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Silk Productivity and Yield Related Characters of Selected Pure Races of Mulberry silkworm, *Bombyx mori* L.

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Experiment was conducted to study the cocoon, biological and yield related characters of selected pure races of *Bombyx mori* L. Among the multivoltine races, significantly higher cocoon, biological and yield related characters were observed in AGL3 and low in Pure Mysore. Among the bivoltine races, significantly higher characters were observed in CSR2 and low in NN6D. The silk productivity had significant positive correlation with the cocoon and yield related characters whereas fifth instar larval duration, cocoon length and breadth ratio, and renditta were negatively correlated, among all the 10 pure races tested.

Key words: *Bombyx mori*, races, silk productivity

India is the second largest producer of silk after China. Silk is produced by the silkworm, *Bombyx mori* L. which is a well-studied, domesticated monophagous lepidopteran insect feeding exclusively on mulberry leaves. In India, silkworm rearing is mainly concentrated in southern states comprising Karnataka, Tamil Nadu, Andhra Pradesh and Kerala. Average cocoon yield per acre per year ranges from 150 to 200kg. This lower cocoon yield is attributed to poor quality mulberry leaves and rearing of low yielding races. Considering the present labour crisis and high costs in sericulture, it is essential to select right silkworm race with higher cocoon yield potential to realize a better cost benefit ratio. Keeping this in mind, an attempt was made to assess the performance of different bivoltine and multivoltine races, and to correlate silk productivity with cocoon, biological and yield related characters.

Materials and Methods

The disease free layings (dfls) of five multivoltines *viz.,* Pure Mysore, Nistari, AGL3, NP1 and BL67, and five bivoltines *viz.,* CSR2, CSR4, CSR6, CSR27 and NN6D races procured from Central Sericultural Research and Training Institute, Mysore were used for the experiment. Rearing of silkworms was taken up by feeding V1 mulberry variety by following standard procedures (Krishnaswami, 1978). The bed disinfectant was applied @ 4 kg/ 100 dfls to prevent diseases immediately after every moult (Baig and Pradip kumar, 1987). Mass rearing was carried out upto third moult and one hundred healthy fourth instar larvae were selected per replication. The races were replicated four times. The biological parameters *viz.,* egg hatchability, fifth instar larval duration and mature larval weight were recorded. Silk productivity was calculated by dividing the shell weight with fifth instar larval duration and expressed as centigram per hour (Ramesha and Govindan, 1989).

Five cocoons per replication were randomly selected on third day after spinning (Sanjeeva Reddy, 2004). The cocoon parameters *viz.,* cocoon length and breadth ratio, cocoon weight, shell weight and shell ratio were recorded. Five cocoons per replication were reeled with euprovette and reeling and yield related parameters *viz.,*filament weight, renditta, cocoon yield in kilogram and number were recorded. The data were subjected to analysis of variance test the significance between parameters of bivoltine and multivoltine races of silkworm.

Results and Discussion

Biological parameters of silkworm races

Biological parameters were higher in bivoltine races as compared to multivoltines. Among the mutivoltine races tested, higher egg hatchability of 87.34 per cent was registered in Nistari which was on par with Pure Mysore (87.27 %) and BL67 (85.90 %). Lower egg hatchability was observed in NP1 (82.34 %) (Table 1). Among the bivoltine races significantly higher egg hatchability of 91.90 per cent was registered in CSR2 which was followed by CSR27 (90.24 %) and the least was noticed in NN6D (87.55 %). These observations are in parity with the findings of Rahmathulla *et al.* (2011) who recorded the egg hatchability of 93.78, 92.07, 88.55 and 90.55 per cent in CSR2, CSR4, CSR6 and CSR27 respectively. Sanjeeva Reddy (2004) also reported the egg hatchability of 87.43 per cent in Nistari and

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87. 24 per cent in Pure Mysore among the multivoltines and 91.90 per cent in CSR2 among the bivoltines.

Among the mutivoltine races, significantly maximum fifth instar larval duration of 159 h was registered in Pure Mysore and minimum was noticed in AGL3 (111 h) (Table 1). Among the bivoltine races, significantly maximum fifth instar larval duration of 216 h was recorded in CSR27 which was followed by CSR4 (180 h) and CSR2 (177 h). The minimum larval duration of 120 h was observed in NN6D. These observations are in agreement with the findings of Brinda *et al.* (2012) who recorded higher fifth instar larval duration of 232 h for Pure Mysore among the multivoltine races and 171 h for NB18

