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Performance of Elite Bivoltine Silkworm Germplasm Stocks in India

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Bivoltine silkworm genetic resources conserved at Central Sericultural Germplasm Resources Centre, Hosur is the largest collection of its kind maintained in India at one place. All the collections were made over a period of 10 years from 1995 and include 180 exotic (13 countries) and 157 indigenous accessions. These collections are well characterized considering different morphological descriptor states and evaluated for various economically important parameters including standard rearing and reeling traits. Breeders require such well characterized and evaluated materials for identification of races suitable for their breeding programme. With this intention the data were evaluated using the cumulative evaluation index and potential accessions with multiple traits were identified among the germplasm stocks conserved. Accession number BBI-0255 was identified for six specialized characters and Accession number BBE-0224 and BBE-0268 were identified for five specialized characters. Seven accessions were found to possess four specialized traits and remaining accessions were found to be superior in few or more characters in comparison with ruling bivoltine breeds in India (CSR-2 and CSR-4) at present.

Key words: Bivoltine, silkworm, germplasm, accessions, evaluation index

Central Sericultural Germplasm Resources Centre (CSGRC), Hosur is maintaining 357 bivoltine silkworm germplasm accessions, which includes 20 mutant genetic stocks. These accessions represent 13 countries including India. The collection in gene bank includes old popular breeds and also newly evolved breeds. Evaluation is the ultimate objective in germplasm management to assess the fitness for field use, based on data generated on various traits (Thangavelu *et al.,* 1997). Selecting promising pure breeds from germplasm stocks is an important duty of the curator of gene bank maintenance to promote their utilisation by the breeder in the crop improvement programme.

Genetic improvement in the evolved silkworm breeds is still required, due to narrow genetic distances among the Indian breeds because some of the breeds are repeatedly used in breeding programmes. Further, it is also known that some of the characters are genetically linked and hence even if the breeder aims at improving one/more-desired character, some other desired character may get altered (Dalton, 1987; Falconer, 1989; Anon, 1997).

Varied silkworm germplasm stocks contribute immensely to the development of viable and hardy silkworm breeds for commercial exploitation (Nirmal Kumar and Sreerama Reddy, 1994). Well-characterized and evaluated silkworm germplasm becomes a handy tool. Breeders want such proven and thoroughly evaluated breeding materials for their breeding programmes and also to evaluate at different regions and in different seasons. Hence, an attempt was made to identify suitable bivoltine silkworm germplasm with special characteristics to meet the present demand for utilizing them in various silkworm breeding programmes.

Materials and Methods

A total of 209 accessions that completed reeling analyses were considered for the present study. Bivoltine accessions were reared once in a year and the average of four crops from 2003 to 2006 has been taken for assessment. DFLs of these accessions are preserved in cold storage following 10 months preservation schedule and are brushed as composite population to avoid inbreeding depression, genetic erosion and to maintain the gene pool as far as possible. Forty disease free layings were chosen at random in each accession and divided into two batches of 20 dfls each. Composite layings were prepared only after the body pigmentation by taking approximately 50 eggs from each laying. All the bits of eggs from 20 laying sources were pasted on a slightly thick brown paper and wrapped in white fine tissue paper after drying. Thus each composite laying consists of about 1000 individual eggs pooled from 20 dfls. Similarly one

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more composite laying was prepared from the rest of the 20 layings. Thus in each accession two composite layings were prepared for brushing as two replications. The replications were maintained for data collection and analysis of economically important quantitative and qualitative characters. Rearing was conducted by following standard rearing procedures (Krishnaswami, 1978). These genetic resources were evaluated for 22 growth and reproductive parameters and 16 reeling and quality parameters.

For the present analysis the data generated on the following important traits were taken into consideration viz; fecundity (no.), weight of 10 larvae (g.), larval duration (hrs.), cocoon yield/10000 larvae by no, cocoon yield/10,000 larvae by wt. (kg), pupation percentage, shell ratio (%), cocoon yield / 100 dfls (kg.), filament length (mts.), denier, renditta (kg), neatness (%) and raw silk recovery (%). The data on these parameters for four years from 2003-2006 were analyzed based on query in indigenously developed database Silkworm Germplasm Information System (SGIS). The query on special characters was made in comparison with the two control accessions CSR-2 and CSR-4.

