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Studies on the Performance of Some Silkworm, *Bombyx mori* L, Breeds in Temperate Region of Jammu and Kashmir, India

Bharath Kumar Neelaboina*, Shivkumar, Mir Nisar Ahmad and M.K. Ghosh

Central Sericultural Research and Training Institute, Central Silk Board, Galandar, Pampore-192121, Jammu and Kashmir, India

**Corresponding author*

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A B S T R A C T

The present investigation was carried out at Central Sericultural Research and Training Institute, Pampore, Jammu & Kashmir (J&K) during spring, summer and autumn, 2017 to study the performance of eleven silkworm, *Bombyx mori* L, breeds (CSR2, CSR6, CSR27, CSR26, CSR50, PAM114, PAM117, APS4, APS5, SK6 and SK7) of different origin under temperate climatic conditions. The rearing was carried out under uniformed laboratory condition by adopting standard method. These eleven breeds were evaluated for their performance in eight metric traits *viz*., fecundity (No.), hatching (%), larval weight (g), yield per 10,000 larvae by number and by weight (kg), single cocoon weight (g), single shell weight (g) and shell ratio (%). The performance of breeds varied from season to season since they were originated from different progenitors. The data generated was analyzed statistically and subjected to multiple trait Evaluation index. On the basis of the evaluation index values ranking (Mano *et al.*, 1993) CSR2, CSR6, CSR26, CSR27, CSR50, PAM114 and PAM117 were performed well in all the three seasons except CSR6 and CSR26 which didn't performed well in summer and autumn whereas, APS4, APS5 and SK6, SK7 performed well in spring, summer and summer, autumn respectively. Based on their performance in all the three seasons, these parental breeds will be utilized for development of foundation crosses which will be further shortlisted for the development of bivoltine silkworm double hybrid suitable to temperate region of J&K as an alternate for ruling CSR double hybrid.

Introduction

The common silkworm *Bombyx mori* Linnaeus (Lepidoptera: Bombycidae) spins valuable silk fibre, making it one of the most beneficial insect to mankind and is becoming an attractive multifunctional material for both textile and non-textile uses Tsukada (2005). The practice of sericulture consist of two major activities *viz*., cultivation of mulberry plants for producing healthy leaf to the silkworm larvae and the rearing of silkworm larvae to produce the quality cocoons, which is the raw material for the silk reeling industry (Bharath Kumar *et al.*, 2017; Bharath Kumar *et al.*, 2018a). Quality of leaf influences the healthy growth of silkworm larvae and thereby the quality of cocoons (Hajare *et al.*, 2008). With the re-orientation of silkworm breeding approaches aimed at sustainability and

increased qualitative silk production, unstinted and coordinated efforts by various silkworm breeders in the country (Datta, 1984; Basavaraja *et al.,* 1995 and Ramesh Babu *et al.,* 2002) resulted in the development of many bivoltine silkworm breeds and hybrids over the last few decades. Systematic breeding approaches adapted by various silkworm breeders in different sericulturally advanced countries (Hirobe, 1968; Krisnaswamy and Tikoo, 1971; He yi, 1991; Mano *et al.,* 1991; Hong *et al.,* 1992; Thiagarajan *et al.,* 1993 and Datta *et al.,* 2001) have contributed to produce silkworm (*Bombyx mori* L.) genotypes of desirable constitution and improvement of several quantitative and qualitative traits of economic value. Till date limited number of silkworm breeds / hybrids has been developed for the spring season under temperate climatic conditions of Kashmir (Trag *et al.,* 1992; Kamili, 1996; Malik *et al.,* 2006 and Malik *et al.,* 2010) Whereas, during summer 10-15 percent farmers take up sericulture in temperate regions of Kashmir (Sahaf *et al.,* 2016) few attempts have also been made for identification of hybrids for summer or autumn season (Farooq *et al.,* 2006; Malik *et al.,* 2009 and Nisar, *et al.,* 2013). It is also need of hour to develop silkworm breeds/ hybrids withstanding the climate change (Bharath Kumar *et al.,* 2018b)

Hence, the present study aims to evaluate the performance of breeds in all the three seasons at CSR&TI, Pampore to develop the foundation crosses which will be shortlisted for the development of bivoltine silkworm double hybrid suitable for Kashmir valley.

