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Sardar Singh
Scientist - D
Regional Sericultural Research Station, Central Silk Board, Miran Sahib, Jammu, Jammu and Kashmir, India

Murali S
Scientist - C
Regional Sericultural Research Station, Central Silk Board, Miran Sahib, Jammu, Jammu and Kashmir, India

Corresponding Author:
Murali S
Scientist - C
Regional Sericultural Research Station, Central Silk Board, Miran Sahib, Jammu, Jammu and Kashmir, India

Study on hybrid evaluation & ascertaining suitable brushing date for autumn cocoon crop under subtropical condition of Jammu (J & K)

Sardar Singh and Murali S

Abstract
A diagnostic study was conducted for selection of better hybrid with suitable brushing date to improve silkworm rearing and cocoon crop under sub tropical condition of Jammu division of J & K. Objective of the study was to evaluate silkworm hybrids and find out suitable date of brushing for autumn crop which is yet to be stabilized in North West India.13 hybrids was reared during first batch of autumn season (2018), brushed on 05.09.2018 (First brushing), according to evaluation index for the hybrids analyzed for desired economic parameters both quantity and quality, hybrids showing the index value above 50 shortlisted as $FC_5 \times FC_6$, $DUN_{17} \times DUN_{18}$, $FC_1 \times FC_2$, $PM \times FC_2$ and $SH_6 \times NB_4D_2$. Second brushing was taken on 15.09.2018 with 12 hybrids during autumn (2018). Hybrids showing the index value above 50 shortlisted as $DUN_{17} \times DUN_{18}$, $FC_5 \times FC_6$, $S_8 \times CSR_{16}$, $SH_6 \times NB_4D_2$, B.con1×B.con4, and $FC_1 \times FC_2$. Date of brushing of 15th September was found suitable as compare to traditional date 5th of September. .

Keywords: Hybrids, Evaluation Index, Autumn season, Sub tropical, Brushing date

Introduction
Sericulture is an agro-based rural industry combining the features of agriculture and village industry. It is an age-old land-based practice in India with high employment potential and economic benefits to agrarian families. It is remarkable for its low investment and quick and high returns which make it an ideal industry or enterprise and fits well into the socio-economic fabric of India [8]. Sericulture is highly recommended for planners and administrators as one of the most effective tools for rural reconstruction and development of the rural society. In India, sericulture has been acknowledged as an important sector of economy, particularly because of its potential for strengthening the rural economy, employment and increasing export earnings. Sericulture has been considered as a subsidiary occupation and introduction of new technology of sericulture has led to making the industry a high remunerative cash crop and the step up in raw silk output being witnessed every year.

Breeding for autumn specific silkworm genotypes for temperate climatic conditions remained a challenge before silkworm breeders in North India. Under North Indian sub-tropical conditions, autumn rearing is entailed with high temperature and high humidity at initial stage of silkworm rearing. In addition, higher pathogen load and inferior quality of mulberry leaf at farmers' field also affect the crop. Under temperate conditions, although the temperature is not high, yet the production is far below the spring average due to poor quality of mulberry leaf and non-availability of desired autumn specific breeds/hybrids. The sericulturally advanced countries like China and Japan have succeeded in increasing the unit production of silk by evolving highly productive season/region specific bivoltine silkworm breeds suitable to their local conditions [13].

Apart, Japan also studied in regard to the seasons (summer and autumn) and evolved a good numbers of breeds and exploited commercially and few attempt were also made in India for success of autumn crop at temperate zone of Kashmir [9]. Hence, it is prime importance to study in detail as to why the autumn crop has not gained momentum so far, even though autumn crop is considered as second largest crop after the spring. Hence, in the present investigation, the authors have utilized twenty five breeding lines to understand the genetic differences during autumn season through biometrical tool of evaluation index under temperate climatic belt of Kashmir Valley.

Traditionally silkworm rearing is twice in a year in Jammu region of J & K, *i.e.* during spring season (1st crop) by brushing of silkworm in the first week of March and during autumn season (2nd crop) by brushing of silkworms from last week of August to first week of September. Being a favorable season cocoon quality and quantity during spring crop is much superior to autumn crop and so is success of crop, this is reason that more than 80 *per cent* of silkworm seed consumption & cocoon production is coming from Spring crop and rest from Autumn crop [1].

In Tropical South India, silkworm rearing is practiced throughout the year and up to six crops are harvested annually whereas in subtropical climate of North West India, only one crop of silkworm cocoons is harvested mainly in spring season as result over the years number of farmers and over all cocoon production of this region do not show significant growth. To make sericulture a economically viable option and at one hand and to increase the cocoon production of this zone there is urgent need to overcome and address the issues related to inherited constraint of single crop sericulture industry by stabilizing the autumn crop. The study is aimed to address these two vital aspects required for sustainable development of sericulture in the entire North-West India [12].

