International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(8): 1214-1219
www.biochemjournal.com
Received: 16-06-2024
Accepted: 21-07-2024

Ashrith S
M.Sc. (Agri), Department of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Pavithra MR
M.Sc. (Agri), Department of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Shruthi GH
Ph.D., Department of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Corresponding Author:
Ashrith S
M.Sc. (Agri), Department of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Impact of silk reeling effluent irrigation on soil physical and chemical properties in mulberry garden

Ashrith S, Pavithra MR and Shruthi GH

DOI: https://doi.org/10.33545/26174693.2024.v8.i8o.1958

Abstract
A field experiment was conducted during 2022-2023 at Department of Sericulture, UAS, GKVK, Bengaluru to know the growth and development of mulberry when 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 percent reeling effluent for irrigation to mulberry plant has recorded highest soil physical and chemical properties *viz*., bulk density (1.39 Mg m^{-3}), water holding capacity (37.83%), soil pH (7.38), electrical conductivity (0.21 dS/m), organic carbon (0.92%), organic matter (1.58%), available N (275.96 kg/ha), available P_2O_5 (54.76 kg/ha), available K_2O (181.41 kg/ha), calcium (3.55 meq/100 g), magnesium (1.75 meq/100 g), sulphur (7.53 ppm), iron (14.40 ppm), manganese (15.28 ppm), zinc (0.71 ppm) and copper (0.91 ppm) compare to control.

Keywords: Reeling effluent, borewell water, mulberry

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 percent of the mulberry region is under the irrigated condition and high yielding mulberry variety (V1) is being cultivated. 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) [10]. 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) [14]. 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) [16]. 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.

Materials 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 Bagalur reeling unit and mixed that 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. The mulberry crop was irrigated through flood irrigation system once in 7 days for 70 days (totally 10 irrigations) (Dandin and Giridhar 2014) [5]. The calculated total water requirement was 1,15,500 liters for 342 m^2 area in entire crop duration.

Treatment details

Treatments	Treatment details
T_1	100% borewell water
T_2	25% reeling effluent + 75% bore-well water
T_3	50% reeling effluent + 50% bore-well water
T_4	75% reeling effluent + 25% bore-well 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. The soil sample collected and analysed for various physical and chemical properties at 60 DAP.

Results and Discussion

Physical properties

Bulk density (Mg m^{-3}) and water holding capacity (%)

The bulk density and water holding capacity was not found significant among different treatment combinations. However, higher bulk density (1.42 Mg m^{-3}) was observed in 100 percent borewell water (T_1) and lower bulk density (1.39 Mg m^{-3}) in 100% reeling effluent (T_5). The water holding capacity was found highest (37.83%) in 100% reeling effluent (T_5) and lowest (35.57%) in 100% borewell water (T_1) (Table 1).

Chemical properties

Soil pH and Electrical conductivity (dS m^{-1})

The initial soil pH and electrical conductivity (EC) were recorded as 7.12 and 0.16 dS m^{-1}, respectively. The soil pH and EC were changed after mulberry garden irrigated with reeling effluent along with recommended dose of NPK and FYM. The significant increase in soil pH was recorded in mulberry plot after irrigated with different combination of reeling effluent and borewell water. The higher soil pH was recorded in T_5 (7.38) (100% reeling effluent irrigation) after 60 days after pruning followed by T_4 (7.32) (75% reeling effluent + 25% borewell water irrigation) whereas, the lower soil pH was recorded in the T_1 (7.15%) (100% borewell water irrigation) (Table 1, Fig 1).

The higher EC was recorded in T_5 (0.21dS m^{-1}) (100% reeling effluent irrigation) after 60 days after pruning followed by T_4 (0.20 dS m^{-1}) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest soil pH was observed in the T_1 (0.17 dS m^{-1}) (100% borewell water irrigation) (Table 1, Fig 1). The increased soil pH in reeling effluent irrigated plot might be due to alkaline pH of reeling effluent when compared to borewell water. The increased soil EC in the reeling effluent irrigated plot might be due to the presence of dissolved salts and minerals. When reeling effluent irrigated to the soil, it carries dissolved ions such as sodium, chloride and other ions into the soil profile, which increases the soil electrical conductivity.

