

## Review

# Sewage irrigation can sustain the soil health: A review

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Water is becoming the most important limiting natural resource nowadays and more than 70% of water is being utilized for irrigation. Shortage of surface and underground water could be partially overcome by reuse or recycling of sewage water and its multiple uses are becoming more and more important to meet the increased demand of agricultural production. Poor water quality degrades soil quality, results in the accumulation of heavy metals and alteration of soil physical, physico-chemical and chemical properties and influences the soil health to a great extent. Studies by different authors on different soil properties, by the effect of domestic sewage irrigation on quality of soils, soil nutrient status, properties are reviewed in this paper.

**Key words:** Sewage water, soil properties, soil health, irrigation.

## INTRODUCTION

Land and water are natural finite resources but due to indiscriminate and unscrupulous utilization, these resources are diminishing at an alarming rate. Water is becoming the most important limiting natural resources nowadays. More food has to be produced per unit of water available for agriculture and to meet the increased demand of agricultural production. Hence, its multiple uses and re-use is becoming more and more important. However use of waste water as a supplemental source of irrigation is inevitable for increased agricultural production in many arid and semi-arid regions where irrigation supplies are insufficient to meet crop water needs.

Use of domestic sewage water in agriculture undoubtedly leads to soil contamination and groundwater pollution is the major environmental concern and also helps to recycle useful nutrients through the food chain. But it also poses risks simultaneously for the profitability of the cultivated crop and human health because of the possible presence of toxic elements in the irrigation water. However in addition to that the domestic sewage water also contains residues of pesticides, heavy metals and many other toxic materials / chemicals which may be hazardous and it may affect the soil micro-flora, soil texture and quality and also the plant growth and development. So in this context it is one of the essential task to study about the effect of sewage water irrigation on soil health.

## Effect of Sewage water on physical properties

### Bulk density and texture

Sewage water irrigation becomes most important source of irrigation in Peri urban areas. It will improve the soil physical properties like infiltration, BD, WHC. Rattan et al., (2005) indicated that fields irrigated with sewage irrigation water around the peri urban areas of Keshopur Sewage Treatment Plant had sand and silt contents ranged from 56 to 86 and 8 to 28%, respectively, while maximum (18%) clay was recorded. Out of 30 samples analyzed, 7 samples belong to loamy sand and 23 samples were classified as sandy loam. It clearly depicts that increased clay content in the soil. Khariche et al. (2011) reported that use of sewage irrigation recorded certain improvement in soil physical properties like bulk density, water retention, hydraulic conductivity, organic carbon and build up of soil N, P, K, micronutrients, heavy metals and microbial count providing the proper aerated conditions.

## Effect of Sewage water on physico-chemical properties

### Soil reaction & EC

Sewage irrigation effects on chemical properties like pH, EC to a great extent and they increased the pH and salt

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content in the soils and soils quality is deteriorated to some extent. Ramesh (2003) reported that Soils irrigated with sewage water recorded higher pH and EC as compared to soils irrigated with normal water. Yaseen and Ishtiaque (2002) concluded from soil salinity data of soils under canal water that there was no remarkable change in EC, pH, SAR and ESP. Almost the same trend was found alternating with marginal water and canal water. However, in marginal water a slight increase in E<sub>ce</sub>, pH, SAR and ESP have been noticed at all the sampling depths up to 120 cm from ground surface.

Bhise et al., (2007) concluded that waste water irrigation had adverse effect on some soil properties like EC, ESP and soluble cations(Na/K and Na/Mg) ratios and heavy metal content.

Keremane (2009) studied that the EC, values of Musi were higher than those recommended by FAO guidelines with urban, periurban and rural areas having 2.1, 2.6, and 2.6 d S m<sup>-1</sup>, respectively. Sewage including paper mill effluent of Jagiroad, Assam had a pH of 7.6 and conductivity of 7.12 dS m<sup>-1</sup> (Dutta and Boissya 1999). Similarly neutral reaction and 0.99 dS m<sup>-1</sup> EC was reported in water contaminated by sewage water at main research station, Hebbal, UAS, Bangalore (Nanjudappa et al., 2002). Tiwari et al., (1996) observed that soils irrigated with treated sewage water had relatively higher pH (8.0) and EC (0.2 d S m<sup>-1</sup>) as compared to soils irrigated with tube well water (7.5) at Banaras Hindu University, Varanasi, U.P. Rattan et al., (2005) concluded that the soil pH dropped on an average, by 0.4 units as a result of the long-term effect of sewage irrigation sewage irrigation.

