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Vinayak Hosamani
P2 Basic Seed Farm, National Silkworm Seed Organization, Central Silk Board, Nagenahally, Kunigal, Karnataka, India

K Sashindran Nair
National Silkworm Seed Organization, Central Silk Board, BTM Layout, Madivala, Bangalore, Karnataka, India

KK Sharmila
P2 Basic Seed Farm, National Silkworm Seed Organization, Central Silk Board, Dharmapura, Karnataka, India

VK Harlapur
National Silkworm Seed Organization, Central Silk Board, BTM Layout, Madivala, Bangalore, Karnataka, India

CR Hegde
Seed Cocoon Procurement Centre, National Silkworm Seed Organization, Central Silk Board, Kunigal, Karnataka, India

RK Mishra
National Silkworm Seed Organization, Central Silk Board, BTM Layout, Madivala, Bangalore, Karnataka, India

Corresponding Author:
Vinayak Hosamani
P2 Basic Seed Farm, National Silkworm Seed Organization, Central Silk Board, Nagenahally, Kunigal, Karnataka, India

Quality assessment of multivoltine silkworm (*Bombyx mori* L.) pure Mysore through mulberry genotypes in Kunigal seed area of Karnataka

Vinayak Hosamani, K Sashindran Nair, KK Sharmila, VK Harlapur, CR Hegde and RK Mishra

Abstract
Mulberry silkworm (*Bombyx mori* L.) is an economically important insect which has been domesticated for centuries for the purpose of obtaining silk, the most sought after natural fibre. Mulberry is the sole food plant of *B. mori* and hence cultivated extensively for production of leaves. Quality of the silk largely depends on the mulberry leaves that the silkworm feeds on. Since the crop performance of the silkworm is highly dependent on the quality of the mulberry leaves, it is pertinent to know the nutritional status of the leaves. An experiment was therefore conducted at P3/P2 Basic Seed Farm Nagenahally, during *kharif* 2018-19 to study the influence of mulberry genotypes on growth and yield components of multivoltine silkworm Pure Mysore, *B. mori*. The experimental results revealed significantly high weight of larvae (26.67 g/10 larvae), yield per 100 dfls by number and weight (40168 and 46.11 kg respectively), cocoon weight (1.148 g), cocoon shell weight (0.173 g), shell percentage (15.11) and pupation percentage (97.00) with the mulberry genotype V1 compared to the genotypes G_4 and S36 whereas lower larval duration (29.07 days) & number of cocoons per kg (870) were significatly low. The study recommends V1 as the most suitable mulberry genotype for raising Pure Mysore silkworm in the Kunigal Seed area of Karnataka among the three popular mulberry genotypes, followed by the next best genotype of G4.

Keywords: *Bombyx Mori*, cocoon, genotypes, mulberry, silkworm

Introduction
Silk, a highly priced agricultural commodity, accounts for about 0.2% of the total world production of textile fibres. Since sericulture stands next to agriculture in rural employment in India, it becomes a matter of great importance to examine the sericulture production trend over the years and the reasons for its tepid growth. Sericulture is an agro-based rural industry having tremendous employment and foreign exchange earning potential. About 4 million people are engaged directly or indirectly in sericulture activity in India (Chowdhary, 1984) [4]. India are at the second position in annual silk production clocking a production of 35261 MT as per the latest statistics (2018-19). India are the only country in the world having the distinction of having all the four types of silkworms *viz*., mulberry silkworm (*Bombyx mori* L.), tasar silkworm (*Antheraea mylitta*), eri silkworm (*Philosamia ricini*) and muga silkworm (*Antheraea assamensis*). Out of the total raw silk produced by India, 71.55 % (25231 MT) is of mulberry silk. Mulberry plant (*Morus alba*) is the sole food plant for silkworm, *B. mori* and is a native of Indo-China region, particularly the lower slopes of Himalayas. The components of the mulberry leaf vary according to the genotypes. However, it is fairly well understood that the growth and development of silkworm and the quality of the cocoon produced mainly depend on factors such as silkworm variety, quality of mulberry leaf (nutritional) and the rearing management (Yokoyama, 1963; Bongale and Chaluvachari, 1995) [17, 1]. It is an established fact that superiority of mulberry variety used as food for silkworm larvae greatly affects the economy of sericulture industry (Das and Sikdar, 1970) [5]. Nutritive value of mulberry leaf is a key factor besides environment and technology adoption for better growth and development of the silkworm larvae and cocoon production. Having said that, Matsumara (1951) and Bose (1989) [10, 3] made it amply clear that, among the various factors influencing silkworm growth and cocoon production, leaf quality plays the most important role. Hence, it is advisable to choose mulberry variety suitable for a particular set of condition with regard to its nutritional superiority to increase cocoon production and to reduce the cost on labour (Ravikumar, 1988) [13].

