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Evaluation and Short Listing of Potential Multivoltine Silkworm Germplasm Using Joint scoring method.

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ABSTRACT

Central Sericultural Germplasm Resources Centre, Hosur is the only and exclusive institute mandated to collect, characterize, evaluate, conserve and promote utilization of the valuable silkworm genetic resources of our country. Presently the centre is in possession of 81 multivoltine silkworm genetic resources which comprises 71 indigenous and 10 exotic origins. India being a country of tropical climate majority of the silk produced is multivoltine types which are inferior when compared with the temperate bivoltine silk produced in the sericulturally advanced countries like China and Japan. Therefore continuous efforts are on to breed for hardy and productive bivoltine silkworm breeds which will withstand the tropical climates prevailing in the Indian sub continent. Though there has been substantial improvement in the bivoltine silk produced in the country over the years, still majority of the silk produced are of multivoltine type, but the concept of Improved Cross Breeds (ICBs) have come into force where in the superior multivoltine breeds are developed and crossed with bivoltine breeds yielding silk which will match the international quality standards of 2A - 4A grade silk. Therefore there is need for diverse parental breeds which can contribute as breeding resource materials in the development of ICBs so that a variety of breeds could be evolved which can contribute and improve the silk production in different zones of the country. The breeders want thoroughly evaluated and proven and stable breeds which can contribute to their resources base. CSGRC, Hosur with such an assemblage of diverse silkworm germplasm could be an important nodal centre in contributing to the needs of the breeders not only as parental materials for higher productivity and quality silk but also in breeding for hardy silkworm breeds which can withstand the harsh and not so conducive tropical climates prevailing in the country. In this study an attempt has been made to evaluate and short list 73 potential multivoltine silkworm germplasm accessions using one of the proven evaluation methodology of joint scoring method which is a handy tool in short listing large number of germplasm and for selection of multiple traits. Potential accessions performing better over different seasons and better performing ones in all environments have been identified and recommended for the silkworm breeders to use them as resources materials.

Key words: Multivoltine, Silkworm, Germplasm, Accessions, Joint score, Season.

Introduction:

Sericulture in India is mostly confined to tropical zones and remains polyvoltine oriented producing low quality silk and the country is also the origin of good number of traditional silkworm (*Bombyx mori* L.) races which are multivoltine in nature (Datta, 1984). The stock and race differences in various biological characters are considered to be the result of adaptation during long generations (Murakami, 1994). The existence of high genetic variability in economic characters is obviously a resource for breeding (Frankel and Brown, 1983; Frey *et al*., 1983). Tazima (1958) recommended that improvement of multivoltine races is only possible through the hybridization with exotic races. In India tropical sericulture is mainly dependent on multivoltine breeds that are usually low in productivity; hence more stress is given to improve the productivity and quality of these breeds. For such kinds of improvement, the conventional methods of breeding need a perfect selection procedure combined with the selection of desired traits for identifying th initial parental line. The theory of selection indices is helpful for combining various attributes in such a fashion that selection on the basis of the resulting index give the best possible economic gain at the genetic level (Smith, 1936; Hazel and Lush, 1942) Studies on the genetic variability namely PCV, GCV, heritability and genetic gain along with the selection indices for selecting the best combiners among the bivoltine breeds has been studied (Kumar *et al*., 1995) similar kinds of studies were made by in multivoltine silkworm germplasm accessions (Kumaresan *et al*,2000*).* Varied silkworm germplasm stocks contribute immensely to the development of viable and hardy silkworm hybrids for commercial exploitation (Nirmal Kumar and Sreerama Reddy, 1994). Wide genetic diversity and season and location specific breeds are essential to achieve high silk productivity (Shankar Rao *et al*, 2001) It is important that the genetic differences between parents should be wide to get heterosis and either positive or negative heterosis is expressed in the cross (Dalton, 1987). CSGRC, Hosur is maintaining 73 multivoltine silkworm genetic resources, which are diverse in nature with wide variability among the economic traits and morphologically unique silkworm genetic resources (Thangavelu *et al*., 1997; 2000; Kamble *et al*., 2009). In order to short list better performing silkworm accessions by the breeders from among a large collection of silkworm germplasm accessions as in the case of gene banks like CSGRC, Hosur many statistical methods are used (Kempthorne, 1952 ; Gower 1971a,b ; Arunachalam and Bandyopadhyay, 1984 and Mano, *et al*, 1993). Balachandran and Kamble (2012) identified some potential parental lines from the multivoltine germplasm stocks using the Mano's evaluation index and also listed some of the better performing breeds when compared with the popular breeds. The present investigations were taken up to select the best performing ones using joint scoring method (Arunachalam and Bandyopadhyay , 1984) from the 73 multivoltine silkworm germplasm accessions conserved at the Central Sericultural Germplasm Resources Centre, Hosur as this method is proposed to make decision jointly on a number of dependent character variables. A score was allotted to each entry for each character. The scores were added across characters to provide a final score for each entry. Based on the final scores, the entries were ranked on their performance over the set of characters.

Materials and Methods

The 73 multivoltine silkworm accessions conserved at CSGRC, Hosur of various geographical origin and nature were taken for the study (Table-1). The experiments were conducted in three seasons *viz.*, summer, rainy and winter in the years 2011 to 2012 in in completely randomized lock design with two replications of 300 larvae each and observations recorded on the 10 quantitative traits of commercial value such as fecundity (no.), hatching percentage (%),Weight of 10 larvae (g), ERR (by no.), ERR(by wt.) (kg.), pupation rate (%), single cocoon weight (g), single shell weight (g), cocoon shell percentage and cocoon yield/100dfls. The standard rearing techniques as recommended by Krishnaswami (1978) were followed.

Table-1: List of multivoltine silkworm germplasm accessions and their passport data.

