Original Research Article

IMPACT OF REELING EFFLUENT IRRIGATION ON GROWTH AND YIELD OF V1 MULBERRY VARIETY

ABSTRACT

A field experiment was conducted during 2022-2023 at Department of Sericulture, UAS, GKVK, Bengaluru to study the growth and development of mulberry irrigated with various proportion of reeling effluent and borewell water along with recommended dose of NPK and FYM. Five treatments were laid out in RCBD with four replications. Among all the treatments application of 100 per cent reeling effluent for irrigation to mulberry plant has recorded highest growth parameters on 30, 45 and 60 DAP, *viz*., number of shoots (20.25, 23.65 and 28.05 No.), highest shoot height (49.74, 109.32 and 137.32 cm), plant height (138.23, 197.47 and 225.47 cm), internodal distance (5.01, 5.58 and 5.82 cm), number of leaves (185.80, 424.40 and 542.90 No.), leaf area (105.21, 204.33 and 219.33) and leaf yield (940.94 g/plant and 58.07 tonnes/ha/yr on 60 DAP, respectively) compare to control.

Key words**:** Reeling effluent, Bore well water, Mulberry.

1. INTRODUCTION

Mulberry is a fast-growing deciduous woody perennial plant having deep root system, grown under varied climatic conditions ranging from temperate to tropical region. The total area under mulberry cultivation in India is about 2.42 lakh hectare. In Karnataka, about 80 per cent of the mulberry region is under the irrigated condition and high yielding mulberry variety (V1) is being cultivated (Anonymous, 2022). Vegetative part is the main component of mulberry, which is influenced by mulberry cultivars, environmental factors, different kinds of soil, chemical fertilizers, methods of irrigation, ideal plant spacing, plant population, appropriate pruning schedules and proper harvesting techniques are some of the crucial elements that encourage production of high-quality leaves. Among these factors irrigation also plays a significant function in improving the quality and quantity of mulberry leaves which directly affects the growth and development of silkworm (Kalpana *et al*., 2018). Water plays several important roles in the soil-plant system, including distributing nutrients throughout the plant, acting as a solvent in biochemical reactions, acting as a medium for solute distribution, assisting in temperature regulation, and providing hydrogen for photosynthesis (Subbaswamy *et al*., 1987). Nearly every component of agriculture relies on water, which ultimately affected crop production. If plants are not properly watered, even good seeds and fertilizer cannot accomplish their full growth.

Waste water generated from different sources can be used as alternate source irrigation, which helps to partially alleviate the scarcity of ground water. Water conservation, nutrient recycling in waste water, a reduction in the direct use of organic fertilizers and a reduction in water body pollution are all aided by the alternative agricultural method known as waste water irrigation (Vasudevan *et al*., 2010). Recently waste water is being applied to agricultural lands to substitute nutritional requirement of crops. In certain areas due to scarcity of water farmers are using the effluent as source of irrigation water as well as source of plant nutrients. This is supposed to solve the problem of disposal as well as source of irrigation and nutrients for crop production. Using different types of waste water such as sewage water, distillery spent wash, silk reeling effluent and industrial waste discharge for irrigation beneficial for the growth and development of mulberry plants. Particularly, using reeling waste water in mulberry cultivation has shown positive effects in mulberry growth and development (Kalpana *et al*., 2018).

India is the second largest raw silk-producing country with an annual production of 15818 MT in 2021-2022. During the production of silk fibre, a considerable quantity of waste water is generated from silk reeling units. It was estimated that 1.000-3.000 m³ of reeling effluent is being generated per day for every 12-20 tonnes of silk fabric production (Akter, 1998). Reeling effluent consist of major nutrients like nitrogen (13.57 mg/l), phosphorus (1.15 mg/l), potassium (22.68 mg/l) and minor nutrients like calcium, magnesium and chloride (109.6 mg/l, 37.44 mg/l and 28.4mg/l, respectively). So, utilization of wastewater for the cultivation of mulberry is effective and eco-friendly. In this background an attempt was made to study the effect of reeling effluent irrigation on growth and yield of mulberry.