Selection of the best mulberry genotype with high nutrient and moisture content until the leaf harvest is a deciding factor that affects the crop quality and quality of silk. Selection of a genotype is one of the earliest and most important decisions a sericulture farmer makes at the time of garden establishment. He is forced to live with this single early decision for many years since mulberry is a perennial crop. So, the profit potential of the mulberry garden and cocoon crop is in fact decided to an extent even before mulberry is planted. Considerations are personal for each producer, encompassing not only yield and quality but also the characteristics of the genotype and management practices relevant to the region where it is planted.

Although India as a sericulture country has been moving at a faster pace towards bivoltine sericulture owing to its obvious advantages, 72.53 % (18302 MT) of *Bombyx* silk produced in the year 2018-19 was still that of cross breed. Cross breeds such as PM x CSR2 and PM x FC2 with Pure Mysore as the maternal parent are predominant across India, making it amply clear that Pure Mysore as a multivoltine race will remain very relevant for many years to come. Hence, the investigations were aimed at evaluating the popular mulberry genotypes of recent years suitable for rearing Pure Mysore race of silkworm in the notified Pure Mysore seed area of Karnataka.

Materials and Methods

The experiment was carried out at the regularly irrigated mulberry farm of Multivoltine Basic Seed Farm, Nagenahally, Kunigal, National Silkworm Seed Organization, Central Silk Board during the year 2018-19. The experiments were laid out on red sandy soil in fixed sites. Composite soil sample was collected from experimental site from the top 30 cm depth before initiation of the experiment. The entire soil characteristics in the experimental site were optimum. Organic carbon was medium (0.76). Status of the available soil nitrogen, phosphorus and potassium was low (110 kg ha^{-1}), high (70.02 kg ha^{-1}) and medium (179.2 kg ha^{-1}), respectively.

The experiment consisted of three treatments such as V1, S36 and G4 mulberry genotypes and replicated seven times. All the agronomic inputs were applied to each genotype after pruning as per the package of practices recommended by Central Sericultural Research & Training Institute (CSRTI), Mysore. Pure Mysore silkworm was used as an experimental material by feeding them with leaves of mulberry genotypes as stated above. In the present study, cellular experimental rearing was conducted *i.e*, the eggs laid by one moth referred to as one disease free laying (dfl). Each such dfl formed a replication of a treatment. Silkworm rearing was conducted by following standard procedure developed by CSRTI, Mysore. Silkworms were fed three times a day at 5 a.m., 12 noon and 7 p.m as proposed by Krishnaswami, 1978 and Rajan *et al.*, 2001 [9, 12]. The temperature regime during young stage and late stage larval growth were 28 ± 1°C and 25± 1°C and the humidity was 85± 5 % and 70 ± 5 %, respectively. Rearing was carried out in ventilated plastic trays measuring 60 x 90 cm and for each replicate, 300 larvae were maintained after the third ecdysis. The mean observations on the quantitative parameters per replication taken from the experiment at different stages were subjected to statistical analysis (Gomez and Gomez, 1984) [7] at P = 0.05 and means were compared using Duncan's Multiple Range Test (DMRT) using SPSS 16.0 version. Third order interactions were presented and discussed.

Results

Results of the investigation on influence of mulberry genotypes on growth and yield components of the multivoltine silkworm, Pure Mysore in the Basic Seed Farm, Nagenahally, Kunigal are presented. The experimental results revealed statistically significant variations in moulting and rearing characters of Pure Mysore silkworm (Table 1 & 2). Among the treatments, the silkworms fed with V1 mulberry leaf recorded the highest hatching percentage (95.39 %), larval weight (26.67 g/10), cocoon weight (1.148 g), cocoon shell weight (0.173 g), yield per 100 dfls by number and weight (40168 and 46.11 kg), pupation percentage (97.00) and shortest larval duration (29.07 days) and lowest number of cocoons per kg (870), while that fed with the variety S36 recorded lowest hatching percentage (95.03) larval weight (25.11 g/10), cocoon weight (1.126 g), cocoon shell weight (0.175 g), yield per 100 dfls by number and weight (38903 & 43.20 kg), pupation percentage (95.81) and longest larval duration (30 days) and highest number cocoons per kg (887). Interestingly, the results with the genotype G4 which was released recently in the year 2013-14 was almost on par with that of the genotype V1 which was released during 1997 in all the quality parameters like larval duration (29.28 days), larval weight (26.57g), cocoon weight (1.145 g), cocoon shell weight (0.172 g), cocoon per kg (873), yield per 100 dfls (39830 & 45.52 kg) and pupation percentage (96.31).

