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Validation of Rearing Performance of Pure Mysore Silkworm Breed on Different Mulberry Varieties

J. Raghavendra, K. G. Banuprakash, T. K. Narayanaswamy and K. C. Narayanaswamy
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru - 560065
E-mail: raghava1186@gmail.com

Abstract

The rearing performance of multivoltine silkworm race Pure Mysore was evaluated with ten varieties of mulberry for various larval and cocoon parameters. Among the selected varieties, the variety V1 has recorded highest values for all the biochemical constituents with least crude fibre content which is advantageous. This has reflected on performance of Pure Mysore silkworm breed reared on the leaves of V1 mulberry leaves which has shown improved larval weight, shortest larval duration, ERR and lowest larval mortality followed by S36 mulberry variety. Silkworm fed with S30 variety leaves has exhibited least larval weight and ERR with highest larval duration and mortality due to its poor biochemical composition. The results also revealed that, silkworm fed with V1 mulberry leaves has recorded highest cocoon shell weight, cocoon shell ratio, silk filament length, silk productivity, finer denier and minimum defective cocoons the similar parameters were found minimum with S30 mulberry variety, except denier and defective cocoon per cent which were maximum.The correlation obtained between biochemical compositions of mulberry leaf with quantitative traits of silkworm indicates that, as biochemical composition of mulberry leaf increases the larval and cocoon characters were also found to be improved except for crude fibre content.

Keywords : Mulberry, silkworm, pure mysore, biochemical, rearing, correlation

Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen, and inherent affinity for dyes, high absorbance, light weight, soft touch and high durability and known as the "Queen of Textiles" the world over. Silkworm is a living organism that converts the leaf protein into silk protein. Since, mulberry leaf is the sole food of silkworm *Bombyx mori* L., feed quality plays an important role on growth and development of silkworm and ultimately on economic traits such as larval and cocoon characters. Improvement in larval and cocoon characters of mulberry silkworm with the increase of chemical composition of mulberry leaf was reported by Venkataramu (1986).

The multivoltine breed, Pure Mysore used in the present study is the single prime breed which is being continuously using as female parent from more than a century in the large production of cross breed cocoons in sericultural dominated places of Southern India. The mulberry genotypes need to be assessed not only for their yield but their influence on silkworm rearing. Hence, the nutritional level of leaves which is believed to differ among the different varieties of mulberry, is deemed to play a pivotal role in cocoon parameters. In this context, understanding the magnitude of relationship between the nutritional quality of mulberry leaf and rearing parameters of silkworm is essential. Therefore, simple correlation coefficients are estimated between the rearing parameters and the leaf quality parameters to know their relationships.

Material and Methods

Mulberry cultivation: The experiment was carried out at the Department of Sericulture, University of Agricultural Sciences, GKVK, Bengaluru during the year 2015-16. Ten mulberry varieties evaluated are M5, S13, S30, S34, S36, MR2, RFS175, S54, DD1and V1. These ten varieties were established nearby rearing house in an area of 500 sq. meters. Each variety has grown in 45.00 sq. meter area. All the cultural operations from time to time were done as per recommendations of Dandin *et al*. (2003). 45 days after pruning, leaves were ready to harvest and they were harvested by plucking individual leaves throughout the experiment.

Biochemical tests: Representative leaf samples were collected separately from each variety 45 days after pruning. Each sample was taken in a paper cover and dried under shade for three days and then the leaf samples were kept in oven at 87±1 °C for 24 hr to remove the moisture.

Plant samples were analysed for moisture content using the formulae:

$$\text{Moisture (\%)} = \frac{\text{Fresh weight - dry weight}}{\text{Fresh weight}} \times 100$$

Leaf samples, which were subjected for on moisture content estimation, are made into fine powder using a grinder. The powdered samples of leaves were stored in polythene containers with airtight lid and used for chemical analysis *viz.,* carbohydrates (Dubios *et al*., 1956), proteins (Lowry *et al.,* 1951), crude fibre (A.O.A.C., 1970), chlorophyll A, chlorophyll B and total chlorophyll content (Arnon, 1949) by using standard procedures.