In order to assess the superiority of silkworm varieties impartially a common index was used. To accomplish the objective an Evaluation Index (EI) (Mano, 1993) was utilized, which is an index of multiple traits or as a performance index, which is a single valued measure of the multiple trait performance of a population. EI was calculated as follows.

$$\text{Evaluation Index (E.I.)} = \frac{A - B}{C} 10 + 50$$

Where,

A - mean of the particular trait

B - overall mean of the particular trait

C - standard deviation

10- fixed value

50 - constant

EI can increase the precision of selection of hybrids among array of breeds and give adequate weightage to all the yield component traits.

Results and Discussion

Among 209 bivoltine accessions, higher fecundity (more than 580 eggs/dfl) was recorded in 19 potential accessions, which is 50 and 30 eggs more than that of the average fecundity of CSR-2 and CSR-4 respectively (Table 1). In case of larval weight (10 Nos.) more than 42 g was recorded in 16 accessions with maximum of 44 in accession no. BBE-35, which was 4-6 g higher than CSR-2 and CSR-4. Shorter larval duration of 22 days was observed in 14 accessions, which was 2 days lesser than ruling breed, where the larval period was 24 days. Higher pupation rate (94-96%) was noticed in 21 accessions whereas, in CSR-2 and CSR-4 it was 92%. Higher cocoon yield per 10000 larvae by numbers was recorded in 26 accessions i.e., 9750- 9870, while it was 9519 in CSR-2 and 9376 in CSR-4. Cocoon yield per 10000 larvae by weight ranged between 21-19 kg in 27 accessions, and it was 19.9 kg in CSR-2 and 17.2 kg in CSR-4. Cocoon yield/100 dfls ranged from 85-77 kg/100dfls in 18 accessions, but in CSR-2 it was 79.6 kg and 68.7 kg in CSR-4. Of the important reeling parameters analysed high silk ratio of 24-22 % was recorded in 22 accessions, whereas it was 21.6 and 22.1 in CSR-2 and CSR-4 respectively. Higher total filament length of more than 1000 meters was recorded in 14 accessions (1190-1000) with 1190 m in accession BBI-0275, whereas CSR-2 and CSR-4 had lower filament length of 1077m and 938m respectively. In 21 accessions, lower denier of less than 2.1 (1.61-2.1) was recorded which are much superior when compared with CSR-2 (2.69) and CSR- 4 (2.6). The renditta recorded was 6.56 in CSR-2 and 7.48 in CSR-4, whereas lower renditta of less than 6.0 (4.8-6.0) was recorded in 14 accessions. Raw silk recovery was in the range of 78-98% in 21 accessions, but in case of ruling breeds it was less than 70% (65.5% in CSR-2 and 66.2 % in CSR-4). 22 accessions showed more than 94% for neatness, whereas in CSR-2 and CSR-4, the values were 85% and 88.5% respectively.

Ranking of bivoltine silkworm Germplasm

To identify the silkworm germplasm accessions which has the potentiality to perform better for more than one trait, ranking analysis was done based on Mano's Evaluation Index for selected economically important eight rearing and five reeling traits (Table 2) and those accessions which ranked for more number of traits were listed out as the potential bivoltine silkworm germplasm accessions among the germplasm stocks maintained at CSGRC, Hosur. The accession BBI-0255 ranked top for six specialized parameters followed by accessions BBE-0224, BBE-0268 possessing better ranking for five specialized parameters. Seven accessions viz., BBE-187, BBE-0035, BBE-0262, BBE-0266, BBE-177, BBE-263 and BBE-212 were found to possess four specialized traits.