Accession No.	**Race Name**	**Origin**	**Larval pattern**	**Cocoon colour**	**Cocoon shape**
BMI-0001	PURE MYSORE	India/Karnataka	Plain	Greenish Yellow	Spindle
BMI-0002	SARUPAT	India/Assam	Plain	Creamy white	Spindle
BMI-0003	MORIA	India/Assam	Plain	Creamy white	Spindle
BMI-0004	TAMILNADU WHITE	India/Tamil Nadu	Marked	White	Spindle
BME-0005	C.NICHI	Japan	Marked	White	Dumb-bell
BMI-0006	HOSA MYSORE	India/Karnataka	Plain	Greenish yellow	Oval

Accession No.	Race Name	Origin	Larval pattern	Cocoon colour	Cocoon shape
BMI-0007	MYSORE PRINCESS	India/Karnataka	Plain	White	Oval
BMI-0008	KOLAR GOLD	India/Karnataka	Plain	White	Oval
BMI-0009	KOLLEGAL JAWAN	India/Karnataka	Plain	White	Oval
BMI-0010	MY-1	India/Karnataka	Plain	Greenish Yellow	Elongated oval
BMI-0011	P2D1	India/Karnataka	Marked	Greenish yellow	Oval
BME-0012	RONG DAIZO	China	Marked	Greenish yellow	Elliptical
BME-0013	GUANGNONG PLAIN	China	Plain	Creamy white	Oval
BMI-0014	OS-616	India/West Bengal	Marked	Yellow	Oval
BME-0015	RAJ	Bangladesh	Marked	Creamy white	Spindle
BMI-0016	G	India/West Bengal	Marked	Golden yellow	Oval
BMI-0017	NISTARI	India/West Bengal	Marked	Golden yellow	Spindle
BMI-0018	NISTARI(M)	India/West Bengal	Marked	Golden yellow	Spindle
BMI-0019	NISTARI(P)	India/West Bengal	Plain	Golden yellow	Spindle
BMI-0020	ZPN(SL)	India/West Bengal	Mixed	Creamy white	Spindle
BMI-0021	CB5	India/West Bengal	Marked	Golden yellow	Oval
BMI-0022	KW2	India/West Bengal	Plain	Creamy white	Elongated oval
BMI-0023	M2	India/West Bengal	Marked	Golden yellow	Oval
BMI-0024	A23	India/West Bengal	Marked	Golden yellow	Oval
BMI-0025	A25	India/West Bengal	Marked	Golden yellow	Elongated oval
BMI-0026	OVAL	India/West Bengal	Marked	Golden yellow	Oval
BMI-0027	O	India/West Bengal	Marked	Golden yellow	Oval
BMI-0028	M83(C)	India/West Bengal	Marked	Golden yellow	Oval
BMI-0029	B	India/West Bengal	Marked	Golden yellow	Elongated
BME-0030	GNM	China	Marked	White	Oval
BMI-0031	A14DY	India/West Bengal	Marked	Golden yellow	Oval
BMI-0032	A4e	India/West Bengal	Marked	Greenish yellow	Elongated oval
BMI-0033	PA12	India/Karnataka	Plain	Greenish yellow	Elongated oval
BMI-0034	AP12	India/Karnataka	Marked	Greenish yellow	Elongated oval
BMI-0035	A13	India/Karnataka	Plain	Greenish yellow	Elongated oval
BMI-0036	PMX	India/Karnataka	Plain	LGY	Elongated oval
BMI-0037	PMS2	India/Karnataka	Plain	LGY	Elongated oval
BMI-0038	MU-1	India/Karnataka	Plain	LGY	Elongated oval
BMI-0039	MU-11	India/Karnataka	Plain	LGY	Elongated oval
BMI-0040	WAI-1	India/Maharashtra	Marked	LGY	Elongated oval
BMI-0041	WAI-4	India/Maharashtra	Marked	Yellow	Oval
BMI-0042	MY23	India/Karnataka	Plain	Greenish yellow	Elongated oval
BMI-0043	MW13	India/Karnataka	Plain	White	Oval
BMI-0044	MHMP(W)	India/Karnataka	Plain	White	Elongated oval
BMI-0045	MHMP(Y)	India/Karnataka	Plain	Greenish yellow	Elongated oval
BMI-0046	P4D3	India/Karnataka	Marked	Greenish yellow	Elongated oval
BME-0047	NISTID(Y)	Bangladesh	Plain	Golden yellow	Spindle
BME-0048	NISTID(W)	Bangladesh	Plain	White	Spindle

Accession No.	Race Name	Origin	Larval pattern	Cocoon colour	Cocoon shape
BME-0049	NK4	Japan	Marked	Yellow	Spindle
BME-0050	CAMBODG	Japan	Marked	Yellow	Spindle
BME-0052	DAIZO	China	Marked	Greenish yellow	Spindle
BMI-0053	LMP	India/West Bengal	Marked	Golden yellow	Spindle
BMI-0054	DMR	India/West Bengal	Marked	Golden yellow	Oval
BMI-0055	LMO	India/West Bengal	Marked	Golden yellow	Oval
BMI-0056	MY1(SL)	India/Karnataka	Mixed	LGY	Spindle
BMI-0057	PM(SL)	India/Karnataka	Mixed	LGY	Spindle
BMI-0058	BL23	India/Karnataka	Plain	Greenish yellow	Oval
BMI-0059	BL24	India/Karnataka	Plain	Greenish yellow	Oval
BMI-0060	MU303	India/Karnataka	Plain	Greenish yellow	Elongated
BMI-0061	MU520	India/Karnataka	Plain	White	Oval
BMI-0062	MU10	India/Karnataka	Plain	White	Oval
BMI-0063	TW x SK6 x SK1	India/Tamil Nadu	Plain	White	Dumb-bell
BMI-0064	SK6 x SK1 x TW	India/Tamil Nadu	Plain	White	Dumb-bell
BMI-0065	BL43	India/Karnataka	Plain	Greenish yellow	Elongated Oval
BMI-0066	APM-1	India/Andhra Pradesh	Plain	Greenish yellow	Oval
BMI-0067	SLKSPM	India/Karnataka	Mixed	Greenish yellow	Spindle
BMI-0068	M12(W)	India/West Bengal	Plain	White	Spindle
BMI-0069	M15	India/West Bengal	Plain	White	Spindle
BMI-0070	M6DP(C)	India/West Bengal	Plain	Chrome yellow	Spindle
BMI-0071	M6DP(C)Green	India/West Bengal	Plain	White	Spindle
BMI-0072	M6M81	India/West Bengal	Plain	Chrome yellow	Oval
BMI-0073	BL-67	India/Karnataka	Plain	Greenish yellow	Oval
BMI-0074	MH-1	India/Karnataka	Marked	Creamy White	Spindle

The data collected on the ten economic traits were analyzed using joint scoring method (Arunachalam and Bandyopadhyay, 1984). This method is adopted to make decisions jointly on a number of dependent character variables. A score was allotted to each entry for each character. The scores were added across the characters to provide a final score for each entry. Based on the final scores, the entries were ranked on their performance over a set of characters.

