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OP Gurjar
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ramawatar Meena
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

AM Latare
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Sumit Rai
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Surya Kant
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Achin Kumar
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ashvini Kumar
Department of Soil Science and Agricultural Chemistry Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad-211007, Uttar Pradesh, India

MK Sheshama
Agricultural College, Bapatla, ANGRAU, AP

Correspondence
OP Gurjar
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Effects of sewage wastewater irrigation compare to ground water irrigation on soil physico-chemical properties

OP Gurjar, Ramawatar Meena, AM Latare, Sumit Rai, Surya Kant, Achin Kumar, Ashvini Kumar and MK Sheshama

Abstract
Today, due to the constraint in availability of the freshwater for irrigation, waste water especially sewage water is being used for irrigation of agriculture fields. Experiment was conducted form crop cultivation field by using sewage water. These fields were irrigated with sewage waste water. Use of the domestic waste water with fertilizers has shown the improvement in the physico-chemical properties of the soil. The domestic wastewater irrigation applied for a season had no significant effects apart from, slight changes in salt solubility and alkalinity on soil with sewage wastewater irrigation. The sewage waste water irrigated field soil was analyzed to study the soil physico-chemical properties. Soil samples were collected from four different locations in Bhilwara region and various parameters were analyzed viz., pH, EC, BD, PD, WHC, OC, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Sulphur. The samples were found to contain mean of pH 7.49, EC 0.84 dSm^{-1}, OC 0.79 %, N 231.13 kg ha^{-1}, P 15.12 kg ha^{-1}, K 439.18 kg ha^{-1}, S 16.47(Cmol (P^{+}) Kg^{-1}), Mg 9.13 (Cmol (P^{+}) Kg^{-1}) and Ca 2.43 (Cmol (P^{+}) Kg^{-1}) respectively.

Keywords: sewage water, soil properties, soil health, irrigation, alkalinity

Introduction
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; Avemelech, 1993). It has been estimated that typical wastewater from domestic sources could supply all the nutrients that are normally required for agricultural crop production (FAO, 1992). The suitability of soils for receiving waste waters without deterioration varies widely, depending on certain properties of the soil such as their infiltration capacity, permeability, cation and anion exchange capacities, water holding capacity and texture (Schneider and Erickson, 1972; Brady and Weil, 1999). In hyper-arid Fezzan region of Libya (UNESCO, 1977) in the central Sahara desert where groundwater is the only natural water resource available, increasing water demand has necessitated reusing treated municipal waste water for irrigation of sandy soils. This study was therefore designed to assess the effects of sewage effluent on a hyper-arid soil.
The results indicated that in sewage water the permissible amounts of total N, total P and potassium which are considered essential nutrients for soil fertility. The analysis showed that in soil concentration the irrigation with sewage water (SW) induces significant decrease of soil pH. EC is greater with SW. For Major elements contents and fertilizer as observed in the irrigation with SW led to a significant increase of N, P, K, Ca, Mg and S contents.

Material & Method

Description of the Study Area

The sewage water used for the irrigation study was obtained from the Bhilwara district in different location. Bhilwara is situated between latitude of 25°26'21.25"N and a longitude of 74°35'3.86"E or 25.439235 and 74.584406 respectively. The location of study area is shown in the map of the Rajasthan state. It has a dry climate due to low rainfall and arid region zone of Rajasthan. The average Rainfall of the study area is 650 mm per year. The temperature range cold season being lowest at 22.2ºC and 7.3º C. Temperature in summer month, June, reaches up to 46º C. Bhilwara district is very much dependent on agriculture. Maize, wheat, barley, til, urd, moong, jeera, gram, groundnut, rai, mustard and cotton are major crops.

Soil Sampling and Analysis

Soil samples were randomly collected from the farmlands where used of sewage water and ground water for irrigation to cultivation crop. The soil used in this study was collected by gathering samples from the surface layer (0-15 cm) of cultivated fields from where sewage water irrigated. The samples were collected during March-June of the year 2016. The soil samples were air dried ground and sieved through 2 mm sieve. The prepared soil samples were then stored in polyethylene bag. Sampling and analysis are carried out from sewage water used for irrigating. The soil samples were analyzed for parameters such as concentrations of EC, pH, OC, available Nitrogen, phosphorous, potash, Sulphur, Mg, Ca and physical properties of soil such as bulk density, particle density, porosity, water holding capacity were determined.

Method of Soil Sample analysis

Soil samples collected from the study area were dried and crushed with the help of wooden rod and passed through 2 mm sieve and well prepared then used for the determination of soil BD, PD, porosity, water holding capacity, pH, organic matter, available nutrients N, P, K, & S by adopting standard laboratory method.

