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STUDIES ON THE PERFORMANCE OF MULTIVOLTINE BREEDS OF SILKWORM, *BOMBYX MORI* L.

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Abstract:-

With the objective of identifying potential parental breeds for breeding, a total of 81 multivoltine silkworm germplasm stocks conserved at Central Sericultural Germplasm Resources Centre, Hosur were evaluated in three replications by rearing in five crops during different seasons of the year. Data on the performance was collected and assessed for 12 quantitative traits of economic importance by employing multiple trait evaluation index method. Significant variations among the multivoltine breeds were observed and based on higher Evaluation Index values for economic parameters, the better performing breeds viz., BMI-023, BMI-080 and BMI-081 with higher values in more traits have been identified as promising breeds. The results of the study lay emphasis on utilization of these breeds expressing higher E. I. values in more number of quantitative traits for further breeding and large scale trials.

Key words:- *Multivoltine, potential breeds, quantitative traits, Evaluation Index, breeding.*

INTRODUCTION

Sericulture industry in India dominated by multibivoltine silk is on the threshold of vitalizing the industry with greater emphasis on improvement of quality through identification / development of potential multivoltine breed(s) as an alternate one to the ruling breed / combination contributing about 90% of silk production in the country despite its innate genetic limitation for production of quality silk. The methods applied for evaluation and identification of potential breeds are of vital importance in achieving the objective of developing parental strains. Therefore, progress in breeding, regardless of seasons or environment, revolves around the efficiency of selecting the potential parental breeds (Basavaraja *et al*., 1995; Datta *et al*., 2000). The breeding progress as measured by the genetic gain in the yield in a particular environment can't be considered as a smooth progression. In addition, clear understanding of the variability in the expression of the economic traits of the breeds is an important step for selection of suitable parental breed.

Currently, despite numerous theoretical and empirical studies (Yokoyoma, 1973), no consensus is found among the silkworm breeders in selection of parental breeds. Selection of breeding material depends on the objective of the breeder to satisfy the need of the industry. In view of this, development of a strategy to meet the required goal in breeding program is very essential in order to lay hands on the suitable parental breeds having the potential of producing variability in yield parameters when crossed in different combinations. The methods of parental breeds' selection and their predicted performance can be divided into two major groups. The first consists of methods to choose the parental breeds on the basis of their performance (Murphy *et al*., 1986). The second one includes the methods of evaluating the parental breeds on the basis of the performance of the progeny (Cox and Frey, 1984).

In addition to analysis of data obtained on the performance of different breeds, multiple trait evaluation index method (Mono *et al*., 1993) has been used to evaluate and identify the parental breeds on the basis of pooled values from various quantitative traits considered for the current study. In this direction, an attempt has been made to evaluate multivoltine germplasm resource material, maintained at CSGRC, Hosur, to identify potential multivoltine silkworm accessions as resource material for further breeding and large scale trials.

MATERIALS AND METHODS

Eighty one multivoltine breeds of indigenous and exotic origin with genetically varied characters maintained at CSGRC, Hosur were utilized. The conservation rearings of the said multivoltine breeds were conducted, in three replications, with 250 larvae per replication by following the standard rearing techniques (Krishnaswami, 1978; Datta *et al*., 1984) in various seasons of the year and mulberry leaves of V1 variety formed as source of food. The performance of all the multivoltine breeds in respect of morphometric traits (from egg incubation till cocoon reeling) were recorded. Observations with reference to pre-cocoon and post-cocoon parameters were recorded. Results in respect of 12 economic traits *viz.*, fecundity, cocoon yield/10000 larvae by weight, cocoon weight, shell weight, cocoon shell ratio, pupation rate, filament length, denier, raw silk percentage, renditta, neatness and boil-off loss parameters were recorded. Analysis of variance was estimated for results data on these important quantitative traits by utilizing multiple trait evaluation index method (Mono *et al*., 1993).

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

Where,

A = Value obtained for a trait in a breed,
B = Mean value of a particular trait of all the breeds,
C = Standard deviation of a trait of all the breeds, 10 = Standard unit, 50 = Fixed value.

