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Characterization of treated sewage water irrigated soils of Banasthali, Tonk district, Rajasthan

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ABSTRACT

The survey study was carried out during 2013-15 to characterize the treated sewage water irrigated soils of Bansthali, district Tonk (Rajasthan). Results revealed the surface soils irrigated with treated sewage water (TSW) contained higher amounts of organic carbon, pH, soluble salt concentration than those irrigated with tube well water (TW). These three parameters tended to decrease with soil depth. Available N, P and K status of TSW irrigated surface soils (0-20 cm) was 351.0, 28.8 and 279.6 kg ha^{-1} respectively. The corresponding values of these nutrients in tube well water irrigated soils were 320.0, 24.6 and 220.0 kg ha^{-1}. These nutrients, in general, tended to decrease with soil depth. The treated sewage water irrigated soils contained 7.1, 1.13, 13.71 and 0.56 mg kg^{-1} DTPA extractable Fe, Cu, Mn and Zn in surface soils, respectively. Whereas adjoining soils irrigated with tube well water contained 6.51, 0.21, 10.25 and 0.69 mg kg^{-1}, respectively. The amounts of these micronutrients tended to decrease with depth and minimum amounts were noted in 80-100 cm depth.

Key words: *Treated sewage water, soil properties, macro and micronutrients*

INTRODUCTION

Crop Production in semi arid regions like Tonk (Rajasthan) is severely affected due to shortage of fresh as well as good quality water. Although rain water harvesting, storage and their précised use in irrigation has paved the ways for sustaining crop production in such areas. In most parts of the country (like Rajasthan) water resources are limited and rather are insufficient to meet the requirement in agriculture therefore, a huge gap exists between available water supply and amount required due to limited quantum of fresh water recourses. In such situations, use of sewage water has been advocated to be utilized in irrigation thereby meeting the existing demand of water and nutrient, the most limiting factor in agriculture production. Irrigation with treated effluents provides water and nutrients to crop on one hand paves the convenient ways for sewage water to be utilized in irrigation because soil system has higher metabolic rates than water (Tiwari *et al.* 2003 and Saraswat *et al.* 2015).

Sewage water is a potential source of irrigation water and plant nutrient. Application of treated sewage effluent at 7.5 cm/ha would provided 36.0, 5.0 and 50.0 kg ha^{-1} N, P and K respectively and considerable amount of secondary and micronutrients to soil (Bhatia *et al.* 2001). Use of sewage water in irrigation is expected to carry a substantial amount of macro (NPK) and micro (Fe, Cu, Mn, Zn) nutrients to soils, thereby controlling crop production and fertility level of soils. Therefore, TSW of domestic origin could be considered as a nutrient source as it contributes to macro and micro nutrients to soil. Although soil acts as a physical filter due to its porous nature, a chemical filter being adsorbent and a biological filter due to decomposing the organic compounds (Kharche *et al.* 2011) but, continuous use of raw sewage or TSW may lead to the buildup of metals and organic residue in soils depending upon the pH, textural composition of soils, cropping practices and frequency of irrigation. This needs regular exercise for characterization and monitoring of such soils with respect to health for sustainable productivity of soil resource to mitigate these effects. More-over studies conducted on characterization and build up of metals have been confined to surface soils of peri-urban areas and in *Indo-Gangetic* plains (IGP). But profile study of soil properties, distribution and accumulation of macro and micro nutrients in raw sewage/treated sewage irrigated areas is virtually lacking in saline-sodic soils of semi arid regions and hence present investigation was carried out during 2011-2014 in TSW irrigated soils with respect to its influence on chemical properties (like pH, EC and organic carbon) in profile and thereby, distribution of macro and micro nutrients in Banasthali block of Tonk district (Rajasthan).

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MATERIALS AND METHODS

The study area is located in Tonk district and lies between upper left $26^0$25'10.21" N latitude to $75^0$51'8.55" E longitude at mean elevation ranging from 304 m above mean sea level. Banasthali Vidyapith a residential campus is situated 65 km away from Jaipur on Jaipur-Kota highway. Banasthali Vidyapith has its own Sewage Treatment plant (STP) of about 1million litre per day (MLD) capacity in Haripura village, where raw sewage of campus is treated physically in STP. Treated sewage water and ground-water samples were collected in neutral plastic bottles from the area and brought to laboratory for further analysis. Collected water samples were analyzed for pH, EC, TDS, BOD, COD, Ca, Mg, K, Na, CO_3, HCO_3 and RSC by using standard procedures as described by Trivedy and Goel (1984), micronutrients (Fe, Cu, Mn, Zn) in water samples were also estimated in di-acid digest using Atomic Absorption Spectrophotometer (AAS Model 4129).