*Silkworm rearing:*The experiment was conducted in a Complete Randomized Design with Pure Mysore silkworm reared on ten mulberry varieties considered as ten treatments with three replications each. The larvae after emerging out of second moult were divided into three replications. Each replication consisted of 50 silkworms. The silkworm rearing was conducted as per Dandin *et al.* (2003). Observations of selected parameters *viz.,* maximum larval weight (g), larval duration (days), larval mortality (%) and Effective Rate of Rearing (ERR) (%) were recorded during larval stage. Single cocoon weight (g), single cocoon shell weight (g), cocoon shell ratio (%), defective cocoons (%), silk filament length (m), silk productivity (cg/day) and Denier were recorded as cocoon and post cocoon parameters.

Statistical analysis: In order to know the basic relationship, simple correlation co-efficients were worked out between leaf constituents of different mulberry varieties versus various larval and cocoon parameters of silkworm. The significance was worked out at probability level 0.05 per cent.

Results and Discussion

Biochemical composition

The significant variations observed in the biochemical composition of leaf and rearing parameters of silkworm fed with different mulberry varieties. V1, S36 and S13 genotypes have recorded highest values for moisture content, carbohydrates,proteins, chlorophyll A, chlorophyll B and total chlorophyll with least crude fibre content. The varieties S30 and DD1 had least values for all these parameters except for crude fibre content which was found to be maximum (Table I). The variation in the leaf biochemical composition among the different mulberry varieties may be attributed to varietal character and agronomic practices followed by prevailing climatic factors during the growth period. The results are in conformity with the findings of Patil *et al.* (2001); Syed Atheeq Ahmed (2002);Chakravorty *et al.* (2006); Doss *et al.* (2007); Ghosh *et al.* (2009) and Mamatha (2014).

Rearing Parameters

The silkworm larvae Pure Mysore fed on the leaves of V1, S36 and S13 varieties attained early maturity with less larval period, higher larval weight and ERR with least larval mortality compared to those reared on the other varieties. The varieties S30 and DD1, which recorded lower values for carbohydrates, proteins, moisture and chlorophyll content are reflected on the minimum larval weight, ERR, prolonged larval duration with highest larval mortality (Table II).

Genotypes V1, S36 and S13 having higher carbohydrates, protein, chlorophyll content and higher moisture content along with least crude fibre content and associated with highest cocoon weight,cocoon filament length, silk productivity, single cocoon shell weight, cocoon shell ratio and lower defective cocoons percentagewith finer denier in significant way. The varieties S30 and DD1 which has recorded the least values for all these biochemical constituents especially protein content and possess highest crude fibre reflected in minimum cocoon weight, cocoon filament length, silk productivity,single cocoon shell weight,cocoon shell ratio and highest defective cocoons per cent with coarse denier (Table III).

TABLE I

Biochemical composition of different mulberry varieties

Varieties	Leaf moisture content (%)	Carbohydrates (%)	Crude protein (%)	Crude fibre (%)	Chlorophyll - a (mg / g)	Chlorophyll - b (mg / g)	Total Chlorophyll (mg / g)
M5	69.77 (56.64)	20.98 (27.26)	16.72 (24.14)	10.70 (19.09)	1.400	0.508	1.908
S13	73.62 (59.09)	23.60 (29.06)	17.91 (25.04)	9.60 (18.05)	1.530	0.784	2.315
S30	66.18 (54.44)	19.50 (26.20)	16.29 (23.80)	10.86 (19.24)	1.323	0.405	1.728
S34	72.89 (58.63)	22.45 (28.28)	17.56 (24.77)	9.84 (18.28)	1.478	0.692	2.170
S36	75.35 (60.23)	24.66 (29.77)	17.97 (25.08)	9.47 (17.92)	1.614	0.801	2.415
MR2	70.81 (57.29)	21.83 (27.85)	17.33 (24.60)	9.96 (18.39)	1.420	0.682	2.103
RFS175	72.99 (58.68)	23.03 (28.68)	17.68 (24.87)	9.65 (18.09)	1.523	0.697	2.220
S54	70.16 (56.89)	21.54 (27.65)	17.06 (24.39)	10.17 (18.60)	1.410	0.513	1.923
DD1	68.58 (55.91)	20.43 (26.87)	16.56 (24.01)	10.78 (19.17)	1.377	0.415	1.792
V1	76.31 (60.87)	25.80 (30.52)	18.35 (25.367)	9.42 (17.87)	1.620	0.809	2.429
F - test	*	*	*	*	*	*	*
SEm ±	0.49	0.15	0.05	0.04	0.0017	0.0016	0.0022
CD at 5%	1.51	0.46	0.17	0.14	0.0056	0.0049	0.0068

