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Evaluation of selected hybrids during summer and ascertain brushing dates for introduction of additional cocoon crop under subtropical condition of Jammu (J & K)

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Abstract
Since decades North Western India is harvesting only two cocoon crops of which only spring crop is popular among sericulture farming community. A diagnostic study was conducted at Regional Sericultural Research Station Jammu in 2018 to explore the possibility of introduction of a third crop in between spring and autumn with selection of suitable hybrid and brushing date for summer rearing under sub-tropical condition of Jammu. Hybrid selection was made after evaluating the pool of silkworm hybrid developed at different institutes. Brushing was ascertained after brushing the silkworm eggs at different dates. Hybrids were evaluated according to evaluation index for desired economic parameters both quantity and quality based on evaluation index developed by Mano *et al.* (1993). Hybrids showing the index value above 50 were shortlisted. First brushing was conducted on 10th of June 2018 with eight hybrids and shortlisted hybrids are $FC_1 \times FC_2$, $D \times O_2$, $D \times O_3$ and $SH_6 \times NB_4D_2$ whereas Nine hybrids was reared during second brushing of summer season (2018), brushed on 25.06.2018. The hybrids showing the index value above 50 were shortlisted as $PM \times FC_2$, $PM \times CSR_2$, $SH_6 \times NB_4D_2$, $SK_6 \times SK_7$ and $D \times O_3$. Based on the study promising silkworm hybrid and suitable date of brushing for introduction of additional summer crop under sub-tropical condition has been workout.

Keywords: Hybrids, evaluation index, summer season, sub-tropical, brushing date

Introduction
Jammu Kashmir, Himachal Pradesh, Uttarakhand, Punjab and Haryana constitute the North-Western sericulture zone of the country. This zone is known for exclusive bivoltine cocoon production, no doubt it has salubrious climatic condition during spring rearing season for production of high quality bivoltine cocoons and there are very few pockets in the country which may be considered as natural home for bivoltine silk. However, it has certain limitations also. Only spring crop has the climatic advantages, hence over decades the entire zones depends on this crop for its annual raw silk output. There are only two silk cocoon crops in vogue in this zone i.e. spring and autumn of which spring crop alone constitutes about 80 *per cent* (except Uttarakhand) of the annual cocoon production. Current scenario limits the development of sericulture industry not only in terms of cocoon production but one of the reason for poor post cocoon support is because of the over dependency on single crop i.e. Spring for availability of raw materials to run the multi end reeling machines through the year.
Limited cocoon crops have been major obstacle for the growth of sericulture industry in North Western India including Jammu and Kashmir. Traditionally silkworm rearing is practices in this zone is twice in a year, 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. Due to sever climatic changes after October next rearing season comes only when mulberry sprouts in the month of February after winter dormancy. Silkworm enjoy fresh mulberry leaves of 50-60 days old, hence brushing of silkworm is ideal in June to explore scope of third crop & keeping intact the other two crops. Source of mulberry leaves are old giant mulberry trees and they are not pruned before autumn crop which adversely affect the autumn crop.
To explore the possibility of multiple cocoon crops under sub-tropical condition of North West India it is expected that introduction of a crop in between spring and autumn will forced the pruning of mulberry trees before autumn crop; hence it will help in stabilization of autumn crop also.

Material and Methods

Experiment trial was carried out during summer (2018) at Regional Sericultural Research Station (RSRS), Miran Sahib as part of diagnostic study to evaluate the *B. mori* hybrids and suitable date of brushing to explore the possibility of summer cocoon crop in between spring and autumn crop. Hybrids for the study were collected from different geographical region of our country (Table 1) & evaluated for their qualitative and quantities traits during summer month by rearing 10 disease free laying (dfls) of each hybrid with two brushing dates, the first batch of brushing was taken on 10.06.2018 and second was on 25.06.2018 respectively. All hybrids were reared in three replications by following standard rearing techniques (Krishnaswami, 1978) [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 determined as per Mano *et al.* (1993) [8].

