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RESEARCH ARTICLE

Quality parameters and economic traits of new mulberry silkworm (*Bombyx mori* L.) hybrids

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ABSTRACT

An experiment was conducted to evaluate the performance of bivoltine mulberry silkworm (*Bombyx mori* L.) hybrids under Marathwada conditions at Sericulture Research Unit, Marathwada Agricultural University, Parbhani during October-November, 2008. The bi x bi hybrid CSR_{16} x CSR_{17} was found significantly superior with hatching percentage of 95.22. Maximum larval weight (45.08 g), maximum single cocoon weight (1.98 g), single shell weight (0.393 g), filament length (950 m), cocoon yield/10000 larvae brushed (18.55 kg), effective rate of rearing (96.33 per cent), whereas significantly superiority in less larval duration and shelling percentage was found in bi x bi hybrid CSR_{18} x CSR_{19} (22.65 days) and CSR_{48} x CSR_4 (20.98 per cent), respectively. The multi x bi hybrid PM x CSR_2 recorded significantly less disease incidence. Based on overall performance it can be concluded that the bivoltine hybrid CSR_{16} x CSR_{17} reared on mulberry variety V-1 was the most suitable and economical for rearing under Marathwada conditions.

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INTRODUCTION

Widespread utilization of hybrids towards achieving sustainability and quality oriented increased production is well established in plants and animals in general and silkworm in particular as it is the only animal where hybrids are used compulsorily . In spite of quantitative increase in the overall silk production in India over years through the development and use of productive silkworm hybrids on commercial scale , there remains a wide quantitative and qualitative yield gap than is mainly attributed to the dearth for potential silkworm hybrids suitable for Indian tropical conditions necessitating the need for more potential silkworm hybrids. Realizing the need for increased qualitative silk production, due emphasis is being laid towards the development of suitable and qualitatively superior bivoltine hybrids for providing tropical conditions of the country in general and region and season specific in particular likewise the present research was conducted to evaluate bivoltine mulberry silkworm hybrids in Marathwada conditions.

The hybridization is most successful and easy way of developing high yielding silkworm races, hence the present investigation was undertaken to evaluate the suitable hybrids of *Bombyx mori* under Marathwada conditions.

MATERIALS AND METHODS

Materials :

An experiment was conducted to evaluate bivoltine mulberry silkworm (*Bombyx mori* L.) hybrids under Marathwada condition for economic traits and disease incidence at Sericulture Research Unit, Marathwada Agricultural University, Parbhani during October-November, 2008. The mulberry plant variety V-1 was used for the feeding. The treatments were CSR_2 x CSR_4, CSR_{18} x CSR_{19}, CSR_{16} x CSR_{17}, CSR_3 x CSR_6, CSR_{48} x CSR_4, CSR_{12} x CSR_{26} and CSR_{12} x CSR_6 bi

x bi and as a check PM x CSR_2 multi x bi hybrids brought from Central Sericulture Research and Training Institute, Mysore.

Methodology :

The experiment was laid out in a Randomised Block Design with eight treatments replicated thrice. The silkworm rearing was carried out according to improved technique given by Krishnaswami (1978) (Table A).

The rearing house and all the rearing appliances were disinfected with Sanitech (ClO_2) solution (500 ppm ClO_2 + 0.5 % slaked lime) to make them free from pathogens before rearing. Paper sheets of disease free layings (dfls) of silkworm hybrids were procured from the multivoltine and bivoltine breeding laboratories of Central Sericulture Research and Training Institute, Mysore and were incubated at of 25 ± 1^{0}C and 75 ± 5 per cent relative humidity. The egg sheets were spread out in a single layer in rearing trays and covered with paraffin paper. Wet foam rubber pad were kept all around the egg sheets to ensure the required humidity for incubation. The trays containing egg sheets were stored in cool place in rearing house. On attaining the blue egg stage, the egg sheets were placed into a card board box and covered by black piece of cloth and left undisturbed for 24 hours for uniform growth of embryo, after which the eggs were exposed to bright light for one hour for uniform hatching.

The newly hatched worms were fed with chopped pieces of fresh tender mulberry leaves of V-1 variety. The leaves were chopped into small pieces of 0.5 sq.cm. size and sprinkled over newly hatched young ones which crawled on the leaves and started feeding from cut edges. The size of chopped leaves was regulated according to the condition and size of worms. Feeding was given four times in a day. Timing of the feeding was fixed at 7 hrs, 11 hrs, 16 hrs and 20 hrs in a day. The cleaning of trays was done once in a day probably in the morning at 8 hrs. The silkworm moults for four times during its larval growth phase (five instar). During moulting period, the worms were not provided any food and were not disturbed when worms showed moulting signs, was spread over their body for uniform moulting. After moulting, worms were spread with disinfectant (Vijetha) to avoid pathogen infection. The quantity of food increased during the fifth instar stage because they eat voraciously during this instar.