Note : * : Significant at 5 per cent; NS : Non- Significant; Figures in the parentheses are angular transformed values

Rayar (2011) who reported that, irrespective of silkworm breeds, V1 and S41 mulberry varieties has shown enhanced performance for larval weight compared to S54 and M5. It is evident from the present results that larval weights were significantly higher in silkworms fed with V1 mulberry leaves. This might be due to the enhancement of bio-availability of nutrients resulting in robust growth of the silkworm as specified by Krishnaswami *et al*. (1970). Kalshetti *et al.* (2014), who reported that larval duration was significantly shorter when reared on 100 per cent of V1 mulberry leaves compared to other varieties of mixed leaves feeding treatments. High nutritional content of V1 mulberry leaves resulted in accelerated metabolic activity in silkworm which might be a cause in decreased larval duration (Table II). Further, they also reported that larval mortality due to disease was minimum when reared on cent per cent of V1 mulberry leaves compared to other varieties of mixed leaves feeding. The crude fibre content was maximum in S30 which may be a reason for less palatability and digestibility, which inturn becomes more susceptible for the diseases resulting in increased larval mortality. The increased ERR was observed in the present

TABLE II

Larval parameters of mulberry silkworm (Pure Mysore) as influenced by different mulberry varieties

Varieties	Maximum larval weight (g)			Maximum larval weight (g)			Larval mortality (%)	ERR (%)
	III instar	IV instar	V instar	III instar	IV instar	V instar		
M5	0.107	0.604	3.203	4.17	4.45	7.53	3.33 (10.40)	93.33 (75.07)
S13	0.112	0.610	3.380	4.05	4.49	7.55	1.33 (5.42)	96.67 (79.60)
S30	0.106	0.602	2.920	4.23	4.88	8.54	4.00 (11.28)	91.33 (72.98)
S34	0.110	0.606	3.277	4.09	4.68	8.10	2.00 (8.13)	95.33 (77.58)
S36	0.113	0.613	3.537	4.04	4.27	7.26	0.67 (2.71)	98.00 (83.44)
MR2	0.109	0.605	3.230	4.12	4.74	8.25	2.67 (9.27)	94.00 (75.95)
RFS175	0.111	0.609	3.300	4.11	4.61	7.62	1.33 (5.42)	96.67 (79.60)
S54	0.108	0.605	3.187	4.15	4.65	7.52	2.67 (9.27)	94.00 (75.82)
DD1	0.107	0.603	3.203	4.18	4.55	7.65	3.33 (10.40)	92.67 (74.53)
Vl	0.115	0.615	3.603	3.99	4.10	7.21	0.67 (2.71)	98.67 (84.58)
F - test	*	*	*	*	*	*	*	*
SEm ±	0.0012	0.0014	0.022	0.021	0.020	0.011	0.699	0.998
CD at 5%	0.0040	0.0047	0.070	0.069	0.065	0.036	2.236	3.163

Note : * : Significant at 5 per cent; NS : Non- Significant; Figures in the parentheses are angular transformed values

findings might be due to the quality of leaf and due to less incidence of diseases during silkworm rearing. These results uphold the findings of Rayar (2011); Venkatesh Kumar *et al.* (2014) and Rathod *et al.* (2015) where it was proven that mulberry varieties had significant influence on the ERR.

Gawade *et al.* (2008) who reported that V1 variety of mulberry has influenced for maximum single cocoon weight and cocoon filament length in silkworm breed, PM×CSR_2 followed by other varieties. Durande *et al.* (2012) reported that all the economic characters including shell weight was highest when PM×CSR_2 silkworms were reared on the V1 mulberry leaves. Rathod *et al.* (2015) observed the significant maximum cocoon shell ratio in the silkworm PM×CSR_2 fed with V1 mulberry leaves. Fazli Subhan *et al.* (2013) who studied the effect of four mulberry species on performance of *Bombyx mori* L. reported that, mulberry species had no significant effect on defective cocoon percentage of silkworm. However, in the present study the mulberry varieties have exhibited differences in defective cocoon percentage (Table III). Mamatha (2014), who reported that finer filament

TABLE III

Cocoon parameters of mulberry silkworm (Pure Mysore) as influenced by different mulberry varieties

