International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(2): 01-08
www.biochemjournal.com
Received: 01-11-2023
Accepted: 05-12-2023

Sanna Parvez
College of Temperate Sericulture Mirgund SKUAST-K, Jammu and Kashmir, India

Dr. Zia ul Haque Rufaie
College of Temperate Sericulture Mirgund SKUAST-K, Jammu and Kashmir, India

Dr. Shabir Ah Bhat
College of Temperate Sericulture Mirgund SKUAST-K, Jammu and Kashmir, India

Dr. Shakeel Ah Mir
Division of Agri Statistics FOH Shalimar SKUAST-K, Jammu and Kashmir, India

Dr. Shaheen Gul
Division of Entomology FOH Shalimar SKUAST-K, Jammu and Kashmir, India

Dr. Ishtiyaq Ahad
Division of Entomology FOA Wadura SKUAST-K, Jammu and Kashmir, India

Salib Shafi
College of Temperate Sericulture Mirgund SKUAST-K, Jammu and Kashmir, India

Corresponding Author:
Sanna Parvez
College of Temperate Sericulture Mirgund SKUAST-K, Jammu and Kashmir, India

To study various economic parameters of some bivoltine breeds of silkworm *Bombyx mori* L. in different seasons under temperate climatic conditions

Sanna Parvez, Dr. Zia ul Haque Rufaie, Dr. Shabir Ah Bhat, Dr. Shakeel Ah Mir, Dr. Shaheen Gul, Dr. Ishtiyaq Ahad and Salib Shafi

DOI: https://doi.org/10.33545/26174693.2024.v8.i2Sa.501

Abstract
The present investigation was carried out at Division of Sericulture Crop Improvement of College of Temperate Sericulture, Mirgund and Division of Basic Science and Humanities, of Faculty of Horticulture, SKUAST-Kashmir, Shalimar during the year 2021 and 2022. Rearing of twelve bivoltine mulberry silkworm breeds(6 plain) namely CSR17, CSR50, CSR27, CSR52, SK7, SK6 and (6 marked) namely SK4, BHR3, CSR26, CSR53, M46 and Sanish 8 were used in this study. During these seasons (spring and autumn) CSR26 breed excelled in most of the parameters excluding fecundity which was highest i.e 590.721 and 567.667 eggs/ laying recorded in Sanish 8. In case of larval characters the CSR26 breed recorded lowest desirable total larval duration of 27.120 and 29.025 days, highest larval weight of 46.097 and 42.885 g, highest silk gland weight of 1.556 and 1.482 g, highest silk gland tissue somatic index of 33.755 and 34.574 %,. In case of other commercial characters of cocoons the highest cocoon yield of 9260.266 and 8841.950 per 10,000 larvae by number, highest cocoon yield of 16.938 and 15.381 kg per 10,000 larvae by weight, highest pupation rate of 93.580 and 90.954%, highest cocoon weight of 1.840 and 1.792 g, highest shell weight of 0.379 and 0.343g, highest shell percentage of 20.597 and 19.173 % highest hatching percentage of 96.283 and 91.743 % was also recorded in CSR 26. In case of post cocoon parameters the highest filament length of 1015.167 and 956.728m, lowest desirable denier of 2.237 and 2.152, highest raw silk percentage of 16.663 and 15.413 % was recorded in CSR26 during both the seasons respectively. Among the twelve breeds which were taken for studies CSR26 performed best followed by M46 and BHR3 breed which is a marked breed. However among the plain breeds CSR27 breed is at the top followed by CSR50 and CSR17.

Keywords: *Bombyx mori* L., plain breeds, marked breeds, commercial characters, post cocoon parameters

Introduction
Sericulture is a process for raising silkworms that combines modern technology and traditional knowledge for the production of silk. Silk is known for its glamour and comfort and the fabric is worn by the people across the cultures and it is cherished for its elegance. Silk is one of the most elegant textile in the world with unparalleled qualities like grandeur, natural sheen, inherent affinity for dyes, high absorbance of moisture, light weight, soft touch, and high durability. These qualities of silk make it the "Queen of Textiles". The development of sericulture industry can achieve good ecological, economic and social benefits (Gao, 2011) [6]. India besides being home to a vast variety of silk secreting fauna. It is also a natural habitat for a diverse range of silk moths. This has enabled India to achieve the unique status of being only producer of all the four varieties of natural silk *viz.*, Mulberry, Tasar, Eri and Muga, of which Muga with its golden yellow silk is a monopoly of India. The bulk of the silk produced in India is mulberry silk which is produced by silkworm, *Bombyx mori* L. The mulberry silkworm, *Bombyx mori* L, is a monophagous insect which feeds only on the leaves of mulberry. In silkworm rearing, food is a factor of paramount importance, which regulates the growth, development and silk yield in commercial sericulture. Evaluation of genetic resources is an essential pre requisite for their effective utilization in order to gauge the extent of variability among genotypes.

