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Research Article

ASSESSMENT OF IMPACT OF DIFFERENT MULBERRY PLANTATION SYSTEMS ON LEAF QUALITY PARAMETERS

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Abstract: 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. The present study was conducted at Regional Sericultural Research Station, Central Silk Board, Miran Sahib, Jammu during Spring, 2019 to assess the impact of different plantation systems of mulberry on leaf quality parameters under sub-tropical conditions of Jammu. The data recorded on leaf quality parameters from three different plantation systems (3x3 ft., 8x8 ft. and 10x10 ft.) revealed that leaf moisture content was significantly higher in 8×8 ft. plantation system (80.54 %) followed by 10×10 ft. plantation system (75.03 %). However, significantly lowest moisture content (%) was recorded in 3×3 ft. plantation system (72.31 %). Lowest leaf moisture loss was found to be in 8×8 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (5.85 %, 7.53 %, 9.23 %, 11.60 % and 18.43 % respectively). Leaf moisture retention capacity was found to be higher in 8×8 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (92.74 %, 90.65 %, 88.54 %, 85.59 % and 77.12 % respectively). All the leaf quality parameters were found to be better in 8×8 ft. plantation system as compared to 3×3 ft. and 10×10 ft. plantation system. Mulberry leaf quality fed to silkworms plays a significant role and it is used as one of the important characters for evaluation of suitable mulberry varieties.

Keywords: *Leaf quality, Mulberry, Moisture content, Moisture retention capacity, Plantation system*

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Introduction

Silkworm, *Bombyx mori* L. is being reared on mulberry leaves (*Morus* spp.) and it makes the mulberry plant one of the significant components of sericulture. The nutritional composition of mulberry leaves influences the larval growth and cocoon production. Leaf quality of mulberry leaves is one of the important characters based on which mulberry varieties are being evaluated [1]. Quality of mulberry varieties fed for silkworms plays a vital role in the economy of sericulture industry [2]. Leaf quality and quantity not only influence the growth and development but also the cocoon production as well as quality of raw silk. Leaf consumption has a direct impact on larval weight, cocoon weight, silk production and number of eggs laid by a moth. Better the quality of mulberry leaves greater are the possibilities of obtaining good cocoon crops [3].

Due to change in the mulberry leaf quality parameters, there will be great impact on the rearing performance of silkworm and silk quality [1]. Nutrition of silkworm is the sole factor which almost individually augmented quality and quantity of silkworm cocoon production and productivity [4]. 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 [5 and 6].

Besides quantity, leaf quality is also important for silkworms. Mulberry leaves contain carbohydrates, proteins, vitamins, minerals and moisture. Water content in mulberry leaves is considered as one of the criteria in estimating the leaf quality [7]. Higher moisture content of mulberry leaves is one of the important factors and has a direct effect on growth and development of silkworms. Moisture content in mulberry leaves improves their ingestion, digestion and also the conversion of nutrition in silkworm. The efficiency of converting the ingested and digested food into body, cocoon and cocoon shell varies among the silkworm breeds under the influence of mulberry varieties and season [8].

The quality of mulberry leaves is also affected by the plantation system. Spacing has a great impact on leaf yield. Spacing has direct influence on plant growth which includes plant height, number of branches/plant, shoot length, number of leaves/plant and leaf yield/plant. Due to lack of space, competition is evident for air, light, soil moisture, nutrients, *etc*., leading to poor yield [9].

Keeping in view the importance of nutritional quality of mulberry leaves, the present study has been conducted to assess the impact of different mulberry plantation systems on the leaf quality parameters under sub-tropical conditions of Jammu.

Materials and Methods

The experiment was conducted at Regional Sericultural Research Station (RSRS), Central Silk Board, CSB Complex, Miran Sahib, Jammu during Spring, 2019. The mulberry variety, S-146, growing in the farm of RSRS, Jammu was used in the present study. This variety is grown under three different plantation systems.