RESULTS

The data on the mean values of 3 trials of rearing performance in respect of the 81 multivoltine breeds studied is as shown in Table 1. Data indicate that all the breeds taken in the present study vary significantly in respect of all the quantitative parameters studied. The minimum fecundity of 366 eggs/dfl was recorded in BMI-011 whereas maximum of 480 eggs/dfl in BMI-080. The highest cocoon yield (by weight) was 12.50 kg recorded in BMI-081 and the lowest was 7.95 kg found in BMI-004. The highest cocoon weight of 1.36g was recorded in BMI-080 and BMI-081 and the lowest of 0.79g was observed in BMI-029. The shell weight was maximum (0.25g) in BMI-081 and the lowest of 0.10g in BMI-064. Highest shell ratio of 18.86% was recorded in BMI-082 and lowest value of 12.11% in BMI-064. The pupation rate was more in BMI-022 (95.32%) and it was less (82.83%) in BM I-077.

The reeling performance of the 81 multivoltine breeds has also shown significant variation in respect of all the parameters studied. Filament length ranged from 214.m (BMI-075) to 829m in BMI-076. The filament size (denier) ranged from 1.14 (BMI-010) to 3.07 (BMI-070). The raw silk percentage ranged from 5.12% inBMI-035 to 14.06% in the breed BMI-076. Highest renditta of 19.44 was found in BMI-035 and the lowest renditta of 7.12 was found in BMI-076. The neatness in the breeds studied ranged from 26.00% (BMI-030) to 93.00:% (BMI-004, BMI-008). The boil-off loss was more (29.40%) in the breed BME-052 and less (15.50%) in BMI-041.

Based on rearing the performance, the quantitative traits were assessed on six precocoon traits like fecundity, cocoon yield (by weight), cocoon weight, shell weight, shell ratio and pupation rate as well as six post-cocoon parameters *viz*., filament

length (m), denier, raw silk (%), rendita, neatness (%) and boil-off loss (%), which are the key factors in determining the quality of raw silk. Based on the mean E. I. values, the data was sorted out in the descending order and out of 81 breeds, multivoltine breeds which recorded the mean E.I. value of >50 were selected as top ranking multivoltine breeds as shown in Table 2. Also, the breeds which scored E. I. values above the limit were considered to possess greater economic value.

As per the evaluation index method, among the 81 multivoltine breeds studied, the breed BMI-023 has scored the individual evaluation index value more than 50 in 11 traits. Similarly, BMI-079, BMI-080, BMI-081 have shown average index value >50 in 10 traits followed by BMI-026, BMI-043, BMI-077, BMI-078 in 09 traits and eleven accessions in 08 traits. However, the breeds with average E. I. values >50 in 11 and 10 parameters out of 12 quantitative traits studied are adjudicated as the potential breeding resource materials.

DISCUSSION

The main objective of silkworm breeding is to identify promising breeds to suit to the tropical climatic conditions of India. Selection of parental breeds is of vital importance for the success of breeding apart from selection procedures and it is essential to measure the degree of phenotypic variability of the traits of economic importance. Over the last five decades, evolution / improvement of a number of productive silkworm breeds has played a pivotal role in boosting the silk production in India (Datta, 1984). Silkworm breeders of Indian tropical conditions are trying very best for the sustainable improvement in the cocoon yield, silk recovery and quality in the silkworm breeds identified. Significant results have been achieved by registering over twenty fold increase in pre and post-cocoon traits. Despite this quantum jump, suitable breeds need to be identified which can sustain the tropical conditions.

In the present study, the mulberry multivoltine silkworm breeds maintained at CSGRC, Hosur were evaluated by testing them at the laboratory under different environmental conditions. But variations in different quantitative traits among the breeds were observed. The variation in different characters may be due to the racial differences among the breeds (Murakami, 1994). The genetic variation observed in different breeds for various traits forms a genetic resource for evaluating new breeds and the observations is in conformity with the findings of Frankel and Brown (1983). In the present study the multivoltine silkworm breeds evaluated in different seasons with different temperature and humidity conditions showed variation in the different economic traits which may be due to the temperature and genetic potentiality of the breeds. This observation corroborates with the earlier work of Kobayashi *et al.*, (1986) where it is reported 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. The observation is also in concurrence with the findings of Falconer (1990) wherein it is concluded that the performance of an insect improved by selection in the environment where they subsequently exploited.

Though the performance of the multivoltine breeds for all the qualitative and quantitative traits were assessed, while short-listing only twelve quantitative traits of economic importance were considered. It has been established that during the breeding of silkworm, the selection pressure applied for one character results in correlated changes in other quantitative traits of economic importance (Kobari and Fujimoto, 1966). In view of this, due importance was given to all the characters of economic importance while shortlisting of the breeds. Multiple trait evaluation index method suggested by Mano *et al*., (1993) was employed for short-listing of the breeds by taking all the traits of economic importance into consideration. The results of the study are in concurrence with the works of Vidyunmala *et al*., (1998); Kumaresan *et al*., (2000) and Rao *et al*., (2004).