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

Where,

A = Value of a particular hybrid for a character.

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

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

10 = Standard Unit

50 = Fixed value

Results

The results of 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:-

Hybrid evaluation during first brushing

Eight hybrids was reared during first batch of summer season (2018), brushed on 10.06.2018 (First brushing), economic traits of data pertaining to evaluation *viz*., Fecundity, hatching%, larval duration (h), larval weight (g), cocoon yield per 10,000 larvae by number, cocoon yield per 10,000 larvae by weight, pupation rate, cocoon weight, cocoon shell weight, and cocoon shell ratio of eight hybrids were presented in Table 2. The perusal of the data reveals that the fecundity ranges from minimum 410.00 ($APS_4 \times APS_5$) to maximum 473.00 ($FC_1 \times FC_2$) which shows statistically significant among all the Hybrids and hatching *per cent* ranged from minimum 84.00 ($APS_4 \times APS_5$) to maximum 97.00 ($FC_1 \times FC_2$) and shows statistical significance among all the hybrids. Larval weight (10 mature larvae) was recorded to a maximum of 41.00 g ($FC_1 \times FC_2$) and minimum of 30.00 g (B.con1×B.con4 & $SK_6 \times SK_7$) showing statistically significant variation among all the hybrids whereas pupation rate showing statistically non-significant among all the hybrids and it was recorded as highest 95.00 *per cent* ($SH_6 \times NB_4D_2$) and less 89.00 *per cent* ($D \times O_3$). With regard to yield per 10,000 larvae by number, B.con1× B.con4 was recorded highest (8067.00) and lowest in $D \times O_3$ (5533.00). Yield per 10,000 larvae by weight (Kg), ranged to the maximum of 10.63 Kg in $FC_1 \times FC_2$ and minimum of 6.67 Kg in $DUN_{17} \times DUN_{18}$ showing statistically significant variation among all the hybrids with regard both by number and weight basis. The single cocoon weight ranged from the maximum of 1.55 g ($FC_1 \times FC_2$) and minimum of 1.11 g ($SK_6 \times SK_7$). The shell weight was maximum (0.27 g) in $FC_1 \times FC_2$ & $DUN_{17} \times DUN_{18}$ and minimum in $SK_6 \times SK_7$ (0.19 g) shows statistically significant among all the hybrids with respect to both cocoon weight and shell weight. The shell ratio (%) shows statistically significant among all the hybrids and was highest in $D \times O_2$ (19.35) and lowest in $SH_6 \times NB_4D_2$ (16.00) respectively. The yield per 100 Dfls for all the hybrids vary with maximum in $FC_1 \times FC_2$ (42.52 Kg) and lowest was recorded in $DUN_{17} \times DUN_{18}$ (26.68 Kg) respectively (Table 2).

Post cocoon parameters

The post cocoon parameters data reveals that, the filament length was highest in $FC_1 \times FC_2$ (979 mtrs) and lowest was recorded in $SK_6 \times SK_7$ (461.00 mtrs) whereas reelability was maximum in $D \times O_3$ (87.00%) and lowest in $SK_6 \times SK_7$ (66.00%). The renditta on dry cocoon was recorded lowest in $FC_1 \times FC_2$ (2.65) and maximum was recorded in $D \times O_3$ (3.68) whereas neatness was recorded highest in $FC_1 \times FC_2$ (98.00%) and lowest was recorded in $D \times O_2$ and B.con1× B.con4 (93.00%). The raw silk *per cent* was maximum in $FC_1 \times FC_2$ (38.10%) and lowest was recorded in $D \times O_3$ (27.46%) (Table 3).