(i) Bush plantation system of S-146 raised in 3 ft. x 3 ft. spacing.
(ii) Tree plantation system of S-146 raised in 8 ft. x 8 ft. spacing.
(iii) Tree plantation system of S-146 raised in 10 ft. x 10 ft. spacing.

The experiment was designed in randomized complete block design (RCBD) with three treatments and seven replications. The recommended package of practices relevant to the crop was followed throughout the crop period. Mulberry growth and yield parameters were recorded from the RCBD field experiment during spring, 2019.

Observations were recorded on leaf quality parameters *viz*., moisture content (%), moisture loss (%) and moisture retention capacity (%) at different time intervals after harvest *i.e*. after 3, 6, 9, 12 and 24 hours of harvest. Middle leaves of the shoot at 45 days after pruning were collected for leaf quality analysis.

Statistical Analysis

Statistical analysis was carried out by using STPR software. The experimental data collected on various leaf quality parameters of mulberry were subjected to analysis of variance (ANOVA) as per method suggested by [10]. Critical difference (C.D.) was calculated wherever the 'F' test was found significant. The data was presented with the level of significance at 5 percent.

Results

The results on leaf quality parameters *viz*., leaf moisture content (%), moisture loss (%) and moisture retention capacity (%) were analysed statistically and presented in [Table-1].

Moisture content (%)

Leaf moisture content (%) ranged from 72.31 % to 80.54 %. Treatments differed significantly for moisture content (%). The moisture content (%) was significantly higher in 8×8 ft. plantation system (80.54 %) followed by 10×10 ft. plantation system (75.03 %). However, significantly lowest moisture content (%) was recorded in 3×3 ft. plantation system (72.31 %).

Moisture loss (%)

Leaf moisture loss (%) has been estimated at different time intervals *viz*., 3 h, 6 h, 9 h, 12 h and 24 h after harvest.

Three hours after harvest

Moisture loss (%) 3 h after harvest ranged from 5.85 % to 9.74 % and differed significantly between the treatments. The moisture loss (%) 3 h after harvest was significantly higher in 3×3 ft. plantation system (9.74 %) followed by 10×10 ft. plantation system (7.95 %) and significantly lowest moisture loss (%) 3 h after harvest was recorded in 8×8 ft. plantation system (5.85 %).

Six hours after harvest

Moisture loss (%) 6 h after harvest ranged from 7.53% to 11.43%. Treatments differed significantly for moisture loss (%) 6 h after harvest. The moisture loss (%) 6 h after harvest was significantly higher in 3×3 ft. plantation system (11.43%) followed by 10×10 ft. plantation system (9.62%). However, significantly lowest moisture loss (%) 6 h after harvest was recorded in 8×8 ft. plantation system (7.53%).

Nine hours after harvest

Moisture loss (%) 9 h after harvest ranged from 9.23 % to 12.92 % and differed significantly between the treatments. The moisture loss (%) 9 h after harvest was significantly higher in 3×3 ft. plantation system (12.92 %) followed by 10×10 ft. plantation system (11.20 %) and significantly lowest moisture loss (%) 9 h after harvest was recorded in 8×8 ft. plantation system (9.23 %).

Twelve hours after harvest

Moisture loss (%) 12 h after harvest ranged from 11.60 % to 14.40 %. Treatments differed significantly for moisture loss (%) 12 h after harvest. The moisture loss (%) 12 h after harvest was significantly higher in 3×3 ft. plantation system (14.40 %) followed by 10×10 ft. plantation system (13.40 %). However, significantly lowest moisture loss (%) 12 h after harvest was recorded in 8×8 ft. plantation system (11.60 %).

Twenty four hours after harvest

Moisture loss (%) 24 h after harvest ranged from 18.43 % to 21.17 % and differed significantly between the treatments. The moisture loss (%) 24 h after harvest was significantly higher in 3×3 ft. plantation system (21.17 %) followed by 10×10 ft. plantation system (19.14 %) and significantly lowest moisture loss (%) 24 h after harvest was recorded in 8×8 ft. plantation system (18.43 %).

Moisture retention capacity (%)

Leaf moisture retention capacity (%) has been estimated at different time intervals *viz*., 3 h, 6 h, 9 h, 12 h and 24 h after harvest.