2. MATERIAL AND METHODS

An investigation entitled "Impact of reeling effluent irrigation on the performance of mulberry and its impact on cocoon production" was carried out in the Department of Sericulture, College of Agriculture, GKVK, Bengaluru. The primarily reeling effluent was collected from Bagaluru reeling unit and mixed in water tank as per treatments and irrigated to mulberry crop according to the treatment combination. The total water requirement for mulberry cultivation under red sandy loamy soil is 13,51,350 liters per crop per ha. The mulberry crop was irrigated through flood irrigation system once in 7 days for 70 days (totally 10 irrigations) (Dandin and Giridhar 2014). The calculated total water requirement was 19,460 litres for entire crop duration

Treatment details

Treatments	Treatment details
T_1	100 % borewell water
T_2	25 % reeling effluent + 75 % borewell water
T_3	50 % reeling effluent + 50 % borewell water
T_4	75 % reeling effluent + 25 % borewell irrigation
T_5	100 % reeling effluent

Note: NPK and FYM applied has per recommendation.

Field Experiment was conducted during March 2022 to May 2023 laid out as per Randomized Complete Block Design (RCBD). The treatments were replicated four times. The mulberry variety Victory 1 which is popularly known as V1 was used for the experiment. A sample consisting of five plants out of 32 plants per treatment was randomly selected and labelled for recording various biometric observations. The observations on various growth parameters were recorded at 30th, 45th and 60th days after pruning (DAP).

3. RESULT AND DISCUSSION

3.1 No. of shoots per plant

There was significant difference observed in number of shoots per plant when mulberry irrigated with various proportion of reeling effluent and borewell water along with recommended dose of NPK and FYM.

At 30th DAP, higher number of shoots was recorded T_5 (20.25) which was followed by T_4 (18.90) whereas, lesser number of shoots was observed in T_1 (17.05). At 45th DAP, significantly higher number of shoots was observed in T_5 (23.65) which was followed by T_4 (22.55) whereas, lesser number of shoots was observed in T_1 (20.15). Similar trend was noticed at 60th DAP with regards to number of shoots where significantly higher number of shoots was observed in T_5 (28.05) which was followed by T_4 (26.75) whereas, lesser number of shoots was observed in T_1 (23.65) (Table 1).

The increased number of shoots might be due to higher nutrient content in reeling effluent that is beneficial for plant growth. Reeling effluent contains nutrient such as nitrogen, phosphorus, potassium and micronutrients that are essential for plant growth and development (Kalpana *et al.*, 2019). The results are compared with the results of Chikkaswamy *et al.* (2014) reported that sewage water irrigation dramatically boosted the shoot counts of two mulberry varieties *i.e.*, S-54 and M-5 by 8.8 and 10.8 respectively when compared to bore well water irrigation (8.4 shoots in S-54 and 9.6 shoots in M-5).

The results of present study comparable to those of Ravindra Chary (2000) recorded application of sewage effluent from the Vrishabhavathy River with recommended dose of FYM and NPK resulted in higher shoot count (20.10). The enhanced growth of the mulberry plants were attributed to the presence of microorganisms within the sewage effluent which actively secreted growth-stimulating compounds, enzymes, hormones and other essential nutrients imperative for the optimal development of the plants.

Table 1: Influence of reeling effluent irrigation on number of shoots in V1 mulberry at 30th, 45th and 60th DAP

Treatments	No. of shoots/ plant		
	30 DAP	**45 DAP**	**60 DAP**
T_1-100 % bore well water irrigation (control)	17.05	20.15	23.65
T_2 -25 % reeling effluent + 75 % bore well water irrigation	17.25	20.60	24.10
T_3 -50 % reeling effluent + 50 % bore well water irrigation	18.20	21.45	24.95
T_4 -75 % reeling effluent + 25 % bore well water irrigation	18.90	22.55	26.75
T_5 -100 % reeling effluent irrigation	20.25	23.65	28.05
F-test	*	*	*
S. Em ±	0.31	0.36	0.44
$CD_{0.05}$	0.96	1.13	1.36

Note: *significant at 5%, DAP- Days After Pruning

3.2 Mean shoot length (cm):

There was significant difference observed in shoot length when mulberry irrigation with various proportion of reeling effluent irrigation along with bore well water.

