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Research Article

SIGNIFICANCE OF REELING WASTE WATER ON THE BIOMETRIC TRAITS OF MULBERRY (*MORUS SP.*)

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ABSTRACT

The present study was conducted in Department of sericulture, Forest college and research institute, Mettupalayam. In the study, we analysed the impact of reeling waste water on the plant propagation and growth of mulberry cuttings, reeling water samples were collected from reeling units in vadavalli, coimabtore district. Cuttings of V1 and G4 were selected and maintained in a pot culture, frequently irrigated with reeling water at different concentrations. Observations pertained to treatments were calculated at 30,60 and 90 days after planting, from that recordings, present investigation was concluded that the sprouting and other studied biometric traits except internodal distance in both V1 and G4 shows higher value at lowest concentration of reeling waste water i.e., T2 (25% reeling waste water + 75% tap water). Highest concentration of reeling waste water reduces the sprouting as well as growth of the mulberry cuttings due to the presence of more amount of elements which affects the metabolic activities of the plants. Except T5 (100% reeling waste water) all other concentrations were exhibited better propagation and growth of mulberry cuttings.

Keywords: Growth traits, Mulberry, Reeling waste water, Sprouting per cent.

INTRODUCTION

India being an agrarian country, its economy largely depends on agriculture and its allied sectors. Sericulture is the second biggest source of employment after agriculture. Huge employment generation and unique selling point are the major two tools for sericulture in rural empowerment. India is the second largest producer of silk next to china, in the year 2022-23 the raw silk production in the country was 36582 MT (CSB report, 2023).From the past two decades, consumption of raw silk in India has increased about 60% as well as raw silk imports have decreased by 60% and the textile sector contributes 2.3% to the country GDP (Ministry of Textile, 2022). Producing one kg of silk requires more water and land than other cultivated cropsat the same time, the market price of silk is much higher than the other agricultural crops. Compare to other cash crops silk generates more economical value per unit of natural resources used. The estimate of 238 kg of leaves to produce 8.5 kg of cocoons per kg of raw silk by Patil *et al*, (2009). Total water requirement of silk depends on the farming practices, on an average 79500 L kg^{-1} under rain-fed conditions and 47800 L kg^{-1} for irrigation conditions with best farming practices (Rick J Hogeboom *et al.*, 2017).

Insufficient irrigation water availability for agriculture due to various reasons such as low rainfall, failure of monsoon or frequent droughts. In India, agriculture sector uses about 93% of water whereas industry sectors use 4% (Rakesh kumar *et al*., 2005). Even 10% of water is saved, 14 mha will benefit additionally. Experts have predicted that India could confront 40% decline in agricultural productivity around 2060s due to global farming. Crop water requirement for mulberry has been estimated around 16000 m^3 / ha per year (CSB, 2020a). Mahimasanthi, (2020) was reported that, water availability is insufficient for 84% of the farmers for their sericulture activities in Tamilnadu. In post cocoon sector water used for many activities such as boiling, reeling, re-reeling etc. For that 1000-3000 m^3 of reeling waste water is being generated per day for every 12-20 MT of silk production. Globally 16% of waste water produced from various industrial sectors like tannery, spent wash, sugarcane factory waste, sewage

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water, paper mill waste and reeling waste water. In the quest of sustainable agricultural practices, the reuse of recycled waste water has gained traction as a potential solution for water scarcity and soil management issues. Utilizing reeling waste water for irrigation ensures the consistent water supply and this is particularly beneficial in areas with limited freshwater resources (Gul *et al.,* 2021). Reeling waste water can serve as a nutrient supplement which often contains nutrients such as Nitrogen (0.13 ppm), Phosphorous (1.10 ppm), Potassium (0.23 ppm) and trace elements like Zn, Cu, Mn which promotes the root development and overall growth of mulberry (Kalpana *et al*.,2019, Garcia , *et.al.*,2015).