Varieties	Single Cocoon weight (%)	Single Cocoon Shell weight (%)	Cocoon Shell Ratio (%)	Defective cocoon (%)	Silk productivity (Cg / day)	Cocoon filament length (m)	Denier
M5	1.027	0.140	13.64 (21.68)	3.440 (10.57)	1.944	338.51	1.93
S13	1.185	0.161	13.59 (21.63)	2.027 (8.18)	2.219	309.93	1.79
S30	0.947	0.130	13.72 (21.74)	4.860 (12.68)	1.604	298.84	1.96
S34	1.133	0.155	13.70 (21.72)	2.720 (9.36)	1.818	323.95	1.84
S36	1.233	0.170	13.79 (21.80)	1.347 (5.45)	2.253	331.94	1.72
MR2	1.095	0.148	13.54 (21.59)	3.427 (10.54)	1.796	307.39	1.80
RFS175	1.165	0.160	13.73 (21.72)	2.027 (8.18)	2.095	329.00	1.78
S54	1.073	0.146	13.56 (21.61)	3.413 (10.53)	1.937	331.44	1.94
DD1	0.985	0.132	13.40 (21.47)	4.150 (11.49)	1.726	309.61	1.90
V1	1.284	0.181	14.10 (22.06)	0.667 (2.71)	2.405	353.14	1.62
F - test	*	*	*	*	*	*	*
SEm ±	0.008	0.01	0.076	0.686	0.016	0.973	0.019
CD at 5%	0.025	0.03	0.243	2.195	0.053	3.114	0.058

Note : * : Significant at 5 per cent; NS : Non- Significant; Figures in the parentheses are angular transformed values

denier was obtained when silkworm reared on V1 mulberry variety, which corroborates the present study. Jyothi *et al.* (2014) studied the biochemical composition of different genotypes of mulberry observed that protein content present in different mulberry varieties had direct bearing on larval growth particularly silk gland development and cocoon characters of silkworm, which was eventually confirmed by the present study.

Correlation between the leaf quality and rearing parameters

At the present study V1 mulberry variety has exceedingly performed well in all the biochemical parameters which inturn has resulted in good quantitative traits of silkworm. The correlation obtained between biochemical composition of mulberry leaf with quantitative traits of silkworm indicates that, as chemical composition of mulberry leaf increases

the larval and cocoon characters were found to be improved except for crude fibre content (Table IV). Positive correlation was obtained between the moisture content, carbohydrates, crude proteins and chl-A, chl-B and total chlorophyll with rearing parameters *viz*., maximumlarval weight, ERR, single cocoon weight, single cocoon shell weight, silk productivity andfilament length. However, all these rearing parameters were negatively correlated with crude fibre content. All the biochemical constituents has shown negative correlation with larval duration, larval mortality and defective cocoons and denier. Whereas, crude fibre has shown positive correlation for the same characters which is disadvantageous for the rearing of silkworm.

Rahmathulla (2006) who noticed that positive correlation between moisture content with larval weight, cocoon weight, shell weight, filament length and negative correlation with larval duration. He also reported that higher moisture content in mulberry leaves favorably affects their ingestion, digestion and assimilation of nutrients. Seriber and Stansky (1981) who noticed the poor nitrogen utilization leading to poor growth in insects due to decrease in water content. Venkataramu (1986) also reported that carbohydrate showed positive correlation with cocoon weight, shell percentage and bave length. The higher carbohydrate content in mulberry leaves forms the bulk of the diet and accelerates the metabolic activity in silkworm results in increased bodyweight and decreased larval

TABLE IV

Correlation between biochemical constituents of mulberry with quantitative traits of silkworm

