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Influence of Different Cultivation Forms of Mulberry Variety BM-3 (*Morus alba*) on Leaf Nutrition, Yield And Economic Traits of Silkworm

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ABSTRACT

Present study was undertaken to find out the influence of different cultivation forms of mulberry variety BM-3 on leaf nutrition, yield and economic traits of silkworm. Leaf harvested from High Bush and Bush contains higher amount of Moisture 70.48%, 69.77% compare to Low-cut and Tree. Bush also contains high crude protein and minerals, 21.25 and 8.95 respectively compare to high bush, low-cut and tree. Nine yield contributing characters were evaluated and all shown significant difference among each other except 10 leaf weight per plant at $p<0.05$ with Duncan multiple range test. Shell ratio for low cut and tree was highly significant at $p<0.01$ similarly raw silk percentage was also found highest for tree (30.26) and second highest for low-cut (30.22). It can be suggested that Mulberry leaf from Bush and High Bush cultivation form is suitable for young age silkworm and leaves from Low-cut and Tree is suitable for late age silkworm.

Introduction

Mulberry variety BM-3 is very popular and widely cultivated in the field level with high productivity and leaf quality. Branching nature is spreading and stem colour is gray-brown. Leaf is unlobed, medium in size but smooth, waxy and dark green in colour. Rooting ability is above 90%. Mulberry plant is such a plant which can be maintained in different shape and size through pruning and known as different cultivation forms viz. Bush, High Bush, Low-cut and Tree. Each of this cultivation forms has its unique pruning pattern. When pruned at the ground level it known as Bush which allows free tillering and also High Bush, Low-cut, Tree has it's certain trunk height 1-1.5′, 4′and 8-10′ respectively. Leaves are always collected from crown.

The ability to grow specific crops in a certain areas, at specific times is mainly determined by the seasons. In Bangladesh, there are four seasons viz. winter, spring, summer and autumn, each with different rainfall, temperature and sunlight patterns. Cropping system is an important component for any farming system.

Intensive cropping processes are now using in sericulture at the aim to increase the income per unit area at the specific period. Multiple cropping and inter-cropping is included in intensive cropping process. Inter cropping is a process of growing subsidiary crops between two widely spaced rows of main crop. Paired row high bush cultivation system of mulberry developed by Bangladesh Sericulture Research and Training Institute (BSRTI) provides inter-cropping facilities.

Considering weather and land status of Bangladesh: high bush cultivation system is suitable for plane land, low-cut for hilly area and tree for river bank, road side and home yard etc. In high bush, low-cut and tree cultivation system the distance between row to row and tree to tree were (90 x 90) cm, (150 x 120) cm and (240 x 240) cm respectively.

For high bush system, plant height was maintained to 30 cm through pruning at the height of 22 cm after plantation then 8 cm after 1 year of plantation. On the other hand, for low-cut plant height was maintained to 120 cm through pruning at the height of 45cm after plantation and then 30 cm, 30 cm and 15 cm after one , two and three year of plantation respectively. Similarly, for tree system, plant height was maintained to 300 cm through pruning at the height of 180 cm after plantation and then 60 cm, 30 cm and 30

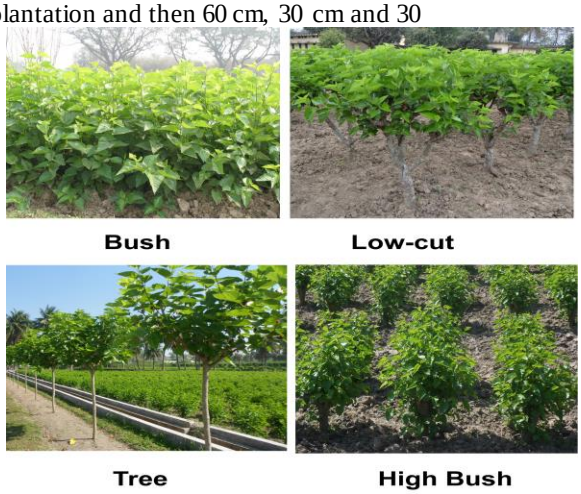

Fig 1. Different cultivation forms of mulberry.

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The silkworm, *Bombyx mori* L., is survives only on mulberry leaves (*Morus spp*.). The quality of mulberry leaves plays an important role in the nutrition of silkworm and in turn cocoon/silk production for the success of sericulture industry (Choudhury et al., 1991). Quantity and quality of mulberry leaves affects growth rate, development, body weight, survival rate of larvae as well as influencing the subsequent fecundity, longevity, movement and competitive ability of the adults. Mulberry leaf quality is determined by its chemical contents (protein, sugar, carbohydrate, starch, minerals, soluble carbohydrate etc.). Quality of mulberry leaves alone contributes 38.20 percent for quality cocoon production.

