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Evaluation of Different Mulberry Plantation Systems for Leaf Yield and Yield Contributing Characters

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Leaf yield and yield related parameters play an important role in improvement of mulberry quality and quantity.The present study was conducted at Regional Sericultural Research Station, Central Silk Board, Miran Sahib, Jammu during Spring, 2019 to evaluate different mulberry plantation systems for growth, yield and its contributing characters under sub-tropical conditions of Jammu. The data recorded on leaf yield and yield contributing characters from three different plantation systems (3x3 ft., 8x8 ft. and 10x10 ft.) revealed that number of new shoots per plant (63.29), longest shoot length (104.74 cm), number of leaves per meter of shoot length (21.43), leaf:shoot ratio (1.21) and leaf yield per plant per crop (3.96 kg) were found to be higher in 10×10 ft. spacing plantation system. Leaf yield per plant and other yield parameters were found to be superior in wider spacing plantation system as compared to narrow spacing which may be due to abundant space for root spread, high uptake of the nutrients and moisture.

Introduction

Mulberry (*Morus* spp.) is a fast growing deciduous woody perennial plant, normally cultivated as bush or dwarf tree by repeated pruning (Magadum *et al.*, 2019). It is the primary food plant of silkworm (*Bombyx mori* L.); hence, availability of good quality leaf has great impact on the sustainability and profitability of sericulture industry.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 (Bongale, 1991). In sericulture, more than 60% of the total cost of cocoon production goes towards mulberry production alone. Hence, in recent years maximum attention has been given for the improvement of mulberry in terms of both quality and quantity. Successful rearing of silkworm depends on three major factors; mulberry leaf, environment and silkworm hybrid Worm health and cocoon characters are highly affected by quality and quantity of food (Koul, 1989; Remadevi *et al.*, 1993).

Leaf yield and yield related parameters also play an important role in improvement of mulberry quality and quantity. Mulberry leaf yield largely depend on various leaf yield contributing characters, genotype and agronomic practices. Mulberry leaf yield depends on the number and length of shoots, internodal distance and leaf yield/plant.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 (Bongale, 1991). Keeping in view the importance of growth, leaf yield and its contributing characters of mulberry, the present study has been conducted to evaluate different mulberry plantation systems for growth, leaf yield and yield contributing characters 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 leaf yield parameters were recorded from the RCBD field experiment during spring, 2019.

Observations were recorded on growth, leaf yield and yield contributing characters *viz.*, number of new shoots per plant, longest shoot length, total shoot length per plant, number of leaves per meter of shoot length, internodal distance, diameter of shoot, leaf area, Leaf: shoot ratio, weight of 100 fresh leaves, leaf yield per plant per harvest, leaf yield per hectare per harvest.

Statistical analysis was carried out by using STPR software. The experimental data collected on various growth and leaf yield parameters of mulberry were subjected to analysis of variance (ANOVA) as per method suggested by Singh and Choudhary (1977). Critical difference (C.D.) was calculated wherever the ‘F’ test was found significant. The data was presented with the level of significance at 5 per cent.

Results and Discussion

The results on growth and leaf yield parameters of mulberry have been analysed statistically and are presented in Table 1.

Number of new shoots per plant

Number of new shoots per plant in different plantation systems ranged from 24.57 to

63.29 and differed significantly between treatments. The number of new shoots per plant was significantly higher in 10×10 ft. plantation system (63.29) followed by 8×8 ft. plantation system (52.43) and least was recorded in 3×3 ft. plantation system (24.57).

Longest shoot length (cm)

Longest shoot length in different plantation systems ranged from 83.87 cm to 104.74 cm. The longest shoot length differed significantly between treatments. The longest shoot length was significantly higher in 10×10 ft. plantation system (104.74 cm) followed by 8×8 ft. plantation system (92.70 cm). However, significantly shortest shoot length was recorded in 3×3 ft. plantation system (83.87 cm).

