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Review Article

A Review on Effect of Wastewater Reuse in Agriculture

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A B S T R A C T

Population growth and rapid urbanization are dramatically increasing the gap between water supply and demand in many countries including India. There is a huge untapped potential of waste water for irrigation in India (Singanan, 2015). An estimated of 20 million hectares (approx. 7%) of land is irrigated using wastewater worldwide (WHO, 2006). Paucity of quality fresh water for agriculture has made waste water (WW) application a popular option. Available data on chemical composition of different waste water, their effect on soil fertility, soil heavy-metal content, crop yield and quality parameters and maximum permissible limits (MPL) of different International environment protection agencies and governments of different countries has been summarized. Chemical composition of WW varied remarkably with respect to their some important physico-chemical quality parameters of water such as pH, alkalinity, suspended solid (SS), total dissolved solids (TDS), electrical conductivity (EC), dissolved oxygen, BOD, COD and heavy metals mainly for Cr, Pb, & Ni (APHA, 1985). More importantly, carbon sequestration through WW irrigation could sustain long-term soil fertility. Periodic monitoring of chemical composition of waste water, soil and crop produce is however, suggested for safe and long term use of waste water. Wastewater can be reused safely in agriculture when it meets the criteria like; pH <7.5, EC 0-25 msm^{-1}, TDS <0.6g/lit, HCO_3^- <1.5meq/lit, Cd <0.01mg/lit, As<0.10mg/lit and Fe <5mg/lit (Environmental studies board, 1973).

Keywords

Wastewater reuse, physical and chemical properties, possible solutions

Introduction

Wastewater reuse in agriculture involves the further use of "treated" wastewater for crop irrigation. The use of sewage water for irrigation is a positive way to dispose of sewage. Such large volumes of water in a country with persistent droughts and unreliable rainfall can be of great agronomic and economic importance. Use of sewage water for irrigation improved chemical properties and fertility status in soil.

Sewage water contains elements essential for plant growth and also contains heavy metals which may be toxic for animals if their concentration exceeds than permissible limit. Irrigation with sewage water can increase water supply for alternative use. The utilization of sewage water also contributes to cleaning of the environment, as the water is not discharged into water bodies that could otherwise get polluted. In addition to these direct economic benefits that conserve natural resources, this water contains a lot of nutrients that can serve as an alternative source to chemical fertilizers which are expensive (FAO, 1992).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, which consumes 70% of available water (Pimentel and Pimentel, 2008). Furthermore, wastewater reuse increases agricultural production in regions experiencing water shortages, thus contributing to food safety (Corcoran *et al.,* 2010). Depending on the local situation, another benefit associated with agricultural wastewater reuse could be the avoided cost of extracting groundwater resources. In this regard, it is worth noting that the energy required to pump groundwater can represent up to 65% of the costs of irrigation activities (Cruz *et al.,* 2009).Additionally, the nutrients naturally present in wastewater allow savings on fertilizer expenses to be realized (Moscoso and Aspectos, 2017), thus ensuring a closed and environmentally favorable nutrient cycle that avoids the indirect return of macro- (especially nitrogen and phosphorous) and microelements to water bodies. Depending on the nutrients, wastewater may be a potential source of macro- (N, P and K) and micronutrients (Ca, Mg, B, Mg, Fe, Mn or Zn) (Liu and Haynes, 2011). Indeed, wastewater reuse has been proven to improve crop yield (Oliveira and Von Sperling, 2008) and result in the reduced use of fertilizers in agriculture (Adrover *et al.,* 2012). Therefore, eutrophication conditions in water bodies would be reduced, as would the expenses for agrochemicals used by farmers (Candela *et al.,* 2007). The prevention of water pollution would be another benefit associated with wastewater reuse in agriculture. A decrease in wastewater discharge helps improve the source quality of receiving water bodies (Toze, 2006). Moreover, groundwater reservoirs are preserved, as agricultural wastewater reuse recharges these sources with higher-quality water.