Variables	Moisture content	Carbohydrates	Crude proteins	Crude fibre	Chl. A	Chl. B	Total Chlorophy II
Maximum larval weight	0.9590 *	0.9597 *	0.9124 *	-0.8412 *	0.9539 *	0.8590 *	0.9133 *
Larval duration	-0.7666 *	-0.7850 *	-0.6749 *	0.5716	-0.7884 *	-0.5676	-0.6665 *
Effective rate of rearing	0.9875 *	0.9878 *	0.9762 *	-0.9452 *	0.9937 *	0.9314 *	0.9741 *
Larval mortality	-0.9774 *	-0.9725 *	-0.9753 *	0.9637 *	-0.9858 *	-0.9368 *	-0.9743 *
Cocoon weight	0.9887 *	0.9921 *	0.9927 *	-0.9657 *	0.9795 *	0.9566 *	0.9840 *
Shell weight	0.5786	0.6877 *	0.6478 *	-0.6296	0.6356 *	0.6429 *	0.6523
Cocoon shell ratio	0.6141	0.6904 *	0.6064	-0.5331	0.6592 *	0.5492	0.6036
Silk productivity	0.9018 *	0.9353 *	0.8809 *	-0.8160 *	0.9265 *	0.8165 *	0.8706 *
Defective cocoons	-0.9853 *	-0.9893 *	-0.9664 *	0.9189 *	-0.9882 *	-0.9167 *	-0.9628 *
Filament length	0.6393 *	0.6406 *	0.5426	-0.4505	0.6174	0.4228	0.5083
Denier	-0.9062 *	-0.9393 *	-0.9171 *	0.8637 *	-0.9181 *	-0.8888 *	-0.9175 *

Note : * Marked correlations are significant at $p < 0.05$ (N=10)

duration. The varieties which had more sugars, will stimulate the larval feeding and help in higher consumption of food which leads to attain good growth (Tazima, 1978). Ruth Lalfelpuii *et al.* (2014) observed the positive correlation between the protein content with larval weight, pupal weight, cocoon weight, shell weight and silk filament length. Further, they concluded that increase in the protein level of mulberry leaves may lead to improvements in cocoon productivity, which corroborates the present study. Patil *et al.* (2001) reported that the existence of positive correlation between the soluble protein with ERR, single cocoon weight and shell weight. Further, they also reported the positive correlation between the total chlorophyll content with larval weight, ERR, single cocoon weight, shell weight and shell ratio. However, they observed negative relationship with larval duration by the total chlorophyll content. High quantity of chlorophyll 'a' and 'b' is advantageous, since they are the most important pigment in photosynthesis which indirectly helps in improving quality of mulberry leaf.

Mulberry varieties like V1, S36 and S13 supported the better larval growth and cocoon parameters. The varieties S30 and DD1 did not recorded maximum leaf chemical constituents which may be the reason for their poor performances with regard to larval growth and cocoon characters. The correlation obtained between chemical composition of mulberry leaf with quantitative traits of silkworm indicates that, as chemical composition of mulberry leaf increases the larval and cocoon characters were also improved except for crude fibre content. Hence, the varieties with good nutritional status can be further exploit for the various purposes, especially the rainfed varieties such as S13.

References

A.O.A.C., 1970, *Official methods of analysis, Daniel Banes* (ed.) pub. by A.O.A.C., Washington, D.C., pp. 1333.

Arnon, D. I., 1949, Copper enzymes in isolated chloroplasts, polyphenoloxidase in *Beta vulgaris*. *Pl. Physio*., **24** : 1 - 15.

Chakravorty, R., Neog, K., Sinha, U. S. P., Goswami, B. C. and Hazarika, L. K., 2006, Comparative study on the nutritive value of thirteen mulberry varieties at different maturity stages. *Indian J. Agric. Chem*., **34** (1) : 1 - 11.

Dandin, S. B., Jayaswal, J. and Giridhar, K, 2003, *Handbook of Sericulture Technologies*, Central Silk Board, Bengaluru, pp. 259.

Doss, S. G., Sengupta, T., Vijayan, K., Das, C., Chakraborti, S. P., Roy, N. P. and Rajeurs, S., 2007, Evaluation of mulberry genotypes through physio-biochemical parameters and leaf yield under irrigated conditions of West Bengal. *Bull. Ind. Acad. Seri.*, **11** (1) : 62 - 67

Dubios, S. M., Giller, K. A., Hamilton, J. K., Lehros, P. A. and Smith, F., 1956, A colorimetric method of estimation of sugars and related substances, *Ann. Chem*., **28** : 350 - 356.

Durande, G. B., Gade, R. S., Jagtap, R. N. and Tayade, D. S., 2012, Effect of feeding mixed leaves of different mulberry varieties on economic traits of silkworm *Bombyx mori* L. *Trends in Biosciences*, **5** (3) : 196 - 198.

Fazli Subhan, Irshad Ahmad, Salim Jan and Maqsood Shah, 2013, The effect of four mulberry varieties on performance of *Bombyx mori* L. *Academic J. Entomol.*, **6** (3) : 121 - 126.