Table 1: Influence of reeling effluent irrigation on soil physico-chemical properties of V1 mulberry garden at 60th DAP

Treatments	Bulk density (Mg m^{-3})	MWHC (%)	Soil pH	Electrical conductivity (dS/m)	Organic carbon (%)	Organic matter (%)
$- Before the experiment	1.42	35.05	7.12	0.16	0.72	1.24
T_1- 100% borewell water irrigation (control)	1.42	35.57	7.15	0.17	0.74	1.27
T_2- 25% reeling effluent + 75% borewell water irrigation	1.40	36.23	7.23	0.18	0.77	1.32
T_3-50% reeling effluent + 50% borewell water irrigation	1.41	36.79	7.27	0.18	0.85	1.46
T_4-75% reeling effluent + 25% borewell water irrigation	1.39	37.15	7.32	0.20	0.89	1.53
T_5-100% reeling effluent irrigation	1.39	37.83	7.38	0.21	0.92	1.58
F-test	NS	NS	*	*	*	*
S. Em±	-	-	0.04	0.003	0.03	0.06
$CD_{0.05}$	-	-	0.13	0.011	0.11	0.18

Note: * Significant at 5%, NS- Non-significant, DAP- Days After Pruning, $- before the experiment at the time of pruning and it's not statistically analyzed with other treatment data

Herman and Emanuel (1987) [8] recorded increased soil pH (8.44) in sewage water irrigated mulberry plot compared to borewell water (8.04). The marginal increased soil pH might be due to the influence of sewage water, which contains high organic matter, nutrients, phosphates and nitrates. Electrical conductivity is a factor that plays a crucial role in shaping soil stability, influence soil structure and determines water availability for plants (Alawsy *et al*., 2018) [1]. The soil EC was ranged between 0.17 to 0.21 dS m^{-1} which is within the permissible limit and if it exceeds above 4.0 dS/m, it may cause problem to the soil as well as plants (Charman and murphy, 1991) [3].

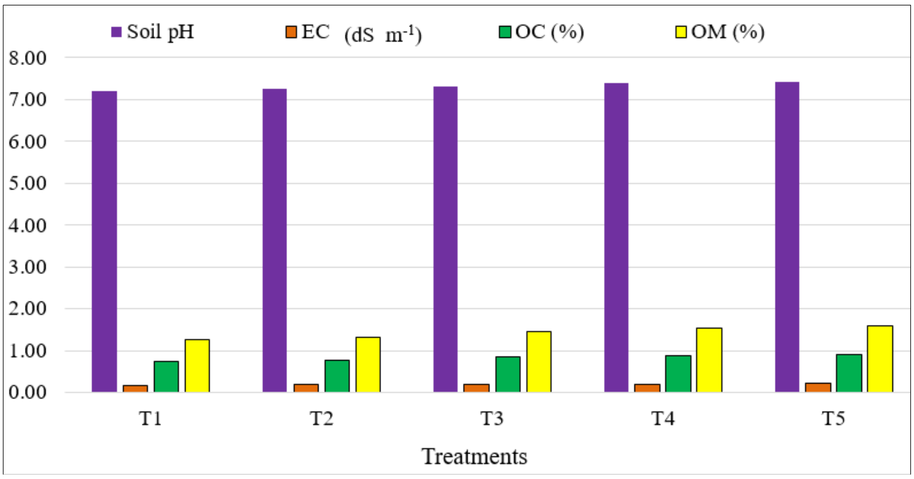

Fig 1: Influence of reeling effluent irrigation on soil pH, electrical conductivity (EC), organic carbon and organic matter of V1 mulberry garden soil at 60th DAP

Soil organic carbon and organic matter (%)

Prior to the irrigation with reeling effluent, the soil organic carbon and organic matter was recorded 0.72 and 1.24 percent, respectively (Table 1). The soil organic carbon and organic matterof the V1 mulberry plots were changed after reeling effluent irrigation with the recommended dose of NPK and FYM.

Significantly highest soil organic carbon was observed in T_5 (0.92%) (100% reeling effluent irrigation) after 60 days after pruning followed by T_4 (0.89%) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest soil organic carbon was observed in the T_1 (0.74%) (100% borewell water irrigation) (Table 1, Fig 1).