In the present study, though there was not even one multivoltine breed with average evaluation index value more than 50 in all the 12 traits assessed, BMI-023 has recorded E. I. values >50 in 11 traits and the breeds, BMI-079 (58.36%), BMI-080 (63.79%) and BMI-081 (62.61%) have recorded average E. I. value in 10 traits. These breeds showing higher E. I. values in more economically important quantitative traits are selected as resource material for further breeding and large scale trials.

Table 1: Rearing performance of multivoltine silkworm germplasm resources
(Mean value of 3 trials)

Acc. No.	Fecu--ndity	ERR (Wt.) (Kg)	Pupn. rate (%)	Cocoon Wt. (g)	Shell Wt. (g)	Shell ratio (%)	Filament length (m)	Denier (d)	Rendita	Raw silk (%)	Neat--ness (%)	Boiloff loss (%)
BMI-001	404	10.58	93.42	1.00	0.14	14.43	307	2.44	12.00	8.38	71.50	22.30
BMI-002	371	8.36	94.01	0.89	0.11	12.71	351	2.21	12.70	7.85	85.00	23.10
BMI-003	407	9.91	94.41	0.93	0.13	14.15	419	2.22	10.80	9.25	89.00	22.60
BMI-004	377	7.95	90.45	0.82	0.11	13.27	429	2.32	10.40	9.68	93.00	26.20
BME-005	386	9.53	93.53	0.98	0.12	12.18	277	1.71	18.40	5.45	49.50	17.70
BMI-006	388	9.39	94.23	0.93	0.11	12.36	515	2.17	10.35	9.65	87.00	22.50
BMI-007	403	10.49	90.67	1.12	0.16	14.25	326	2.01	18.05	5.55	88.50	26.90
BMI-008	383	9.74	93.80	0.90	0.13	14.03	548	1.64	13.10	7.65	93.00	18.00
BMI-009	389	10.64	95.38	0.97	0.13	13.85	699	1.64	12.65	7.90	85.00	18.60
BMI-010	384	8.88	94.30	0.87	0.10	12.14	544	1.14	18.45	5.40	68.00	21.40
BMI-011	366	8.75	94.41	0.90	0.11	12.78	475	1.95	12.50	8.00	90.50	23.05
BME-012	400	10.35	91.41	1.07	0.15	13.91	266	2.10	15.35	6.50	72.00	21.60
BME-013	382	9.04	94.51	0.88	0.11	12.17	365	1.33	14.80	6.80	75.50	18.90
BMI-014	414	8.74	92.70	0.92	0.14	14.85	621	1.35	13.15	7.63	89.00	20.20
BME-015	404	8.33	94.70	0.84	0.12	13.96	502	1.25	14.65	6.85	92.00	21.70
BMI-016	376	9.00	93.75	0.89	0.11	12.87	598	1.28	13.20	7.58	89.00	25.10
BMI-017	381	8.80	94.19	0.86	0.11	12.24	399	1.91	13.65	7.33	83.50	21.10
BMI-018	388	8.48	93.90	0.84	0.10	12.19	287	2.70	13.45	7.44	77.50	22.00
BMI-019	399	8.28	94.36	0.84	0.11	12.85	432	1.98	12.40	8.07	87.00	20.10
BMI-020	379	9.21	94.59	0.99	0.14	14.30	301	2.09	15.15	6.61	63.50	23.00
BMI-021	399	8.81	93.68	0.82	0.11	14.13	563	2.16	10.01	10.00	71.00	20.10
BMI-022	380	9.60	95.32	0.95	0.13	13.72	393	2.21	11.35	8.82	82.00	24.30
BMI-023	404	10.09	94.29	1.09	0.15	14.18	519	2.61	11.25	8.90	84.00	23.50
BMI-024	407	10.68	91.67	1.12	0.15	13.39	442	2.40	12.05	8.30	74.00	24.20
BMI-025	397	11.03	93.24	1.07	0.15	13.61	520	2.01	12.76	7.95	84.00	21.50
BMI-026	397	10.39	92.94	1.07	0.14	13.30	528	2.57	10.51	9.54	79.50	20.60
BMI-027	379	9.70	93.68	0.98	0.13	13.85	526	2.62	8.96	11.17	76.50	20.50
BMI-028	405	10.04	92.27	0.91	0.12	12.79	402	2.49	10.53	9.51	63.00	19.10
BMI-029	386	8.24	94.92	0.79	0.11	14.19	563	1.79	11.50	8.68	85.00	20.70
BME-030	394	9.89	93.52	0.90	0.14	15.17	519	2.83	7.86	12.73	26.00	19.20
BMI-031	401	8.50	93.69	0.86	0.15	17.40	470	2.50	10.30	9.70	68.00	20.50
BMI-032	375	9.28	92.73	0.96	0.17	17.22	570	2.63	14.04	7.10	81.50	25.40
BMI-033	390	9.49	91.88	0.90	0.13	14.04	517	2.78	9.07	10.99	82.50	25.60
BMI-034	392	9.98	91.85	0.95	0.12	13.18	610	2.70	9.95	10.00	82.00	25.20
BMI-035	382	9.20	93.06	0.88	0.12	13.47	344	2.07	19.44	5.12	80.00	19.70
BMI-036	400	9.29	93.97	0.87	0.11	12.30	281	2.74	16.02	6.22	63.00	17.00
BMI-037	403	9.58	91.90	0.87	0.12	13.39	378	2.80	12.30	8.15	63.00	19.90
BMI-038	382	9.14	93.02	0.90	0.12	13.13	433	2.15	12.95	7.75	90.00	23.75
BMI-039	402	10.15	94.48	0.97	0.13	13.30	413	2.30	12.05	8.30	75.00	19.60
BMI-040	402	9.74	92.47	0.97	0.12	12.45	440	2.50	12.25	8.20	67.00	21.20