Total shoot length per plant (cm)

Total shoot length per plant ranged from 1818.29 cm to 4650.43 cm. All the treatments differed significantly for total shoot length per plant. The total shoot length per plant was significantly higher in 10×10 ft. plantation system (4650.43 cm) followed by 8×8 ft. plantation system (3951.86 cm) and significantly lowest total shoot length per plant was recorded in 3×3 ft. plantation system (1818.29 cm).

Number of leaves per meter of shoot length

The mean number of leaves per meter of shoot length ranged from 18.86 to 21.43 and differed significantly between the treatments. The number of leaves per meter of shoot length was significantly higher in 10×10 ft. plantation system (21.43) followed by 8×8 ft. plantation system (20.29). However, significantly lowest number of leaves per meter of shoot length was recorded in 3×3 ft. plantation system (18.86).

Internodal distance (cm)

The mean internodal distance (cm) ranged from 4.57 cm to 5.41 cm and differed significantly between the treatments. The internodal distance (cm) was significantly higher in 3×3 ft. plantation system (5.41 cm) followed by 8×8 ft. plantation system (4.94 cm) and significantly lowest internodal distance (cm) was recorded in 10×10 ft. plantation system (5.41 cm).

Diameter of shoot (cm)

The average diameter of shoot (cm) ranged from 3.77 cm to 5.13 cm. Treatments differed significantly for average diameter of shoot (cm). The diameter of shoot (cm) was significantly higher in 10×10 ft. plantation system (5.13 cm) followed by 8×8 ft. plantation system (4.34 cm). However, significantly lowest diameter of shoot (cm) was recorded in 3×3 ft. plantation system (3.77 cm).

Leaf area (cm^2)

The mean leaf area (cm^2) ranged from 159.24 cm^2 to 184.53 cm^2 and differed significantly between the treatments. The leaf area (cm^2) was significantly higher in 3×3 ft. plantation system (184.53 cm^2) followed by 10×10 ft. plantation system (175.17 cm^2) and significantly lowest leaf area (cm^2) was recorded in 8×8 ft. plantation system (159.24).

Leaf:Shoot ratio

The leaf:shoot ratio ranged from 1.03 to 1.21. Treatments differed significantly for leaf:shoot ratio. The leaf:shoot ratio was significantly higher in 10×10 ft. plantation system (1.21) followed by 3×3 ft. plantation system (1.12). However, significantly lowest leaf:shoot ratio was recorded in 8×8 ft. plantation system (1.03).

Table.1 Effect of different mulberry plantation systems on growth and yield characters

Mulberry plantation systems	Number of new shoots/ plant	Longest shoot length (cm)	Total shoot length/ plant (cm)	Number of leaves/ meter	Internodal distance (cm)	Diameter of shoot (cm)	Leaf area (cm^2)	Leaf: shoot ratio	Weight of 100 fresh leaves (g)	Leaf yield/ plant/ harvest (kg)	Leaf yield/ hectare/ harvest (kg)
3x3 ft.	24.57	83.87	1818.29	18.86	5.41	3.77	184.53	1.12	135.00	0.72	8568.43
8x8 ft.	52.43	92.70	3951.86	20.29	4.94	4.34	159.24	1.03	212.14	3.13	5272.86
10x10 ft.	63.29	104.74	4650.43	21.43	4.57	5.13	175.17	1.21	182.28	3.96	4257.14
F-test	**	**	**	*	**	**	**	**	**	**	**
SE.m±	2.04	2.31	167.76	0.52	0.09	0.08	4.28	0.03	6.26	0.05	95.63
CD at 5%	6.27	7.13	516.85	1.60	0.28	0.25	13.12	0.08	19.29	0.16	294.62
CV (%)	11.52	6.53	12.78	6.82	4.81	4.80	6.54	6.04	9.39	5.43	4.19

Weight of hundred fresh leaves (g)

Weight of hundred fresh leaves (g) ranged from 135.00 g to 212.14 g and differed significantly between the treatments. Weight of hundred fresh leaves (g) was significantly higher in 8×8 ft. plantation system (212.14 g) followed by 10×10 ft. plantation system (182.28 g) and significantly lowest weight of hundred fresh leaves (g) was recorded in 3×3 ft. plantation system (135.00 g).