Table 1. Biological parameters of multivoltine races of *B. mori*

Race	Egg hatchability (%)	V_{th} instar larval duration (h)	Mature larval weight (g)	Silk productivity (cg/ h)
Pure Mysore	87.27	159	2.01	0.100
Nistari	87.34	135	2.4	0.139
AGL3	85.65	111	2.95	0.241
NP1	82.34	135	3.04	0.159
BL67	85.90	127	2.89	0.181
S.Ed.	0.82	5.60	0.12	0.035
C.D. (0.05)	1.64	11.45	0.26	0.076
Bivoltine				
CSR2	91.90	177	4.08	0.203
CSR4	89.26	180	3.43	0.172
CSR6	89.48	192	3.63	0.167
CSR27	90.24	216	3.67	0.171
NN6D	87.55	120	3.81	0.192
S.Ed.	0.95	5.26	0.07	0.010
C.D. (0.05)	2.00	11.21	0.15	0.020

among the bivoltine races. Farshid Ghasemi and Mahesha (2012) recorded fifth instar larval duration of 660 h in Pure Mysore and 578 h in CSR2. Similar results were reported by Govindan *et al.* (1990).

The larval weight was higher in bivoltine races as compared to multivoltine races. Among the mutivoltines studied, NP1 registered significantly higher larval weight of 3.04g. The lower larval weight was noticed in Pure Mysore (2.01g) (Table 1). Among the bivoltines, significantly higher larval weight of 4.08g was observed in CSR2 and was followed by NN6D (3.81g). The least larval weight was noticed in CSR4 (3.43 g) (Table 1). The increase in larval body weight in bivoltines might have been mainly due to more metabolic rate. Farshid Ghasemi and Mahesha (2012) reported the larval weight of 2.01 g, 2.83 g and 4.07 g in Pure Mysore, Nistari and CSR2, respectively. Sanjeeva Reddy (2004) reported higher larval weight of 3.09g in CSR2 and lower larval weight of 1.04g in Pure Mysore. These results are in agreement with the present observations.

Silk productivity also greatly varied among bivoltine and multivoltine races. In multivoltines, the higher silk productivity of 0.241 cg/ h was recorded in AGL3 which was on par with BL67 (0.181 cg/ h) and lower silk productivity of 0.139 cg/ h was observed in Nistari (Table 1). In bivoltines, the higher silk productivity of 0.203 cg/ h was recorded in CSR2 and lower silk productivity of 0.167 cg/ h was observed in CSR6 (Table 1b). Better silk productivity observed in present investigation could be due to higher shell weight and reduced fifth instar larval duration. Similar results were observed by Ramesha and Govindan (1989).

Biometric parameters of cocoon of silkworm races

The results of different cocoon biometric parameters of selected bivoltine and multivoltine silkworm races are given in the Table 2. Variations in the cocoon and yield related parameters of various silkworm races were studied in detail by Jolly (1983) and Basavaraja (2001).

Table 2. Biometric parameters of cocoons of races of *B. mori*

Race	Cocoon L:B ratio	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)
Multivoltine				
Pure Mysore	3.47	0.99	0.16	16.16
Nistari	2.80	1.17	0.19	16.40
AGL3	1.95	1.38	0.27	19.57
NP1	2.03	1.35	0.22	16.29
BL67	1.91	1.32	0.23	17.42
S.Ed.	0.35	0.07	0.03	1.38
C.D. (0.05)	0.70	0.15	0.06	2.84
Bivoltine				
CSR2	1.92	1.68	0.36	21.43
CSR4	2.08	1.54	0.31	20.13
CSR6	1.92	1.63	0.32	19.63
CSR27	1.96	1.57	0.37	23.57
NN6D	2.00	1.52	0.23	15.13
S.Ed.	0.07	0.06	0.02	1.05
C.D. (0.05)	0.14	0.13	0.04	2.24

Among the five mulvoltine races, maximum cocoon weight of 1.38g was registered in AGL3 which was statistically on par with NP1 (1.35g) and BL67 (1.32g), whereas, low cocoon weight of 0.99g was observed in Pure Mysore. Among the five bivoltine races, significantly higher cocoon weight of 1.68g was recorded in CSR2 which was on par with CSR6 (1.63g). Low cocoon weight was observed in NN6D (1.52g). The races showed distinct variations with regard to cocoon length and breadth ratio. The length and breadth ratio ranged from 1.91 to 3.47 among multivoltine races and from 1.92 to 2.08 among the bivoltine races. Among the multivoltines, significantly higher shell weight of 0.27g in AGL3 and 0.22g in NP1 was observed whereas lower shell weight of 0.16g was noticed in Pure Mysore. The shell weight was higher in CSR27 with 0.37g which was statistically on par with CSR2 (0.36g) and the least was registered in NN6D (0.23g). The shell ratio ranged from 16.16 to 19.57 per cent with maximum in AGL3 and minimum in Pure Mysore in case of multivoltines. Higher shell ratio of 23.57 per cent was registered in CSR27 which was on par with CSR2 (21.43 %) and significantly differed from all other races. The least shell ratio of 15.13 per cent was noticed in NN6D in case of bivoltines. Higher synthesis and accumulation of fibroin in the silkgland might have resulted in higher cocoon and shell weights and ultimately shell ratio.