Fukuda (1960), reported that about 70% of the protein produced by the silkworm is directly derived from the mulberry leaves. Dasgupta (1961), observed that difference in quality of mulberry leaves is due to different cultivation forms as seen from rearing practices.

Bhuyian (1981), reported that nutritional status of mulberry leaves were greatly influenced by cultivation forms and that bush plants contains higher moisture and less dry matter contents than those of low-cuts and trees.

M.A. Qaiyyum et al.,1991 , studied on leaf yield and nutritive value for BSRM-5 and showed significant seasonal & nutritional variations with different cultivation forms.

Phenotypic variability of mulberry germplasm has been detected, (Thangavelu et al., 2000; Tikader & Rao, 2002). This kind of performance was reported by Ogunbodede and Ajibade, (2001), to be a function of environmental adaptation as well as genetic component. The leaf apex, margin, surface and texture could be used for identification purpose. Stem, young shoot, and newly sprouted leaf colors are also forms of identification of the different mulberry accessions (Adolkar et al., 2007).

Growth and development of silkworm larvae and subsequently silk production is greatly influenced by the nutrition quality of mulberry leaf. Quality and quantity of mulberry leaf varies according various factor Viz. Soil, kinds of fertilizers, cultivation methods, irrigation, pruning and mulberry variety. But among this factors improved mulberry variety, improved plantation system and cultural practices are the main considerations for quality and quantity leaf production.

Present study was undertaken to find out the influence of different cultivation forms on leaf nutrition, yield and economic traits of silkworm for mulberry variety BM-3.

Methodology

Mulberry variety BM-3 was grown in four different forms viz. bush, high bush, low cut and tree on sandy clay loam soil at the Bangladesh Sericulture Research and Training Institute (BSRTI), Rajshahi, and used for the this study. Identical agronomical practices were adopted as and when needed. The experiment was laid out in randomized block design with three replications.

Leaves were harvested by pruning the whole shoots each after three months interval synchronized with the four commercial silkworm rearing seasons in Bangladesh, i.e; Chaita (February-March), Jaishta(May-June), Bhaduri(August-September) and Augrahani (October-November) and designated as S1, S2, S3 and S4 respectively in the year of 2011-2014. For nutritional analysis leaf samples were weighted and dried in an oven at 80^0C until constant weight was obtained then desiccated and moisture content was determined. The dried leaves were powdered and stored for chemical analysis.

The quality of leaves were determined by estimating crude protein, Total minerals, total sugar, reducing sugar, starch and soluble carbohydrate contents according to the standard procedures of AOAC (1980).

Result and Discussion

The simple correlation coefficients were estimated among seven nutritional components of the mulberry leaf are presented in Table 1. The estimated correlation coefficients reveal that Moisture is positively associated with crude protein and mineral but negatively associated with reducing sugar, total sugar, starch and soluble carbohydrate. Soluble carbohydrate shows highly positive correlation (0.748) with starch and similarly starch shows highly positive correlation (0.738) with total sugar. Reducing sugar and starch negatively correlated with moisture and mineral.

Different nutritional values of Bush, High Bush, Low-cut and Tree mulberry leaves were estimated in Table 2. Leaf harvested from High Bush and Bush contains higher amount of moisture 70.48%, 69.77% compare to Low-cut and Tree. Bush also contains high crude protein and minerals, 21.25 and 8.95 respectively compare to high bush, low-cut and tree. Mineral content of leaf were near about similarly to all cultivation form but highest mineral content was found in leaves harvested from High Bush (8.95%) and lowest in Tree (8.44%). Both Starch and soluble carbohydrate was found comparably highest in Tree cultivation form (13.44%, 17.85%).

Low protein % was found in traditional tree and high in bush and low-cut plantation system.

From these result it was found that moisture % and mineral % is decreased as the plant height increased. On the other hand protein % and carbohydrate in the leaf was increased as the plant high increased. M.A.Quader et.al (1991) studied on the nutritive value of different cultivation form and different maturity stages of mulberry leaves form the mulberry variety BSRM-5 and also reported that Bush contains higher amount of crude protein and minerals.

Higher amount of crude fiber and minerals in the leaves is desirable for early stages silkworm whereas higher crude protein, starch, and soluble carbohydrate content is required for late age silkworm.

Table 1. Simple correlations for different nutritional parameters of mulberry leaves (BM-3).