Leaf yield per plant per harvest (kg)

The leaf yield per plant per harvest (kg) ranged from 0.72 kg to 3.96 kg. Treatments differed significantly for leaf yield per plant per crop (kg). The leaf yield per plant per crop (kg) was significantly higher in 10×10 ft. plantation system (3.96 kg) followed by 8×8 ft. plantation system (3.13 kg). However, significantly lowest leaf yield per plant per crop (kg) was recorded in 3×3 ft. plantation system (0.72 kg).

Leaf yield per hectare per harvest (kg)

The leaf yield per hectare per harvest (kg) ranged from 4257.14 kg to 8568.43 kg and differed significantly between the treatments. The leaf yield per hectare per crop (kg) was significantly higher in 3×3 ft. plantation system (8568.43 kg) followed by 8×8 ft. plantation system (5272.86 kg) and significantly lowest leaf yield per hectare per crop (kg) was recorded in 10×10 ft. plantation system (4257.14 kg).

Das (1986) mentioned the criteria for selection in mulberry that included characters like plant height, internodal distance, number of primary and secondary shoot, leaf area and leaf yield per plant. Dandin (1986) opined that selection of promising genotypes was essential for planning and devising breeding programmes. In addition to the leaf yield, due importance was given to the yield attributing traits that reduced ineffective selection of genotypes.

In the present investigation the number of new shoots per plant was found significantly superior in 10×10 ft. plantation system (63.29) followed by 8×8 ft. plantation system (52.43) and least was recorded in 3×3 ft. plantation system (24.57). The longest shoot length was significantly highest in 10×10 ft. plantation system (104.74 cm) followed by 8×8 ft. plantation system (92.70 cm) and lowest recorded in 3×3 ft. plantation system (83.87 cm). This might be due to spacing effect, where, wider spacing has much scope for vigorous growth with no competition for nutrients and space. Similar results were also noticed by Ghosh *et al.,* (2009) who reported that contributing characters and leaf yield were significantly superior in wider spacing plantation systems as compared to the narrow spacing plantations. Rao*et al.,* (2000), Patil *et al.,* (2001), Murthy *et al.,* (2013) and Ananya (2014) reported significantly higher number of branches per plant and longer shoot length in mulberry plantations with wider spacing. Further, Vanitha *et al.,* (2019) also recorded higher number of shoots in tree mulberry as compared to bush mulberry.

Total shoot length per plant was significantly higher in 10×10 ft. plantation system (4650.43 cm) followed by 8×8 ft. plantation system (3951.86 cm) and significantly lowest in 3×3 ft. plantation system (1818.29 cm). The number of leaves per meter of shoot length was significantly higher in 10×10 ft. plantation system (21.43) followed by 8×8 ft. plantation system (20.29) and lowest in 3×3 ft. plantation system (18.86). This might be due to increased plant height and good crop stand of the plant in wider spacing with no competition for spreading of the branches. Increased number of leaves per plant is mainly because of increased plant height, more number of branches and higher shoot length. The reports of Rao *et al.,* (2000), Patil*et al.,* (2001), Ghosh *et al.,* (2009), Ananya (2014) and Vanitha *et al.,* (2019) were also in accordance with the results obtained in the present study.

The internodal distance was significantly higher in 3×3 ft. plantation system (5.41 cm) followed by 8×8 ft. plantation system (4.94 cm) and lowest in 10×10 ft. plantation system (5.41 cm). Fotadar *et al.,* (1989) observed that internodal distance varied in plants grown under different spacing and it is an important genotypic character which determines total foliage produced by a plant. Murthy *et al.,* (2013) also observed that mulberry variety Vishwa grown with a spacing of 4×4 ft. showed shorter internodal distance.