Contd……

Contd……

Acc. No.	Fecu--ndity	ERR (Wt.)	Pupn rate (%.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell ratio (%)	Fil. length (m)	Denier (d)	Rendita	Raw silk (%)	Neat--ness (%)	Boil-off loss (%)
BMI-041	398	10.31	92.54	1.01	0.14	13.49	501	2.44	9.68	10.34	80.00	15.50
BMI-042	383	9.04	92.40	0.89	0.12	13.21	350	2.30	12.00	8.30	88.50	23.30
BMI-043	407	9.39	93.34	0.99	0.14	14.21	481	2.30	9.36	10.76	83.50	18.40
BMI-044	402	10.50	91.22	0.97	0.13	13.17	402	2.51	11.15	9.00	80.00	26.30
BMI-045	374	9.26	94.09	0.90	0.12	13.16	495	2.40	11.15	8.95	55.00	18.00
BMI-046	398	8.66	93.91	0.89	0.12	13.39	354	2.25	14.70	6.80	82.00	18.30
BME-047	370	8.14	93.51	0.84	0.12	13.89	368	2.85	11.90	8.64	65.50	25.50
BME-048	375	10.56	90.72	1.12	0.17	15.04	427	2.16	12.71	7.87	81.50	21.00
BME-049	386	9.25	91.78	0.84	0.11	13.66	413	1.96	13.10	7.73	83.00	27.20
BME-050	396	9.78	93.16	0.88	0.14	17.49	449	2.35	9.70	10.35	81.50	18.70
BME-052	408	9.11	92.74	0.96	0.13	13.16	311	2.10	12.25	8.10	84.00	29.40
BMI-053	382	8.89	91.91	0.91	0.11	12.56	402	2.34	10.35	9.70	81.50	19.85
BMI-054	380	9.84	92.36	0.89	0.12	13.47	432	2.59	9.70	10.30	67.00	18.90
BMI-055	413	9.68	92.56	1.01	0.13	12.78	567	1.84	10.14	9.88	86.00	23.20
BMI-056	393	8.94	92.92	0.95	0.13	13.61	423	2.24	11.90	8.40	58.00	20.70
BMI-057	366	9.75	92.56	0.97	0.13	13.48	425	2.80	11.10	8.95	85.00	25.20
BMI-058	386	8.51	89.75	0.89	0.12	13.50	308	2.55	17.10	5.86	82.00	22.80
BMI-059	404	10.00	92.36	0.98	0.13	13.74	275	2.91	17.05	5.82	60.50	20.20
BMI-060	392	9.83	93.72	0.90	0.12	13.37	327	2.91	13.17	7.55	76.50	20.85
BMI-061	382	9.96	93.37	0.97	0.14	14.41	419	2.57	11.87	8.44	79.00	20.50
BMI-062	397	9.83	91.89	0.96	0.13	13.87	402	2.28	13.80	7.25	78.50	20.40
BMI-063	381	9.80	92.08	0.90	0.11	12.21	262	2.20	18.80	5.30	56.50	22.95
BMI-064	380	8.38	90.38	0.80	0.10	12.11	246	2.35	16.90	5.90	56.00	21.75
BMI-065	400	9.11	91.37	0.94	0.15	15.84	415	2.72	11.23	8.92	66.50	20.68
BMI-066	400	8.96	91.67	0.93	0.14	14.71	511	2.36	10.35	9.85	85.00	21.74
BMI-067	405	9.85	88.78	1.03	0.16	15.17	325	2.23	12.25	8.19	62.50	23.39
BMI-068	401	8.40	93.69	0.93	0.14	15.54	346	2.23	14.70	6.82	51.00	24.73
BMI-069	407	9.24	93.69	0.86	0.13	15.10	366	2.42	12.32	8.12	51.50	24.91
BMI-070	401	10.33	90.71	0.98	0.15	15.27	239	3.07	11.48	8.73	58.50	23.97
BMI-071	408	9.50	92.50	0.96	0.13	13.63	405	2.43	9.85	10.16	63.50	28.28
BMI-072	392	9.76	92.02	0.93	0.12	12.64	299	2.83	13.07	7.66	60.50	23.84
BMI-073	386	10.79	91.09	1.03	0.18	17.20	280	2.26	14.41	6.94	35.00	21.48
BMI-074	427	11.15	85.70	1.19	0.20	17.43	481	2.40	10.10	9.92	60.00	18.51
BMI-075	390	8.74	84.35	1.15	0.18	16.05	214	2.33	17.07	5.86	28.00	25.28
BMI-076	427	11.06	88.63	1.25	0.22	18.14	829	1.84	7.12	14.06	78.75	20.78
BMI-077	447	9.71	82.83	1.27	0.21	16.53	524	1.91	8.64	11.58	78.00	22.40
BMI-078	477	10.76	84.70	1.23	0.20	16.53	519	2.07	9.44	10.60	83.25	22.83
BMI-079	446	9.44	92.93	1.05	0.18	17.27	603	2.31	7.74	12.92	86.00	23.43
BMI-080	480	11.68	92.68	1.36	0.24	17.97	546	2.50	9.08	11.03	64.00	22.87
BMI-081	424	12.50	91.31	1.36	0.25	18.11	587	2.33	9.01	11.10	78.00	22.22
BMI-082	426	11.27	86.06	1.26	0.24	18.86	609	2.14	10.59	9.45	73.50	22.95