This article reviews the effects, both positive and negative, of wastewater reuse in agriculture. The effect of wastewater are headed as

Effects of wastewater uses on soil physical properties

Effects of wastewater uses on soil chemical properties

Effects of wastewater uses on soil physical properties

Gurjar *et al.,* (2017) studied that the physical properties analysis of the sewage water and ground water that were used for irrigation purpose and results found that the physical property of soil for treatments of the sewage water irrigated area increase the bulk density (BD) 0.01g cm^{-3}, particle density (PD) 0.02 g cm^{-3}, porosity 1.03% and water holding capacity (WHC) 6.20 % to camper to ground water irrigated area.

Tabriz *et al.,* (2011) studied that the impact of sugar mill’s wastewater that caused an increase in the porosity but decrease in the bulk density of soil. There were some positive impacts of the sugar mill’s wastewater on soil hydraulic properties, the gravitational water, field capacity and saturated hydraulic conductivity increased due to the effect of wastewater. The average bulk density decreased from 1.30 to 1.02 g cm^{-3} for the disturbed soil and from 1.38 to 1.12 g cm^{-3} for the undisturbed soil. The wastewater contained considerable quantity of ash and organic matters such as bagasse, press mud, molasses, etc., which accumulated in the soil over time and were responsible for the reduction of the bulk density. Due to the effect of wastewater, porosity increased by 10.5%. Also showed that the accumulation of organic matter and ash improved soil structure and consequently raised the porosity of soil. The improved structure of the wastewater-affected soil also raised the saturated hydraulic conductivity. Due to the effect of wastewater, the water holding capacity of the soil increased both for the disturbed and undisturbed conditions at the two sites. The wastewater contained organic and inorganic substances that improved soil structure and, consequently, increased the porosity as well as the water holding capacity of the wastewater affected soils.

Mathan (1994) recorded significantly lower bulk density and increased hydraulic conductivity in sewage farm soils with sewage irrigation for 15 years. This can be attributed to improvement in total porosity and aggregate stability in the sewage-irrigated soils due to addition of organic matter which plays an important role in improving soil physical environment.

Singh, R. A. (2011) observed that the bulk density of soils irrigated with sewage water was low (1.2 to 1.39 Mg m^{-3}) as compared to those for the well-irrigated soils. The hydraulic conductivity was also higher (1.10 to 1.33 cm h^{-1}) for sewage irrigated soils. Continuous use of sewage and industrial effluents irrigation recorded improvement in water retention, hydraulic conductivity.

Effects of wastewater uses on soil chemical properties

Gurjar *et al.,* (2017) reported that after irrigation with sewage water, pH decreased significantly and increase OC and EC with comparison to ground water.

Abegunrin *et al.,* (2013) concluded the pH of the soil decreased with the irrigation of wastewater had the lowest pH value of 6.0 while soil irrigated with rainwater had the highest pH of 6.9. A pH of 6.7 was obtained for soil irrigated with groundwater initial decrease in pH may be observed in soil irrigated with kitchen wastewater but after a while it may cause an increase of soil pH. SAR increased in soil solution with the three water treatments as maximum value of 12.46 was observed in soil irrigated with groundwater. Soil irrigated with wastewater gave the lowest SAR value of 10.14 while soil irrigated with rainwater gave a value of 12.15.

Mohammed *et al.,* (2014) analysed that in soil concentration the irrigation with sewage water (SW) and treated sewage water (TSW) induces significant ($P<0.05$) decrease of soil pH when compared to control treatment groundwater (GW). The SW and TSW affect significantly the EC indeed, in comparison with groundwater (GW), EC is greater with SW and TSW treatment.

Singh and Swami (2014) the effluent was applied in 50 and 100% strength and a control plot received normal groundwater as irrigation water under wheat cropping system. No fertilizer was applied in effluent treated crop while field with groundwater received normal dose of chemical fertilizer. The values of chemical properties of soil extracted from control field were comparatively lower than that of soil irrigated with 50% and 100% effluent. The pH of the control soil was observed to be near neutral scale (i.e. 7.38). After the application of 50% diluted effluent, an increased effect on soil pH was observed, the pH was raised up to 8.38 and after the application of 100% raw effluent the pH of the soil increased up to 8.92. Similarly a marginal increase in EC also took place in agriculture soils after applications of distillery effluent which suggest the uploading of inorganic substances in soils. In the soil without distillery effluent application, the EC was recorded as 2.06 dS m^{-1}. However, the shift was observed in EC in soil supplied with 50 and 100% distillery effluent, maximum in 100% effluent treated soil (3.76 dS m^{-1}).