The highest soil organic matter was observed in T_5 (1.58%) (100% reeling effluent irrigation) after 60 days after pruning followed by T_4 (1.53%) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest soil organic matter was observed in the T_1 (1.27%) (100% borewell water irrigation) (Table 1, Fig 1).

The higher organic carbon was recorded in 100 percent reeling effluent which was supported Garcia *et al.* (2015) [7] suggested that reeling effluent can be used as alternate source of organic fertilizer for mulberry garden. Similarly, Garcia *et al.* (1993) [6] reported that sewage sludge decomposition was known to improve the soil organic matter and soil organic carbon.

Major nutrients (N, P_2O_5 and K_2O kg/ha) status of soil of V1 mulberry garden

Prior to the application of reeling effluent, the available nitrogen, phosphorous and potassium were recorded as 225.79 kg/ha, 38.54 kg/ha and 165.12 kg/ha, respectively. The significant improvement in soil fertility was noticed with regard to macronutrient status of mulberrygarden after irrigation reeling effluent. The highest Nitrogen, Phosphorous and Potassium content of 275.96 kg/ha, 54.76 kg/ha and 181.41 kg/ha were recorded in T_5 (100% reeling effluent irrigation) after 60 days after pruning followed by T_4 (260.28 N, 51.68 P_2O_5 and 177.69 K_2O kg/ha) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest NPK was observed in the T_1 (237.55 N, 42.06 P_2O_5 and 168.96 K_2O kg/ha) (100% borewell water irrigation) (Table 2, Fig 2).

The increase in nitrogen content in soil over the initial value might be due to irrigation with reeling effluent which contain organic nitrogen compound that was broken down by microorganisms through processes like mineralization, leading to the release of inorganic nitrogen forms (ammonium and nitrate) into the soil. Waste water contains vital nutrients helps in growth and development of agricultural crops. In comparison to paper mill waste water, sewage waste water, reeling effluent and tap water, the reeling effluent rich in nutrients improves the soil fertility, plant growth and leaf quality traits in the mulberry (Kalpana *et al.*, 2019) [9].

The results are compared to Kumar *et al.* (2020) [12] reported that improvement in soil fertility was noticed with regard to macronutrient status of mulberry garden after irrigated with raw sewage water. The highest available NPK content at 60th DAP in the soil (265.25 N, 42.08 P_2O_5 and 195.33 K_2O kg/ha) was recorded in 100 percent raw sewage water when compared to borewell water irrigated plot.

Table 2: Influence of reeling effluent irrigation on macronutrient status of soil in V1 mulberry garden at 60th DAP

Treatments	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
$-Before the experiment	225.79	38.54	165.12
T_1-100% borewell water irrigation (control)	237.55	42.06	168.96
T_2- 25% reeling effluent + 75% borewell water irrigation.	247.74	43.60	171.45
T_3- 50% reeling effluent + 50% borewell water irrigation	255.58	47.45	174.51
T_4- 75% reeling effluent + 25% borewell water irrigation	260.28	51.68	177.69
T_5- 100% reeling effluent irrigation	275.96	54.76	181.41
F-test	*	*	*
S. Em ±	6.25	1.22	2.14
$CD_{0.05}$	19.26	3.77	6.61

Note: * Significant at 5%, DAP- Days After Pruning, $- at the time of pruning and it's not statistically analyzed with other treatment data

The results are comparable with the findings of Chikkaswamy *et al.* (2014) [4], who reported that applying sewage water to mulberry fields increased the amount of phosphorous and potassium that was readily available in the soil (48.66 kg/ha and 222.66 kg/ha, respectively) when compared to soil irrigated with borewell water (44.27 kg/ha and 210.48 kg/ha). Similarly, Baddesha *et al.* (1997) [2] reported that the domestic wastewater improves fertility levels of soil.

