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STUDIES ON COMMERCIAL EXPLOITATION OF SELECTED MULTIVOLTINE RACES OF THE SILKWORM *BOMBYX MORI* L. IN DIFFERENT SEASONS OF RAYALASEEMA REGION (A. P.) IN INDIA

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ABSTRACT
Utilization of the available genotypes of the silkworm races under the climatic changes is a challenging phenomenon for the sericulture. Our study evaluated the performance of selected new multivoltine races along with the control in different seasons of the year in Rayalaseema region, Andhra Pradesh, Idia. The evaluation has been made on the basis of expression of eleven economic parameters of the silkworm *Bombyx mori* L. The data generated was analyzed to understand their performance and it is evident that all the three selected multivoltine races were found to be superior to the control.

INTRODUCTION

The mulberry silkworm, *Bombyx mori* L., is a very important economic insect that contributes substantially to the national economy of India and provides gainful occupation to lakhs of people. Besides providing optimal environmental conditions to increase the productivity, the science of breeding is necessary for the production of optimal for the available environments (Raman and Ahmad, 1988). Since the environmental conditions varied a great deal in tropical climates, manipulation of the temperature and relative humidity play a vital role in the successful harvest of the cocoon crops. It is also clear that the seasonal differences in the environment considerably influence the phenotypic expression as well as the coefficient values of the heritability of the important characters such as cocoon weight, shell weight, cocoon shell ratio (Nacheva and Junka, 1989). But due to its long history of domestication, some varieties have become extremely sensitive to environmental conditions, especially seasonal variations and temperature in the tropical areas (Kogure, 1932; Malik, 1992; Lakshmi and Chandrashekaraiah, 2007). Even though India is one of the oldest silk producing countries, majority of the silk is produced by Andhra Pradesh next to Karnataka. Though plenty of traits are available are not successful in the unit of production and the quality of silk produced remains poor, since the inherent defects of pure races are passed on to the hybrids (Nirupam and Singh, 2007). Therefore the want of suitable high yielding and robust races to sustain the macro and micro environmental conditions appear to be on of the major constraints to the growth and development of sericulture in tropical areas of Rayalaseema region. In view of the above it is paramount importance that the genotypes of the available silkworm races in the country need to be studied intensely in order to reorganize the genotypes and synthesizes the silkworm breeds responding favorably to the conditions prevailing in Rayalaseema region. Studies related to commercial exploitation of selected races in the Rayalaseema region which is geographically, seasonally and environmentally different are scanty. Therefore present study has been made to evaluate the performance of three new multivoltine races viz. Mysore university $(MU)_1$, MU_{11}, MU_{303} along with the control PM in different seasons of the year.