Silkworms have been evaluated in many environments and agro climatic conditions in order to identify the season and region specific breeds for utilization (Malik *et al*., 2002; Bhat *et al.*, 2017) [11, 5]. The necessity for identification of season/region specific breeds/hybrids arises due to variation in quantitative characters during different environmental conditions. A series of studies have also been conducted to identify suitable bivoltine breeds / hybrids during different seasons under Kashmir climatic conditions (Nazim *et al*., 2020) [14]. As such, the present investigation was proposed with the aim to evaluate some of the pure breeds of silkworms by conducting studies on various economic parameters.

Materials and Methods

The present investigation was carried out at Division of Sericulture Crop Improvement of College of Temperate Sericulture, Mirgund and Division of Basic Science and Humanities, of Faculty of Horticulture, SKUAST-Kashmir, Shalimar during the year 2021 and 2022. Rearing of twelve bivoltine mulberry silkworm breeds (6 plain) namely CSR17, CSR50, CSR27, CSR52, SK7, SK6 and (6 marked) namely SK4, BHR3, CSR26, CSR53, M46 and Sanish 8 were used in this study.

Experimental Layout

Experimental site: CoTS Mirgund
Experimental lab: DSCI CoTS.
Race type: 02

- T_1: Plain
- T_2: Marked

No. of races /type: 06

- Plain: 6 breeds
- Marked: 6 breeds

Total no. of races: 12
Mulberry varieties: Chawki: Ichinose
Late age: Goshoerami
No. of seasons: 02
S1: Spring
S2: Autumn
Total no. of treatment combination: 24
12 spring
12 autumn

Treatment combination detail

Code	Notation	Treatment detail
T_1	$T_1R_1S_1$	CSR17+ Spring 2021
T_2	T_1R_2 S_1	CSR50+ Spring 2021
T_3	T_1R_3 S_1	CSR27+ Spring 2021
T_4	T_1R_4 S_1	CSR52+ Spring 2021
T_5	T_1R_5 S_1	SK7+ Spring 2021
T_6	T_1R_6 S_1	SK6+ Spring 2021
T_7	T_2R_1 S_1	SK4+ Spring 2021
T_8	T_2R_2 S_1	BHR3+ Spring 2021
T_9	T_2R_3 S_1	CSR26+ Spring 2021
T_{10}	T_2R_4 S_1	CSR53+ Spring 2021
T_{11}	T_2R_5 S_1	M46+ Spring 2021
T_{12}	T_2R_6 S_1	Sanish-8+ Spring 2021
T_{13}	$T_1R_1S_2$	CSR17+ Autumn 2021
T_{14}	T_1R_2 S_2	CSR50+ Autumn 2021
T_{15}	T_1R_3 S_2	CSR27+ Autumn 2021
T_{16}	T_1R_4 S_2	CSR52+ Autumn 2021
T_{17}	T_1R_5 S_2	SK7+ Autumn 2021
T_{18}	T_1R_6 S_2	SK6+ Autumn 2021
T_{19}	T_2R_1 S_2	SK4+ Autumn 2021
T_{20}	T_2R_2 S_2	BHR3+ Autumn 2021
T_{21}	T_2R_3 S_2	CSR26+ Autumn 2021
T_{22}	T_2R_4 S_2	CSR53+ Autumn 2021
T_{23}	T_2R_5 S_2	M46+ Autumn 2021
T_{24}	T_2R_6 S_2	Sanish-8+ Autumn 2021

*The same experiment was repeated in spring and autumn seasons of 2022

Results and discussion

The results recorded in silkworm growth and economic parameters during spring and autumn season are furnished below:

Total larval duration (days)

Larval duration is considered as an important economic trait in sericulture as the reduction in larval duration would help in reducing the amount of the total food consumption and labour requirement, besides completion of larval period in desirable time period (Rahmathulla and Suresh, 2012) [16]. During spring and autumn season among the plain breeds of silkworm the total larval duration of 27.253 days and 29.232 days was recorded lowest in CSR27 and among the marked breeds of silkworm the lowest total larval duration of 27.120 days and 29.025 days was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that lowest total larval duration of 27.120 days, 29.025 days, was recorded in CSR26 and the longest total larval duration of 27.888 days and 29.858 days was recorded in Sanish 8. (Table 1).These results obtained in our study are also inconformity with the results of Nisar *et al.*, 2019 [15] who has reported that the total larval duration of 26.25 days was recorded in CSR26, CSR27 and SK7 while as SK6 has recorded larval duration of 26.17 days.

