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Impact of Sewage Water on Human Health and Agricultural Land: A Review

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Abstract

Sewage and disposal is being used in developing countries to cover the shortage of water in agriculture lands. Sewage increase heavy metal in the soil which goes into the food chain but it has nutrients for the plants. Many remedies for polluted soils exist, including inversion of soil with benign substances such as sulphate, lime, calcium, and organic matter; these innocuous compounds produce insoluble metal complexes. This will reduce the amount of metal available to plants. This article examines the sewage irrigation quality and its impacts on soil parameters and other veggies in various places. Although many industrial effluents are suitable for irrigation, sewage quality varies depending on the source. In comparison to soluble salts and heavy metals such as zinc, copper, manganese, nickel, and cobalt, the samples gathered from hospitals, tanneries, clinical labs, and the steel industry were detrimental. The quality of sewage in main drains was better than in industry outlets, however irrigation was not done safely. Metals accumulated more in the roots of fruits and vegetables than in the leaves of the plants. There is a need for safe management solutions based on scientific research. One element that appears to be especially detrimental to leafy crops is cadmium.

Keywords: Sewage water, Heavy metals, Pollutants, Agricultural land,fruits and vegetables and Human health

Introduction

Using urban sewage water in agriculture is a long-standing practice. It has attracted attention in many parts of the world, particularly in arid and semi-arid areas, where it is the primary cause of water scarcity. Sewage can be defined as untreated industrial effluents and home waste water. Due to more population and industrialization increased pressure on land resources and water, which may leads to more volume discharge of sewage. Waste water supports the resources of poor farmers but it change the quality of environment. The country where safe effluents are not available, sewage is used in those areas to irrigate the crops and vegetables (Ensink et al., 2004).Urban treated wastewater, one of the unconventional water resources that has been presented as an option for irrigation in dry locations with severe rivalry among water consumers, has been used because of its acceptable quality (Zhang and Shen, 2019; Khalid et al., 2018). The implications of using urban treated wastewater on soil physicochemical qualities, plant production, pollution levels, and surface and groundwater resources have long piqued the interest of researchers interested in the effects of short- and long-term wastewater irrigation on soil physicochemical qualities, plant production, pollution levels, and surface and groundwater resources.In locations where freshwater is scarce, using treated wastewater in farmland is today regarded not only a solution for wastewater disposal, but also a solution for sustainable agriculture (Duan et al., 2010) The usefulness of this water resource in arid and semi-arid areas has been proved by the effects of treated wastewater on plant growth, since its nutrients can enhance agricultural yields while eliminating the use of unnecessary chemical fertilizers (Zhang and Shen, 2019).Wastewater contains three important macronutrients: nitrogen, phosphorus, and potassium, as well as a range of micronutrients required for plant growth. According to Jiménez et al. (2011) and Murtaza et al. (2010), this can greatly reduce the use of chemical fertilizers in farmlands. However, depending on the wastewater's quality, it may have negative effects on human health, crop production, and soil physicochemical characteristics. Microbial contamination-related diseases, increased soil salinity and sodium absorption ratio, changes in soil hydraulic conductivity, nutrient accumulation, and plant toxicity are only a few of them(Shoushtarian and Negahban Azar, 2020; Muyen et al., 2011; Andrews et al., 2016).Salinity, sodium absorption, and organic matter available in treated wastewater, for example, had a complex effect on soil hydraulic conductivity, according to Levy et al. (2011), and these effects were depending on the treated wastewater quality and soil parameters. In general, wastewater use improves soil organic matter and structure, resulting in increased soil hydraulic conductivity. After eight years of irrigation of olive trees with urban treated effluent in desert areas, soil nitrogen, phosphate, potassium, and salinity increased (Erel et al., 2019).The annual rise in soil salinity had no effect on the salt content in plant leaves, toxicity, or yield. The tolerance of the olive tree, seasonal rainfall, and proper soil drainage, they said, were the main factors in preventing excessive saline levels. Despite this, their findings demonstrated a steady increase in the sodium absorption ratio and, as a result, a rise in the soil's exchangeable sodium concentration. According to other studies, increased sodium exchangeable content in soil as a result of a high salt absorption ratio in urban treated wastewater promotes soil degradation, permeability, and hydraulic conductivity reduction, as well as negative impacts on root development (Paudel et al., 2016; Yalin et al., 2017).Sewage water in used in areas where have only sewerage system to irrigate almost 32500 ha (Ensink et al., 2004),but there is no definite approximate which crop will be irrigate by sewage water.Vegetables have high price in market so poor famers give value to sewage water as it has nutrias and good supply Ensink et al. (2004). There are some landlords farmers which treated the sewage water and give to the famers on rent. Sewage water increase the cropping intensity so that is why canal water US$ 43 $ha^{-1}$is used less as compare to sewage water (US$ 173 ha^{-1})so in this situation sewage water considered as win –win situation for all people. Higher population, poor distribution of water, drought and salinity increase the shortage of canal water which may leads to the more use of sewage water. Sewage has composition from site to site but it has organic and inorganic compounds and heavy metals (Hussain et al., 2002).The main objective of this study is to

