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Research Article

EVALUATION OF EXOTIC BIVOLTINE BREEDS TO IDENTIFY PROMISING PARENTAL GENETIC RESOURCES FOR TROPICS

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Abstract: CSGRC plays a pivotal role in the inter-institutional collaboration for screening /testing/evaluation of sericultural germplasm through traditional as well as molecular tools. Presently, CSGRC is maintaining 369 silkworm genetic resources in the gene bank comprising 209 indigenous and 160 exotic accessions. Based on the rearing and reeling performance, 20 exotic bivoltine accessions were shortlisted from 169 accessions and utilised for hybrid preparation by crossing with the popular breed CSR2/CSR4. The hybrids of 20 exotic bivoltine accessions were tested by conducting four trials in favourable seasons at three tropical test centres along with control to assess the potentiality of the exotic bivoltine accessions as parents. The study indicated that the accessions *viz*. BBE-0197 and BBE-0267 performed as better combiners with CSR4 and revealed as promising exotic bivoltine accessions.

Keywords: *Silkworm germplasm, Exotic bivoltine accessions, Evaluation index, Hotspots*

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Introduction

In India, most of the sericultural areas are under tropical regions and majority of the raw silk production comes from crossbreeds (Multivoltine x bivoltine). Since bivoltine races were also one of the counterparts to produce crossbreed, emphasis was given towards development of high yielding bivoltine breeds. Among the Research Institutes, Central Sericultural Research and Training Institute, Berhampore, Mysore and Pampore and Regional stations working under those institutes were the pioneers in silkworm breeding. CSR&TI, Berhampore initiated silkworm breeding by working in an elaborate way between 1960s to 1980s and came out with many new high yielding bivoltine breeds like SK3, SK4, SK5, SK6, SK7, YB and BHR series. The success of silkworm breeds developed judiciously by the silkworm breeders mainly depends on its combining ability. Quite a good number of bivoltine breeds with high silk content and raw silk recovery developed at CSR&TI, Mysore are being maintained systematically and presently the single hybrid CSR2×CSR4 and the double hybrid (CSR2×CSR27) x (CSR6xCSR26) are being extensively reared in India which have played a key role in boosting bivoltine silk production in India [1]. Therefore, the silkworm breeding strategy should be oriented towards preparation of bivoltine hybrids with high silk productivity. In this context, the present study was taken up to utilize the promising exotic bivoltine breeds shortlisted from bivoltine germplasm resources for preparing hybrids by crossing with CSR2/CSR4 to evaluate their performance. The identified potential exotic bivoltine parental breeds can be utilized in breeding and hybrid seed production for commercial exploitation.

Materials and Methods

In the present study, a total of 369 bivoltine accessions were reared in three batches (200-Indigenous and 169 Exotic) and evaluated in three different seasons (BV-I batch with 115 accessions during June-Sept., BV-II batch with 137 accessions during Sept.-Dec. and BV-III batch with 113 accessions during Dec-March of every year.

The accessions were evaluated for their important economic parameters such as fecundity (no.), pupation (%), ERR by wt. (Kg), single cocoon weight (g), single shell weight (g), filament length (m), reelability (%), raw silk (%), boil-off loss and neatness (%). The data on the rearing and reeling performance of all the exotic bivoltine accessions were collected, compiled and analysed through Mano's Evaluation Index / Multiple Trait Evaluation Index method [2] and 20 top ranking exotic bivoltine accessions were shortlisted [Table-1].

Table-1 *Details of the shortlisted exotic bivoltine 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 20 exotic accessions were used for conducting line x tester analysis by crossing with popular bivoltine breed as tester (Oval lines x CSR2 and Dumb-bell lines x CSR4) in order to identify the promising exotic bivoltine breeds as parents.