Weight of 10 mature larvae (g)

Larval weight is considered as one of the important parameter in silkworm larvae which determines not only the health of the larvae, but also determines the quality and the quantity of the cocoons produced. Larval weight of different breeds affects the seed production and silk productivity as well. During spring and autumn season among the plain breeds of silkworm the highest larval weight of 44.167, 40.835 grams was recorded in CSR27 and among the marked breeds of silkworm the highest larval weight was in CSR26 which recorded the larval weight of 46.097 grams and 42.885 grams respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest larval weight of 46.097 grams and 42.885 grams, was recorded in CSR26 and the lowest larval weight of 37.802 grams and 34.657 grams was recorded in Sanish 8. (Table 1).The results are supported by Bashir *et al*., (2014a) [4], who has reported larval weights of 39.00 g, 52.46 g, 49.56 g and 49.53 g in various pure bivoltine breeds like CSR2, SK-1, SK-31 and SK-6 in spring season under temperate conditions.

Silk gland parameters

The silk gland weight is an important parameter and has direct relation with the quantity of silk produced by the silkworm. During spring and autumn season among the plain breeds of silkworm the highest silk gland of 1.459 grams and 1.385 grams, was recorded in CSR27 and among the marked breeds of silkworm the highest silk gland weight was recorded in CSR26 which recorded the silk gland weight of 1.556 grams and 1.482 grams respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest silk gland weight of 1.556 grams and 1.482 grams was recorded in CSR26 and the lowest silk gland weight of 1.229 grams and 1.154 grams was recorded in Sanish 8. (Table 2). The growth of silk gland is marked by the accumulation of organic compounds particularly by reference to proteins (Tazima 1978) [21]. A significant difference was also recorded in tissue somatic index of these breeds during spring season. During spring and autumn season among the plain breeds of silkworm the highest silk gland tissue somatic index of 33.300 percent and 33.907 percent, was recorded in CSR52, CSR27 and among the marked breeds of silkworm the highest silk gland tissue somatic index was recorded in CSR26 which recorded the silk gland tissue somatic index of 33.755 percent and 34.547 percent respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest silk gland tissue somatic index of 33.755 percent and 34.547 percent was recorded in CSR26 and the lowest silk gland tissue somatic index of 32.157 percent and 33.161 percent was recorded in CSR 53. The increase in tissue somatic index may be due to the increased growth of silk gland of silkworm. The silk conversion index of silkworms did not differ significantly but comparatively highest silk conversion index was recorded in SK6 i.e 25.706 percent during spring and 24.430 percent in SK6 during autumn season. (Table 2).

Cocoon parameters (Economic traits of silkworm)

Cocoon yield by number is an important trait for studying the probability of survival of the breeds. Higher values of cocoon yield by number is indicative of higher survival which results in higher silk productivity and a good cocoon crop. During spring and autumn season among the plain breeds of silkworm the highest cocoon yield of 9144.229 and 8714.855 per 10,000 larvae, was recorded in CSR27 and among the marked breeds of silkworm the highest cocoon yield of 9260.266 and 8841.950 per 10,000 larvae was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest cocoon yield of 9260.266 and 8841.950 per 10,000 larvae was recorded in CSR26 and the lowest cocoon yield of 8749.409 and 8322.803 per 10,000 larvae was recorded in Sanish 8. (Table 3). The higher cocoon yield by number could be attributed to the higher survivability of the breeds due to favorable hygrothermic conditions for the rearing and by feeding quality mulberry leaf during rearing. These findings are in conformity with Legay (1958) [10], Rao *et al*., (2004) [4], Ramesh Babu *et al*., (2009) [18] and Hussain *et al.,* (2011) [9] who have reported that cocoon production is chiefly dependent on larval nutrition and nutritive value of mulberry leaves and conversion efficiency of larvae which is affected by weather conditions.

The cocoon yield by weight shows that the quantum of cocoons obtained after rearing. During spring and autumn season among the plain breeds of silkworm the highest cocoon yield of 15.987 (kg) and 14.574 (kg) per 10,000 larvae, was recorded in CSR27 and among the marked breeds of silkworm the highest cocoon yield of 16.938 (kg) and 15.381 (kg) per 10,000 larvae was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest cocoon yield of 16.938 (kg) and 15.381 (kg) per 10,000 larvae was recorded in CSR26 and the lowest cocoon yield of 14.527 (kg) and 12.916 (kg) per 10,000 larvae was recorded in Sanish 8.. (Table3). Similar types of results have been reported by Narayanswamy *et al*., (2000) [12] who has reported maximum ERR (by number) in NB4D2 (252.37 g/200 larvae) and Ashwath *et al*., (2010) [2] who found maximum ERR (by weight) in CSR2 (17.9 kg/10,000 larvae). These results are also supported by Nisar *et al.,* (2019) [15] who has reported that CSR26 recorded 14.94 kg, CSR27 14.72 kg, SK6 13.63 kg and SK7 13.54 Kg/10000 larvae. The difference in the cocoon yield (by weight) could be attributed to climatic factors prevailing during rearing and potential of the breed to adjust to the prevailing environment. The results of this study revealed that irrespective of breeds the yield/10,000larvae by weight was higher in spring season compared to autumn season. The higher cocoon yield in spring season than in autumn season could be attributed to higher survivability of races under congenial room temperature. The findings of current study are also well supported by the studies of Naseema *et al*., (2000) [13] who have reported that bivoltine breeds have high effective rate of rearing (ERR) under different sets of climatic conditions.