Gawade, B. V., Lande, U. L., Bhute, N. K. and Khan, F. S., 2008, Evaluation of some mulberry varieties in respect of cocoon weight and cocoon filament length of silkworm *Bombyx mori* L. *Ind. J. Entomol*., **70** (3) : 282 - 283.

Ghosh, M. K., Shivnath, Ghosh, P. K., Ghosh, A., Datta, R. N. and Bajpai, A. K., 2009, Mechanism of pest tolerance in mulberry. *Indian silk*, **48** (1) : 4 - 5.

Jyothi, M., Prathap, M. and Thimma Naik, S., 2014, Studies on biochemical constituents of different mulberry genotypes of *Morusalba* L. *Int. J. Pharm & Bio Sci.,* **5** (2) : 835 - 840.

Kalshetti, M. M., Latpate, C. B. and Dhandge, S. R., 2014, Effect of feeding admixture of leaves of different mulberry varieties on growth parameters and economic traits of silkworm *Bombyx mori* L. *J. Agri. Vet. Sci.,* **7** (5) : 20 - 24.

Krishnaswami, S., Noamani, M. K. R. and Ahsan, M., 1970, Studies on the quality of mulberry leaves and silkworm cocoon crop production. Part-1.Quality difference due to varieties.*Indian J. Seric.*, **9** : 1 - 10.

LOWRY, O. H., ROSEBROUGH, N. J., FARR, A. L. AND RANDALL, R. J., 1951, Protein measurement with the folin phenol reagent. *J. Biol. Chem*., **193** : 265 - 275.

MAMATHA, N. S., 2014, Comparative performance of multivoltine × bivoltine cross breed of silkworm (*Bombyx mori* L.) on different varieties of mulberry. *M.Sc. (Agri.) Thesis*, UAS, Bengaluru, pp. 54.

PATIL, S. V., MALLIKARJUNAPPA, R. S., DANDIN, S. B. AND ESWARA RAO, M. S., 2001, Evaluation of improved genotypes of mulberry through leaf chemical analysis and bioassay with silkworm race NB_4D_2. *Sericologia*, **4** (2) : 219 - 226.

RAHMATHULLA, V. K., TILAK, R. AND RAJAN, R. K., 2006, Influence of moisture content of mulberry leaf on growth and silk production in *Bombyx mori* L. *Caspian J. Environ. Sci.,* **4** (1) : 25 - 30.

RATHOD, B. S., NALWANDIKAR, P. K., SHETGAR, S. S., SAWANT, C. G. AND SONKAMBLE, M. M., 2015, Effect of feeding proportionately mixed leaves on double hybrid silkworm. *The Bioscan*, **10** (1) : 01 - 04.

RAYAR, S.G., 2011, Performance of new bivoltine breeds of silkworm, *Bombyx mori* L. on improved mulberry varieties during rainy season. *J. Ent. Res*., **35** (1) : 69 - 74.

RUTH LALFELPUII, BIDYUTH NATH CHOUDHURY, GURUSUBRAMANIAN, G. AND SENTHHIL KUMAR, N., 2014, Effect of different mulberry plant varieties in growth and economic parameters of silkworm *Bombyx mori* L. in Mizoram. *Sci. Vision*, **14** (1) : 34 - 38.

SERIBER, J. M. AND STANSKY, F., 1981, The nutritional ecology of immature insects. *Annal. Rev. Ent.,* **26** : 185 - 211.

SYED ATHEEQ AHMED, 2002, Response of new bivoltine hybrids to different varieties of mulberry. *M.Sc. (Agri.) Thesis*, UAS, Bengaluru, pp. 87.

TAZIMA, Y., 1978, *The silkworm - an important laboratory tool*. Kodansha Ltd., Tokyo, Japan, pp. 121 - 152.

VENKATESH KUMAR, R., DHIRAJ KUMAR AND RAM PHER, 2014, Varietal influence of mulberry on silkworm *Bombyx mori* growth and development. *Int. J. Adv. Research*., **2** (3) : 921 - 927.

VENKATARAMU, B.V., 1986, Nutrient status of different mulberry varieties and its effect on growth and development of *Bombyx mori* L. *M.Sc. (Agri.) Thesis*, UAS, Bengaluru, pp.89.

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