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assess the impact of sewage and treated sewage water on soil nutrients and agriculture crops and human health.

Pollution in Pakistan

Use of metal and their discharge is increasing day by day with the change in life style at alarming rate. Soil has the property to absorb everything in it, so metals goes to the soil then into plant and ultimately goes to the animals so this system is called soil-water-plant-animal system . According to the survey of major cities of Pakistan, paper, pulp, food processing, metal works are the main addition of the pollution (UNIDO, 2000). Some of the waste are biodegradable but mostly is not which cause damage to environment. Different data confirmed that the effluents from different sources increase the load of pollutants and ultimately threat for environment (UNIDO, 2000). it is very alarming situation that needed good management strategies. Increase of sewage water used in crops enhances the nitrogen and phosphorus. When plant nutrition requirements do not match irrigation requirements, nutrients contained in irrigation water might cause problems (Asano and Pettygrove, 1987). Only 10% of irrigation systems remove salts from plants (Oster and Rhoades, 1985). That is why, in order to maintain growth, salts should be leached from the root zone.In arid and semiarid regions problem of salinity prevails due to the not leaching of sewage water salts which may reduce the growth. So there is aneed of farming practices will be beneficial.

Effluents quality

In Pakistan, total discharge of sewage for different cities (14) of Pakistan is almost 1.83 × 107 m3 h−1 (FAO, 2002). For sewage, acceptable criteria for crop irrigation is depend upon 1) SAR, RSE, TSS and ionic ratios 2) trace metals such as (Pb, Ni, Se, Cd, Zn, Cu, Fe, As, Hg, and Cr), soil type, crop type, season and rainfall, (Ayers and Westcot, 1985). There are other parameters which are not considered are hardness, pathogens, COD and BOD.

Source of heavy metals in agriculture

Inorganic and organic fertilisers are the most common sources of heavy metals in agricultural soils (A fertiliser is a material added to soil to increase plant development and yield.). Liming, sewage sludge, irrigation fluids, and pesticides are all sources of heavy metals in agricultural soils (Table 1).

Depending on their sources, other chemicals such as fungicides, inorganic fertilisers, and phosphate fertilisers include various levels of Cd, Cr, Ni, Pb, and Zn. Cadmium is a major source of worry in plants because it accumulates at exceptionally high levels in the leaves, which can be consumed by animals or people. The usage of sewage sludge, manure, and lime can also produce cadmium enrichment(Yanqun et al., 2005).Despite the fact that heavy metal levels in agricultural soil are modest, regular phosphate application might pose difficulties. Fertilizer and long-term persistence, as well as time for metals, may be linked. Metal accumulation can be dangerously high (Verkleji ,1993). Mn, Zn, and other trace elements are added to the soil by animal excrement. sewage sludge contains Zn, Cr, Pb, Ni, Cd, and Cu, as well as Zn, Cr, Pb, Ni, Cd, and Cu (Verkleji, 1993). Liming has a bigger influence on soil heavy metal levels than nitratefertilizers and compost waste (1994, Ross). One of the most common sources of heavy metal contamination in the soil is sewage sludge (Table 2).Several heavy metal–based insecticides are used to treat illnesses in grain, fruit, and vegetable crops, and they damage the soil with heavy metals. (Ross, 1994; Verkleji, 1993).