At 30th DAP, higher mean shoot length (49.74 cm) was recorded in which was followed by T4 (43.34 cm) whereas, shortest mean shoot length observed in T_1 (32.55 cm). At 45th DAP, significantly longest shoot length was observed in T_5 (109.32 cm) which was followed by T_4 (106.48 cm) whereas, shortest mean shoot length was observed T_1 (91.47 cm). Similar trend was noticed at 60th DAP with regards to shoot length where significantly longest shoot length was observed in T_5 (137.32 cm) followed by T_4 (134.48 cm) whereas, shortest mean shoot length was observed in T_1 (119.47 cm) (Table 2).

In the present study reeling effluent irrigated mulberry plants recorded highest shoot height which might be due to irrigation of reeling effluent which has higher nutrient content compared to bore well water. These findings were in conformity with Garcia *et al*.(2015) reported that mulberry plants displayed a substantial increase in shoot length (104.07 cm) when irrigated with recycled reeling effluent compared to conventional tap water.

The obtained results aligned with Ravindra Chary (2000) reported notable increase in shoot length (90.6 cm) with the application of sewage effluent from the Vrishabhavathy River with the recommended doses of FYM and NPK.

Table 2: Influence of reeling effluent irrigation on mean shoot length in V1 mulberry at 30th, 45th and 60th DAP

Treatments	Mean shoot length (cm)		
	30 DAP	**45 DAP**	**60 DAP**
T_1-100% bore well water irrigation (control)	32.55	91.47	119.47
T_2 -25% reeling effluent + 75% bore well water irrigation.	38.76	94.76	122.76
T_3 -50% reeling effluent + 50% bore well water irrigation	40.13	101.98	129.98
T_4 -75% reeling effluent + 25% bore well water irrigation	43.34	106.48	134.48
T_5 -100% reeling effluent irrigation	49.74	109.32	137.32
F-test	*	*	*
S. Em ±	1.59	2.20	2.20
$CD_{0.05}$	4.91	6.77	6.77

Note: *significant at 5%, DAP- Days After Pruning

3.3 Plant height (cm):

There was significant difference observed in plant height when mulberry irrigation with various proportion of reeling effluent irrigation along with borewell water (Table 3). At 30th DAP, higher plant height was observed in T_5 (138.23 cm) followed by T_4 (132.10 cm) whereas, lesser plant height was observed in T_1 (116.00 cm). At 45th DAP, significantly higher plant height was observed in T_5 (197.47 cm) followed by T_4 (194.96 cm) whereas, lesser plant height was observed T_1 (178.19 cm). Similar trend was noticed at 60th DAP with regards to plant height where significantly higher plant height was observed in T_5 (225.47 cm) followed by T_4 (222.97 cm) whereas, lesser plant height was observed in T_1 (206.19 cm).

The increased plant height in mulberry might be due to increased photosynthetic rate and water use efficiency when irrigated with raw sewage water (Paramanik, 2015). The current findings are supported by Chikkaswamy *et al*. (2014) reported that two mulberry varieties (S-54 and M-5) resulted in a significant increase in plant height. Specifically, the plant height for S-54 reached 142.28 cm while M-5 reached 166.70 cm. Similarly, Si *et al*. (2018) recorded that application of 100 per cent sewage sludge led to a notable increase in plant height reaching 102.12 cm, representing a 12.1per cent increase compared to the control group.

Table 3: Influence of reeling effluent irrigation on plant height in V1 mulberry at 30th, 45th and 60th DAP

Treatments	**Plant height (cm)**		
	30DAP	**45DAP**	**60DAP**
T_1- 100% bore well water irrigation (control)	116.00	178.19	206.19
T_2 -25% reeling effluent + 75% bore well water irrigation.	121.33	183.04	211.05
T_3 -50% reeling effluent + 50% bore well water irrigation	123.65	189.90	217.91
T_4 -75% reeling effluent + 25% bore well water irrigation	132.10	194.96	222.97
T_5 -100% reeling effluent irrigation	138.23	197.47	225.47
F-test	*	*	*
S. Em ±	4.23	2.12	2.13
$CD_{0.05}$	13.04	6.56	6.56

Note: *significant at 5%, DAP- Days After Pruning

3.4 Internodal distance (cm):

There was significant difference observed in internodal distance when mulberry irrigation with various proportion of reeling effluent irrigated along with bore well water (Table 4). At 30th DAP, shorter internodal distance was observed in T_5 (5.01 cm) followed by T_5 (5.20 cm) whereas, higher internodal distance was observed in T_1 (5.60 cm). At 45th DAP, significantly shorter internodal distance was observed in T_5 (5.49 cm) followed by T_4 (5.58 cm) whereas, higher internodal distance was observed in T_1 (5.81 cm). Similar trend was noticed at 60th DAP with regards to internodal distance where significantly shorter internodal distance was observed in T_5 (5.73 cm) followed by T_4 (5.82 cm) whereas, higher internodal distance was observed in T_1 (6.05 cm).