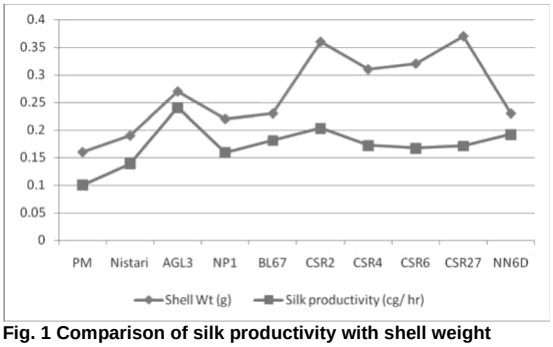

Fig. 1 Comparison of silk productivity with shell weight

Jolly (1983) recorded higher cocoon weight (1.90g), shell weight (0.42g) and shell ratio (21.60 %) in bivoltine races. Kalpana *et al.* (1994) reported 0.86 g and 0.91 g of cocoon weight, 0.11g and 0.13g shell weight, and 13 and 14.2 per cent of shell ratio in Nistari and Pure Mysore races, respectively. Basavaraja (2001) reported that CSR races were found to possess higher cocoon weight (1.7g – 1.8g), shell weight (0.3g – 0.5 g) and shell ratio (21-24 %). Similar types of results were reported by

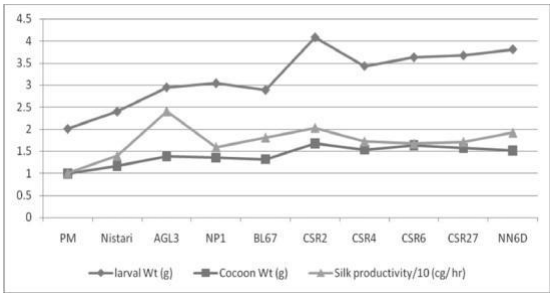

Fig. 2 Comparison of silk productivity with larval and cocoon weights

scientists from CSR&TI, Mysore (Anonymous, 1982). Rahmathulla *et al.* (2011) reported higher cocoon weight (1.52 to 1.64 g), shell weight (0.34 to 0.39 g) and shell ratio (20.73 to 23.09 %) in CSR races. Farshid Ghasemi and Mahesha (2012) observed cocoon weight, shell weight and shell ratio of 1.02g, 0.12 g and 12.57 per cent, respectively in Pure Mysore among the multivoltine races and 1.81g, 0.43 g and 24.02 per cent, respectively in CSR2 among the bivoltine races. These findings are in agreement with the present observations on cocoon characters.

Reeling and yield related characters of silkworm races

There was no significant difference in filament weight among the silkworm pure races. However, the filament weight ranged from 0.085g to 0.180g in multivoltines and from 0.183g to 0.252g in case of bivoltines (Table 3). Yang Mingying *et al.* (2000) reported similar results in Japanese races.

In multivoltines, lower renditta of 9.00 kg was recorded in BL67 which was followed by NP1 (10.32 kg) and higher was exhibited in Nistari (11.75 kg) (Table 3). In bivoltines, lower renditta of 5.47 kg was recorded in CSR6 which was statistically superior over all other races and was followed by CSR2 (6.56

Table 3. Reeling and yield related parameters of races of *B. mori*

Race	Filament weight (g)	Renditta (Kg)	Cocoon Yield (Kg/ 10000 larvae)	Cocoon yield (No/ 10000 larvae)
Multivoltine				
Pure Mysore	0.085	10.50	8.30	9672
Nistari	0.080	11.75	7.98	8429
AGL3	0.129	10.86	11.40	9242
NP1	0.158	10.32	9.81	7885
BL67	0.180	9.00	11.34	9074
S.Ed.	0.05	0.45	0.25	38.4
C.D. (0.05)	NS	0.90	0.53	81.8
Bivoltine				
CSR2	0.203	6.56	16.26	9680
CSR4	0.155	7.48	14.60	9710
CSR6	0.218	5.47	15.43	9785
CSR27	0.252	6.90	15.13	9764
NN6D	0.183	7.65	14.56	9815
S.Ed.	0.043	0.49	0.52	37.3
C.D. (0.05)	NS	1.02	1.10	79.6