Material and Methods

A diagnostic study was carried out at Regional Sericultural Research Station, Jammu on selected *B. mori* hybrids for their qualitative and quantities traits as per the objective of the study. The hybrids were received for the study from different geographical region of our country listed in Table 1. The experiment trial was carried out during autumn (2018) at Regional Sericultural Research Station (RSRS), Miran Sahib, Jammu with two brushing dates, the first batch of brushing was on 5.09.2018 and second was on 15.09.2018 respectively. All hybrids were reared in three replications by following standard rearing techniques [7]. Three hundred larvae were retained after 2nd moult in each replication. The data pertaining to the economic parameters were recorded from time to time. During the entire period of research, same microclimate and feeding conditions were ensured as per the larval stage. For rearing S - 146 mulberry variety grown in loamy soil with spacing of 3 × 3 ft and 8 × 9 ft plantation was used for the experiment and it is maintained in the institute. The data was collected on the following parameters for pre-cocoon *viz*., Fecundity, Hatchability (%), Larval period, Weight of full grown larvae (g), ERR by Weight & Number, Pupation Rate (%), Single Cocoon Weight, Single Shell Weight and Cocoon Shell Ratio (%) etc. and post cocoon parameters *viz*., Average filament length, Denier, Renditta, Raw Silk (%) and Reelability (%).

Observations on various economic traits recorded during rearing trial were analyzed statistically by one way ANOVA using Indo-stat package. Evaluation Indices (E.I) were also determined [10].

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

Where,

A = Value of a particular hybrid for a character.

B = Mean value of particular trait of all the hybrids combinations.

C = Standard deviation of particular trait of all the hybrids combinations.

10 = Standard Unit.

50 = Fixed value

Results

The results of the experiment conducted for different hybrids with different brushing dates on growth, development and economic parameters of silkworm, *Bombyx mori* L. under sub- tropical condition of Jammu (J & K) are presented here under.

First brushing for autumn crop (2018)

Thirteen hybrids was reared & brushed on 05.09.2018 (First brushing) i.e. the traditional date of brushing for autumn season in sub tropical Jammu. Economic parameters recorded as- Fecundity ranges between 521.33 - 415.33 for $FC_1 \times FC_2$ and $RSJ_3 \times RSJ_1$ respectively (Table 2). The hatching percentage ranges from 97.25 - 94.09 for $DUN_{17} \times DUN_{18}$ and $D \times O_2$, 5th day larval duration ranges between 4:19 - 5:14 (D: H), Larval weight (10 mature larvae) recorded as 42.33 g ($DUN_{17} \times DUN_{18}$) to 29.67 g ($APS_5 \times APS_4$). The ERR/10000 larvae by No. ranged from 9155.67 ($SK_6 \times SK_7$) to 7678.00 ($FC_5 \times FC_6$) and weight basis ranged between 13.19 Kg ($PM \times FC_2$) to 11.08 Kg ($APS_5 \times APS_4$) with Single Cocoon Weight ranges between 1.65 g ($FC_5 \times FC_6$) to 1.39 g ($SK_6 \times SK_7$, $D \times O_2$ & $APS_5 \times APS_4$) and Shell percentage recorded as 20.24 ($FC_5 \times FC_6$) to 16.74 *per cent* ($D \times O_2$) (Table 2). Yield per 100 DFLs was recorded as 52.76 Kg ($PM \times FC_2$) followed by 51.32 Kg ($FC_5 \times FC_6$) followed by 49.87 Kg ($DUN_{17} \times DUN_{18}$) and 48.92 Kg (B.con1×B.con4) respectively. When analyzed all the parameters for statistically shows that all hybrids were significantly differed from each other.

Post cocoon parameters

The post cocoon parameters data reveals that, the filament length was recorded highest for $APS_5 \times APS_4$ (893 mtrs) and lowest was recorded in $PM \times CSR_2$ (478.00 mtrs) whereas reelability was maximum in $SH_6 \times NB_4D_2$ (74.51 %) and lowest in $SK_6 \times SK_7$ (56.19 %). The renditta (dry cocoon) was recorded lowest in $SH_6 \times NB_4D_2$ (3.28) and maximum was recorded in $SK_6 \times SK_7$ (5.45) whereas neatness was recorded highest in $APS_5 \times APS_4$, $DUN_{17} \times DUN_{18}$, $D \times O_3$, $D \times O_2$, $FC_5 \times FC_6$ (93.00 %) and lowest was recorded in B.con1 × B.con4 (80.00 %). The raw silk *per cent* was recorded in maximum in $SH_6 \times NB_4D_2$ (30.79 %) and lowest was recorded in $SK_6 \times SK_7$ (18.71 %) (Table 3).

