

Impact of treated sewage effluent on soil fertility, salinization, and heavy metal content

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ABSTRACT: A long-term experiment (2013 to 2017) of treated sewage effluent (TSE) levels via fertigation in a humid tropical region was installed in Jaboticabal, state of São Paulo, Southeast of Brazil, to evaluate the impact of TSE on soil fertility and the potential for salinization and heavy metal contamination of an Oxisol. The area was cultivated with *Urochloa brizantha* under the application of four TSE levels at the irrigation depth (0, 11, 60, and 100% TSE) during the four years of the experiment. The TSE chemical composition was monitored throughout the experimental period. The heavy metal levels and soil fertility were evaluated in the 0–0.10 and 0.10–0.20 m layers at the end of the four years of the experiment. Fertigation using TSE did not increase the concentration of potentially toxic elements (As, Cd, Cu, Hg, Mo, Ni, Pb, Se, and Zn) in the soil due to their low concentration in the effluent. A higher Na concentration was also observed at high TSE levels (60 and 100%). However, the sodium adsorption rate in the TSE was low, generating no potential for soil salinization and sodification. Fertigation with TSE levels increased soil fertility, increasing by more than 30% the P content and base saturation in the soil compared to control. According to the chemical attributes evaluated in the soil and effluent, this long-term study showed that TSE application via fertigation in humid tropical regions on clayey soils cultivated with forage grasses is recommended.

Key words: water reuse, environmental contamination, soil chemical analysis, potentially toxic elements, wastewater.

INTRODUCTION

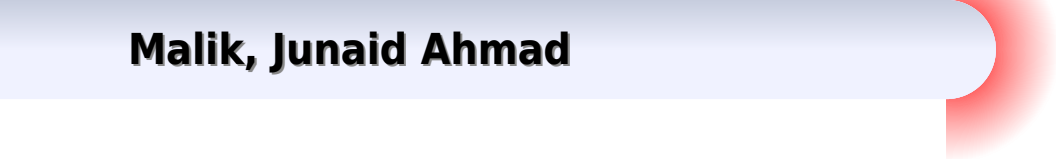
The increasing demand for food and water and the environmental pollution as a result of constant population growth are important global challenges facing humanity nowadays. Water consumption has increased in recent years at twice the rate of population growth and will continue to grow at a similar rate in the near future (Lavrnić et al. 2017). The agricultural sector is the most affected by water scarcity, as it accounts for 70% of global freshwater withdrawals for irrigation and over 90% of consumption (Norton-Brandão et al. 2013). On the other hand, the concentration of the human population in urban areas has significantly increased the production of sewage wastewater, which causes detrimental environmental impacts if appropriate actions are not taken.

In this context, wastewater can be an important component of an integrated water management policy (Van Lier and Huibers 2010; Andrews et al. 2016). Treated domestic wastewater is a widely available sustainable hydric source that can be used to meet the growing demand for agricultural irrigation (Santos et al. 2017). Thus, in recent years, wastewater recycling has gained importance as part of agricultural water sources in many countries facing water scarcity (Coelho et al. 2020).

The application of treated sewage effluent (TSE) in agricultural areas may be a viable alternative for nutrient recycling, reducing the water footprint in agriculture and increasing soil fertility. Therefore, it is necessary to examine the quality of the effluent to be used for this purpose. The application of TSE in agriculture provides essential nutrients to crops, especially