The difference in the mean values of population were tested by t-test. The differences in the mean population i and j was tested by

$$T = \frac{Xi-Xj}{e\,[(I/ni) + (I/nj)]}$$

Where ,

Xi :mean of the population i,

Xj : mean of the population of j,

ni : Number of components (selection) making up population I,

nj : Number of selected traits of jth race,

e : error m.s in the ANOVA

The t would follow a t-distribution with error d.f

The population means were arranged in groups based on t-test. The top most group containing population with the highest mean was given score 1, the next best was a score 2 and so on. If k was the number of groups for a particular character, the population in group were given a score =1/k, those in group 2, a score =2/k and so on to obtain standardized scores across the characters later on. When overlapping of groups occur it is possible that a population was found in group 1 and also in group 2. The score for that population was taken to be the average which would thus be equal to (1+2) / 2k =3/2k. Populations occurring in more than 2 groups would be treated in a like manner for allotment of scores. The individual scores for each character was added up to provide a total scores for each population. The populations were ranked in descending order of numerical values of total scores.

Results and Discussion

The scores for the individual traits were worked out and added to arrive at the joint scores and ranking was done of all the 73 accessions for the three different seasons *viz*., summer (Table-2), rainy (Table-3) and winter (Table-4) and presented, as multivoltine accessions were reared al through the year by following 35 days preservation schedules.

Summer season

The results of the summer season showed the total joint score ranging from 1.72 to 7.85. Accession BMI-0065 was ranked as the top performing accession with a score of 1.72 followed by BMI-0074 (2.02), BMI-0066 (2.28), BMI-0067 (2.43) and BMI-0059 (2.52). Similarly BMI-0032 with a joint score of 7.85 was ranked as the least performing accession (73rd rank) followed by BMI-0031 (7.49), BMI-0017 (7.31), BMI-0055 (7.13) and BMI-0029 (7.08).

Table-2: Ranking of 73 multivoltine silkworm germplasm using Joint scoring method (Summer Season)

Accession No.	Fecundity	Hatching	Weight of 10 larvae	ERR by No.	ERR by Wt.	Pupation Rate	Single cocoon weight	Single Shell weight	Shell ratio	Cocoon Yield /100 Dfls	Total Score	Rank
BMI-0065	0.20	0.21	0.06	0.19	0.33	0.22	0.09	0.10	0.05	0.28	1.72	1
BMI-0074	0.05	0.08	0.14	0.59	0.17	0.69	0.06	0.05	0.02	0.16	2.02	2
BMI-0066	0.38	0.25	0.03	0.56	0.10	0.42	0.03	0.10	0.30	0.10	2.28	3
BMI-0067	0.15	0.31	0.21	0.34	0.27	0.11	0.15	0.31	0.33	0.24	2.43	4
BMI-0059	0.08	0.56	0.09	0.13	0.31	0.19	0.15	0.31	0.41	0.28	2.52	5
BMI-0003	0.33	0.21	0.17	0.38	0.04	0.42	0.56	0.43	0.16	0.04	2.73	6
BMI-0001	0.38	0.04	0.33	0.50	0.17	0.28	0.12	0.26	0.49	0.16	2.73	7
BMI-0058	0.30	0.42	0.12	0.16	0.15	0.36	0.21	0.55	0.82	0.14	3.21	8
BMI-0041	0.20	0.27	0.14	0.38	0.08	0.89	0.29	0.45	0.54	0.08	3.32	9
BMI-0037	0.30	0.19	0.09	0.38	0.19	0.58	0.47	0.50	0.59	0.18	3.46	10
BMI-0043	0.10	0.54	0.24	0.34	0.63	0.42	0.34	0.29	0.12	0.58	3.60	11
BMI-0039	0.22	0.06	0.24	0.38	0.27	0.58	0.74	0.55	0.37	0.24	3.64	12
BMI-0046	0.23	0.56	0.23	0.19	0.40	0.06	0.59	0.57	0.49	0.36	3.67	13
BMI-0061	0.70	0.31	0.18	0.38	0.63	0.42	0.15	0.21	0.18	0.58	3.74	14
BMI-0027	0.87	0.31	0.26	0.75	0.17	0.75	0.24	0.21	0.10	0.16	3.81	15
BMI-0062	0.73	0.75	0.29	0.19	0.44	0.36	0.15	0.29	0.34	0.40	3.93	16
BME-0048	0.82	0.75	0.06	0.28	0.67	0.28	0.19	0.19	0.09	0.62	3.94	17
BMI-0014	0.92	0.42	0.23	0.38	0.46	0.53	0.37	0.26	0.10	0.44	4.09	18
BMI-0025	0.35	0.33	0.09	0.91	0.23	0.86	0.19	0.43	0.51	0.20	4.10	19
BMI-0045	0.87	0.92	0.20	0.34	0.23	0.17	0.60	0.45	0.23	0.20	4.21	20
BMI-0073	0.67	0.79	0.55	0.19	0.75	0.25	0.15	0.14	0.05	0.72	4.25	21
BMI-0040	0.23	0.46	0.21	0.19	0.67	0.50	0.18	0.50	0.73	0.62	4.29	22
BME-0052	0.17	0.17	0.76	0.59	0.48	0.67	0.38	0.43	0.22	0.48	4.34	23
BMI-0026	0.50	0.71	0.17	0.88	0.13	0.86	0.12	0.36	0.67	0.12	4.50	24
BMI-0023	0.35	0.88	0.70	0.38	0.54	0.64	0.29	0.19	0.07	0.52	4.56	25
BME-0005	0.23	0.10	0.55	0.38	0.56	0.31	0.53	0.62	0.82	0.54	4.63	26
BMI-0071	0.17	0.13	0.73	0.38	0.79	0.53	0.56	0.45	0.23	0.78	4.74	27
BMI-0034	0.20	0.38	0.30	0.19	0.92	0.28	0.63	0.55	0.49	0.90	4.83	28
BMI-0008	0.48	0.73	0.30	0.78	0.52	0.56	0.32	0.40	0.24	0.50	4.85	29
BMI-0038	0.57	0.56	0.08	0.19	0.63	0.42	0.37	0.64	0.87	0.58	4.89	30
BMI-0044	0.42	0.44	0.21	0.50	0.63	0.56	0.29	0.57	0.72	0.60	4.93	31
BME-0050	0.28	0.35	0.36	0.06	0.75	0.50	0.69	0.64	0.61	0.70	4.96	32
BMI-0072	0.60	0.27	0.53	0.38	0.75	0.36	0.18	0.45	0.76	0.70	4.97	33
BMI-0007	0.23	0.38	0.44	1.00	0.48	0.92	0.31	0.45	0.41	0.44	5.06	34
BMI-0069	0.18	0.33	0.85	0.63	0.67	0.58	0.50	0.43	0.28	0.64	5.09	35
BMI-0057	0.82	0.98	0.30	0.34	0.75	0.25	0.44	0.36	0.20	0.72	5.16	36
BMI-0056	0.45	0.46	0.42	0.19	0.65	0.33	0.66	0.64	0.76	0.60	5.16	37
BMI-0019	0.20	0.42	0.56	0.41	0.65	0.36	0.85	0.69	0.48	0.60	5.21	38
BMI-0070	0.90	0.42	0.67	0.50	0.83	0.42	0.37	0.31	0.17	0.80	5.38	39
BMI-0068	0.22	0.42	0.95	0.31	0.73	0.14	0.63	0.62	0.72	0.70	5.44	40
BMI-0004	0.87	0.23	0.83	0.50	0.29	0.42	0.69	0.69	0.71	0.26	5.49	41