Four soil profiles in TSW irrigated area at farmers field of Haripura village and one soil profile from Tube well irrigated field were dug in 2012. Horizon wise five samples using GPS from each core layer i.e. 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm were collected with the help of core cutter, stored in polythine bags and marked properly. Collected soil samples were analyzed for their pH, EC, organic carbon, available N,P,K and DTPA extractable Fe, Cu, Mn and Zn in soil samples as described by Jackson (1973) and Lindsay and Norvell (1978) respectively.

RESULTS AND DISCUSSION

Quality of treated sewage water

Data (Table 1) reveal that treated sewage water had pH 8.0, EC 1.5 dSm^{-1}, NH^+_4 and NO^-_3 (34.0 and 15 mg L^{-1}) respectively. It contained total phosphorus 9.6 mg L^{-1}, TDS 805 mg L^{-1}, BOD 30 mgL^{-1}, COD 100 mgL^{-1}, The amounts of calcium, magnesium, sodium and potassium were 6.9, 4.7, 3.2, and 6.3 meL^{-1}respectively. Carbonates, bicarbonates and RSC were 9.6, 8.8 and 6.8 $meqL^{-1}$ respectively. Trace element analysis of TSW also showed presence of Fe (2.4), Cu (4) Mn (3.0) and Zn (0.9) mg L^{-1} respectively and absence of Cr, Cd and Ni. Concentration of Ca, Mg and Na indicate no salinity hazards but presence of higher RSC value indicates sodicity hazards in this water (Richards 1954). Macro nutrient contents were suitable to meet irrigation quality standards in TSW. The BOD (30), COD (100), and TDS (805) in TSW were somewhat lower than the prescribed limits or utilized in irrigation. Results of chemical analysis showed higher range of TDS and RSC in TSW but, on the basis of other irrigation quality parameter, the TSW of municipal origin proved to be a good source of irrigation.

Table 1: Quality of Treated sewage water (STP Banasthali) and Tube well water (TW)

Quality Parameter	TSW*	TW*
pH	8.0	8.5
EC ($dS\ m^{-1}$)	1.5	2.0
Ca^{+2} (meq L^{-1})	16.8	5.2
Mg^{+2} (meq L^{-1})	14.7	2.9
Na^+ (meq L^{-1})	16.9	8.0
CO_3^{--}(meq L^{-1})	22.6	11.2
HCO^-_3(meq L^{-1})	16.0	7.2
RSC (meq L^{-1})	7.1	10.3
TDS (mg L^{-1})	805	400
Total N (mg L^{-1})	49.0	1.5
Total P (mg L^{-1})	9.6	0.8
Total K (mg L^{-1})^1)	6.3	1.0
BOD (mg L^{-1})	30.0	Nil
COD (mg L^{-1})	100	Nil
Fe (mg L^{-1})	24.0	6.0
Cu (mg L^{-1})	4.0	0.4
Mn (mg L^{-1})	3.0	2.0
Zn (mg L^{-1})	0.9	0.6

**Mean values of 3 seasons*

Basic soil properties

TSW irrigated soils showed relatively higher pH values (7.4-8.6) in different soil layers being lowest at 60-80 cm. The same trend was observed in TW irrigated soil profiles. The pH decreased with increasing depth of the profile up to 60-80 cm depth in both areas. This could be attributed to the presence of higher base saturation resulting in to elevated pH at the same depth. The EC of TSW and TW irrigated soils also decreased in profile being highest in top (0-20 cm) and lowest at 80-100 cm. A critical perusal of the pH and EC values in TSW and TW irrigated soil profiles reveals that these soils have in herently higher pH. Neutral soluble salts (Cl- and SO4-- of Na+) which are invariably present in soil solution attributed to higher pH and lower EC in present investigation. Data on organic carbon in soil profiles showed a wide variation in the profile. The organic carbon varied from 3.95-1.8 and 3.22-2.31 gkg^{-1} in TSW and TW irrigated soils respectively. Presence of higher organic carbon in surface layer might be attributed to the use of TSW in irrigation by the farmers in the area. Patel *et al.* (2004) also reported higher organic carbon in surface and subsurface soils receiving sewage water irrigation as compared to those of tube well irrigation. Surface layer of TSW irrigated areas contained higher organic carbon than those of TW irrigated one at farmer's field. This is evident due to the presence of suspended solid matter in TSW.