Table-2 *Mean performance of 20 exotic bivoltine accessions in all the 4 trials at CSGRC, Hosur*

Hybrids	Fec (No.)	Hat (%)	Larval Wt	Yld/10000		Pupation	SCW	SSW	SR	AFL	Cu EI
			(10 no.) (g)	By No.	By Wt (in kg.)	rate %	(g)	(g)	(%)	(m.)	
BBE-0005 X 290	402	98.55	46.61	9030	13.59	86.23	1.621	0.300	18.59	860	47.09
BBE-0163 X 290	428	97.91	50.38	9184	14.55	89.13	1.650	0.313	19.06	849	54.07
BBE-0232 X 290	400	98.20	52.64	8719	12.36	82.60	1.642	0.321	19.60	828	49.40
BBE-0329 X 290	440	96.28	49.78	8747	13.21	84.12	1.669	0.319	19.18	940	51.43
BBE-0013 X 290	434	96.33	48.33	9248	13.94	90.67	1.606	0.310	19.52	798	50.22
BBE-0154 X 290	402	94.69	55.05	9234	14.44	88.96	1.568	0.316	20.31	899	53.82
BBE-0201 X 290	428	97.54	49.47	9248	13.48	89.59	1.570	0.303	19.27	970	52.74
BBE-0225 X 290	378	97.14	50.47	8828	12.59	82.78	1.628	0.329	20.29	826	48.60
BBE-0043 X 290	430	95.44	49.38	9262	14.60	90.38	1.641	0.304	18.69	816	49.66
BBE-0266 X 290	424	97.18	49.78	8262	11.21	77.25	1.629	0.318	19.64	869	44.17
BBE-0143 X 291	432	96.26	45.80	8437	12.21	79.55	1.616	0.301	18.79	856	40.62
BBE-0155 X 291	433	96.25	46.44	9392	13.68	91.42	1.534	0.296	19.45	877	48.40
BBE-0164 X 291	470	97.40	50.43	8774	13.72	83.98	1.650	0.312	19.01	852	51.56
BBE-0268 X 291	454	97.26	47.76	9159	13.74	88.75	1.535	0.290	18.98	922	49.15
BBE-0169 X 291	457	95.57	50.04	9013	13.54	87.27	1.584	0.296	18.67	927	48.77
BBE-0267 X 291	456	98.29	49.95	9050	13.76	86.50	1.630	0.309	19.08	921	54.15
BBE-0177 X 291	462	96.28	49.48	9298	13.98	90.04	1.539	0.297	19.32	882	50.86
BBE-0197 X 291	468	97.00	49.84	9192	14.71	87.84	1.642	0.332	20.27	879	58.62
BBE-0050 X 291	424	98.07	47.08	9008	13.14	87.12	1.544	0.291	18.91	851	45.34
BBE-0035 X 291	438	95.95	49.56	8855	13.96	85.08	1.683	0.312	18.69	812	48.56
290 x 291	425	96.28	49.91	9188	13.47	90.60	1.600	0.325	20.32	821	52.77
Average	433	96.85	49.44	9006	13.52	86.66	1.609	0.309	19.32	869	-
SD	23.8	1.04	2.07	294	0.86	3.83	0.050	0.010	0.58	46.6	-
CV %	5.51	1.07	4.19	3.27	6.35	4.42	2.82	3.94	2.98	5.37	-

Table-3 *Top performing exotic bivoltine accessions with percent improvement at CSGRC, Hosur*

Hybrids	Fec	Hat	Larval Wt	Yld/10000		Pupation	SCW	SSW	SR	AFL	Cu EI	P.I
	(No.)	(%)	(10 no.) (g)	By No.	By Wt(kg)	rate %	(g)	(g)	(%)	(m.)		(%)
BBE-0197 X 291	468	97.00	49.84	9192	14.71	87.84	1.642	0.332	20.27	879	58.62	11.09
BBE-0267 X 291	456	98.29	49.95	9050	13.76	86.50	1.630	0.309	19.08	921	54.15	2.62
BBE-0163 X 290	428	97.91	50.38	9184	14.55	89.13	1.650	0.313	19.06	849	54.07	2.48
BBE-0154 X 290	402	94.69	55.05	9234	14.44	88.96	1.568	0.316	20.31	899	53.82	2.00
BBI-290 x 291 (C)	425	96.28	49.91	9188	13.47	90.60	1.600	0.325	20.32	821	52.77	-

