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Assessment of six Mulberry (*Morus*) Germplasm varieties through Moulting and Bioassay parameters by using Crossbreed Silkworms *Bombyx mori* L. for Commercial Exploitation in Kolar District, Karnataka, INDIA

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Abstract

A critical assessment study comprising six mulberry germplasm varieties viz., Tr_8, Tr_{12}, Tr_{20}, Matigara black, Morus nigra and M_5 was conducted at Bethamangala village in Bangarpet taluk, Kolar district for their leaf quality through economic characters of silkworms. Silkworm rearing experiments were performed using crossbreed (PM x NB_4D_2) silkworms. Taxa studied differ significantly in respect of moulting and bioassay trials. Moulting test results revealed that, silkworm larvae reared on Tr_8 mulberry leaves recorded highest values and lowest values were recorded in silkworm larvae reared on Morus nigra leaves both in I and II moult respectively. Silkworm rearing performance revealed that, silkworms reared on Tr_8 mulberry leaves proved better and lower values were observed in silkworms reared on Morus nigra leaves in all the bioassay parameters. From the results, it is proved that, mulberry variety Tr_8 turns out to be a superior in moulting and bioassay tests compared to other varieties studied under the same agro climatic conditions.

Keywords: Mulberry genotypes, evaluation, *bombyx mori*, cocoon characters, feeding.

Introduction

Silkworm *Bombyx mori* L. is an economically important insect used for silkworm rearing and silk production essentially a monophagous insect feeds solely on mulberry leaves (*Morus* spp.) as the sole natural food. Silkworm larval growth and development and cocoon crop yield are mainly influenced by yield and nutritional quality of mulberry (*Morus* spp.) leaf used as feed[1-4]. Evaluation of mulberry plants aimed at selecting superior varieties for rearing performance mainly depends on leaf quality[5]. It is a known fact that, around 60% of the total cost of cocoon production goes towards mulberry production alone in sericulture. Hence, in recent years maximum attention has been given for the improvement of mulberry in terms of both quality and quantity[6]. Quality of mulberry varieties fed for silkworms plays a vitol role in the economy of sericulture industry[7]. Among the various factors influencing silkworm growth and cocoon production, leaf quality plays a major role[8,9]. It is a confirmed fact that, leaf quality differs among mulberry varieties which in turn responsible for the difference in silkworm rearing performances[10]. Increased production of superior quality mulberry leaves with high nutritive value enhances the chances of good cocoon crop and successful sericulture[11,12]. In the present experiment an attempt has been made to screen better performing mulberry variety through silkworm rearing experiment in Kolar district is one of the premier and traditional sericulture belt accounts for 40% of the total raw silk production in Karnataka state.

Material and Methods

In the present study mulberry varieties like Tr_8, Tr_{12}, Tr_{20}, *Matigara black*, *Morus nigra* and M_5 were used. M_5 mulberry variety is used as a check variety for the comparison purpose. Cuttings of these varieties were procured from CSGRC, Hosur, Tamil Nadu, India and disease free cross breed (PM x NB_4D_2) egg layings obtained from National Silkworm Seed Project (NSSP), Bangalore, Karnataka were used. Mulberry plants were grown in field at Bethamangala village in Bangarpet taluk Kolar district of Karnataka state as it is shown in figure 1. Experiment was conducted in RBD method with 4 replications / variety. Two years old plants were used for silkworm rearing from time to time in different season's viz., summer, rainy and winter and the average values were tabulated in tables.

Silkworm Moulting: Moulting test was carried out up to 2nd moult following standard rearing methods with four replications/variety and 100 larvae/replication. Tender leaves (1st-4th order) on healthy shoots were harvested and fed to young age silkworm larvae up to second moult[13]. Silkworm rearing was conducted under standard conditions[14,15]. Daily three

feedings were given at 7am, 2pm and 10pm from brushing to end of II moult with tender, succulent and nutritious leaves. First appearance of one larva out of moult was considered as commencement of moulting[16]. Comparative moulting ratio with respect of all the varieties leaves under evaluation was fixed depending on time duration which recorded more than 50% of the larvae under moult. Larval weight was also recorded.