Table 2. Evaluation index values of multivoltine silkworm germplasm resources
(Mean value of 3 trials)

Acc. No.	Evaluation Index values (E. I.)												Avg. E. I.
	Fec.	Yld (Wt)	Pupn %	Coc. Wt.	Shell Wt.	Shell ratio	FL	Den.	Ren.	RS %	Neat- -ness	BOL	
BMI-001	53.34	61.22	54.60	52.75	51.49	51.47	39.02	54.15	48.80	49.30	48.18	51.17	51.29
BMI-002	37.28	36.01	57.03	43.89	42.51	41.14	42.75	48.42	51.38	46.41	57.69	54.13	46.55
BMI-003	54.68	53.66	58.71	47.14	47.77	49.81	48.64	48.80	44.39	54.11	60.51	52.28	51.71
BMI-004	40.50	31.31	42.27	38.36	41.27	44.52	49.46	51.28	42.92	56.45	63.33	65.60	47.27
BME-005	44.70	49.26	55.05	50.80	43.44	38.01	36.39	35.98	72.36	33.22	32.69	34.14	43.85
BMI-006	45.55	47.69	57.97	46.65	42.20	39.06	56.85	47.43	42.73	56.31	59.10	51.91	49.45
BMI-007	52.91	60.21	43.19	62.10	56.45	50.40	40.65	43.44	71.07	33.77	60.16	68.19	53.56
BMI-008	43.42	51.67	56.18	44.21	46.23	49.09	59.73	34.36	52.85	45.31	63.33	35.25	48.47
BMI-009	45.91	61.93	62.71	50.15	48.39	48.01	72.66	34.36	51.20	46.69	57.69	37.47	51.43
BMI-010	43.72	41.85	58.25	41.86	39.72	37.74	59.38	21.79	72.54	32.94	45.72	47.84	45.28
BMI-011	35.02	40.43	58.72	44.21	42.82	41.60	53.41	41.95	50.64	47.24	61.57	53.94	47.63
BME-012	51.33	58.65	46.24	58.36	53.35	48.39	35.45	45.81	61.13	38.99	48.53	48.58	49.57
BME-013	42.51	43.71	59.13	43.24	40.34	37.93	44.00	26.52	59.11	40.64	51.00	38.58	43.89
BMI-014	58.51	40.29	51.60	46.00	49.32	54.00	66.00	27.14	53.04	45.18	60.51	43.39	49.58
BME-015	53.58	35.59	59.90	39.91	43.44	48.68	55.77	24.52	58.56	40.92	62.62	48.95	47.70
BMI-016	39.59	43.28	55.96	43.89	42.82	42.15	64.02	25.40	53.22	44.90	60.51	61.53	48.11
BMI-017	42.45	41.00	57.80	41.12	40.03	38.33	46.92	41.08	54.88	43.53	56.63	46.73	45.88
BMI-018	45.55	37.30	56.59	39.66	38.79	38.05	37.25	60.74	54.14	44.13	52.41	50.06	46.22
BMI-019	51.09	35.02	58.51	39.42	40.65	41.98	49.76	42.70	50.28	47.62	59.10	43.02	46.60
BMI-020	41.29	45.69	59.45	51.94	51.49	50.69	38.46	45.43	60.40	39.60	42.55	53.76	48.40
BMI-021	50.90	41.13	55.67	37.63	42.82	49.71	60.98	47.30	41.46	58.21	47.83	43.02	48.06
BMI-022	41.90	50.11	62.49	48.44	47.46	47.23	46.40	48.55	46.41	51.75	55.58	58.57	50.41
BMI-023	53.22	55.67	58.20	59.66	54.90	50.01	57.23	58.50	46.04	52.19	56.99	55.61	**54.85**
BMI-024	54.92	62.36	47.32	62.26	53.35	45.28	50.63	53.28	48.99	48.86	49.94	58.20	52.95
BMI-025	50.17	66.34	53.87	58.44	52.42	46.57	57.32	43.44	51.60	46.96	56.99	48.21	52.69
BMI-026	50.23	59.09	52.60	58.12	51.18	44.73	58.03	57.51	43.30	55.68	53.82	44.87	52.43
BMI-027	41.35	51.25	55.67	50.88	49.01	47.99	57.86	58.75	37.60	64.67	51.70	44.50	50.94
BMI-028	54.07	55.10	49.82	45.35	43.13	41.66	47.21	55.52	43.39	55.51	42.20	39.32	47.69
BMI-029	44.58	34.60	60.81	35.92	42.20	50.07	61.02	38.09	46.96	50.98	57.69	45.24	47.35
BME-030	48.47	53.39	55.00	44.54	49.63	55.96	57.22	63.98	33.57	73.22	16.13	39.69	49.23
BMI-031	51.76	37.58	55.71	41.37	52.73	69.31	53.04	55.77	42.55	56.59	45.72	44.50	50.55
BMI-032	39.41	46.41	51.71	49.58	58.93	68.22	61.62	59.00	56.31	42.29	55.23	62.64	54.28
BMI-033	46.40	48.83	48.20	44.62	46.54	49.16	57.04	62.74	38.00	63.68	55.93	63.38	52.04
BMI-034	47.37	54.38	48.09	48.77	45.92	44.02	65.06	60.74	41.26	58.23	55.58	61.90	52.61
BMI-035	42.57	45.55	53.09	42.67	43.75	45.70	42.20	44.94	76.17	31.40	54.17	41.54	46.98
BMI-036	51.39	46.56	56.89	41.69	40.03	38.70	36.78	61.62	63.60	37.43	42.20	31.55	45.70
BMI-037	53.09	49.83	48.28	42.43	43.44	45.23	45.12	63.23	49.91	48.06	42.20	42.28	47.76
BMI-038	42.87	44.85	52.95	44.46	43.44	43.67	49.80	47.05	52.30	45.86	61.21	56.53	48.75
BMI-039	52.30	56.37	58.98	50.47	47.16	44.70	48.13	50.79	48.99	48.89	50.65	41.17	49.88
BMI-040	52.36	51.68	50.65	49.91	44.37	39.63	50.45	55.77	49.72	48.34	45.01	47.10	48.76

Contd….

Contd….