Table-4 *Mean performance of 20 exotic bivoltine accessions in all the 4 trials at CSRTI Mysore*

Hybrids	Fec	Hat	Larval Wt	Yld/10000		Pupation	SCW	SSW	SR (%)	AFL	Cu EI
	(No.)	(%)	(10 no.) (g)	By No.	By Wt (kg)	rate %	(g)	(g)		(m.)	
BBE-0005 X 290	380	94.32	40.70	9402	13.75	90.68	1.518	0.274	18.22	842	46.33
BBE-0163 X 290	484	95.06	41.85	9286	13.34	87.08	1.553	0.282	18.26	845	50.08
BBE-0232 X 290	361	93.81	40.68	9134	13.72	87.51	1.578	0.292	18.56	863	47.44
BBE-0329 X 290	435	92.69	42.29	8718	12.87	84.32	1.553	0.291	18.66	855	45.48
BBE-0013 X 290	445	93.01	42.93	8742	12.68	83.05	1.585	0.292	18.61	817	46.00
BBE-0154 X 290	437	88.40	43.33	9582	14.45	92.72	1.544	0.286	18.44	875	52.71
BBE-0201 X 290	448	94.43	42.12	9437	13.82	91.52	1.560	0.300	19.35	907	56.66
BBE-0225 X 290	405	93.73	41.98	9270	12.64	88.27	1.543	0.300	19.54	839	49.35
BBE-0043 X 290	470	90.47	41.26	8850	13.05	84.92	1.588	0.287	18.15	795	43.61
BBE-0266 X 290	456	92.74	42.01	9121	13.92	87.26	1.573	0.305	19.54	859	53.13
BBE-0143 X 291	420	93.58	41.38	9196	13.21	87.68	1.576	0.284	18.10	879	48.13
BBE-0155 X 291	515	94.20	39.65	8962	12.21	84.54	1.522	0.283	18.65	863	44.14
BBE-0164 X 291	499	96.17	40.66	9110	13.12	86.30	1.575	0.289	18.45	907	51.43
BBE-0268 X 291	422	94.25	41.57	8594	12.50	82.64	1.534	0.285	18.63	796	41.07
BBE-0169 X 291	487	92.77	41.67	9363	13.97	90.18	1.640	0.311	19.00	933	59.06
BBE-0267 X 291	444	92.15	41.93	9302	13.76	88.75	1.578	0.304	19.37	945	55.26
BBE-0177 X 291	397	94.10	40.46	9133	13.18	87.53	1.537	0.286	18.64	841	45.33
BBE-0197 X 291	444	93.49	43.22	9188	14.12	88.52	1.635	0.324	19.80	906	60.35
BBE-0050 X 291	428	93.00	41.09	9432	13.74	90.84	1.526	0.279	18.29	828	47.78
BBE-0035 X 291	455	90.69	41.52	9177	13.85	86.51	1.591	0.279	17.62	818	46.07
290 x 291	469	95.70	42.06	9287	13.73	92.07	1.591	0.325	20.35	869	60.61
Average	*443*	*93.27*	*41.64*	*9156*	*13.411*	*87.76*	*1.567*	*0.293*	*18.77*	*861*	-
SD	*38.2*	*1.78*	*0.92*	*257.5*	*0.59*	*2.88*	*0.03*	*0.01*	*0.66*	*41.2*	-
CV %	*8.63*	*1.91*	*2.21*	*2.81*	*4.43*	*3.28*	*2.11*	*4.79*	*3.53*	*4.79*	-

Table-5 *Top performing exotic bivoltine accessions with percent improvement at CSRTI Mysore*

Hybrids	Fec	Hat	Larval Wt	Yld/10000		Pupation	SCW	SSW	SR	AFL	Cu EI	P.I.
	(No.)	(%)	(10 no)(g)	By No.	By Wt(kg)	rate %	(g)	(g)	(%)	(m.)		(%)
BBI-290 x 291 (C)	469	95.70	42.06	9287	13.73	92.07	1.591	0.325	20.35	869	60.61	-
BBE-0197 X291	444	93.49	43.22	9188	14.12	88.52	1.635	0.324	19.80	906	60.35	-0.44
BBE-0169 X291	487	92.77	41.67	9363	13.97	90.18	1.640	0.311	19.00	933	59.06	-2.57
BBE-0201 X290	448	94.43	42.12	9437	13.82	91.52	1.560	0.300	19.35	907	56.66	-6.53
BBE-0267 X291	444	92.15	41.93	9302	13.76	88.75	1.578	0.304	19.37	945	55.26	-8.83