Table 1: Rearing performance of Pure Mysore silkworm, *B. mori* on three different mulberry genotypes

Mulberry genotype	Fecundity (No.)	Hatching percentage	Larval duration (Days)	Weight of larvae in g (10 no.)	Cocoon weight (g)	Shell weight (g)	Shell Percentage
G4	493	95.37^{b}	29.28^{a}	26.57^{a}	1.145^{a}	0.172^{b}	15.02^{b}
V1	493	95.39^{b}	29.07^{a}	26.67^{a}	1.148^{a}	0.173^{b}	15.06^{b}
S36	492	95.03^{a}	30.00^{b}	25.11^{b}	1.126^{b}	0.175^{a}	15.54^{a}
S.Em.±	0.001	0.002	0.17	0.13	0.002	0.0001	0.001
C.D. at 5%	NS	NS	0.54	0.43	0.006	0.002	0.003
C.V	0.23	0.15	1.55	1.40	0.53	0.35	0.48

Table 2: Yield parameters of Pure Mysore silkworm, *B. mori* when reared on three different mulberry genotypes

Mulberry genotype	Yield per 100 dfls by no.	Yield per 100 dfls by weight (kg)	Cocoons per kg (no.)	Pupation Percentage
G4	39830^{a}	45.52^{b}	873^{b}	96.23^{a}
V1	40168^{a}	46.11^{a}	870^{b}	97.00^{a}
S36	38903^{c}	43.20^{c}	887^{a}	95.81^{c}
S.Em.±	147.76	0.17	1.45	0.03
C.D. at 5%	460.36	0.53	4.52	0.09
C.V	0.986	1.00	0.43	2.31

Discussion and conclusion

Silk, a highly priced agricultural commodity, accounts for about 0.2% of the total world production of textile fibre. The mulberry silk worm, *Bombyx mori* is an economically important insect which has been domesticated for centuries for the purpose of obtaining silk. In India, there are 12.47 lakh farmers involved in raising *Bombyx* silkworm. They raise the silkworms indoor on the mulberry foliage following the latest and appropriate technologies. At the end of the feeding phase, the larvae build the silk cocoons. The cocoons are harvested by the farmers on pupae formation and sell it to silk reelers who reel out the silk yarn.

The quality and the quantity of the cocoon crop and the silk yarn are directly dependent on the quality and quantity of mulberry leaf consumed by silkworm larvae. This in turn means that the growth and development of silkworm *B. mori* ought to vary depending on the quality of mulberry leaf used as food source (Das and Sikdar, 1970 [5]; Krishnaswami *et al*., 1970 [9]; Koul *et al*., 1979 [8]; Tayade and Jawale, 1984) [15]. Hence it becomes pertinent to know the quality of mulberry variety chosen for a silkworm crop and its yield potential. Since the multivoltine silkworm race, Pure Mysore still remains as the lifeline of Indian Sericulture due to its contributions as the maternal parent to the famed combination, PM x CSR2, identification of the suitable mulberry genotype from the available resources, from time to time is relevant.

Several reports are available on the evaluation of mulberry varieties through silkworm rearing performances (Narayanan *et al*., 1966; Das and Vijayaraghavan, 1990) [11, 6]. It is quite evident that tender, succulent and nutritious leaves favour good growth and development in young stage silkworms whereas progressively mature leaves with less moisture content are required for late stage silkworms. In the present investigation, the rearing performance of silkworm reared on V1 genotype excelled in all cocoon characters and other economically important rearing parameters in comparison with the other two genotypes, S36 and G4 when the conditions offered were same. This superiority is indicative of the quick sprouting ability, capacity of absorbing the available resources quickly, high yielding ability and more nutritive value of the leaf (78 % moisture, 27 % protein and 26 % carbohydrate) of V1 genotype. From the results, it is also evident that the genotype G4 was very close to V1 in all the quality parameters, probably due to its better adaptation to irrigated condition, faster growing and high branching ability, rich chlorophyll content in leaves, unlobed and high rooting ability and higher nutritional content (75 % moisture, 26 % protein and 25 % carbohydrate).

It can be concluded that the rearing performance of Pure Mysore silkworm was better when fed with the leaves of V1 genotype. This was followed by that on G4 mulberry genotype. Cocoon characters recorded with the leaves of V1 and G4 mulberry genotypes were promising. Leaves of both these genotypes supported good growth and development in Pure Mysore silkworm larvae, which is reflected in better cocoon characteristics. Thus, V1 mulberry genotype could be the first choice to the farmers belonging to Kunigal Seed Area for rearing Pure Mysore silkworm among the three popular mulberry genotypes as evident from the present study and G4 mulberry genotype could be the next best option.

Plate 1: Layout of an experiment with three treatments (varieties and seven replications) in rearing room

Plate 2: Cocoons harvested from the three different mulberry varieties

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