



International Journal of Biology Sciences

ISSN Print: 2664-9926
 ISSN Online: 2664-9934
 NAAS Rating (2026): 4.82
 IJBS 2026; 8(3): 97-101
www.biologyjournal.net
 Received: 26-12-2025
 Accepted: 29-01-2026

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Impact of sewage wastewater application on nursery parameters of Mulberry (*Morus indica* L.)

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DOI: <https://www.doi.org/10.33545/26649926.2026.v8.i3b.598>

Abstract

A pot culture experiment was conducted at the Department of Sericulture, Forest College and Research Institute, Mettupalayam during 2018-19. Application of sewage wastewater had significantly influenced the growth, yield and biochemical parameters of mulberry. Among the treatments, lowest concentration of sewage wastewater was significantly different when compared to other treatments. The sewage wastewater with 25% concentration was noticed the increasing growth and yield parameters viz., sprouting percentage of 90.00%, shoot length of 23.11 cm, number of leaves per shoot was 9.36, number of shoots per plant of 4.39, leaf area of 16.45 cm². Among the treatments, sewage wastewater was significantly different when compared to other treatments.

Keywords: Sprouting percentage, shoot length, number of leaves per shoot, number of shoots per plant, leaf area

Introduction

India is the second largest producer of silk in the world next to China with an annual silk production of around 23,000 MT. Different types of silk, viz., Mulberry, Eri, Muga and Tasar are produced in India. Mulberry silk is the most popular variety in India, contributing more than 81% of the country's silk production. About 24,427 farmers are practicing sericulture in Tamil Nadu by cultivating 46,570 acres of Mulberry which gives an employment opportunity to 2.32 lakh persons.

Out of the total silk production in the country, the major share of Mulberry silk is from the traditional sericulture states such as Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal and Jammu and Kashmir. Mulberry is a hardy, deep-rooted perennial plant that grows continuously throughout the year under favorable climatic conditions as prevailing under the tropics and is extensively cultivated over a wide range of soils. The Mulberry leaf quality and quantity depend on the soil type, varieties, available plant nutrients in soil, agronomical practices and agro-climatic conditions. Hence, native soil fertility alone cannot be relied upon for quantity and quality of Mulberry leaf productivity.

In Mulberry, morphological traits such as plant height, number of shoots per plant, number of nodes per meter length, leaf yield, shoot yield and biological yield per plant, physiological traits, i.e., photosynthetic rate, transpiration rate and water use efficiency; biochemical traits, i.e. total protein, sugar, starch and amino acid contents in the S-54 and M5 Mulberry varieties were found increased in sewage wastewater treated plant compared to bore well water treated plant (Chikkaswamy and Paramanik, 2014b) ^[5]. Wastewater was considered as a potential water resource, because it contains a considerable amount of nutrients which may prove beneficial for plant growth (Mishra *et al.* 1997) ^[15] and hence the use of wastewater in agriculture has gained importance rapidly.

Nowadays, water scarcity is making agriculture increasingly dependent on the reuse of water which leads to the search for alternative sources of application which could substantiate the yield potential of crops and also serve as an alternative source for fresh water. Due to population explosion, it leads to water crisis for application by 2050. It helps for the conservation of water, recycling of nutrients in wastewater, reducing the direct application of organic fertilizers and minimizing the contamination of water bodies (Vasudevan *et al.* 2010) ^[23]; (Thapliyal *et al.* 2009) ^[21]; (Hylander *et al.* 2006) ^[11].

Materials and Methods

The experimental materials for the current study were the V1 (Victory-1) Mulberry variety and sewage wastewater collected from Ukkadam in Coimbatore district.

Location

A pot culture experiment was carried out in the Department of Sericulture, Forest College and Research Institute, Mettupalayam, Tamil Nadu during 2018 - 2019. It is located at longitude of 11.19' N, latitude of 77.56' E, annual rainfall of about 830 mm and temperature between 23.20 °C and 32.20 °C.

Mulberry variety

The Mulberry variety V₁ was used for the pot culture experiment. The characteristic features of this Mulberry variety are as follows: Victory-1 (V₁) is a new hybrid variety (S30×Ber. C-776) with higher leaf yield, evolved from Central Sericultural Research & Training Institute, Mysore.

Selection of Mulberry cuttings

Morus indica species cuttings were selected from FC&RI, Mettupalayam based on the morphological features viz., shoot length, number of leaves/plant, and stem girth.