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Safe limits of heavy metals: Table 1

sample	Standards	Cd	Cu	Pb	Zn	Mn,Ni		Cr
Agricultural soil (pg CI)	Indian standard (Awashthi 2000) WHO/FAO (2007)	3-6	135-270	250-500	300-600	_	57-150	_
	European union standards (EU 2002)	3	140	300	300		75	150

(Awashthi, 2000)

Heavy metal concentration (μ/g) in agricultural amendments: Table 2

Metals	**Agriculture amendment**							
	Sewage Sludge	**Compost refuse**	**Farmyard manure**	**Phosphorus fertilizer**	**Nitrate fertilizer**	**limit**	**pesticides**	
Cr	8.40-600	1.8-410	1.1-55	66-245	3.2-19	10-15		
Ni	6-5,300	0.9-279	2.1-30	7-38	7-34	10-20		
Cu	50-8,000	13-3580	2-172	1-300	-	2-125		
Zn	91-49,000	82-5894	15-556	50-1450	1-42	10-450		
Cd	Less than 1-34,10	0.01-100	0.1-0.8	0.1-190	0.05-8.5	0.04-0.1		
Pb	2- 7,000	1.3-2240	0.4-27	4-1000	2-120	20-1250	11-26	

(Sharma RK et al, 2005)

Chemical composition

Industries effluents are mixed and diluted with the residential areas effluents. Discharge effluents quality depends upon the two sources. Sewage which comes from drain is not useable as it has high SAR, EC, RSC and high level of metals that needs special control measures.As a result, the quality of the effluent emitted will be determined by the proportion of each source. Due to high EC, SAR, RSC, and higher levels of various metals, sewage in drains is unsuitable for irrigation, necessitating site-specific treatment solutions.DOC has the ability to affect the bioavailabilityof many nutrients. DOC from treated plant can easily decompose as compare to the DOC present in the sewage (Ramirez-Fuentes et al., 2002). Major plant nutrients such as (N, P, K) and trace nutrients such as (Cu, Zn, Fe) are preset in the dissolved solids in sewage water. 10–100, 1–25 and 10–40 mg L^{-1} concentration are the range of (N, P, K) in the waste water respectively(Hussain et al.,2002).

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(Ibrahim and Salmon, 1992) reported that sewage irrigation of 40 cm are applied at Faisalabad includes NPK range about 116 to 195, 7 to 21, and 108 to 249 kg ha−1, respectively. Quantities of these N and P are enough for any crop but low of K, The solubility of P is higher that applied through sewage as compared to phosphorus applied through fertilizer(Ensink et al., 2002) reported that NPK in the range of up to 2 030, 1 110 and 1 580 kg ha^{-1} was applied through sewage water. Efficiencies of nutrients of depend upon the amount of sewage and crop type (Ensink et al., 2002).

(Pak-EPA-OECC, 2004) reported that concentration of Nitrogen range from (6.95 to 10.29 mg L^{-1}) was present in the sewage water of Peshawar. So farmers mostly use this water as a substitute for NPK and they prefer over canal water. Industries of Pakistan discharge untreated effluents which contain different concentration of heavy metals. So could not be differentiating between waste water an industrial. Effluents of food industries considers safe for irrigation of crops. Application of sewage water in the vagetables reached the toxic level with three metals Cd, Cr and Pb (Hussain, 2000; Qadir et al., 2000).