kg) and higher renditta was observed in NN6D (7.65 kg). Rao *et al.* (2003) reported significantly lower renditta in newly evolved breeds exhibiting their superiority over the traditional breeds. Dandin *et al*. (2005) recorded low renditta of 5.0 to 5.5 kg in the bivoltine hybrids. Farshid Ghasemi and Mahesha (2012) recorded the renditta of 11.77 kg and 13.26 kg in multivoltine races, Pure Mysore and Nistari, respectively and the renditta of 5.78 kg in bivoltine race, CSR2. These findings support the present observations.

Among the multivoltine races, the cocoon yield in kilogram for 10000 larvae was higher in AGL3 (11.40 kg) and lower in Pure Mysore (8.30 kg) whereas the cocoon yield in number for 10000 larvae was higher in Pure Mysore (9672) and lower in NP1 (7885) (Table 3). Among the bivoltine races, higher cocoon yield was recorded in CSR2 (16.26 kg) and lower in NN6D (14.56 kg) whereas the cocoon yield

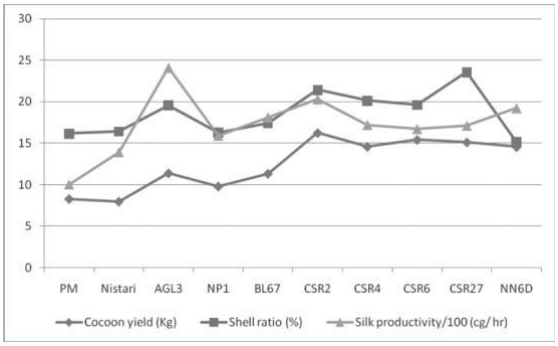

Fig. 3 Comparison of silk productivity with shell ratio and cocoon yield

in number for 10000 larvae was higher in NN6D (9815) and lower in CSR2 (9680). It is suggested that increase in cocoon yield may be due to increase in cocoon and shell weights (Venkataramireddi and Benchmin, 1989). This was supported by the findings of Rahmathulla *et al.* (2011) who registered higher cocoon yield of 13.77 kg and 13.54 kg in CSR4 and CSR2, respectively which were on par with each other and lower cocoon yield in case of multivoltine races. In the present observation, the cocoon yield in numbers was lower in AGL3 and

Table 4. Correlation between silk productivity and yield related characters of different races of mulberry silkworm, *B. mori* L.

Parameter	Egg hatchability (%)	V_{th} instar larval duration (days)	Mature larval weight (g)	Cocoon L:B ratio	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)	Filament weight (g)	Renditta (kg)	Cocoon yield (Kg/ 10000 larvae)	Cocoon yield (No/ 10000 larvae	Silk productivity (cg/ hr)
Egg hatchability (%)	1.000											
V_{th} instar larval duration (days)	0.717*	1.000										
Mature larval weight (g)	0.542	0.402	1.000									
Cocoon L:B ratio	-0.099	-0.071	-0.801**	1.000								
Cocoon weight (g)	0.554	0.461	0.975**	-0.838**	1.000							
Shell weight (g)	0.689*	0.694*	0.824**	-0.680*	0.890**	1.000						
Shell ratio (%)	0.657*	0.742*	0.541	-0.448	0.636*	0.917**	1.000					
Filament weight (g)	0.450	0.571	0.845**	-0.759*	0.843**	0.813**	0.638*	1.000				
Renditta (kg)	-.0704*	-0.688*	-0.840**	0.555	-0.850**	-0.785**	-0.570	-0.855**	1.000			
Cocoon yield (Kg/ 10000 larvae)	0.700*	0.556	0.946**	-0.703*	0.950**	0.878**	0.653*	0.848**	-0.935**	1.000		
Cocoon yield (No/ 10000 larvae	0.768**	0.493	0.443	-0.076	0.426	0.488	0.443	0.419	-0.685*	0.675*	1.000	
Silk productivity (cg/ hr)	0.077	-0.248	0.594	-0.800**	0.620	0.517	0.373	0.402	-0.235	0.518	0.149	1.000

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

CSR2 and higher in Pure Mysore and NP1. The low cocoon weight of these races might be the reason for the low cocoon yield. The significant variations noticed in the biological and yield related characters of both multivoltine and bivoltine races can be attributed to the genetic architecture and their response to the environmental variations. It is evident from the present study that the biological, cocoon and cocoon yield related traits varied in silkworm races.