Evaluation index

Evaluation index for the hybrids were analyzed for desired economic parameters both quantity and quality. Hybrids showing the index value above 50 shortlisted as $FC_5 \times FC_6$, $DUN_{17} \times DUN_{18}$, $FC_1 \times FC_2$, $PM \times FC_2$ and $SH_6 \times NB_4D_2$ (Table 4).

Second brushing for autumn crop (2018) - Postponement of existing brushing date

Twelve hybrids was brushed on 15.09.2018 & reared during autumn season (2018). Economic parameters recorded as - Fecundity ranges between 576.67 - 395.67 for $FC_1 \times FC_2$ and $RSJ_3 \times RSJ_1$ respectively (Table 5). Hatching percentage ranges from 97.43 - 92.29 for B.con1×B.con 4 and $S_8 \times CSR_{16}$; 5th day larval duration ranges between 4:10 - 6:00 (D: H); Larval weight (10 mature larvae) recorded as 50.00 g ($FC_5 \times FC_6$) to 38.67 g ($D \times O_2$). ERR/10000 larvae by No.

ranged from 8633.67 (DUN_{17}×DUN_{18}) to 8067.00 (FC_1×FC_2) and weight basis ranged between 15.16 Kg (FC_5×FC_6) to 11.05 Kg (RSJ_3×RSJ_1); Single cocoon weight ranges between 1.75 g (SH_6×NB_4D_2) to 1.49 g (D×O_3 & RSJ_3×RSJ_1) and Shell percentage recorded as 22.02 (FC_5×FC_6) to 17.67 *per cent* (SK_6×SK_7) (Table 5). The yield per 100 DFLs was recorded as 60.65 Kg (FC_5×FC_6), 57.83 Kg (B.con 1×B.con 4) followed by 56.27 Kg (PM×FC_2), 55.77 Kg (PM×CSR_2), 55.60 Kg (FC_1×FC_2), 54.23 Kg (SH_6×NB_4D_2) and 53.32 Kg (DUN_{17}×DUN_{18}) respectively. When analyzed all the parameters for statistically shows that all hybrids were significantly differed from each other except for ERR/10,000 larvae by No. showed non-significant (Table 5).

Post cocoon parameters

The post cocoon parameters data reveals that, the Filament length was highest recorded highest in FC_1×FC_2 (888 mtrs) and lowest was recorded in PM×FC_2 (479.00 mtrs) whereas Reelability was maximum in DUN_{17}×DUN_{18} (78.10 %) and lowest in RSJ_3×RSJ_1 (59.13 %). Rendita (dry cocoon) was recorded lowest in DUN_{17}×DUN_{18} (3.08) and maximum was recorded in SK_6×SK_7 (4.65) whereas Neatness was recorded highest in DUN_{17}×DUN_{18}, SH_6×NB_4D_2 (93.00 %) and lowest was recorded in PM×FC_2 (83.00 %). The Raw Silk *per cent* was recorded maximum in DUN_{17}×DUN_{18} (32.82 %) and lowest was recorded in SK_6×SK_7 (21.73 %) (Table 6).

Evaluation Index

According to evaluation index for the hybrids analyzed for desired economic parameters both quantity and qualitatively, hybrids showing the index value above 50 were shortlisted as DUN_{17}×DUN_{18}, FC_5×FC_6, S_8×CSR_{16}, SH_6×NB_4D_2, B.con 1× B.con 4 and FC_1×FC_2 (Table 7).

Discussion

Finding of the study is encouraging and generate hope that by adding innovative ideas and improving overall rearing conditions cocoon production and productivity can be improved during autumn crop under sub tropical conditions of Jammu. Isolated efforts made at farm and farmer level had so far not yielded desired results and autumn crop is yet to stabilized at farmers level as a result about 75-80 *per cent* of the cocoon are being produced from spring crop only. Some of the reasons from farmer's point of views for the non stabilization/failure of autumn rearing are crop failure & low return; if this bottleneck is addressed improvement is possible at farmer's level also. Findings of the study improved upon the findings were studied for rearing performance of autumn crop in Jammu province and reported that Jammu division contributes around 90 per cent of the total annual cocoon production of the J & K state. However, the cocoon production during autumn in the region remains around 1 per cent of total annual production. This is because, less than 10 per cent of the total silkworm rearers take up second cocoon crop in autumn and that too with a very low productivity level of around 8 Kg/ounce. They also found that productivity levels under CSB control area in the region have also a productivity range from around 15 to 40 Kg/Ounce [2].