Evaluation Index

The selected hybrids were evaluated by multiple trait evaluation index (EI) as suggested by Mano *et al.* (1993) [8]. The evaluation of data during summer, 2019, reveals that the average EI values ranged from maximum of 58.21 ($FC_1 \times FC_2$) and to a minimum of 44.48 ($SK_6 \times SK_7$). Four hybrids *viz*., $FC_1 \times FC_2$, $D \times O_2$, $D \times O_3$ and $SH_6 \times NB_4D_2$ recorded above 50 EI value by evaluation index method (Table 4). Accordingly higher ranked 4 hybrids were selected for further laboratory trials for further short listing of hybrid (Table 4) in next rearing season.

Hybrid evaluation during second brushing

Pre - cocoon parameters

Nine hybrids were reared during second batch of summer rearing (2018). Brushed on 25.06.2018 (Second brushing), the perusal of the data reveals that the fecundity was recorded from 378.00 ($D \times O_2$) to 451.00 ($SH_6 \times NB_4D_2$) which shows statistically insignificant among all the Hybrids and hatching *per cent* ranged from 87.00 ($DUN_{17} \times DUN_{18}$) to 93.00 ($D \times O_3$) and found statistically non-significant among all the hybrids whereas larval weight was recorded a maximum of 35.00 g ($D \times O_3$) and minimum of 22.00 g ($SK_6 \times SK_7$) showing statistically significant among all the hybrids whereas pupation rate showing statistically significant among all the hybrids and it was recorded as highest 96.00 *per cent*

(PM×CSR_2) and low 67.00 *per cent* (DUN_{17}×DUN_{18}) (Table 5). With regard to yield per 10,000 larvae by number, SH_6×NB_4D_2 was recorded highest (7633.00) and lowest in D×O_3 (5467.00). Yield per 10,000 larvae by weight (Kg), ranged to the maximum of 10.40 Kg in PM×FC_2 and minimum of 7.00 Kg in APS_5×APS_4, it was found statistically non-significant among all the hybrids on the base of number and significant on the basis of weight. The cocoon weight ranged from the maximum of 1.64 g (PM × CSR_2) and minimum of 1.12 g (APS_5×APS_4). The shell weight was maximum (0.29 g) in PM × CSR_2 and minimum in APS_5×APS_4 (0.19 g) and was statistically significant among all the hybrids with respect to both cocoon weight and shell weight. The shell ratio (%) shows statistically significant among all the hybrids and was highest in PM×CSR_2 (17.50) and lowest in SH_6 × NB_4D_2 (15.13) respectively. The yield per 100 Dfls for all the hybrids vary with maximum in PM×FC_2 (41.60 Kg) and lowest was recorded in APS_5×APS_4 (28.00 Kg) respectively (Table 5).

Post cocoon parameters

The post cocoon parameters data reveals that, the filament length was highest in SK_6× SK_7 (721 mtrs) and in B.con1× B.con4 (558.00 mtrs) whereas reelability was maximum in D×O_2 & D×O_3 (79.00%) and lowest in B.con1×B.con4 (64.00%). The renditta on dry cocoon was recorded lowest in D×O_3 & APS_5×APS_4 (2.80) and maximum was recorded in B.con1× B.con 4 (4.38) whereas neatness was recorded highest in B.con1× B.con4, SH_6×NB_4D_2, PM× FC_2 and PM×CSR_2 (90.00%) and lowest was recorded in DUN_{17}×DUN_{18} (87.00%). The raw silk *per cent* was maximum recorded in D×O_3 (36.25%) and lowest was recorded in B.con1× B.con 4 (23.23%) (Table 6).

Evaluation Index

The selected hybrids were evaluated by the multiple trait evaluation index (E.I). The evaluation of data during summer (2018), reveals that the average E.I values ranged from maximum of 55.64 (PM×FC_2) to a minimum of 44.65 (APS_5×APS_4). The five hybrids *viz*., PM × FC_2, PM×CSR_2, SH_6×NB_4D_2, SK_6×SK_7 and D×O_3 were found having above 50 E.I value by evaluation index method (Table 4). Higher ranked 5 hybrids were selected for further laboratory trials and short listing (Table 7) for next season rearing.