The diameter of shoot was significantly higher in 10×10 ft. plantation system (5.13 cm) followed by 8×8 ft. plantation system (4.34 cm) and lowest in 3×3 ft. plantation system (3.77 cm). The leaf area was significantly higher in 3×3 ft. plantation system (184.53 cm^2) followed by 10×10 ft. plantation system (175.17 cm^2) and lowest in 8×8 ft. plantation system (159.24). This might be due to the sufficient sunlight, aeration and also abundant supply of the nutrients and moisture. This is in conformity with observations of Shyla (2012), Ananya (2014) and Vanitha *et al.,* (2019).

Weight of hundred fresh leaves (g) was significantly higher in 8×8 ft. plantation system (212.14 g) followed by 10×10 ft. plantation system (182.28 g) and significantly lowest in 3×3 ft. plantation system (135.00 g). The leaf yield per plant per crop (kg) was significantly higher in 10×10 ft. plantation system (3.96 kg) followed by 8×8 ft. plantation system (3.13 kg) and lowest in 3×3 ft. plantation system (0.72 kg). This is may be due to abundant space for root spread, high uptake of the nutrients and moisture and also due to increase in leaf yielding contributers like plant height, number of branches and leaves. This is in conformity with Eltayb *et al.,* (2013) who found that *M.alba* and *M. mesozygia* recording highest weight of leaves and yield per unit area in 1.00×1.00 m and 1.50×1.00 m. Similar results were reported by Ghosh *et al.,* (2009), Patil *et al.,* (2001), Ramakant *et al.,* (2001), Ananya (2014) and Vanitha *et al.,* (2019).

The leaf yield per hectare per crop was significantly higher in 3×3 ft. plantation system (8568.43 kg) followed by 8×8 ft. plantation system (5272.86 kg) and lowest in 10×10 ft. plantation system (4257.14 kg). Kour and Nazir (1998) have reported leaf yield of 10,439 kg/ha/year in bush mulberry with a spacing 1.8 x 0.9 m and 4,084 kg/ha/year in tree mulberry with a spacing 2.7 x 2.7 m, which indicated that higher leaf yield can be obtained in bush mulberry per hectare basis due to more number of plants per hectare as compared to tree mulberry, which is supporting the results of the present investigation. Singh and Kaul (1997) reported that the leaf yield/ha showed a decreasing trend with increasing plant spacing. The closest spacing of 50x50 cm showed a marked improvement in leaf yield (50%) over wider spacing of 50x75 cm.

Kasiviswanathan *et al.,* (1979) reported an annual mulberry leaf yield of 31,711 kg/ha in four harvests under irrigated conditions. Total leaf dry matter production was highest in 50x50 cm spacing. However, it showed a decline in dry matter production with increased spacing and was less than half in 75x100 cm spacing. Due to close spacing, mulberry does not show any adverse population effect on leaf yield and dry matter of individual plant. Higher yield in closer spacing was mainly due to increased number of plants per unit area corresponding to

11,960 plants/ha in 3x3 ft. spacing plantation systems and decreasing to 1682 plants/ha in 8x8 ft. spacing and 1076 plants/ha in 10x10 ft. spacing plantation systems *i.e.*, closer spacing increased the yield per unit area without any additional inputs.

Kuno (1979) observed that the dense population in mulberry decreases the number of branches, stem elongation, leaf expansion and size of the growing point of apical end. 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 (Bongale, 1991).

From the findings of the present study, it has been observed that many of the yield parameters were found to be superior in wider spacing plantation system as compared to narrow spacing. This might be due to spacing effect, where, wider spacing has much scope for vigorous growth with no competition for nutrients and space. Leaf yield per plant was highest in wider spacing which may be due to abundant space for root spread, high uptake of the nutrients and moisture.

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