

Seasonal Study of Physico-Chemical Parameters of Secondary Treated Waste Water from Delawas Sewage Treatment Plant

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ABSTRACT: Water is quite essential natural element for all kinds of life. The quality of water is vital concern for mankind since it is directly linked with human welfare. The aim of this study is to assess physico – chemical properties of waste water after secondary treatment. The water samples were collected from Delawas Sewage Treatment plant, Pratap Nagar, Jaipur. The study was carried out for a period of one year. Results revealed that pH varied between 7.65 to 8.28 and Electrical Conductivity between 1.44 to 2.84 mmhos/cm. Total solids from 743 mg/l to 998 mg/l. Calcium and Magnesium hardness ranged between 460 to 534 mg/l and 278 to 292 mg/l respectively. The Total Hardness was found between 738 to 826 mg/l. Chloride and Alkalinity values were between 256.40 to 325.48 mg/l and 790 to 834 mg/l. Dissolve Oxygen found between 5.8 to 6.42 mg/l respectively, Biological oxygen demand ranges from 58.4 mg/l to 78 mg/l and Chemical oxygen demand ranges from 115 mg/l to 177.8 mg/l. Nitrate, Phosphate and Sulphate varies from 16.4 to 24.8 mg/l, 7.83 to 10.89 mg/l, 28.8 to 35.2 mg/l respectively. Heavy metals were also analyzed, from the results it was found that the concentration of heavy metals such as Zinc (Zn), Copper (Cu), Chromium (Cr), Cadmium (Cd), Nickel (Ni), Manganese (Mn), Iron (Fe) and Cobalt (Co) was found 0.05 to 0.06mg/l , 0.014 to 0.029 mg/l, 0.004 to 0.006 mg/l, 0.003 to 0.005 mg/l, 0.011to 0.020 mg/l, 0.024 to 0.032 mg/l, 0.192 to 0.202 mg/l and 0.04 to 0.05 mg/l respectively, which was low as compared to established standards; these heavy metal concentrations were well below hazardous level. This study showed that treated waste water can be used safely for irrigation. The treated water was found suitable for irrigational purpose.

KEYWORDS: Physico – chemical, Sewage Treatment Plant, Secondary Treated Waste Water, Heavy Metals, Irrigation

I. INTRODUCTION

Human evolution has led to immense scientific and technological improvement. In recent time new challenges have to be taken in the field of environmental protection and conservation due to worldwide development (**Bennett et al., 2003**). Due to industrialization and urbanization natural resources have been exploited extremely by human being. Water is quite essential natural element for all kinds of life. The quality of water is vital concern for mankind since it is directly linked with human welfare. Due to the rapid urbanization, wastewater has been continuously and excessively released into the environment, causing significant impacts on human and wild life (**Borkar R.P et al., 2013**). Many organic compounds in municipal wastewater are detected in different types of wastewater, affecting water quality, human health and biodiversity in the ecosystem. The major sources of organic pollution in fresh water aquatic ecosystems are sewage which includes domestic, hospital and small scale industrial wastes operating under municipal area. Huge volume of sewage water is being produced in metropolitan

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cities due to ever increasing population. Sewage disposal is a major problem in most of the cities in India. In most of the cases the untreated sewage either finds way to the nearest water bodies or is intentionally put into the agricultural fields by the farmers as a substitute for irrigation. The water collected through sewerage system in outskirts of the city is discharged to agricultural lands without treatment which has both toxic and fertilizer values (**Sankar Narayan Sinha and Dipak Paul 2013**). There is an increase in the use of sewage water for irrigation especially in the out skirts of the cities, particularly in the dry area where there is scarcity of natural water (**Girisha and Raju, 2008**). Sewage and other industrial effluents rich in organic matter and plant nutrients are finding agricultural application as cheaper way of disposal (**Nathet et al., 2009; Nagajyothi et. al., 2009**). The use of industrial effluents for irrigation has emerged in the recent past as an important way of utilizing waste water. There are several advantage and disadvantage in using this sewage water for irrigation purpose (**Raman et al., 2002; Saravanmoorthy and RanjithaKumari, 2007**). Sewage water contains higher amounts of nutrients which increases crop yield substantially and reduce the need for fertilizer, and ultimately decreases overall cost of production. According to **Otobbanget et al., (1997)** sewage sludge consists of multi-element organic wastes that are also used commonly as manure. Continuous use of sewage waste water may lead to environmental problems such as soil sickness, soil and ground water contamination and phytotoxicity (**Karunaichamy et al., 1990; Hicks and Hird, 2000**).