Discussion

Economic importance of sericulture beside other factors is short gestation period of cocoon crop. Average life span of a silkworm *Bombyx mori* L. is about 25-26 days and thereafter it spins in to cocoon and cocoon are generally harvested after 6th day of spinning & cocoon are thus ready for sale if green cocoon is marketed. If the number of crops is increased it equally increases the chances of return from silkworm rearing. That is why it is very important that number of cocoon crops is increased in this part of the country to its possible extent. Lack of more cocoon crops in North Western India is major issue for the development of sericulture and to keep sericulture competitive with other cash crops in North-Western states it is imperative to introduce another one or two crops. Reasons observed for two crop patterns and low productivity is poor quality of mulberry leaves during summer and autumn month, non-adoption of proper rearing technologies for summer and autumn crop and non-availability of sturdy bivoltine hybrids tolerant to high temperature and high humidity. To overcome challenge it is important to finalize suitable brushing schedule for summer crop without disturbing the autumn crop, identification of suitable hybrids among available hybrids in the country at present and improvement in mulberry leaf quality. Earlier attempts for summer crop also reflected these views.

Chakrabarti and Siddiqui (2006) [13] reported that in district Dehradun of Uttarakhand during the years 2003, 2004, 2005 and 2006 average cocoon yield per 100 Dfls with a new thermo tolerant hybrid was 40.00 Kg, 43.60 Kg, 17.00 Kg and 30.50 Kg respectively while in control the average cocoon yield was only 5.00 Kg, 42.00 Kg, 8.00 Kg and 12.20 Kg respectively. Pooled data of four years showed that new thermo tolerant hybrid recorded an average cocoon yield of 32.20 Kg per 100 Dfls while in control the yield was only 17.00 Kg in adverse conditions.

Dar *et al*. (2006) [6] highlighted the constraints in the development of sericulture in J & K in general and for second commercial cocoon crop in particular. The management for silkworm rearing for the second crop has been highlighted. Procedure for rearing the one year or older silkworm eggs, through single and double refrigeration, for summer or pre-autumn silkworm rearing after 35-60 days for spring rearing has been recommended for adoption of the method. The method for the management of mulberry plantation for raising the second crop has been proposed. The cocoon yield for summer and pre-autumn silkworm rearing has been recorded as 24 and 34 Kg/oz. respectively.

Tayal *et al*. (2006) [13] reported that the main reason for limited number of crops in North West India is low productivity with higher mortality due to silkworm diseases during summer and monsoon rearing as a result sericulture is not attractive occupation in this region due to practicing of two crops only with low returns. The possibility of additional silkworm crop with sericulture more remunerative and more viable. However by adopting crop protection measure by means of supplementation of inorganic salts disease incidence can be controlled up to 60 *per cent.*

Khan (2006) [6] expressed that 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.

Dhar (2010) [4] reported that Dr. Tazima on his visit to Kashmir way back in 1957 had suggested that 'If one wishes prosperous future for Kashmir sericulture, the rearing of sericulture should be done more than twice in year with appropriate and effective manuring'. He also reported that bulk quantity of mulberry leaves during subsequent month after spring rearing remains unutilized and poor mulberry quality is a hindrance in commercializing of summer/autumn rearing to maximum extent. While suggesting the strategies for multiple cocoon crops it is reported there is need to adopt a new pruning schedule after two years of plantation for production of two to three healthy crops such as shoot let harvesting until IV instars and thereafter complete shoot harvesting leaving some shoot/shoot lets bearing on leaf behind and during monsoon/ autumn rearing only apical

portion of the branches should be harvested. Suggesting the cropping for sub-tropical zone it was reported to conduct spring (major crop) with bivoltine hybrids with shoot harvesting and date of brushing 5-10th April, Monsoon (minor crop) crop with Multi x Bi hybrids with date of brushing 1st July-31 July with leaf plucking/apical cut of branches/thinning of shoots, followed by Autumn (minor crop) having date of brushing 10 September to 10th of October with leaf plucking/apical cut of branches/thinning of shoots.