Table-6 *Mean performance of 20 exotic bivoltine accessions in all the 4 trials at CSRTI, Berhampore*

Hybrids	Fec	Hat	Larval Wt	Yld/10000		Pupation rate %	SCW (g)	SSW	SR	AFL	Cu EI
	(No.)	(%)	(10 no.)(g)	By No.	By Wt(kg.)			(g)	(%)	(m.)	
BBE-0005 X 290	482	93.72	37.66	5928	7.45	54.27	1.386	0.262	18.91	734	42.47
BBE-0163 X 290	513	96.52	39.09	5852	8.33	55.55	1.484	0.292	19.71	773	52.99
BBE-0232 X 290	468	97.12	39.57	6238	8.63	59.43	1.475	0.299	20.26	822	54.42
BBE-0329 X 290	506	95.12	40.22	2840	4.28	27.00	1.436	0.264	18.22	857	41.79
BBE-0013 X 290	483	96.75	40.06	3989	5.88	37.80	1.414	0.282	20.09	739	45.24
BBE-0154 X 290	468	96.15	40.38	4723	6.58	40.80	1.466	0.304	20.52	799	50.25
BBE-0201 X 290	516	96.30	37.23	6282	8.67	59.38	1.418	0.290	20.42	810	52.06
BBE-0225 X 290	472	90.63	37.23	7044	9.72	68.64	1.393	0.286	20.69	771	48.19
BBE-0043 X 290	523	94.88	36.34	5782	8.37	53.21	1.458	0.272	18.81	747	46.70
BBE-0266 X 290	479	97.04	38.20	5366	7.86	51.76	1.470	0.290	19.86	874	51.53
BBE-0143 X 291	504	97.01	37.30	4342	5.57	38.85	1.407	0.262	18.61	687	40.23
BBE-0155 X 291	503	95.07	39.02	6782	8.90	64.09	1.384	0.275	19.72	733	49.33
BBE-0164 X 291	505	97.12	38.15	5963	8.57	56.44	1.485	0.292	19.63	766	52.39
BBE-0268 X 291	488	97.47	37.78	5907	7.97	54.17	1.457	0.272	18.90	842	49.40
BBE-0169 X 291	544	94.98	38.95	5797	7.94	54.81	1.443	0.295	20.53	881	54.86
BBE-0267 X 291	539	97.32	39.81	6053	8.51	58.93	1.420	0.286	20.25	845	55.39
BBE-0177 X 291	485	97.35	38.65	6220	8.87	60.53	1.433	0.291	20.42	855	53.87
BBE-0197 X 291	513	95.13	39.17	3984	6.00	38.04	1.481	0.320	21.69	847	52.88
BBE-0050 X 291	452	95.69	39.65	6827	9.24	65.74	1.458	0.286	19.55	879	53.45
BBE-0035 X 291	485	96.42	37.86	5914	8.62	53.30	1.538	0.288	18.50	731	49.96
SK6 x SK7	463	90.96	41.38	7416	10.98	74.16	1.490	0.271	18.14	832	52.62
Average	495	*95.65*	*38.75*	*5679*	*7.95*	*53.66*	*1.447*	*0.285*	*19.69*	*801*	-
SD	24.75	*1.91*	*1.28*	*1127*	*1.54*	*11.51*	*0.04*	*0.010*	*0.93*	*58.2*	-
CV %	5	*2*	*3.29*	*19.8*	*19.39*	*21.44*	*2.73*	*5.1*	*4.75*	*7.27*	-

Table-7 *Top performing exotic bivoltine accessions with percent improvement at CSRTI Berhampore*