Accession No.	Fecundity	Hatching	Weight of 10 larvae	ERR by No.	ERR by Wt.	Pupation Rate	Single cocoon weight	Single Shell weight	Shell ratio	Cocoon Yield /100 Dfls	Total Score	Rank
BMI-0002	0.60	0.67	0.92	0.91	0.15	0.78	0.76	0.45	0.13	0.14	5.51	42
BMI-0018	0.35	0.38	0.62	0.38	0.63	0.28	0.96	0.86	0.49	0.60	5.52	43
BMI-0010	0.50	0.58	0.94	0.22	0.44	0.17	0.74	0.74	0.83	0.42	5.57	44
BMI-0036	0.38	0.81	0.23	0.34	0.52	0.47	0.63	0.81	0.90	0.50	5.60	45
BMI-0020	0.80	0.40	1.00	0.41	0.48	0.44	0.69	0.55	0.37	0.48	5.61	46
BME-0047	0.93	0.75	0.73	0.41	0.21	0.33	0.91	0.81	0.41	0.18	5.67	47
BMI-0060	0.80	0.77	0.18	0.41	0.73	0.58	0.19	0.55	0.79	0.68	5.68	48
BME-0015	0.22	0.42	0.56	0.50	0.73	0.42	0.50	0.81	0.91	0.70	5.76	49
BMI-0042	0.62	0.31	0.47	0.59	0.79	0.39	0.79	0.62	0.44	0.76	5.79	50
BMI-0006	0.30	0.83	0.56	0.38	0.38	0.36	0.82	0.95	0.94	0.34	5.86	51
BMI-0024	0.03	0.15	0.56	0.66	0.96	0.47	0.88	0.81	0.55	0.94	6.01	52
BMI-0016	1.00	0.73	0.59	0.75	0.79	0.42	0.26	0.40	0.43	0.76	6.13	53
BMI-0009	0.60	0.58	0.67	0.72	0.71	0.47	0.41	0.55	0.77	0.66	6.14	54
BMI-0028	0.95	0.50	0.65	0.38	0.38	0.36	0.88	0.90	0.84	0.32	6.16	55
BMI-0035	0.60	0.81	0.20	0.25	0.77	0.42	0.75	0.81	0.84	0.72	6.17	56
BMI-0021	0.57	0.48	1.00	0.38	0.79	0.28	0.97	0.74	0.26	0.78	6.24	57
BME-0030	0.87	1.00	0.39	0.63	0.58	0.83	0.72	0.45	0.18	0.58	6.24	58
BME-0049	0.63	0.58	0.50	0.38	0.77	0.42	0.72	0.76	0.83	0.74	6.33	59
BMI-0053	0.92	0.75	0.83	0.09	0.83	0.08	0.84	0.81	0.49	0.80	6.45	60
BMI-0054	0.53	0.35	0.62	0.94	0.79	0.94	0.82	0.55	0.20	0.80	6.55	61
BMI-0063	0.73	0.23	0.70	0.19	0.75	0.58	0.79	0.98	0.98	0.70	6.63	62
BMI-0022	0.97	0.96	0.62	0.38	0.96	0.47	0.62	0.50	0.39	0.96	6.82	63
BMI-0011	0.83	0.63	0.89	0.50	0.85	0.36	0.79	0.74	0.45	0.84	6.89	64
BMI-0033	0.75	0.75	0.73	0.22	0.88	0.36	0.79	0.81	0.76	0.86	6.90	65
BMI-0064	0.62	0.54	0.73	0.38	0.63	0.72	0.75	1.00	1.00	0.58	6.94	66
BME-0013	0.55	0.85	0.91	0.38	0.79	0.33	0.62	0.86	0.96	0.76	7.01	67
BME-0012	0.25	0.19	0.98	0.50	0.98	0.81	0.87	0.81	0.70	0.98	7.06	68
BMI-0029	0.75	0.58	0.67	0.47	0.90	0.39	0.91	0.90	0.65	0.86	7.08	69
BMI-0055	0.12	0.38	0.86	0.97	0.79	1.00	0.81	0.81	0.63	0.76	7.13	70
BMI-0017	0.87	0.67	0.82	0.81	0.48	0.56	0.85	0.90	0.88	0.48	7.31	71
BMI-0031	0.77	0.67	0.98	0.31	1.00	0.19	1.00	1.00	0.56	1.00	7.49	72
BMI-0032	0.87	0.94	0.79	0.19	0.94	0.53	0.93	0.90	0.85	0.92	7.85	73

Rainy Season

The joint scores of 73 multiple accessions studied for the rainy season ranged 1.21 to 7.63. The top ranking accession was BMI-0074 (1.21) followed by BMI-0065 (1.86), BME-0012 (2.41), BMI-0027 (2.87) and BMI-0023 (2.97). The least performing accessions are in the order of BMI-001 with a joint score of 7.63 followed by BMI-0029(7.44), BMI-0063 (7.35), BMI-0010(7.26) and BMI-0031(7.24).