MATERIALS AND METHODS

The pure races of Mulberry silkworm *Bombyx mori Viz*., three new multivoltine races, MU_1, MU_{11}, MU_{303} and one PM as control were chosen for the study. Basic stocks of the above races were procured from the germplasm bank, Department of Studies in Sericultural Science, University of Mysore, Manasagangothri, Mysore, Karnataka and were maintained in the department of Sericulture, Sri Padmavathi Mahila Visvavidyalayam, Tirupati, Andhra Pradesh by following standard methods of race maintenance. Seed cocoons of the above said races were collected and layings of the pure races were prepared adopting the method described by Tazima (1962). After incubation of eggs at 25 $\pm$ 1°C, rainfall of 29-33cm and relative humidity of 80 $\pm$ 5%, layings of each of the pure races were selected. The larvae were fed with M5 variety of mulberry (*Morus indica*) leaves. The months from December to February rather exhibit moderate temperature of 15-33ºC with low humidity of 30-60% and rainfall of 3-30cm occasionally exhibiting short spells of heavy rainfall is designated as post monsoon. On the other hand pre-monsoon which falls in the months of March and May is characterized by high temperature ranging from 30-40ºC with a low relative humidity of 30-40% with occasional showers at the end of May. The experimental rearing was initiated by selecting five disease free layings of each one of the eight races in three replicates. The eggs were incubated and black boxed at the pinhead stage to ensure synchrony in the embryonic development and uniform hatching. On the tenth day, the larvae were brushed into the rearing trays and chawki reared as described by Narasimhanna and Krishnaswami (1972) under feeding the mulberry leaf of M5 variety harvested from the irrigated mulberry garden and maintained in department of Sericulture, Sri Padmavathi Mahila Viswa Vidyalayam, Tirupati. After the third moult, the rearing was conducted by keeping 300 larvae foreach replicate. The late age rearing was conducted by following standard rearing techniques suggested by Yokoyama (1963) and Narasimhanna and Krishnaswamy (1972). The environmental fluctuations prevealing in tropical area, utmost care was taken, throughout the rearing period by optimum quantity of leaf to ensure healthy growth and development by the silkworms. Of the total of four rearings conducted for the study, two rearings were made in monsoon, one rearing in post-monsoon and the other rearing in pre-monsoon. For assessing the comparative performance of the races, eleven economic characters namely Fecundity, Hatching percentage, Larval duration, Larval weight, Cocoon yield by number, Cocoon yield by weight, Single cocoon weight, Single shell weight, Cocoon Shell ratio, Filament length and Pupation rate were analyzed in three different seasons of the year.

The replication mean values obtained for each trait and for each race was subjected to analysis of variance by two-way classification according to the method of Kempthrone (1952) to analyze the variation among the seasons, races and their interactions.

RESULTS AND DISCUSSION

The salient features of the selected multivoltine races along with the control were mentioned in the Table 1. Evaluation of the data pertaining to eleven economic traits presented in tables for multivoltine races exhibit a typical picture of genotype and environmental interactions (Table 2 to 4). The varied responses in the expression of eleven metric traits in different silkworm races to the prevailing environmental conditions during the period of rearing clearly demonstrates the genetic architecture of the races as well their interaction with different environmental conditions (Table 5). The analysis of the data presented above reveal that all the three new multivoltine races were found to be superior to the control PM with respect to all the eleven metric traits studied. However significant differences ($p < 0.05$) were observed only for four traits viz., fecundity, hatching percentage, larval duration and filament length, while the difference for other traits such as larval weight, cocoon yield by number, cocoon yield by weight, cocoon weight, shell weight, shell ratio and pupation rate was found to be insignificant ($p > 0.05$). The interaction between season and race was found to be significant ($p < 0.05$) only for the traits like cocoon weight, shell weight, shell ratio, filament length, larval weight and larval devotion. MU_{303} was found to exhibit higher values for cocoon weight, shell weight and shell ratio during monsoon season; longer filament length during post-monsoon and higher larval weight in pre-monsoon season, while MU_{11} was found to record shorter larval duration during the monsoon season. The magnitude in the phenotypic variability is dependent on the responsiveness of the different genotypes to different environmental conditions. Such studies are well documented in both plants and animals (Griffing and Zsiros, 1971; Orozco, 1976; Strickberger, 2002). It is understood that the performance of a race or a breed is mainly dependent on the combined action of hereditary potential of its population and the extent to which such potential is permitted to express in the environment to which it is exposed. The differential expression of different races in different seasons recorded in the present study is in conformity with the observations of several workers (Kashiviswanathan *et al.*, 1970, Anonymous, 1971; Krishnaswami and Narasimhanna, 1974; and Ueda *et al.*, 1975). This is largely due to the variable gene frequencies at different loci in different silkworm races which make them to respond differently to changing environmental conditions and parallels (Ueda *et al.*, 1969; Subramanya, 1985; Kalpana, 1992; Nanjundaswamy, 1997). The highest values observed for majority of the traits viz., fecundity, hatching percentage, larval weight, cocoon yield by number, cocoon yield by weight, single cocoon weight, single shell weight, shell ratio, filament length and pupation rate for all the races under study in monsoon and post-monsoon seasons and lower values observed for the above traits in pre-monsoon season indicates the positive / negative response of the respective genotypes to favourable / unfavourable rearing environmental conditions prevailing during the different seasons is in conformity with the earlier findings (Subramanya, 1985; Rajanna, 1989; Raju, 1990; Maribashetty, 1991; Kalpana, 1992; Nanjundaswamy, 1997 and Veeraiah, 1999).