Materials and Methods

Eleven silkworm genotypes {CSR2, CSR6, CSR27, CSR26 and CSR50 [CSR&TI, Mysore] PAM114 and PAM117 [CSR&TI, Pampore] APS4 and APS5 [APSSRDI, Hindupur] SK6 and SK7 [CSR&TI, Berhampore]} procured from different Institutes were reared during spring (May-June), summer (July-August) and autumn (August- September), 2017 at Central Sericultural Research and Training Institute, Central Silk Board, Pampore, Kashmir. The characteristics of the parental breeds are presented in Table 1. The standard rearing techniques were followed Krishnaswamy (1978). The important quantitative and qualitative traits *viz*., fecundity, hatching percentage, yield per 10,000 larvae by weight, single cocoon weight, single shell weight, shell ratio and pupation rate were recorded in all the eleven silkworm breeds during spring, summer and autumn, 2017. All the breeds were reared following completely randomised design with three replications each and 250 larvae were maintained in each replication after 3^{rd} moult. At the end of 5^{th} instar, the spinning larvae were collected manually and mounted in plastic collapsible mountages.

The evaluation index value was calculated for all the eight traits studied. The evaluation index (EI) was calculated as per the below mentioned procedure (Mano *et al.,* 1993).

$$\text{Evaluation Index} = \frac{A - B}{C} \times 10 + 50$$

Where,

A = Value obtained for a particular trait in a particular breed

B = Mean value of a particular trait of all the breeds

C = Standard deviation of a particular trait of all the breeds

10 = Standard unit

50 = Fixed value

The index value obtained for all the traits was combined and the average EI values were obtained. The EI value fixed for the selection of a line is 50 or >50. The line, which scored above the limit, is considered to possess greater economic value.

Results and Discussion

The present research findings revealed that nine breeds *viz*., CSR2 (50.20), CSR6 (52.31), CSR26 (50.58), CSR27 (50.11), CSR50 (54.31), PAM114 (51.18) PAM117 (55.29), APS4 (54.06) and APS5 (52.68) were performed well in the spring season except SK6 (40.19) and SK7 (38.52). During summer season except CSR6 (45.28) and CSR26 (43.78) remaining breeds *viz.*, CSR2 (51.91), CSR27 (52.31), CSR50 (55.65), PAM114 (51.06) PAM117 (50.04), APS4 (50.13) and APS5 (50.01), SK6 (52.28) and SK7 (52.74) shown E.I above 50.

In autumn CSR2 (50.71), CSR27 (53.46), CSR50 (51.48), PAM114 (59.60) PAM117 (50.14), SK6 (50.31) and SK7 (53.48) recorded E.I above 50 except CSR6 (45.41), CSR26 (41.83), APS4 (44.88) and APS5 (47.20) (Table 8). Since these breeds originated from different parts of the country, the performance of these breeds varies from season to season indicating the degree of variability in genetic potential.

The performance of eleven breeds during spring, summer and autumn 2017 is depicted in Table 2, 4 and 6. CSR breeds from Mysore and PAM breeds from Pampore performed well in all the three seasons except CSR6 and CSR26 which didn't performed well in summer and autumn season. APS breeds from Hindupur performed well in spring and summer only whereas SK breeds from Berhampore recorded E.I value above 50 during summer and autumn, 2017. Evaluation index values of all the parental breeds for particular traits during spring, summer and autumn, 2017 is depicted in Table 3, 5 and 7.

Success of any breeding programme is dependent on the degree of genetic variability of the available genetic resources and the selection of suitable and genetically diverse parental lines to build heterotic combinations. Results of various economic parameters showed significant difference among the breeds which revealed their genetic potential as well as variability of the breeds. These breeds have immense potentiality as breeding material as they displayed adequate variability for economic traits.

