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Research Article

EVALUATION OF EXOTIC BIVOLTINE GENETIC RESOURCES TO IDENTIFY PROMISING BIVOLTINE BREEDS FOR TEMPERATE REGIONS OF INDIA

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Abstract: Under conservation and maintenance of silkworm genetic resources, a total of 475 (83 multivoltine, 369 bivoltine and 23 mutants) silkworm germplasm accessions were conserved in disease free conditions after thorough characterization and evaluation. Based on the performance, 20 exotic bivoltine accessions were shortlisted from the available germplasm resources which include top ten each of oval and dumb-bell accessions. These accessions were evaluated at temperate zone (Pampore, Jammu & Kashmir) during autumn and spring season for two years and data on rearing and reeling performance was collected. The analyzed data revealed that the exotic bivoltine accessions that spun oval cocoons *viz.* BBE-0201 and BBE-0329 and that spun dumbbell cocoons, *viz.*, BBE-0197, BBE-0267 and BBE-0268 were better combiners with CSR2 and CSR4 respectively and exhibited greater efficacy during two different seasons (autumn season & spring season) in temperate region. These breeds can be utilized for single and double hybrid preparation for commercial utilization at field level in temperate regions of India.

Keywords: *Silkworm Germplasm, Exotic bivoltine accessions*

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Introduction

As per the statistics available with Central Silk Board, more than 90% of the silk produced in the country is of multivoltine x bivoltine hybrid cocoons. The silk produced from such cocoons falling in to the lower grades in the international grades for silk and cannot be suitable to use in the power looms especially for warp threads and hence reelers prefer imported silk for want of quality. It is a well-known fact that bivoltine silk excels in quality and productivity, it is inevitable to go for large scale production of bivoltine sericulture in the country. During last two decades, quite a good number of bivoltine breeds/hybrids (F1s) were evolved at Central Sericultural Research and Training Institute, Mysore [1]. However, the silkworm rearing is restricted only to certain seasons in some places. In South India, Tamil Nadu, Andhra Pradesh and Kerala, silkworm rearing is conducted throughout the year except during April and May. In case of North India, bivoltine silkworm rearing is carried out only during spring and autumn season.

Keeping in view the need for evolving season and region-specific silkworm breeds, the present study was planned to evaluate the promising exotic bivoltine breeds for assessing their performance in temperate zone of Jammu & Kashmir. Based on the performance, the silkworm breeds identified will be recommended as resource material for evolving new silkworm breeds for the specific region as well as for commercial exploitation.

Materials and Methods

Evaluation of 369 bivoltine accessions *viz.* 209 indigenous and 160 exotic bivoltine silkworm germplasm resources was carried out by rearing in 3 batches in three different seasons *viz.* June-Sept., Sept.-Dec. and Dec.-March). Out of 369 bivoltine accessions, the 160 exotic bivoltine accessions were evaluated further for important economic parameters *viz.* fecundity (no.), pupation (%), ERR by wt. (Kg), single cocoon weight (g), single shell weight (g), filament length (m), reelability (%), raw silk (%).

The pooled data of 160 exotic bivoltine accessions was analyzed using Mano's Evaluation Index/Multiple Trait Evaluation Index method [2] and selected top twenty exotic bivoltine accessions. These shortlisted bivoltine accessions were further divided into two groups, *viz.*, 10 bivoltine accessions spinning oval cocoons and 10 bivoltine accessions spinning dumbbell cocoons [Table-1].

