**Evaluation of Different spacing for growth and Yield Contributing Characters of Tree type mulberry**

**Abstract**

To develop package of practices for tree type mulberry various studies were conducted to select the suitable package of practice. Effect of different spacing on growth, yield parameters in the two tree type mulberry varieties V1 and G4 were checked in the studies. The results showed that the mulberry growth attributes changes based on the spacing. Among the various spacing, 6ft x 6ft recorded highest shoot length (133.10 cm), minimum internodal length (3.95 cm), Length of longest shoot (128.47 cm), total shoot length (1267.18 cm), physiological attribute like leaf area (137.75 cm2) and yield attributes such as single leaf weight of 5.35 g, weight of 100 leaves (518.50 g), number of leaves per shoot (61.75) in the tree type mulberry variety V1 followed by 7ft x 7ft.

**Keywords:** *Growth; Spacing; Tree mulberry; Yield*

**Introduction**

Mulberry is the only host plant for *Bombyx mori* L. and one of the most significant economic crops grown specifically for silkworm rearing. Mulberry is accountable for 38.20% of the cocoons that are successfully produced. Mulberry must be precisely maintained with the application of the necessary quantity of organic and inorganic fertilizers because it is a perennial crop and is pruned periodically (Rahman *et al.,* 2020). Poor soil health in mulberry gardens and inadequate management techniques may cause a considerable decline in leaf quality. In these conditions, applying soluble nutrients or elicitors to the leaves can enhance leaf quality and biomass production (Nithin Kumar *et al*., 2020).

Mulberry (*Morus* spp.) is Fast-growing, woody, perennial plants are typically pruned repeatedly to form bushes or dwarf trees. Because it is the main source of food for silkworms (*Bombyx mori* L.), the availability of high-quality leaves has a significant impact on the viability and profitability of the sericulture sector. The plantation system has an impact on mulberry leaf quality as well (Sekhar *et al.,* 2015). Leaf yield is significantly impacted by spacing. Plant growth, including plant height, number of branches per plant, shoot length, number of leaves per plant, and leaf yield per plant, is directly influenced by spacing. In sericulture, the production of mulberries accounts for more than 60% of the entire cost of cocoon production (Wani *et al.,* 2014). The yield of leaves and other criteria that are related to yield are also crucial for improving mulberry quality and yield. The numerous leaf yield contributing traits, genotype, and agronomic techniques all play a significant role in mulberry leaf yield. Mulberry leaf yield is influenced by plant leaf yield, internodal distance, and the quantity and length of shoots (Pawan *et al.,* 2017). Leaf yield is significantly impacted by spacing. Plant growth, including plant height, number of branches per plant, shoot length, number of leaves per plant, and leaf yield per plant, is directly influenced by spacing. Competition for air, light, soil moisture, nutrients, and other resources is visible due to a shortage of space, which results in a poor yield (Setua *et al.,* 2011). The current study was undertaken to assess the different spacing on tree type mulberry plantation for growth, leaf yield, and yield contributing characters.

**Materials and Methods**

The experiments were carried out to develop package of practices for tree type mulberry, completely fulfilling all objectives included in the study. The experimental study was done in Agriculture Research Station, Bhavanisagar, Tamil Nadu. All materials and methods used in the field experiments are detailed below.

Design : Split plot design

Treatments : Three

Replication : Six

Crop : Mulberry

Variety : V1 and G4

Plot size : 46ft x 312ft

Spacing between blocks : 10 ft

**Treatments**

T1: Plot with 5’x 5’ spacing

T2: Plot with 6’x 6’ spacing

T3: Plot with 7’x 7’ spacing

**Mulberry growth attributes**

From each replication, five mulberry plants which was randomly selected under main field conditions was labelled for recording growth parameters.

**Plant height**

Plant height is the measure of total distance between highest point on the plant and lowest point on ground level. It was generally expressed in terms of cm.

**Inter-nodal distance**

Length between the nodes having fourth leaf and fifth leaf from the highest tip of the plant was recorded. The mean value measured were generally expressed in cm.

**Physiological attributes**

**Leaf area (LA)**

 Each replication consists of ten mulberry plants from which five plants were randomly selected and fifth leaf from the tip of the plant was collected and leaf area was measured by following length and breath method recommended by Montgomery (1911). Mean value was expressed in cm²/ plant.

 LA (A) = l x b x c

 Where, A- leaf area, l – leaf length, b – leaf breath, c – constant factor (0.676)

**Yield attributes of mulberry**

Each replication consists of ten mulberry plants from which five plants were randomly selected under main field conditions and labelled for recording yield parameters.

**Fresh leaf weight (g)**

The leaves from middle portion of five randomly selected plants in each replication was collected and weighed immediately after harvesting. The average was computed and expressed in grams/plant.

**Number of leaves per plant**

From five randomly selected plants in each replication, total number of leaves per plant was counted and recorded. It was generally expressed in numbers/plant.

**Number of shoots per plant**

From each replication, five plants were randomly selected and total number of shoots per plant was observed and expressed in numbers/plant.