The higher fecundity recorded for all the races under study than the control can be attributed to the genetic potential. Similarly higher fecundity observed in monsoon and post-monsoon seasons indicate their favorable response to the conditions prevailing in those two seasons. The reduced larval duration exhibited by multivoltine races compared to respective control reflect their better genotypic response for faster growth and development. However slightly longer larval duration observed during post-monsoon season can be attributed to the reduced rate of metabolism resulting in slow growth rate due to lower temperature and other associated environmental conditions (Yokoyama, 1962 and Morohoshi, 1969). The higher larval weight exhibited by the multivoltine races than the control can be ascribed to their favourable genetic response. The superiority in effective rate of rearing as evidenced by the cocoon yield by number in multivoltine races can be attributed to the favourable combinations of genes exhibiting a positive response to the changing environmental conditions in the expression of the trait. Similarly the highest

Table 1: Salient features of selected multivoltine races of silkworm *Bombyx mori* L.

S.N.	Race	Parentage	Method adopted	Larval markings	Cocoon colour	Cocoon shape
1.	MU_1	PM	Mutation breeding (X-ray irradiation)	Plain	Pale green	Oval
2.	MU_{11}	PM x NB_{18}	Conventional breeding	Plain	Pale green	Oval
3.	MU_{303}	NB_{18} x PM	Mutation breeding (Chemical Mutagen)	Plain	Green	Oval
4.	PM	—	—	Plain	Greenish Yellow	Spindle

Table 2: Mean performance of the eleven economic traits of selected multivoltine races in pre-monsoon season

	Fecundity	Hatching %	Larval duration	Larval wt.	Cocoon yield by number	Cocoon yield by wt.	Cocoon wt.	Shell wt.	Shell ratio	Silk filament length	Pupation rate
PM	383.66	85.70	622.00	25.37	8333.00	9.01	0.97	0.14	15.11	394.33	82.63
MU_1	456.66	93.36	530.00	32.61	8899.66	10.75	1.20	0.17	14.56	581.33	87.92
MU_{11}	471.33	96.25	522.00	31.90	8710.66	10.48	1.20	0.17	14.12	579.00	85.88
MU_{303}	471.33	94.16	542.00	32.23	8644.00	10.35	1.19	0.17	14.18	568.66	85.00
Mean	445.75	92.36	554.00	30.52	8646.83	9.89	1.14	0.16	14.49	530.83	85.35

Table 3: Mean performance of the eleven economic traits of selected multivoltine races in monsoon season

	Fecundity	Hatching %	Larval duration	Larval wt.	Cocoon yield by number	Cocoon yield by wt.	Cocoon wt.	Shell wt.	Shell ratio	Silk filament length	Pupation rate
PM	406.66	86.76	668.00	27.43	9066.00	10.10	1.11	0.15	13.56	419.66	90.05
MU_1	481.33	94.46	568.00	34.32	9610.66	11.90	1.23	0.19	15.31	607.66	95.11
MU_{11}	484.00	95.85	558.00	35.31	9677.66	11.90	1.23	0.19	15.74	620.00	96.03
MU_{303}	488.00	95.24	568.00	35.50	9577.66	11.87	1.24	0.20	16.30	638.66	94.83
Mean	465.00	93.08	590.50	33.14	9483.00	11.44	1.20	0.18	15.22	571.49	94.00

Table 4: Mean performance of the eleven economic traits of selected multivoltine races in pre-monsoon season