Table-3: Ranking of 73 multivoltine silkworm germplasm using Joint scoring method (Rainy Season)

Accession No.	Fecundity	Hatching	Weight of 10 larvae	ERR by No.	ERR by Wt.	Pupation Rate	Single cocoon weight	Single Shell weight	Shell ratio	Cocoon Yield /100 Dfls	Total Score	Rank
BMI-0074	0.03	0.14	0.03	0.42	0.06	0.33	0.05	0.05	0.03	0.06	1.21	1
BMI-0065	0.29	0.39	0.11	0.38	0.14	0.13	0.10	0.11	0.05	0.15	1.86	2
BME-0012	0.11	0.54	0.19	0.35	0.11	0.47	0.20	0.21	0.13	0.11	2.41	3
BMI-0027	0.79	0.46	0.53	0.42	0.05	0.13	0.13	0.16	0.15	0.05	2.87	4
BMI-0023	0.35	0.39	0.53	0.42	0.22	0.23	0.34	0.21	0.06	0.21	2.97	5
BMI-0066	0.72	0.39	0.13	0.73	0.03	0.67	0.08	0.11	0.16	0.03	3.04	6
BMI-0025	0.47	0.32	0.06	0.46	0.22	0.60	0.13	0.24	0.51	0.21	3.22	7
BMI-0059	0.04	0.07	0.36	0.50	0.08	0.63	0.34	0.53	0.60	0.08	3.23	8
BMI-0014	0.89	0.36	0.44	0.12	0.28	0.13	0.25	0.32	0.23	0.29	3.30	9
BMI-0039	0.07	0.18	0.26	0.38	0.14	0.37	0.61	0.66	0.59	0.12	3.38	10
BME-0048	0.85	0.46	0.08	0.23	0.19	0.43	0.50	0.37	0.11	0.18	3.41	11
BMI-0043	0.17	0.50	0.26	0.42	0.31	0.73	0.23	0.26	0.20	0.33	3.42	12
BMI-0069	0.11	0.46	0.89	0.08	0.67	0.07	0.29	0.24	0.06	0.68	3.55	13
BME-0052	0.19	0.43	0.81	0.19	0.30	0.37	0.31	0.39	0.29	0.30	3.58	14
BMI-0026	0.83	0.54	0.17	0.62	0.16	0.27	0.16	0.32	0.48	0.14	3.66	15
BMI-0024	0.06	0.21	0.36	0.96	0.28	0.93	0.18	0.24	0.36	0.29	3.87	16
BMI-0073	0.78	0.64	0.14	0.81	0.34	0.60	0.15	0.11	0.03	0.36	3.96	17
BMI-0007	0.22	0.68	0.22	0.77	0.09	0.93	0.03	0.16	0.80	0.09	3.99	18
BMI-0071	0.08	0.50	0.97	0.42	0.36	0.37	0.55	0.32	0.09	0.39	4.05	19
BMI-0041	0.18	0.54	0.39	0.62	0.20	0.43	0.53	0.63	0.39	0.20	4.10	20
BMI-0003	0.22	0.39	0.28	0.38	0.64	0.17	0.24	0.53	0.86	0.65	4.36	21
BMI-0040	0.15	0.68	0.31	0.31	0.27	0.20	0.74	0.74	0.75	0.27	4.41	22
BMI-0034	0.07	0.36	0.46	0.19	0.42	0.30	0.64	0.82	0.78	0.42	4.45	23
BMI-0045	0.79	0.50	0.32	0.38	0.23	0.43	0.38	0.58	0.63	0.24	4.48	24
BMI-0009	0.65	0.79	0.60	0.62	0.13	0.47	0.23	0.45	0.50	0.11	4.52	25
BMI-0061	0.71	0.46	0.14	0.62	0.59	0.60	0.38	0.37	0.14	0.59	4.59	26
BMI-0062	0.61	0.61	0.49	0.42	0.53	0.47	0.40	0.37	0.18	0.53	4.60	27
BMI-0042	0.58	0.39	0.42	0.65	0.23	0.43	0.69	0.58	0.41	0.23	4.62	28
BMI-0054	0.74	0.71	0.06	0.42	0.47	0.67	0.21	0.37	0.53	0.47	4.64	29
BMI-0067	0.15	0.39	0.89	0.42	0.75	0.10	0.40	0.45	0.35	0.76	4.66	30
BMI-0058	0.40	0.32	0.65	0.46	0.23	0.47	0.29	0.71	0.89	0.24	4.67	31
BME-0030	0.90	0.46	0.60	0.38	0.64	0.23	0.45	0.39	0.13	0.65	4.84	32
BMI-0008	0.51	0.57	0.53	0.81	0.23	0.47	0.20	0.47	0.83	0.23	4.85	33
BMI-0019	0.13	0.54	0.72	0.42	0.72	0.20	0.48	0.58	0.41	0.74	4.93	34
BMI-0060	0.82	0.43	0.60	0.27	0.34	0.47	0.40	0.63	0.71	0.36	5.03	35
BMI-0036	0.26	0.39	0.53	0.27	0.39	0.40	0.75	0.84	0.79	0.41	5.03	36
BMI-0070	0.86	0.68	0.75	0.27	0.81	0.23	0.25	0.24	0.14	0.82	5.05	37
BMI-0037	0.14	0.11	0.40	0.42	0.73	0.33	0.73	0.79	0.68	0.76	5.09	38
BMI-0055	0.24	0.39	0.25	0.92	0.52	1.00	0.35	0.47	0.45	0.52	5.11	39
BMI-0006	0.49	0.68	0.60	0.27	0.44	0.40	0.28	0.66	0.90	0.44	5.14	40