Acc. No.	Evaluation Index values (E. I.)												Avg. E. I.
	Fec.	Yld (Wt)	Pupn %	Coc. Wt.	Shell Wt.	Shell ratio	FL	Den.	Ren.	RS %	Neat--ness	BOL	
BMI-041	50.48	58.22	50.93	53.48	49.32	45.86	55.66	54.27	40.27	60.08	54.17	26.00	49.89
BMI-042	43.12	43.71	50.37	43.97	43.75	44.15	42.71	50.79	48.80	48.89	60.16	54.87	47.94
BMI-043	54.80	47.69	54.26	51.69	50.87	50.19	53.94	50.66	39.09	62.42	56.63	36.73	50.75
BMI-044	52.24	60.36	45.48	50.39	46.85	43.93	47.15	56.01	45.68	52.74	54.17	65.97	51.75
BMI-045	38.86	46.26	57.39	44.46	43.44	43.87	55.17	53.28	45.68	52.46	36.56	35.25	46.06
BMI-046	50.60	39.44	56.61	43.56	44.06	45.26	43.01	49.54	58.74	40.64	55.58	36.36	46.95
BME-047	36.73	33.44	54.96	39.66	43.44	48.27	44.22	64.48	48.44	50.76	43.96	63.01	47.61
BME-048	39.22	61.07	43.41	62.18	58.62	55.15	49.33	47.30	51.42	46.52	55.23	46.36	51.32
BME-049	44.64	46.12	47.80	39.82	42.82	46.88	48.13	42.32	52.85	45.73	56.28	69.30	48.56
BME-050	49.63	52.10	53.53	42.59	52.11	69.88	51.18	51.91	40.34	60.16	55.23	37.84	51.37
BME-052	55.22	44.55	51.76	49.01	46.23	43.86	39.32	45.81	49.72	47.79	56.99	77.45	50.64
BMI-053	42.57	42.00	48.35	45.19	42.82	40.25	47.14	51.66	42.73	56.59	55.23	42.10	46.38
BMI-054	41.72	52.82	50.18	43.81	44.37	45.74	49.79	58.01	40.34	59.86	45.01	38.58	47.52
BMI-055	57.60	50.96	51.04	53.24	47.16	41.60	61.40	39.34	41.94	57.58	58.40	54.50	51.23
BMI-056	48.29	42.57	52.53	48.60	46.85	46.58	48.98	49.17	48.44	49.44	38.67	45.24	47.11
BMI-057	35.09	51.82	51.02	50.31	47.77	45.80	49.11	63.23	45.49	52.46	57.69	61.90	50.98
BMI-058	44.52	37.72	39.37	43.73	44.37	45.90	39.08	56.89	67.58	35.47	55.58	53.02	46.93
BMI-059	53.46	54.67	50.20	50.88	48.70	47.37	36.22	65.85	67.39	35.23	40.43	43.39	49.48
BMI-060	47.37	52.67	55.82	44.54	44.37	45.10	40.75	65.85	53.09	44.76	51.70	45.80	49.32
BMI-061	42.87	54.23	54.38	50.47	50.25	51.39	48.63	57.38	48.33	49.66	53.47	44.50	50.46