Silkworm Rearing: As in figure 2, Silkworm rearing was conducted to test the efficiency of selected mulberry varieties. Rearing experiments were conducted at different seasons (rainy: July-August, winter: Nov-Dec, summer: March-April). For each mulberry variety, one egg laying was reared and four replications were maintained. After III moult, about 100 larvae / replication were maintained. Appropriate cellular rearing techniques were adopted and separate rearing trials were conducted for different varieties[17,18]. Leaves were harvested during cooler hours of the day and preserved in wet gunny cloth till the feeding time. Larvae were fed three times daily (7am, 2pm, 10pm) with healthy, fresh mulberry leaves. Young age larvae were fed with tender, succulent and nutritious leaves which are known to favour the growth and development of chawki silkworms, while mature and coarse leaves were fed to larvae when they grow till ripening. Cocoons shown in figure 3 were collected on 5th day of mounting and were assessed for commercial cocoon characters. Standard methods employed for the assessment of cocoon quality[19].

Statistical Analysis: Data collected on various parameters were tabulated and subjected to critical statistical analysis by adopting 'Method of Analysis of Variance' appropriate to the design of the experiment[20,21].

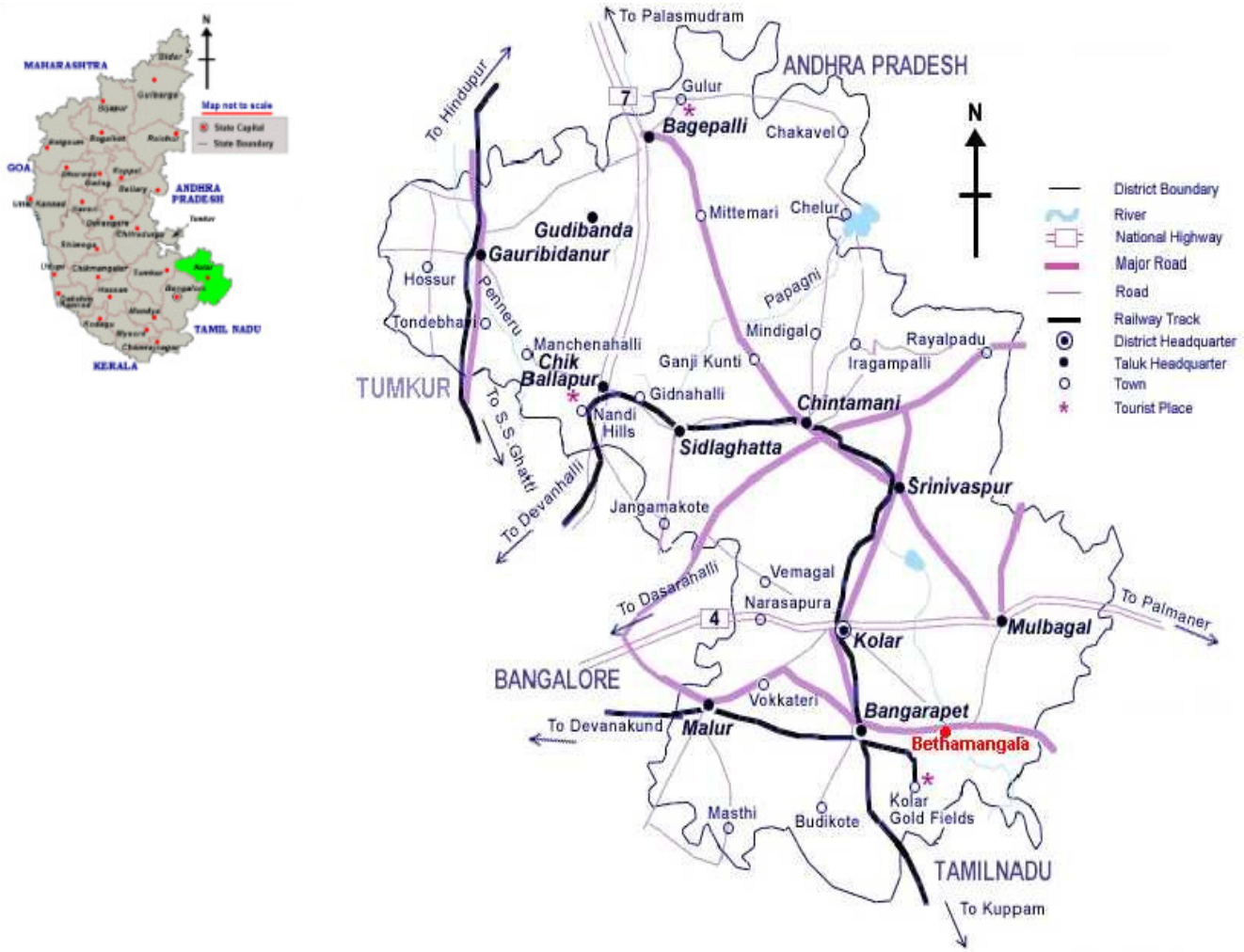

Figure-1
Map showing location of experimental area: Bethamangala in Kolar District

Results and Discussion

Silkworm (*Bombyx mori* L.) larval growth and development is vary depending on the quality and quantity of mulberry leaf used as food source, which in turn indicated by commercial characteristics of cocoon crop[22,23,24,25]. Several reports are available on the evaluation of mulberry varieties through silkworm rearing performances[26-29]. It is quite evident that tender, succulent and nutritious leaves are known to favour the good growth and development of young age silkworms whereas progressively mature leaves with less moisture content are required for late age silkworms[30].

