AN OVERVIEW OF POLYVOLTINE SILKWORM BREEDS DEVELOPED AT CSR&TI, MYSORE DURING THE LAST FIVE DECADES

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ABSTRACT: Improvement of silkworm breeds / hybrids for higher cocoon yield is the direct and efficient way to achieve good quality raw silk. Accordingly, over the last fifty years, development of polyvoltine silkworm breeds has played a pivotal role in boosting the silk production in India particularly in three southern states *viz*., Andhra Pradesh, Karnataka and Tamil Nadu. In this direction, contribution of silkworm breeders of Central Sericultural Research and Training Institute CSR&TI), Mysore towards the development of promising polyvoltine silkworm breeds / hybrids is the milestone. Indigenous polyvoltine races though well acclimatized to fluctuating eco-climatic conditions, they are poor in cocoon productivity and silk quality. During the last decade, few polyvoltine silkworm breeds having higher cocoon yield coupled with better silk quality, have been developed. Some of the polyvoltine silkworm breeds / hybrids developed at CSR&TI, Mysore for the last five decades have been compiled in one place and made it available to the scientists and students engaged in sericulture research.

KEY WORDS: *Bombyx mori,* breeding, evaluation, polyvoltine silkworm breeds / hybrids.

Systematic mulberry silkworm breeding programmes started in India during the mid 20th century after the establishment of Central Silk Board and its research and regional institutes. During 1960's, experiments were initiated at Central Sericultural Research and Training Institute (CSR&TI), Mysore with the main objective to improve polyvoltine silkworm breeds resulting in the development of quite a good number of silkworm breeds. Narayanan and his group by utilizing Nan Nung 6D, an exotic bivoltine race as male component with Pure Mysore and crossing with Japanese hybrid, Shungetsu × Hosho developed a few white polyvoltine breeds *viz,* Kolar Gold, Kollegal Jawan and Mysore Princess. Later, Krishnaswami and his group developed Hosa Mysore series during 1973. During the last two decades, promising polyvoltine silkworm breeds namely, MY_1 (Nagaraju et al., 1987), PM (SL) (Nagaraju et al., 1989), MHMP(Y), MY_3, HMN_7, MHN_7, P_2D_1 and P_4D_1 (Noamani et al., 1990), BL_{67}(Rao et al., 2002), ND_5 (Rao et al., 2005), NP_1(Singh et al., 2006), ND_7 (Dandin et al., 2006, 2007) etc. were developed. Of late, promising polyvoltine silkworm breeds have been developed through application of artificial parthenogenesis (Gangopadhyay & Singh, 2008) and androgenesis as a breeding tool (Singh et al., 2009, 2011). Superior silk quality ((2A) grade has been obtained from a recently developed polyvoltine × bivoltine hybrid L_{14} × CSR_2 (Rao et al., 2011).A brief account of some important polyvoltine breeds / polyvoltine × bivoltine hybrids is mentioned below:

1. PM × C. Nichi (Traditional polyvoltine hybrid, 1960 - 1970)

The parental indigenous race Pure Mysore (PM) is characterized by longer larval period and exotic C. Nichi race by lesser larval period and low productivity. PM produces greenish yellow, spindle shaped with more floss percentage (18 – 20 %) and C. Nichi white dumbbell cocoons and high renditta (11 - 12). The silkworm hybrid is low in productivity but well suited for subsistence farming condition, fluctuating temperature and poor hygienic conditions, hence popular among poor farmers. The traditional hybrid is characterized by larval period 18-20 days, cocoon weight 1.1 - 1.2 g, cocoon shell percentage 13 -14 %, filament length 450 - 525 m, raw silk recovery 8 - 9 %, filament size 2.0 d, renditta 12.0 - 13.0 and produces non gradable silk. The hybrid is still popular and suitable for rearing in rain-fed areas and it produces the cocoon yield of 15 - 20 kg / 100 dfls at the farmer level.

Larvae of PM × C. Nichi

Cocoons of PM × C. Nichi

2. PM × KA (1970 - 1972)

Pure Mysore with longer larval period and KA was developed by a Japanese silkworm breeder at Kalimpong, West Bengal through hybridization from a cross between (N_{122} × C_{110}) × (N_{124} × C_{124}). The hybrid is characterized by larval period 23 - 24 days, cocoon weight 1.6 - 1.7 g, cocoon shell percentage 17 - 18 %, renditta 9.0 - 9.5 and produces non gradable silk. The hybrid was popular during 70's and produces cocoon yield of 30 - 35 kg / 100 dfls at the farmer level.