MATERIALS AND METHODS

This study was conducted as a pot culture experiment which was carried out in Department of Sericulture, FC&RI, Mettupalayam.

Plant samples

V1 and G4 both are high yielding mulberry varieties, cuttings of these varieties were used for this experiment, 15-20 cm long with pencil thickness healthy cuttings were taken from mulberry field. Those were dipped in IBA (3000ppm) solution for 10-15 minutes and then the cuttings were planted in pot filled with soil: sand: FYM in the ratio of 1:1:1.

Water samples

Tap water and reeling water were used as a water source for the cuttings. Reeling water samples were collected from Vadavalli reeling units.

Treatment	Treatment details
T1	Tap water
T2	25% reeling water + 75 % tap water
T3	50% reeling water + 50 % tap water
T4	75% reeling water + 25 % tap water
T5	100% reeling water

Observations pertaining to studied traits were recorded at 30, 60 and 90th day after planting. Each treatment has 3 replications and FCRD design was used for this study.

Methodology

Characteristics of reeling water could be assessed by various methodologies.

S.No	Parameters	Methods
1	Colour	--
2	Odour	--
3	pH	pH meter
4	Electrical Conductivity(ds/m)	Electrical conductivity meter
5	Total dissolved solids (ppm)	Filtration method
6	BOD (ppm)	5 days' incubation @ 20°C and titration of initial and final dissolved oxygen
7	COD (ppm)	Reflux method
8	Nitrogen (%)	Kjendahl method
9	Phosphorous (%)	photometric measurement
10	Potassium (ppm)	Photoelectric colorimeter
11	Calcium (ppm)	Titration method
12	Magnesium (ppm)	Titration method

Sprouting per cent

Sprouting observed on the 7th day after planting and sprouting per cent calculated by using the formula,

$$\textbf{Sprouting per cent} = \frac{\text{Number of Sprouted cuttings}}{\text{Total number of cuttings}} \times 100$$

Number of branches

The number of branches were counted at 30,60 and 90th day after planting and mean number of branches was calculated by using the following formula,

$$\text{Number of branches} = \frac{\text{Total number of branches}}{\text{Number of plants}}$$

Length of Shoots (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.

Number of Roots

Number of roots calculated at 90th day after planting.

Length of Roots (cm)

This was measured from the base of the longest roots to the tip of the roots.

Number of leaves

The leaves were counted in the cuttings at 30,60 and 90th day after planting and mean number of leaves per plants was calculated by using the formula.

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

Internodal Distance (cm)

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

Table 1. Comparison of the characteristics of tap water and reeling waste water.

S.No	Parameters	Tap Water	Reeling waste water
1	Colour	Colourless	Pale white
2	Odour	Odourless	Foul smell
3	pH	7.04	7.67
4	Electrical Conductivity(ds/m)	1.42	15.03
5	Total dissolved solids (mg/l)	2100	6800
6	Dissolved oxygen (mg/l)	8.9	0.21
7	BOD (mg/l)	4.8	25.4
8	COD (mg/l)	84	704
9	Nitrogen (mg/l)	9.33	17.6
10	Phosphorous (mg/l)	1.31	1.10
11	Potassium (mg/l)	63.8	59.22
12	Calcium (mg/l)	90.7	110
13	Magnesium (mg/l)	26.4	46.0