BMI-062	49.87	52.67	48.23	49.50	48.39	48.14	47.22	50.29	55.43	43.12	53.11	44.13	49.18
BMI-063	42.33	52.39	49.05	44.13	40.96	38.19	35.14	48.30	73.83	32.39	37.62	53.57	45.66
BMI-064	41.66	36.16	42.00	36.16	38.48	37.54	33.75	52.03	66.84	35.69	37.26	49.13	42.23
BMI-065	51.51	44.55	46.10	48.12	53.66	59.98	48.28	61.24	45.95	52.27	44.66	45.15	50.12
BMI-066	51.63	42.84	47.35	46.82	51.80	53.19	56.53	52.28	42.71	57.41	57.69	49.09	50.78
BMI-067	54.13	52.96	35.35	54.95	55.52	55.95	40.53	49.04	49.71	48.26	41.84	55.18	49.45
BMI-068	51.82	36.44	55.70	46.65	51.80	58.17	42.37	48.92	58.72	40.72	33.74	60.16	48.78
BMI-069	54.86	45.99	55.72	41.04	47.16	55.54	44.06	53.77	49.96	47.90	34.10	60.83	49.24
BMI-070	52.12	58.37	43.37	50.72	53.35	56.53	33.14	69.83	46.89	51.23	39.03	57.35	50.99
BMI-071	55.53	48.97	50.79	49.42	47.77	46.72	47.47	54.02	40.89	59.09	42.55	73.28	51.38
BMI-072	47.74	51.96	48.77	46.65	43.44	40.75	38.32	63.86	52.74	45.34	40.43	56.85	48.07
BMI-073	44.64	63.64	44.94	55.43	62.33	68.09	36.69	49.79	57.67	41.41	22.47	48.13	49.60
BMI-074	64.59	67.77	22.58	67.79	70.69	69.49	53.97	53.28	41.81	57.77	40.08	37.14	53.91
BMI-075	46.46	40.29	16.99	64.54	63.57	61.21	31.04	51.41	67.47	35.47	17.54	62.20	46.52
BMI-076	64.65	66.76	34.73	73.24	76.89	73.74	83.85	39.21	30.82	80.56	53.29	45.54	60.27
BMI-077	74.45	51.39	10.66	74.46	71.93	64.09	57.69	41.08	36.44	66.92	52.76	51.54	54.45
BMI-078	89.05	63.35	18.42	71.37	70.08	64.11	57.22	45.06	39.38	61.53	56.46	53.13	57.43
BMI-079	73.96	48.26	52.57	57.06	63.26	68.54	64.43	51.04	33.13	74.29	58.40	55.35	58.36
BMI-080	90.33	73.75	51.53	81.70	82.16	72.75	59.59	55.64	38.04	63.87	42.90	53.28	**63.79**
BMI-081	63.11	83.14	45.83	81.94	83.39	73.58	63.10	51.53	37.80	64.28	52.76	50.87	**62.61**
BMI-082	64.33	69.10	24.07	73.81	80.30	78.10	64.98	46.80	43.61	55.18	49.59	53.55	58.62