The rapid growth of the world's urban population continues to place increased demands on limited fresh water supplies. There is a serious struggle to balance water use among domestic, industrial and agricultural users (**Darvishiet al., 2010**). On the other hand, water resources of good quality are becoming more scarcer and are being allocated with priority for urban water supply. Taking into account the scarcity of conventional water resources, due to water demand increases both for human consumption and for agricultural use, the reuse of saline, brackish, and treated wastewater (TWW) could be a realistic way for reducing water shortage, as it has been demonstrated in many countries in the Mediterranean basin (**SaidaBedbabis et al., 2014**). The TWW can constitute a reliable water and nutrient source for crops (**B.Jimenez-Cisneros 1995**) and its use for irrigation reduces the amount of nutrient-rich water returned to rivers or sea. Treated wastewater has been used for crop irrigation in the developing countries (**Kansal and Singh, 1983; Abdel-Reheemet et al., 1986; Bahri, 1988**). Waste-water possesses different biological, physical and chemical effects on the environment. Some physicochemical analysis of soil affected by industrial pollution significantly needed (**E. Y. Oyinlola and I. A. Aliyu 2005**). Direct use of waste water have significant impacts on receiving water bodies so as finding of an appropriate treatment of wastewater is very essential. Therefore, an attempt has been made to know the physico-chemical properties of treated waste water. Currently, the effluent used for irrigation is mainly obtained after biological treatment (secondary treatment). However, this effluent differs from fresh water for salinity, pH, and concentrations of micro- elements and nutrients. The main objective of this study is to analyze the physico – chemical parameters of water & to assess the applicability of treated waste water for irrigation purpose.

II. RELEATED WORK

Ukpong, E. C. (2013) in his research he observed the performance of Activated Sludge Wastewater Treatment Plant (ASWTP) at QIT, Ibeno Local Government Area of Akwalbom State. In this study he investigated the level of effectiveness of the activated sludge process. The result showed that wastewater had no smell with clear colour at normal temperature and equilibrium pH value of 7. The TSS, TDS, total alkalinity reduction values were 4.68, 8.61 and 0% respectively. The DO value reduction was in the range of 40 to 45% and the BOD and COD values reduced by 28 to 32.79% and 46.42 to 49.54%, respectively. On the basis of the results of the study the wastewater treatment plant, has good potential to produce high quality effluent on a continuous bases.

Gašpariková, E. et al., (2005) in their research seven small wastewater treatment plants were chosen for evaluation. These WWTPs work on the principle of anaerobic pre-treatment and aerobic post-treatment. When operated at suitable conditions, the results match the directive water discharge from small wastewater treatment plants in the Slovak Republic. An integrated system originated from the combination of anaerobic and aerobic technologies was studied. Following operational experiences it is concluded that the properly operated two-stage technology is effective for the removal of organic pollution and suspended solids, while under optimal conditions even nutrient removal can be

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achieved. The results obtained from WWTP operation confirmed the viability of an integrated anaerobic- aerobic system for municipal wastewater treatment, even in a country with a temperate climate.

Ali, M. F. and Shakrani, S.A. (2011) were analyzed the effects of secondary treated wastewater irrigation on green mustard (*Brassica Campestris Sp. Parachinensis*) vegetable growth with soil and soilless culture. The final secondary treated wastewater (FSTW) and biological secondary treated wastewater (BSTW) used for irrigation were collected from the Mawar Wastewater Treatment Plant located at UiTM. The results revealed the significant concentrations of trace elements in soil and plants irrigated with secondary treated wastewater.

Ali A. Aljaloud (2010) in his paper addressed the reuse of treated municipal wastewater and its effect on soil and plants. This experiment was conducted to determine the effect of irrigation with treated municipal waste water on crop yield, plant composition and soil properties with special emphasis on accumulation of trace metals. Research was conducted in Riyadh, Saudi Arabia. This study showed that treated municipal waste water can be used safely for irrigation of a selected group of crops. It enriched the soil in minerals, increased plant nutrient uptake, promoted crop yield, and improved the overall profit.

These findings show that the secondary treated wastewater irrigation along with proper monitoring and continuous assessments are required in order to prevent any long term risk associated with human and environment.