Pupation rate is one of the important economic characters to determine the viability of a breed. The genetic and environment interaction gets more reflected in this character. Quantity of cocoon and silk produced by a breed is directly related to the pupation rate and larval weight. Healthier larvae have greater pupation rates and cocoon weight and quality of cocoon and silk depends on a number of factors including among them genetics. During spring and autumn season among the plain breeds of silkworm the highest pupation rate of 92.367 percent and 85.964 percent was recorded in CSR27 and among the marked breeds of

silkworm the highest 93.580 percent and 90.954 percent was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest pupation rate of 93.580 percent and 90.954 percent was recorded in CSR26 and the lowest pupation rate of 84.344 percent and 78.612 percent was recorded in Sanish 8. The result is also well supported by the findings of Nisar *et al*., 2019 [15] who has reported 93 and 90 percent of pupation rate in case of CSR26 silk worm breed during spring and autumn season. The difference in the pupation rate can be attributed to the environmental conditions, haemolymph content and the quality of food.

During spring and autumn season among the plain breeds of silkworm the highest growth index of 3.389 and 2.937 was recorded in CSR27 and among the marked breeds of silkworm the highest growth index of 3.451 and 3.130 was recorded in CSR26 respectively. Among all the breeds races under study (plain and marked) during spring and autumn season the results revealed that highest growth index of 3.451 and 3.130 was recorded in CSR26 and the lowest growth index of 3.024 and 2.630 was recorded in Sanish 8.. (Table3).

Cocoon weight, shell ratio and filament length are highly heritable traits and are significantly important as these determine the quality, quantity and efficiency of the reeling process. During spring and autumn season among the plain breeds of silkworm the highest single cocoon weight of 1.768 grams and 1.720 grams was recorded in CSR27 and among the marked breeds of silkworm the highest single cocoon weight of 1.840 grams and 1.792 grams was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest single cocoon weight of 1.840 grams and 1.792 grams was recorded in CSR26 and the lowest single cocoon weight of 1.650 grams and 1.605 grams was recorded in Sanish 8. (Table4). The cocoon weight of all the breeds evaluated was relatively lower in autumn season than spring season which could be attributed to poor quality of mulberry leaf available in autumn season which affects weight of cocoons. Present findings are also in conformity with the reports of Singh *et al.,* (2010) [20] who have concluded that environmental factors influence the physiology of insects and also have deleterious effect on economic traits such as cocoon weight and shell weight.

Cocoon and shell weights are the major traits evaluated for productivity in sericulture and cocoon weight is an important commercial characteristic used to determine approximately the amount of raw silk that can be obtained. Shell weight gives a better measure, but cannot be determined in commercial cultures because it requires damaging the cocoon. The difference between the two measures is the weight of the pupa (Gaviria *et al.,* 2006) [8]. Cocoon shell weight is an important character in determining the silk weight. The present study revealed that shell weight was variable under different sets of environmental conditions. However during spring and autumn season among the plain breeds of silkworm the highest single shell weight of 0.358 grams and 0.322 grams was recorded in CSR27 and among the marked breeds of silkworm the highest single shell weight of 0.379 grams and 0.343 grams was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring fand autumn season the results revealed that highest single shell weight of 0.379 grams and 0.343 grams was recorded in CSR26 and the lowest single shell weight of 0.314 grams and 0.280 grams was recorded in Sanish 8. Again during spring and autumn season among the plain breeds of silkworm the highest shell percentage of 20.243 percent and 18.749 percent was recorded in CSR27 and among the marked breeds of silkworm the highest shell percentage of 20.597 percent and 19.173 percent was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest shell percentage of 20.597 percent and 19.173 percent was recorded in CSR26 and the lowest shell percentage of 19.060 percent and 17.481 percent was recorded in Sanish 8. (Table 4) The present findings also corroborate with the results of. Ashoka *et al.* (2012) [1], who have also observed the highest shell ratio of 21.29 percent was recorded in CSR26 which is a bivoltine breed.