Studies also suggested that to overcome the constraint of autumn crop there is need to improve the quality of mulberry leaves, modification in rearing practices, development of hardy breeds. Silkworm rearing conducted by adopted farmers of Research Extension Centers of Central Silk board in Jammu & Kashmir, Uttaranchal & Himachal also suggests that by integration of rearing technology and improvement in rearing practices production and productivity can be improved [3]. Study also reported yield per 100 DFLs in Jammu and Kashmir during autumn ranges from 41.71 – 45.75 Kg during year 2003 - 2005 under REC Tikri by integration of rearing technologies [6] and also reported that improvement in productivity was observed in autumn crop by restoring by pruning of mulberry plantation and rearing with seed produced by Central Silk Board. Further reported that during the year 2003 - 2005 the productivity level in Uttaranchal ranged from 27.23 to 40.76 Kg and 19.21 to 28.57 Kg in spring and autumn crop. Suggesting the strategy for autumn crop it was reported that leaf quality can be improved by pruning mulberry during 3rd or 4th week of June, mass disinfection, quality seed supply, selection of hybrid for autumn rearing (SH_6×NB_4D_2), working out silkworm brushing calendar (10-15th September in plain region and last week of august or first week of September in hilly areas) and crop protection measures are the major areas to be addressed to stabilize the autumn crop by adopting these measures in North India [6]. The field rearing in Jammu province of J&K can be multiplied and good quality cocoon crops can be produced if properly planned. It is suggested that if a package is evolved by the research institutions, the department can utilize the optimum conditions of the spring weather in a better way facilitating the farmers to have double crop in one season. These can be named as early and late spring crops. Moreover, the farmers will have handsome price of the cocoons produced during the spring season because of better competition in the market. In view of this a comprehensive package has to be worked out to have multiple cropping during spring, summer and autumn in the state of Jammu and Kashmir [5]. The reasons for second silkworm crop, the main constraint felt are poor yielding mulberry varieties, non-availability of own mulberry garden, non – application of FYM and chemical fertilizers and not following the proper pruning operation. Likewise, the use at traditional silkworm races, non-availability of separate rearing houses, improper disinfections and silkworm diseases are the serious concern for obtaining successful second silkworm crop [11].

Various suggestions has been given over the period of time to stabilized autumn crop in this region, some on theoretical consideration and some on work and practical experience, these include need for suitable hybrid, suitable date of pruning, adoption of pruning etc. present study has attempted to address these issues in practical and scientific manner. Finding of the study is clearly suggestive of that there is need to relook at the traditional attitude to overcome the issues related to autumn crop. It also suggests that we cannot have same hybrid for spring and autumn crop because rearing conditions are different. Brushing dates needs to be relooked at different location and hybrids has to be shortlisted on desired economic traits.

Table 1: Hybrids received from different institutes for the study

Sl. No.	Hybrids	Source
1	B.con 1×B.con 4	Central Sericultural Research & Training Institute, Berhampur
2	$SK_6 \times SK_7$	
3	$D \times O_2$	Regional Sericultural Research Station, Sahaspur, Dehradun
4	$D \times O_3$	
5	$DUN_{17} \times DUN_{18}$	
6	$SH_6 \times NB_4D_2$	
7	$APS_5 \times APS_4$	
8	$PM \times FC_2$	Central Sericultural Research & Training Institute, Manandawadi Road, Srirampura, Mysore
9	$S_8 \times CSR_{16}$	
10	$FC_5 \times FC_6$	
11	$PM \times CSR_2$	
12	$FC_1 \times FC_2$	Silkworm Seed Production Centre, Vijayapura
13	$RSJ_3 \times RSJ_1$	Regional Sericultural Research Station, Miran Sahib, Jammu

Table 2: Showing average data recorded for different hybrids studied during autumn (2018) (First brushing: 05.09.18)

