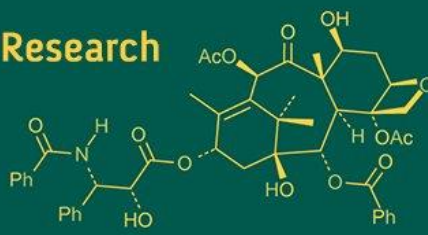
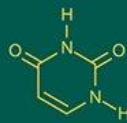


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 985-989
www.biochemjournal.com
Received: 01-05-2026
Accepted: 04-06-2026

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Effect of harvesting methods on growth parameters of mulberry

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7SI.9165>

Abstract

The investigation entitled “Comparative effect of harvesting methods on mulberry leaf yield in Kashmir” was carried out at the College of Temperate Sericulture Mirgund, SKUAST-K, where in different leaf harvesting methods during autumn were used to see their impact on spring leaf yield and yield attributing parameters in mulberry. The various parameters recorded during spring depicted significant differences among the various treatments. Among the different treatments T₆ (25% branch cut by length) has resulted in comparatively better yield being at par with the yield in Control where no leaf was plucked during the previous year. During spring, leaf yield in T₂ was just 1.03 kilograms per plant as against 2.87 kilograms per plant in T₆. Annual yield in T₂ (4.53 kg/plant) though at par with T₇, T₆, T₅ and T₃ yet the yield during spring, the main crop at farmers level, was very low. T₆ has outscored (in Leaf yield per plant) all the treatments where second flush was harvested during autumn either by defoliation or by branch cut. Leaf area was the highest 112312.83 (cm²) per plant in T₁ being at par with the 105352.83 (cm²) per plant in T₆ (25% branch cut by length) on 30th May. Leaf area was the highest 112312.83 (cm²) per plant in T₁ being at par with the 105352.83 (cm²) per plant in T₆ (25% branch cut by length) on 30th May and was recorded lowest 84348.57 (cm²) per plant in T₂ (100% leaf plucking).

Keywords: Mulberry, leaf harvesting, moisture status, branch cutting, leaf yield, sericulture

1. Introduction

Mulberry (*Morus* Sp.) is a typical East Asian plant which can be trained as bush, dwarf and tree. It is widely distributed in varied ecological and geographical zones from intensive cultivation temperate, subtropical and tropical areas to natural occurrence in forests throughout the world. This clearly indicates that mulberry possesses a high degree of adaptability to changes in the environment. The crop production is highly influenced by fixed inherent characteristics of the plant itself, the cultivation technique and the environmental conditions during the growth of the plant. The permanent characteristics of the plant are important factors in the cultivation of a crop. In order to increase the production efficiency of mulberry field, the first important step is to select better variety of mulberry. The practical characteristics are those which are important for cultivation as well as for silkworm rearing. Yield being a complex character entails information regarding its correlation that exists among important character. An understanding of correlation that exists among economic characters provides useful tool in evaluating and planning future breeding programmes. Quality of mulberry leaves is one of the major factors influencing the healthy growth of silkworms and subsequently the successful cocoon crop. This quality of mulberry leaves also depends on number of factors like mulberry variety, package of practices, control of pest and diseases. Silkworm is a highly sensitive insect and responds sharply to the changes in feed quality. High leaf moisture content has favourable effects on the palatability and assimilability of nutrients and is considered as one of the criteria in estimating the leaf quality (Sengupta *et al.* 1971) [8]. In the usual practice there is a considerable gap between the harvesting of mulberry leaf and its feeding to the silkworms and also between two successive feedings. During this long period, coupled with improper methods of storage, considerable amount of leaf moisture is lost, consequently making the leaf less palatable to the worms and the entire efforts made by the farmers prove to be futile.