III. STUDY AREA

Study area was confined to Delawas area of Pratap Nagar in the Jaipur district. There are two sewage treatment plants, having an individual capacity of 62.5 MLD therefore peak capacity of plant is about 125 MLD. This treated waste water (after secondary treatment) is utilized in agricultural fields for crop production.

IV. MATERIALS AND METHODS

For the present study the secondary treated waste water and soil samples were collected from the of sewage treatment plant of Delawas area, Pratap Nagar Jaipur. These samples were collected during different periods of the year of 2013. Water samples were collected in cleaned and washed glass bottles whereas soil samples were collected in clean polyethylene bags. The collected water samples have been analyzed to determine their physico – chemical characteristics as pH, EC, TDS (Total dissolved solids). Total hardness, alkalinity, Calcium and Magnesium Hardness, Chloride and D.O. and estimation of metal ions were also done. Collected soil samples have been analyzed for pH, EC, Chloride and Organic Matter. The water and soil samples, after collection were subjected to analysis following the procedure followed by APHA methods (1998).

Heavy Metal Analysis by Atomic Absorption Spectrophotometer Atomic Absorption Spectrophotometer (AAS Model GBC 932) was used for analysis of heavy metals in water hollow cathode lamps were used for each heavy metal determination. The suitable volume of the sample was digested in di acid mixture of HNO₃ and per chloric acid in the ratio of (10:1). The digestion was performed in 100 ml conical flasks and to facilitate complete digestion the samples in di acid mixture were kept overnight at room temperature. These flasks containing samples and di acid mixture were heated at hot plate until a clear solution was obtained. This was followed by a slow but complete evaporation of acids. Then, the volume of the digested samples was made up to 100 ml with the help of the double distilled water. These solutions were analyzed by Atomic Absorption Spectrophotometer.

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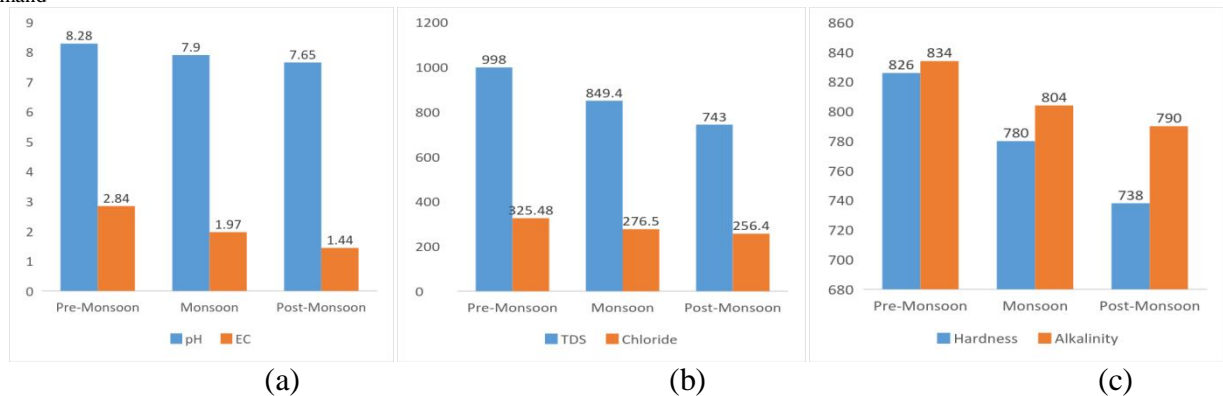
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S. No.	Parameters	Pre-Monsoon Season	Monsoon Season	Post-Monsoon Season
1.	Temperature	30	27	23
2.	Colour&Odour	Pale Yellow & Odour Less	Pale Yellow & Odour Less	Pale Yellow & Odour Less
3.	pH	8.28 (± 0.144)	7.9 (± 0.083)	7.65 (± 0.158)
4.	EC (mmhos/cm)	2.84 (± 0.116)	1.97 (± 0.083)	1.44 (± 0.167)
5.	TDS(mg/l)	998 (± 4.472)	849.4 (± 4.393)	743 (± 3.464)
6.	Chloride(mg/l)	325.48 (± 0.083)	276.5 (± 0.122)	256.4 (± 0.158)
7.	Total Hardness(mg/l)	826 (± 11.401)	780 (± 10.00)	738 (± 8.366)
8.	Ca ⁺² Hardness(mg/l)	534 (± 11.401)	492 (± 8.366)	460 (± 7.071)
9.	Mg ⁺² Hardness (mg/l)	292 (± 8.366)	288 (± 4.472)	278 (± 8.366)
10.	Alkalinity(mg/l)	834 (± 13.416)	804 (± 11.401)	790 (± 10.00)
11.	DO(mg/l)	5.8 (± 0.070)	6.42 (± 0.0836)	6.18 (± 0.083)
12.	BOD (mg/l)	78 (± 1.870)	58.4 (± 1.140)	67 (± 1.581)
13.	COD (mg/l)	177.8 (± 1.923)	115 (± 1.870)	145 (± 1.870)
14.	Nitrate (mg/l)	24.8 (± 1.483)	20.6 (± 1.140)	16.4 (± 1.341)
15.	Phosphate (mg/l)	10.89 (± 0.817)	9.85 (± 0.780)	7.83 (± 0.400)
16.	Sulphate (mg/l)	35.2 (± 1.303)	30.6 (± 1.140)	28.8 (± 1.643)