Larvae of PM × KA

Cocoons of PM × KA

3. PM × NN_6D (1970 - 1972)

NN_6D an exotic peanut shaped is characterized by white cocoons. The hybrid is characterized by larval period 24 - 25 days, cocoon weight 1.5 - 1.6 g, cocoon shell percentage 17 - 18 %, renditta 9.0 - 9.5 and produces non gradable silk. The hybrid was popular during 70's and produces cocoon yield of 30 - 35 kg / 100 dfls at the farmer level.

Larvae of PM × NN_6D

Cocoons of PM × NN_6D

4. PM × NB_4D_2 / NB_{18} (1975 - 2000)

Bivoltine silkworm breeds NB_{18} / NB_4D_2 were evolved utilizing Japanese hybrid (Koko × Seihaku) × (N_{124} × C_{124}). The polyvoltine × bivoltine hybrids are better suited for subsistence farming condition, fluctuating temperature and poor hygienic conditions, hence popular among farmers. The hybrids are characterized by larval period 23 - 24 days, cocoon weight 1.6- 1.8 g, cocoon shell percentage 16 - 17 %, filament length 700 - 800 m, raw silk percentage 11 - 1 2 %, renditta 9.0 - 9.5 and produces non gradable silk. The hybrid is suitable for rearing throughout the year and produces cocoon yield of 50 - 60 kg / 100 dfls at the farmer level.

Larvae of PM × NB_4D2 / NB_{18}

Cocoons of PM × NB_4D_2 / NB_{18}

5. Hosa Mysore (HM) × NB_4D_2 / NB_{18} (1970 - 1978)

During 1970's, for the first time an attempt was made to replace the female component (PM) through introduction of a new polyvoltine breed Hosa Mysore (HM) developed at CSRTI, Mysore through hybridization utilizing two polyvoltine breeds PM and A_4E. A_4E is a low productive breed but better than PM and C. Nichi and is characterized by greenish yellow elongated oval shaped cocoons with coarse grains. Sometimes hibernating eggs appear. Poor post cocoon parameters but better than PM and C. Nichi. These hybrids are characterized by larval period 23 - 24 days, cocoon weight 1.6 - 1.8 g, cocoon shell percentage 16 -17 %, filament length 700 - 800 m, raw silk percentage 11 – 12 %, renditta 9.0 - 9.5 and produces non gradable silk. The hybrid is suitable for rearing throughout the year and produces cocoon yield of 50 - 60 kg / 100 dfls at the farmer level. It produces 10 – 15 % higher yield than the existing hybrid PM × NB_4D_2. The hybrid could not be popularized due to frequent crop loss and occurrence of hibernating eggs.

Larvae of HM × NB_4D_2 / NB_{18}

Cocoons of HM × NB_4D_2 / NB_{18}

6. MY_1 × NB_4D_2 / NB_{18} (1984 - 1987)

MY_1 was developed during 1980's utilizing two polyvoltine races Pure Mysore and Nistari. MY_1 is characterized by higher cocoon yield than PM, plain larvae with shorter larval duration and light greenish yellow elongated oval cocoons with coarse grains. Better post cocoon quality parameters than Pure Mysore. It has renditta of 11-12. Hybrid gives higher cocoon yield, shorter larval duration as compared to PM × NB_4D_2. Recommended for rearing in West Bengal, Bihar and Assam. A quantity of 3.0 lakhs dfls tested with farmers showed 15 % improvement in yield over PM × NB_4D_2.

Larvae of $MY_1 \times NB_4D_2$ / NB_{18}

Cocoons of $MY_1 \times NB_4D_2$ / NB_{18}

7. $BL_{23} \times NB_4D_2$ for rain-fed areas (1997)

BL_{23} was developed at CSRTI, Mysore during 1990s. Parentage: (Oval × A_2) × (Oval × Daizo). BL_{23} is characterized by higher cocoon yield than Pure Mysore, plain larvae and greenish yellow elongated oval cocoons with coarse grains. Floss percentage less than Pure Mysore. Post cocoon parameters better than Pure Mysore. Recommended for rain-fed areas of South India. High renditta (10 - 11). $BL_{23} \times NB_4D_2$ is characterized by robust larvae, high cocoon shell weight, high silk content, long filament length and better neatness with higher reelability as compared to PM × C Nichi. Larvae are plain and bluish white in colour. Cocoons are light greenish-yellow and intermediate in shape. Total larval duration is 22 - 23 days. Higher yield than existing hybrid PM × C. Nichi. Floss with reference to cocoon shell is less (4.8 %). Recommended for rain-fed areas. A quantity of 12,000 dfls of $BL_{23} \times NB_4D_2$ was tested with farmers showed 58 % improvement in cocoon yield compared to PM × NB_4D_2.