	Moisture	Mineral	Crude protein	Reducing sugar	Total sugar	Starch	Soluble carbohydrate
Moisture	1	0.184	0.407**	-0.490**	-0.069**	-0.110	-0.279
Mineral		1	0.399**	-0.464**	-0.346*	-0.307*	-0.367
Crude protein			1	-0.444**	-0.199	0.018	-0.244
Reducing sugar				1	0.342*	0.369**	0.617**
Total sugar					1	0.738**	0.710**
Starch						1	0.748**
Soluble carbohydrate							1

** Correlation is signification at the 0.01 level (2-tailed)

* Correlation is signification at the 0.05 level (2-tailed)

Table 2. Mean Nutritive values of mulberry leaves with different cultivation form for different seasons.

Cult. forms	Different season	Moisture	Mineral	Crude protein	Reducing sugar	Total sugar	Starch	Soluble carbohydrate
Bush	Season1	68.17	8.49	20.02	1.78	3.58	12.86	16.21
	Season2	70.67	8.84	22.15	1.87	3.69	13.26	17.48
	Season3	72.14	9.21	22.41	1.50	2.90	12.43	15.71
	Season4	68.11	9.26	20.43	1.52	3.37	12.99	16.92
	Total mean± std.	69.77±1.81	8.95±0.35	21.25±1.09	1.67±0.18	3.38±0.32	12.88±0.39	16.58±0.72
High Bush	Season1	70.18	8.16	16.46	1.66	3.67	12.97	16.17
	Season2	71.70	8.98	17.76	1.94	3.84	13.63	17.77
	Season3	70.67	8.87	16.82	1.70	3.26	12.67	16.36
	Season4	69.37	8.47	15.93	1.78	3.31	12.68	17.28
	Total mean± std.	70.48±1.01	8.62±0.36	16.74±0.70	1.77±0.12	3.52±0.26	12.99±0.49	16.89±0.72
Low cut	Season1	65.61	8.94	18.24	1.87	2.93	12.58	16.68
	Season2	68.64	8.70	21.58	1.89	3.96	13.87	18.17
	Season3	68.52	8.95	20.72	1.61	3.33	13.35	16.18
	Season4	67.58	8.76	19.92	1.83	3.49	13.58	17.17
	Total mean± std.	67.59±1.31	8.84±0.25	20.11±1.29	1.80±0.13	3.43±0.39	13.35±0.55	17.05±0.78
Tree	Season1	65.43	9.14	14.85	1.94	3.88	13.07	17.24
	Season1	68.07	8.06	17.42	2.02	4.11	14.18	18.77
	Season1	66.29	8.38	16.83	2.31	3.16	12.90	17.12
	Season1	65.70	8.19	15.51	2.03	3.80	13.59	18.26
	Total mean± std.	66.37±1.12	8.44±0.45	16.15±1.10	2.07±0.17	3.74±0.38	13.44±0.64	17.85±0.78

From the above table it is clearly observed that Low-cut and Tree cultivation system contains higher amount of crude protein, starch and soluble carbohydrate 20.11, 13.35, 17.05 and 16.15, 3.74, 17.85 respectively compare to the Bush and High Bush cultivation form.

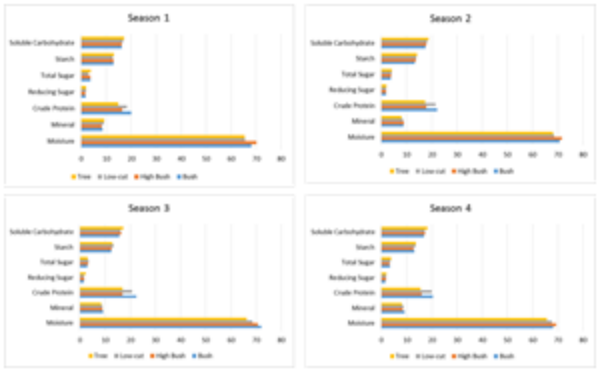

Fig 2. Seasonal variations among four different cultivation forms of mulberry BM-3.

In case of seasonal variations from Fig 2. it was seen that season S2 and S3 shows higher nutritional performances compare to other seasons.

Sahu et al., (1995), Vijayan et al., (1997b) and Susheelamma et al., (1998) who reported the positive association of number of branches per plant with leaf yield in mulberry . Das and Krishnaswamy (1969) investigated the interrelations among three characters like leaf yield, plant height and average number of branches per plant and reported that mutual correlation both at phenotypic and genotypic levels was positive and significant. Susheelamma et *a/.* (1988) studied the path analysis of important leaf yield components under stress and non-stress conditions. It was suggested that number of primary branches, number of leaves per meter length of a shoot and moisture percentage of leaf are important traits contributing to leaf yield under stress conditions whereas under non-stress conditions, number of primary branches, number and weight of leaves per meter length of a shoot were found to be important traits, having major direct effects on leaf yield in mulberry. Nine yield contributing characters viz. total branch number per plant (TBN/P), total branch height per plant (TBH/P), length of longest shoot (LLS), nodes per meter (N/M), 10 leaf area per plant (10LA/P), 10 leaf weight per plant (10LW/P), total shoot weight per plant (TSW/P), total leaf weight per plant (TLW/P), total weight per plant (TW/P) were considered for this study. In table 3. all yield contributing characters were shown significant difference among each other except 10 leaf weight per plant at $p<0.05$

Table 3. Mulberry leaf yield and yield contributing characters for different cultivation practices.