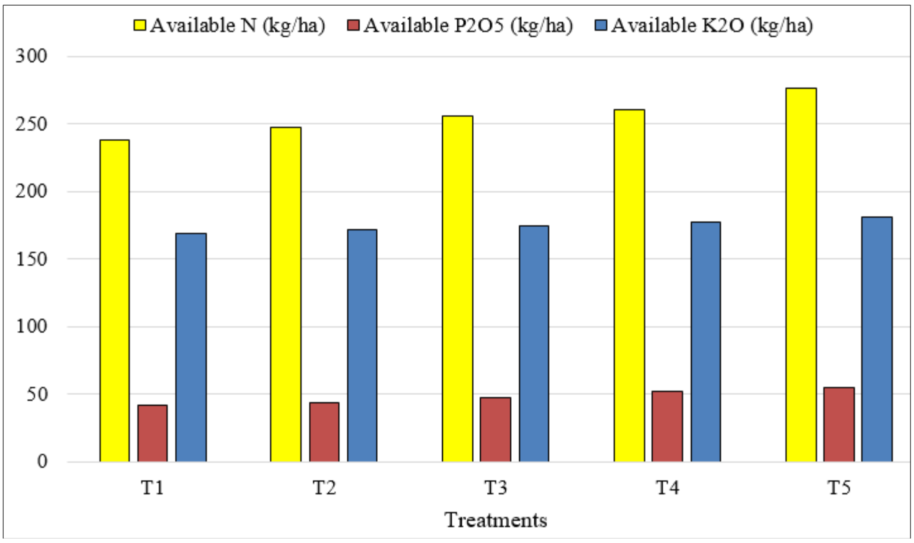

Fig 2: Influence of reeling effluent irrigation on macronutrient status of soil in V1 mulberry garden at 60th DAP

Secondary nutrients [Ca, Mg (meq/100 g) and S (ppm)] status of V1 mulberry garden soil

The initial exchangeable calcium, magnesium and sulphur content was recorded 2.24 (meq/100 g), 1.23 (meq/100 g) and 5.95 (ppm), respectively. The significant improvement in soil fertility was noticed with regard to secondary nutrient status of mulberry garden after irrigation with reeling effluent. The higher calcium content (3.55 meq/100 g) was recorded in T_5 (100% reeling effluent) after 60th DAP of mulberry which was followed by T_4 (3.35 meq/100 g) (75% reeling effluent + 25% borewell water) whereas, lowest calcium content was recorded in T_1 (2.72 meq/100 g) (100% borewell water) (Table 3, Fig 3).

The higher magnesium content was recorded in the T_5 (1.75 meq/100 g) (100% reeling effluent irrigation) after 60th DAP of mulberry garden followed by T_4 (1.63 meq/100 g) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest magnesium content was recorded in the T_1 (1.28 meq/100 g) (100% borewell water irrigation) (Table 3, Fig 3).

The higher sulphur content was recorded in the T_5 (7.53 ppm) (100% reeling effluent irrigation) after 60 days after pruning followed by T_4 (7.19 ppm) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest sulphur content was (6.09 ppm) in T_1 (100% borewell water irrigation) (Table 3, Fig 3).

Table 3: Influence of reeling effluent irrigation on secondary nutrient status of soil in V1 mulberry garden at 60th DAP

Treatments	Calcium (meq/100 g)	Magnesium (meq/100 g)	Sulphur (ppm)
$ - Before the experiment	2.24	1.23	5.95
T_1- 100% borewell water irrigation (control)	2.72	1.28	6.09
T_2- 25% reeling effluent + 75% borewell water irrigation.	3.15	1.35	6.39
T_3- 50% reeling effluent + 50% borewell water irrigation	3.20	1.45	6.72
T_4- 75% reeling effluent + 25% borewell water irrigation	3.35	1.63	7.19
T_5- 100% reeling effluent irrigation	3.55	1.75	7.53
F-test	*	*	*
S. Em ±	0.08	0.07	0.21
$CD_{0.05}$	0.27	0.24	0.53

Note: *Significant at 5%; NS- Non-significant; DAP- Days after Pruning; $- at the time of pruning and it's not statistically analyzed with other treatment data

The increased calcium and magnesium availability inthe soil mainly influenced by soil pH. In acidic soils, both may become less available, while in alkaline soils availability of these nutrients tends to increase (USDA Natural Resources Conservation Service, 1998) [15]. The increased sulphur was observed in the reeling effluent irrigated mulberry garden might be due to the release of sericin protein, which has sulphur-containing amino acids such as cysteine and methionine.