	Fecundity	Hatching %	Larval duration	Larval wt.	Cocoon yield by number	Cocoon yield by wt.	Cocoon wt.	Shell wt.	Shell ratio	Silk filament length	Pupation rate
PM	393.00	91.48	704.00	27.30	8818.33	9.42	1.06	0.15	14.04	435.33	86.86
MU_1	466.66	95.80	580.00	34.28	9132.66	11.14	1.22	0.18	15.26	588.66	90.08
MU_{11}	481.00	96.86	584.00	33.51	9077.33	11.13	1.22	0.18	15.40	636.33	89.88
MU_{303}	473.66	95.60	586.00	32.30	9155.33	11.31	1.23	0.19	16.09	648.33	90.16
Mean	453.58	94.93	613.50	31.84	9045.91	10.75	1.18	0.18	15.20	577.15	89.24

Table 5: Analysis of variance (ANOVA) for multivoltine races of silkworm *Bombyx mori* L.

Traits	Df	Fecundity	Hatching %	Larval duration	Larval weight	Cocoon yield by no.	Cocoon yield by wt.	Cocoon weight	Shell weight	Shell ratio	Silk filament length	Pupation rate
Season (S)	2	15.63*	10.34*	465.76*	34.04*	60.28*	80.51*	28.29*	40.19*	7.80*	181.92*	61.87*
Race (R)	3	211.41*	61.27*	1032.01*	176.26*	12.19*	103.52*	164.84*	109.61*	9.93*	1977.69*	10.59*
Interaction (S x R)	6	0.55^{NS}	2.43^{NS}	7.46*	3.10*	0.77^{NS}	1.99^{NS}	5.97*	5.22*	8.54*	19.46*	0.71^{NS}
Error	22	0.0402	0.0056	0.0099	0.6010	0.9602	0.0894	0.0004	0.0000	0.0044	42.1364	0.0101
CD at 5%	0.33	0.12	0.16	1.30	1.65	0.50	0.03	0.008	0.11	10.93	0.16	

* = Significant; NS - Non - Significant

mean values for this trait observed in different seasons indicate higher viability compared to the respective controls. In addition, higher values observed for the productivity traits such as cocoon yield by weight, cocoon weight, shell weight and shell ratio in multivolitne races than the control confirm their superiority. Similarly the longer filament length exhibited by these new multivoltine races clearly indicates the superiority of the gene combinations present in the races.

The overall superiority observed in the expression of the most of the economic traits analyzed in the new multivoltine races over their control in different seasons of the year confers their genetic advantages over the control. All the three new multivoltine races selected for the study, thus prove their superiority under the tropical conditions prevailing in Rayalaseema region.

REFERENCES

Anonymous 1971. Sericulture. Overseas Technical co-operation Agency, Japan, P. 106.

Griffing, B. and Zsiros, E. 1971. Heterosis associated with genotype-environment interactions. *Genetics*. **68:** 443-445.

Kalpana, G. V. 1992. Breeding of superior races of silkworm *Bombyx mori*. L for tropical climates. Ph.D Thesis, Univ. of Mysore, Mysore.

Kashiviswanathan, K., Iyengar, M. N. S. and Krishnaswami, S. 1970.

Effect of feeding leaves grown under different systems of mulberry cultivation on the silkworm cocoon crops. *Ind. J. Seric.* **9(1):** 53-58.

Kempthrone, O. 1952. An introduction to genetics statistics. John Wiley and Sons, New York, p. 631.

Kogure, K. 1932. The influence of light and temperature on certain characters of silkworm, *Bombyx nwri*. *J. Dept. Agri. Kyushu Imperial Univ.* **4:** 1-93.

Krishnaswami, S. and Narasimhanna, M. N. 1974. Large scale trails on bivoltine hybrids in Mysore state. *Ind. J. Genet. PI. Breed.* **34A:** 229-236.