Accession No.	Fecundity	Hatching	Weight of 10 larvae	ERR by No.	ERR by Wt.	Pupation Rate	Single cocoon weight	Single Shell weight	Shell ratio	Cocoon Yield /100 Dfls	Total Score	Rank
BMI-0044	0.43	0.25	0.54	0.62	0.39	0.90	0.35	0.58	0.70	0.41	5.17	41
BMI-0068	0.32	0.39	0.93	0.62	0.55	0.47	0.69	0.47	0.24	0.55	5.22	42
BMI-0022	0.99	0.68	0.58	0.35	0.58	0.33	0.38	0.47	0.34	0.59	5.28	43
BMI-0038	0.79	0.39	0.36	0.42	0.30	0.47	0.60	0.82	0.86	0.32	5.33	44
BMI-0046	0.40	0.36	0.35	0.42	0.61	0.27	0.55	0.84	0.94	0.61	5.34	45
BMI-0056	0.50	0.36	0.36	0.58	0.41	0.77	0.55	0.71	0.84	0.41	5.48	46
BME-0049	0.75	0.39	0.50	0.35	0.48	0.57	0.48	0.82	0.91	0.48	5.73	47
BMI-0033	0.61	0.39	0.53	0.62	0.48	0.87	0.58	0.71	0.56	0.47	5.82	48
BMI-0016	1.00	0.46	0.72	0.23	0.77	0.13	0.46	0.66	0.63	0.77	5.83	49
BMI-0020	0.86	0.21	0.83	0.46	0.63	0.80	0.66	0.47	0.29	0.62	5.84	50
BME-0047	0.94	0.89	0.83	0.27	0.22	0.37	0.91	0.82	0.44	0.21	5.90	51
BMI-0072	0.51	0.93	0.64	0.42	0.55	0.33	0.48	0.74	0.79	0.55	5.93	52
BME-0050	0.44	0.29	0.71	0.35	0.75	0.43	0.61	0.79	0.86	0.77	6.01	53
BME-0005	0.21	0.50	0.64	0.15	0.83	0.23	0.71	0.92	1.00	0.83	6.03	54
BMI-0021	0.63	0.39	0.86	0.08	0.94	0.10	0.95	0.89	0.31	0.94	6.09	55
BMI-0032	0.90	0.61	0.61	0.42	0.70	0.70	0.61	0.53	0.30	0.71	6.10	56
BME-0015	0.15	0.36	0.76	0.46	0.84	0.20	0.93	0.92	0.70	0.85	6.17	57
BMI-0017	0.65	0.39	0.68	0.38	0.86	0.07	0.88	0.82	0.64	0.86	6.23	58
BMI-0053	0.93	0.75	0.75	0.27	0.64	0.40	0.90	0.79	0.26	0.65	6.34	59
BMI-0004	0.71	1.00	0.49	0.62	0.70	0.40	0.50	0.63	0.60	0.73	6.37	60
BME-0013	0.56	0.82	0.57	0.46	0.78	0.23	0.43	0.79	0.96	0.79	6.39	61
BMI-0028	0.92	0.43	0.81	0.42	0.89	0.33	0.66	0.63	0.50	0.89	6.49	62
BMI-0002	0.68	0.46	0.78	0.42	0.75	0.37	0.66	0.84	0.95	0.77	6.69	63
BMI-0018	0.38	0.21	1.00	0.42	0.91	0.27	0.95	0.95	0.71	0.91	6.70	64
BMI-0057	0.96	0.96	0.53	0.62	0.47	0.83	0.71	0.66	0.54	0.47	6.75	65
BMI-0035	0.65	0.46	0.60	0.42	0.75	0.47	0.84	0.95	0.98	0.77	6.89	66
BMI-0011	0.86	0.61	0.74	0.69	0.59	0.50	0.86	0.84	0.74	0.58	7.01	67
BMI-0064	0.54	0.57	0.81	0.42	0.86	0.47	0.81	0.92	0.98	0.86	7.24	68
BMI-0031	0.71	0.54	0.86	0.42	0.95	0.23	0.96	0.95	0.66	0.95	7.24	69
BMI-0010	0.56	0.46	0.94	0.85	0.59	0.60	0.78	0.92	0.99	0.58	7.26	70
BMI-0063	0.82	0.39	0.83	0.19	0.98	0.17	1.00	1.00	0.98	0.98	7.35	71
BMI-0029	0.82	0.46	0.90	0.42	0.97	0.33	0.98	0.95	0.64	0.97	7.44	72
BMI-0001	0.65	0.21	0.81	1.00	1.00	1.00	0.79	0.66	0.51	1.00	7.63	73

Winter Season

The range of joint score among the 73 multivoltine accessions for the winter season was between 1.66 to 8.23. In winter season again BMI-0074 was the top ranking accession with a least joint score of 1.66. BME-0012 was the second best performing accession with the joint score of 2.07 followed by BMI-0065 (2.36), BMI-0067 (3.01) and BMI-0043 (3.19). The least performing accession for this season were *viz*., BMI-0029 (8.23), followed by BME-0047 (8.09), BMI-0017 (7.7), BMI-018 (7.69) and BMI-0016 (7.61).

Table-4: Ranking of 73 multivoltine silkworm germplasm using Joint scoring method (Winter season)