Table-1 *Shortlisted promising exotic bivoltine silkworm accessions*

SN	Acc. No.	Name	Cocoon shape	Performance
1	BBE-0005	MEIGITSU	Oval	Top ranking
2	BBE-0163	THAICHOAN	Oval	Top ranking
3	BBE-0232	NB1	Oval	Top ranking
4	BBE-0329	MIR-4	Oval	AIMSGEP
5	BBE-0013	CHAUNG NAUNG	Oval	Top ranking
6	BBE-0154	J-MARKED	Oval	Top ranking
7	BBE-0201	C124	Oval	Top ranking
8	BBE-0225	JZH (PO)	Oval	Top ranking
9	BBE-0043	BELKOKONA-II	Oval	Top ranking
10	BBE-0266	J2P	Oval	AIMSGEP/Hot spot
11	BBE-0143	KY-1	Dumb-bell	Top ranking
12	BBE-0155	J-DEEP MARKED	Dumb-bell	Top ranking
13	BBE-0164	SHOGETSU HOSHO	Dumb-bell	Top ranking
14	BBE-0268	J1M	Dumb-bell	AIMSGEP
15	BBE-0169	SHINKI RAYAKU (M)	Dumb-bell	Top ranking
16	BBE-0267	14M	Dumb-bell	Top ranking
17	BBE-0177	JPN5 x B25	Dumb-bell	Top ranking
18	BBE-0197	A	Dumb-bell	AIMSGEP
19	BBE-0050	UKR-2	Dumb-bell	Top ranking
20	BBE-0035	SANISH-18(M)	Dumb-bell	Top ranking

These promising top ten, each of oval and dumb-bell accessions, were used for conducting line x tester analysis for identification of promising exotic bivoltine accessions as parents.

Table-2 Mean performance of 20 exotic bivoltine accessions in all the 3 trials conducted at CSRTI,Pampore

Hybrids	Fec (No.)	Hat (%)	Larval Wt (10 no.) (g)	Yld/10000 By Wt (in kg.)	Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (mt.)	Cu EI
BBE-0005 X 290	409	93.22	39.97	13.17	94.73	1.616	0.335	20.77	810	48.99
BBE-0163 X 290	393	91.38	39.47	14.41	97.73	1.592	0.325	20.37	766	49.02
BBE-0232 X 290	406	94.26	40.78	13.79	93.80	1.595	0.314	19.72	821	45.84
BBE-0329 X 290	403	93.05	39.86	14.36	93.76	1.662	0.338	20.40	807	51.70
BBE-0013 X 290	382	92.31	39.31	13.70	93.38	1.594	0.328	20.55	795	43.00
BBE-0154 X 290	415	90.91	39.58	14.27	94.49	1.635	0.332	20.28	819	49.06
BBE-0201 X 290	400	92.84	41.36	14.57	96.64	1.628	0.336	20.58	783	53.52
BBE-0225 X 290	398	91.97	41.34	14.24	94.13	1.644	0.332	20.21	822	49.89
BBE-0043 X 290	398	90.37	39.39	14.56	94.47	1.667	0.339	20.39	801	49.23
BBE-0266 X 290	408	91.51	39.89	14.35	92.66	1.657	0.334	20.17	791	46.35
BBE-0143 X 291	412	93.52	40.61	14.02	95.89	1.587	0.316	19.92	800	48.58
BBE-0155 X 291	422	92.21	39.94	14.31	95.16	1.625	0.326	20.12	788	49.33
BBE-0164 X 291	436	92.21	39.55	13.90	95.56	1.587	0.316	19.97	754	45.56
BBE-0268 X 291	426	93.08	40.53	14.41	94.52	1.649	0.334	20.24	819	53.91
BBE-0169 X 291	422	92.34	40.56	14.31	95.90	1.614	0.320	19.85	767	48.54
BBE-0267 X 291	383	92.60	41.67	14.72	96.29	1.639	0.344	20.99	828	56.98
BBE-0177 X 291	414	93.87	39.94	13.76	96.82	1.540	0.307	19.93	797	46.79
BBE-0197 X 291	407	93.25	40.36	14.77	96.53	1.654	0.348	21.03	780	57.17
BBE-0050 X 291	401	90.46	40.77	14.47	95.16	1.643	0.33	20.11	809	49.43
BBE-0035 X 291	402	91.03	40.10	14.32	92.36	1.664	0.322	19.39	779	41.9
BBI-0290 x 0291*	450	94.91	45.20	14.69	95.71	1.665	0.342	20.57	853	66.88
Average	*409*	*92.44*	*40.48*	*14.24*	*95.03*	*1.627*	*0.329*	*20.26*	*799*	-
SD	*16.2*	*1.22*	*1.27*	*0.39*	*1.41*	*0.030*	*0.01*	*0.41*	*23.6*	-
CV %	*3.96*	*1.32*	*3.14*	*2.77*	*1.48*	*2.08*	*3.25*	*2*	*2.96*	-