Fecundity and Hatching percentage

The egg laying capability of *Bombyx mori* L. has been a heritable character expressed within the genotypic limitations of the insects like *Bombyx mori*. The superior fecundity of this breed in both the seasons is due to its genetic constitution. Gaur and Upadhyay (2002) [7] have reported that fecundity of *Bombyx mori* L. varies due to variation in the genetic makeup of silkworm race and it is influenced by number of physiological and ecological factors. During spring and autumn season among the plain breeds of silkworm the highest fecundity of 553.353 and 528.039 was recorded in CSR52 and among the marked breeds of silkworm the highest fecundity of 590.721 and 567.667 was recorded in Sanish 8 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest fecundity of 590.721 and 567.667 was recorded in Sanish 8 and the least fecundity of 511.021 and 489.667 was recorded in SK7.. (Table5).

In silkworm *Bombyx mori* L. hatching of eggs is an important component reflecting viability of the eggs and the fitness of an organism. The parameter is calculated in percentage. Higher the percentage of hatching better is the quality of eggs, however essential conditions like temperature, humidity, light also effect hatching in silkworm eggs. The reduced hatching percentage is not favored by natural selection. However, increased hatching percentage reflects the genetic background and physiological state of the female moth. During spring and autumn season among the plain breeds of silkworm the highest hatching percentage of 93.600 percent and 88.877 percent was recorded in CSR27 and among the marked breeds of silkworm the highest hatching percentage of 96.283 percent and 91.743 percent was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest hatching percentage of 96.283 percent and 91.743 percent was recorded in CSR26 and the least hatching percentage of 91.793 percent and 87.553 percent was recorded in Sanish 8. (Table5).

Post cocoon parameters

Filament length is one of the important attributes of the silkworm breed. The silk filament length obtained is different in silkworm breeds under different sets of rearing conditions and rearing seasons (Basavaraja *et al.,* 1995) [3]. During spring and autumn season among the plain breeds of silkworm the highest average filament length of 949.202

meter and 894.062 meter was recorded in CSR27 and among the marked breeds of silkworm the highest average filament length of 1015.167 meter and 956.728 meter was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest average filament length of 1015.167 meter and 956.728 meter was recorded in CSR26 and the least average filament length of 869.387 meter and 804.395 meter was recorded in Sanish 8. (Table6) During spring and autumn season among the plain breeds of silkworm the lowest denier of 2.293 and 2.208 was recorded in CSR 27 and among the marked breeds of silkworm the lowest denier of 2.237 and 2.152 was recorded in CSR 26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that lowest denier of 2.237 and 2.152 was recorded in CSR 26 and the highest denier of 2.600 and 2.515 was recorded in Sanish 8. (Table 6).) Has observed that filament size deviation is a racial character, the lesser filament size deviation increases the reliability percentage and raw silk recovery.

In sericulture percentage of raw silk is also considered as one of the important factor in determining cocoon quality. During spring and autumn season among the plain breeds of silkworm the highest raw silk percentage of 16.157 percent and 14.907 percent was recorded in CSR27 and among the marked breeds of silkworm the highest raw silk percentage of 16.663 percent and 15.413 percent was recorded in CSR26 respectively. Among all the breeds under study (plain and marked) during spring and autumn season the results revealed that highest raw silk percentage of 16.663 percent and 15.413 percent was recorded in CSR26 and the least raw silk percentage of 12.797 percent and 11.547 percent was recorded in Sanish 8. (Table 6). These findings are analogous with the earlier observations of Raju and Krishnamurthy (1995) [17], who have evaluated traditional and new multi hybrids of the silkworm, *Bombyx mori* L. with reference to the seasons and found that all the new hybrids performed better in terms of yield attributing traits in pre-monsoon, monsoon and post monsoon seasons.

Table 1: Total larval duration (days) and weight of 10 mature larvae (g) in various silkworm breeds (*Bombyx mori* L.) during spring and autumn seasons.

Season / Silkworm breeds	Spring		Autumn	
	Total larval duration (days)	Weight of 10 mature larvae (g)	Total larval duration (days)	Weight of 10 mature larvae (g)
T_1: CSR 17	27.527	41.550	29.502	38.235
T_2: CSR 50	27.422	41.850	29.402	38.535
T_3: CSR 27	27.253	44.167	29.232	40.835
T_4: CSR 52	27.592	40.430	29.565	37.568
T_5: SK7	27.653	40.347	29.618	37.435
T_6: SK6	27.838	38.432	29.802	35.035
SUB MEAN	27.548	41.129	29.520	37.941
T_7: SK4	27.793	38.825	29.762	35.435
T_8: BHR 3	27.320	43.383	29.292	40.035
T_9: CSR 26	27.120	46.097	29.025	42.885
T_{10}: CSR 53	27.720	39.680	29.682	36.235
T_{11}: M46	27.190	44.872	29.172	41.435
T_{12}: Sanish 8	27.888	37.802	29.858	34.657
SUB MEAN	27.505	41.776	29.465	38.447
C.D ($p \leq 0.05$) Race type	0.014	0.234	0.016	0.285
C.D ($p \leq 0.05$) Race x type	0.035	0.573	0.038	0.697

*T_1-T_6: Plain breeds, T_7-T_{12}: Marked breeds

Table 2: Silk gland weight (g), silk gland tissue somatic index (%), silk conversion index (%) in various silkworm breeds (*Bombyx mori* L.) during spring and autumn seasons.

