IMPACTOFREELINGEFFLUENTIRRIGATIONONGROWTHANDYIELD OFV1MULBERRYVARIETY

ABSTRACT

A field experiment was conducted during 2022-2023 at Department of Sericulture, UAS, GKVK, Bengaluru to study the growth and development of mulberry when irrigated with various proportions of reeling effluent and borewell water along with recommended doses 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 the 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.. An overview of the study revealed that 100 per cent reeling effluent has significantly improved the growth and yield parameters

of mulberry.

***Keywords*:**Reelingeffluent,Borewellwater,Mulberry.

1. INTRODUCTION

Mulberry is a fast growing deciduous woody perennial plant with having deep root system, grown under varied climatic conditions ranging from temperate to tropical regions. 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 irrigated conditions and high yielding mulberry variety (V1) is being cultivated (Anonymous, 2022). The 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 the 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 silkworms (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.

Wastewater 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 wastewater, 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 wastewater is being applied to agricultural lands to substitute the nutritional requirement of crops. In certain areas due to scarcity of water farmers are using the effluent as a source of irrigation water as well as a source of plant nutrients. This is supposed to solve the problem of disposal as well as a source of irrigation and nutrients for crop production. Using different types of wastewater such as sewage water, distillery spent wash, silk reeling effluent and industrial waste discharge for irrigation is beneficial for the growth and development of mulberry plants. Particularly, using reeling wastewater in mulberry cultivation has shown positive effects on mulberry growth and development (Kalpana *et al*., 2018)

India is the second largest raw silk-producing country with an annual production of15818 MT in 2021-2022. During the production of silk fibre, a considerable quantity of wastewater is generated from silk reeling units. It was estimated that 1.000-3.000 m³ of reelingeffluent 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 (1.15mg/l), potassium (22.68 mg/l) and minor nutrients like calcium, magnesium and chloride (109.6mg/l, 37.44 mg/l and 28.4mg/l, respectively). So, theutilization of wastewater for the cultivation ofmulberry is effective and eco-friendly. With this background, this study was aimed to investigate theeffectofreeling effluentirrigationon thegrowthand yield ofmulberry.

2. MATERIALANDMETHODS

An investigation was carried out in the Department of Sericulture,College of Agriculture, GKVK, Bengaluru. The primarily reeling effluent was collected fromBagaluru reeling unit mixed in a water tank as per treatments and irrigated to the mulberry cropaccording to the treatment combination. The total water requirement for mulberry cultivationunder red sandy loamy soil is 13,51,350 litersper crop per ha. The mulberry crop was irrigatedthrough flood irrigation system once in 7 days for 70 days (total 10 irrigations) (Dandin andGiridhar2014).Thecalculatedtotalwaterrequirement was19,460litres fortheentirecropduration

List 1. Treatmentdetails

Treatments	Treatmentdetails
T_1	100%borewellwater
T_2	25%reelingeffluent+75%borewellwater
T_3	50%reelingeffluent+50%borewellwater
T_4	75%reelingeffluent+25%borewellirrigation
T_5	100%reelingeffluent

Note:NPKandFYM appliedhasper recommendation.

FieldExperimentwasconductedduringMarch2022toMay2023laidoutasperRandomized Complete Block Design (RCBD). The treatments were replicated four times. Themulberry variety Victory 1 which is popularly known as V1 was used for the experiment. Asample consisting of five plants out of 32 plants per treatment was randomly selected andlabelledforrecordingvariousbiometricobservations.Theobservationsonvariousgrowthparametersswererecorded at 30th, 45th and 60thdays after pruning(DAP).

Statistical Analysis

The data recorded on various parameters were subjected to Fisher's method of Analysis of Variance (ANOVA) and interpreted according to Gomez and Gomez (1984).Thelevel of significance used in F and t-tests was P=0.05 for RCBD and P=0.01 for CRD. The critical difference (CD) values were computed where the F test was found significant.

3. RESULTANDDISCUSSION

No. ofshoots perplant

There was significant difference observed inthe number of shoots per plant when mulberrywasirrigated with various proportions of reeling effluent and borewell water along with therecommendeddoseof NPK andFYM.

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,asignificantlyhigher 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).A similar trend was noticed at 60th DAP withregards tothe number of shoots where significant higher number of shoots was observed in T_5(28.05) which was followed by T_4 (26.75) whereas,a lesser number of shoots was observed in T_1(23.65)(Table1).