Figure-2
5th instar Crossbreed (PM X NB_4D_2) Silkworms

Figure-3
Crossbreed (PM X NB_4D_2) Cocoons

Silkworm Moulting: Highly significant differences were observed in larval weight and moulting ratio in silkworm larvae fed with selected mulberry varieties as shown in table 1. Silkworms reared on Tr_8 leaves revealed highest single larval weight (4.02mg) and moulting ratio (74.97%) and lowest single larval weight (2.74mg) and moulting ratio (66.04%) was observed in *Morus nigra* leaves in I moult. In II moult, high single larval weight (23.90mg) and moulting ratio (83.70%) was observed in silkworms reared on Tr_8 leaves and lowest single larval weight (15.94mg) and moulting ratio (70.04%) was recorded in *Morus nigra* leaves. Degree and uniformity of moulting varies with mulberry leaf quality that favours the higher moulting ratio, ensures better growth rate and silkworm larval weight. It was reported that, higher proteins and lower sugars in S_{41} variety supported high larval weight and moulting ratio[31,32]. Lower larval weight and moulting ratio in Mysore local variety were associated with lower leaf moisture content and moisture retention ability. It was recorded that, 89.16% and 92.82% moulting ratio in PM x NB_4D_2 and NB_{18} x NB_7 races respectively with S_{54} mulberry genotype leaves[33]. When CB and BV larvae fed on Tr_{10} and MR_2 mulberry varieties leaves have showed higher moulting ratio and larval weight[34]. Mulberry genotypes S_{30}, S_{36} and Vishwa were superior over M_5 genotype in moulting ratio and larval weight[35].