Season / Silkworm breeds	Spring			Autumn		
	Silk gland weight (g)	Silk gland tissue somatic index (%)	Silk conversion index %	Silk gland weight (g)	Silk gland tissue somatic index (%)	Silk conversion index %
T_1: CSR 17	1.358	32.684	25.294	1.284	23.957	33.571
T_2: CSR 50	1.377	32.904	25.272	1.302	23.991	33.803
T_3: CSR 27	1.459	33.034	24.537	1.385	23.293	33.907
T_4: CSR 52	1.346	33.300	25.222	1.272	23.908	33.848
T_5: SK7	1.317	32.648	25.246	1.243	23.862	33.193
T_6: SK6	1.239	32.239	25.706	1.164	24.430	33.241
SUB MEAN	1.349	32.801	25.212	1.275	23.907	33.594
T_7: SK4	1.258	32.402	25.715	1.183	24.334	33.402
T_8: BHR 3	1.426	32.870	24.684	1.352	23.418	33.760
T_9: CSR 26	1.556	33.755	24.357	1.482	23.185	34.547
T_{10}: CSR 53	1.276	32.157	25.665	1.202	24.302	33.161
T_{11}: M46	1.505	33.540	24.352	1.431	23.138	34.526
T_{12}: Sanish 8	1.229	32.514	25.590	1.154	24.295	33.315
SUB MEAN	1.375	32.873	25.060	1.301	23.778	33.785
C.D ($p \leq 0.05$) Race type	0.008	0.174	NS	0.010	NS	0.161
C.D ($p \leq 0.05$) Race x type	0.023	0.612	NS	0.025	NS	0.558

*T_1-T_6: Plain breeds, T_7-T_{12}: Marked breeds

Table 3: Cocoon yield by number, weight (kg) /10,000 larvae, pupation rate (%) and growth index in various silkworm breeds (*Bombyx mori* L.) during spring and autumn seasons.

Season / Silkworm breeds	Spring				Autumn			
	Cocoon yield		Pupation rate (%)	Growth index	Cocoon yield		Pupation rate (%)	Growth index
	By No.	By Wt (kg)			By No.	By Wt (kg)		
T_1: CSR 17	9003.355	15.343	90.597	3.291	8568.225	13.921	82.227	2.783
T_2: CSR 50	9079.532	15.600	91.743	3.346	8646.678	14.175	82.641	2.807
T_3: CSR 27	9144.229	15.987	92.367	3.389	8714.855	14.574	85.964	2.937
T_4: CSR 52	8959.754	15.166	89.327	3.237	8523.618	13.761	80.854	2.731
T_5: SK7	8934.800	15.025	88.555	3.202	8496.845	13.546	80.223	2.705
T_6: SK6	8790.663	14.705	85.630	3.076	8359.225	13.078	78.931	2.645
SUB MEAN	8985.389	15.304	89.703	3.257	8551.574	13.843	81.807	2.768
T_7: SK4	8900.382	14.883	86.692	3.119	8460.855	13.332	79.124	2.655
T_8: BHR 3	9122.392	15.850	91.845	3.362	8690.122	14.387	84.787	2.891
T_9: CSR 26	9260.266	16.938	93.580	3.451	8841.905	15.381	90.954	3.130
T_{10}: CSR 53	8909.060	14.940	87.472	3.156	8468.802	13.450	79.741	2.683
T_{11}: M46	9180.089	16.446	93.180	3.427	8749.712	15.033	87.910	3.014
T_{12}: Sanish 8	8749.409	14.527	84.344	3.024	8322.803	12.916	78.612	2.630
SUB MEAN	9020.266	15.597	89.519	3.256	8589.033	14.083	83.521	2.834
C.D ($p \leq 0.05$) Race type	30.618	0.105	NS	0.161	24.987	0.170	NS	NS
C.D ($p \leq 0.05$) Race x type	74.997	0.256	1.171	0.098	67.216	0.416	2.610	0.090

*T_1-T_6: Plain breeds, T_7-T_{12}: Marked breeds

Table 4: Single cocoon weight (g), Single shell weight and shell percentage in various silkworm breeds (*Bombyx mori* L.) during spring and autumn seasons.