The vegetative multiplication of the selected Mulberry variety was carried out by preparing hardwood cuttings, with 3-4 active buds, 15 - 20 cm long and 0.3 to 0.5 cm diameter. The cuttings were dipped in IBA (3000 ppm) solution about 15 - 20 minutes and planted in cement pots containing mixture of soil and sand.

Growth performance of cuttings at nursery

Biometric observations such as sprouting percentage (%), shoot length (cm), internodal distance (cm) and number of shoots per plant were recorded at 30 days after planting.

Sprouting percentage (%)

The number of cuttings sprouted in each treatment was counted on the 7th day after sowing. The total sprouting percentage was calculated by using the following formula.

$$\text{Sprouting percentage} = \frac{\text{Total number of cuttings sprouted}}{\text{Total number of cuttings sown}} \times 100$$

Leaf length and breadth (cm² plant⁻¹)

Leaf length and breadth were measured for individual leaf from each treatment in different replications.

Shoot length (cm): The length of the shoot was measured from base of the shoot to the tip of the fully opened leaf of the main shoot expressed in centimeter.

Plant height (cm)

The plant height was measured from the base of the plant to the tip of the fully opened leaf of all the labeled plants and mean shoot height was measured and calculated at 30 days after planting.

$$\text{Mean plant height} = \frac{\text{Total shoot length}}{\text{Number of shoots}}$$

Number of shoots per plant

The number of shoots per plant was recorded from labeled plants at an interval of 30 days after planting and number of shoots was calculated using the formula.

$$\text{Number of shoots per plant} = \frac{\text{Total number of shoots}}{\text{Number of plants}}$$

Internodal distance (cm)

Distance between two nodes was measured from main shoot and expressed in centimeter.

Number of leaves per plant

The leaves were counted from labeled plants at 30 days after planting and mean number of leaves per plant was calculated by using the formula.

$$\text{Number of leaves per plant} = \frac{\text{Total number of leaves}}{\text{Number of plants}}$$

Leaf area (cm²)

Leaf area was measured by taking the length and breadth of individual leaves from each treatment. Single leaf area is calculated by factor method.

$$\text{SLA} = L \times B \times 0.69$$

Where, SLA = Single leaf area

- L = Length
- B = Breadth
- 0.69 = Correction factor

Growth and yield parameters of Mulberry (V₁ variety)

Observations were recorded in the Mulberry plant at 30 days after planting in pots by application with different concentrations of wastewater (Table 1).

Table 1: Effect of Sewage wastewater application on propagation parameters of Mulberry V1 variety

Treatments	Sprouting percentage (%)	Shoot length (cm)	Internodal length (cm)	Number of leaves per shoot	Shoots per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm ²)
T ₁ - 25% WW	90.00 ^a	23.11 ^a	3.49 ^c	9.36 ^a	4.39 ^a	7.16 ^a	3.33 ^a	16.45 ^a
T ₂ - 50% WW	88.00 ^d	22.46 ^a	3.54 ^{bc}	8.72 ^b	4.05 ^b	7.05 ^a	2.80 ^b	13.62 ^b
T ₃ - 75% WW	85.00 ^b	22.32 ^a	3.63 ^{ab}	7.83 ^c	3.75 ^c	6.73 ^b	2.35 ^c	10.91 ^c
T ₄ - 100% WW	80.00 ^c	18.12 ^b	3.67 ^a	7.32 ^d	3.52 ^d	6.11 ^c	2.17 ^d	9.14 ^d
T ₅ - Control	75.00 ^d	17.24 ^b	3.72 ^a	7.15 ^d	3.42 ^d	6.08 ^c	1.59 ^e	6.67 ^e
Mean	83.60	20.65	3.61	8.07	3.82	6.63	2.45	11.35
SE(d)	0.98	0.50	0.05	0.14	0.07	0.12	0.03	0.15
CD (0.05)	2.10 ^{**}	1.07 ^{**}	0.10 ^{**}	0.31 ^{**}	0.15 ^{**}	0.26 ^{**}	0.06 ^{**}	0.32 ^{**}

*Significant with each other,

**Highly significant each other

Each value is the mean of four replications.

Mean followed by same alphabets are on par with each other.

Sprouting percentage (%) of Mulberry (V₁ variety)

Among the treatments, T₁ - 25% concentration of wastewater recorded the highest sprouting percentage of 90.00% in sewage wastewater followed by T₂ - 50% concentration of wastewater recorded the sprouting percentage of 88.00% in sewage wastewater, respectively. The lowest sprouting percentage of 75.00% was recorded in sewage wastewater under the treatment T₅ - tap water application.