Bindroo (2010) [1] reveals that there are reports on success of staggered cocoon crop after 20 days of spring rearing extending to summer from Rajouri and Udhampur districts of J & K, this is an indication that field rearing can be multiplied and good quality cocoon crop can be produced if properly planned however requirement of comprehensive management package for maintaining suitability and availability of mulberry leaves at various periodic stages of multiple rearing period is needed. He also suggested that details of pruning scheduled for Kashmir region of J & K from 15th of March to 15th of August to ensure periodic leaf readiness for conducting multiple silkworm rearing in Kashmir.

Raina *et al.* (2011) [10] reported that for introduction of multiple cropping, crop stability is of prime importance and one of the important factor is mulberry leaf availability. They suggested that at CRC level two set of mulberry plantation can be maintained one for spring and autumn crop and other for spring and summer crop, reason given is that in some areas mulberry leaves form CRC garden is utilized for late age rearing also and harvesting of leaf extended up to April. The pruning and cultural practices for spring and autumn reared shall be adhered as per the existing package of practices for mulberry plantation, however mulberry plantation for spring and summer/monsoon crop were suggested to be maintained as pruning of plants (top clipping of denuded branches or bottom pruning (2nd week of May date of pruning to be coincided with onset of monsoon or plantation to be irrigated in May first/second week). They further reported that with introduction of Multi x Bi seed during autumn season the cocoon yield increased from an initial average of 10.38 to 21.61 Kg, thus results in to higher seed intake and production as well during autumn crop.

Sardar Singh and Singh (2012) [11] reported successful trial of summer crop in Himachal Pradesh where 2000 dfls of PM×CSR_2 was reared at farmers level and an average yield of 45 Kg/100 dfls were obtained during July 2010, where organized mulberry plantation was developed in 2006 were used for silkworm rearing.

Present study is based on the information gathered on success and failure as well to generate scientific information and base for identification of suitable hybrid and brushing date for summer crop, earlier attempt has not sustained and isolated success also did not go beyond a certain level, hence through scientific study and regress selection process both for hybrid and brushing was necessary. The hybrid will be further evaluated on suitable dates of brushing before taking the protocol at farmer's level trial.

Table 1: Hybrids received from different institutes for the study

Sl. No.	Hybrids	Source
1	B.con1×B.con4	Central Sericultural Research & Training Institute, Berhampur
2	SK_6×SK_7	
3	D×O_2	Regional Sericultural Research Station, Sahaspur, Dehradun - 248001
4	D×O_3	
5	DUN_{17}×DUN_{18}	
6	SH_6×NB_4D_2	
7	APS_5×APS_4	
8	PM×FC_2	Central Sericultural Research & Training Institute, Manandawadi Road, Srirampura, Mysore
9	PM×CSR_2	
10	FC_1×FC_2	SSPC, Vijayapura

Table 2: Showing average data recorded for different hybrids studied during summer (2018) (First brushing: 10.06.18)