Theincreasednumberofshootsmightbeduetohighernutrientcontentin reelingeffluent that is beneficial for plant growth. Reeling effluent contains nutrients 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 mulberryvarieties *i.e.*, S-54 and M-5 by 8.8 and 10.8 respectively when compared to bore well waterirrigation(8.4 shoots in S-54 and 9.6 shoots in M-5).

The results of thepresent study arecomparable to those of Ravindra Chary (2000) recordedapplicationofsewageeffluentfromtheVrishabhavathyriverwiththerecommendeddoseofFYM

and NPK resulted in higher shoot count (20.10). The enhanced growth of the mulberry plantswas attributed to the presence of microorganisms within the sewage effluent which activelysecretedgrowth-stimulatingcompounds,enzymes,hormonesandotheressentialnutrientsimperativeforthe optimal development of the plants.

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

Treatments	No. ofshoots/ plant		
	30DAP	**45DAP**	**60DAP**
T$_1$-100%borewellwaterirrigation(control)	17.05	20.15	23.65
T$_2$-25%reelingeffluent+75%borewell waterirrigation	17.25	20.60	24.10
T$_3$-50%reelingeffluent+50%borewell waterirrigation	18.20	21.45	24.95
T$_4$-75%reelingeffluent+25%borewell waterirrigation	18.90	22.55	26.75
T$_5$-100%reelingeffluentirrigation	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:*significantat5%,DAP-DaysAfterPruning

Meanshootlength(cm):

There was a significant difference observed in shoot length when mulberry irrigation withvariousproportionsof reelingeffluentirrigation alongwithborewellwater.

At 30th DAP, higher mean shoot length (49.74 cm) was recorded in which was followedby T4 (43.34 cm) whereas, the shortest mean shoot length was observed in T$_1$ (32.55 cm). At 45th DAP, asignificant longest shoot length was observed in T$_5$(109.32 cm) which was followed by T$_4$(106.48 cm) whereas, the shortest mean shoot length was observed T$_1$ (91.47 cm). Similar trend wasnoticed at the 60th DAP with regards to shoot length where significantly longest shoot length wasobserved in T_5 (137.32 cm) followed by T_4 (134.48 cm) whereas, the shortest mean shoot length wasobservedinT_1(119.47 cm) (Table2).

In the present study reeling effluent irrigated mulberry plants recorded highest shootheight which might be due to irrigation of reeling effluent which has higher nutrient contentcomparedtoborewellwater. Thesefindingsconformedwith Garcia*etal*.(2015)reported that mulberry plants displayed a substantial increase in shoot length (104.07 cm) whenirrigatedwithrecycled reelingeffluentcomparedtoconventionaltapwater.

The obtained results aligned with Ravindra Chary (2000) reported a notable increase inshoot length (90.6 cm) with the application of sewage effluent from the Vrishabhavathy Riverwiththerecommended doses of FYMand NPK.

Table2:InfluenceofreelingeffluentirrigationonmeanshootlengthinV1mulberryat30th,45th and 60th DAP

Treatments	Meanshootlength (cm)		
	30DAP	**45DAP**	**60DAP**
T_1-100%borewellwater irrigation(control)	32.55	91.47	119.47
T_2-25%reelingeffluent+75%borewellwaterirrigation.	38.76	94.76	122.76
T_3-50%reelingeffluent+50%borewellwaterirrigation	40.13	101.98	129.98
T_4-75%reelingeffluent+25%borewellwaterirrigation	43.34	106.48	134.48
T_5-100%reelingeffluentirrigation	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:*significantat5%,DAP-DaysAfterPruning

Plantheight(cm):

There was a significant difference observed in plant height when mulberry irrigation withvarious proportions of reeling effluent irrigation along with borewell water (Table 3). At 30thDAP, higher plant height was observed in T_5 (138.23 cm) followed by T_4 (132.10 cm) whereas,lesserplantheightwasobservedinT_1(116.00cm).At 45thDAP, significantlyhigherplant height

was observed in T_5(197.47 cm) followed by T_4 (194.96 cm) whereas, lesser plant height wasobserved T_1(178.19 cm). A similar trend was noticed at 60th DAP with regards to plant heightwhere significantly higher plant height was observed in T_5 (225.47 cm) followed by T_4 (222.97cm)whereas, lesser plantheight was observedinT_1(206.19 cm).

