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Studies on performances of Bivoltine hybrids SK6 x SK7 and its Reciprocal crosses during April crop in West Bengal

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Abstract

The present investigation was carried out during 2017 during April Crop at the Dept. of Sericulture, Krishnath College, Berhampore, West Bengal with the aim to evaluate the performance of bivoltine hybrids of SK6 x SK7 (Bivoltine x Bivoltine) and it's reciprocal race in favorable season in West Bengal. Present study reveals that rearing of Bivoltine hybrids SK-6×SK-7 and its reciprocal even in April crop can give 10 kg more yield /100 dfls than traditional multivoltine hybrids. Present investigation also reveals that performance of SK-6×Sk-7 and its reciprocal are almost similar. So grainures may also take the advantages of using both male and female components as per their availabilities. Present study clearly indicates that bivoltine hybrids SK-6× SK-7 have also slowly emerged as a suitable material for rearing in favourable season. Present study also reveals that if we ensure full swing of supply of bivoltine hybrids SK-6× SK-7, it will end the era of rearing of traditional low yielder in West Bengal in terms of rearing of silkworm breeds.

Keywords: Favourable Season, Reciprocal cross, Bivoltine, Multivoltine, Silk worm breeds.

Introduction

The success of sericulture industry depends upon several factors of which the impact of the environmental factors such as biotic and abiotic factors is of vital importance. Among the abiotic factors, temperature plays a major role on growth and productivity of silkworm, as it is a poikilothermic (cold blooded) insect (Benchamin and Jolly, 1986). It is also known that the late age silkworms prefer relatively lower temperature than young age and fluctuation of temperature during different stages of larval development was found to be more favourable for growth and development of larvae than constant temperature. There is ample literature stating that good quality cocoons are produced within a temperature range of 22-27°C and above these levels makes the cocoon quality poorer (Krishnaswami et al., 1973). The effect of temperature higher than 30°C on silkworm larvae was reported earlier by Takeuchi et al., 1964 and Ohi and Yamashita, 1977. Huang et al. 1979 and He and Oshiki, 1984 used survival rate of silkworm as a main characteristic for evaluating thermo-tolerance. The hot climatic conditions of tropics prevailing particularly in summer are contributing to the poor performance of the bivoltine breeds and the most important aspect is that many quantitative characters such as viability and cocoon traits decline sharply when temperature is higher than 28°C (Shibukawa, 1964). The continued efforts for the

improvement of cocoon characters of domesticated silkworm were aimed at increased quality silk production. The main objective of silkworm rearing is to produce qualitatively and quantitatively superior cocoons, which in turn will have a direct bearing on the raw silk production. Therefore, it becomes imperative or essential to develop bivoltine breeds/hybrids which can with stand high temperature stress conditions. Sericulture, the viable agro-based industry aptly matches the socio-economic backdrop of rural India. One of the main aims of the breeders is to recommend silkworm breeds/hybrids to farmers that are stable under different environmental conditions and minimize the risk of falling below a certain yield level. Silkworm breeds that are reared over a series of environment exhibiting less variation are considered stable. The climatic conditions prevailing in the tropics are most unpredictable and the problems of tropical sericulture are occurrence of aggravated silkworm diseases, unsuitable mulberry leaf for bivoltine silkworms and lack of sustainable silkworm breeds for effective selection of desirable characters. In order to introduce bivoltine races in a tropical country like India, it is necessary to have stability in cocoon crop under high temperature environment. The pre-requisite of summer breeds is healthiness and adaptability to adverse conditions of high temperature, low food quality, relatively higher economic traits, with potential for increased cocoon production. In fact, Genotype environment interactions are of major importance to the silkworm breeders while developing new breeds. The concept of genotype and environment interactions has been well documented in both plants and animal species (Griffing and Zsiros, 1971). Although, it is not necessary to breed a genotype that is adapted to all ecological conditions, breeding methods can be designed towards producing a high yielding one with a considerable degree of general adaptability (Eberhart and Russel, 1966). Further, the methods of management practices, effective disease control through sanitation and raising suitable mulberry leaf under diversified environmental factors prevailing in the tropics plays an important role in the expression of quantitative traits of the silkworm (Benchamin et al., 1983) . Summer breeds are having significant importance in increasing cocoon production through rearing bivoltine hybrids round the year in tropical areas. The advantages of summer hybrids are high pupation rate, adaptabilities to high temperature coupled with high and low humidity and inferior food quality during the rearing. Stable cocoon crop under the bad conditions of high temperature with low quality mulberry leaves are difficult, but summer breeds/hybrids should have the potentiality for increasing production under such un-favourable weather conditions.