**Indicates that CSR2 x CSR4(control)*

Table-3 Top performing exotic bivoltine accessions at CSRTI Pampore

Hybrids	Fec (No.)	Hat (%)	Larval Wt (10 no.)(g)	Yld/10000 By Wt(in kg.)	Pupation rate %	SCW (g)	SSW (g)	SR (%)	AFL (mt.)	Cu EI
BBI-290 x 291 (C)	450[75.36]*	94.91[70.23]	45.2[87.05]	14.69[61.33]	95.71 [54.81]	1.665 [61.37]	0.342 [61.75]	20.57 [57.52]	853 [72.60]	66.88
BBE-0197 X 291	407 [48.82]	93.25 [56.62]	40.36 [49.02]	14.77 [63.36]	96.53 [60.65]	1.654 [58.12]	0.348 [67.36]	21.03 [68.85]	780 [41.78]	57.17
BBE-0267 X 291	383 [34.02]	92.60 [51.29]	41.67 [59.31]	14.72 [62.09]	96.29 [58.94]	1.639 [53.69]	0.344 [63.62]	20.99 [67.87]	828 [62.05]	56.98
BBE-0268 X 291	426 [60.55]	93.08 [55.23]	40.53 [50.36]	14.41 [54.24]	94.52 [46.35]	1.649 [56.64]	0.334 [54.27]	20.24 [49.39]	819 [58.24]	53.91
BBE-0201 X 290	400 [44.51]	92.84 [53.26]	41.36 [56.88]	14.57[58.29]	96.64 [61.43]	1.628 [50.44]	0.336 [56.14]	20.58 [57.77]	783 [43.04]	53.52
BBE-0329 X 290	403 [46.36]	93.05 [54.98]	39.86 [45.09]	14.36 [52.97]	93.76 [40.95]	1.662 [60.48]	0.338 [58.01]	20.40 [53.33]	807 [53.18]	51.7

**value indicated in parentheses are evaluation index value*

The promising 20 exotic bivoltine accessions *viz.*10 oval and 10 dumbbell accessions were crossed with CSR2 (BBI-0290-Tester) – Oval x Oval and CSR4 (BBI-0291-Tester) - Dumbbell x Dumbbell respectively and reared the F1 progeny so as to assess the performance at temperate zone.

Results

The rearing performance of the hybrid combinations of the 20 shortlisted exotic bivoltine accessions were assessed against control CSR2 x CSR4 (BBI-0290 x BBI-0291) by taking up 3 rearing trials at CSR&TI, Pampore (Northern Zone-Temperate zone) during Sept-Oct'17 (Autumn season), Sept-Oct'18 (Autumn season) and May-June'19 (Spring season) by maintaining 3 replications per accession [250 larvae/ replication]. The data collected from all the 3 trials on the rearing and reeling parameters *viz.*, Fecundity (No,), Hatching %, Larval weight (g), Yield/10,000 larvae (no.), Yield /10,000 larvae by weight (kg.), Single cocoon weight (g), Single shell weight (g), Shell ratio (%), Pupation rate (%), Avg. Filament length (m.) were pooled and analyzed in order to find out the promising exotic bivoltine accessions as parental breeds for temperate zone.