Larvae of $BL_{23} \times NB_4D_2$

Cocoons of $BL_{23} \times NB_4D_2$

8. PM × CSR_2 (Kolar Gold) (1999)

Realizing the productivity potential of bivoltine CSR breeds, CSR_2 was crossed with Pure Mysore and released in the field in the name of **Kolar Gold** and gained wide acceptance by the sericulturists of South India.

The hybrid is characterized by robust larvae. Higher reelability as compared to PM × NB_4D_2. Larvae are plain and bluish white in colour. Cocoons are light greenish-yellow hybrid cocoons with oblong shape gives higher yield than existing hybrid, PM × NB_4D_2.

Larvae of PM × CSR_2

Cocoons of PM × CSR_2

9. $BL_{43} \times NB_4D_2$ (Kapila) for irrigated areas (2002)

BL_{43} was developed during 1990's. Parentage: Pure Mysore, Hosa Mysore and Nistari. BL_{43} is characterized by higher cocoon yield than Pure Mysore, plain larvae and greenish yellow elongated oval cocoons with coarse grains. Less floss

percentage and post cocoon parameters better than Pure Mysore. Recommended for irrigated areas of South India. Renditta (9-11).

$BL_{43} \times NB_4D_2$ (Kapila) is characterized by robust larvae, high cocoon shell weight, high silk content, longer filament length and better neatness and reelability. Larvae are plain and bluish white in colour. Cocoons are light greenish-yellow and intermediate in shape. Total larval duration is 22 - 23 days. Renditta is about 8. Produces 10 - 15% higher cocoon yield than PM × NB_4D_2. Central Silk Board authorized the hybrid for commercial exploitation during the year 2002.

Larvae of $BL_{43} \times NB_4D_2$

Cocoons of $BL_{43} \times NB_4D_2$

10. Cauvery ($BL_{67} \times CSR_{101}$) for irrigated areas (2005)

BL $_{67}$ was developed during 1990's. parentage: $BL_{24} \times BL_{27}$. Higher cocoon yield than Pure Mysore. BL_{67} is characterized by plain larvae and light greenish yellow elongated oval shaped cocoons with medium to coarse grains. Less floss percentage with renditta ranging from 8 – 9. Post cocoon parameters better than Pure Mysore. Recommended for irrigated areas of South India.

The polyvoltine × bivoltine hybrid **Cauvery ($BL_{67} \times CSR_{101}$)** has been identified with better productivity, high silk recovery and less renditta (6.5 - 7.0). The cocoons fetched higher rate of Rs. 15 - 20 per kg with A - 2A grade silk as compared to PM × NB_4D_2. Recommended for irrigated areas of South India. Tolerant to high temperature and BmNPV. A quantity of 1,00,467 dfls tested with 483 farmers of Karnataka, Tamil Nadu and Andhra Pradesh during 2001 - 03 recorded an average yield of 55.18kg / 100 dfls as against 46.0 kg in PM × NB_4D_2.

Larvae of $BL_{67} \times CSR_{101}$

Cocoons of $BL_{67} \times CSR_{101}$

11. BL_{24} × C Nichi (Varuna) polyvoltine hybrid for rain-fed areas (2005)

In order to replace the existing PM × C. Nichi in rain-fed areas, a new polyvoltine hybrid **Varuna (BL_{24} × C. Nichi)** with high survival and better productivity has been developed. The average cocoon yield is 31 kg / 100 dfls and renditta of 10 - 11 as compared to 23 kg / 100 dfls and 12 - 13 renditta in PM × C. Nichi. Cocoons of the hybrid fetched Rs. 8 - 10/- more per kg as compared to the control PM × C. Nichi.

The hybrid is characterized by robust larvae, high cocoon shell weight, high silk content, long filament length and better neatness with higher reelability as

compared to PM × C. Nichi. Larvae are plain and bluish white in colour. Cocoons are light greenish-yellow in colour and intermediate in shape. Higher yield than existing hybrid PM × C. Nichi. Recommended for rain-fed areas of South India.