Over the years, Sericulture research in India has resulted in increase of silk production, but silk quality remains low due to inherent defects of Multi x Bi cocoons, from which 90% of the silk is produced (Datta, 1984). To overcome the problem in production of the quality silk and also to produce silk of International grade, this is necessary to rear bivoltine hybrids in India. Being a tropical country, bivoltine cannot be reared throughout year due to viable climatic conditions. In recent years, productive and superior quality silk producing bivoltine hybrids have been evolved for commercial exploitation (Basavarajaet al., 1995; Dattaet al.,2000a, b; 2001). But these hybrids have been recommended for rearing during favourable seasons of the year (Nov to Apr) in some parts of India.

West Bengal is one of the major traditional silk producing states of India. It is the third largest silk producing state of our country. In West Bengal rearing season is divided mainly in two parts i.e. favourable season and unfavourable season. November to April comes under favourable season and May to October comes under unfavourable season. During favourable season, generally dry summer is predominant and during unfavourable season wet summer is predominant. Mulberry is the sole food plant of *Bombyx mori L*. Mulberry crop span is 70 days. So, five leaf harvests as well as five rearing of silkworm are done in a year. November crop (winter or Agrahani), February crop (spring or Falguni) and April crop (summer or Baishaki) come under favourable season (dry summer) where June-July crop (Rainy or Shrabani) and August-September crop (autumn or Aswina) come under unfavourable season (wet summer). As Bivoltine races and their hybrids are more susceptible to high temperature and relative humidity, so rearing of these races is advocated in the month of November and February. But rearing of silkworm is not easier in April crop in West Bengal. Because prevailing of comparatively high temperature in the environment. Particularly during the 5^{th} instar very high temperature is experienced by Sericulturists in West Bengal which is highly detrimental for silkworm larvae. Because silkworm larvae of 5^{th} instar usually prefer comparatively lower temperature (24-25°C). But in later part of April crop we usually experience almost 40° C in West Bengal. Even humidity also becomes lower some times. Sarkar *et al*

2014 suggested that farmers start to switch in the rearing of Multivoltine hybrids like Nistari× M_{12} (W) from April crop onwards due to that climatic behavior. Keeping this in view, this study has been undertaken to evaluate bivoltine hybrids SK6 x SK7 and it's reciprocal race during April crop under West Bengal conditions. Here an effort is done towards the rearing of bivoltine hybrids and their reciprocal races in April also.

Materials and Methods

The present investigation was carried out during April, 2017 at the Dept. of Sericulture, Krishnath College, Berhampore (latitude 24°50′N and longitude 88°13′E), Murshidabad, West Bengal, India with the aim to evaluate the performance of Bivoltine hybrids of SK6 x SK7 (Bivoltine x Bivoltine) and it's reciprocal race in favorable season in West Bengal. The detail methodology adopted during the course of investigation is given below.

Meteorological Condition:

- The rearing was conducted in favorable season i.e. in the month of April (summer / Baishaki) during 2017.
- Average temperature & humidity recorded during silkworm rearing in April (summer / Baishaki) are 27.7°C & 61.25%, respectively.
- Average rainfall recorded during silkworm rearing (April crop) is 39.8 mm.

[Data was collected in the Post Graduate Department of Sericulture with the help of Department of Geography, Krishnath College, Berhampore, Murshidabad, West Bengal and Pulses and oil seeds Research Station. Berhampore, Murshidabad, West Bengal]

Experimental races:

In West Bengal rearing season is divided mainly in two parts i.e. favourable season and unfavourable season. November to April comes under favourable season and May to October comes under unfavourable season. During favourable season, generally dry summer is predominant and during unfavourable season wet summer is predominant. Mulberry crop span is 70 days. So, five harvests as well as five rearing can be done in a year. November crop (winter / Agrahani), February crop (spring / Falguni) and April crop (summer / Baishaki) come under favourable season (dry summer) where as June-July crop (Rainy / Shrabani) and August-September crop (autumn / Aswina) come under unfavourable season (wet summer) (Das *et al*., 1994, 2006).

As during the unfavorable season (May to September) temperature and relative humidity are relatively higher than the favorable season (November to April) so it is very difficult to rear productive races *i.e* bivoltine hybrids and their reciprocal races during this season. Even in April crop it is also quite difficult to rear bivoltine races and their hybrids.