Science of mulberry cultivation is an applied science which involves a detailed study of morphological, physiological and ecological features of mulberry (Mandal and Krishnaswami, 1965) [3]. The study encompasses cultivation techniques suited for these features so as to produce the best mulberry leaves for the rearing of silkworms and to obtain rich harvest of such leaves from a constant cultivation area in a reasonably economic manner. Improvement is a continuous process, it is pre-requisite to document all the variations found in the morphology in the initial stages of growth for tree improvement programmes. Mulberry leaf protein is the only source for silkworm to synthesize the commercial silk. It is impossible for the silkworm to complete the growth in the absence of mulberry. The host specificity of *Bombyx mori* L. is not only due to the nutritional superiority of leaves but primarily due to the presence of some attracting, biting and swallowing factors. The leaves are highly nutritious with high protein, sugar and mineral content. The proverb that “all mulberry will not yield cocoons” is true in the sense that mulberry leaves of bad quality will damage the silkworm crop. Since silkworm is monophagous and depends solely upon mulberry for nutrition, the quality of mulberry has a direct influence on the health and growth of silkworm. Mulberry is a sun loving, perennial, woody, either monoecious or dioecious and a deep-rooted plant. It grows in all type of soils and thrives well in slightly acidic soils with a pH ranging from 6.2 to 6.8 and at temperature ranging from 18-30 degree Celsius. The plant after proper establishment within four to five years can come to full yielding capacity and continue to yield for about seventeen years under tropical conditions without any significant deterioration in the leaf yield. However, under temperate conditions mulberry grows luxuriantly for 50-60 years. The productivity and profitability of sericulture, depends mainly on maximization of leaf yield per unit area at an economically viable cost. Mulberry (*Morus* spp.) is the only food to silkworm (*Bombyx mori* L.). Amongst different factors-feed, climate, rearing technique, silkworm race and silkworm seed, the feed i.e., the mulberry leaf has been found to contribute the maximum (38.2%) towards the success of silkworm rearing (Miyashita, 1986) [6]. In Kashmir it is found as a tree growing in a scattered manner on roadsides, river bunds, farm boundaries and other waste lands and hardly receives any attention in terms of inputs and other management practices. This may be because of less land with the farmers who prefer other crops to sericulture as it is a subsidiary occupation and practised for a period of just 20-30 days during spring (May-June). Farmers therefore feel reluctant to devote their land exclusively to mulberry cultivation and even if made to go for silkworm rearing feel short of leaf and do not get a good produce. In order to make sericulture more popular, efforts are to be made to make sericulture more remunerative which can be done by integrating sericulture with other farming practices and exploring possibilities of multiple cocoon crops in a year. The latter is possible by growing separate plantation for different crops or manipulating the harvesting schedule to harvest maximum from a plant without sacrificing the spring crop which is established as the best season for silkworm rearing under Kashmir climatic conditions. Under Kashmir conditions the winter buds in mulberry sprout during March-April and the leaf becomes available during May-June. The

leaf requirement during the 5th Instar is so tremendous that the leaf is harvested along with the shoots and fed to worms as such which incidentally coincides with the annual pruning of mulberry. The lower buds left on the stump after pruning the plant sprout again and the leaf becomes available again during August-September which is harvested by individual plucking either along with the petiole or leaving the petiole on the plant to avoid damage to the buds that will sprout in the next spring. In no case can we go for complete pruning as more than one pruning in a year can prove deleterious. Harvesting by individual plucking though helps the plant, is not practicable because it is laborious and moisture which plays a crucial role, is lost faster as compared to leaves harvested along the shoots. The present study therefore aims to find out comparative effect of harvesting methods on mulberry leaf yield in Kashmir.

2. Materials and Methods

The present investigation, “Evaluation of different Harvesting Method for Second Cocoon Crop under temperate conditions of Kashmir” was carried out at College of Temperate Sericulture, SKUAST-K Mirgund during the year (2018-2019). Established dwarf mulberry plants of Goshorami (mulberry variety mostly used for commercial rearing in the region) having uniform growth and vigour were used for the study. Cultural practices were followed as per the package of practices recommended by the College of Temperate Sericulture, SKUAST-K, and Mirgund except leaf harvesting which was done as per the experiment.

2.1 Treatment details

- T₁: No leaf plucking
- T₂: 100% leaf plucking
- T₃: 50% leaf plucking
- T₄: 25% branch cut (By No)
- T₅: 50% branch cut (By No)
- T₆: 25% branch cut (By Length)
- T₇: 50% branch cut (By Length)

The treatments were given during the 1st week of September (2018), the leaf so got was taken as the autumn leaf yield per plant. The plantation was left as such during the winter and the observations on various growth and yield parameters were recorded during spring 2019-20.

