrids on V_1 mulberry varietiey of *Morus alba*. The experiment was conducted in rearing house at Sericulture Research Unit, VNMKV, Parbhani laid in Randomized Block Design with eight treatments, replicated thrice. Disease free layings of silkworm hybrids (CSR_2×CSR_4), (CSR_{16}×CSR_{17}), (CSR_{50}×CSR_{51}), (CSR_{58}×CSR_{16}), SHP_2, SHR_1, DHR_4, DHP_5 procured from Central Sericulture Research & Training Institute, Mysore were used as test hybrid against mulberry variety V-1, in present investigation. During study it was observed that hatching percentage were significantly highest in hybrid CSR_{16}xCSR_{17} (97.48 percent), Minimum larval duration were observed in CSR_{58}xCSR_{16} (20.39), The weight of ten mature larvae was significantly superior in hybrids CSR_{16}xCSR_{17} (37.92 g) and DHP_5 (36.96 g), In single cocoon weight hybrid CSR_{16}xCSR_{17} (1.558 g) has shown superior performance followed by SHR_1 (1.538 g). The hybrid CSR_{16}xCSR_{17}(0.281g) recorded highest shell weight (g), The shell ratio (%) was higher in hybrid CSR_2xCSR_4 (20.15 percent).The hybrids DHP_5 (987 m), CSR_{16}xCSR_{17} (937.67 m), CSR_{50}xCSR_{51} (937.62 m) recorded superior performance in filament length (m), hybrid CSR_{16}xCSR_{17} (1.787 g) recorded significantly higher filament weight, the denier value and cocoon yield/10,000 larvae brushed were superior in hybrid SHR_1(1.869) and SHR_1(15.40 kg) respectively, the lowest disease incidence was recorded in hybrid CSR_{50}xCSR_{51} (6.00 percent).

Keywords: bivoltine hybrids, *Bombyx mori* L, economic traits, V_1

Introduction
Mulberry plant is first choice of mulberry silkworms. It is believed that mulberry plant is native of India or China particularly from lower slopes of Himalayas. Mulberry leaves form the basic food material for mulberry silkworm. For the first tme, the Indian Silk Industry has crossed 30,000 MT mark in terms of total raw silk producton in 2016-17 and recorded a producton of 30,348 MT as compared to 28,523 MT in 2015-16 indicatng an annual increase of 6.4%. Out of the total raw silk producton, mulberry sector contributed a total of 21,273 MT (Bivoltne (BV) - 5,266 MT and Cross Breed (CB) - 16,007 MT) as compared to 20,478 MT (BV - 4,613 MT and CB - 15,865 MT) in 2015-16. (Annonymous 2016-17) [3] In India traditionally silk producing states are Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu & Kashmir. Other states are Bihar, Madhya Pradesh and Uttar Pradesh. Out of these Karnataka produce 50% of the country total production and ranks 1st in India. Majority of Indian silk is from polyvoltine origin produced by small scale operators which cannot compete in international market in quality and uniformity. Therefore, there is a large scope for the increased production of quality silk to cater the need of power loom which could be possible only through the successful introduction of bivoltine sericulture on large scale coupled with large scale multiend reeling unit. The evolution of bivoltine breeds suited to farmer's condition, *i.e.*, inferior management levels, poor quality mulberry leaves and fluctuating microclimatic conditions thus become necessary to maintain at optimum condition (Quadri *et al*., 2013) [7]. In India during 2016-17 area under Mulberry was 216810 ha and Total Silk Production was 21273 MT. In Maharashtra state during 2016-17 the area under mulberry plantation was 3480 ha. Production of raw silk was 231 MT. (Anonymous 2016 - 17) [2].

Materials and Methods
The present investigation was undertaken during August to December 2017-18 to study on economic traits of bivoltine silkworm hybrids on V_1 mulberry varieties of *Morus alba*.

The experimental was conducted in Randomized Block Design with eight treatments and three replications.

Silkworm Hybrids

T_1 - $CSR_2 \times CSR_4$
T_2 - $CSR_{16} \times CSR_{17}$
T_3 - $CSR_{50} \times CSR_{51}$
T_4 - $CSR_{58} \times CSR_{16}$
T_5 - SHP_2
T_6 - SHR_1
T_7 - DHR_4
T_8 - DHP_5

The improved technology of silkworm rearing adapted in this present investigation was described by Krishnaswami (1978) [4].