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)					
B.con1×B.con4	460.00 (21.46)	93.00 (74.40)	24.00	5.05	30.00	8067.00 (89.75)	9.00	1.22	0.21	17.53 (24.73)	92.00 (73.43)	36.00
SK_6× SK_7	447.00 (21.15)	87.00 (68.53)	23.00	5.15	30.00	8000.00 (89.43)	7.70	1.11	0.19	16.96 (24.31)	93.00 (74.26)	30.80
D×O_2	430.00 (20.75)	91.16 (72.20)	24.06	5.17	36.00	7933.00 (89.06)	9.10	1.48	0.29	19.35 (26.08)	90.00 (72.19)	36.40
D×O_3	452.00 (21.28)	85.00 (67.08)	24.05	6.00	35.00	5533.00 (74.38)	7.67	1.33	0.24	17.99 (25.08)	89.00 (70.50)	30.68
FC_1×FC_2	473.00 (21.77)	97.00 (80.60)	24.00	5.19	41.00	7500.00 (86.54)	10.63	1.55	0.27	17.14 (24.45)	92.00 (74.48)	42.52
DUN_{17}×DUN_{18}	416.00 (20.41)	80.33 (63.72)	24.00	5.19	35.00	5767.00 (75.66)	6.67	1.49	0.27	18.38 (25.37)	90.00 (72.58)	26.68
APS_4×APS_5	410.00 (20.27)	84.00 (66.17)	23.05	5.09	37.00	6467.00 (80.41)	8.07	1.49	0.25	17.01 (24.34)	93.00 (75.01)	32.28
SH_6×NB_4D_2	430.00 (20.71)	92.00 (74.22)	24.00	5.19	36.00	6766.00 (82.24)	9.50	1.41	0.23	16.00 (23.57)	95.00 (77.09)	38.00
CD@5%	0.96	5.41	0.28	0.34	2.33	6.07	0.73	0.07	0.01	0.61	-	2.93
Sem±	0.31	1.79	0.09	0.11	0.77	2.00	0.24	0.02	0.005	0.20	2.64	0.96
CV (%)	2.62	4.38	0.69	3.77	3.80	4.16	4.91	2.99	3.27	1.43	6.20	4.91

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 during summer (2018) (First brushing: 10.06.18)

Hybrids	AFL (mtr)	Reelability (%)	Denier	Renditta	Neatness (%)	Raw silk (%)
B. con1 × B.con 4	683.00	70.00	2.10	3.04	93.00	33.33
SK_6× SK_7	461.00	66.00	2.34	3.33	95.00	30.24
D×O_2	702.00	80.00	2.28	3.33	93.00	30.22
D×O_3	866.00	87.00	2.32	3.68	95.00	27.46
FC_1×FC_2	979.00	83.00	2.68	2.65	98.00	38.10
DUN_{17}×DUN_{18}	714.00	77.00	2.38	3.24	95.00	31.15
APS_4×APS_5	794.00	83.00	2.46	3.42	95.00	29.56
SH_6×NB_4D_2	735.00	78.00	2.49	3.00	95.00	33.74

Note: AFL – Average filament length

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

Hybrids	F (No.)	H (%)	LD (D:h)	5th LD (D:h)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	AFL (mtr)	Reelability (%)	Denier	Renditta	Neatness (%)	Raw silk (%)	Avg.
					No.	Wt. (Kg.)											
B. con1 × B. con 4	59.25	57.82	54.99	43.34	60.43	53.65	39.15	40.12	45.66	51.26	46.10	38.59	33.45	44.51	37.92	54.90	47.83
SK_6× SK_7	53.31	46.94	33.28	46.61	59.77	43.28	32.13	33.83	43.68	56.31	31.38	32.88	47.57	53.81	50.81	45.46	44.48
D×O_2	45.55	54.48	56.30	47.26	59.11	54.45	56.10	63.77	66.68	41.17	47.36	52.85	44.04	53.81	37.92	45.40	51.70
D×O_3	55.59	43.32	56.08	74.39	35.56	43.04	46.55	49.10	52.77	36.13	58.24	62.84	46.40	65.03	50.81	36.97	50.90
FC_1×FC_2	65.18	65.07	54.99	47.92	54.87	66.66	60.77	56.59	58.41	51.26	65.74	57.13	67.58	32.01	70.13	69.48	58.21
DUN_{17}×DUN_{18}	39.16	34.85	54.99	47.92	37.86	35.06	56.94	58.38	54.12	41.17	48.16	48.57	49.93	50.92	50.81	48.24	47.57
APS_4×APS_5	36.42	41.51	34.37	44.65	44.73	46.23	56.88	53.29	43.83	56.31	53.47	57.13	54.63	56.69	50.81	43.38	48.46
SH_6×NB_4D_2	45.55	56.01	54.99	47.92	47.66	57.64	51.49	44.91	34.84	66.40	49.55	50.00	56.40	43.23	50.81	56.16	50.85