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Handbook of Research on Microbial Remediation and Microbial Biotechnology for Sustainable Soil Malik, Junaid Ahmad,2021-06-11 The introduction of contaminants due to rapid urbanization and anthropogenic activities into the environment causes distress to the physio chemical systems including living organisms which possibly is threatening the dynamics of nature as well as the soil biology by producing certain xenobiotics Hence there is an immediate global demand for the diminution of such contaminants and xenobiotics that can otherwise adversely affect the living organisms Some toxic xenobiotics include synthetic organochlorides such as PAHs and some fractions of crude oil and coal Over time microbial remediation processes have been accelerated to produce better more eco friendly and more biodegradable solutions for complete dissemination of these xenobiotic compounds The advancements in microbiology and biotechnology led to the launch of microbial biotechnology as a separate area of research and contributed dramatically to the development of areas like agriculture environment biopharmaceutics fermented foods and more The Handbook of Research on Microbial Remediation and Microbial Biotechnology for Sustainable Soil provides a detailed comprehensive account for microbial treatment technologies bioremediation strategies biotechnology and the important microbial species involved in remediation The chapters focus on recent developments in microbial biotechnology in the areas of agriculture and environment and the physiology biochemistry and the mechanisms of remediation along with a future outlook This book is ideal for scientists biologists academicians students and researchers in the fields of life sciences microbiology environmental science environmental engineering biotechnology agriculture and health sciences

Manures, Fertilizers And Soil Fertility S Mohandas,2023-09-20 Organic manure is the decomposition product of dead plant and animal residues which is added to soil to enrich soil fertility All the decomposable residues can be made into manure including human and animal excreta Manures Fertilizers and Soil Fertility is a comprehensive textbook comprising of eleven chapters that cover the prime areas comprise of manures fertilizers and soil fertility thoroughly covering the syllabus sequentially arranged which imparts broad knowledge on three important areas of soil fertility management viz manures fertilizers and soil fertility This book will be useful for undergraduate students in the field of soil fertility and its management at various agricultural horticulture universities

Sustainable Use of Wastewater in Agriculture Megh R. Goyal,Gaurav Saini,2025-07-11 Water is an essential resource for agriculture but harvesting water for irrigation is a major issue for farmers in developing and underdeveloped countries This new volume addresses the challenges of repurposing wastewater in agriculture processes with a special focus on low and middle income regions of the world The book details the application of wastewater treated

and untreated in agriculture and the latest and most economical techniques for making wastewater suitable for irrigation purposes. It also looks at the uptake of heavy metals and emerging contaminants by the irrigated crops, soil, etc. from wastewater. The book discusses utilizing water generated from rainwater harvesting systems, use of water quality indices for checking water suitability, the Internet of Agribot Things (IoAT) for wastewater applications, and more.

Sewage and Biomass from Wastewater to Energy Inamuddin, Tariq Altalhi, Mohammad Luqman, Joseph K. Bwapwa, 2024-06-21. Written and edited by a team of industry experts, this exciting new volume covers clean energy production from sewage and biomass while achieving a zero waste strategy. Wastewater treatment plants are critical in protecting both the environment's resources and human health. A wastewater treatment plant's technological system focuses not only on the effectiveness of the treatment but on the costs and energy consumption of the entire system. Municipal wastewater treatment produces a significant amount of sewage sludge all over the world. The majority of this sludge's dry matter content is made up of organic compounds which are not toxic and they consist of both primary and secondary microbiological sludge. There is also a substantial quantity of inorganic substances in the sludge along with a small quantity of toxic matter. Also, various raw sewage treatment options can include energy production, heat, electricity, or biofuel to reduce dependence on external energy supply during treatment. The most important options used for energy production from sewage and biomass can use the following approaches: anaerobic digestion, co-digestion, incineration with energy recovery, co-incineration, pyrolysis, gasification, supercritical wet oxidation, and hydrolysis. Generally, these processes or methods are cost-effective, but they can still have some setbacks related to the nature of the methods or the raw material used for conversion. There are also operating conditions to comply with to get a successful outcome. This book combines information from many disciplines related to wastewater treatment technologies to show how the circular economy approach can be used to achieve zero waste and produce energy that can be useful for plants and communities. This approach focuses on clean technologies for green energy resources such as biohydrogen, biofuels, and biogas from biomass and sewage sludge for zero waste production. This is aimed to also integrate the issue of energy demand and the one of energy production.