Observations: Observations were taken on following parameters on ten randomly selected larvae/ cocoons of silkworm hybrids from each replication of each treatment

Hatching percentage: The mean number of larvae hatched out of the total eggs laid by a female moth in three dfls per hybrid was recorded and expressed in percentage.

$$\text{Hatching (\%)} = \frac{\text{No. of hatched eggs}}{\text{Total No. of eggs}} \times 100$$

Ten Larval weight (g): The maximum larval weight will recorded by taking the weight to matured larvae just before the onset of spinning.

Larval duration (days): The total larval period will be measured by recording period from hatching to the onset of spinning.

Single cocoon weight: The cocoon weight will recorded on 6th day of spinning. The average of 10 cocoons is taken as single cocoon weight.

Single shell weight: The cocoon will cut open at one end and shell weight will recorded after removing pupae.

Cocoon shell Ratio (%)

$$\text{Shell Ratio (\%)} = \frac{\text{Single shell weight}}{\text{Single cocoon weight}} \times 100$$

- **Cocoon filament length (m)-**Cocoon filament weight will be measured by reeling 10 cocoons in four replication with the help of electronic balance.
- **Denier -** It is the term used to denote the thickness of silk filament and expressed in terms of ratio of weight of filament, to the filament length multiplied by 9000. (Vanvathy, 1965).

$$\text{Denier} = \frac{\text{Filament weight (g)}}{\text{Filament length (m)}} \times 9000$$

Result and Discussion

The perusal of literature revealed that very meager information is available on the mulberry silkworm hybrids under Marathwada conditions. Hence, the results obtained are discussed in the light of available literature on the other related hybrids.

Percent hatching: It is evident from the Table-1 that that significantly highest hatching was recorded in the hybrid $CSR_{16}xCSR_{17}$ (97.48 percent) followed by hybrid CSR_2x CSR_4 (95.676 percent), SHR_1 (95.16 percent), $CSR_{50}xCSR_{51}$ (93.49 percent) and DHR_4 (90.91 percent).The lowest hatching percentage was recorded in hybrid SHP_2 (60.81) which was at par with DHP_5 (64.36 percent), CSR_{58} x CSR_{16} (83.30 percent) and CSR_{16} x CSR_{17} (79.79 percent).
Vidhate (2009) [11] and Salunke (2003) [8] observed that bivoltine hybrid $CSR_{16}xCSR_{17}$ was superior with hatching percentage (95.22 and 97.22 percent respectively) in their experiment confirming results of present findings.

Larval duration (days) of silkworm: Among all the silkworm hybrids, The bivoltine hybrid $CSR_{58}xCSR_{16}$ had shown the shortest larval duration (20.39) days and found significantly superior over CSR_2xCSR_4 (22.59) followed by CSR_{16} x CSR_{17} (22.46), DHP_5 (22.37) and CSR_{50} x CSR_{51} (22.00) However it was at par with DHR_4 (21.58), SHR_1 (21.59) and SHP_2(21.61). The treatment CSR_2 x CSR_4 (22.59) shown longest larval larval duration which was at par with CSR_{16} x CSR_{17} (22.46), DHP_5 (22.37) and CSR_{50}x CSR_{51} (22.00). (Table 1).
Salunke (2003) [8] reported that under favourable condition the bivoltine hybrid CSR_{18} x CSR_{19} recorded significantly shortest larval duration (21.43 days) than all other bivoltine hybrids. Vidhate (2003) [10] had observed the larval duration of CSR18 x CSR19 (21.68 days) as significantly superior than others. Rayar (2010) observed 575 hrs larval developmental period in $CSR_2 \times CSR_4$.

Weight of ten mature larvae: The bivoltine hybrid $CSR_{16}xCSR_{17}$ (37.92 g) was observed significantly superior over rest of hybrids followed by DHP_5 (36.96 g), $CSR_{50}xCSR_{51}$ (35.27 g), SHR_1(35.15 g) and DHR_4(34.95). The lowest weight of ten mature larvae was recordrd in check CSR_2xCSR_4 (30.81 g). (Table 1)
Shinde (2010) and Paighan (2012) [6] recorded highest larval weight in bivoltine hybrid $CSR_{16}xCSR_{17}$ (43.85 g and 34.70 g respectively) over the rest of the hybrids tested.