Sl. No.	Hybrids	F (No.)	H (%)	LD (D:h)	5th LD (D:h)	LW (g.)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	Yield/100 DFLs (Kg)
							No.	Wt. (Kg)					
1	$PM \times CSR_2$	429.00 (29.73)	96.43 (79.07)	23.01	5.14	36.67	8377.67 (91.53)	12.00	1.46	0.28	18.91 (25.76)	97.67 (81.49)	47.99
2	$PM \times FC_2$	504.67 (22.48)	96.05 (78.53)	23.01	5.14	39.00	8944.67 (94.58)	13.19	1.49	0.29	19.28 (26.03)	98.33 (82.63)	52.76
3	$FC_5 \times FC_6$	430.33 (20.76)	96.43 (79.10)	23.01	5.14	41.67	7678.00 (87.62)	12.83	1.65	0.33	20.24 (26.72)	96.00 (78.49)	51.32
4	B.con1×B.con4	471.00 (21.72)	94.50 (76.43)	23.06	5.01	34.67	8511.00 (92.25)	12.23	1.51	0.26	16.87 (24.24)	98.00 (82.01)	48.92
5	$SK_6 \times SK_7$	458.00 (21.42)	95.82 (78.33)	23.05	5.00	32.67	9155.67 (95.68)	11.66	1.39	0.24	16.98 (24.32)	96.33 (79.01)	46.64
6	$SH_6 \times NB_4D_2$	442.33 (21.05)	97.14 (80.22)	23.05	5.00	37.67	8522.33 (92.32)	12.19	1.44	0.26	17.82 (24.95)	96.67 (79.47)	48.76
7	$S_8 \times CSR_{16}$	426.00 (20.66)	95.68 (78.30)	23.00	5.00	33.33	8333.00 (91.25)	11.73	1.41	0.28	19.57 (26.24)	97.00 (80.08)	46.93
8	$D \times O_2$	436.33 (20.91)	94.09 (75.91)	23.05	5.00	30.33	8688.67 (93.21)	11.97	1.39	0.23	16.74 (24.14)	96.67 (79.62)	47.87
9	$D \times O_3$	469.33 (21.66)	95.82 (78.20)	23.05	5.00	31.00	8555.33 (92.49)	11.63	1.41	0.23	16.11 (23.65)	94.33 (76.28)	46.52
10	$DUN_{17} \times DUN_{18}$	438.00 (20.94)	97.25 (80.43)	23.00	5.02	42.33	8477.67 (92.07)	12.47	1.52	0.29	19.29 (26.04)	94.00 (75.82)	49.87
11	$RSJ_3 \times RSJ_1$	415.33 (20.40)	95.50 (77.73)	23.00	4.19	32.67	8455.67 (91.95)	11.50	1.42	0.27	19.05 (25.86)	97.00 (80.61)	46.00
12	$APS_5 \times APS_4$	422.00 (20.56)	96.69 (79.54)	23.00	4.19	29.67	8177.67 (90.43)	11.08	1.39	0.25	18.27 (25.29)	96.33 (79.20)	44.31
13	$FC_1 \times FC_2$	521.33 (22.85)	95.83 (78.22)	24.04	5.04	34.67	8066.67 (89.81)	11.57	1.40	0.26	18.33 (25.34)	96.00 (78.49)	46.28
CD @5 %		0.73	2.50	0.01	0.008	1.13	2.26	0.63	0.02	0.01	0.44	1.29	2.63
Sem±		0.25	0.85	0.00	0.003	0.38	0.77	0.21	0.009	0.03	0.15	1.83	0.90
CV (%)		2.05	1.21	0.02	0.09	1.89	1.46	3.10	1.03	2.17	1.03	2.82	3.25

Note: F- Fecundity; H- hatching; LD – Larval duration; D-days; H-hours; LW- Larval weight; ERR- Effective rate of rearing; PR- pupation rate; SCW- Single cocoon weight; SSW- Single shell weight; SR – Shell ratio; Values in parentheses are statistically transformed; CD-critical difference; Sem- Standard Error of Mean; CV- Co- efficient of variation

Table 3: Showing post cocoon parameters recorded for different hybrids studied during Autumn (2018)

Sl. No.	Hybrids	AFL (mtrs)	Denier	Renditta	Neatness (%)	Reelability (%)	Raw silk (%)
1	$PM \times CSR_2$	478.00	2.07	4.25	90.00	68.62	23.72
2	$PM \times FC_2$	496.00	2.22	4.12	83.00	64.53	24.55
3	$FC_5 \times FC_6$	618.00	2.54	3.40	93.00	69.59	29.72
4	B.con1×B.con4	502.00	2.26	4.19	80.00	64.92	24.14
5	$SK_6 \times SK_7$	591.00	2.31	5.45	90.00	56.19	18.71
6	$SH_6 \times NB_4D_2$	684.00	2.50	3.28	83.00	74.51	30.79
7	$S_8 \times CSR_{16}$	656.00	2.28	3.53	90.00	72.54	28.61
8	$D \times O_2$	711.00	2.51	3.49	93.00	72.60	29.06
9	$D \times O_3$	564.00	2.43	3.51	93.00	74.36	28.81
10	$DUN_{17} \times DUN_{18}$	672.00	2.73	3.33	93.00	71.09	30.44
11	$RSJ_3 \times RSJ_1$	622.00	2.52	4.26	90.00	59.13	23.76
12	$APS_5 \times APS_4$	893.00	2.34	3.48	93.00	72.50	30.10
13	$FC_1 \times FC_2$	776.00	2.71	3.67	88.00	73.04	27.59
	Average	635.62	2.42	3.84	89.15	68.74	26.92
	SD	117.45	0.19	0.60	4.45	5.88	3.63

Note: AFL – Average filament length; SD - Standard deviation

Table 4: Showing evaluation index for different hybrids studied during autumn (2018)