Soil Fertility Evaluation and Control Charles A. Black, 2013-12-29. Soil Fertility Evaluation and Control presents the theoretical background for practical applications of scientific work on soil fertility. The book emphasizes the use of response curves as the basic biological standard for both evaluation and control, and it discusses soil testing and plant analysis as secondary standards. The principal application.

Soil Health and Environmental Sustainability Pravat Kumar Shit, Partha Pratim Adhikary, Gouri Sankar Bhunia, Debashish Sengupta, 2022-09-27. This book demonstrates the measurement, monitoring, mapping, and modelling of soil pollution and land resources. This book explores state-of-the-art techniques based on open sources, software, radioactive wastes, microbiology of soil and sediments, soil salinity and sodicity, pollution from landfill sites, soil erosion and contamination from agricultural activities, heavy metal pollution, and health risk, environmental impact, and risk assessment, sustainable land use, landscape management, and governance, soil

degradation and risk assessment agricultural soil pollution pollution due to urban activities soil pollution by industrial effluents and solid wastes pollution control and mitigation in extreme environments The content of this book is of interest to researchers professionals and policy makers whose work is in soil science and agriculture practices The book equips with the knowledge and skills to tackle a wide range of issues manifested in geographic data including those with scientific societal and environmental implications Effects of Sewage Sludge Applications to Agricultural Soils on Soil Microbial Activity and the Implications for Agricultural Productivity and Long-Term Soil Fertility United Kingdom Water Industry Research,2008-01-01 Evolution of Sanitation and Wastewater Technologies through the Centuries Andreas N. Angelakis,Joan B. Rose,2014-09-14 Most of the technological developments relevant to water supply and wastewater date back to more than to five thousand years ago These developments were driven by the necessity to make efficient use of natural resources to make civilizations more resistant to destructive natural elements and to improve the standards of life both at public and private level Rapid technological progress in the 20th century created a disregard for past sanitation and wastewater and stormwater technologies that were considered to be far behind the present ones A great deal of unresolved problems in the developing world related to the wastewater management principles such as the decentralization of the processes the durability of the water projects the cost effectiveness and sustainability issues such as protection from floods and droughts were intensified to an unprecedented degree New problems have arisen such as the contamination of surface and groundwater Naturally intensification of unresolved problems has led to the reconsideration of successful past achievements This retrospective view based on archaeological historical and technical evidence has shown two things the similarity of physicochemical and biological principles with the present ones and the advanced level of wastewater engineering and management practices Evolution of Sanitation and Wastewater Technologies through the Centuries presents and discusses the major achievements in the scientific fields of sanitation and hygienic water use systems throughout the millennia and compares the water technological developments in several civilizations It provides valuable insights into ancient wastewater and stormwater management technologies with their apparent characteristics of durability adaptability to the environment and sustainability These technologies are the underpinning of modern achievements in sanitary engineering and wastewater management practices It is the best proof that the past is the key for the future Evolution of Sanitation and Wastewater Technologies through the Centuries is a textbook for undergraduate and graduate courses of Water Resources Civil Engineering Hydraulics Ancient History Archaeology Environmental Management and is also a valuable resource for all researchers in the these fields Authors Andreas N Angelakis Institute of Iraklion Iraklion Greece and Joan B Rose Michigan State University East Lansing MI USA *Physico-Chemical Wastewater Treatment and Resource Recovery* Robina Farooq,Zaki Ahmad,2017-05-03 The book on Physico Chemical Treatment of Wastewater and Resource Recovery provides an efficient and low cost solution for remediation of wastewater This book focuses on physico chemical

treatment via advanced oxidation process adsorption its management and recovery of valuable chemicals It discusses treatment and recovery process for the range of pollutants including BTX PCB PCDDs proteins phenols antibiotics complex organic compounds and metals The occurrence of persistent pollutants poses deleterious effects on human and environmental health Simple solutions for recovery of valuable chemicals and water during physico chemical treatment of wastewater are discussed extensively This book provides necessary knowledge and experimental studies on emerging physico chemical processes for reducing water pollution and resource recovery

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