Accession No.	Fecundity	Hatching	Weight of 10 larvae	ERR by No.	ERR by Wt.	Pupation Rate	Single cocoon weight	Single Shell weight	Shell ratio	Cocoon Yield /100 Dfls	Total Score	Rank
BMI-0074	0.03	0.08	0.03	0.71	0.03	0.59	0.08	0.04	0.03	0.04	1.66	1
BME-0012	0.18	0.25	0.09	0.42	0.07	0.45	0.03	0.09	0.43	0.07	2.07	2
BMI-0065	0.12	0.36	0.09	0.54	0.10	0.50	0.16	0.18	0.21	0.11	2.36	3
BMI-0067	0.23	0.06	0.21	0.17	0.72	0.14	0.38	0.21	0.16	0.73	3.01	4
BMI-0043	0.13	0.67	0.17	0.58	0.18	0.41	0.41	0.25	0.19	0.20	3.19	5
BMI-0073	0.60	0.39	0.19	0.54	0.28	0.64	0.23	0.07	0.04	0.32	3.30	6
BMI-0054	0.57	0.69	0.09	0.08	0.42	0.14	0.20	0.38	0.41	0.46	3.44	7
BMI-0025	0.40	0.50	0.09	0.54	0.28	0.41	0.09	0.34	0.50	0.32	3.48	8
BME-0052	0.17	0.58	0.40	0.54	0.23	0.50	0.18	0.30	0.32	0.25	3.48	9
BME-0048	0.77	0.36	0.06	0.25	0.35	0.59	0.11	0.29	0.35	0.38	3.50	10
BMI-0007	0.32	0.53	0.06	0.63	0.30	0.50	0.26	0.30	0.31	0.32	3.52	11
BMI-0026	0.72	0.50	0.13	0.63	0.27	0.59	0.05	0.14	0.29	0.30	3.62	12
BMI-0066	0.67	0.47	0.03	0.92	0.05	0.95	0.09	0.14	0.26	0.05	3.64	13
BMI-0071	0.15	0.14	0.80	0.54	0.35	0.50	0.49	0.29	0.21	0.38	3.83	14
BMI-0008	0.58	0.50	0.21	0.83	0.13	0.64	0.14	0.30	0.37	0.14	3.85	15
BMI-0024	0.03	0.17	0.11	0.83	0.25	0.86	0.31	0.52	0.65	0.29	4.02	16
BMI-0072	0.37	0.47	0.63	0.21	0.33	0.36	0.23	0.45	0.62	0.36	4.02	17
BMI-0023	0.27	0.11	0.66	0.96	0.35	0.73	0.14	0.25	0.32	0.38	4.15	18
BMI-0002	0.60	0.47	0.57	0.13	0.53	0.09	0.62	0.38	0.21	0.57	4.17	19
BMI-0003	0.20	0.22	0.46	0.58	0.45	0.41	0.31	0.48	0.59	0.48	4.18	20
BMI-0055	0.07	0.42	0.23	0.63	0.40	0.91	0.15	0.45	0.54	0.43	4.21	21
BMI-0056	0.45	0.47	0.14	0.63	0.17	0.50	0.43	0.63	0.75	0.18	4.34	22
BMI-0027	0.83	0.67	0.44	1.00	0.12	1.00	0.08	0.11	0.24	0.13	4.61	23
BMI-0014	0.82	0.47	0.69	0.67	0.42	0.59	0.16	0.18	0.18	0.45	4.61	24
BMI-0009	0.70	0.50	0.49	0.33	0.32	0.41	0.64	0.55	0.37	0.34	4.64	25
BMI-0068	0.18	0.36	1.00	0.46	0.50	0.50	0.70	0.34	0.09	0.54	4.67	26
BMI-0062	0.65	0.64	0.26	0.63	0.20	0.64	0.51	0.48	0.47	0.21	4.69	27
BMI-0058	0.15	0.22	0.27	0.58	0.52	0.41	0.73	0.77	0.59	0.54	4.77	28
BMI-0040	0.18	0.53	0.46	0.54	0.25	0.50	0.55	0.70	0.82	0.27	4.80	29
BMI-0059	0.08	0.25	0.20	0.54	0.72	0.50	0.54	0.63	0.62	0.73	4.81	30
BMI-0001	0.18	0.36	0.43	0.54	0.93	0.41	0.50	0.30	0.24	0.93	4.82	31
BMI-0057	0.82	0.86	0.39	0.54	0.37	0.41	0.28	0.41	0.40	0.39	4.87	32
BMI-0034	0.27	0.08	0.33	0.25	0.72	0.45	0.88	0.77	0.46	0.71	4.92	33
BMI-0006	0.67	0.36	0.53	0.54	0.35	0.50	0.35	0.59	0.75	0.38	5.01	34
BMI-0041	0.42	0.64	0.39	0.58	0.37	0.59	0.32	0.55	0.78	0.39	5.03	35
BMI-0039	0.10	0.50	0.46	0.46	0.62	0.50	0.58	0.70	0.69	0.61	5.21	36
BMI-0046	0.27	0.39	0.56	0.54	0.52	0.41	0.68	0.73	0.65	0.54	5.27	37

Accession No.	Fecundity	Hatching	Weight of 10 larvae	ERR by No.	ERR by Wt.	Pupation Rate	Single cocoon weight	Single Shell weight	Shell ratio	Cocoon Yield /100 Dfls	Total Score	Rank
BME-0050	0.15	0.72	0.80	0.29	0.63	0.23	0.68	0.70	0.46	0.66	5.31	38
BME-0005	0.35	0.08	0.63	0.50	0.72	0.27	0.61	0.70	0.74	0.73	5.32	39
BMI-0045	0.87	0.61	0.23	0.58	0.27	0.59	0.58	0.66	0.66	0.30	5.35	40
BMI-0069	0.28	0.28	0.96	0.67	0.82	0.59	0.72	0.29	0.07	0.84	5.51	41
BME-0013	0.77	0.64	0.11	0.42	0.52	0.41	0.66	0.80	0.84	0.54	5.70	42
BMI-0070	0.93	0.97	0.96	0.54	0.37	0.59	0.61	0.25	0.10	0.39	5.72	43
BMI-0044	0.20	0.22	0.50	0.88	0.52	0.59	0.62	0.80	0.90	0.54	5.76	44
BMI-0042	0.58	0.53	0.34	0.79	0.58	0.59	0.55	0.59	0.71	0.59	5.86	45
BMI-0010	0.52	0.53	0.84	0.58	0.45	0.41	0.46	0.70	0.93	0.48	5.89	46
BMI-0061	0.80	0.81	0.40	0.83	0.40	0.82	0.53	0.52	0.37	0.43	5.90	47
BMI-0022	0.98	0.56	0.81	0.42	0.75	0.59	0.61	0.30	0.13	0.77	5.92	48
BMI-0037	0.17	0.36	0.30	0.58	0.73	0.77	0.91	0.84	0.71	0.75	6.12	49
BMI-0036	0.23	0.22	0.61	0.25	0.85	0.50	0.76	0.88	0.96	0.88	6.13	50
BMI-0038	0.63	0.47	0.27	0.42	0.88	0.41	0.54	0.73	0.93	0.89	6.18	51
BMI-0011	0.82	0.47	0.74	0.54	0.57	0.41	0.61	0.70	0.79	0.57	6.22	52
BME-0049	0.52	0.50	0.43	0.50	0.68	0.77	0.82	0.77	0.50	0.73	6.23	53
BMI-0004	0.82	0.50	0.36	0.71	0.45	0.59	0.62	0.80	0.94	0.48	6.27	54
BMI-0033	0.77	0.64	0.64	0.58	0.45	0.68	0.89	0.73	0.41	0.48	6.28	55
BMI-0020	0.60	0.28	0.89	0.63	0.73	0.73	0.85	0.59	0.26	0.75	6.30	56
BMI-0031	0.60	0.31	0.73	0.50	0.97	0.27	0.97	0.70	0.31	0.96	6.32	57
BMI-0032	0.97	0.89	0.76	0.58	0.47	0.36	0.73	0.73	0.53	0.50	6.52	58
BMI-0021	0.52	0.81	0.97	0.58	0.62	0.32	0.80	0.77	0.57	0.63	6.58	59
BME-0015	0.22	0.28	0.93	0.54	0.95	0.41	0.54	0.80	0.97	0.95	6.59	60
BMI-0060	0.77	0.67	0.70	0.75	0.45	0.73	0.91	0.80	0.44	0.48	6.69	61
BMI-0019	0.15	0.36	0.87	0.54	0.92	0.36	0.76	0.89	0.97	0.91	6.74	62
BME-0030	0.97	0.67	0.63	0.50	0.90	0.18	0.68	0.73	0.69	0.91	6.85	63
BMI-0053	0.90	0.94	0.59	0.54	0.87	0.41	0.70	0.66	0.37	0.88	6.85	64
BMI-0035	0.47	0.58	0.47	0.50	1.00	0.50	0.77	0.84	0.87	1.00	7.00	65
BMI-0064	0.53	1.00	0.90	0.38	0.60	0.41	0.78	0.98	1.00	0.61	7.19	66
BMI-0063	0.60	0.81	0.79	0.42	0.67	0.41	0.91	1.00	1.00	0.70	7.29	67
BMI-0028	0.97	0.75	0.79	0.54	0.80	0.45	0.62	0.84	0.93	0.82	7.51	68
BMI-0016	1.00	0.83	0.86	0.50	0.82	0.45	0.73	0.80	0.79	0.82	7.61	69
BMI-0018	0.50	0.67	0.99	0.54	0.98	0.50	0.93	0.88	0.72	0.98	7.69	70
BMI-0017	0.82	0.19	0.87	0.54	0.93	0.50	0.96	0.98	0.97	0.93	7.70	71
BME-0047	0.95	0.92	0.87	0.54	0.77	0.59	0.97	0.93	0.76	0.79	8.09	72
BMI-0029	0.73	0.67	0.99	0.58	1.00	0.68	1.00	0.96	0.62	1.00	8.23	73