### Organic Carbon

Due to sewage irrigation increase in the soil organic carbon content is a positive sign of improved soil health to certain extent. Ramesh (2003) proved that the effect of continuous irrigation with sewage water on soil properties like organic carbon was high as compared to soils irrigated with normal water. Rattan et al., (2005) indicated that there was an increase in organic carbon content ranging from 38 to 79 per cent in sewage-irrigated soils (content varied from 0.14 to 3.71% with average of 0.65% ) as compared to tube well water-irrigated ones (content varied from 0.14–0.76 with an average of 0.39 per cent) from a study on long term effect of sewage irrigation on heavy metal content in soils, plants and groundwater in peri-urban agricultural lands under Keshopur Effluent Irrigation Scheme (KEIS) of Delhi. Sashikanth (2010) reported that the soil under Musi irrigation recorded high level of OC percentage i.e., > 1.0 per cent (ranging from 1.35 at Budwel to 1.84 at Afzalgunj).

### Effect of Sewage water on chemical properties Exchangeable cations

Ramesh (2003) found that the effect of continuous irrigation with sewage water increase exchangeable cations to a lot of extent. Ambika *et al.* (2010) suggested that waste water application increases the soil salinity, organic carbon, N, K, Ca, Mg cations to a lot. Soil is a bio filter that can reduce a large part of domestic waste water pollutants, but this filtering increased EC, SAR, Na, Ca and Mg of soil. (Darvishi et al., 2010)

### Available N, P, K

The sewage water have a high nutrient load, suspended solids, dissolved nitrates. It adds available N, P, K, Fe, Mn, Zn and Cu to soil, indicating their significant addition through sewage suggesting use of sewage water as a low grade cheap fertilizer in agriculture which can markedly reduce the cost due to substitution of chemical fertilizers.

Nutrient status of sewage water irrigation (Ali A. Aljaloud, 2010.)

Parameter	Treated municipal waste water(mg/l)	Fresh water (mg/l)
Ammonia- nitrogen	20.7	--
Phosphate-phosphorus	7.0	--
Potassium	15.1	2.9

Priyanie amerasinghe et.al., (2008) observed that direct and lift irrigation with Musi sewage water plots showed that increased soil total N content, available phosphorus and exchangeable K content. Kharche et al., (2011) concluded that the sewage irrigated soils recorded higher available N, P, and K indicating their significant addition through sewage water as low grade cheap fertilizers. Yadav et al., (2003) reported a nutrient potential of 8100, 1200 and 11000 tonnes of N, P and K through sewage discharges of 485 million litres/day that can be used for irrigation (supplemented) to an area of 16000-32000 ha/annum in peri-urban areas in Haryana. Cao van Phung et al., (2009) proved that waste water was rich in nitrogen, phosphorus, and potassium and analysis of soil samples at harvest time showed that total nitrogen, phosphorus and potassium in rice irrigated with wastewater were significantly higher than plots without wastewater application, Kiziloglu et al., (2007) reported that the waste water and preliminary treated waste water significantly affected the soil chemical properties up to 0-30 cm soil depth and plant nutrient contents of cabbage plants irrigated with waste water for one year.

## Micronutrients and Heavy metals

Rattan et al., (2005) reported that 45 per cent of wastewater irrigated areas in China are contaminated with heavy metal at the most serious level. Cadmium and lead are the elements most seriously contaminating soils, not only in China, this has been a problem in several other countries like Germany, France and India as well (Ingwersen and Strect, 2006; Dere et al., 2006 and Singh and Kumar (2006). The excessive accumulation of heavy metals in agricultural soils through wastewater irrigation, may not only result in soil contamination, but also lead to elevated heavy metal uptake by crops, and thus affect food quality and safety (Muchuweti et al., 2006). Kharche et al., (2011) concluded that the mean content of Fe, Mn, Zn, Cu, Cd, Cr and Ni in 0-30 cm layer of sewage irrigated soils was 1.05, 1.24, 3.98, 1.51, 2.10, 1.62, 1.24 more times than their content in normal soil. Mathavan (2001) reported that among the 25 samples studied for toxic metal contents, lead was found to be at toxic levels where as Cd, Ni, Cr and Co were in higher range when compared to the contents encountered in normal soils. The Pb contents in sewage water were above the recommended level ( $0.05 \text{ mg l}^{-1}$ ) for use of sewage water for irrigation. Similarly, Yadav et al., (2003) expressed that the sewage water discharged through all the districts of Haryana contained micronutrients like Zn, Fe and Co to the extent of. 30.1, 178.8 and  $4.3 \text{ mg l}^{-1}$ , respectively.