RESULTS AND DISCUSSION

Table 1 represents the physico chemical traits of reeling waste water. It looks pale white in colour and it became turbid due to the presence of silk proteins. During the process of cocoon reeling sericin and fibroin were dissolves in reeling water and it changes the colour of reeling water (Ashrith *et al*, 2019). On the other hand, turbid water could reduce the level of dissolved oxygen, biological oxygen demand and chemical oxygen demand due to the presence of organic and inorganic salts in the reeling waste water. It also increases the hardness of water (Buvaneswari *et al*.,2013).Reeling waste water have foul smell by cause of anaerobic decomposition of organic substances by microorganisms which are present in the reeling waste water (Vijayaraghavan *et al*.,2011). Analysed pH value of reeling waste water is in alkaline condition (7.67) due to the presence of carbonates and bicarbonates. The findings were contrary to the results of Kalpana *et al*, (2019), they were reported that the reeling waste water was in acidic condition.Electrical conductivity recorded in reeling waste water is 15.03 dsm^{-1} which was higher than the BIS prescribed limit. EC is the concentration of conductive ions in the water, ions originated from chlorides, alkalis, carbonate, sulphide compounds and dissolved salts (Kuzhali *et al*., 2012).

Table 2. Impact of reeling waste water on the growth traits of V1 mulberry**.**

S.No	Trait	DOP	T_1 (control)	T_2	T_3	T_4	T_5	Mean	SE(d)	CD
1	Sprouting per cent	7th day	70.00	90.00	88.00	82.00	80.00	82.00	3.52	7.39*
2	Number of leaves/ branch	30th day	3.41	4.95	4.10	3.94	3.60	4.00	0.27	0.56**
		60th day	5.27	7.52	7.07	6.58	6.01	6.49	0.40	0.83*
		90th day	9.22	11.33	10.33	10.07	9.88	10.17	0.34	0.72*
3	Number of branches/ plant	30th day	1.59	2.23	2.18	2.00	1.51	1.90	0.15	0.31*
		60th day	2.75	3.10	3.72	2.95	2.77	3.06	0.18	0.37*
		90th day	3.72	5.71	5.02	4.88	4.10	4.67	0.35	0.74**
4	Shoot length (cm)	30th day	12.56	16.03	16.56	15.90	14.15	15.04	0.74	1.56**
		60th day	16.90	24.66	28.11	29.15	22.03	24.17	2.21	4.65*

		90th day	22.25	31.05	40.50	38.64	30.33	32.55	3.27	6.86*
5	Internodal distance (cm)	30th day	5.70	5.15	5.36	5.49	5.63	5.47	0.10	0.21*
		60th day	5.65	5.10	5.30	5.42	5.41	5.38	0.09	0.19*
		90th day	5.62	5.03	5.26	5.35	5.39	5.33	0.10	0.20**
6	Number of roots/ plant	90th day	5.25	8.72	7.29	7.02	6.41	6.94	0.57	1.19*
7	Roots length (cm)	90th day	12.39	19.97	17.36	17.02	15.12	16.37	1.26	2.65**

*Significant with each other; **Highly significant with each other

Table 3. Impact of reeling waste water on the growth traits of G4 mulberry.

S.No	Trait	DOP	T_1	T_2	T_3	T_4	T_5	Mean	SE(d)	CD
1	Sprouting per cent	7th day	71.00	92.00	86.00	85.00	80.00	82.80	3.51	7.38**
2	Number of leaves/ branch	30th day	4.15	5.33	5.09	4.98	4.41	4.79	0.22	0.46**
		60th day	4.91	7.02	7.34	6.21	6.01	6.29	0.43	0.89**
		90th day	9.10	12.23	11.02	10.39	10.15	10.58	0.52	1.08**
3	Number of branches/ plant	30th day	1.91	3.06	2.77	2.93	2.02	2.54	0.24	0.50**
		60th day	2.67	5.82	4.13	4.49	3.19	4.06	0.55	1.15**
		90th day	3.52	6.02	5.66	5.31	4.86	5.07	0.43	0.91**
4	Shoot length (cm)	30th day	13.05	15.15	17.03	14.13	12.55	14.38	0.80	1.68**
		60th day	19.53	28.71	26.10	25.11	24.33	24.76	1.50	3.15**
		90th day	27.90	39.75	35.65	33.77	30.33	33.48	2.06	4.33**
5	Internodal distance (cm)	30th day	6.02	5.35	5.40	5.51	5.68	5.59	0.12	0.25**
		60th day	5.95	5.20	5.35	5.49	5.61	5.52	0.13	0.27**
		90th day	5.95	5.18	5.33	5.35	5.50	5.46	0.13	0.28**
6	Number of roots/ plant	90th day	5.31	8.06	7.92	7.02	6.36	6.93	0.51	1.07**
7	Roots length (cm)	90th day	15.22	20.41	18.50	16.96	16.01	17.42	0.93	1.94**