Sl. No.	Hybrids	F (No.)	LD (D:h)	5th LD (D:h)	H (%)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	AFL (mtr)	Denier	Renditta	Neatness (%)	Reelability (%)	Raw silk (%)	Avg.
						Number	Weight											
1	PM × CSR_2	43.23	46.74	56.96	55.33	47.86	49.89	51.48	53.85	55.02	59.37	36.58	31.99	56.73	51.90	49.80	41.17	49.24
2	PM × FC_2	66.47	46.74	56.96	51.24	63.12	70.50	54.62	57.35	57.96	64.66	38.11	39.78	54.58	36.17	42.84	43.45	52.78
3	FC $_5$× FC_6	43.64	46.74	56.96	55.40	29.02	64.28	76.13	73.65	65.50	46.13	48.50	56.39	42.68	58.64	51.44	57.71	54.55
4	B.con1×B.con4	56.13	48.50	52.97	34.19	51.45	53.92	58.20	46.86	39.05	62.01	38.62	41.85	55.74	29.43	43.51	42.32	47.17
5	SK $_6$×SK_7	52.13	48.15	52.67	48.65	68.80	44.08	42.07	39.88	39.92	48.78	46.20	44.45	76.57	51.90	28.67	27.35	47.52
6	SH_6×NB_4D_2	47.32	48.15	52.67	63.10	51.75	53.23	48.35	46.86	46.49	51.43	54.12	54.31	40.69	36.17	59.81	60.67	50.94
7	S_8×CSR_{16}	42.31	46.38	52.67	47.11	46.66	45.34	44.76	53.85	60.26	54.07	51.74	42.89	44.82	51.90	56.46	54.65	49.74
8	D×O_2	45.48	48.15	52.67	29.77	56.23	49.37	42.07	38.71	38.03	51.43	56.42	54.83	44.16	58.64	56.56	55.89	48.65
9	D×O_3	55.62	48.15	52.67	48.65	52.64	43.56	43.86	36.38	33.08	32.89	43.90	50.68	44.49	58.64	59.55	55.20	47.50
10	DUN_{17}×DUN_{18}	45.99	46.38	53.28	64.35	50.55	58.01	59.10	59.68	58.06	30.25	53.10	66.25	41.52	58.64	53.99	59.70	53.68
11	RSJ_3×RSJ_1	39.03	46.38	27.82	45.18	49.96	41.31	45.21	50.36	56.12	54.07	48.84	55.35	56.89	51.90	33.66	41.28	46.46
12	APS_5× APS_4	41.08	46.38	27.82	58.21	42.47	34.00	41.18	45.70	50.00	48.78	71.92	46.01	44.00	58.64	56.39	58.76	48.21
13	FC_1× FC_2	71.59	83.16	53.89	48.83	39.49	42.52	42.97	46.86	50.52	46.13	61.95	65.21	47.14	47.41	57.31	51.84	53.55

Note: F – Fecundity; H-hatching; LD- Larval duration; ERR- Effective rate of rearing; PR- pupation rate; SCW- Single cocoon weight; SSW- Single shell weight; SR – Shell ratio; AFL – Average filament length; AVG-Average

Table 5: Showing average data recorded for different hybrids studied during Autumn (2018) (2nd brushing: 15.09.18)

Sl. No.	Hybrids	F (No.)	H (%)	LD (D:h)	5th day LD (D:h)	LW (g.)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	Yield/100 DFLs (Kg)
							No.	Wt. (g.)					
1	FC_5×FC_6	466.33 (21.61)	94.99 (77.06)	23.05	4.10	50.00	8167.00 (92.25)	15.16	1.71	0.38	22.02 (27.97)	94.33 (76.80)	60.65
2	B.con1×B.con4	472.33 (21.75)	97.43 (80.81)	25.05	6.00	45.00	8466.67 (91.99)	14.46	1.63	0.29	17.91 (25.07)	97.87 (81.57)	57.83
3	PM×FC_2	480.00 (21.93)	96.74 (79.59)	23.05	4.10	46.67	8411.00 (91.65)	14.07	1.61	0.32	20.12 (26.63)	97.33 (80.60)	56.27
4	PM×CSR_2	430.00 (20.76)	97.20 (80.45)	23.05	4.10	48.00	8600.00 (92.69)	13.94	1.58	0.33	20.63 (26.99)	98.33 (82.63)	55.77
5	SH_6×NB_4D_2	523.67 (22.90)	95.48 (77.85)	25.05	6.00	44.67	8189.00 (90.49)	13.56	1.75	0.32	18.47 (25.44)	92.33 (74.35)	54.23
6	SK_6×SK_7	473.67 (21.78)	96.38 (79.00)	25.05	6.00	40.67	8488.67 (92.07)	13.13	1.60	0.28	17.67 (24.84)	94.33 (76.34)	52.52
7	D×O_2	454.33 (21.33)	95.59 (77.92)	25.05	6.00	38.67	8155.33 (90.29)	12.11	1.54	0.31	20.34 (26.79)	96.00 (78.59)	48.45
8	D×O_3	518.00 (22.78)	96.06 (78.56)	25.05	6.00	39.67	8500.00 (92.26)	12.05	1.49	0.29	19.64 (26.29)	96.33 (79.10)	48.20
9	S_8×CSR_{16}	483.33 (22.00)	92.29 (73.86)	25.05	6.00	45.00	8333.33 (91.28)	13.40	1.66	0.35	20.84 (27.15)	95.67 (78.29)	53.60
10	DUN_{17}×DUN_{18}	478.00 (21.88)	94.50 (76.79)	25.05	6.00	44.33	8633.67 (92.92)	13.33	1.61	0.34	21.16 (27.37)	92.33 (74.25)	53.32
11	RSJ_3×RSJ_1	395.67 (19.91)	95.20 (77.31)	25.05	6.00	46.00	8467.00 (92.13)	11.05	1.49	0.28	18.97 (25.79)	85.00 (67.37)	44.21
12	FC_1×FC_2	576.67 (24.03)	95.96 (78.38)	23.04	5.04	47.67	8067.00 (89.75)	13.90	1.70	0.32	18.98 (25.81)	80.00 (63.52)	55.60
CD @ 5 %		0.58	2.98	0.01	0.001	1.57	-	1.01	0.03	0.01	0.50	5.67	4.07
Sem±		0.19	1.01	0.005	0.00	0.53	1.35	0.34	0.01	0.006	0.17	1.93	1.38
CV (%)		1.56	2.25	0.03	0.01	2.07	2.55	4.50	1.31	3.18	1.12	4.39	4.50