Larvae of BL_{24} × C Nichi

Cocoons of BL_{24} × C Nichi

12. Jayalakshmi (ND_7 × CSR_2 - For irrigated areas) (2007)

Concerted efforts have been made to develop polyvoltine breeds with better fibre quality. This has resulted in the development of a promising polyvoltine breed ND_7 with better fibre quality and productivity. The breed was tested with all authorized CSR breeds and hybrids and one hybrid **ND_7 × CSR_2** was found promising and christened as "Jayalakshmi".

The hybrid is characterized by high pupation rate 90 %, cocoon weight 1.962 g, cocoon shell weight 41. 3 cg, cocoon shell percentage 21 %, filament length 900 m, renditta 6.5 and neatness 90 points. The hybrid was tested under large scale trials with the farmers. Testing of 2.0 lakhs dfls with the farmers of Karnataka, Tamilnadu and Andhra Pradesh recorded an average yield of 63.40 kg / 100 dfls. Presently the hybrid is undergoing Race Authorization Test of Central Silk Board.

Larvae of ND_7 × CSR_2

Cocoons of ND_7 × CSR_2

13. D_1 × CSR_2 (For rain-fed areas) (2007)

D_1 polyvoltine silkworm breed is characterized by marked larvae, dark greenish yellow, spindle shaped cocoons and hibernating eggs. The new hybrid was evaluated in the laboratory and found promising in respect of economic characters. D_1 × CSR_2 is suited to the rain-fed areas. The hybrid is characterized by high pupation (95%) cocoon weight (1.6 - 1.7 g), cocoon shell weight (0.30 - 0.33 g), cocoon shell percentage (18 - 19%), longer filament length (700 -750m), Reelability (85%) and renditta (7 - 8) as against 90%, 1.00 - 1.10g, 0.125 - 140 g, 12.5 - 12.7 %, 400 - 450m, 80% and 11-12 in PM × C. Nichi. Further the hybrid is characterized by shorter larval duration of 20 days compared to 22 days in PM × C. Nichi. A quantity of 5,560 dfls of D_1 × CSR_2 has been distributed to the farmers in Chamarajanagar area through RSRS, Chamarajanagar during 2006-07. Data indicated an average yield of 42.5 kg / 100 dfls and a cocoon rate of Rs.115 / kg in D_1 × CSR_2 compared to 28.75 kg and Rs.88=60 in PM × C. Nichi and an improvement of 47% in cocoon yield was recorded.

Larvae of $D_1 \times CSR_2$

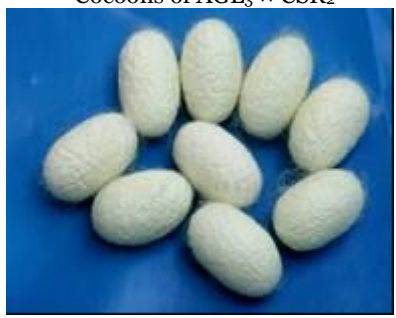
Cocoons of $D_1 \times CSR_2$

14. $AGL_3 \times CSR_2$ (2008)

A polyvoltine silkworm breed "AGL_3" was developed by using dispermic androgenesis. The breed was developed by crossing F_2 males derived from a polyvoltine hybrid $BL_{68} \times BL_{69}$ with another polyvoltine race "Nistari" and exposing the eggs at 38 ºC for 200 minutes. Laboratory evaluation showed superiority of the hybrid $AGL_3 \times CSR_2$ in terms of higher fecundity, pupation rate, yield/10,000 larvae by weight, cocoon shell weight, cocoon shell percentage, filament length and neatness. The hybrid exhibited maximum average evaluation index value and manifested high hybrid vigour for several characters. The cocoons obtained from the new hybrid fetch more price which is more than 20 rupees as compared to the control ($PM \times CSR_2$). The hybrid was tested on farm trials through the nested units of CSRTI, Mysore. Large scale trials have recorded an average cocoon yield of 71.945 kg/100 dfls as against 68.643 kg in the control. The striking features of the new hybrid are that it produces cocoons with high cocoon shell weight, cocoon shell percentage, filament length and neatness.

Larvae of $AGL_3 \times CSR_2$

Cocoons of $AGL_3 \times CSR_2$



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