*Significant with each other; **Highly significant with each other

Total dissolved solids are the measure of inorganic and organic salts dissolved in the water (Mahananda *et al*., 2010), TDS present in the reeling waste water (6800mg/l) is triple times higher than the TDS present in tap water (2100mg/l).Dissolved oxygen is defined as the amount of oxygen present in the water which is essential to the growth and reproduction of aerobic aquatic organisms. Average limit for DO is 8-9 mg/l, which will support for the living of microorganisms. In this study DO level in reeling waste water is 0.21 mg/l and calculated value of DO in tap water is 8.9 mg/l. Biological Oxygen Demand (BOD) is the amount of dissolved oxygen utilized by the aerobic microorganisms for breakdown the organic compounds at a specific temperature. Temperature, pH, microbes, organic and inorganic elements were influences the rate of oxygen consumption. BOD presented in reeling waste water is 25.4 mg/l , it indicates that the effluent was not suited for living, if organism present in the sample, it become stressed, suffocate and die (Lokhande *et al*.,2011). Chemical Oxygen Demand (COD) is the measure of oxygen required for chemical reactions to decompose organic substances. High amount of COD present in reeling waste water (704 mg/l), it indicates the presence of high level of pollutants in the sample (Das *et al*., 2004). Reeling waste water contains essential nutrients such as nitrogen (17.6 mg/l), phosphorus (1.10 mg/l), potassium (59.22 mg/l), calcium (110 mg/l) and magnesium (46 mg/l) which promotes the development of root and shoots of mulberry cuttings and the findings were supported by Ambika *et al*., (2011) and Garcia *et al*., (2019)

Table 2 and Table 3 represent the values of biometric traits of V1 and G4 mulberry cuttings respectively. In V1, sprouting per cent was higher in T2 (90%) followed by T3 (88%), T4 (82%) and T5 (80%). Compare to control all other treatments have high values for sprouting per cent. Similarly, in G4 highest sprouting per cent was observed in T2 (92%). These results were concordance with the findings of Srivastava *et al.*, (1987), Kaushik *et al.*, (2005), Vaithiyanathan *et al*., (2016) and supported that the highest dilution of effluent provides a required amount of nutrients for better sprouting and initial growth of mulberry cuttings. Among the treatments T2- 25% reeling waste water irrigation recorded the highest number of leaves in G4 variety (12.23) and 11.33 number of leaves in V1 variety on 90th day. The Number of leaves were observed and recorded on different growth stages like 30, 60, 90 days after planting. On the 30th day, the control plants of variety V1 recorded 3.41, when was 4.15 in the G4 variety. This proves that the tap water fails to provides necessary nutrients as compared to the reeling water and this is on par with the findings of Kalpana *et al*., (2019).While considering, the results of 60th day seedling, the cuttings irrigated with tap water alone in V1 and G4 recorded 5.27 and 4.91 respectivelyin both the varieties. On the other hand, in 100 per cent reeling waste water irrigation impact on the variety V1 and G4values (6.01) are on par with each other. This values proved that, while increasing the concentration of reeling waste water irrigation the number of leaves will get decreased gradually, this is in line with the results of Garcia *et al*., (2019).