C.Form	TBN/P	TBH/P (cm)	LLS (cm)	N/M	10LA/P (cm^2)	10LW/P (g)	TSW/P (g)	TLW/P (g)	TW/P (g)
Bush	9.67* ±1.15 a	1.26.00±29.05 a	88.33±1.15 a	20.33±0.57 a	356.00±3.00 a	18.67±2.50 a	337.67±13.32 a	592.67±7.37 a	930.33± 13.58 a
H.Bush	12.33±0.58 a	1290.33±60.93a	101.00±2.00 b	24.67±1.53 b	458.00±3.00 b	22.33±4.16 a	466.00±19.67 b	653.00±13.12 b	1119.00± 30.41b
Low cut	16.33±0.58 b	1610.00±37.27 b	110.67±2.52 c	21.67±1.15 ab	467.33±4.04 b	23.67±6.11 a	776.67±13.65 c	1108.33±26.08 c	1885.00± 36.59c
Tree	35.00±2.00 c	3489.67±193.14 c	11467±5.13 c	23.33±1.53 ab	502.67±11.5 c	22.67±4.04 a	1492.67±18.17d	2010.33±29.91 d	3503.00± 43.21d
C.V	6.68	5.61		2.97	5.59	1.41	20.14	2.14	1.94

Figure(s) followed by the same letter(s) are not significantly different at $P<0.05$ as per DNMRT,Data shows as mean ± SD

*Average of four seasons data

Table 4. Performance of mulberry leaf from different cultivation forms on economic traits of silkworm.

C.Form	SCW	SW	SR	FL	SCFD	RS%	Rendita
Bush	1.12±0.03	0.1±0.02	11.92±0.09**	363.33±9.01NS	3.12±0.05NS	28.30±0.41**	10.4±0.04**
H.Bush	1.16±0.02	0.13±0.02	12.07±0.03**	369.33±13.20NS	28.94±0.13NS	28.94±0.13**	10.06±0.17**
Low cut	1.21±0.02**	0.16±0.01**	12.25±0.04**	347.67±7.51NS	3.18±0.04NS	30.22±0.08**	9.05±0.06**
Tree	1.28±0.04**	0.17±0.02**	12.30±0.03**	384.67±12.34NS	3.17±0.05NS	30.26±0.02**	9.15±0.09**
C.V	2.64	11.62	0.46	2.89	1.50	0.75	1.08

*significant at P<0.05, **significant at P<0.01 and NS = Not significant, Values given are the average of 4 season's data
SCW= Single Cocoon Weight, SW= Shell Weight, SR= Shell ratio, FL= Filament Length, SCFD= Single Cocoon Filament Denier, RS= Raw Silk.

with Duncan multiple range test. It was found that total number of branch per plant as well as leaf yield was increase with the increase the shoot height in the cultivation forms. In case of 10 leaf area per plant (cm^2) high bush and low cut shows similar performance but for inter nodal distance high bush shows better performance 24.67 compare to other cultivation practices.

Denier is important as it indicate the number of cocoon filaments to be assembled for obtaining the required size of the reeled silk. It also indicates the quality of reeled silk that can be expected in a unit time. Higher value of SCFD needs lower No. of cocoons to achieve the targeted Denier 20/22. In Table 1. it was found that nutritional quality of mulberry leaves were varies with different cultivation forms and it also influence on cocoon production as well as on raw silk quality. Masthan et al. 2011, found the growth and development of larvae, and subsequent cocoon production, are greatly influenced by the nutritional quality of mulberry leaves. Arsen'ev and Bromlei (1957) found that cocoon weight of the oak silkworm directly related to protein content of the leaves.

In Table 4. there were no significant difference in filament length and single cocoon filament denier. Shell ratio for low cut and tree was highly significant at p<0.01 similarly raw silk percentage was also found highest for tree (30.26) and second highest for lowcut (30.22). The amount of silk cocoons need to get one kg raw silk is consider as its Renditta. Lowest renditta value (9.05) was found for low-cut cultivation form. Hence in Table 4. considering all economic traits low-cut and tree cultivation form was shown the best result.

Form the above discussion it can be suggested that Mulberry leaf from Bush and High Bush cultivation form is suitable for young age silkworm and leaves from Low-cut and Tree is suitable for late age silkworm. Further investigation is needed for different cultivation forms with others high yielding mulberry varieties and nutritive response for different maturity level.

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