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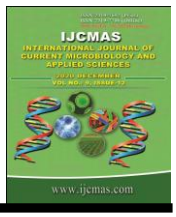

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Waste Water Reuse for Agriculture Irrigation- A Review

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A B S T R A C T

The world has lot of water crisis which is majorly impacting developing economies like our India. Considering the ever increasing population and the surging demand of water, there is an urgent need to supplement the current water supply with secondary sources of water. Agricultural irrigation is major consumer of fresh water. Therefore, fresh water required for irrigation can be considered for replacement with treated waste water. The practice will help in decreasing water use pressure and also can moderate the water pollution. This article presents a literature review that addresses the effectiveness of treated waste water irrigation in vegetable and fruit crops along with the farmers' perceptions towards the waste water utilization.

Introduction

Wastewater (or waste water) is any water that has been contaminated by human use. Wastewater is "used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and any sewer inflow or sewer infiltration". Therefore, wastewater is a by-product of domestic, industrial, commercial or agricultural activities. The world has lot of water crisis which is majorly impacting developing economies like our India. Considering the ever increasing population and the surging demand of water, there is an urgent need to supplement the current water supply with secondary sources of water. However, the incorporation of reuse schemes in the present scenario of the country comes with strings attached such as acceptability by public and feasibility in terms of technical and economic aspects. The objective of this paper is to investigate the necessity of incorporating the scope of wastewater reuse in different sectors.

As almost 70% of the world water is used in agriculture, the reuse of treated wastewater (TWW) for crop irrigation can substantially reduce the amount of water to be extracted from fresh water sources, such as groundwater and rivers, apart from reducing ejection of wastewater to the environment (Gleick, 2000; Pedrero *et al.,* 2010). Hence, the limited availability of freshwater in many parts of the world is a serious constraint for agricultural production (Sheidaei *et al.,* 2016). The water scarcity around the globe leads to adoption and use of unconventional waters, such as treated municipal wastewater and saline drainage water as well as other kinds of wastewater in many large urban areas, which were previously thought to have sufficient water resources (Dixon *et al.,* 1999; Weizhen and Andrew, 2003; Junying *et al.,* 2004).

The current paper aims on the research done by various authors and the literature available on wastewater reutilization for agricultural irrigation is reviewed and given comparison of use of waste water in different sectors and what are the impacts on willingness of farmers to accept this technology.

Wastewater reuse for irrigating vegetable crops

A field experiment was conducted by Lahhama *et al.,* (2003) to study the impact of treated wastewater irrigation on quality attributes and contamination of tomato fruit in 1999 and 2000. Results also showed that tomato fruit size and weight increased in both varieties with increasing the percentage of treated wastewater. Reuse of domestic wastewater treated in macrophyte ponds to irrigate tomato and eggplant in semi-arid West-Africa was studied by Irenikatche *et al.,* (2011). The study showed that the treated wastewater provided variable nutrients supply depending on year and element. Both crops responded better to mineral fertilizer (52% for tomato and 82% for eggplant) and the effects of the treated wastewater and fertilizer were additive. Manjuntha *et al.,* (2015) also studied an effect of untreated and engineered constructed wetland treated wastewater on yield, water productivity and economics of brinjal crop. The performance of brinjal crop with application of engineered constructed wetland treated wastewater in comparison to other sources of water was studied through field experiment conducted at University of Agricultural Sciences, Dharwad during kharif season of year 2015. Application of the domestic wastewater resulted in higher net returns and B:C ratio (2,18,355/ha and 2.68) followed by conjunctive use of engineered constructed wetland treated wastewater and domestic wastewater irrigation (2,17,035/ha and 2.67). Busaidi and Ahmed (2017) studied maximum use of treated wastewater in agriculture. The aim of the study was to maximize the usage of treated wastewater reuse in conjunction with groundwater or any available water resource by taking into consideration their quality and quantity, in addition to the environmental, economic and agronomic components. The study was conducted at Sultan Qaboos University, Oman with three types of crops (eggplant, radish and okra). Significant increase in plant productivity was noticed when plants were irrigated with treated wastewater. An impact of municipal wastewater reuse through micro-irrigation system on the incidence of coliforms in selected vegetable crops was studied by Tripathi *et al.,* (2019). The incidence of coliforms in soil and agricultural produce was evaluated in two vegetable crops, cauliflower and eggplant, which were grown using wastewater for irrigation. Study results revealed that, the critical role of subsurface drip irrigation in reducing the load of coliform both in the soil and the crop produce ensuring safety of the consumers against health hazards. Serrano *et al.,* (2020) seen the progress on green table olive

processing with KOH and wastewaters reuse for agricultural purposes. Olives of the "Manzanilla" and "Hojiblanca" cultivars with a greenish-yellow color on the surface were supplied by a farming cooperative located in Lora de Estepa (Seville, Spain) during the 2018-2019 and 2019-2020 seasons. Overall, it has been demonstrated that Spanish-style green olives can be processed with KOH and the effluents valorised to be used as bio fertilizer.