Mean Value (\pm S.D.)

EC-Electrical Conductivity, TDS- Total Dissolved Solids , DO- Dissolve Oxygen, BOD-Biological Oxygen Demand, COD-Chemical Oxygen Demand



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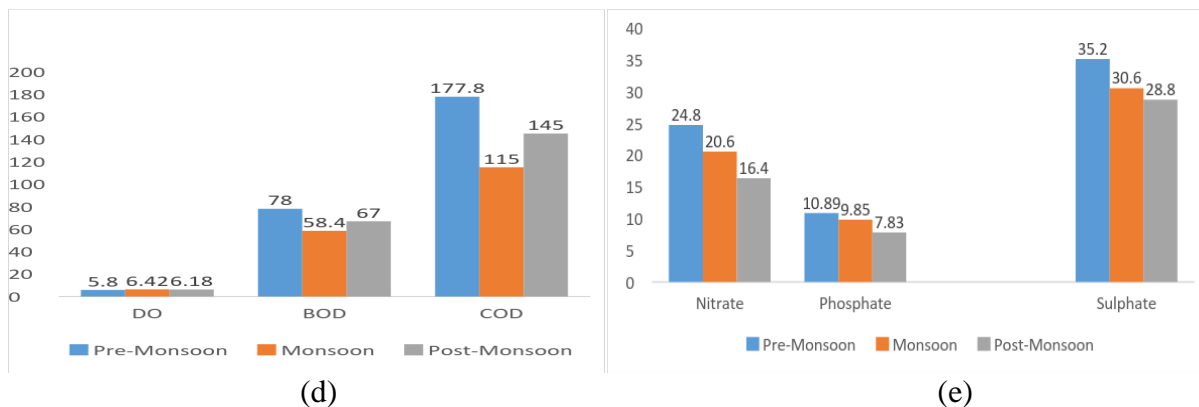


Fig. 1 Graph showing physico-chemical parameters of different seasons (a) pH & Electrical Conductivity (b) Total Dissolved Solids & Chloride (c) Hardness & Alkalinity (d) Dissolve Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand (e) Nitrate, Phosphate & Sulphate

Table-2: Heavy Metal analysis of water samples.

S. No.	Heavy Metals	Pre-Monsoon Season (mg/l)	Monsoon Season (mg/l)	Post-Monsoon Season (mg/l)	WHO standards of water (mg/l)
1.	Zn	0.062(±0.013)	0.052(±0.007)	0.056 (±0.011)	5
2.	Cu	0.029(±0.007)	0.014 (±0.005)	0.018 (±0.008)	1.0
3.	Cr	0.006(±0.001)	0.004 (±0.001)	0.005 (±0.001)	0.05
4.	Cd	0.005(±0.002)	0.003 (±0.001)	0.004(±0.000)	0.05
5.	Ni	0.020(±0.005)	0.011 (±0.004)	0.013(±0.005)	–
6.	Mn	0.032(±0.013)	0.024 (±0.005)	0.028(±0.008)	–
7.	Fe	0.202(±0.022)	0.192 (±0.008)	0.198(±0.014)	0.3
8.	Co	0.05(±0.015)	0.04 (±0.015)	0.04(±0.007)	–

Mean Value (±S.D.)