The data of all the three trials on both rearing and reeling performance subjected to multiple trait analysis. Based on the analysis, though the control BBI-290 x 291 (control) performed top, among the hybrid combinations of the bivoltine accessions evaluated, the accessions *viz.*BBE-0197, BBE-0267, BBE-0268 performed as better combiner with CSR4 followed by BBE-0201 and BBE-0329 with CSR2. The evaluation index values along with mean of all the traits, standard deviation and CV% are also included [Table-2].

The analyzed data revealed that, among 20 exotic bivoltine accessions, 5 accessions have recorded >50 evaluation index values *viz.* BBE-0197, BBE-0267, BBE-0268, BBE-0201 and BBE-0329 which can be thus considered as economically viable accessions [Table-3].

Discussion

In India, indigenous races are well adapted to fluctuating tropical climatic conditions characterized by high temperature, but they are poor in productivity. Keeping this in view, efforts were taken over a decade to improve the quality of raw silk that has resulted in the development of many productive and qualitatively superiors bivoltine breeds/hybrids. However, these bivoltine breeds were developed only for favourable seasons. The silkworm breeds which are reared over a series of environments exhibiting less variation are considered stable. The breeders are to recommend those breeds to farmers that are stable under different environmental conditions. In China, high silk yielding silkworm breeds have been developed for rearing in spring season [3,4] and during summer-autumn season at a temperature of 28-30˚C and humidity 85-90% [5,6,7]. In Japan also, silkworm breeds suitable for spring, summer and autumn seasons were evolved and were also commercially exploited [8].

In the present study, combinations of shortlisted 20 exotic bivoltine accessions with CSR2 (BBI-0290) / CSR4 (BBI-0291) were evaluated at CSR&TI, Pampore which is temperate zone. The results clearly revealed the better combiners and their seasonal performance trends for the economic traits for temperate zone. The performance of silkworm genotypes is largely dependent on the combined action of heredity of its population and its environment to which it is exposed. There is a profound role of genotype x environment interaction on yield attributes [11,12]. The present study is also in accordance to the reports of [13] who stated that the performance of the insect is improved by selection in the environment where they are subsequently exploited. The variations observed for different economic traits among the exotic bivoltine accessions in different seasons with diverse temperature and humidity conditions could be due to the inherent genetic potentiality of the breeds to perform during environmental variations especially in temperature and humidity.

These observations establish the fact that the breeding materials should be evaluated under the agro-climatic condition where they are to be exploited [14]. Multiple trait evaluation index method has become a very useful tool for evaluation and identification of promising silkworm breeds / hybrids and is widely applied by many silkworm breeders [15,16]. In the present study, the exotic bivoltine accessions identified as better combiners for multi-traits recorded >50 index values, in turn clearly revealed maximum expression of economic traits during favourable seasons *viz*. autumn and spring seasons [17-20]. Particularly the accessions which are showing >50 index value expressed the effects for quantitative characters like cocoon weight and cocoon shell weight which in turn indicates that the additive gene action is important for these characters [21,22].

Conclusion

Out of 20 selected bivoltine accessions, combinations of 5 bivoltine accessions *viz*., BBE-0197 x 291, BBE-267 X 291, BBE-0268 X 291, BBE-0201 X 290 and BBE-0329 X 290 exhibited greater efficacy during autumn and spring season in temperate region of Jammu & Kashmir, India. It is concluded that the identified oval and dumbbell exotic bivoltine accessions can be utilized as parental breeds in temperate zones for improved silk production in India.

Application of Research: The results suggest that the hybrid combinations of the top performing bivoltine accessions which showed average evaluation index >50 and can be utilized for hybrid and double hybrid preparation for commercial utilization at field level in the temperate region of Jammu & Kashmir. The tested hybrids will serve as base material for hybrid evaluation among these hybrids as well as with other hybrids developed earlier.