The findings of the current study are consistent with the results reported by Chikkaswamy *et al*. (2014) reported that the utilization of sewage water for irrigation had a significant impact on two mulberry varieties (S-54 and M-5). This impact was particularly evident in a notable reduction in internodal distances in S-54 to 15.2 nodes per meter when compared to borewell irrigation, which resulted in 14.6 nodes per meter. Similarly, for M-5, the internodal distance decreased to 18.1 nodes per meter compared to the 17.1 nodes per meter observed with borewell irrigation.

Table 4: Influence of reeling effluent irrigation on intermodal distance of V1 mulberry at 30th, 45th and 60th DAP

Treatments	Internodal distance (cm)		
	30 DAP	**45 DAP**	**60 DAP**
T_1- 100% bore well water irrigation (control)	5.60	5.81	6.05
T_2 -25% reeling effluent + 75% bore well water irrigation.	5.48	5.77	6.01
T_3 -50% reeling effluent + 50% bore well water irrigation	5.41	5.73	5.98
T_4 -75% reeling effluent + 25% bore well water irrigation	5.20	5.58	5.82
T_5 -100% reeling effluent irrigation	5.01	5.49	5.73
F-test	*	*	*
S. Em ±	0.06	0.03	0.04
$CD_{0.05}$	0.20	0.16	0.12

Note: *significant at 5%, NS- Non significant, DAP- Days after pruning

3.5 Number of leaves per plant

There was significant difference observed in number of leaves when mulberry irrigation with various proportion of reeling effluent irrigation along with borewell water. At 30th DAP, higher number of leaves was observed in T_5 (185.80) followed by T_4 (163.15) whereas, lesser number of leaves was observed in T_1 (120.60). At 45th DAP, significantly higher number of leaves was observed in T_5 (424.40) followed by T_4 (387.35) whereas, lesser number of leaves was observed T_1 (253.30) (Table 5). Similar trend was noticed at 60th DAP with regards to number of leaves where significantly highernumber of leaves was observed in T_5 (542.90) followed by T_4 (505.85) whereas, lesser number of leaves was observed in T_1 (371.80) (Table 10). The increased number of leaves might be due to the reduction in the internodal distance in mulberry apparently is due to the supply of reeling effluent containing macro nutrients and micro nutrients, which increased number of internodes and in turn gave rise to more number of leaves and leaf area per plant.

The results of present study align with the discoveries made by Ravindra Chary (2000) documented a noteworthy increased in the number of leaves per plant (243.00) when raw sewage effluent from the Vrishabhavathy River was applied with recommended doses of FYM and NPK. This result was also comparable to the use of filtered effluent, which resulted in 238.2 leaves and lowest number of leaves per plant observed in bore well water irrigated mulberry.

Table 5: Influence of reeling effluent irrigation on number of leaves in V1 mulberry at 30th, 45th and 60th DAP

Treatments	No. of leaves/plant		
	30DAP	**45DAP**	**60DAP**
T_1- 100% bore well water irrigation (control)	120.60	253.30	371.80
T_2-25% reeling effluent + 75% bore well water irrigation.	139.15	297.90	416.40
T_3 -50% reeling effluent + 50% bore well water irrigation	145.75	342.40	460.90
T_4 -75% reeling effluent + 25% bore well water irrigation	163.15	387.35	505.85
T_5 -100% reeling effluent irrigation	185.80	424.40	542.90
F-test	*	*	*
S. Em ±	2.01	6.37	6.38
$CD_{0.05}$	6.20	19.65	18.54

Note: *significant at 5%, NS- Non significant, DAP- Days after pruning

3.6 Leaf area (cm^2)

There was significant difference observed in leaf area when mulberry irrigation with various proportion of reeling effluent irrigation along with borewell water (Table 6).