Silkworm Rearing: Results revealed that, highly significant differences were observed in bioassay parameters and cocoon characters of silkworms reared on mulberry varieties as tabulated in table 2. Weight of ten 5th instar larvae (36.95g) was found significantly higher in silkworms reared on Tr_8 leaves and lower larval weight (27.86g) was recorded in silkworms reared on *Morus nigra* leaves. Single cocoon weight (1.71g) was higher in cocoons obtained from silkworms reared on Tr_8 leaves. However, significantly lower cocoon weight was (1.38g) registered in silkworms reared on *Morus nigra* leaves. Shell weight and percentage were significantly high in cocoons obtained from silkworms rearing on Tr_8 leaves (0.35g and 21.18% respectively) while the cocoons obtained by rearing silkworms on *Morus nigra* leaves recorded lower shell weight and shell weight percentage (0.23g and 16.24%) respectively. Filament length and reelability percentage was significantly high in cocoons obtained from silkworms reared on Tr_8 leaves (926.81mts, 77.50% respectively). Lower filament length and lower reelability was recorded in cocoons harvested from silkworms reared on *Morus nigra* leaves (786.32mts, 59.69%). Significantly lower renditta (6.68) was recorded in the cocoons procured from silkworms reared on Tr_8 leaves, while higher renditta (7.86) was found in the cocoons recovered from silkworms reared on *Morus nigra* leaves. Finer denier was recorded in cocoons procured from silkworms reared on Tr_8 leaves (2.16) while cocoons procured from silkworms reared on *Morus nigra* leaves (2.82) produced coarser denier. Effective rate of rearing was significantly higher in silkworms reared on Tr_8 leaves (87.04%) and lower effective rate of rearing was recorded in silkworms reared on *Morus nigra* leaves (79.25%).

Berhampore variety was better than Kosen and Mandalaya with regard to effective rate of rearing and cocoon weight[22]. Mulberry variety Catteneo was found best in silkworm rearing trials compared to $Burmose_2$, Tsukasakhu and Local mulberry varieties[36]. Mulberry variety S_1 showed distinct varietal effect

on all economic characters[37]. Mulberry variety S_{54} recorded higher values in rearing parameters and coon yield[38]. S_{41} and S_{54} mulberry varieties supported good larval growth and recorded high cocoon weight compare to cocoons obtained from S_{36} while Mysore local and $Kanva_2$ registered lowest cocoon weight[39]. Mulberry variety S_{54} was found to be superior followed by S_{41} and $Kanva_2$ for feeding silkworms[40,41]. Feeding of Ichinose leaves to silkworms resulted in higher cocoon characters compared to other two varieties[42]. Silkworm larvae fed with $Kokuso_{27}$ variety leaves revealed best results among other varieties studied[43]. Mulberry variety S_{30} showed better performance than S_{36}, S_{41} and K_2 for commercial characters of bivoltine cocoons[44]. Mulberry variety S_{36} was found superior in silkworm rearing trials and recorded highest cocoon yield, ERR and shell percentage[45]. Among the seven mulberry cultivars tested for rearing parameters by using bivoltine silkworms and observed that, C_{763} performed best followed by S_{1630} and C_{1730} mulberry varieties[46].

Silkworm breeds (PM x NB_4D_2) and (NB_4D_2) performed well when both the races larvae reared on M_5 mulberry variety leaves[47,48]. Mulberry variety RFS_{175} was found superior in silkworm rearing trials with maximum cocoon production[49]. It was reported that, mulberry variety S_{1635} was found superior in silkworm rearing trials with good commercial characters of cocoons when compared to all other varieties examined[50,51,52]. Mulberry varieties Tr_{10} and MR_2 were found superior as they secured maximum scores for silkworm races CB (PM x NB_4D_2) and BV (NB_4D_2) in rearing tests[53]. According to many scientists rearing performance of silkworm races differed significantly when they are subjected to same conditions, some of them performed better and poor performance by some races[54,55,56]. Present study also confirms the same as S_{1708} mulberry variety gives better results in pre-cocoon and post-cocoon characters when compared to other varieties tested. Among eight mulberry varieties i.e. S_1, S_{146}, S_{1635}, AR_{12}, AR_{14}, TR_{10}, BR_2 and K_2 evaluated for nutritional potential by silkworm rearing experiments, silkworms reared on BR_2 leaves showed higher larval weight and cocoon parameters compared to other varieties[57]. Out of the ten mulberry varieties like Tr_8, Tr_{12}, Tr_{20}, S_{1708}, MS_5, *Matigara black*, C_6, C_{10}, *Morus nigra* and M_5 varieties screened for their nutritional superiority through bioassay experiments, bivoltine (NB_4D_2) silkworm reared on S_{1708} and Tr_8 leaves recorded significantly high moulting ratio, high larval weight and commercial cocoon parameters compared to other varieties[58]. Three silkworm races namely EC_1, EJ_1 and EJ_2 were evaluated for their growth and productivity by feeding them with S_{36} mulberry leaves and reported that, EJ_2 silkworms showed a higher and consistent growth rates compared to other silkworm races for all the developmental stages[59]. Rearing performance of bivoltine silkworm hybrid NB_4D_2 x SH_6 reared during spring season revealed good performance in respect of cocoon parameters such as single cocoon weight (1.81g) and shell weight (0.384g)[60]. Cocoon weight and shell weight are the most important characters evaluated for productivity[61]. Shell weight percentage indicates the amount of raw silk can be reeled from the given quantity of fresh cocoons and shell weight percentage varies according to age and breed of silkworm. Total silk filament length is ranging from 600m-1500m out of which only 80% is reelable[62]. In the present study, silk filament length of cocoons recovered from silkworms reared on different mulberry varieties falls within this range and cocoons recovered from silkworms reared on Tr_8 mulberry variety leaves produced longest filaments length with lowest denier.