Cadmium metal is considered harmful for the food when it is exceeded its limits as it is mostly accumulated in the crops (McLaughlin et al., 2006). Hussain et al.(2006); Khan et al. (2007); Murtaza et al.(2008) reported that metal concentration of (pb, Cr, Cd) in waste water is more in major cities of Pakistan that its permissible limits. In the same way, Peshawar drain water have more concentration of metal than its permissible limits (Tariq et al., 2006).Other studies reported that Cr concentration is 2-10 times higher in sewage water than its permissible limits (Hussain, 2000; Hussain et al. 2006).

Effects of sewage on vegetables and health

Uptake of metals by vegetables

By irrigating edible sections of crops with sewage water from several locations across Pakistan, metal concentrations were discovered to be greater than their permissible limits (Hussain, 2000). Metal concentrations in soil range from below the soil limit to above the permissible limits in edible parts. Metals in soil, in terms of phytotoxin concentration (Cd, Pb, Cr) as well as (Zn, Ni, Cu, Fe, and Mn) have the same tendency in plants. According to one study, Cd accumulated in leaf vegetables at twice the rate of Mn in fruit portions (Qadir et al., 2000).Ensink et al. (2004) reported by the application of sewage water in Faisalabad at different sites, Cd concentration limits increased at the level of $0.1 mgkg^{-1}$ (Codex Alimentarius Commission, 2002).Hussain (2000) and Hussain et al. (2006) reported that safe limits of Cr and Pb is 1.3 and 2.0 mg kg−1, respectively which become higher by the sewage application up to 31–62 and 3–13 times respectively.

Threshold's limit of metal concentration has not been established yet now.

Health and livelihood

Waste water irrigation in crops causes harmful impacts on the people by hookworm, mostly when they work in the field on the barefoot **(Table 3)** Ensink et al. (2004) found that hookworm infection increased from 4 to 5 fold by the sewage water application in Faisalabad and Haronabad. Diseases of Malaria and filariasisindicate that vector born diseases created by the wastewater. Other diseases such as Cholera and typhoid are transmitted by vegetables sewage water. More of the diseases are

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caused by the waste water treatment in the vegetable which are eaten by the people such as viral hepatitis, helmisthes infections (Bryan.,1977).

Table 3: Important Heavy Metals and effects on health

Heavy metal	Permissible level mg/l)	Major source	Toxic effect
Lead	0.1	Mining, paint, pigments, electroplating, manufacturing of batteries, burning of coal	Anemia, brain damage, anorexia, malaise, loss of appetite, liver, kidney, gastrointestinal damage, and mental retardation in children are all symptoms of anaemia, brain damage, anorexia, malaise, and loss of appetite.
Copper	0.1	Plating, copper polishing, paint, printing operations	neurotoxicity, and acute toxicity, dizziness, diarrhea
Cadmium	0.06	Plastic, welding, pesticide, fertilizer, mining, refining	Damage to the kidneys, bronchitis, gastrointestinal disorders, bone marrow, malignancy, lung insufficiency, hypertension, Itai–Itai disease, and weight loss are all symptoms of kidney disease.
Zinc	15	Mining, refineries, brass manufacturing, plumping	Causes short term-metal-fume fever‖, gastrointestinal distress
Mercury	0.01	Batteries, paper industry, paint industries, mining	Protozoal toxicity, caustic to the skin, eyes, and muscles, dermatitis, and kidney damage
Nickel	0.2	Porcelain enameling, non-ferrous metal, paint formulation,	Chronic bronchitis, reduced lung function, lung cancer

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		electroplating	
Arsenic	0.02	Smelting, mining, rock sedimentation, pesticides,	Bronchitis, dermatitis, bone marrow depression, hemolysis, hepatomegaly,

(Jaishankar M et al .2014)

Control measures

There are many practices should be adopted for safe irrigation such as

1) management of water soil and plant ,
2) environmental impacts should be reduced and proper disposal of waste water, Further, there are many other practices are following

Implementation of industrial policies, rules and regulations

According to the EPA Act 1997, People are not using proper legislation and there is no good policy in the near past but on the other hand these policies are not much effective to reduce environmental impacts (UNIDO, 2000).