3. Parameters recorded

3.1 No. of shootlets per plant: The shoot lets were counted manually in three plants of each treatment to calculate average number of shoot lets per plant.

3.2 Average shootlet length (cm): All the shoots of three plants from each treatment were measured to calculate the average shoot let length.

3.3 Length of longest shootlet (cm): The longest shoot let among the measured shoot lets was considered as the length of the longest shoot let.

3.4 Total shoot length (m): The length of all the shoot lets of a plant was added up to get the total shoot length per plant in each of the three plants. The average shootlet length; length of longest shootlet and total shoot length were recorded by means of a measuring tape.

3.5 Leaf yield per plant (Kg): For this, leaf of each of the three plants from each treatment was harvested completely and weighed to get the leaf yield per plant.

3.6 Leaf area (cm²) per plant: Leaf area was measured by disc method suggested by Vivekanandan *et al* (1972). Fifty discs of known size were taken from each leaf sample taken for moisture studies. The discs were taken by using a punch of known diameter and the dry weight of these discs recorded after they were completely dried in an oven. The leaf area was calculated by considering the leaf yield per plant, and dry weight of the samples taken for moisture studies.

$$LA = W_s \times A/WD$$

Where, LA = Leaf area centimeter square per plant, W_s = dry weight of sample leaves per plant, WD = dry weight of fifty discs (g) and A = area of fifty discs in centimeter square.

4. Results

4.1 Growth Parameters of mulberry in spring: The various growth parameters in mulberry-number of shoot lets per plant, longest shoot let length and total shoot let length per plant are furnished in Table-1 and described here under

4.1.1 Number of shoot lets per plant: It was the highest (88.00) in T₁(No leaf plucking), being statistically different from rest of the treatments. Treatments T₃, T₄, T₅, T₆ and T₇ registered 79, 76, 71.67, 80.33 and 79.33 number of shoot lets per plant respectively. The number of shootlets on the other hand was the lowest (61.33) in T₂ (100% leaf plucking).

4.1.2 Total shoot let length per plant: It was the highest (22.73m) in T₁ being at par with the treatments T₆, T₄, T₇ and T₃ registering respectively 22.67, 22.00, 21.83 and 21.67 meter total shoot length per plant. Total shoot let length was the lowest (18.67m) in T₂ (100% leaf plucking) which was however, statistically at par with T₅ (50% branch cut by number), registering 19.33 meters of shoot length per plant

4.1.3 Longest shoot let length: The length of the longest shootlet was the maximum (47 cm) in T₁ (no leaf plucking) which was at par with the longest shoot let length of 46.67cm, 46, 00cm and 45.33cm respectively in treatments

T₅, T₆, and T₄. The length of the longest shoot let was the least (41.33cm) in T₂(100% leaf plucking).

4.1.4 Leaf yield per plant (Kg): The leaf yield harvested per plant during the spring crop, and autumn crop to get the annual yield per plant is furnished in table-2 and described in brief: During autumn, the yield per plant was maximum (3.50kg) in T₂ (100% leaf plucking) which was significantly higher than the rest of the treatments with 1.80, 1.77, 1.74, 1.29 and 0.82 kilograms per plant respectively in T₅, T₇, T₃, T₆ and T₄. In T₁ no leaf could be got as it was left unharvested. During spring highest yield per plant (3.00kg) was registered in T₁ (no leaf plucking) which was however statistically at par with (2.87kg) leaf per plant in T₆ (25% branch cut by length). Leaf yield of 2.76, 2.51, 1.03 kilograms was recorded respectively in T₇, T₄ and T₂ where as both T₃ and T₅ registered a leaf yield of 2.40 kg per plant. The annual leaf yield per plant was the highest (4.53 kg) in T₇ (50% branch cut by length) which was statistically at par with 4.53, 4.20 and 4.16 kilograms leaf per plant recorded respectively in T₂, T₅ and T₆. Annual leaf yield per plant was the least (3.00 kg) in T₁ (no leaf plucking).