Table-1
Crossbreed silkworms (PM X NB_4D_2) moulting performance on different mulberry varieties

Mulberry varieties	I Moult		II Moult	
	Single larval weight (mg)	Moulting ratio (%)	Single larval weight (mg)	Moulting ratio (%)
Tr_8	4.02	74.97	23.90	83.70
Tr_{12}	3.95	74.60	23.51	82.81
Tr_{20}	3.72	73.63	23.30	81.88
Matigara black	3.10	71.80	21.19	77.85
Morus nigra	2.74	66.04	15.94	70.04
M_5	3.66	72.81	22.59	80.78
CD @ 5%	0.01	0.03	0.03	0.03

Table-2
Crossbreed silkworms (PM X NB_4D_2) bioassay performance on different mulberry varieties

Mulberry varieties	Weight of 10 5^{th} instar larvae(g)	Single cocoon weight (g)	Single shell weight (g)	Shell weight percentage (%)	Filament length (mts)	Reelability percentage (%)	Renditta	Denier	ERR (%)
Tr_8	36.95	1.71	0.35	21.18	926.81	77.50	6.68	2.16	87.04
Tr_{12}	34.95	1.64	0.35	20.25	879.16	76.25	6.96	2.29	83.68
Tr_{20}	33.38	1.63	0.32	19.81	860.43	75.00	7.25	2.38	86.40
Matigara black	29.10	1.45	0.26	17.71	804.73	62.50	7.66	2.71	82.59
Morus nigra	27.86	1.38	0.23	16.24	786.32	59.69	7.86	2.82	79.25
M_5	32.16	1.54	0.30	19.59	830.86	97.50	7.28	2.50	84.56
CD @ 5%	0.36	0.05	0.01	0.37	19.01	7.06	0.09	0.02	0.14

Conclusion

It is evident from the present studies that, moulting ratio, silkworm larval weight and rearing performance of crossbreed silkworms is significantly high when silkworms fed with Tr_8 mulberry variety leaves. Commercial cocoon characters like finer denier, lower renditta were recorded high in cocoons procured from silkworms reared on Tr_8 leaves compared to other mulberry varieties studied. Next to Tr_8 variety, Tr_{12} and Tr_{20} varieties were proved promising followed by check variety M_5. These varieties leaves supported good growth and development of silkworm larvae,that reflected in better commercial cocoon characteristic features. Mulberry varieties *Matigara black* and *Morus nigra* occupied the last place in bioassay results. From the results, it is concluded that, Tr_8 mulberry germplasm variety turns out to be a superior in moulting and bioassay tests compared to other varieties studied under the same agro climatic conditions. Such genotype may be recommended for more trials at field level by the farmers and could be exploited for commercial purpose under Kolar area for sustainable growth and development of sericulture industry.

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