So, in this experiment Bivoltine hybrid SK6 x SK7 was considered as the experimental material and compared with the reciprocal race of the same material i.e SK7 x SK6 during April crop.

- SK6 x SK7 (Bivoltine x Bivoltine)
- SK7 x SK6 (Reciprocal of above one)

Characteristics of mulberry variety:

Variety name: S_{1635}

- This is a triploid variety belongs to *Morus indica*.
- The variety is developed through selection from seedlings of open pollinated hybrids of CSRSII.
- The variety is recommended for the irrigated areas of West Bengal.
- Leaves are un-lobed, big in size, dark green in colour, cordate, smooth surface and glossy.
- Approximate yield is 40-45 MT/ha/yr.

Rearing Procedure:

The bivoltine hybrid of SK6 x SK7 and it's reciprocal race were reared by feeding S_{1635} mulberry leaves maintained under irrigated condition. Three feeding schedules (6 a.m., 11 a.m., 4 p.m. and 8 p.m.) were followed in a day. The rearing of above races were conducted favorable season i.e. in the month of April (summer / Baishaki), during 2017.

Experimental Design:

In this experiment the larvae were divided in two groups and each group had 3 replicates. For each replicate 400 larvae were maintained. After completion of the rearing and mounting operation is done of above mentioned two races, the cocoons were harvested on sixth day and the parameters such as larval duration, larval weight, effective rate of rearing, single cocoon weight, single shell weight, shell ratio, melting percentage and cocoon yield were recorded, subsequently the cocoons were subjected to reeling operation and the following parameters like average filament length, non-breakable filament length (NBFL), denier, renditta, reelability percentage, raw silk recovery percentage were recorded. The average data each of above mentioned parameters were recorded and depicted in tables.

Following standard formulae are used to calculate various parameters:

1. $SR\% \ X \frac{\text{Shell Weight}}{\text{Green Cocoon Wt.}} \times 100$

2. $\text{Non breakable filament length } X \frac{\text{Total Filament length}}{1 \Gamma \text{ Number of breaks}}$

3. $\text{Denier } X \frac{\text{Weight of silk filament in gm.}}{\text{Length in meter}} \times 9000$

4. $\text{Reelability}\% \ X \frac{\text{No of good cocoon fed}}{\text{No of casting}} \times 100$

5. $\text{Recovery}\% X \frac{\text{Silk Weight (gm)}}{\text{Silk wt(gm)} \Gamma \text{Silk waste wt(gm)}} \times 100$

6. $\text{Renditta} = \frac{\text{Green cocoon wt}}{\text{Silk wt}}$

7. $\text{Melting}\% \ X \frac{\text{Number of melted cocoon x 100}}{\text{Total number of Cocoons.}}$

8. Effective rate of rearing(ERR)=

$$\frac{\text{Total number of Cocoon harvested x 10000}}{\text{Total number of larvae brushed or counted after 3rd moult}}$$

Results and Discussion

The present investigation was carried out during 2017 during April Crop at the Dept. of Sericulture, Krishnath College, Berhampore, West Bengal with the aim to evaluate the performance of bivoltine hybrids of SK6 x SK7 (Bivoltine x Bivoltine) and it's reciprocal race in favorable season in West Bengal. (Table: 1-2).

In case of Silkworm races SK6 × SK7 and its reciprocal cross SK7 × SK6, there is not any significant differences between in various commercial characters in April crop in terms of average filament

length (723.60 meter & 719.58 meter), non breakable filament length (657.82 meter & 649.07 meter), denier (2.98 &2.95), renditta (6.92 kg & 7.04 kg), raw silk recovery percentage (76.23 % and 76.59 %) and reelability percentage (76.59% & 76.16%) respectively [Table-1].

Table 1: Performance of SK6 x SK7 and SK7 x SK6 on reeling character on April crop

Name of the Hybrid	Average Filament Length (m)	Non Breakable Filament Length (m)	Denier	Renditta (Kg.)	Raw Silk Recovery Percentage	Reeliability Percentage
SK6 x SK7	723.60	657.82	2.98	6.92	76.23	76.59
SK7 x SK6	719.58	649.07	2.95	7.04	75.68	76.16
CV%	0.2294	0.2850	0.2662	0.1044	0.0688	0.0596
SE±	0.540	0.239	0.006	0.012	0.0545	0.029
CD at 5%	1.7173	1.1927	0.0176	0.0328	0.0468	0.0533
Significance level	NS	NS	NS	NS	NS	NS

Same trends were observed in case of various yield and cocoon character like Cocoon yield (45.40 kg/100DFLs & 44.71 kg/100 DFLs), single cocoon weight (1.650 &1.651 gm), single shell weight (0.310 gm & 0.308 gm) , SR% (20% & 19.73%) and larval weight (46.25 gm for 10 larvae and 45.17 gm for 10 larvae) . Effective Rate of Rearing in case of SK6 × SK7 (7966.67) was slightly higher than SK7 × SK6 (7891.67) [Table-2].