Abbreviations: Cu EI: Cumulative Evaluation Index

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References

[1] Basavaraja H.K., Nirmal Kumar S., Suresh Kumar N., Mal Reddy M., Kshama Giridhar, Ashan M.M. and Datta R.K. (1995) *Indian Silk*,34(2), 5-9.
[2] Mano Y., Nirmal Kumar S., Basavaraj H.K., Mal Reddy N. and Datta R.K. (1993) *Indian Silk*, 31,53.
[3] Hourong X., Chen H., Zheng M.L., Zhengiong Z. and Sheng L. (1996) *Canye Kexue*, 22, 150-154.
[4] Wang Z.E. (1997) *Canye Kexue*, 23,14-19.
[5] He K., Meng Z., Yu B., Xia J. and Ye A. (1989) *Acta Agric. Zhejiang*,1(1), 32-38.
[6] Sohn K.W., Kim K.M., Hong K.W., Ryu K.S., Choi S.R., Mahyi, Kim K.Y., Lee S.P. and Kwon Y.H. (1987) *Res. Rep. Rural Dev. Adm. (Suweon),* 29,54-60.
[7] Yang M. (1998) *Canye Kexue*, 24,1-5.
[8] Eguchi R., Shimazaki A., Ichiba M. and Shibukawa (1995) *Bull. Natl.Inst. Seric. Entomol.Sci*.,12,47-93.
[9] Khan M.Z., Das S.K., Das K.K. and Saratchandra B. (2003*) Indian J. Entomol*., 65,551-560.
[10] Suresh kumar N., Basavaraja H.K., Kalpana G.V., Mal Reddy N., Joge P.G., Palit A.K., Nanje Gowda B. and Dandin S.B. (2006) *Indian J. Seric*., 45, 85-103.
[11] Khan M.Z., Sengupta A.K., Das K.K., Sen S.K and Saratchandra B. (2001) *Perspective in Cytol. Genet*., 10,747-757.
[12] Kobayashi J., Edinuma,H.E. and Kobayashi N. (1986) *J. Seri. Sci.Jpn*, 55, 345-348.
[13] Falconer D.S. (1990) *Genet.Res*, 56, 57-70.
[14] Naseema Begum A.R., Basavaraja H.K., Joge P.G. and Palit A.K. (2008) *Int. J. Indust. Entomol*. 16,15-20.
[15] Ramesh Babu M., Chandrasekaraiah, Lakshmi H. and Prasad J. (2001) *Bull. Indian Acad Seric*., 5,9-17.
[16] Sudhakara Rao P., Ravindra Singh., Kalpana G.V., Nishita Naik V., Basavaraju H.K., Ramaswamy G.M and Datta R.K. (2001) *Int. J. Indust. Entomol*., 3,31-35.
[17] Shivkumar, Bharath kumar N., Mir Nisar Ahmad., Shakeel Ahmad., Ravindra M.A and Ghosh M.K. (2018) *Journal of Entomology and Zoology Studies*, 6(4), 677-682.
[18] Bharath Kumar N., Shivkumar, Mir Nisar Ahmad and Ghosh M.K. (2018) *International Journal of Current Microbiology and Applied Science*, 7(11):2192-2201.
[19] Mir Nisar Ahmad., Bharath Kumar N., Shivkumar, and M.K. Ghosh (2019b) *Journal of Crop and Weed*, 14(3), 88-93.
[20] Mir Nisar Ahmad., Shivkumar., Bharath Kumar N., and M.K. Ghosh (2019a) *Journal of Entomology and Zoology Studies*, 7(1), 1030-1035.
[21] Satenahalli S.B., Govindan R., Goud J.V. and Magadum S.B. (1990) *Mysore J.Agric.Sci*., 24,491-495.
[22] Rajalakshmi E., Chauhan T.P.S., Thiagarajan V., Lakshmanan V. and Kamble C.K. (1997) *Indian J.Agric.Sci*., 67(7), 287-290.