Hybrids	Fec	Hat	Larval Wt	Yld/10000		Pupation	SCW	SSW	SR	AFL	Cu EI	P.I
	(No.)	(%)	(10 no.)(g)	By No.	By Wt(kg.)	rate %	(g)	(g)	(%)	(m.)		(%)
BBE-0267 X 291	539	97.32	39.81	6053	8.51	58.93	1.420	0.286	20.25	845	55.39	5.28
BBE-0169 X 291	544	94.98	38.95	5797	7.94	54.81	1.443	0.295	20.53	881	54.86	4.27
BBE-0232 X 290	468	97.12	39.57	6238	8.63	59.43	1.475	0.299	20.26	822	54.42	3.42
BBE-0177 X 291	485	97.35	38.65	6220	8.87	60.53	1.433	0.291	20.42	855	53.87	2.37
BBE-0050 X 291	452	95.69	39.65	6827	9.24	65.74	1.458	0.286	19.55	879	53.45	1.58

Hybrid evaluation of all the 20 exotic bivoltine accessions along with control (CSR2 x CSR4/ SK6 x SK7) was carried out in collaborative institutes *viz*; CSGRC, Hosur, CSR&TI, Mysore and Berhampore by taking up four rearing trials in favourable seasons to assess the parental performance.

Data collected on rearing and reeling parameters of 20 exotic bivoltine accessions along with control of all the four trials conducted in the test centres were compiled and subjected for general statistics and multi-traits evaluation index analysis to identify the centre wise potential exotic bivoltine accessions as parental breeds.

Results

CSGRC, Hosur

During the period, 4 trials on hybrids of 20 exotic bivoltine accessions along with control (CSR2 x CSR4) was carried out during June-July'17 (monsoon), Sept-Oct'17 (monsoon), Sept-Oct'18 (monsoon) and Mar-Apr'2019 (spring) to evaluate the economic traits *viz*., Fecundity (No,), Hatching %, Larval weight (g), Yield /10,000 larvae by no. and by weight (kg.), Single cocoon weight (g), Single shell weight (g), Shell ratio (%), Pupation rate (%), Filament length (mt.) of parental breeds. The data on the rearing and reeling performance of 20 exotic bivoltine hybrids along with control of all the trials conducted in favourable seasons were collected, compiled and subjected for general statistics as well as multi-trait analysis. Analysed data revealed that, the accessions *viz*. BBE-0163 and BBE-0154 performed as better combiners with CSR2 followed by BBE-0267 and BBE-0197 with CSR4 [Table-2]. The top-ranking exotic accessions were also analysed for percentage of improvement over control and presented in [Table-3].

CSR&TI, Mysore

Under this centre, the rearing trials were taken up on 20 exotic bivoltine accessions as hybrids during Aug-Sept'2017, Oct-Nov'2017, Aug-Sept'2018 and Mar-April'2019 respectively to evaluate the rearing and reeling traits of the parental breeds. The pooled data on rearing and reeling performance of all the four trials conducted at Mysore was subjected to multi-trait analysis and percent improvement and presented in [Table-4] & [Table-5]. The analysed data revealed that the accessions *viz*., BBE-0197, BBE-0169 and BBE-0267 performed better with CSR4 and BBE-0201 with CSR2 and recorded next to control.

CSR&TI, Berhampore

Under this centre, four rearing trials were taken up with hybrids of 20 exotic bivoltine silkworm accessions along with SK6 x SK7 (control) during Oct-Nov'17, Feb-Mar'18, Oct-Nov'18 and Feb-Mar'2019 to assess the parental performance. Further, the pooled data on the rearing and reeling parameter of 20 exotic bivoltine accessions along with SK6 x SK7 (control) of all the 4 trials was subjected to general statistics and multi trait analysis [Table-6]. Analysed data on the same revealed that the accessions *viz*. BBE-0232 was recorded as better combiner with CSR2 followed by BBE-0267, BBE-0169, BBE-0177 and BBE-0050 with CSR4. The percentage of improvement was also recorded for the top performing accessions and presented in [Table-7]. The promising exotic bivoltine accessions identified under the tropical conditions of the test centres *viz*. Hosur, Mysore and Berhampore from all the four trials conducted in favourable seasons are presented in [Table-8].