During last four decades, several bivoltine breeds were evolved (Krishnasami, 1983; Datta, 1984; Govindan *et al.,* 1996; Thangavelu *et al.*, 1997; Thangavelu *et al.*, 2000). Since the multivoltine races are poor in productivity and cocoons produced from these races do not yield quality silk yarns suitable for power looms, bivoltine breeds are given much importance so as to compete in International silk market. Heterosis breeding in silkworm has substantially contributed to the increase in cocoon production and also in improving the quality of raw

Table 1. Comparative performance of elite bivoltine silkworm germplasm with ruling bivoltine pure breeds

Character	Value	Range	No. of Accessions	Accessions	CSR-2	CSR-4
1. Higher Fecundity (No.of eggs)	>580	580 - 632	19	BBI-0277, BBE-0179, BBI-0255, BBE-0177, BBI-0046, BBE-0225, BBE-0013, BBE-0272, BBE-0186, BBE-0216, BBE-0201, BBE-0224, BBE-0181, BBI-0286, BBE-0187, BBI-0172, BBE-0006, BBI-0276, BBE-0010	536	559
2. Higher larval weight (g.)	>42	42 - 44	16	BBE-0035, BBE-0004, BBI-0129, BBI-0079, BBI-0113, BBE-0206, BBE-0329, BBE-0177, BBE-0202, BBI-0081, BBI-0137, BBE-0268, BBI-0066, BBI-0045, BBI-0091, BBE-0212	37.4	38.9
3. Shorter Larval duration (Days)	<23	23 - 22	11	BBE-0021, BBI-0073, BBI-0072, BBE-0022, BBI-0069, BBI-0103, BBE-0024, BBE-0020, BBE-0014, BBE-0016, BBE-0015	24	24
4. Higher Pupation rate (%)	>94	94 - 96	21	BBE-0194, BBI-0058, BBE-0210, BBI-0066, BBE-0212, BBE-0037, BBI-0255, BBI-0207, BBI-0061, BBI-0071, BBI-0077, BBE-0005, BBE-0015, BBI-0044, BBE-0222, BBI-0103, BBI-0257, BBE-0042, BBE-0196, BBI-0063, BBI-0069	92.6	92.03
5. Higher cocoon yield/10000 larvae (No.)	>9750	9750 - 9870	26	BBI-0106, BBI-0117, BBE-0194, BBE-0222, BBE-0196, BBI-0097, BBE-0199, BBE-0193, BBI-0103, BBI-0137, BBI-0113, BBI-0132, BBI-0207, BBI-0123, BBE-0224, BBI-0091, BBE-0005, BBI-0239, BBI-0124, BBE-0226, BBI-0136, BBE-0001, BBI-0140, BBE-0260, BBI-0098, BBI-0255	9519	9376
6. Higher cocoon yield/10000 larvae (Kg.)	>19	19 - 21	27	BBI-0113, BBE-0010, BBI-0133, BBE-0268, BBE-0004, BBI-0044, BBI-0255, BBE-0035, BBE-0006, BBI-0134, BBI-0129, BBI-0137, BBE-0224, BBI-0126, BBI-0091, BBI-0086, BBI-0068, BBI-0056, BBE-0003, BBE-0225, BBI-0172, BBI-0079, BBE-0050, BBE-0043, BBI-0127, BBE-0270, BBI-0045	19.9	17.2
7. Higher cocoon yield/100dfls(Kg.)	>77	77 - 85	18	BBI-0113, BBE-0010, BBI-0133, BBE-0268, BBE-0004, BBI-0044, BBI-0255, BBE-0035, BBE-0006, BBI-0134, BBI-0129, BBI-0137, BBE-0224, BBI-0126, BBI-0091, BBI-0086, BBI-0056, BBI-0068	79.6	68.7
8. Higher Cocoon Shell Ratio (%)	>22	22 - 24	22	BBE-0225, BBE-0226, BBE-0185, BBE-0182, BBI-0275, BBE-0269, BBE-0262, BBE-0266, BBE-0236, BBE-0272, BBE-0263, BBE-0186, BBE-0197, BBI-0325, BBE-0247, BBE-0193, BBE-0181, BBE-0267, BBE-0265, BBE-0224, BBI-0239, BBE-0270	21.6	22.1
9. Higher Filament length (m.)	>1000	1000-1190	14	BBI-0275, BBE-0267, BBE-0266, BBE-0265, BBI-0326, BBE-0225, BBE-0262, BBE-0263, BBE-0270, BBE-0268, BBE-0171, BBE-0177, BBE-0202, BBE-0214	1077	938
10.Low denier (d)	<2.1	2.1-1.61	21	BBE-0026, BBE-0195, BBI-0062, BBI-0126, BBI-0115, BBI-0109, BBE-0024, BBE-0250, BBE-0219, BBE-0025, BBE-0214, BBE-0260, BBE-0035, BBI-0085, BBE-0015, BBI-0073, BBE-0051, BBE-0018, BBE-0050, BBE-0041, BBI-0255.	2.69	2.6
11. Low Renditta (Kg.)	<6.0	6.0-4.8	14	BBE-0182, BBE-0262, BBI-0325, BBE-0263, BBE-0187, BBI-0326, BBE-0227, BBE-0212, BBE-0216, BBE-0188, BBE-0185, BBE-0202, BBE-0201, BBE-0266	6.56	7.48
12. Higher Raw silk recovery (%)	>78	78-90	21	BBE-0182, BBE-0262, BBE-0216, BBI-0235, BBE-0013, BBI-0325, BBE-0187, BBE-0266, BBI-0275, BBE-0263, BBE-0227, BBI-0172, BBE-0267, BBI-0083, BBE-0219, BBI-0054, BBI-0286, BBE-0214, BBI-0273, BBE-0212, BBE-0193	65.5	66.2
13. High Neatness (%)	>94	94-98	22	BBI-0124, BBE-0185, BBI-0106, BBI-0125, BBI-0132, BBE-0177, BBI-0112, BBI-0105, BBI-0108, BBE-0188, BBI-0134, BBE-0187, BBE-0265, BBI-0072, BBI-0285, BBI-0327, BBI-0127, BBE-0261, BBE-0268, BBE-0229, BBI-0294, BBI-0136	90.0	88.5