After full development, the ripe worms were identified as they looked translucent with creamy colour and ceased to eat and crawled towards periphery of trays and tried to spin the cocoon, such worms were hand picked and kept on the mountages. Larvae spun cocoons within 48 to 72 hrs. The pupa remains inside the cocoon till emergence. The harvesting of cocoons was made on fifth day of release of worms from mountages.

Observations :

The observation on hatching percentage, larval duration, larval weight, single cocoon weight, single shell weight, cocoon shell ratio, cocoon filament length, denier and disease incidence were recorded. Observations were recorded on following parameters on ten randomly selected larvae / cocoons of silkworm hybrids from each replication of each treatment.

Larval duration (days) :

It is the period from (egg hatching) emergence of larvae brushed to the date of spinning.

Single cocoon weight (g)

Ten randomly selected cocoons of each replication were weighed and average was computed.

Shell ratio (%) :

It is the ratio of cell weight to the cocoon weight expressed as percentage as below :

$$\text{Shell ratio} = \frac{\text{Single shell weight}}{\text{Single cocoon weight (kg)}} \times 100$$

Cocoon yield per 10000 larvae weight (kg) :

The mean weight of cocoons harvested from larvae retained after 3rd moult in a replication was taken and converted for 1000 larvae.

Table A : Characteristics features of different silkworm hybrids

Hybrids	Combination	Larva	Cocoon shape	Cocoon colour
CSR_2 x CSR_4	Bi x Bi	Plain with bluish white colour	Elongated oval shape	White
CSR_3 x CSR_6	Bi x Bi	Plain white	Elongated oval shaped	Bright white
CSR_{12} x CSR_6	Bi x Bi	Plain white marked larvae	Oval shaped	White
CSR_{12} x CSR_{26}	Bix Bi	Plain white marked larvae	Oval shaped	White
CSR_{16} x CSR_{17}	Bi x Bi	Plain white marked larva	Oval and elongated	White
CSR_{18} x CSR_{19}	Bi x Bi	Plain white with reddish tinge sex expression	Oval shaped	White with creamy colour
CSR_{48} x CSR_4	Bi x Bi	Plain bluish white	Oval and dumbbell	Bright white
PM x CSR_2	Multi x Bi	Plain gray white	Elongated oval shaped	Greenish yellow

Effective rate of rearing (%)

Effective rate of rearing was calculated as :

$$\text{Cocoon yield /1000 larvae by weight (kg)} = \frac{\text{Total cocoon yield by weight (kg)}}{\text{No. of larvae ratained after 3 rd moult.}} \times 1000$$

Cocoon filament length :

It is the average length of silk reeled from total number of cocoons. Average filament length was measured by reeling 10 randomly selected cocoons with the help of epprouvette after boiling in water.

Denier :

It is the term used to denote the thickness of the silk filament and expressed in terms of ratio of weight of filament, to the filament length multiplied by 9000.

$$\text{Denier} = \frac{\text{Weight of raw silk reeled (g)}}{\text{Langth of raw silk reeled (m)}} \times 9000$$

Disease incidence

Observation on incidence of grasserie and flachrrie diseases were recorded separately by recording number of healthy and diseased larvae during the course of rearing in different hybrids and percentage incidence was worked out as:

$$\text{Disease incidence (\%)} = \frac{\text{Weight of raw silk reeled (g)}}{\text{Langth of raw silk reeled (m)}} \times 9000$$

The data collected on these parameters were analysed and results were interpreted accordingly. The results were discussed in the light of earlier research work. The findings of the present investigation are summarized as below.

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Larval duration (days) of silkworm :

Among all the silkworm hybrids, the bivoltine hybrid CSR_{18} x CSR_{19} recorded significantly minimum larval duration (22.65 days) followed by CSR_{12} x CSR_{26} (22.83 days), CSR_{16} x CSR_{17} (23.05 days) (Table 1). The control treatment PM x CSR_2 (23.91 days) recorded longer larval duration except bivoltine hybrid CSR_{12} x CSR_6 (24.45 days). The larval duration constribute little in the yield of cocoons.

Venugopalapillai *et al*. (1987) reported that bivoltine hybrid displayed shorter larval duration compared to PM combination. Salunke (2003) reported that under favourable condition the bivoltine hybrid CSR_{18} x CSR_{19} recorded significantly shortest larval duration (21.43 days) than all other bivoltine hybrids. Vidhate (2003) had observed CSR_{18} x CSR_{19} (21.68 days) as significantly superior.