Three hours after harvest

Moisture retention capacity (%) 3 h after harvest ranged from 86.53 % to 92.74 % and differed significantly between the treatments. The moisture retention capacity (%) 3 h after harvest was significantly higher in 8×8 ft. plantation system (92.74 %) followed by 10×10 ft. plantation system (89.40 %) and significantly lowest moisture retention capacity (%) 3 h after harvest was recorded in 3×3 ft. plantation system (86.53 %).

Six hours after harvest

Moisture retention capacity (%) 6 h after harvest ranged from 84.19 % to 90.65 %. Treatments differed significantly for moisture retention capacity (%) 6 h after harvest. The moisture retention capacity (%) 6 h after harvest was significantly higher in 8×8 ft. plantation system (90.65 %) followed by 10×10 ft. plantation system (87.17 %). However, significantly lowest moisture retention capacity (%) 6 h after harvest was recorded in 3×3 ft. plantation system (84.19 %).

Nine hours after harvest

Moisture retention capacity (%) 9 h after harvest ranged from 82.13 % to 88.54 % and differed significantly between the treatments. The moisture retention capacity (%) 9 h after harvest was significantly higher in 8×8 ft. plantation system (88.54 %) followed by 10×10 ft. plantation system (85.07 %) and significantly lowest moisture retention capacity (%) 9 h after harvest was recorded in 3×3 ft. plantation system (82.13 %).

Twelve hours after harvest

Moisture retention capacity (%) 12 h after harvest ranged from 80.08 % to 85.59 %. Treatments differed significantly for moisture retention capacity (%) 12 h after harvest. The moisture retention capacity (%) 12 h after harvest was significantly higher in 8×8 ft. plantation system (85.59 %) followed by 10×10 ft. plantation system (82.14 %). However, significantly lowest moisture retention capacity (%) 12 h after harvest was recorded in 3×3 ft. plantation system (80.08 %).

Twenty four hours after harvest

Moisture retention capacity (%) 24 h after harvest ranged from 70.71 % to 77.12 % and differed significantly between the treatments. The moisture retention capacity (%) 24 h after harvest was significantly higher in 8×8 ft. plantation system (77.12 %) followed by 10×10 ft. plantation system (74.50 %) and significantly lowest moisture retention capacity (%) 24 h after harvest was recorded in 3×3 ft. plantation system (70.71 %).

Discussion

Leaf quality parameters

High leaf moisture content and moisture retention capacity of the mulberry genotypes has a positive influence on the growth and development of silkworm. For successful rearing the maintenance/retention of sufficient moisture content in the leaves for prolonged periods is of immense important [11, 12 and 13]. Different genotypes are said to influence the leaf moisture content and its retention in harvested leaf. Besides, environmental factors, leaf anatomical parameters like stomatal size, stomatal frequency, mesophyll tissue, cuticle thickness and leaf thickness also influence the moisture content of the leaf and its retention capacity. It has been reported by [14] that nutritional qualities of leaves play an important role in silkworm rearing, higher moisture content is known to increase the amount of ingestion and digestibility of silkworm because moisture act as an olfactory and gustatory stimulant. Leaf moisture content was found to be higher in 8×8 ft. plantation system (80.54 %) followed by 10×10 ft. plantation system (75.03 %) and lowest in 3×3 ft. plantation system (72.31 %). This might be due to leaves grown under wider spacing were narrow, thick and more succulent. Further, the plants grown in wider spacing had abundant space for root spread, deep root system, increased uptake of water and nutrients. Four improved mulberry genotypes were evaluated by [15] and reported that leaf moisture content was significantly higher in Viswa (77.74%) and S-36 (77.24%) genotypes. It has been reported by [16] that leaf moisture content was good in 4 ×4 ft. spacing. These findings are in conformity with the reports of [17-21].