The increased plant height in mulberry might be due to increased photosynthetic rate andwater use efficiency when irrigated with raw sewage water (Paramanik, 2015). The currentfindings are supported by Chikkaswamy *et al*. (2014) reported that two mulberry varieties (S-54and M-5) resulted in a significant increase in plant height. Specifically, the plant height for S-54reached 142.28 cm while M-5 reached 166.70 cm. Similarly, Si *et al*. (2018) recorded that theapplicationof100percentsewagesludgeledtoanotableincreaseinplantheightreaching102.12cm,representinga12.1percent increase comparedtothecontrol group.

Table 3: Influence of reeling effluent irrigation on plant height in V1 mulberry at 30th, 45thand60thDAP

Treatments	Plantheight(cm)		
	30DAP	**45DAP**	**60DAP**
T_1-100%borewellwaterirrigation(control)	116.00	178.19	206.19
T_2-25%reelingeffluent+75%borewellwaterirrigation.	121.33	183.04	211.05
T_3-50%reelingeffluent+50%borewell waterirrigation	123.65	189.90	217.91
T_4-75%reelingeffluent+25%borewellwaterirrigation	132.10	194.96	222.97
T_5-100%reelingeffluentirrigation	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:*significantat5%,DAP-DaysAfterPruning

Internodaldistance(cm):

Therewasasignificantdifferenceobservedintheinternodaldistancewhenmulberryirrigation with various proportion of reeling effluent was irrigated along with bore well water (Table4). At 30th DAP, a shorter internodal distance was observed in T_5 (5.01 cm) followed by T_5 (5.20cm) whereas, higher internodal distance was observed in T_1 (5.60 cm). At 45th DAP, a significantlyshorter internodal distance was observed in T_5(5.49 cm) followed by T_4(5.58 cm) whereas,ahigher internodal distance was observed in T_1 (5.81 cm). A similar trend was noticed at 60th DAPwith regards to the internodal distance where a significantly shorter internodal distance was observedinT_5(5.73cm)followedbyT_4(5.82cm)whereas,thehigherinternodaldistancewasobservedin T_1(6.05cm).

ThefindingsofthecurrentstudyareconsistentwiththeresultsreportedbyChikkaswamy *et al*. (2014) reported that the utilization of sewage water for irrigation had asignificant impact on two mulberry varieties (S-54 and M-5). This impact was particularlyevident in a notable reduction in internodal distances in S-54 to 15.2 nodes per meter whencompared to borewell irrigation, which resulted in 14.6 nodes per meter. Similarly, for M-5, theinternodal distance decreased to 18.1 nodes per meter compared to the 17.1 nodes per meterobserved with borewell irrigation.

Table4:Influenceofreelingeffluentirrigationonthe intermodaldistanceofV1mulberryat30th,45th and 60th DAP

Treatments	Internodaldistance(cm)		
	30DAP	**45DAP**	**60DAP**
T_1-100%borewell waterirrigation(control)	5.60	5.81	6.05
T_2-25%reelingeffluent+75%borewell waterirrigation.	5.48	5.77	6.01
T_3-50%reelingeffluent+50%borewell waterirrigation	5.41	5.73	5.98
T_4-75%reelingeffluent+25%borewell waterirrigation	5.20	5.58	5.82
T_5-100%reelingeffluentirrigation	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:*significantat5%,NS-Nonsignificant,DAP-Days afterpruning

Numberof leaves perplant

There was significant difference observed in the number of leaves when mulberry irrigationwith various proportions of reeling effluent irrigation along with borewell water. At 30th DAP,ahigher number of leaves was observed in T_5(185.80) followed by T_4(163.15) whereas, lessernumber of leaves was observed in T_1(120.60). At 45th DAP, a significantly higher number ofleaves was observed in T_5(424.40) followed by T_4(387.35) whereas, lesser number of leaveswas observed T_1(253.30) (Table 5). A similar trend was noticed at 60th DAP with regards to anumber of leaveswhere significantlyhigher number of leaveswasobservedin T_5(542.90)followed by T_4 (505.85) whereas, a lesser number of leaves was observed in T_1 (371.80) (Table5). The increased number of leaves might be due to the reduction in the internodal distance inmulberry due to the supply of reeling effluent containing macro nutrients and micronutrients, which increased thenumber of internodes and in turn gave rise to more number of leavesandleafareaper plant.

The results of the present study align with the discoveries made by Ravindra Chary (2000)documentedanoteworthy increasinthenumberofleavesperplant(243.00) whenraw sewage effluent fromthe Vrishabhavathy river was applied with recommended doses of FYM andNPK. This result was also comparable to the use of filtered effluent, which resulted in 238.2leavesandthelowest numberofleavesperplantobservedinbore wellwaterirrigatedmulberry.