Kalpana *et al.* (2019) [9] recorded that higher concentration of calcium and magnesium in reeling effluent (109.6 mg/l and 37.44 mg/l) compared to borewell water (24.20 mg/l and 98.4 mg/l). The increased Ca and Mg in 100 percent reeling effluent irrigated plot might be due to the absorption of these nutrients from the effluent. Similarly, Sanjivkumar (2014) [13] reported that increased exchangeable Ca, Mg and S content of soil might be due to release of nutrients from added organic sources.

Soil micronutrients (Iron, Manganese, Zinc and Copper ppm) status of V1 mulberry garden: Before application of reeling effluent, the iron, manganese, zinc and copper content were recorded 12.13, 10.56, 0.53 and 0.80 ppm, respectively. After irrigation with reeling effluent, the significant improvement in soil micronutrient status of mulberry garden was noticed except iron.

After irrigation with reeling effluent, the availability of iron in the soil of mulberry garden was not found to be significant among different treatments at 60 days. However, higher iron content (14.40 ppm) was recorded in T_5 (100% reeling effluent irrigation) and lower iron content (13.63 ppm) was recorded in 100 percent borewell water irrigated plot (Table 4, Fig 4).

Significantly highest manganese content (15.28 ppm) was observed in T_5 (100% reeling effluent irrigation) after 60 days after pruning of the mulberry garden which was T_4 followed by (14.42 ppm) (75% reeling effluent + 25% borewell water) whereas, the lowest manganese content was observed in the T_1 (12.08 ppm) (100% borewell water) (Table 4, Fig 4).

Significantly higher zinc content was observed in the T_5 (0.71 ppm) (100% reeling effluent irrigation) after 60 days after pruning of mulberry garden which was followed by T_4 (0.67 ppm) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest zinc content was observed in the T_1 (0.57 ppm) (100% borewell water irrigation) (Table 4, Fig 4).

Significantly highest copper content was recorded in the T_5 (0.91 ppm) (100% reeling effluent irrigation) after 60 days after pruning of mulberry garden which was followed by T_4 (0.89 ppm) (75% reeling effluent + 25% borewell water irrigation) whereas, the lowest copper content was observed in the T_1 (0.83 ppm) (100% borewell water irrigation) (Table 4, Fig 4).

Table 4: Influence of reeling effluent irrigation on micronutrient status of soil in V1 mulberry garden at 60th DAP

Treatments	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
$- Before the experiment	12.13	10.56	0.53	0.80
T_1- 100% borewell water irrigation (control)	13.63	12.08	0.57	0.83
T_2- 25% reeling effluent + 75% borewell water irrigation.	13.85	13.13	0.61	0.85
T_3- 50% reeling effluent + 50% borewell water irrigation	14.06	13.84	0.64	0.87
T_4- 75% reeling effluent + 25% borewell water irrigation	14.26	14.42	0.67	0.89
T_5- 100% reeling effluent irrigation	14.40	15.28	0.71	0.91
F-test	NS	*	*	*
S.Em ±	-	0.41	0.01	0.01
$CD_{0.05}$	-	1.27	0.03	0.03

Note: * Significant at 5%; NS- Non significant; DAP- Days after Pruning; $- at the time of pruning and it's not statistically analyzed with other treatment data

The increased availability of micronutrient in soil noticed after irrigated with reeling effluent might be due to higher concentration of manganese, zinc and copper in reeling effluent 1106, 35 and 116 mg/l, respectively when compared to tap water (Kalpana *et al*., 2019) [9]. The results are analogous to those of Chikkaswamy *et al*. (2014) [4] reported that, irrigation of mulberry plot with raw sewage water increased micronutrients content *viz*., Fe (16.36 ppm), Zn (2.61 ppm) and Mn (56.22 ppm) in comparison to soil micronutrients from borewell irrigation.

The present findings were in line with Kumar *et al*. (2020) [12] reported that micronutrient availability in soil has shown significant difference among different treatments, 100 percent raw sewage water irrigated plot registering the maximum availability of Zn, Fe, and Mn (9.03, 18.76 and 16.01 ppm respectively). Similarly, Kharche *et al*. (2011) [11] reported that irrigation of mulberry plot with sewage water enhanced micronutrient concentration of soil. The concentration of Fe, Mn, Zn and Cu in sewage irrigated soils were 1.05, 1.24, 3.98 and 1.51 times higher than in borewell water irrigated soils, respectively.