Higher the variability more is the scope for obtaining higher amount of heterotic potential and also more variability is expected to surface in segregating generations of such crosses (Shabir Ahmad Bhat *et al.,* 2018). Similar studies based on evaluation index values had also been conducted by Naseema Begum (2000), Quadir *et al.,* (2000), Suresh Kumar *et al.,* (2006), Nazia Choudhary and Ravindra Singh (2006), Ganaie *et al.,* (2012), Nisar *et al.,* (2013) and Nooruldin *et al.,* (2014).

The eleven parental breeds utilised for the present study performed well during Spring (CSR2, CSR6, CSR26, CSR27, CSR50, PAM114, PAM117, APS4 and APS5), summer (CSR2, CSR27, CSR50, PAM114, PAM117, SK6, SK7, APS4 and APS5) and autumn (CSR2, CSR27, CSR50, PAM114, PAM117, SK6 and SK7), 2017.

The variation in the performance of these breeds during three different seasons indicates the degree of genetic variability. The identified parental breeds will be utilised for further breeding programmes to develop foundation crosses which will be further shortlisted to develop bivoltine double hybrid suitable to temperate region of J&K as an alternate for ruling CSR double hybrid.

Table.1 Characteristic features of the eleven silkworm parental breeds

S. No.	Breeds	Larval Marking	Cocoon Colour	Cocoon Shape	S. No.	Breeds	Larval Marking	Cocoon Colour	Cocoon Shape
1	CSR2	Plain	White	Oval	7	PAM117	Plain	White	Constricted
2	CSR6	Marked	White	Constricted	8	APS4	Plain	White	Constricted
3	CSR26	Marked	White	Constricted	9	APS5	Plain	White	Oval
4	CSR27	Plain	White	Oval	10	SK6	Plain	White	Constricted
5	CSR50	Plain	White	Oval	11	SK7	Plain	White	Constricted
6	PAM114	Plain	White	Oval					

Table.2 Rearing Performance of the eleven silkworm parental breeds during spring, 2017

S. No.	Parental breeds	Fecundity (No.)	Hatching (%)	Yield / 10, 000 larvae brushed		Single cocoon wt. (g)	Single shell wt.(g)	Shell ratio (%)	Pupation rate (%)
				By No.	By Wt.(kg)				
1	CSR-2	515	97.02	9500	15.04	1.60	0.32	20.18	91.33
2	CSR-6	523	96.93	9486	14.49	1.62	0.34	20.93	91.08
3	CSR-26	510	94.41	9475	14.78	1.62	0.33	20.59	91.59
4	CSR-27	475	95.80	9501	15.00	1.64	0.34	20.48	90.59
5	CSR-50	526	95.57	9504	15.03	1.67	0.34	20.33	90.69
6	Pam-114	500	98.80	9538	15.01	1.61	0.33	19.95	90.58
7	Pam-117	494	96.55	9485	15.35	1.60	0.34	21.33	91.02
8	APS-4	531	96.21	9495	15.12	1.61	0.33	20.61	91.25
9	APS-5	529	97.03	9426	15.15	1.61	0.33	20.46	91.35
10	SK-6	545	97.59	9359	14.68	1.58	0.31	19.62	90.25
11	SK-7	460	93.12	9479	14.86	1.59	0.31	19.81	90.38
	Avg.	510	96.28	9477	14.96	1.61	0.33	20.39	90.92
	SD	26	1.55	47	0.24	0.03	0.01	0.49	0.44

Table.3 Evaluation index values of eleven silkworm parental breeds during spring, 2017