Table 1: Procedure used for physico-chemical analysis of soil

Properties	Method applied	Reference
Physical properties		
Bulk density (g cm^{-3})	Pycnometer	Black *et al.* (1965)
Particle density (g cm^{-3})	Pycnometer	Black *et al*. (1965)
Porosity (%)	-	Black (1965)
Water holding capacity (%)	Keen box	Piper (1966)
Chemical properties		
pH	Glass electrode pH meter	Jackson(1973)
EC (dSm^{-1})	Electrical conductivity meter	Jackson(1973)
Organic carbon (%)	Wet oxidation method	Walkey and Black (1934)
Available Nitrogen (kg/ha)	Alkaline KMnO4 method	Subbiah and Asija(1956)
Available phosphorus (kg/ha)	Bray s method Olsen s method	Bray and Kurtz (1945) Olsen *et al*. (1954)
Available Potassium (kg/ha)	Ammonium acetate method	Hanway and Heidal (1952)
Available Sulphur (kg/ha)	Calcium Chloride method	Chesnin and yien (1950)
Available Calcium and Magnesium (meq/100g)	Complexmetric titration method	Chensnin and Bray(1951)

Results and Discussion

Physico-Chemical Properties of the Used Sewage and Ground Water irrigated area

The result of physico-chemical properties analysis of the sewage water and ground water that were used for irrigation. The all parameters results are in table 3. The results of 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 capasity(WHC) 6.20 % to camper to ground water irrigated area. Due to sewage water irrigation in include in house waste and human waste. The irrigation with Ground water (8.31) and sewage water (7.49) induces decrease of soil pH and increase OC with comparison to ground water. Similar results were noticed by [3, 14] who reported that after irrigation with different dilution of sewage water, pH decreased significantly. The reason for decreasing of soil pH and increase of OC may be due to decomposition of organic matter and production of organic acids in soils irrigated with wastewater [6, 15]. The sewage (SW) significantly the EC increase (Table 3). Indeed, in comparison with groundwater (GW), EC is greater with SW. These results were in agreement with several authors like [5, 7, 8, 13]. According to this increase in EC for soil irrigated with wastewater compared with soil irrigated with ground water. For Major elements contents and nutrients fertilizer as observed in table 3, the irrigation with SW led to an increase of N, P, K and, Ca in comparison with the GW. For, S and Mg decrease with sewage water irrigation., The increase were in particular concerned N 37.71 kg ha^{-1}, P 0.70 kg ha^{-1}, K 19.48 kg ha-1, Ca 2.33 Cmol (p^{+}) kg^{-1}, S 0.70 Cmol (p^{+}) kg^{-1} and Mg 0.02 Cmol (p^{+}) kg^{-1} comparison to the control (GW). The same results were reported by [1, 9] they found that the EC, N, P and K concentrations increased significantly in sewage water irrigation compared to ground water irrigation also Similar results were noticed by [5] who investigated the effect of sewage water on soil, the irrigation with treated wastewater increased significantly ($P<0.05$) the soil EC, major element contents as Ca, Mg and fertilizer elements as N, P and K. This observations was confirmed by [2] reported that irrigation using raw sewage water probably increases soil organic matter, nitrogen and concentrations of major cations. The optimum pH for irrigated based on FAO (1992) tolerance limit of pH of water samples for irrigation showed be 6.50 to 8.40. The same results were reported by [4] shows that sewage has often high values of temperature, pH, alkalinity, organic carbon, nitrogen, phosphorus, potassium, calcium.

Table 3: Mean values of physico-Chemical properties of soils irrigated with different water

S. No	Parameters	Unit	Soil sewage water	Soil ground water
1	BD	g cm^{-3}	1.34	1.35
2	PD	g cm^{-3}	2.55	2.52
3	Porosity	**%**	47.45	46.42
4	WHC	**%**	42.93	36.73
5	pH	-	7.49	8.31
6	EC	dSm^{-1}	0.84	0.61
7	OC	**%**	0.79	0.50
8	N	kg ha^{-1}	231.13	193.42
9	P	kg ha^{-1}	15.12	14.42
10	K	kg ha^{-1}	458.48	439.18
11	S	Cmol (p^{+}) kg^{-1}	17.17	16.47
12	Ca	Cmol (p^{+}) kg^{-1}	9.13	6.80
13	Mg	Cmol (p^{+}) kg^{-1}	2.45	2.43

Conclusion

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. Due to sewage water irrigation in include in house waste and human waste. 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 different location in Bhilwara district Rajasthan. 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, electrical conductivity, OC, N, P, K, Ca, Mg and S in soils irrigated by sewage water compared to the ground water irrigation.

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