Single cocoon weight :

The bivoltine hybrid CSR_{16} x CSR_{17} showed maximum single cocoon weight (1.98 g) and found significantly superior over rest of hybrids.

The control treatment PM x CRS_2 (1.83 g) showed poor result as compared to all other bivoltine hybrids *viz.*, CSR_{16} x CSR_{17} (1.98 g), CSR_{12} x CSR_{26} (1.92 g), CSR_2 x CSR_4 (1.87 g), CSR_3 x CSR_6 (1.86 g) and CSR_{12} x CSR_6 (1.84 g) except only two bivoltine hybrids CSR_{48} x CSR_4 (1.78 g) and CSR_{18} x CSR_{19} (1.77 g) (Table 1). Vidhate (2003) had observed CSR_{16} x CSR_{17} (1.975 g) as significantly superior over the multivoltine x bivoltine hybrids.

The performance of cross breed and bivoltine hybrids was evaluated at CSR and TI, Mysore (Anonymous, 1999). The multi x bivoltine hybrids P_2D_1 x NB_4D_2, MY_1 x NB_4D_2, BL24 x NB_4D_2 and PM x NB_4D_2 recorded single cocoon weight of 2.005g, 1.819g, 1.897 g and 1.797 g while the bivoltine hybrids CSR_2 x CSR_4, CSR_2 x CSR_5, CSR_{16} x CSR_{17} and CSR_{18} x CSR_{19}

Table 1 : Economic traits of different biovoltine mulberry silkworm hybrids

Sr. No.	Treatments	Larval duration (days)	single cocoon weight (g)	Shell ratio (%)	filament length (m)	Cocoon yield/10000 larvae brushed (kg)	Effective rate of rearing (%)	Denier	Disease incidence (%)
1.	CSR_2 x CSR_4	23.70	1.87	20.16	902	18.05	93.33	3.762	4.11
2.	CSR_3 x CSR_6	23.37	1.86	19.76	890	17.99	90.66	3.738	5.15
3.	CSR_{12} x CSR_6	24.45	1.84	20.25	898	17.46	92.33	3.741	5.07
4.	CSR_{12} x CSR_{26}	22.83	1.92	20.53	938	18.35	95.66	3.735	4.74
5.	CSR_{16} x CSR_{17}	23.05	1.98	19.97	950	18.55	96.33	3.729	3.84
6.	CSR_{18} x CSR_{19}	22.65	1.77	20.44	865	17.20	94.66	3.762	4.01
7.	CSR_{48} x CSR_4	23.45	1.78	20.98	875	17.32	90.33	3.844	2.83
8.	PM x CSR_2	23.91	1.83	19.94	872	17.35	92.34	3.839	2.67
S.E.±		0.261	0.025	0.30	8.4	0.086	1.140	0.039	0.48
C.D. at 5%		0.792	0.077	0.91	25.52	0.26	3.452	0.119	1.47

recorded 2.024 g, 1.992 g, 2.134 g and 1.743 g single cocoon weight, respectively.

The performance of bivoltine hybrids was evaluated at CSR and TI, Mysore. The result showed that CSR_{16} x CSR_{17} had shown single cocoon weight 2.13 g. Akio (2000) also reported CSR_{16} x CSR_{17} as superior in single cocoon weight (2.13 g).

Per cent shell ratio

The data on shelling percentage are presented in Table 2. The data revealed that, the highest shelling percentage was found in bivoltine hybrid CSR_{48} x CSR_4 (20.98 per cent), whereas the bivoltine hybrid CSR_3 x CSR_6 showed lowest shell ratio.

The control treatment PM x CSR_2 hybrid was poor in shell ratio than other silkworm hybrids (bi x bi) except CSR_3 x CSR_6 (19.76 %) Salunke (2003) recorded significantly higher shell percentage in bi x bi CSR_2 x CSR_4 hybrid (22.03 %).

The performance of cross breed and bivoltine hybrids was evaluated at CSR and TI, Mysore (Anonymous, 1999). The multi x bivoltine hybrids P_2D_1 x NB_4D_2, MY_1 x NB_4D_2, BL_{24} x NB_4D_2 and PM x NB_4D_2 recorded shell per cent of 20 per cent, 18.05 per cent, 17.76 per cent, 18.5 per cent respectively. While the bivoltine hybrids CSR_2 x CSR_4, CSR_2 x CSR_5, CSR_{16} x CSR_{17} and CSR_{18} x CSR_{19} recorded 23.4 per cent, 23.6 per cent, 23.00 per cent and 21.7 per cent shell percentage, respectively.