The dissolved salt content of the Musi river water indicated that it can be used for irrigation with restrictions. Nutrient concentration in most of the locations studied was above the permissible limit which predisposes the sewage water and soil for biomagnifications in the cultivated paragrass samples (Urmila Devi, 2005).

Kuhad et al., (1989) reported that the DTPA extractable Zn content ranged from  $0.28$  to  $89.3 \text{ mg kg}^{-1}$  in sewage irrigated soils in Haryana and observed that the contents of available micronutrients decreased with increase in depth through maximum accumulation of micronutrients was observed in the surface horizons of all soils. Priyanie amerasinghe et al., (2008) concluded that soil Pb, Zn and Cd concentrations in soils irrigated with Musi sewage water, were significantly lower than the EU (European Union) Maximum Permissible (MP) level in most of the samples expect few samples those significantly higher. Priyanie amerasinghe et al., (2008) concluded that significantly higher concentrations of Cd and Pb levels for 'direct' and 'liff' irrigated rice plots ( $4.56$  and  $2.24 \text{ mg kg}^{-1}$  and  $14.6$  and  $11.9 \text{ mg kg}^{-1}$ ) respectively and groundwater irrigated, plots were relatively lower having  $1.41$  and  $9.78 \text{ mg kg}^{-1}$ , Cd and Pb levels respectively. Simmons et al., (2006) concluded that soils irrigated with Sewage water for 20 years resulted into significant build-up of DTPA extractable Zn (2.1 times), Cu (1.7 times), Fe (1.7 times), Ni (63.1%) and Pb (29%) in sewage-irrigated soils over

adjacent tube well water irrigated soils. Rattan et al., (2005) studied the long term (20 years) impact of irrigation with sewage effluents on heavy metal content in soil, crops and ground water and found that sewage water contain much higher amount of P, K, S, Zn, Cu, Fe, Mn and Ni compared to ground water. Similar results were reported by Malla et al., (2007). Ambika et al., (2010) reported that Sewage water often have a high nutrient load, suspended solids, dissolved nitrates, pesticides, heavy metals and many other toxic materials / chemicals which may be hazardous and it may affect the soil micro-flora, soil texture and quality and also the plant growth and development.

## CONCLUSIONS

Sewage irrigation shows an improvement in soil physical properties like bulk density, water retention, and hydraulic conductivity. The physico chemical properties like pH and electrical conductivity was increased due to sewage water having three high amount of salts and deteriorating the soil structure to some extent and the chemical properties like presence of high amount of organic carbon and build-up of soil available N, P, K, and micronutrient status in the sewage-irrigated soils and improving the soil fertility status to certain extent however the heavy metals like were found to be accumulated in surface soil and plant due to long-term use of sewage irrigation. This warrants the potential hazard to soil and plant health suggesting necessity of their safe use after pretreatment in order to make use of sewage effluents as a cheap potential alternative source of plant nutrients in agriculture. Finally sewage irrigation-it's never new, only recycle and reuse.

## REFERENCES

- Ali AA (2010). Reuse of wastewater for irrigation in Saudi Arabia and its effect on soil and plant. Paper presented in 2010 19th World Congress of Soil Science, Soil Solutions for a Changing World 1 – 6 August 2010, Brisbane, Australia.
- Ambika SR, Ambika PK, Govindaiah (2010). Crop growth and soil properties affected by sewage water irrigation a review. *Agril Reviews*. 31 (3): 203-209.
- Bhise PM, Challa O, Venungopalan MV (2007). Effect of waste water irrigation on soil properties under different land use systems. *J. Indian Soc. Soil. Sci* 55(3): 254-258.
- Cao van Phung, Nguyen BP, Tran KH, Bell RW (2009). Technical Report Irrigating rice crops with waste water to reduce environmental pollution from catfish production in the Mekong Delta, Australia.
- Dutta SK, Boissya CL (1999). Effect of paper mill effluent on growth, yield and N, P, K contents of transplanted rice (*Oryza sativa* L. var. Mahsuri). *J. Environ. Biol* 20 (1): 29-32.