REFERENCES

[1]. Basavaraja HK, Nirmal Kumar S, Suresh Kumar N, Mal Reddy N, Kshama Giridhar, Ahsan MM and Datta RK 1995. New productive bivoline hybrids. *Indian Silk*, **34(2)**: 5-9.

[2]. Cox DJ and Frey KJ 1984. Combining ability and selection of parents for inter-specific out ratings. *Crop Sci.*, **24**:963-967.

[3]. Datta RK 1984. Improvement of silkworm race (*Bombyx mori* L.) in India. *Sericologia*, **24**: 394-415.

[4]. Datta RK, Suresh Kumar N, Basavaraja HK and Mal Reddy N 2000. CSR18xCSR19- a robust bivoltine hybrid for rearing throughout the year in the tropics. *Abstact in Seminar on Sericulture Technology – an appraisal*, 6-7.

[5]. Falconer DS 1990. Improvement in performance of an insect, *Genet. Res*. **56**: 57-70.

[6]. Frankel OH and Brown AHD 1983. A critical appraisal, *XV Int. cong. Genet. Applied Genetics.*, **IV**: 3-13.

[7]. Kobari K and Fujimoto N 1966. Studies on the selection of cocoon filament length and cocoon filament size in *Bombyx mori*. *Nissenzatsu* **35:** 427-434.
[8]. Kobayashi J, Edinuma HE and Kobayashi N 1986. The effect of diapause egg production in the tropical race of the silkworm, *Bombyx mori* L. *J. Seric. Sci. Jpn*., **55**:345348.
[9]. Kumaresan P, Sinha RK, Sahni SK and Seka S 2000. Genetic variability and selection indices for economic quantitative traits of multivoltine mulberry silkworm (*Bombyx mori* L.) genotypes. *Sericologia*, **40**: 595-605.
[10]. Krishnaswami S 1978. New Technology of Silkworm Rearing, *Bulletin No. 2*, Central Sericultural Research and Training Institute, Central Silk Board, India, 23.
[11]. Mono Y, Nirmal Kumar S, Basavaraja HK, Mal Reddy N *and Datta RK* 1993. A new method to select promising silkworm breeds / hybrids, *Indian silk,* **31(10)**:10.
[12]. Murakami A 1994. Growth phenomenon in *Bombyx mori* with a special reference to genetic factors responsible for growth acceleration and moultanism, *Indian J. Seric.,* **33**: 12-14.
[13]. Murphy JP, Cox TS and Rodgers DM 1986. Cluster Analysis of red winter wheat cultivators based upon co-efficients of percentage, *Crop Sci.*, **26:** 672-680.
[14]. Rao CGP, Chandrashekaraiah K, Ibrahim Basha, Sheshagiri SV, Ramesh C and Nagaraju H 2004. Identification of superior polyvoltine hybrids (polyvoltine x bivoltine) of silkworm (*Bombyx mori* L.). *Int. J. Indust. Entomol*. **8**: 43-49.
[15]. Vidyunmala SB, Narasimha Murthy and Sivarami Reddy N 1998. Evolution of new mulberry silkworm (*Bombyx mori* L.) hybrids (multivoltine x bivoltine) through multiple trait evaluation index, *J. Entomol. Res.* **22**:49-53.
[16]. Yokoyoma T 1973. History of Entomology. *Annual Review*–PaloAlto California, 267-84.