From the results an analysis was made to find out the accessions which are performing best across all the seasons and it was found that BMI-0074, BMI-0065 BMI-0066 performed best in all the three seasons. Accessions BME-0012, BMI-0025 and BMI-0067 performed better in both rainy and winter seasons, whereas BMI-0059 performed better in summer and rainy seasons. Some of the accessions like BMI-0027, BMI-0023, BMI-0014 and BMI-0039 though performed among the top ten accessions in rainy season did not perform in the top level the other seasons. Accessions BMI-003, BMI-001, BMI-0058, BMI-0041 and BMI-0037 some of the top ten accessions in the summer season ranked low in other seasons. Analysis of the joint scores for the winter season revealed BMI-043, BMI-073, BMI-054, BME-052 and BMI-048 among the top ten whereas they were not among the top category in other seasons.

Selection of suitable breeding resource material helps the breeder to successfully amalgamate desired traits. Appropriate experimental designs and selection methods employed in fixing the major traits contributing to the improved cocoon yield leads to the success of breeding programme. Understanding the genetic diversity of parental lines to be utilized in the breeding programme by systematic evaluation, critical assessment of their quantitative nature which is greatly influenced by the environmental factors such as temperature, light, relative humidity, nutrition and rearing techniques paves the way for the breeder for their effective utilization (Kogure,1933 ; Legay,1958 ; Ueda and Lizuka, 1962; Suzuki *et al*, 1962; Yokogama,1963; Arai and Ito,1967; Horie *et al*.1967, Naseema Begum *et al*., 2001 and Sudhakara Rao *et al*., 2002)

It is important to measure the phenotypic expressions of the major contributing traits of economic importance in the silkworm accessions under diversified environmental conditions to understand the genetic endowment pertaining to adaptability and productivity. Balancing the desirable traits during the course of breeding for varied climatic conditions is a challenging task for the breeder. The choice of the parental material is critical and difficult to evaluate all the available silkworm breeds by the breeders therefore it is the job of the gene bank to thoroughly characterize and evaluate them in different seasons employing proven selection methodologies and make the list available for the breeders to make use of them readily as per their breeding requirement.

According to Allard and Bradshaw (1964) performance of the strain itself in a given environment indicates its superiority. While evaluation emphasis was give on the phenotypic expression of traits of economic importance during three different seasons prevailing in the tropics. The present study has been done during the different seasons to know the potential nature of the germplasm. Therefore any germplasm which are found performing better over the seasons should serve as a potential breeding material. Therefore the accessions identified as better performers *viz*., BMI-0074, BMI-0065 BMI-0066 for all the three seasons and BME-0012, BMI-0025 and BMI-0067 in both rainy and winter seasons and BMI-0059 in summer and rainy seasons should be considered as superior ones. However every study will aim at greater viability and higher productivity will be given equal importance while selection of the parents.

Significant variations observed in the phenotypic manifestation for the traits analyzed can be attributed to the genetic constitution of the strains and their degree of expressions to which they are exposed during rearing. Such variations in the manifestation of phenotypic traits of the strains studied can be attributed to the influence of environmental conditions prevailing in different seasons of the tropics as evident from the performance of the 73 breeds and their ranks (Table2-4). Variable gene frequencies at different loci make them respond differently. The results are in line with the findings of Watanabe (1928); Hassanein and Sharawy (1962); Krishnaswami and Narasimhana (1974); Ueada et al., (1975); Rajanna (1989); Raju (1990); Maribashetty (1991); Kalpana (1992); Nirmal Kumar (1995); Basavaraja (1996) and Sudhakara Rao *et al* (2001).

Breeders use various approaches to tackle the complex problem of selecting a few genotypes from a rich germplasm collection. Generally breeders assign a floor value to each character and allot a population score +1 or -1 when it exceed of falls short of the floor value. The aggregate scores across the characters are used for ranking the populations. Alternately an arbitrary weight is associated with each character and a discriminate function is set up. Using the values of discriminate scores, the populations are arranged in their order of merit. But in joint scoring /ranking method the differences are tested statistically for its significance. The number of groups that is obtained by t-test is taken in to account in assigning the score for each population and each character. If there is no significant differences among the populations for a character, all the populations will occur in one group, consequently each getting a score 1. It can be easily seen that such a character does not add to the differentiation between populations. But the scoring process takes care of the varying potential of characters in differentiation. Since lower total score will mean higher rank this implies that character X is weighted more compared to Y for population 1 and similarly for others. When a number of characters are considered there could be sequential relationship between them, in general. Thus the three mechanisms scoring processes, t-test of differences and decision based on a large number of characters ensure the superiority of the proposed method over the traditional ones (Arunachalam and Bandyopdhyay, 1984). Therefore the multivoltine silkworm accessions identified BMI-0074, BMI-0065 BMI-0066 for all the three seasons and BME-0012, BMI-0025 and BMI-0067 in both rainy and winter seasons and BMI-0059 are recommended as potential breeding resource materials which can contribute to the ICB breeding programmes for the tropical climatic conditions of India and also for the abiotic stress conditions rising out of the climatic changes due to global warming.

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