Season / Silkworm breeds	Spring			Autumn		
	Single cocoon weight (g)	Single shell weight (g)	Shell percentage	Single cocoon weight (g)	Single shell weight (g)	Shell percentage
T_1: CSR 17	1.723	0.343	19.941	1.674	0.308	18.363
T_2: CSR 50	1.736	0.348	20.040	1.688	0.312	18.512
T_3: CSR 27	1.768	0.358	20.243	1.720	0.322	18.749
T_4: CSR 52	1.713	0.340	19.824	1.664	0.304	18.263
T_5: SK7	1.693	0.333	19.639	1.645	0.296	18.029
T_6: SK6	1.665	0.319	19.129	1.617	0.285	17.599
SUB MEAN	1.716	0.340	19.803	1.668	0.305	18.253
T_7: SK4	1.680	0.324	19.255	1.627	0.288	17.706
T_8: BHR 3	1.752	0.352	20.091	1.704	0.316	18.579
T_9: CSR 26	1.840	0.379	20.597	1.792	0.343	19.173
T_{10}: CSR 53	1.687	0.328	19.407	1.639	0.292	17.816
T_{11}: M46	1.810	0.367	20.248	1.765	0.331	18.758
T_{12}: Sanish 8	1.650	0.314	19.060	1.605	0.280	17.481
SUB MEAN	1.736	0.344	19.777	1.688	0.309	18.252
C.D ($p \leq 0.05$) Race type	0.009	0.003	0.169	0.013	0.006	0.231
C.D ($p \leq 0.05$) Race x type	0.023	0.019	0.414	0.031	0.024	0.616

*T_1-T_6: Plain breeds, T_7-T_{12}: Marked breeds

Table 5: Fecundity (no) and hatching percentage in various silkworm breeds (*Bombyx mori* L.) during spring and autumn seasons.

Season / Silkworm breeds	Spring		Autumn	
	Fecundity (no)	Hatching percentage	Fecundity (no)	Hatching percentage
T_1: CSR 17	549.187	93.198	523.041	88.543
T_2: CSR 50	544.043	93.305	518.000	88.640
T_3: CSR 27	541.912	93.600	515.753	88.877
T_4: CSR 52	553.353	92.568	528.039	88.057
T_5: SK7	511.021	93.000	489.667	88.337
T_6: SK6	538.020	92.110	508.005	87.647
SUB MEAN	539.589	92.964	513.751	88.350
T_7: SK4	560.002	92.417	534.000	88.033
T_8: BHR 3	583.837	93.453	556.333	88.697
T_9: CSR 26	545.208	96.283	520.750	91.743
T_{10}: CSR 53	550.035	92.207	525.737	87.737
T_{11}: M46	585.854	93.937	560.207	89.203
T_{12}: Sanish 8	590.721	91.793	567.667	87.553
SUB MEAN	569.276	93.348	544.116	88.828
C.D ($p \leq 0.05$) Race type	1.694	NS	2.023	NS
C.D ($p \leq 0.05$) Race x type	4.149	1.480	4.955	NS

*T_1-T_6: Plain breeds, T_7-T_{12}: Marked breeds

Table 6: Average filament length (m), denier and raw silk percentage in various silkworm breeds (*Bombyx mori* L.) during spring and autumn seasons.

Season / Silkworm breeds	Spring			Autumn		
	Average filament length (m)	Denier	Raw silk percentage	Average filament length (m)	Denier	Raw silk percentage
T_1: CSR 17	920.683	2.377	14.756	865.728	2.292	13.506
T_2: CSR 50	931.167	2.350	15.044	875.062	2.265	13.794
T_3: CSR 27	949.202	2.293	16.157	894.062	2.208	14.907
T_4: CSR 52	911.000	2.410	14.247	854.062	2.325	12.997
T_5: SK7	904.685	2.457	13.759	846.395	2.372	12.509
T_6: SK6	874.870	2.560	12.863	811.395	2.475	11.613
SUB MEAN	915.268	2.408	14.471	857.784	2.323	13.221
T_7: SK4	884.369	2.520	12.977	821.395	2.435	11.727
T_8: BHR 3	935.860	2.317	15.707	880.728	2.232	14.457
T_9: CSR 26	1015.167	2.237	16.663	956.728	2.152	15.413
T_{10}: CSR 53	896.869	2.480	13.493	835.395	2.395	12.243
T_{11}: M46	965.035	2.260	16.395	907.395	2.175	15.145
T_{12}: Sanish 8	869.387	2.600	12.797	804.395	2.515	11.547
SUB MEAN	927.781	2.402	14.672	867.673	2.317	13.422
C.D ($p \leq 0.05$) Race type	8.958	NS	0.155	8.571	NS	0.158
C.D ($p \leq 0.05$) Race x type	31.101	0.045	0.381	29.312	0.048	0.384

*T_1-T_6: Plain breeds, T_7-T_{12}: Marked breeds

Conclusion

During the course of study, it was observed that differences exist among the silkworm breeds with respect to economic traits. Among these breeds on the basis of economic parameters CSR26 & M46 have performed best in almost all the parameters. These were followed by other silkworm breeds like CSR27, BHR3, CSR50, CSR17 and CSR52. It is therefore concluded that these breeds could be used as a breeding resource material with appropriate combinations for evolution of new silk worm breeds, hybrids and for formation of foundation crosses in order to make some potential double hybrid for commercial exploitation under temperate climatic conditions of Kashmir.