Zinc (Zn), Copper (Cu), Chromium (Cr), Cadmium (Cd), Nickel (Ni), Manganese (Mn), Iron (Fe) and Cobalt (Co)

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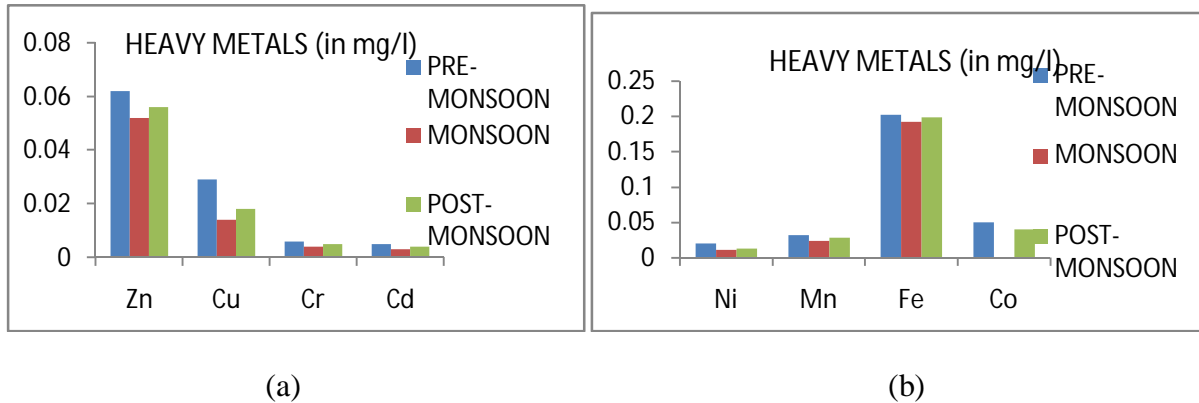


Fig. 2 Graph showing heavy metals concentration in different seasons (a) concentration of Zn, Cu, Cr & Cd (b) concentration of Ni, Mn, Fe & Co

Table 3. Recommended limits for constituents in reclaimed Water for irrigation. (Adapted from Rowe and Abdel-Magid, 1995)

Constituent	Long-term use (mg/L)	Short-term use (mg/L)	Remarks
Aluminum (Al)	5.0	20	Can cause poor poor productivity in acid soils, but soils at pH 5.5 to 8.0 will precipitate the ion and eliminate toxicity.
Arsenic (As)	0.10	2.0	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to less than 0.05 mg/L for rice.
Beryllium (Be)	0.10	0.5	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Boron (B)	0.75	2.0	Essential to plant growth, with optimum yields for many obtained at a few-tenths mg/L in nutrient solutions. Toxic to many sensitive plants (e.g., citrus) at 1 mg/L. Most grasses relatively tolerant at 2.0 to 10 mg/L.
Cadmium (Cd)	0.01	0.05	Toxic to beans, beets, and turnips at concentrations as low as 0.1 mg/L in nutrient solution. Conservative limits recommended.
Chromium (Cr)	0.1	1.0	Not generally recognized as essential growth element. Conservative limits recommended due to lack of knowledge on toxicity to plants.
Cobalt (Co)	0.05	5.0	Toxic to tomato plants at 0.1 mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Copper (Cu)	0.2	5.0	Toxic to a number of plants at 0.1 to 1.0 mg/L in nutrient solution. Inactivated by neutral and alkaline soils.
Fluoride (F ⁻)	1.0	15.0	Inactivated by neutral and alkaline soils.
Iron (Fe)	5.0	20.0	Not toxic to plants in aerated soils, but can contribute to soil acidifi- acidification and loss of essential phosphorus and molybdenum.
Lead (Pb)	5.0	10.0	Can inhibit plant cell growth at very high concentrations. Tolerated by most crops at up to 5 mg/L; mobile in soil. Toxic to citrus at low doses recommended limit is 0.075 mg/L.
Lithium (Li)	2.5	2.5	Toxic to a number of crops at a few-tenths to a few mg/L in acid soils.
Manganese (Mn)	0.2	10.0	Nontoxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high levels of available molybdenum.
Molybdenum (Mo)	0.01	0.05	Toxic to a number of plants at 0.5 to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Nickel (Ni)	0.2	2.0	Toxic to plants at low concentrations and to livestock if forage is grown in soils with low levels of added selenium.
Selenium (Se)	0.02	0.02	Toxic to many plants at relatively low concentrations.
Vanadium (V)	0.1	1.0	Toxic to many plants at widely varying concentrations; reduced toxicity at increased pH (6 or above) and in fine-textured or organic soils.
Zinc (Zn)	2.0	10.0	