4.1.5 Leaf area per plant (cm²): Leaf area per plant (cm²) is furnished in the (Table-3) the results revealed that leaf area was significantly influenced by harvesting methods. Leaf area per plant (cm²) was the highest (16512.61cm²/plant) in T₁ (No leaf plucking) and was at par with 14117.06, 15361.11, 16333.33 and 15738.72(cm²/plant) registered respectively in T₃ (50% leaf plucking), T₄ (25% branch cut By No), T₆ (25% branch cut By Length) and T₇ (50% branch cut By Length) on 1st May. Leaf area (11124.17cm²/plant) was the lowest in T₂ (100% leaf plucking). On 10th May it was the highest 57137.1157 (cm²) per plant in T₁ which was at par with 52571.56(cm²) per plant T₆ (25% branch cut by number) and it was the lowest 41455.55(cm²) per plant in T₂ (100% leaf plucking). On 20th May the leaf area again followed the same trend as on 10th May. It was the highest 81316.6757 (cm²) per plant in T₁ which was at par with 76494.45 (cm²) per plant in T₆ (25% branch cut by number) and it was the lowest 54833.33 (cm²) per plant in T₂ (100% leaf plucking). Leaf area was the highest 112312.83 (cm²) per plant in T₁ being at par with the 105352.83 (cm²) per plant in T₆ (25% branch cut by length) on 30th May. Leaf area was lowest 84348.57 (cm²) per plant in T₂ (100% leaf plucking).

Table 1: Growth parameters of mulberry in spring as influenced by leaf harvesting method during autumn

Treatments	No. of shoot lets	Total shootlet length (m)	Longest shootlet length (cm)
T ₁ (No leaf plucking)	88.00 ^a	22.73 ^a	47.00 ^a
T ₂ (100% leaf plucking)	61.33 ^e	18.67 ^c	41.33 ^d
T ₃ (50% leaf plucking)	79.00 ^b	21.67 ^b	43.00 ^c
T ₄ (25% branch cut(By No)	76.00 ^c	22.00 ^{ab}	46.00 ^a
T ₅ (50% branch cut (By No)	71.67 ^d	19.33 ^c	46.67 ^a
T ₆ (25% branch cut (By Length)	80.33 ^b	22.67 ^a	45.33 ^a
T ₇ (50% branch cut (By Length)	79.33 ^b	21.83 ^a	45.00 ^b
C.D ($p \leq 0.05$)	2.50	0.93	1.85

Table 2: Leaf yield per plant (Kg) during different season:

Treatments	Autumn	Spring	Annual
T ₁ (No leaf plucking)	0.00	3.00 ^a	3.00
T ₂ (100% leaf plucking)	3.50 ^a	1.03 ^c	4.53
T ₃ (50% leaf plucking)	1.74 ^b	2.40 ^b	4.14
T ₄ (25% branch cut (By No))	0.82 ^d	2.51 ^b	3.33
T ₅ (50% branch cut (By No))	1.80 ^b	2.40 ^b	4.20
T ₆ (25% branch cut (By Length))	1.29 ^c	2.87 ^a	4.16
T ₇ (50% branch cut (By Length))	1.77 ^b	2.76 ^b	4.53
C.D ($p \leq 0.05$)	0.068	0.132	0.44

Table 3: Leaf area per plant (cm²)

Treatments	01-May	10-May	20-May	30-May
T ₁ (No leaf plucking)	16512.61 ^a	57137.11 ^a	81316.67 ^a	112312.83 ^a
T ₂ (100% leaf plucking)	11124.17 ^b	41455.55 ^c	54833.33 ^d	84348.57 ^d
T ₃ (50% leaf plucking)	14117.06 ^a	42427.78 ^c	65989.78 ^c	93545.72 ^c
T ₄ (25% branch cut (By No))	15361.11 ^a	42933.33 ^c	64672.22 ^c	90852.86 ^c
T ₅ (50% branch cut (By No))	11822.22 ^b	43555.56 ^c	62455.56 ^c	87704.28 ^c
T ₆ (25% branch cut (By Length))	16333.33 ^a	52571.56 ^a	76494.45 ^a	105352.83 ^a
T ₇ (50% branch cut (By Length))	15738.72 ^a	50639.94 ^b	72061.11 ^b	99345.71 ^b
C.D ($p \leq 0.05$)	3688.134	4999.636	5938.752	8238.116