Note: LD – Larval duration; D-days; H-hours; LW- Larval weight; PR- pupation rate; SCW- Single cocoon weight; SSW- Single shell weight; SR – Shell ratio; Values in parentheses are statistically transformed; CD-critical difference; Sem- Standard Error of Mean; CV- Co- efficient of variation

Table 6: Showing post cocoon parameters recorded for different hybrids studied during autumn (2018)

Sl. No.	Hybrids	AFL (mtrs)	Denier	Renditta	Neatness (%)	Reelability (%)	Raw silk (%)
1	FC_5×FC_6	884.00	2.59	3.33	88.00	74.01	30.33
2	B.con1×B.con4	662.00	2.47	4.04	90.00	62.93	25.02
3	PM×FC_2	479.00	2.14	4.39	83.00	69.58	22.97
4	PM×CSR_2	685.00	2.34	3.88	90.00	69.58	26.07
5	SH_6×NB_4D_2	591.00	2.31	3.13	93.00	71.02	32.12
6	SK_6×SK_7	572.00	2.36	4.65	85.00	59.18	21.73
7	D×O_2	677.00	2.58	3.56	88.00	70.87	28.37
8	D×O_3	545.00	2.45	3.40	85.00	71.28	29.69

9	S_8×CSR_{16}	852.00	2.53	3.28	90.00	73.68	30.78
10	DUN_{17}×DUN_{18}	748.00	2.55	3.08	93.00	78.10	32.82
11	RSJ_3×RSJ_1	622.00	2.52	4.26	90.00	59.13	23.76
12	FC_1×FC_2	888.00	2.66	3.39	88.00	73.36	29.78
	Average	683.75	2.46	3.70	88.58	69.39	27.79
	SD	135.13	0.15	0.53	3.09	5.96	3.74

Note: AFL – Average filament length; SD-standard deviation

Table 7: Showing evaluation index for different hybrids studied during autumn (2018)

Sl. No	Hybrid	F (No.)	H (%)	LD (D: h)	5th LD (D: h)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	AFL (mtr)	Denier	Renditta	Neatness	Reelability (%)	Raw silk (%)	Avg.
						No.	Wt.											
1	FC_5×FC_6	47.17	45.22	36.49	34.28	39.00	65.95	61.51	70.85	66.94	51.83	64.82	58.96	43.01	48.11	57.74	56.79	53.04
2	B.con1×B.con4	48.48	62.92	56.77	56.49	54.98	59.74	51.82	40.47	36.56	58.24	48.39	50.79	56.45	54.59	39.16	42.61	51.15
3	PM×FC_2	50.14	57.91	36.49	34.28	52.01	56.32	48.99	51.71	52.87	57.28	34.85	28.33	63.08	31.92	50.31	37.13	46.48
4	PM×CSR_2	39.27	61.23	36.49	34.28	62.09	55.24	46.16	52.91	56.64	59.09	50.09	41.94	53.42	54.59	50.31	45.41	49.95
5	SH_6×NB_4D_2	59.64	48.73	56.77	56.49	40.18	51.84	66.36	51.71	40.70	48.21	43.14	39.90	39.22	64.30	52.73	61.57	51.34
6	SK_6×SK_7	48.77	55.32	56.77	56.49	56.16	48.10	48.59	37.36	34.78	51.83	41.73	43.31	68.00	38.40	32.87	33.82	47.02
7	D×O_2	44.56	49.53	56.77	56.49	38.38	39.17	40.91	48.13	54.52	54.86	49.50	58.28	47.37	48.11	52.48	51.56	49.41
8	D×O_3	58.41	52.99	56.77	56.49	56.76	38.61	35.26	40.95	49.35	55.46	39.73	49.43	44.34	38.40	53.16	55.08	48.82
9	S_8×CSR_{16}	50.87	25.57	56.77	56.49	47.87	50.47	55.86	60.09	58.22	54.25	62.45	54.88	42.06	54.59	57.19	58.00	52.85
10	DUN_{17}×DUN_{18}	49.71	41.63	56.77	56.49	63.89	49.85	48.99	57.69	60.56	48.21	54.75	56.24	38.28	64.30	64.60	63.44	54.71
11	RSJ_3×RSJ_1	31.81	46.72	56.77	56.49	55.00	29.86	34.86	37.60	44.39	34.90	45.43	54.20	60.62	54.59	32.79	39.24	44.70
12	FC_1×FC_2	71.17	52.24	36.38	45.27	33.67	54.86	60.70	50.52	44.47	25.83	65.12	63.73	44.15	48.11	56.65	55.32	50.51