Al-Jaboobi *et al.,* (2014) showed that the wastewater soil pH ranged from 7.89 to 7.55 in soil irrigated with wastewater which less than from 8.27 to 8.08 in groundwater soil irrigation with wastewater was resulted in an increase in EC from 893 to 943 µS/cm with an average of 921 µS/cm, in soil irrigated with wastewater while the average value of EC in the soil irrigated with ground water varied from 600 to 705 µS/cm with a mean of 657 µS/cm. The best amount of organic matter was found in the soil irrigated with wastewater. It showed 2.00 % compared to 0.74 % obtained in the case of the soil irrigated with groundwater. This implies that wastewater contains organic matter compounds. Average values of Phosphorus were high in soil irrigated with wastewater, 27.33 ppm, compared to 6.22 mg/l in soil irrigated with groundwater. Total nitrogen in soil which was significantly high in SW with average of 40.33 mg/kg compared to those irrigated with groundwater 16 mg/kg. Observed that there is increase in value of potassium in the soil irrigated with wastewater (519 ppm) than the other type of soil (115 ppm).

Yen-Yiu Liu and Haynes, R. (2010) revelled the effects of irrigation with dairy factory wastewater on soil properties were investigated at two sites that had received irrigation for > 60 years. In comparison with paired sites that had not received effluent, long-term wastewater irrigation resulted in an increase in pH, EC, extractable P, exchangeable Na and K and ESP. These changes were related to the use of phosphoric acid, NaOH and KOH as cleaning agents in the factory. Despite these clear changes in soil chemical properties, there were no increases in soil organic matter content (organic C and total N) and the size (microbial biomass C and N) and activity (basal respiration) of the soil microbial community were, in fact, increased by wastewater irrigation. These increases were attributed to regular inputs of soluble C (e.g. lactose) present as milk residues in the wastewater.

Tabriz *et al.,* (2011) showed that the wastewater contained various dissolved organic and inorganic substances, which elevated the electrolyte content of the soils with a consequent increase in their electrical conductivity. The EC of the wastewater affected soil was 0.53 dS m^{-1}. The wastewater raised the electrical conductivity but reduced the pH of soil. The wastewater, by raising phosphorous, potassium, sulphur and organic matter contents in the soil improved soil fertility.

Possible solutions of problems associated with the sewage and industrial effluents

To exploit the sewage waters as a potential source of irrigation and maintain environment the sewage waters must be diluted either with canal or underground water to avoid the excessive accumulation of soluble salts in the soils. It will help in maintaining the productivity of agricultural crop without any harmful effect on soil properties.

Entry of heavy metals into food chain can be reduced by adopting soil and crop management practices, which immobilize these metals in soils and reduce their uptake by plants.

Heavy phosphate application and also the application of kaolin / zeolite to soils can reduce the availability of heavy metals.

Application of organic manures can mitigate the adverse effect of the toxic metals on crops.

Thus in the soil contaminated with high amount of toxic metals, application of organic manures is recommended to boost the yield potentials as well as decrease the metal availability to plants.

Raising hyper accumulator plants (mustard /trees) in toxic metals contaminated soils is recommended to avoid the entry of toxic metal in the food chain.

The results of the physical property of soil for treatments of the sewage water irrigated area increase the BD, PD, porosity and WHC to camper to ground water irrigated area. The present results is to compare the influence and the difference between chemical elements levels in soil that results from applying sewage and ground water when they are used for irrigation.

The used water sources evaluated as a source of irrigation water according to the FAO system of water quality classification which appeared the suitable use of these sources in leaching and irrigation the saline soils especially in the short-time. The result showed that the soil parameters are significantly affected by application of sewage water irrigation. Irrigation with sewage water increased the concentrations of pH, EC, OC, N, P, K, Ca, Mg and S in soils irrigated by sewage water compared to the ground water irrigation.

References

Abegunrin, T. P., Awe, G. O., Idowu, D. O., Onigbogi, O. O. and Onofua, O. E. (2013) Effect of kitchen wastewater irrigation on soil properties and growth of cucumber (*Cucumissativus*). *J. Soil Sci. Environ. Manage*. 4(7): 139- 145.