silk (Govindan *et al.,* 1996). It is obvious that the silkworm germplasm constitutes the potential raw material having wide variation in their genotypic expressions besides additive effect. The silkworm germplasm available at CSGRC, Hosur is predo minantly of evolved breeds in addition to some old races. Most of the evolved breeds were not tested in the fields due to lack of major information on genetic constituents and lack of diversity among the parents used. This study throws light on the availability of some of the potential bivoltine silkworm accessions, which are superior to the ruling silkworm pure breeds. Many of the characterization parameters based on morphological traits also showed very high degree of variability among the 209 bivoltine accessions studied.

Table 2. List of top ranking bivoltine silkworm germplasm with multiple qualifying parameters

Ranking of Germplasm	No. of Parameters Qualified	Character*
BBI-0255	6	1(619.5), 4(94.324), 5(9750.167), 6(19.917), 8(79.626), 10(2.1),
BBE-0224	5	1(591.167), 5(9776), 6(19.533), 7(22.284), 8(78.081)
BBE-0268	5	2(42.311), 6(20.033), 8(80.203), 9(1026), 13(94.5),
BBE-0187	4	1(586.333), 11(5.6), 12(80.85), 13(96),
BBE-0035	4	2(44.09), 6(19.712), 8(78.857), 10(2.055),
BBE-0262	4	7(23.089), 9(1038.4), 11(4.85), 12(90.115),
BBE-0266	4	7(23.06), 9(1085), 11(6), 12(80.85),
BBE-0177	4	1(610), 2(42.736), 9(1017.85), 13(97.5),
BBE-0263	4	7(22.715), 9(1037.65), 11(5.515), 12(80.65),
BBE-0212	4	2(42.054), 4(94.824), 11(5.895), 12(78.495),

*Fecundity (No.), Weight of 10 larvae (g.), Larval duration (Days), Pupation percentage, Cocoon yield/10000 larvae by no, Cocoon yield/10,000 Larvae by wt. (Kg), Cocoon yield /100 dfls (Kg.), Cocoon, Cocoon Shell ratio (%), Filament length (m.),Denier(d), Renditta (Kg.), Raw silk recovery (%), Neat ness (%).

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