Shoot length (cm) of Mulberry (V₁ variety)

Among the treatment combinations, T₁ - 25% concentration of wastewater recorded the highest mean shoot length of 23.11 cm in sewage wastewater followed by T₂ - 50% concentration of wastewater noticed the shoot length of 22.46 cm in sewage wastewater. The lowest mean shoot length of 17.24 cm was recorded in sewage wastewater under the treatment T₅ - tap water application.

Internodal length (cm) of Mulberry (V₁ variety)

Among the treatments, T₁ - 25% concentration of wastewater was recorded shortest mean internodal length of 3.49 cm in sewage wastewater was recorded followed by T₂ - 50% concentration of wastewater recorded the mean internodal length of 3.54 cm in sewage wastewater. The longest internodal length of 3.72 cm was recorded in sewage wastewater under the treatment T₅ - tap water application.

Number of leaves per shoot of Mulberry (V₁ variety)

Application of wastewater showed positive trend with regard to the number of leaves per shoot. Among the treatments, T₁ - 25% concentration of wastewater recorded the maximum mean number of leaves per shoot of 9.36 in sewage wastewater followed by T₂ - 50% concentration of wastewater recorded the 8.72 in sewage wastewater. The minimum mean number of leaves per shoot of 7.15 was recorded in sewage wastewater under the treatment T₅ - control.

Number of shoots per plant of Mulberry (V₁ variety)

Among the treatments, T₁ - 25% concentration of wastewater recorded the highest mean number of shoots per plant of 4.39 in sewage wastewater followed by T₂ - 50% concentration of wastewater recorded the number of shoots per plant of 4.05 in sewage wastewater. The lowest mean number of shoots per plant of 3.42 was recorded in sewage wastewater under the treatment T₅ - tap water application.

Leaf length (cm) of Mulberry (V₁ variety)

Among the treatments, T₁ - 25% concentration of wastewater recorded the highest mean leaf length of 7.16 cm in sewage wastewater followed by T₂ - 50% concentration of wastewater recorded 7.05 cm in sewage wastewater. The lowest mean leaf length of 6.08 cm was recorded in sewage wastewater under the treatment T₅ - tap water application.

Leaf breadth (cm) of Mulberry (V₁ variety)

Among the treatments, T₁ - 25% concentration of wastewater showed the maximum leaf breadth of 3.33 cm in sewage wastewater followed by T₂ - 50% concentration of wastewater recorded leaf breadth of 2.80 cm in sewage wastewater. The minimum mean leaf breadth of 1.59 cm was recorded in sewage wastewater under the treatment T₅ - tap water application.

Leaf area (cm²) of Mulberry (V₁ variety)

Among the treatments, T₁-25% concentration of wastewater recorded the highest leaf area of 16.45 cm² in sewage wastewater followed by treatment T₂ -50% concentration of wastewater recorded leaf area of 13.62 cm² in sewage wastewater. The lowest leaf area of 6.67 cm² was recorded in sewage wastewater under the treatment T₅ - tap water.

Discussion

The application of wastewater on Mulberry had a significant effect on sprouting percentage. In Mulberry, T₁ - 25% concentration of wastewater recorded the highest sprouting percentage of 90.00% in sewage wastewater. Increasing growth parameters in Mulberry were recorded at the lowest concentration of wastewater application when compared to control. The wastewater enriched with essential nutrients helped for the robust plant growth of Mulberry and cocoon productivity. The highest concentration of wastewater decreased growth parameters of the plant due to the presence of excess amount of elements in the wastewater which inhibit the sprouting and growth by affecting the metabolic activities reported by Srivastava *et al.* (1987) ^[19], Kaushik *et al.* (2005) ^[12], Lakshmi and Sundaramoorthy (2000) ^[13] and Vaithyanathan *et al.* (2014) ^[22].

The results of the present study are supported by the findings of Medhi *et al.* (2008) ^[14] and it was observed that the highest plant growth and sprouting percentage at lower concentration of paper mill wastewater in mustard, pea and rice. Similar results were observed by Singh *et al.* (2014) ^[18] in cowpea and similar such result was obtained by Dhevagi and Oblisami (2000) ^[7] who confirmed that the paper mill wastewater, at lowest concentration showed a maximum sprouting percentage.