There are many reason of this act such as political instability, lack of institution building, economic stagnation, weak information system, budget constraints, under paid environmental agency stag, lack of education of industry owner. EPA system have not ability to implement the rules and regulation .So there is a need of strong environmental policy to reduce the effect of these constrains 1970s (UNIDO, 2000).

Effluent treatment

Preliminary, primary, secondary, and tertiary treatment are all handled by the municipal waste water committee.There treatments required for the environmental protection. So, secondary treatment is needed to use in Pakistan to treat waste water. There is three to four treatment plants are using to treat waste water in Pakistan now a days at primary level. This primary level plant is considered very poor UNIDO survey (2000).According to the survey, industrial zone ofKarachi is 16 % very polluting and 59 % is low polluting. After treatment these polluting effluents shows that removal of effluents is poor as treatment plant is not much efficient (UNIDO, 2000).

Soil treatment

Contaminated soil can be managed by selection of crop and use of good management strategies. This can be attained by adding insoluble metals in soil as it reduce the adsorption by plant. Insoluble metal complexes can be achieved by adding insoluble metals such as organic matter and calcium sulphate in the soil (Zhu and Alva, 1993). This management will break the soil-water-plant-animal system.

Discussion

Modern lifestyles and industrialization have caused several environmental issues by generating various forms of trash and discarding them without sufficient treatment. These wastes pollute the environment, having the most critical and catastrophic consequences on living things, putting their survival in jeopardy. The discharge and accumulation of metals, particularly heavy metals, is the most dangerous aspect of industrial effluents and other wastes. Before being released into the environment, wastes should be treated to reduce their environmental impact by converting them to less dangerous forms. However, once these contaminants have contaminated the water or soil, suitable treatment procedures must be undertaken before they may be put into widespread usage. Treatments that are effective are highly pricey. The most efficient and cost-effective solution in this regard has been proven to be bioremediation, which involves the employment of living organisms to treat particular pollution-causing circumstances through efficient uptake of toxins from the desired environment. The use of plants to clean up pollutants, known as Phytoremediation has proven to be highly successful. Phytoremediation is the process of employing plants to remove heavy metals from the environment. Plants can absorb heavy metals through the soil and water. Heavy metals are absorbed by plant tissue and accumulate there. Based on the amount of heavy metals they accumulate, they are classified as hyper accumulators or Non Hyper accumulators. Hyper accumulators can absorb heavy metals from their roots and translocate them to shoots and leaves.Non-hyper accumulators, or accumulators, on the other hand, are plant species that can store heavy metals in their below-ground components but cannot translocate them to shoots and leaves, with the exception of a few that do. Hyper accumulators have been found in about 450–500 plants.Angiosperm families account for roughly 45 percent of hyper accumulators, with the Brassicaceae family accounting for 25% of hyperaccumulators. Members of the Asteraceae, Caryophyllaceae, Fabaceae, Cyperaceae, Poaceae, Cunoniaceae, Lamiaceae, and other families are among the others.

Conclusion

On the basis of data, it is difficult to say that waste water is safe for irrigation or not. There are many countries where waste water is evaluated for the itschemical, physical and biological characters but there is need of assessment of environmental impacts before the use of waste water in agriculture. It is clear that use of waste water for irrigation has nutritional value but side effects are discussed earlier. As waste water is useful as it reduce the use of fresh water for salt affected soil and also for drinking purpose. But there are many other factors should be considered as waste water has the pathos and contaminants which can affect the soil structure. Everything is possible by management so it should be managed though proper treatments and management practices It can be suggest that waste water should be used in agriculture as its volume is increasing day by day in urban areas and fresh water is reducing. There should be a meetings of agriculture officers and farmers for the purpose of awareness.

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