Source: GuyFipps Irrigation Water Quality Standards and Salinity Management

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V. RESULTS

The mean values of Physico-chemical characteristics of secondary treated waste water are summarized in Table 1. The Treated waste water pH varies from 7.65 to moderately alkaline 8.28. Electrical conductivity ranges from 1.44 mmhos to 2.84 mmhos, Total dissolved Solids varies from 743 mg/l to 998 mg/l. Chloride in treated waste water ranges from 256.40 mg/l to 325.48 mg/l, Total hardness ranges from 738 mg/l to 826 mg/l, Ca+2 hardness varies from 460 mg/l to 534 mg/l. and Mg+2 hardness from 278 mg/l to 292 mg/l. Total alkalinity ranges from 790 mg/l to 834 mg/l. Dissolved oxygen in water samples varies from 5.8 mg/l to 6.42 mg/l. Biological oxygen demand ranges from 58.4 mg/l to 78 mg/l and Chemical oxygen demand ranges from 115 mg/l to 177.8 mg/l. Nitrate, Phosphate and Sulphate varies from 16.4 to 24.8 mg/l, 7.83 to 10.89 mg/l, 28.8 to 35.2 mg/l respectively. Average concentration of heavy metal present in secondary treated waste water is presented in Table – 2. From the results, it is found that the average concentration of Zn, Cu, Cr, Cd, Ni, Mn, Fe and Co was 0.05 to 0.06 mg/l, 0.014 to 0.029 mg/l, 0.004 to 0.006 mg/l, 0.003 to 0.005 mg/l, 0.011 to 0.020 mg/l, 0.024 to 0.032 mg/l, 0.192 to 0.202 mg/l and 0.04 to 0.05 mg/l respectively, which is in permissible limit set by WHO. All the heavy metals show in Table – 2 are also found in the acceptable range for irrigation (Rowe and Abdel Magid 1995).

VI. DISCUSSION

Above results reveal that physico- chemical properties of secondary treated waste water which is collected from Delawas Sewage Treatment Plant are found within the acceptable range for irrigation. Results also show that amount of heavy metals presented in treated waste water is in minute quantity. All the heavy metals also found in the acceptable range set by WHO and also found suitable for irrigation (Rowe and Abdel Magid 1995). The treatment of the wastewater be made to render the wastewater suitable for irrigation in agricultural land. The main finding of this research is that reusing treated waste water for irrigation is environmentally sound. Seasonal variation may influences soil quality and plant growth when irrigated with treated waste water. It may enrich the soil in minerals, increases plant nutrient uptake, promote crop yield, and improve the overall profit. If adequate amounts of macronutrient concentrations such as nitrogen, phosphorus and potassium availability in treated wastewater, successful growing plants will be achieved. The use of secondary treated wastewater was believed to improved soil properties and thus increased plant growth and productivity. J. Abedi-Koupalet *al.*, (2006) and Ali A. Aljaloud (2010) also found the same observation.

VII. CONCLUSION

Due to the enormous volume of water expelled out of the textile industry may help in encountering the water crisis. For this, treatment of wastewater and elimination of pollutants is crucial for human health and environmental welfare. Thus we can say that the treated wastewater is considered one of the most important renewable and unconventional resources for irrigation and this type of Sewage Waste Water Treatment plant can be considered as a good source of water for irrigation purpose that can also solve the problem of sewage waste water and scarcity of water which is a burning problem of our country. Hence irrigation with treated waste water is safe and is a potential source of supplemental irrigation to meet growing crop water needs. The reuse of treated wastewater for purposes such as agricultural irrigation can reduces the amount of water that needs to be extracted from environmental water sources.

VIII. RECOMMENDATIONS

The findings allow recommending farmers and families in rural areas, to continue reusing the treated wastewater for restricted irrigation, without apprehensive for long term reuse. Also, it's recommended to legalize the reuse of treated waste water in agricultural irrigation. Increase the farmer's awareness of treated wastewater use in useful fodder production (barley, trefoil, maize) and also set training programs for researchers and specialists in the field of fodder production using treated wastewater. Make rules and strict controls on the use of untreated wastewater in agriculture and livestock breeding.

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