References

1. Ashoka J, Narayanswamy TK, Narayanswamy KC. Performance of multivoltine and bivoltine silkworm breeds, *Bombyx mori* L. for larval, cocoon, yield and silk filament traits. J Appl Zool Res. 2012;23(1):51-58.
2. Ashwath SK, Sreekumar S, Toms JT, Dandin SB, Kamble CK. Identification of RAPD markers linked to digestive amylase genes using near isogenic lines of the silkworm, *Bombyx mori* L. J Insect Sci. 2010;10(84):1-10.
3. Basavaraja HK, Nirmal K, Datta RK. New productive bivoltine hybrids. Indian Silk. 1995;34(5):5-9.
4. Bashir M, Afifa SK, Sharma RK. Assessment of variability between growth and yield attributes of bivoltine silkworm, *Bombyx mori* L. under temperate climatic conditions. Int J Adv Biol Res. 2014;4(3):374-379.
5. Bhat SA, Farooq M, Khan IL, Sahaf KA. Studies on performance of some races of silkworm, *Bombyx mori* L, hybrids during summer season in Kashmir. J Entomol Zool Stud. 2017;5(5):1346-1348.
6. Gao S. Sustainable development of sericulture Industry. Int J Bus Manage. 2011;6:3-8.
7. Gaur KP, Upadhyay VB. Influence of ecological factors on the duration and pupal weight of *Bombyx mori* L. J Exp Zool. 2002;5(1):113-118.
8. Gaviria DA, Aguilar E, Serrano HJ, Algeria AH. DNA fingerprinting using AFLP markers to search for markers associated with yield attributes in the silkworm, *Bombyx mori* L. J Insect Sci. 2006;6(5):1-10.
9. Hussain M, Khan SA, Naeem M, Mohsin AU. Effect of relative humidity on factors of seed cocoon production in some inbred silk worm (*Bombyx mori*) lines. Int J Agric Biol. 2011;13(1):57-60.
10. Legay JM. Recent advances in silkworm nutrition. Annu Rev Entomol. 1958;3(1):75-86.
11. Malik GN, Kamili AS, Wani SA, Dar HU, Ahmad R, Sofi AM. Evaluation of some bivoltine silkworm *Bombyx mori* L. genotypes. SKUAST J Res. 2002;4:83-87.
12. Narayanswamy TK, Govindan R, Ananthanarayana SR. Performance of bivoltine x multivoltine cross breeds of silkworm for cocoon and silk traits. Indian J Sericulture. 2000;39:169-171.
13. Naseema Begam M, Basavaraja HK, Sudhakara Roa P, Rekha M, Ahsan MM. Identification of bivoltine silkworm hybrids suitable for tropical climate. Indian J Sericulture. 2000;39(1):24-29.
14. Nazim N, Bhat SA, Baqual MF, Mir SA. Performance of some bivoltine silkworm, *Bombyx mori* L. hybrids during summer. Curr J Appl Sci Technol. 2020;39(43):38-42.
15. Nisar AM, Shivkumar, Bharat Kumar, Neelabiona, Ghoesh MK. Evaluation of selected genotypes of bivoltine silkworm *Bombyx mori* L. during different seasons of Kashmir. J Entomol Zool Stud. 2019;7(1):1030-1035.
16. Rahmathulla VK, Suresh HM. Seasonal variation in food consumption, assimilation and conversion efficiency of Indian bivoltine hybrid silkworm, *Bombyx mori* L. J Insect Sci. 2012;12(82):1-14.
17. Raju PJ, Krishnamurthy NB. Comparative evaluation of traditional and multi-bihybrids of silkworm *Bombyx mori* L. across seasons. Indian J Seric. 1995;34:38-41.
18. Ramesh-Babu K, Ramakrishna S, Reddy YHK, Lakshmi G, Naidu NV, Basha-Sadak S, Bhaskar M. Metabolic alteration and molecular mechanism in silkworm larvae during viral infection, A review. Afr J Biotechnol. 2009;8(6):899-907.

19. Rao CGP, Chandrashekaraiah Ramesh C, Ibrahim Basha K, Seshagiri SV, Nagaraju H. Evaluation of polyvoltine hybrids based on silk productivity in silkworm, *Bombyx mori*. Int J Ind Entomol. 2004;8(2):181-187.
20. Singh A. Low temperature induced alterations in certain biochemical constituents of 5th instar larvae of eri silkworm, *Philosamia ricini*. J Insect Physiol. 2010;11:16.
21. Tazima Y. The Silkworm: An Important Laboratory Tool. Tokyo, Japan: Kodansha Ltd; c1978.