Correlation between silk productivity and yield related characters

Positive correlation between silk productivity and yield related characters in bivoltine and multivoltine pure races were recorded (Fig.1, 2 and 3). The minimum correlation coefficient of 0.077 was recorded for egg hatchability and maximum coefficient of 0.620 for cocoon weight. Significantly negative correlation between silk productivity and fifth instar larval duration, cocoon length and breadth ratio, and renditta denier was recorded (-0.248, - 0.800 and 0.235, respectively) (Table 4). Thus, the silk productivity responds differently to different pure races of silkworm. Based on the above results it is concluded that multivoltine race, AGL3 and bivoltine race, CSR2 registered higher biological, cocoon and yield related characters and hence they can be utilized for higher cocoon and raw silk yield. These races may also be exploited as parental materials for the production of hybrids in cross breeding programme.

References

Anonymous. 1982. Hosa Mysore series. Annual Report Central Sericultural Research and Training Institute Mysore, pp. 87-88.

Baig, M and T. Pradipkumar. 1987. Silkworm diseases and pests. pp. 108 -138. In: *Appropriate Sericulture Technique* (Ed., Jolly, M.S.),

Basavaraja, H.R. 2001. Characters of CSR breeds and their hybrids seed production technology for silkworm breeders, Silkworm seed Technological Laboratory, CSB, Bangalore. pp.45-54.

Brindha, S., Maragathavalli, S., Gangwar, S. K. and Annadurai, B. 2012. Effect of juvenile hormone on enhanced silk production in *Bombyx mori* L. *Inter. J. Adv. Biol. Res.*, **2**: 396-402.

Dandin, S.B. and Bajavaraja, H.K. 2005. Large scale bivoltine farming – reality under tropical conditions. *Indian Silk*, **43**: 10-12.

Farshid Ghasemi and Mahesha, H.B. 2012. Correlation studies on haemolymph and midgut tissue proteins with commercial characters of silkworm *Bombyx mori* L. *Asian. J. Exp. Biol. Sci,* **3**: 642 -653.

Govindan, R., Magadum, S.B. and Ashoka, J. 1990. Variability in larval silkglands, cocoon and shell weights in some bivoltine single and double cross hybrids of silkworm, *Bombyx mori* L. *Mysore J. Agri. Sci*., **24**: 222-224.

Jolly, M. S. 1983. Silkworm genetics and breeding. In: Proc. *Natl. Semi. Seri. Res.* and *Dev.,* Central Silk Board, Bangalore, p.19.

Kalpana, G.V., Raju, P.J., Subramanya, G. and Sreerama Reddy, G. 1994. Synthesis of promising multivoltine races of silkworm *Bombyx mori* with productivity merits In: *Proc. Natl. Workshop on Silkworm Breeding,* Sreerama Reddy, G. (Ed.) held at University of Mysore, March 18-19th 1994. Oxford and IBH Publ. Co. Pvt. New Delhi,pp. 79-101.

Krishnaswami, S. 1978. New Technology of Silkworm Rearing. Bulletin No.2 CSB, Bangalore, p.42.

Rahmathulla, V.K., Kishore Kumar, C.M. Manjula, A. and Sivaprasad, V. 2011. Effect of different season on crop performance of parental stock races of bivoltine silk worm (*Bombyx mori* L). *Mun. Ent. Zool.* **6**: 886 - 892.

Ramesha, B.S. and Govindan, R. 1989. Influence of some plant growth regulators on larval and cocoon traits of silkworm, *Bombyx mori* L. In: Proc. S*ilkworm Management* in Tropics, Volume II, UAS, Bangalore. p.206-207.

Rao, P.S., Ravidra Singh, Nisitha Naik, Basavaraja, H.K., Rekha, M. and Datta, R.K. 2003. Seasonal performance of newly evolved bivoltine hybrids of the silkworm (*Bombyx mori* L.) in tropics. *Bull. Indian Acd. Seric.,* **7**: 21-27.

Sanjeeva Reddy, K. 2004. Study of molecular diversity and digestive amylase activity in *Bombyx mori* L., M.Sc. (Seri.) Thesis, Tamil Nadu Agric. Univ., Coimbatore, 60 p.

Venkataramireddi, K. and Benchmin, K.V. 1989. Studies on tissue somatic index and growth of silkworm, *Bombyx mori* during fifth instar. *Seric*. **29**: 463-476.

Yang Mingying, Zhu Liangjun, Mia Yungen. 2000. Relationship between wrinkles and reelability in the cocoon of mulberry silkworm, *Bombyx mori* L. *Bull. Ind. Acad. Seri.,* **4**: 57-61.

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