5. Discussion

The number of shoot lets per plant, total shoot let length and length of the longest shoot was invariably highest in T₁ (No leaf plucking) and the lowest in T₂ (100% leaf plucking) which could be due to more sprouting and more reserves of food in the shoots of plants of these treatments due to non or partial defoliation during the previous autumn that has sustained the buds during sprouting besides helping the shoots to grow more. The carbohydrate content in mulberry is the greatest during autumn and helps in better growth in spring (Hatta and Homma, 1972., Sakai, 1957) [2] the stems of mulberry tree function as major sinks for photosynthates (Satoh 1974) [7] and may complete with young expanding leaves and growing shoots in ensuing spring. T₆ (25% branch cut by length) and T₇ (50% branch cut by length) too have registered better results in the shootlet number, total shoot let length and length of the longest shoot let which could be due to cutting the apical portion of the branch that has done away with apical dominance and helped the lateral shoots to grow better and more. T₂ though yielding the highest (3.50 kg per plant) during autumn does not seem to be economic as the treatment has adverse effect on the yield of following spring which is the main crop at farmer's level in Kashmir. T₁ (No leaf plucking) during spring too has yielded 3 kilograms leaf per plant being the highest in spring. T₇ (50% branch cut by length) seems to be a better treatment for two crop system in Kashmir valley as the growth and yield of the plants is improved besides providing the farmer options for 2 crops in a year. Fresh weight of 100 leaves did not show any significant difference due to the harvesting method employed during the previous autumn supporting the fact that these features are genetically controlled as only one. The single crop of cocoons popular in Kashmir does not seem to attract the farmers of the region. Though second crop of cocoons is possible in early autumn (Baksh *et al* 2000) [11], the individual leaf plucking in absence of an easy and scientific method of leaf harvesting has not helped to pick the second crop up. (Ullah and Narasimhana 1981) have highlighted the importance of different pruning and harvesting methods to take up multiple crops in temperate regions like Japan. Complete defoliation

by individual plucking during autumn has been found to be deleterious to the mulberry plant (Mir *et al* 2005, 2008) [4, 5]. The findings of the present study also support the fact that complete defoliation on one hand being uneconomical to the farmers is not beneficial to the plant as well. This is because the development of new shoots and yield in perennials such as mulberry are greatly affected by the food material accumulated in the shoots by the leaves left intact during the previous autumn (Yamashita 1983) [10]. Thus the economic way to harvest leaf during autumn without effecting the yield and quality during the coming spring is by pruning 25-50% of the branch length. This can provide a considerable quantum of leaf for the autumn crop without affecting the next spring crop which is the main crop at farmer's level in Kashmir. Leaf area per plant (cm²) in general was the highest in T-1 (No leaf plucking) followed by T₆ and T₇ and the lowest in T₂ (100% leaf plucking). Thus all the growth, yield and physiological parameters were the least in T₂ (100% leaf plucking) and better in T₆ and T₇ as far as two crops per year are considered.

The present study aimed at maximization of leaf in mulberry through identification of a suitable harvesting method during autumn for second crop has thrown open some important findings. Harvesting method during autumn had a pronounced effect on the physiological aspects of mulberry that got reflected in the yield and yield attributing parameters in mulberry during spring season. The growth parameters like number of shoot lets, length of the longest shootlet and shoot length per plant was significantly influenced by the harvesting method employed during the autumn. Similarly the leaf yield per plant particularly during the spring crop was also influenced by the harvesting method with T₆ (25% branch cut by length) yielding the maximum 2.87 kilograms per plant. The treatment has yielded a good quality of leaf (1.77 kg/plant) during the previous autumn which is better than almost all the treatments. Complete defoliation in autumn by individual plucking (T₂) has resulted in weakening the plant that has resulted in decreased yield in spring, the main crop at farmer's level in Kashmir. The treatment T₂ (100% leaf plucking), T₆ (25% branch cut by length) has outscored all

other treatments except T₁(no leaf plucking) as far as annual leaf yield per plant there by seems to have promise for two crops system under Kashmir climate conditions.

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