Wastewater reuse for irrigating fruit crops

Effects of citrus sinensis irrigation with treated wastewater on microbiological quality of soil and fruits were studied by Monia Trad Raïs (2019). The study aimed to evaluate bacterial contamination of soil and orange fruits when secondary TWW are used for irrigation. The study was carried out in north eastern Tunisia. The orchard was irrigated by drip irrigation. Soil and fruit samples were free of Salmonella. Fruit contamination by faecal indicators was negligible, which suggested that TWW can be useful as an alternative for drip irrigation of citrus orchards in water-scarce areas.

Waste water reuse by various methods

Almas and Scholz (2014) found that the wastewater treatment with waste stabilization ponds (WSP) is a very efficient, low cost and low maintenance operation. This paper includes an outline of the social, religious and political reasons for the water crisis, and explores the idea of reuse of effluent for different irrigation practices. The reuse of treated wastewater for agricultural purposes in Nicaragua; Central America, was studied by Platzer *et al.,* (2004). The first subsurface flow wetland (SSFW) system for about 1,000 PE, was constructed in Nicaragua in 1996 to apply this technology in the form of an integral project, combining the treatment of domestic wastewater with its reuse for crop production in small and medium size communities. The SSFW effluent meets all standards established in the national regulations for wastewater reuse in agriculture, except for faecal coli forms, existent at an average concentration of 7 × 104 MPN/100 ml.

Farmers perception towards waste water reuse

Farmers' acceptance and willingness to pay for using treated wastewater in crop irrigation in western Iran was studied by Zoherh *et.al.* (2020). Use of appropriate incentives, such as price reduction of treated wastewater according to quality, testing physico-chemical properties and microbial contamination of treated wastewater, as well as extension training courses can be effective on promoting farmers' willingness to use treated wastewater for crop irrigation. Perceptions of water quality among farmers towards water reuse for irrigation in were studied by Jordan Carr *et al.,* (2011). The reuse of treated wastewater (reclaimed water) for irrigation is a valuable strategy to maximise available water resources, but the often marginal quality of the water can present agricultural challenges. Farmer perception of reclaimed water may be a function of its quality, but consideration should also be given to farmers' capacity to manage the agricultural challenges associated with reclaimed water (salinity, irrigation system damage, marketing of produce), their actual and perceived capacity to control where and when reclaimed water is used, and their capacity to influence the quality of the water delivered to the farm. The study conducted by Blanca and Navarro (2017) describes both the positive and negative effects on human health associated with the use of wastewater for agricultural production. It is concluded that in order to address the current and future effects of the extensive use of wastewater irrigation in low-income regions, it is important to set sound

policies to affordably and realistically preserve advantages (livelihoods and food security), while controlling health and environmental risks in such a way that the situation may be progressively improved. Following table shows the effluent standards for sewage treatment plant.

Table.1 Effluent discharges standards for sewage treatment plant

Sr. No.	Parameters	Parameters limit
1	pH	6.5-9.0
2	BOD (mg/l)	Not more than 10
3	COD (mg/l)	Not more than 50
4	TSS (mg/l)	Not more than 20
5	NH_4N (mg/l)	Not more than 5
6	N -total (mg/l)	Not more than 10
7	Fecal Coliform (MPN/100ml)	Less than 100

(Source: NGT standards)

Abbreviations:

TWW	**Treated Waste water**
FAO	Food and Agricultural Organization
WHO	World health organization
IARI	Indian Agriculture Research Institute
SSWA	Sub Saharan West Africa
B:C	Benefit: Cost
KOH	Potassium Hydroxide
PE	Population Equivalent
US$	United States Dollar
WSP	Waste stabilization Pond
COD	Chemical Oxygen Demand
BOD	Biological Oxygen Demand
TSS	Total Suspended Solids
TC	Total Coliforms
FC	Faecal Coliforms
EPA	Environmental Protection Act

In conclusions, One of the most recognized benefits of wastewater use in agriculture is the associated decrease in pressure on freshwater sources. Thus, wastewater serves as an alternative irrigation source, especially for agriculture, the greatest global water user. Waste water can be used for vegetables, fruits and other agricultural crops by proper treatment. The agricultural produce produced using waste water irrigation can be good for consumption for human being as well as livestock.

Farmers are also showing their willingness to adopt this new technology still some awareness is required to implement in rural area for the same.

From the study it is concluded that waste water after treatment can be an alternative for clean irrigation water which would be scarce resource in upcoming years.

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