Adrover, M.; Farrús, E.; Moyà, G.; Vadell, J. (2012) Chemical properties and biological activity in soils of mallorca following twenty years of treated wastewater irrigation. *Environ. Manag.*, 95: S188–S192.

AL-Jaboobi, M., Tijane, M., EL-Ariqi, S., El Housni, A., Zouahri, A. and Bouksaim, M. (2014) Assessment of the impact of wastewater use on soil properties. *J. Mater. Environ. Sci.*, 5 (3): 747-752.

APHA, 1985. Standard methods for the examination of water and wastewater. American public health association, Washington, D.C.

Candela, L.; Fabregat, S.; Josa, A.; Suriol, J.; Vigués, N.; and Mas, J. (2007) Assessment of soil and groundwater impacts by treated urban wastewater reuse. A case study: Application in a golf course (Girona, Spain). *Sci. Total Environ.*, 374: 26–35.

Corcoran, E.; Nellemann, C.; Baker, E.; Bos, R.; Osborn, D.; Savelli, H. (2010) Sick Water? The Central Role of Wastewater Management in Sustainable Development: A Rapid Response Assessment; Earthprint: Arendal, Norway.

Cruz, R., Medición, del, Agua and de Riego. (2009) Tecnicaña, 34: 27–33.

Environmental studies broad, 1973. International journal of water resources and arid environment, 2015.

FAO. Wastewater Treatment and Use in Agriculture. Avaliable online:

http://www.fao.org/docrep/T0551E/ T0551E00.htm (1992).

Gurjar, O.P., Meena, R., Latare, A. M., Rai,S., Kant, S., Kumar, A., Kumar, A. and Sheshama, M. K. (2017) Effects of sewage wastewater irrigation compare to ground water irrigation on soil physicochemical properties. I*nter. J. Chemical Studies,* 5(6): 265-267.

Liu, Y. and Haynes, R. (2011) Origin, nature, and treatment of effluents from dairy and meat processing factories and the effects of their irrigation on the quality of agricultural soils. Crit. Rev. *Environ. Sci. Technol*, 41: 1531–1599.

Mathan, K.K. (1994). Studies on the influence of long-term municipal sewage effluent irrigation on soil properties. *Bioresource Tech.*, 48: 275-276.

Mohammed A., Alghobar, Lathamani Ramachandra, Sidduraiah Suresha (2014) Effect of sewage water irrigation on soil properties and evaluation of the accumulation of elements in Grass crop in Mysore city, Karnataka, India *American J. Envir. Prot.*; 3(5): 283-291.

Moscoso, J., Aspectos, T. (2017) Agricultura con Aguas Residuales. Availabe online: h*ttp://bvsper.paho. org/bvsacd/scan/019502.pdf*.

Oliveira, S. and Von Sperling, M. (2008) Reliability analysis of wastewater treatment plants. *Water Res.*, 42: 1182–1194.

Pimentel, D. and Pimentel, M. (2008) Food, Energy, and Society; Taylor & Francis Group: Boca Raton, FL, USA.

Singanan, M. and Peters, E. (2015) Removal of toxic heavy metal from synthetic wastewater using a novel biocarbon technology. *J. Env. Chem. Eng.*, 1: 884-890.

Singh, R. A. (2011) Impact of Sewage and Industrial Effluents on Soil-Plant Health, Availabe online: *www.intechopen.com.*

Singh, S. V. and Swami, V.K. (2014) Impact of Distillery Wastewater Irrigation on Chemical Properties of Agriculture Soil. *Inter. J. Innovative Res. Sci., Engineering and Tech.*, 3:10.

Tabriz, S. S., Mojid, M. A. and Wyseure, G. C. L. (2011) Irrigation suitability of North Bengal Sugar Mill's effluent and its impact on soil properties. *J. Bangladesh Agril. Univ*. 9(2): 283–290.

Toze, S. (2006) Reuse of effluent water. Benefits and risks. Agric. *Water Manag.,* 80: 147–159.

Yen-Yiu Liu and Haynes, R. (2010) Effect of long-term irrigation with dairy factory wastewater on soil properties. 19th World Congress of Soil Science, Soil Solutions for a Changing World 2958 1 – 6 August, Brisbane, Australia.