S. No.	Parental breeds	Fecundity (No.)	Hatching (%)	Yield / 10, 000 larvae brushed		Single cocoon wt. (g)	Single shell wt. (g)	Shell ratio (%)	Pupation rate (%)	Mean E.I
				By No.	By Wt.(kg)					
1	CSR-2	51.92	54.77	54.89	53.33	46.67	35.00	45.71	59.32	50.20
2	CSR-6	55.00	54.19	51.91	30.42	53.33	59.00	61.02	53.64	52.31
3	CSR-26	50.00	37.94	49.57	42.50	52.33	53.00	54.08	65.23	50.58
4	CSR-27	36.54	46.90	55.11	51.67	60.33	56.00	51.84	42.50	50.11
5	CSR-50	56.15	45.42	55.74	52.92	70.67	60.00	48.78	44.77	54.31
6	Pam-114	46.15	66.26	62.98	52.08	48.67	50.00	41.02	42.27	51.18
7	Pam-117	43.85	51.74	51.70	66.25	46.33	61.00	69.18	52.27	55.29
8	APS-4	58.08	49.55	53.83	56.67	50.33	52.00	54.49	57.50	54.06
9	APS-5	57.31	54.84	39.15	57.92	51.00	50.00	51.43	59.77	52.68
10	SK-6	63.46	58.45	24.89	38.33	38.33	29.00	34.29	34.77	40.19
11	SK-7	30.77	29.61	50.43	45.83	41.67	34.00	38.16	37.73	38.52

Table.4 Rearing Performance of the eleven silkworm parental breeds during summer, 2017

S. No.	Parental breeds	Fecundity (No.)	Hatching (%)	Yield / 10, 000 larvae brushed		Single cocoon wt. (g)	Single shell wt.(g)	Shell ratio (%)	Pupation rate (%)
				By No.	By Wt.(kg)				
1	CSR-2	524	98.09	9693	15.08	1.59	0.32	20.06	90.50
2	CSR-6	507	98.18	9507	14.63	1.58	0.32	20.51	90.45
3	CSR-26	506	97.87	9600	14.71	1.57	0.31	20.04	90.51
4	CSR-27	507	97.94	9667	14.89	1.58	0.33	21.05	90.00
5	CSR-50	538	98.85	9693	14.89	1.59	0.33	20.60	90.48
6	Pam-114	556	97.45	9640	14.81	1.58	0.32	20.56	90.29
7	Pam-117	544	96.80	9612	14.59	1.57	0.33	20.83	91.00
8	APS-4	557	96.71	9667	14.65	1.55	0.32	20.65	91.29
9	APS-5	542	97.29	9640	14.95	1.59	0.32	20.12	90.48
10	SK-6	516	96.92	9600	15.09	1.61	0.33	20.24	91.45
11	SK-7	518	98.83	9667	15.16	1.60	0.32	20.09	90.05
	Avg.	529	97.72	9635	14.86	1.58	0.32	20.43	90.59
	SD	19	0.75	54	0.20	0.02	0.01	0.34	0.47

Table.5 Evaluation index values of eleven silkworm parental breeds during summer, 2017

S. No.	Parental breeds	Fecundity (No.)	Hatching (%)	Yield / 10, 000 larvae brushed		Single cocoon wt. (g)	Single shell wt. (g)	Shell ratio (%)	Pupation rate (%)	Mean E.I
				By No.	By Wt.(kg)					
1	CSR-2	47.37	54.93	60.74	61.00	55.00	49.00	39.12	48.09	51.91
2	CSR-6	38.42	56.13	26.30	38.50	49.50	54.00	52.35	47.02	45.28
3	CSR-26	37.89	52.00	43.52	42.50	43.50	44.00	38.53	48.30	43.78
4	CSR-27	38.42	52.93	55.93	51.50	51.00	63.00	68.24	37.45	52.31
5	CSR-50	54.74	65.07	60.74	51.50	53.50	57.00	55.00	47.66	55.65
6	Pam-114	64.21	46.40	50.93	47.50	48.00	54.00	53.82	43.62	51.06
7	Pam-117	57.89	37.73	45.74	36.50	45.00	57.00	61.76	58.72	50.04
8	APS-4	64.74	36.53	55.93	39.50	35.00	48.00	56.47	64.89	50.13
9	APS-5	56.84	44.27	50.93	54.50	55.00	50.00	40.88	47.66	50.01
10	SK-6	43.16	39.33	43.52	61.50	63.00	55.00	44.41	68.30	52.28
11	SK-7	44.21	64.80	55.93	65.00	61.50	52.00	40.00	38.51	52.74