Table 2: Performance of SK6 x SK7 and SK7 x SK6 on yield and cocoon character on April crop

Name of the Hybrid	10full grown larval weight (gm)	Larval duration (hrs in 5th instar)	E.R.R by number (10000 larvae)	Single cocoon Wt (gm.)	Single Shell Weight (gm.)	SR%	Yield (kg./100 DFLs)	Melting %
SK6 x SK7	46.25	140	7966.67	1.650	0.310	20	45.40	4.76
SK7 x SK6	45.17	137	7891.67	1.651	0.308	19.73	44.41	4.41
CV%	0.0559	0.6480	1.1210	0.2437	0.0945	0.1060	0.2238	0.0027
SE±	0.0146	0.7650	4.0050	0.011	0.004	0.0126	0.0104	0.7105
CD at 5%	0.0239	2.1716	4.7190	0.0079	0.00240	0.014	0.0304	0.0442
Significance level	NS	NS	**	NS	NS	NS	NS	NS

** Significant

From above observation it is clear that bivoltine races and its reciprocal can be successfully reared even in April crop in West Bengal. Average cocoon yield/100 DFLs is around 44-45 kg in bivoline races which are quite higher than traditional multivoltine hybrids. Sarkar *et al* (2017) during his study on performances of multivoltine, mutivoltine hybrids during April Crop in West Bengal stated that among multivoltine races performance of Nistari×M12 (W) is the best. According to them production of Nistari×M12 (W) for 100 DFLs is 34.160 kg in April Crop. So rearing of bivoltine hybrids SK6 × SK7 and its reciprocal even in April crop can give 10 kg more yield /100 DFLs than traditional multivoltine hybrids. This observation is similar to observation laid by Das *et al* (2006) suggested that in case of Sk6 × Sk7, Shell Ratio percentage, Filament Length and pupation rate are 20.68%, 910 meter and 90.50% respectively in favourable season and Shell Ratio percentage, Filament Length and pupation rate are 19.25%, 884 meter and 88.50% respectively in unfavourable season. But Only Govt grainages supply the DFLs of SK6 × SK7 at subsidized rate. Besides that Govt. grainages also provide bed disinfectants along that layings. But it is not possible for private grainages to supply the layings of SK6 × SK7 at subsidized rate along with adjacent facilities.

In West Bengal 80% of total layings are supplied by private grainages, so layings supplied by only Govt. sectors cannot reach near to the bulk of the farmers. We hope that this problem will be sorted out in future. Present investigation also reveals that performance of SK6 × Sk7 and its reciprocal are almost similar. So grainures may also take the advantages of using both male and female components as per their availabilities.

Even in April crop Production of (SK6 × Sk7) and its reciprocal in 100 DFLs is around 45 kg (Table-2). But still it is not popular at farmers' level due to wide distribution of this DFLs is not possible till now. But it is definitely a good sign for West Bengal Sericulture. Present study clearly indicates if we ensure full swing to supply of bivoltine hybrids SK6 × SK7, it will end the era of rearing of traditional low yielder in West Bengal in terms of rearing of silkworm breeds. Besides that Sarkar *et al* 2008 and 2014 indicates the increasing unpopularity of Nistari×NB4D2 at field level. In this cross breed NB4D2 is used as bivoltine Parent since 1960's. So continuous exploitation of NB4D2 as bivoltine parent is now no longer helpful to bring maximum vigour in F1.This was happened similarly in case of C. Nichi in early 1920's.Continuous exploitation of C.Nichi as bivoltine parent in tropical and subtropical condition in India for the preparation of cross breed turned C.Nichi as a multivoltine parent rather than bivoltine one. So in this junction a suitable bivoltine parent is required instead of NB4D2. Bivoltine parent like SK6, SK7 have now slowly emerged as a suitable material for rearing in favourable season.

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