**Results and Discussion**

**Effect of different spacing on growth attributes of tree type mulberry**

The different spacing of tree type mulberry elucidated positive significant effect on shoot length of mulberry (Table 1). Among the various spacing, significantly higher shoot length (133.10 cm) was recorded in 6ft x 6ft spacing, which was followed by 7ft x 7ft. Regarding different mulberry varieties, V1 recorded longest shoot length of 134.20 cm followed by G4 (129.20 cm), which were found to differ significantly from each other. In interaction between different spacing and varieties, significantly maximum shoot length (135.40 cm) was recorded in the V1 variety at 6ft x 6ft, which was statistically superior to all other treatments. At the same time, minimum shoot length of 127.50 cm was observed in G4 at 5ft x 5ft. Ramakant *et al.*  (2001) confirmed the same results. In accordance to Rao et al. (2000), plants with a 120 x 60 spacing had the largest number of shoots (7.58), total length (750.51 cm), and shoot weight (317.93 g) per plant.

 As shown in table 1, the data indicated in different spacing and mulberry varieties impact on the internodal length. Among spacing evaluated, minimum internodal length of 3.95 cm was found in 6ftx 6ft spacing, followed by 7ft x 7ft (4.56 cm). The lowest internodal length of 4.28 cm was observed in V1 variety while it was G4 in 4.85 cm. In interaction between different spacing and varieties, significantly minimum internodal length (3.17 cm) was recorded in the V1 variety at 6ft x 6ft, which was statistically superior to all other treatments. At the same time, maximum internodal length of 5.00 cm was observed in G4 at 7ft x 7ft. Murthy *et al*. (2013) also noted that the internodal distance was lower in mulberry variety Vishwa when it was planted with a spacing of 4x4 feet.

 Length of longest shoot significantly varied between spacing with longest shoot of 128.47 cm in 6ft x 6ft (Fig. 1). The next better treatment was 7ft x 7ft (119.43 cm). The lowest shoot length of 111.90 cm was observed in 5ft x 5ft. Among different mulberry varieties, V1 registered notably longest shoot length of 123.97 than G4. The interaction between different spacing and different mulberry varieties infer that a significantly longest shoot length was found in the 6ft x 6ft of V1 (132.37). This was followed by 6ft x 6ft of G4 (124.57). The lowest shoot length was recorded in G4 at 5ft x 5ft (108.24). In mulberry plantations with wider spacing, Murthy et al. (2013) found a considerably increased number of branches per plant and longer shoot length. Additionally, Vanitha *et al.* (2019) found that tree mulberry had higher number of shoots than bush mulberry. According to the data obtained by Santoshkumar *et al.* (2020) from three different plantation systems (3x3 feet, 8x8 feet, and 10x10 feet), the number of new shoots per plant (63.29), longest shoot length (104.74 cm), number of leaves per metre of shoot length (21.43), leaf:shoot ratio (1.21), and leaf yield per plant per crop (3.96 kg) were all higher in 10x10 feet. plantation spacing system

The different spacing of tree type mulberry elucidated positive significant effect on total shoot length of mulberry (Fig 1). Among the various spacing, significantly higher total shoot length (1267.18 cm) was recorded in 6ft x 6ft spacing, which was followed by 7ft x 7ft. Regarding mulberry varieties, V1 recorded longest shoot length of 1252.99 cm followed by G4 (1138.49 cm), which were found to differ significantly from each other.

In interaction between different spacing and varieties, significantly maximum shoot length (1300.25 cm) was recorded in the V1 variety at 6ft x 6ft, which was statistically superior to all other treatments. At the same time, minimum shoot length of 1060.59 cm was observed in G4 at 5ft x 5ft. Ananya (2014) reported increased plant height, more branches, and longer shoots are the primary causes of the increased number of leaves per plant.

**Effect of different spacing on yield attributes of tree type mulberry**

Single leaf weight significantly varied between spacing and varieties (Fig 2). The highest single leaf weight of 5.35 g was recorded in 6ft x 6ft spacing. The next better treatment was 7ft x 7ft (5.05 g) which was found to be on par with 5ft x 5ft (4.75). Among mulberry varieties, V1 registered notably high single leaf weight of 5.30 than G4. In case of interaction, there was no significant difference in the single leaf weight in response to spacing and mulberry varieties. Similar findings were reported by Ghosh et al. (2009), who indicated that wider spacing plantation systems had considerably better contributing traits and leaf yield than narrow spacing plantation systems.

Weight of 100 leaves significantly different between spacing and varieties (Fig 2). The highest weight of 100 leaves was recorded in 6ft x 6ft spacing with 518.50 g followed by 7ft x 7ft spacing with 496 g. Among mulberry varieties, V1 registered highest weight of 100 leaves (511.33 g) than G4 (478.33g). In case of interaction, there was no significant difference in the weight of 100 leaves in response to spacing and mulberry varieties. According to Eltayb *et al.* (2013), *M. alba* and *M. mesozygia* recorded the maximum leaf weight and yield per unit area in plots measuring 1.00 x 1.00 m and 1.50 x 1.00 m, respectively.