Table-1 Influence of different mulberry plantation systems on moisture content (%), moisture loss (%) and moisture retention capacity (%) of leaves at different time intervals after harvest

Mulberry plantation systems	Moisture content (%)	Moisture loss (%)					Moisture retention capacity (%)				
		3 HAH	6 HAH	9 HAH	12 HAH	24 HAH	3 HAH	6 HAH	9 HAH	12 HAH	24 HAH
3x3 ft.	72.31	9.74	11.43	12.92	14.40	21.17	86.53	84.19	82.13	80.08	70.71
8x8 ft.	80.54	5.85	7.53	9.23	11.60	18.43	92.74	90.65	88.54	85.59	77.12
10x10 ft.	75.03	7.95	9.62	11.20	13.40	19.14	89.40	87.17	85.07	82.14	74.50
F-test	**	**	**	**	**	**	**	**	**	**	**
SE.m±	0.33	0.25	0.28	0.30	0.32	0.33	0.35	0.41	0.43	0.47	0.51
CD at 5%	1.03	0.76	0.88	0.92	0.99	1.03	1.08	1.28	1.33	1.45	1.58
CV (%)	1.16	8.28	7.92	7.13	6.52	4.53	1.03	1.26	1.34	1.51	1.83

(HAH= Hours after harvest)

Leaf moisture loss was found to be higher in 3×3 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (9.74 %, 11.43 %, 12.92 %, 14.40 % and 21.27 % respectively) followed by 10×10 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (7.95 %, 9.62 %, 11.20 %, 13.40 % and 19.14 % respectively) and lowest in 8×8 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (5.85 %, 7.53 %, 9.23 %, 11.60 % and 18.43 % respectively). Leaf moisture loss was found to be high in closer spacing as compared to wider spacing. This may be due to mulberry leaves grown under closer spacing were broad, thin, papery like and less succulent. Further, the plants grown in closer spacing had less space for root spread, shallow root system, reduced uptake of water and nutrients due to competition among adjacent plants. The reports of [22] and [15] were also in accordance with the results obtained in the present study.

Leaf moisture retention capacity was found to be higher in 8×8 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (92.74 %, 90.65 %, 88.54 %, 85.59 % and 77.12 % respectively) followed by 10×10 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (89.40 %, 87.17 %, 85.07 %, 82.14 % and 74.50 % respectively) and lowest in 3×3 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest (86.53 %, 84.19 %, 82.13 %, 80.08 % and 70.71 % respectively). This might be due to leaves grown under wider spacing were narrow, thick and more succulent. Further, the plants grown in wider spacing had abundant space for root spread, deep root system, increased uptake of water and nutrients. These findings are in conformity with [15-26].

Conclusion

Leaf moisture content was found to be higher in 8×8 ft. plantation system. Lowest leaf moisture loss was recorded in 8×8 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest. Further, leaf moisture retention capacity was also found to be higher in 8×8 ft. plantation system at 3, 6, 9, 12 and 24 h after harvest. Overall, mulberry leaf quality parameters were found to be better in 8×8 ft. plantation system as compared to 3×3 ft. and 10×10 ft. plantation system. Mulberry leaf quality fed to silkworms plays a significant role and it is used as one of the important characters for evaluation of suitable mulberry varieties. The nutrient quality of food plants affects its conversion into insect biomass, and this in turn affects the economic traits of cocoons [27 and 28].

Application of research: Mulberry leaf quality parameters were found to be better in 8×8 ft. plantation system as compared to 3×3 ft. and 10×10 ft. plantation systems.

Research Category: Mulberry breeding and improvement.

Abbreviations: ft. - Feet, % - Percent, h - Hour

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Research Station: Regional Sericultural Research Station, Central Silk Board, Ministry of Textiles, Govt. of India, CSB Complex, Miran Sahib, Jammu, 181101, Jammu & Kashmir, India.

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Study area / Sample collection: Regional Sericultural Research Station, Central Silk Board, Ministry of Textiles, Govt. of India, CSB Complex, Miran Sahib, Jammu, 181101, Jammu & Kashmir, India.

Cultivar / Variety / Breed name: Mulberry (*Morus* spp.)

Conflict of Interest: None declared.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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