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

Treatments	**No.ofleaves/plant**		
	30DAP	**45DAP**	**60DAP**
T_1-100%borewell waterirrigation (control)	120.60	253.30	371.80
T_2-25%reelingeffluent+75%borewellwaterirrigation.	139.15	297.90	416.40
T_3-50%reelingeffluent+50%borewell waterirrigation	145.75	342.40	460.90
T_4-75%reelingeffluent+25%borewellwaterirrigation	163.15	387.35	505.85
T_5-100%reelingeffluentirrigation	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:*significantat5%,NS-Nonsignificant,DAP-Days afterpruning

Leafarea (cm^2)

There was a significant difference observed in leaf area when mulberry irrigation withvariousproportionsofreelingeffluentirrigationalongwithborewellwater(Table6).

At 30th DAP, a larger leaf area was observed in T_5(105.21 cm^2) followed by T_4 (101.12cm^2) whereas, asmaller leaf area was observed in T_1 (83.62 cm^2). At 45th DAP, a significantly largerleaf area was observed in T_5(204.33 cm^2) followed by T_4(189.49 cm^2) whereas, a smaller leafarea was observed in T_1 (149.99 cm^2). A similar trend was noticed at 60th DAP with regards tothenumber of leaves where significantly larger leaf area was observed in T_5 (219.33 cm^2) followedbyT$_4$(204.49 cm^2)whereas, a smaller leafareawasobservedinT$_1$(164.99cm^2).

The larger leaf area observed in the reeling effluent compared to borewell watermight be due to the irrigation of reeling effluent which has more NPK content than borewellwater which influences the growth and development of mulberry.The results of the current studyalign with Ravindra Chary (2000) recorded increased leaf area per plant (1376.30 cm^2) whensewage effluent from the Vrishabhavathy river was applied with recommended doses of FYMandNPK compared to borewell water irrigated plot.

Similarly, Rao *et al*. (2011) noted a decrease in the internodal distance in mulberryirrigated with sewage water which has more macro and micro nutrients. This nutrient-rich supplyled to an increase in the number of internodes, consequently resulting in a greater number of leavesandan expanded leaf areaper plant.

Table 6: Influence of reeling effluent irrigation on leaf area of V1 mulberry at 30th, 45th and60thDAP

Treatments	**Leafarea (cm^2)**		
	30DAP	**45DAP**	**60DAP**
T_1-100%borewellwaterirrigation(control)	83.62	149.99	164.99
T_2 -25%reelingeffluent+75%borewellwaterirrigation.	90.00	156.20	171.21
T_3-50%reelingeffluent+50%borewellwaterirrigation	92.60	170.94	185.94
T_4-75%reelingeffluent+25%borewellwaterirrigation	101.12	189.49	204.49
T_5-100%reelingeffluentirrigation	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:*significantat5%,NS-Nonsignificant,DAP-Days afterpruning

Leafyield(g/plantandtonnes/ha/yr)

At 60th DAP, the leaf yield of individual plant differed significantly in mulberry gardenirrigated with reeling effluent (Table 6). However, higher leaf yield was observed in T_5 (940.94 gplant^{-1} and 58.07 tonnes ha^{-1}) followed by T_4 (871.28 g plant^{-1} and 53.77 tonnes ha^{-1}), whereasthelowest 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 waterirrigation, compared to borewell water irrigated plot (46760 kg) in mulberry. Similarly, RavindraChary (2000) recorded a leaf yield of 42,276 kilograms per hectare per year when sewageeffluent was applied with the recommended doses of FYM and NPK compared to borewell waterirrigationthat yielded 37,928kilograms perhectareper year.

Table7:InfluenceofreelingeffluentirrigationonleafyieldofV1mulberryat60thDAP

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

Note:*significantat 5%. NS-Nonsignificant.DAP-Daysafter pruning

4. CONCLUSION

Reeling effluent contains significant quantities of essential nutrients, required for growthand development of plants, offering an effective and eco-friendly solution for an alternate source ofirrigation. Among the different treatments 100 per cent reeling effluent irrigation has recordedmaximum growth and yield attributes *viz*., Number of shoots/plant, mean shoot length, plantheight,internodaldistance,No.ofleaves/plant,leafarea andleafyieldcomparedtoallothertreatments.

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