Conclusion

In conclusion, the impact of irrigating silk reeling effluent and borewell water on soil physico-chemical properties in mulberry gardens is significant. Through this study, it has been elucidated that the choice of irrigation water significantly influences soil characteristics. Silk reeling effluent irrigation tends to alter soil pH, organic matter content, and nutrient levels, potentially affecting crop growth and soil fertility. On the other hand, borewell water irrigation showed less drastic effects on soil properties. However, both sources of irrigation demand careful monitoring and management to mitigate adverse effects on soil quality and ensure sustainable mulberry cultivation. Future research should focus on optimizing irrigation practices to maintain soil health while maximizing crop productivity in mulberry gardens. Overall, understanding the impact of irrigation water on soil properties is crucial for sustainable agriculture and the long-term viability of mulberry cultivation systems.

References

1. Alawsy WSA, Alabadi LAS, Khaeim HM. Effect of sewage water irrigation on growth performance, biomass, and nutrient accumulation in maize and barley. Int J Agric Stat Sci. 2018;14(2):519-524.
2. Baddesha HS, Chhabra R, Ghuman BS. Changes in soil chemical properties and plant nutrient content under eucalyptus irrigated with sewage water. J Indian Soc. Soil Sci. 1997;45(2):358-362.
3. Charman P, Murphy BW. Soil: Their properties and management. Sydney: Sydney University Press; c1991.
4. Chikkaswamy BK, Prasad MP, Paramanik RC. Effect of sewage irrigation on physio-biochemical characterization of two mulberry varieties. J Chem. Pharm Sci. 2014;4:30-32.
5. Dandin SB, Giridhar K. Handbook of Sericulture Technologies. Bangalore: Central Silk Board; c2014. p. 427.
6. Garcia C, Hernandez T, Costa F, Cecanti C, Ganni A. Hydrolases in organic matter fraction of sewage sludge: Changes in composting. Bioresour Technol. 1993;44:17-23.
7. Garcia JM, Libunao FM, Damasco CN, Ancheta LAA, Supsup RD. Recycled reeling waste water: effective for mulberry production. Silk Green World Sustainable Dev.; c2015. p. 1-17.

8. Herman B, Emanuel. Quality requirements for irrigation with sewage water. J Irrig. Drain Eng. 1987;113(4):516-535.
9. Kalpana PV, Jothimani P, Umapathy G. Characterization of waste water for cultivation of mulberry. J Pharmacogn Phytochem. 2019;8(3):141-144.
10. Kalpana PV, Jothimani P, Shanmugam R, Umapathy G. Utilization of different waste water irrigation on mulberry sericulture: Review. Int J Chem. Stud. 2018;6(6):1971-1976.
11. Kharché VK, Desai VN, Pharande AL. Effect of sewage irrigation on soil properties, essential nutrient and pollutant element status of soils and plants in a vegetable growing area around Maharashtra. J Indian Soc. Soil Sci. 2011;59(2):177-184.
12. Kumar A, Chandrashekhar S. Effect of treated sewage water on mulberry production and its impact on cocoon quality. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bengaluru; c2020.
13. Sanjivkumar V. Effect of integrated nutrient management on soil fertility and yield of maize crop (*Zea mays*) in EnticHaplustart in Tamil Nadu, India. J App Natural Sci. 2014;6(1):294-297.
14. Subbaswamy MR, Basavanna HM, Suryanarayana N. Quality of irrigation water for mulberry gardens. Indian Silk; c1987. p. 47-49.
15. USDA Natural Resources Conservation Service. Soil Quality Indicators: pH; c1998. Available from: https://web.extension.illinois.edu/soil/sq_info/ph.pdf.
16. Vasudevan P, Thapliyal A, Srivastava RK, Pandey A, Dastidar MG, Davies P, *et al*. Fertigation potential of domestic wastewater for tree plantations. J Sci. Indus Res. 2010;69:146-150.