At 30th DAP, larger leaf area was observed in T_5 (105.21 cm^2) followed by T_4 (101.12 cm^2) whereas, smaller leaf area was observed in T_1 (83.62 cm^2). At 45th DAP, significantly larger leaf area was observed in T_5 (204.33 cm^2) followed by T_4 (189.49 cm^2) whereas, smaller leaf area was observed in T_1 (149.99 cm^2). Similar trend was noticed at 60th DAP with regards to number of leaves where significantly larger leaf area was observed in T_5 (219.33 cm^2) followed by T_4 (204.49 cm^2) whereas, smaller leaf area was observed in T_1 (164.99 cm^2).

The larger leaf area was observed in the reeling effluent compared to borewell water might be due to the irrigation of reeling effluent which has more NPK content than borewell water which influence the growth and development of mulberry.The results of the current study align with Ravindra Chary (2000) recorded increased leaf area per plant (1376.30 cm^2) when sewage effluent from the Vrishabhavathy River was applied with recommended doses of FYM and NPK compared to borewell water irrigated plot.

Similarly, Rao *et al*. (2011) who noted a decrease in internodal distance in mulberry irrigated with sewage water which has more macro and micro nutrients. This nutrient-rich supply led to an increase in the number of internodes, consequently resulting in greater number of leaves and an expanded leaf area per plant.

Table 6: Influence of reeling effluent irrigation on leaf area of V1 mulberry at 30th, 45th and 60th DAP

Treatments	**Leaf area (cm^2)**		
	30DAP	**45DAP**	**60DAP**
T_1- 100% bore well water irrigation (control)	83.62	149.99	164.99
T_2 -25% reeling effluent + 75% bore well water irrigation.	90.00	156.20	171.21
T_3 -50% reeling effluent + 50% bore well water irrigation	92.60	170.94	185.94
T_4 -75% reeling effluent + 25% bore well water irrigation	101.12	189.49	204.49
T_5 -100% reeling effluent irrigation	105.21	204.33	219.33
F-test	*	*	*
S. Em ±	0.19	3.63	3.63
$CD_{0.05}$	3.62	11.20	15.56

Note: *significant at 5%, NS- Non significant, DAP- Days after pruning

3.7 Leaf yield (g/plant and tonnes/ha/yr)

At 60th DAP, leaf yield of individual plant differed significantly in mulberry garden irrigated with reeling effluent (Table 6). However, higher leaf yield was observed in T_5 (940.94 g plant^{-1} and 58.07 tonnes ha^{-1}) followed by T_4 (871.28 g plant^{-1} and 53.77 tonnes ha^{-1}), whereas lowest leaf yield was observed in T_1 (734.68 g plant^{-1} and 45.34 tonnes ha^{-1}). Kumar *et al.* (2022) recorded significantly higher leaf yield (54319 kg) in 100 per cent raw sewage water irrigation, compared to borewell water irrigated plot (46760 kg) in mulberry. Similarly, Ravindra Chary (2000) who recorded leaf yield of 42,276 kilograms per hectare per year when sewage effluent applied with the recommended doses of FYM and NPK compared to borewell water irrigation that yielded 37,928 kilograms per hectare per year.

Table 7: Influence of reeling effluent irrigation on leaf yield of V1 mulberry at 60th DAP

Treatments	Leaf yield (g/plant)	Leaf yield (tonnes/ha/yr)
T_1- 100% bore well water irrigation (control)	734.68	45.34
T_2 -25% reeling effluent + 75% bore well water irrigation.	770.86	47.58
T_3 -50% reeling effluent + 50% bore well water irrigation	839.43	51.81
T_4 -75% reeling effluent + 25% bore well water irrigation	871.28	53.77
T_5 -100% reeling effluent irrigation	940.94	58.07
F-test	*	*
S. Em ±	26.16	16.14
$CD_{0.05}$	80.60	49.75

Note: *significant at 5 %. NS- Non significant. DAP- Days after pruning

4. CONCLUSION

Reeling effluent contains significant quantities of essential nutrients, required for growth and development of plant, offering an effective and eco-friendly solution for alternate source of iriigation. Among the different treatments 100 per cent reeling effluent irrigation has recorded maximum growth and yield attributes *viz*., Number of shoots/plant, mean shoot length, plant height, internodal distance, No. of leaves/ plant, leaf area, leaf yield compare to all other treatments.

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