Filament length (m)

The observations on filament length per cocoon are presented in Table 2. It was observed that, the longest filament was observed in the bivoltine hybrid CSR_{16} x CSR_{17} (950 m). However, the bivoltine hybrid CSR_{18} x CSR_{19} (865 m) recorded lowest filament length.

When compared to control treatment, PM x CSR_2 (872 m) the only one bivoltine hybrid CSR_{18} x CSR_{19} (865 m) recorded shorter filament length than control treatment. Whereas, all other treatment (bi x bi) hybrids showed better result than control treatment. Better performance of bi x bi hybrids with respect to filament length has been recorded by many workers 1189 m (Anonymous, 1999), 1151m (Sureshkumar *et al*., 2002) and 1191.66 m (Vidhate, 2003).

Present findings are in agreement with above workers recording more filament length in bi x bi hybrids over multi x bi hybrids. This may be due to bivoltine hybrid possessing high potential for yield higher cocoon shell weight.

Cocoon yield/10000 larvae brushed :

Observations on cocoon yield in kg/10000 larvae brushed are presented in Table 2. It was found that significantly highest cocoon yield was observed in CSR_{16} x CSR_{17} (18.55 kg) followed by CSR_{12} x CSR_{26} (18.35 kg). The lowest yield was recorded from bivoltine hybrid CSR_{18} x CSR_{19} (17.20 kg) followed by CSR_{48} x CSR_4 (17.32 kg). This character is directly related to the weight of mature larvae, hence it has been observed that the bivoltine hybrids CSR_{16} x CSR_{17} (18.55 kg), CSR_{12} x CSR_{26} (18.35 kg), CSR_2 x CSR_4 (18.05 kg), CSR_3 x CSR_6 (17.99 kg), CSR_{12} x CSR_6 (17.46 kg) recorded the higher cocoon yield than control treatment PM x CSR_2 (17.35 kg). Bhekhariah (1981) reported that the overall performance of bivoltine hybrids was markedly superior as compared to multivoltine hybrids. Vidhate (2003) observed significantly highest cocoon yield in hybrid CSR_{16} x CSR_{17} (18.05 kg). Basavaraja (2002) also reported less cocoon weight performance of CSR_{18} x CSR_{19}.

Effective rate of rearing (%) :

The bivoltine hybrid CSR_{16} x CSR_{17} observed highest effective rate of rearing (96.33 %) followed by CSR_{12} x CSR_{26} (95.66 %) and CSR_{18} x CSR_{19} (94.66 %) as per data revealed in Table 1.

Salunke (2003) had shown the bivoltine hybrid CSR_{16} x CSR_{17} (91.33 %) and CSR_{18} x CSR_{19} (91.00 %) significantly higher effective rate of rearing during 2002 in favourable season. Findings of present study are in conformity with the results of above workers.

Denier :

As denier is the thickness of silk thread, higher the denier value coarse the filament while lower the denier value fine the filament.

The hybrid CSR_{16} x CSR_{17} (3.729) recorded significantly lowest and finer denier followed by CSR_{12} x CSR_{26} (3.735), (Table 1). The control treatment PM x CSR_2 had course filament as compared to all other (bi x bi) treatments except one bivoltine hybrid CSR_{48} x CSR_4 as it recorded high denier value than control treatment PM x CSR_2 (3.839). Whereas, all other bivoltine hybrids recorded lower denier value.

Akio (2000) recorded the 3.44 denier value of CSR_{16} x CSR_{17} which was significantly superior. Salunke (2003) recorded CSR_{18} x CSR_{19} (2.56) denier value. Better performance of bi x bi hybrids for filament denier has been reported by Rayar *et al.* (1990) confirming the present findings.

Incidence of disease

The observations on disease incidence are presented in Table 2. The control treatment PM x CSR_2 (2.83 %) recorded significantly less disease incidence (2.67 %) than other hybrids followed by bivoltine hybrid CSR_{48} x CSR_4 (2.83 %) CSR_{16} x CSR_{17} (3.84 %).

Singh *et al*. (1990) studied the relative susceptibility of few pure bivoltine (NB7, NB18, NB_4D_2 and PCM) and multivoltine (PM, C-nichi and MY) races over the seasons and higher incidence of disease was recorded in bivoltine as compared to multivoltine races. Venkatasubaiah *et al*. (1990) conducted the study on relative susceptibility of different

silkworm breeds and indicated that bivolitne races exhibited highest disease occurrence and multivoltine recorded minimum incidence of disease.

Based on overall performance, it can be concluded that the bivoltine hybrid CSR_{16} x CSR_{17} reared on mulberry variety V-1 was the most suitable and economical for rearing under Marathwada conditions.

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