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 summer (2018) (Second brushing: 25.06.18)

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)					
PM×FC_2	409.00 (20.23)	92.00 (73.54)	23.23	5.18	31.00	7467.00 (86.47)	10.40	1.59	0.27	17.02 (24.34)	95.00 (77.68)	41.60
PM×CSR_2	382.00 (19.56)	90.00 (71.63)	23.23	5.18	34.00	6734.00 (78.02)	10.00	1.64	0.29	17.50 (24.70)	96.00 (78.64)	40.00
D×O_2	378.00 (19.42)	88.00 (69.77)	23.19	5.14	32.00	5833.00 (76.41)	8.40	1.49	0.24	16.07 (23.62)	90.00 (72.17)	33.60
D×O_3	421.00 (20.52)	93.00 (73.21)	23.20	5.16	35.00	5467.00 (77.04)	7.27	1.40	0.23	16.04 (23.57)	77.00 (61.67)	29.08
DUN_{17} × DUN_{18}	388.00 (19.72)	87.00 (65.84)	23.23	5.18	32.00	6067.00 (77.81)	7.43	1.48	0.24	16.56 (23.98)	67.00 (53.53)	29.72
APS_5 × APS_4	412.00 (20.33)	90.00 (72.85)	23.05	5.00	28.00	6300.00 (79.29)	7.00	1.12	0.19	16.04 (23.58)	84.00 (66.40)	28.00
SH_6 ×NB_4D_2	451.00 (21.26)	90.00 (72.05)	23.23	5.18	30.00	77633.00 (86.48)	8.60	1.33	0.20	15.13 (22.87)	69.00 (56.57)	34.40
SK_6×SK_7	428.00 (20.70)	91.00 (72.44)	23.19	5.14	22.00	6911.00 (83.13)	7.16	1.30	0.21	16.15 (23.64)	81.00 (63.96)	28.64
B.con1×B.con4	390.00 (19.58)	88.00 (68.35)	24.19	5.20	23.00	7267.00 (85.20)	8.17	1.14	0.17	15.31 (23.03)	78.00 (62.24)	32.68
CD @ 5 (%)	-	-	0.01	0.01	2.64	-	1.00	0.15	0.02	0.43	5.97	4.02
Sem±	0.80	2.77	0.004	0.006	0.88	2.89	0.33	0.05	0.007	0.14	1.99	1.34
CV (%)	6.88	6.75	0.02	0.18	5.14	6.18	7.03	6.54	5.68	1.06	5.24	7.03

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

Hybrids	AFL (mtr.)	Denier	Renditta	Neatness (%)	Reelability (%)	Raw silk (%)
PM×FC_2	564.00	2.67	3.33	90.00	78.00	30.22
PM×CSR_2	604.00	2.23	4.29	90.00	69.00	23.53
D×O_2	651.00	2.37	3.00	88.00	79.00	33.56
D×O_3	615.00	2.69	2.80	88.00	79.00	36.25
DUN_{17} × DUN_{18}	630.00	2.39	3.34	87.00	77.00	31.15
APS_5 × APS_4	690.00	2.03	2.80	88.00	68.00	36.16
SH_6 ×NB_4D_2	640.00	2.59	3.23	90.00	78.00	33.74
SK_6×SK_7	721.00	2.02	3.64	88.00	73.00	27.90
B.con1×B.con4	558.00	2.12	4.38	90.00	64.00	23.23

Note: AFL – Average filament length

Table 7: Showing evaluation index for different hybrids studied during summer (2018) (Second brushing: 25.06.18)