Note: F – Fecundity; H-hatching; LD- Larval duration; ERR- Effective rate of rearing; PR- pupation rate; SCW- Single cocoon weight; SSW- Single shell weight; SR - Shell ratio; AFL-Average filament length

Conclusion

Present study clearly suggest that 15th September is better date for brushing than traditional date of 5th September under Jammu condition during autumn, it is also suggested that postponing brushing date by week or 10 days for autumn crop may give good result under the changing climatic regime. Date for other location can be pronounced accordingly *vis a vis* that for current date. Many shortlisted hybrids are commercially available and had performed better compared to ruling CSR double hybrid under autumn rearing conditions and can be reared along with ruling CSR double hybrid in future rearing. Cocoon productivity and production can also be improved. Future study will reassure these findings and finally it can be taken to farming community for better cocoon production during autumn rearing as well.

References

1. Anonymous. Annual sericulture report on cocoon production Department of industry Govt. of H. P, Shimla, 2006.
2. Bindroo BB, Khan MA. Autumn cocoon crop in Jammu division (J&K state) - Status, Problems and Prospects. Proceedings of regional seminar on prospects of problems of sericulture as an economic enterprise in North West India, 2006, 252-256.
3. Chakrabarti S, Siddiqui AA. Discussion on the Introduction of Summer crop and measures to improve the productivity in autumn in North Western states. Proceedings of regional seminar on prospects of problems of sericulture as an economic enterprise in North West India. 2006, 247-251.
4. Dar HU, Singh TP, Singh, Haque Rufaie SZ. Commercialization of second silkworm crop in Kashmir – Means and measures. A work shop on stabilization of second silkworm crop in North India organized by CSR&TI, Pampore (J & K) and Sericulture Development Department (J &K) on 2006, 29.
5. Khan MA. Multiple cocoon cropping in J & K - Prospects and bottlenecks. A work shop on stabilization of second silkworm crop in North India organized by CSR&TI, Pampore (J &K) and Sericulture Development Department (J &K) on, 2006, 19-22.
6. Khatri RK, Babulal AA, Siddiqui, Sharma AK. Management of seed production and approaches for stabilization of autumn crop in North India. Proceedings of regional seminar on prospects of problems of sericulture as an economic enterprise in North West India, 2006, 268-274.
7. Krishnaswami S. New technology of silkworm rearing. Bulletin no. 2, Central Seri-cultural Research and Training Institute, Mysore, India, 1978, 4-8.
8. Kumar CS, Sekharappa BM, Sarangi SK. Role of temperature and leaf quality on the larval growth and development during the young age of silkworm, Bombyx mori. Journal of Experimental Zoology, 2000; 3(1):9-16.
9. Malik MA, Kamili AS, Sofi AM, Malik GN, Sabahat A, Bhat SA. Second commercial silkworm rearing in Kashmir - A ray of hope, Indian Silk. 2009; 9:10-11.
10. Mano Y, Nirmal Kumar S, Bhargava HK, Mal Reddy N, Datta RK. A new method to select promising silkworm breeds /hybrid combinations. Indian Silk, 1993; 31:53.
11. Singh T, Singhal BK, Koul S, Khan MA, Sengupta D, Dhar SL. Feasibility of stabilization of second silkworm crop by R & D in North India. A work shop on stabilization of second silkworm crop in North India organized by CSR&TI, Pampore (J &K) and Sericulture Development Department (J & K) on 2006, 39.
12. Tyagi SK, Ranjan Tewari, Sardar Singh, Chakrabarti S. Study on the feasibility of additional summer silkworm crop in Himachal Pradesh. Proceedings of regional seminar on prospects of problems of sericulture as an economic enterprise in North West India. 2006, 280-282.
13. Yokoyama T. Silkworm selection and hybridization. In: Genetics in relation to insect management. Working papers. The Rockfeller Foundation. 1979, 71-83.