Lakshmi, H. and Chandrashekaraiah. 2007. Identification of breeding research material for the development of Thermo-tolerant breeds of silkworm *Bombyx mori*. *J. Exp. Zool. India.* **10(1):** 55-63.

Malik, M. A. 1992. Studies on the performance and adaptation of bivoltine races of silkworm *Bombyx mori* L of Kashmir and evolution of Heterosis in their hybrids under temperature and sub tropical climates. Ph. D Thesis Univ. of Mysore, Mysore.

Maribashetty, V. G. 1991. Evolution of superior bivoltine races of silkworm *Bombyx mori* L. for tropics. Ph. D Thesis Univ. of Mysore, Mysore.

Morohoshi, S. 1969. The control of growth and development in *Bombyx mori* L. Relationship between environmental moulting and voltine characters. *Proc. Jpn. Acd.* **45:** 797-802.

Nacheva, J. and Junka, 1989. Phenotypic and genotypic characterization of silkworm character during the different seasons of silkworm feeding. *Genet. Sel.* **22(3):** 242-247.

Nanjundaswamy, L. 1997. Studies on the combining ability in silkworm *Bombyx mori* L. Ph. D Thesis Univ. of Mysore, Mysore.

Narasimhanna, M. N. and Krishnaswami, S. 1972. Improved techniques of silkworm rearing. Paper presented at seminar on sericulture, 1- 11, CSRTI, Mysore.

Nirupam, R. and Singh, R. 2007. Evaluation of polyvoltine breeds of the mulberry silkworm, *Bombyx mori* L. *J. Exp. Zool. India.* **10(2):** 341- 344.

Orozco, F. 1976. Heterosis and genotype environment interaction: Theoritical and experimental aspects. Bulletin Technique, Dept. de genetique Animal. *Institute National de la Racherche Agronomique No.* **24:** 43-52.

Rajanna, G.S. 1989. Evolution of suitable bivoltine races of silkworm *Bombyx mori* L. for tropics. Ph. D Thesis Univ. of Mysore, Mysore.

Raju, P.J. 1990. Studies on the hybridization and synthesis of new breeds of silkworm *Bombyx mori* L. Ph. D Thesis Univ. of Mysore, Mysore.

Raman, S.M. and Ahmad, S.U. 1988. Stability analysis for silk yield in some promising genotypes of silkworm *Bombyx mori* L. In: Proceedings of International congress on tropical sericultural practices. Part III. pp: 27-30.

Strickberger, W., 2002. Genetics. Third edition. Prentice-Hall of India Private Limited, New Delhi - 110 001.

Subramanya, G. 1985. Ecogenetic approach for determination of high yielding breeds of silkworm *Bombyx mori* L. Ph.D Thesis Univ. of Mysore, Mysore.

Tazima, Y. 1962. Silkworm egg: scientific brochure-1, pp. 1-49, Central Silk Board Bombay, India.

Ueda, S., Kimura, R. and Suzuki, K. 1969. Studies on growth of the silkworm *Bombyx mori* II. The influence of rearing condition upon the larval growth, productivity of silk substance and eggs and boil off loss in cocoon chell. *Bull. Seric. Expt. Stn.* **23:** 290-293.

Ueda, S., Kimura, R. and Suzuki, K. 1975. Studies on the growth of the silkworm *Bombyx mori*.IV mutual relationship between the growth in the fifth instar larvae and productivity of silk substance and eggs. *Bull. Seric. Expt. Stn.* **26(3):** 233-247.

Veeraiah, T. M. 1999. Studies on the exploitation of heterosis in silkworm *Bombyx mori* L. Ph.D Thesis Univ. of Mysore, Mysore.

Yokoyama, T. 1962. Synthesized science of sericulture. Translated and published by Central Silk Board, India. p. 283.

Yokoyama, T. 1963. Sericulture. *Ann. Rev. Entomol.*, (Ann.Rev. Inc. California). **8:** 287-306.