Hybrids	F (No.)	H (%)	LD (D:h)	5th LD (D:h)	ERR/10000 larvae		SCW (g.)	SSW (g.)	SR (%)	PR (%)	AFL	Denier	Renditta	Neatness (%)	Reelability (%)	Raw silk (%)	Avg.
					No.	Wt. (Kg)											
PM×FC_2	51.01	60.74	47.79	54.81	47.07	67.24	61.14	62.08	60.90	62.58	37.59	62.31	48.40	60.17	57.31	49.15	55.64
PM×CSR_2	39.89	50.57	47.79	54.81	46.76	64.00	63.75	66.40	67.30	63.54	45.07	45.62	64.86	60.17	41.30	35.55	53.59
D×O_2	38.24	40.39	46.60	48.15	46.38	51.05	55.38	53.45	48.24	57.78	53.87	50.93	42.74	43.53	59.09	55.94	49.49
D×O_3	55.95	65.83	46.90	51.48	46.23	41.91	50.81	49.67	47.84	45.31	47.13	63.07	39.32	43.53	59.09	61.41	50.97
DUN_{17} × DUN_{18}	42.36	35.30	47.79	54.81	46.48	43.20	54.89	53.45	54.77	35.71	49.94	51.69	48.57	35.21	55.53	51.04	47.55
APS_5 × APS_4	52.24	50.57	42.45	24.85	46.58	39.72	35.31	39.96	47.84	52.03	61.16	38.03	39.32	43.53	39.53	61.23	44.65
SH_6 ×NB_4D_2	68.30	50.57	47.79	54.81	76.66	52.67	47.11	43.46	35.70	37.63	51.81	59.27	46.69	60.17	57.31	56.31	52.89
SK_6×SK_7	65.65	65.27	20.32	40.02	49.85	41.83	58.92	59.71	61.20	52.88	80.49	46.21	37.32	33.36	66.01	59.50	52.41
B.con1×B.con4	43.18	40.39	76.28	58.14	46.99	49.19	36.34	35.91	38.10	46.27	36.47	41.44	66.40	60.17	32.41	34.94	46.41

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

References

1. Bindroo BB. Management of mulberry for regular and suitable leaf supply for the conduct of multiple cocoon cropping in Kashmir. Souvenir of Workshop on Multiple Cocoon crops for Sustainable Sericulture in J&K State on, 2010, 58-61.
2. 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.
3. 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.
4. Dhar A. Strategies for production of quality mulberry leaf for multiple cocoon crops in J & K state. Souvenir of Workshop on Multiple Cocoon crops for Sustainable Sericulture in J&K State on 2010; 36:41
5. Gangwar SK. Screening of region and season specific bivoltine silkworm (*Bombyx mori* Linn.) hybrid breeds of West Bengal in spring and summer season of Uttar Pradesh climatic condition. International Journal of Plant, Animal and Environmental Sciences. 2011; 1(1):74-87.
6. 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.
7. Krishnaswami S. New technology of silkworm rearing. Bulletin no. 2, Central Seri-cultural Research and Training Institute, Mysore, India, 1978, 4-8.
8. 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.
9. Quadir SM, Khan MA. Performance of silkworm hybrids during summer rearing in Temperate areas of Kashmir. 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, 32.
10. Raina SK, Chauhan TPS, Tayal MK, Pandey, Rajat Mohan RK. Multiple silkworm cocoon cropping in Jammu Division. Technical Compendium of Workshop on Recent Trends in Development of Bivoltine sericulture in Jammu & Kashmir held at Sher e Kashmir International Convention Centre, Srinagar. 2011; 63:65
11. Sardar Singh, Singh RD. Technical Compendium on Cluster Project for Mulberry Sericulture in HP-Implementation, Outcome and Handing Over. 2012, 27-28.
12. 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.
13. Tayal MK, Chauhan TPS, Siddiqui AA, Mishra PN, Chakrabarti S. Feasibility of additional silkworm crop in Uttaranchal through supplementation of inorganic tissue salts. Proceedings of regional seminar on prospects of problems of sericulture as an economic enterprise in North West India. 2006, 264-267.