This is also in accordance with the results of Sahai *et al.* (1979) ^[17], who found that lowest concentration of wastewater increases the germination parameters due to presence of growth promoting nutrients in the diluted wastewater. Misra and Behera (1991) ^[16] found that higher concentration of wastewater application decreases the germination percentage, chlorophyll pigment, carbohydrates and protein content in plants. Doke *et al.* (2011) ^[6] reported that higher concentration of paper mill wastewater affected the germination percentage, vegetative parameters of the green gram due to presence of high amount of organic and inorganic compounds, which becomes toxic to plants. These results are in accordance with Ezhilvannan *et al.* (2011) ^[9], who reported that higher concentration of paper mill wastewater affected the plant growth and decreased the amino acid and protein content in maize.

The application of sewage wastewater had a significant effect on shoot length. Among the treatments, T₁ - 25% concentration of wastewater recorded the highest mean shoot length of 23.11 cm in sewage wastewater. The highest shoot length might be due to the enriched wastewater with essential nutrients and in the lowest concentration of wastewater helps for the robust growth of Mulberry. Similarly, highest concentrations of wastewater (50, 75 and 100%) decrease growth parameters of the plant. Because of the presence of excess amount of elements in the wastewater which inhibits the growth by affecting the metabolic activities reported by Srivastava *et al.* (1987) ^[19], Kaushik *et al.* (2005) ^[12], Lakshmi and Sundaramoorthy (2000) ^[13] and Vaithyanathan *et al.* (2014) ^[22]. The present finding was strengthened by Chandraju *et al.* (2012) ^[3] and El-Sawaf

(2005) ^[8] revealed that lower concentration of wastewater increased the shoot length in Mulberry. The internodal length of Mulberry plants was significantly influenced by application with wastewater treatments. At 25% concentration of wastewater, shortest mean internodal length of 3.49 cm in sewage wastewater was recorded. In this present study, while increasing the dilution of wastewater, the internodal length was decreased and *vice versa*. This might be due to the presence of highest load of organic compounds in wastewater. This is in line in accordance with findings of Ganesh keremane *et al.* (2004) ^[10] reported the shortest internodal length with the application of organic formulation on Mulberry. The present findings were supported by Sori and Gebreselassie (2016) ^[20] and noticed the internodal length in 4.40 cm in kumbi Mulberry genotype. Application of wastewater showed positive trend with regard to the number of leaves per shoot. As above, at 25% concentration of wastewater treatments, maximum number of leaves per shoot, *viz.*, 9.36 in sewage wastewater was recorded. The increase in number of leaves per shoot was due to short internodal length. The present result corroborated the findings of El-Sawaf (2005) ^[8], who noticed the highest number of leaves per shoot in lower concentration of sewage wastewater.

Among the all treatments, lowest concentration of wastewater had maximum number of shoots per plant of 4.39 was recorded in sewage wastewater. The number of shoots per plant significantly increased at lower concentration and this might be due to the presence of high amount of total nitrogen content in wastewater than tap water. This work was supported by Chikkaswamy and Paramanik (2014a) ^[4] and reported that number of shoots per plant in lower concentration of wastewater application. Leaf area of Mulberry was significantly influenced by the application of wastewater. The lowest concentration of wastewater application at 25% recorded the highest leaf area of 16.45 cm² in sewage wastewater. This might be due to increase in the photosynthetic rate and water use efficiency of Mulberry. El-Sawaf (2005) ^[8] opined that application with sewage wastewater at lower concentration increased the leaf area in sorghum varieties.

Conclusion

In Mulberry, T₁ - 25% concentration of wastewater application recorded the highest sprouting percentage of 90.00% in sewage wastewater. Among the treatments, T₁ - 25% concentration of wastewater recorded the highest mean shoot length of 23.11 cm in sewage wastewater. At 25% concentration of wastewater, shortest mean internodal length of 3.49 cm in sewage wastewater was recorded. At 25% concentration of wastewater treatments, maximum number of leaves per shoot of 9.36 in sewage wastewater was recorded. Among the all treatments, lowest concentration of wastewater had maximum number of shoots per plant of 4.39 was recorded in sewage wastewater. The lowest concentration of wastewater application at 25% recorded the highest leaf area of 16.45 cm² in sewage wastewater respectively.