- Keremane (2009). Urban wastewater use for irrigation: A case study of farmers along Musi river in Hyderabad. *Kar J. Agric. Sci.* 22(1): 235-237.
- Kharche VK, Desai VN, Pharande AL (2011). Effect of sewage irrigation on soil properties, essential nutrient and pollutant element status of soils and plants in a vegetable growing area around Ahmednagar city in Maharashtra. *J. Ind. Soc. Soil Sci.* 59 (2): 177-184.
- Kiziloglu FM, Turan M, Sahin U, Angin I, Anapall O, Okuroglu M (2007). Effect of waste water irrigation on soil and cabbage plant (*Brassica oleracea var. capitata cv yalova-1*) chemical properties. *J. Plant Nutr. Soil Sci.* 170: 166-172.
- Kuhad MS, Malik RS, Sing A, Dahiya IS. (1989). Background levels of heavy metals in agricultural soils in Indo-Gangetic plains of Haryana. *J. Ind Soc. Soil Sci.* 37: 700-705
- Kumar R, Singh RD, Sharma KD (2005) Water resources of India. *Cur Sci.* 89(5): 794-811.
- Mathavan CM (2001). Performance of some decontaminants in abetting the toxic metal effects in polluted agricultural soils. *M.Sc.(Ag.) Thesis*, Acharya N.G. Ranga Agricultural University, Hyderabad.
- Muchuweti M, Birkett JW, Chinyanga E, Zvauya R, Scrimshaw MD, Lester JN (2006). Heavy metal content of vegetables irrigated with mixture of wastewater and sewage sludge in Zimbabwe: Implications for human health. *Agric. Ecol. Environ.* 112: 41-48.
- Nanjundappa G, Reddy VC, Yogananda SB (2002). Performance of fodder grasses on sewage water. *Mys J. Agric. Sci.* 36 (3): 254-256.
- Priyane A, Philipp W, Robert S, Sreedhar A, Axel D (2008). An atlas of water quality, health and agronomic risks and benefits associated with wastewater irrigated agriculture-A study from the banks of the Musi river, India.
- Ramesh M (2003). Soil and water resource characteristics in relation to land disposal of sewage effluents and suitability of sewage water for irrigation. *M.Sc. (Ag.) Thesis* Acharya N.G. Ranga Agricultural University, Hyderabad.
- Rattan RK, Datta SP, Chhonkar PK, Suribabu K, Singh AK (2005). Long-term impact of irrigation with sewage effluents on heavy metal content in soils, crops and groundwater—a case study. *Agric. Ecol. Environ.* 109: 310–322.
- Sashikanth (2010) .Evaluation of pesticide residues in soil, water and crop along the course of river Musi, Hyderabad. *M.Sc (Ag) Thesis*, Acharya N.G. Ranga Agricultural University, Hyderabad.
- Simmons RW, Blummel M, Ramakrishna Reddy Ch, Arif Ali Khan (2006). Impact of wastewater irrigation on Cd and Pb concentrations in rice straw and paragrass: Implications for food safety. A report of International Water Management Institute (IWMI), South Asia Regional Office.
- Tiwari RC, Arvind Kumar Mishra AK (1996). Influence of treated sewage and tube well water irrigation with different fertilizer levels on rice and soil properties. *J. Ind Soc. Soil Sci.* 44(3): 547-549.
- Urmila Devi (2005). Effect of sewage and effluent water on paragrass in Musi river bed - problem analysis using GIS tools. *M.Sc (Ag) Thesis*, Acharya N.G. Ranga Agricultural University, Hyderabad.
- Yadav RK, Chaturvedi RK, Dubey SK, Joshi PK, Minhas PS (2003). Potential and hazards associated with sewage irrigation in Haryana. *Indian J. Agric. Sci.* 73(5): 249-255.
- Yaseen SM, Ishtiaque M (2002). Effect of marginal quality groundwater on crop yields and Soil. *J. Dry and Water Manag.* 6(2): 49-54