Table-8 *Promising exotic bivoltine accessions identified in test centres*

CSGRC, HOSUR	CSRTI, MYSORE	CSRTI BERHAMPORE
BBE-0197 X BBI-0291	BBE-0197 X BBI-0291	BBE-0267 X BBI-291
BBE-0267 X BBI-0291	BBE-0169 X BBI-0291	BBE-0169 X BBI-0291
BBE-0163 X BBI-0290	BBE-0201 X BBI-0290	BBE-0232 X BBI-0290
BBE-0154 X BBI-0290	BBE-0267 X BBI-0291	BBE-0177 X BBI-0291

Discussion

Although, India ranks second in global silk production, there exists a wide gap in the overall qualitative and quantitative silk output. This is attributed to the bulk production of multivoltine x bivoltine (cross breed) necessitating the adoption of bivoltine sericulture under tropical conditions to improve silk quality and productivity [3]. In this direction, a few bivoltine breeds which were evolved could not adjust to the fluctuating tropical conditions [4-6].

In the present study, different combinations of shortlisted 20 exotic bivoltine accessions with CSR2 (BBI-0290) / CSR4 (BBI-0291) were evaluated at three test centres. The results indicated in the [Table-8] clearly revealed the centre wise promising parental breeds as better combiners based on their seasonal performance trend for the economic traits under various agro-climatic locations. In general, the breed performance is largely dependent on the combined action of heredity of its population and its environment to which it is exposed. Studies on the interaction of genotype x environment with respect to the seasonal variation has been reported by several investigators [7,8]. 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 the many silkworm breeders [9, 10]. In the present study, analysis was carried out based on Mano's evaluation index as well as multi-trait analysis and the outcome of the study revealed the profound role of genotype x environmental interaction on yield attributes [11]. Most of the economically important traits of the silkworm are polygenic in nature and are greatly influenced by environment [12,13]. The present study also reported that the racial differences in various biological characters are due to adaptation in the particular place [14]. Further, the environmental factors especially temperature and humidity play a very important role in the lifecycle of silkworm in determining the cocoon characters and its existence in a particular zone [15]. Apart temperature, humidity also influences the productivity pattern in the silkworm [16, 17]. 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. This observation informs that the environment is dynamic which brings about profound changes in the physical and biotic factors governing the expression of commercial characters in the organism [18]. Positive correlation has been reported between cocoon weight, shell weight, shell ratio % and filament length. Particularly the accessions which are showing >50 index value expressed the effects for qualitative characters like cocoon weight and cocoon shell weight indicates the additive gene action is important for these characters [19-21]. In the present study also, the exotic bivoltine accessions identified as better combiners for multi-traits recorded >50 index values. Studies have clearly revealed maximum expression of economic traits during favourable seasons like monsoon and post monsoon compared to unfavourable seasons [22]. In China, high silk yielding silkworm breeds have been developed for rearing in spring season [23,24] and during summer-autumn season at a temperature of 28-30˚C and humidity 85-90% [25-27]. In Japan also, silkworm breeds suitable for spring, summer and autumn seasons were evolved and are also commercially exploited [28].

Conclusion

The results of the study helped in identifying the promising exotic bivoltine accessions, *viz*. BBE-0197, BBE-0169 and BBE-0267 as parental breeds in varied agro-climatic conditions. These potential breeding resource materials can be effectively utilised to develop more viable and productive bivoltine hybrids adaptable to tropical conditions.

Application of research: The present investigation will help to utilize the promising exotic bivoltine accessions to evolve the potential bivoltine hybrids for varied agro-climatic conditions.

Research Category: Exotic Bivoltine Breeds

Abbreviations: ERR by no.: Effective rate of rearing/ number
ERR by wt.: Effective rate of rearing by weight (kg)

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Study area / Sample Collection: Central Sericultural Germplasm Resources Centre, Central Silk Board, Hosur, 635109, Tamil Nadu, India
Cultivar / Variety / Breed name: Exotic bivoltine accessions

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