In 25 per cent reeling waste water irrigation, the variety V1 recorded 7.52 and G4 recorded 7.02 on the 60th day, which is found to be superior to all other treatments. Considerable amount of micronutrients which may increase the photosynthetic rate and water use efficiency of the plants (Sarker *et al.*, 2000).The presence of such micronutrients in the reeling waste water, may also attracts a considerable amount of microbes and that may also help the plants by secreting growth promoting substances required for the plant growth (Rattan *et al*., 2005 and Bashir Ahmed *et al*., 2006). Among the treatments in G4 variety T2 (25% concentration of reeling waste water) showed the highest value for number of shoots 3.06, 5.82 and 6.02 in 30th, 60th and 90th day respectively. Likewise, in V1 variety T2 exhibits the values for number of shoots were2.23 on 30th day, 3.10 on 60th day and 5.71 on 90th day after planting. Present findings were supported by Misra and Behera (1991).

On the 30th,60th and 90thday, the control plants of variety V1 recorded 12.56 cm,16.9 and 22.25cm shoot length, when was 13.05 cm, 19.53 and 27.90cm in the G4 variety. 25 per cent concentration of reeling waste water could promotes better shoot length than other treatments, the variety V1 recorded 16.03 cm and the variety G4 recorded 15.15 cm on the 30th day. Since in 60th day the variety V1 recorded 24.66 cm shoot length and G4 variety has recorded 28.71 cm shoot length on the 90th day, 31.05 cm in variety V1 and 39.75 cm in variety G4. This may be due to the early and direct availability of essential nutrients like Nitrogen and Potassium in the reeling waste water. These findings were coinciding with the results of Subramani *et al*., (2012). Lowest internodal distance was considered as a beneficial trait attributed to yield because of the shoot which has less nodal distance contains more number of leaves. According to this, T2 (25% reeling waste water) recorded the shortest Internodal distance of 5.06 cm in V1 and 5.18 cm on 90th day. While increasing the concentration of the reeling waste water, the Internodal distance also increased. In T3 (50 per cent reeling waste water), V1 variety recorded the Internodal distance of 5.26 cm and the variety G4 recorded the internodal distance of 5.33 cm. In control tap water alone, the variety V1 recorded the intermodal distance of 5.62 cm and G4 recorded the intermodal distance of 5.95 cm. Since in T4, internodal distance value observed in V1 and G4 were on par with each other (5.35 cm). Apart from that T5 (100%) has highest internodal distance at 90th day, which was superior to the other treatments (5.39 cm in variety V1 and 5.50 cm in variety G4). On account of reeling waste water irrigation internodal distance was decreased in frequent intervals, in G4 variety, at 30th day observation of internodal distance in T2 was 5.35cm and at 90th day it has been 5.18cm in the same concentration. The observations of the present study are consistent with the results reported by Ashrith *et al*., (2019) reported that the utilization of reeling waste water had a notable impact on internodal distance.

Among the treatments T2 had highest number of roots in both V1 (8.72) and G4 (8.06) followed by T3 had 7.29 number of roots in V1 and 7.92 in G4. Lowest number of roots was recorded in control plants, 5.25 in V1 and 5.31 in G4. The results indicated that the response of reeling waste water is higher in G4 than V1 and also the better response was observed in higher dilution of reeling waste water. Longest root length was observed in T2 (25% concentration of reeling waste water) 19.97cm in V1 and 20.41 in G4 variety. On the other hand, shortest root length was recorded in control plants 12.39cm in V1 and 15.22cm in G4 variety, followed by T5-100% concentration of reeling waste water had 16.01cm root length in G4 and 15.12 in V1 variety. These results were supported by Garcia *et al*., (2019) and reported that the presence of essential nutrients in reeling waste water promotes the rooting per cent and length of the roots in mulberry.

CONCLUSION

Present investigation on the impact of reeling waste water on two mulberry varieties concludes that the highest dilution of reeling waste water contains required amount of nutrients and it promotes sprouting as well as growth of mulberry cuttings better than other concentrations. High concentration of reeling waste water constantly reduces the plant growth due to the presence of excess amount of nutrients. At the same time compare to V1, G4 respond well to reeling waste water and it shows superior results in propagation and growth traits.

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