Available major nutrients

The mean value of available N in TSW irrigated profiles (0-100 cm) varied from 351.6-182.9 kg ha^{-1} being lowest at 60-80 cm layer in soil. The same trend was also observed with respect to available nitrogen in TW irrigated soil profiles. Available Phosphorus in soil profiles varied from 11.13- 28.8 and 13.0-24.6 kg ha^{-1} respectively in TSW and TW irrigated profiles (Table 2). Available phosphorus tended to decrease with increasing depth in both the profiles barring 60-80 cm in TSW irrigated soil profile. Restricted movement of available phosphorus along the soil depth might be due to high absorptivity of available phosphorus in surface and subsurface layers. The surface and subsurface (0-20 and 20-40 cm) layers of TSW irrigated area contained significantly higher amount as compared to TW irrigated profile. Saraswat *et al.* (2015) also reported higher available nitrogen, phosphorus and potassium in surface and subsurface layers in sewage water and treated sewage water irrigated areas as compared to those of TW irrigated one. Generally potassium availability in sodic soils has been reported adequate, because of predominance of micaceous minerals in soils of arid and semi arid regions (Gupta and Abrol 1990).

Table 2: Status and distribution of macro and micronutrients in soils irrigated with TSW and TW

Soil Parameters	Soil profile depth (cm)				
	0-20	20-40	40-60	60-80	80-100
pH	8.6	8.43	7.7	7.4	7.55
EC(dSm^{-1})	1.45	1.35	1.31	0.96	0.68
OC(g/kg)	3.95	3.47	2.84	2.07	1.8
Avail. N(kg/ha)	351.0	339.8	281.75	182.9	194.5
Avail. P(kg/ha)	28.8	26.55	12.16	14.1	11.13
Avail. K(kg/ha)	279.62	265.38	236.25	205.5	189
Avail. Fe(mg/kg)	7.1	6.1	2.88	2.66	1.98
Avail. Cu(mg/kg)	1.13	1.29	1.07	0.89	0.44
Avail. Mn(mg/kg)	13.71	12.39	11.31	12.55	9.67
Avail. Zn(mg/kg)	0.56	0.5	0.48	0.46	0.44
pH	8.4	8.2	7.6	7.4	7.5
EC(dSm^{-1})	1.4	1.7	1.4	1.0	0.8
OC(g/kg)	3.32	3.31	2.69	2.31	2.31
Avail. N(kg/ha)	320.0	325.0	265.5	185.0	190.0
Avail. P(kg/ha)	24.6	21.0	19.2	14.0	13.0
Avail. K(kg/ha)	220.0	214.0	196.0	164.0	156.0
Avail. Fe(mg/kg)	6.51	5.51	2.48	2.45	2.44
Avail. Cu(mg/kg)	0.21	0.19	0.18	0.17	0.17
Avail. Mn(mg/kg)	10.25	10.24	10.21	10.19	9.48
Avail. Zn(mg/kg)	0.69	0.68	0.58	0.42	0.13

Available micronutrients

The Fe content in surface (0-20 cm) layer ranged from 1.98-7.1 and 2.44-6.51 mg kg^{-1} in TSW and TW irrigated profiles under study. Iron content decreased with increasing depth of the profile. Similarly copper also showed a variable pattern of distribution in the profiles in both study areas. The TSW irrigated soils (0-40 cm) contained relatively higher Mn as compared to TW irrigated areas under study. The mean values of DTPA extractable Zn in TW irrigated soils (0-40 cm) contained higher Zn contents as compared to TSW irrigated area.

The study has revealed that long term use of treated sewage water in irrigation improved the basic soil properties as well as available macro and micro nutrients in surface and subsurface layers of soils. TSW irrigated soils contained relatively higher amounts of nutrients. It is concluded that TSW instead of raw sewage water could be used in irrigation without adverse effect on soil fertility which is important factor in agricultural economy.

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