Single cocoon weight: The highest significant cocoon weight was found in bivoltine hybrid $CSR_{16}xCSR_{17}$ (1.558 g) followed by SHR_1 (1.538 g). The single cocoon weight was lowest in the hybrid CSR_2xCSR_4 (1.155 g) which was at par with DHR_4 (1.199 g). (Table 1)
The bivoltine hybrid $CSR_{16}xCSR_{17}$ showed maximum single cocoon weight(1.98 g) and found significantly superior over rest of hybrids. Akio (2000) also reported hybrid $CSR_{16}xCSR_{17}$ superior in single cocoon weight.

Single shell weight: The bivoltine hybrid CSR_{16} x CSR_{17} (0.281g) recorded highest shell weight followed by DHP_5 (0.276 g) CSR_{50} x CSR_{51} (0.274 g). The lowest shell weight was recorded in hybrid DHR_4 (0.232 g). (Table 1)
Paighan (2012) [6] recorded highest shell weight in CSR_{16} x CSR_{17} (0.340 g). Shinde (2010) and Vidhate (2009) [11] observed that hybrid $CSR_{16}xCSR_{17}$ recorded maximum shell weight of (0.391 g) and (0.393 g) and found superior over rest of hybrids. Akio (2000) and Salunke (2003) [8] recorded highest shell weight in CSR_{16} x CSR_{17} bivoltine hybrid.

Shell ratio: The significantly highest shell ratio was observed in DHP_5 (22.26 Percent) which is followed by the CSR_2 x CSR_4 (20.15 percent). The lowest shell ratio was observed in hybrid SHR_1 (17.58 percent). (Table 1)

Filament length (m): The bivoltine hybrid DHP_5 (987 m) recorded significantly higher filament length over the rest of hybrids followed by $CSR_{16}xCSR_{17}$ (937.67 m) $CSR_{50}xCSR_{51}$ (937.62 m). The lowest filament length was recorded by hybrid DHR_4 (770 m).
Paighan (2012) [6] and Shinde (2010) in their experiment hybrid $CSR_{16}xCSR_{17}$ recorded highest filament length (903 m) and (940 m) respectively. (Table 1)

Denier: The hybrid SHR_1 (1.869) has significantly higher denier value followed by CSR_{16} x CSR_{17} (1.715), CSR_2 x CSR_4 (1.715). The lowest denier value was recorded by hybrid DHP_5 (1.204). (Table 1)

Conclusion

Based on overall performance it can be concluded that the bivoltine hybrid CSR16 x CSR17 reared on mulberry variety V-1 is the most suitable for rearing under Marathwada conditions.

Table 1: Performance of bivoltine silkworm hybrids on different economic traits

Treatments	Hatching (%)	Larval duration (Days)	Weight of 10 mature larvae	Single cocoon wt (g)	Single shell wt(g)	Shell ratio (%)	Filament length (m)	Denier
CSR_2xCSR_4	95.67 (78.024)	22.590	30.818	1.155	0.233	20.15 (26.65)	861.94	1.701
$CSR_{16}xCSR_{17}$	97.48 (80.806)	22.467	37.921	1.558	0.281	18.09 (25.21)	937.67	1.715
$CSR_{50}xCSR_{51}$ (C)	93.49 (75.300)	22.007	35.274	1.472	0.274	18.63 (25.24)	937.62	1.678
$CSR_{58}xCSR_{16}$	83.30 (65.673)	20.390	31.378	1.339	0.262	19.55 (26.21)	890.17	1.402
SHP_2	60.81 (51.807)	21.617	34.694	1.347	0.254	18.885 (25.72)	910.33	1.674
SHR_1	95.16 (77.053)	21.593	35.151	1.538	0.263	17.58 (24.78)	850.17	1.878
DHP_5	64.36 (53.357)	22.377	36.962	1.239	0.276	22.26 (28.19)	987.00	1.279
DHR_4	90.91 (72.393)	21.587	34.950	1.199	0.232	19.37 (26.17)	777.41	1.653
SE +	2.45	0.512	0.482	0.023	0.004	0.34	12.09	0.045
CD at 5%	7.50	1.577	1.478	0.071	0.011	1.05	37.05	0.137

*-Significant at @5% level

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