Significantly higher number of leaves per shoot of 61.75 was observed 6ft x 6ft followed by 7ft x 7ft (55.30) (Table 2). With respect to mulberry varieties, more number of leaves per shoot of 59.26 was noticed in V1 followed by G4 (53.30).In interaction of spacing and different mulberry varieties, significantly higher number of leaves per shoot (65.30) was found in 6ft x 6ft spacing of V1. This was followed by 7ft x 7ft of V1 (58.30) and 6ft x 6ft of G4 (58.20) and all were statistically on par with each other. The lower number of leaves per shoot was observed in 5ftx 5ft (49.40) of G4. According to Ghosh et al. (2009), mulberry leaf yield and growth metrics were both higher with wider spacing than with close spacing. In accordance with Yadav *et al*. (2019) study, 270cm x 60cm spacing produced the highest plant height (194.56 cm), number of branches per plant (13.59), number of leaves per plant (286.27), and leaf yield per plant (1.35 kg), followed by 240cm x 60cm spacing.

**Effect of different spacing on physiological attributes of tree type mulberry**

 Leaf area showed considerable variation among the different spacing on mulberry plants (Table 2). Among these spacing’s, higher value of leaf area (137.75 cm2) was noticed in 6ft x 6ft which was found to be on par with 7ft x 7ft (135.75 cm2). This was followed by 5ft x 5ft (129.00 cm2). Regarding mulberry varieties, V1 had significantly high leaf area of 139.06 cm2 than G4 (129.26 cm2). In case of interaction, there was no significant difference in the leaf area in response to spacing and mulberry varieties. Thanga Roja *et al.* (2021) found that the influence on the VI variety of mulberry considerably increased shoot length (170.67 cm), number of shoots per plant (9.03), number of leaves per shoot (29.48), leaf area (130.26 cm2), and leaf area index (2.72).

**Conclusion:**

According to the findings of this study, among the various spacing, 6ft x 6ft recorded higher in all the growth and yield contributing factors. These study reveals that numerous yield metrics were found to be better in wider spacing plantations systems when compared to narrow spacing. This could be related to the spacing effect, in which broader spacing allows for more vigorous growth with less competition for nutrients and space. Leaf yield per plant was highest with wider spacing, possibly due to adequate area for root spread and good fertilizer and moisture uptake.

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**Ethics statement**

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

**Consent for publication**

All the authors agreed to publish the content.

**Competing interests**

There were no conflict of interest in the publication of this content

**Author contributions**

All the authors are equally contributed to research work.

**Table 1. Effect of different spacing on Shoot length (cm) and Internodal length (cm)**

**of tree type mulberry**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Shoot length (cm)** | **Internodal length (cm)** |
| **V1** | **G4** | **Mean** | **V1** | **G4** | **Mean** |
| **5ft x 5ft** | 133.00 | 127.50 | **130.25** | 5.14 | 4.82 | **4.98** |
| **6ft x 6ft** | 135.40 | 130.80 | **133.10** | 3.17 | 4.73 | **3.95** |
| **7ft x 7ft** | 134.20 | 129.20 | **131.70** | 4.54 | 5.00 | **4.77** |
| **Mean** | **134.20** | **129.20** | **131.69** | **4.28** | **4.85** | **4.56** |
| **CD (P=0.05)** | **T** | 4.39\*\* | 0.23\*\* |
| **V** | 2.53\*\* | 0.19\*\* |
| **T X V** | 7.33\* | 0.33\*\* |

\*Significant, \*\* Highly Significant, NS – Non Significant; Each value is mean of six replications and pooled mean of two crops

**Figure 1. Impact of different spacing on length of longest shoot (cm) and total shoot length (cm) of tree type mulberry**

**Figure 2. Impact of different spacing on single leaf weight (g) and weight of 100 leaves (g) of tree type mulberry**

**Table 2. Impact of different spacing on number of leaves (nos.) and leaf area (cm2) of tree type mulberry**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Number of leaves (nos.)** | **Leaf area (cm2)** |
| **V1** | **G4** | **Mean** | **V1** | **G4** | **Mean** |
| **5ft x 5ft** | 54.20 | 49.40 | **51.80** | 137.50 | 120.50 | **129.00** |
| **6ft x 6ft** | 65.30 | 58.20 | **61.75** | 140.50 | 135.00 | **137.75** |
| **7ft x 7ft** | 58.30 | 52.30 | **55.30** | 139.20 | 132.30 | **135.75** |
| **Mean** | **59.26** | **53.30** | **56.28** | **139.06** | **129.26** | **134.16** |
| **CD (P=0.05)** | **T** | 4.55\*\* | NS |
| **V** | 3.71\*\* | 8.41\* |
| **T X V** | 8.01\* | NS |

\*Significant, \*\* Highly Significant, NS – Non Significant; Each value is mean of six replications and pooled mean of two crops

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