References

1. Anonymous. Annual report. Indian Silk; 2018a.
2. Anonymous. Annual report of Tamil Nadu Sericulture; 2018b.
3. Chandraju S, Nagendraswamy G, Chidan Kumar CS, Nagendra Swamy R. Studies on the yields of cocoons of CSR19, Kolar Gold and CSR2 × CSR4 reared fed with M5 variety of mulberry leaves cultivated by spent wash application. *Int J Pharm Biol Res.* 2012;3(2).
4. Chikkaswamy, Paramanik RC. Effect of sewage application on physio-biochemical characterization of two mulberry varieties. *J Chem Pharm Sci.* 2014a;9(4):2115-2115.
5. Chikkaswamy BK, Paramanik RC. Effects of tannery effluents on mulberry genotypes for biomass production. 2014b.
6. Doke KM, Khan EM, Rapolu J, Shaikh A. Physico-chemical analysis of sugar industry effluent and its effect on seed germination of *Vigna angularis*, *Vigna cylindrica* and *Sorghum cernum*. *Ann Environ Sci.* 2011;5(1):1-2.
7. Dhevagi P, Oblisami G. Effect of paper mill effluent on germination of agricultural crops. *J Ecobiol.* 2000;12(4):243-249.
8. El-Sawaf N. Response of *Sorghum* spp. to sewage wastewater application. *Int J Agric Biol.* 2005;7(6):869-874.
9. Ezhilvannan D, Sharavanan PS, Vijayaragavan M. Effect of sugar mill effluent on growth and amino acid and protein contents of maize (*Zea mays* L.) plants. *J Ecobiotechnol.* 2011.
10. Keremane G, Huga I, Girish I, Vanitha B, Asharani CM. Use of effective microorganisms in sericulture. *Indian Silk.* 2004;42(10):9-10.
11. Hylander LD, Kietlińska A, Renman G, Simán G. Phosphorus retention in filter materials for wastewater treatment and its subsequent suitability for plant production. *Bioresour Technol.* 2006;97(7):914-921.
12. Kaushik A, Nisha R, Jagjeeta K, Kaushik CP. Impact of long- and short-term application of a sodic soil with distillery effluent in combination with bioamendments. *Bioresour Technol.* 2005;96(17):1860-1866.
13. Lakshmi S, Sundaramoorthy P. Effect of sugar mill effluent on germination, seedling growth and biochemical changes in ragi (*Eleusine coracana* Gaertn). *Indian J Environ Ecoplann.* 2000;3(3):501-506.
14. Medhi UJ, Talukdar AK, Deka S. Effect of pulp and paper mill effluent on seed germination and seedling growth of mustard (*Brassica campestris*), pea (*Pisum sativum*) and rice (*Oryza sativa*) seeds. *Pollut Res.* 2008;27(4):437-442.
15. Mishra A, Patel S, Behera RK, Mishra BK, Behera GB. Dye-surfactant interaction: role of an alkyl chain in the localization of styrylpyridinium dyes in a hydrophobic force field of a cationic surfactant (CTAB). *Bull Chem Soc Jpn.* 1997;70(12):2913-2918.
16. Misra RN, Behera PK. Effect of paper industry effluent on growth, pigments, carbohydrates and proteins of rice seedlings. *Environ Pollut.* 1991;72(2):159-167.
17. Sahai R, Agrawal N, Khosla N. Effect of fertilizer factory effluent on seed germination, seedling growth and chlorophyll content of *Phaseolus radiatus* Linn. *Trop Ecol.* 1979;20(2):155-162.
18. Singh A, Dahiru R, Musa M, Haliru BS. Effect of osmopriming duration on germination, emergence and early growth of cowpea (*Vigna unguiculata* (L.) Walp.)

- in the Sudan Savanna of Nigeria. Int J Agron. 2014;2014:1-7.
19. Srivastava N, Sahai R. Effects of distillery waste on the performance of *Cicer arietinum* L. Environ Pollut. 1987;43(2):91-102.
 20. Sori W, Gebreselassie W. Evaluation of mulberry (*Morus* spp.) genotypes for growth, leaf yield and quality traits under southwest Ethiopian condition. J Agron. 2016;15(4):173-178.
 21. Thapliyal A, Vasudevan P, Dastidar MG. Domestic wastewater for fertigation: a solution for water recycling and application. Proc Micropol Ecohazard. 2009;6.
 22. Vaithyanathan T, Soundari M, Sundaramoorthy P. Response of black gram (*Vigna mungo* L.) to sugar mill effluent treatment. Int J Res Bot. 2014;4(1):15-18.
 23. Vasudevan P, Thapliyal A, Srivastava RK, Pandey A, Dastidar MG, Davies P. Fertigation potential of domestic wastewater for tree plantations. 2010.