Table.6 Rearing Performance of the eleven silkworm parental breeds during autumn, 2017

S. No.	Parental breeds	Fecundity (No.)	Hatching (%)	Yield / 10, 000 larvae brushed		Single cocoon wt. (g)	Single shell wt.(g)	Shell ratio (%)	Pupation rate (%)
				By No.	By Wt.(kg)				
1	CSR-2	528	98.65	9533	14.61	1.569	0.308	19.63	91.58
2	CSR-6	518	98.26	9507	14.44	1.552	0.307	19.78	91.44
3	CSR-26	518	98.17	9507	14.37	1.547	0.302	19.52	91.48
4	CSR-27	521	98.08	9653	14.73	1.562	0.314	20.1	91.42
5	CSR-50	535	98.69	9653	14.8	1.568	0.306	19.52	91.14
6	Pam-114	539	98.9	9693	14.75	1.557	0.316	20.3	91.32
7	Pam-117	540	98.6	9615	14.43	1.55	0.311	20.06	90.89
8	APS-4	557	97.94	9520	14.2	1.518	0.308	20.29	90.99
9	APS-5	545	97.92	9507	14.47	1.56	0.307	19.68	91.47
10	SK-6	515	98.14	9462	14.51	1.586	0.313	19.84	91.78
11	SK-7	528	98.72	9547	14.75	1.586	0.313	19.74	91.22
	Avg.	531	98.37	9563	14.55	1.56	0.31	19.86	91.34
	SD	13	0.35	76	0.19	0.02	0.004	0.29	0.26

Table.7 Evaluation index values of eleven silkworm parental breeds during autumn, 2017

S. No.	Parental breeds	Fecundity (No.)	Hatching (%)	Yield / 10, 000 larvae brushed		Single cocoon wt. (g)	Single shell wt. (g)	Shell ratio (%)	Pupation rate (%)	Mean E.I
				By No.	By Wt.(kg)					
1	CSR-2	47.69	58.00	46.05	53.16	54.50	45.00	42.07	59.23	50.71
2	CSR-6	40.00	46.86	42.63	44.21	46.00	42.50	47.24	53.85	45.41
3	CSR-26	40.00	44.29	42.63	40.53	43.50	30.00	38.28	55.38	41.83
4	CSR-27	42.31	41.71	61.84	59.47	51.00	60.00	58.28	53.08	53.46
5	CSR-50	53.08	59.14	61.84	63.16	54.00	40.00	38.28	42.31	51.48
6	Pam-114	56.15	65.14	67.11	60.53	48.50	65.00	65.17	49.23	59.60
7	Pam-117	56.92	56.57	56.84	43.68	45.00	52.50	56.90	32.69	50.14
8	APS-4	70.00	37.71	44.34	31.58	29.00	45.00	64.83	36.54	44.88
9	APS-5	60.77	37.14	42.63	45.79	50.00	42.50	43.79	55.00	47.20
10	SK-6	37.69	43.43	36.71	47.89	63.00	57.50	49.31	66.92	50.31
11	SK-7	47.69	60.00	47.89	60.53	63.00	57.50	45.86	45.38	53.48

Table.8 Mean Evaluation index values of eleven silkworm parental breeds during spring, summer and autumn 2017

Breeds / Seasons	CSR-2	CSR-6	CSR-26	CSR-27	CSR-50	Pam-114	Pam-117	APS-4	APS-5	SK-6	SK-7
Spring	50.20	52.31	50.58	50.11	54.31	51.18	55.29	54.06	52.68	40.19	38.52
Summer	51.91	45.28	43.78	52.31	55.65	51.06	50.04	50.13	50.01	52.28	52.74
Autumn	50.71	45.41	41.83	53.46	51.48	59.60	50.14	44.88	47.20	50.31	53.48

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