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# Effects of Municipal Wastewater on Accumulation of Nutrients and Heavy Metals in the soils of Guntur

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**ABSTRACT**

A study was carried out to investigate the effects of municipal wastewater on accumulation of nutrients and heavy metals in soil. The soil samples were collected at eight different locations in Guntur and soil characteristics such as soil reaction (pH), electrical conductivity (EC), organic matter (OM), extractable Fe, Mn, Cu, Zn and heavy metals such as chromium, nickel and lead were measured. The research study showed that use of municipal waste water in irrigation provided soils with sufficient levels of nutrients such as Nitrogen (N), Phosphorus (P) and Potassium (K), Sulphur and other micro-nutrients. The heavy metal concentrations are well below hazardous levels in almost all the experimental sites. This study showed that municipal sewage water can be used safely for irrigation. It enriched the soil mineral nutrients and improved the fertility of soils.

Key words*: Heavy metals, Sewage.*

The use of untreated sewage in agriculture is a practice in many parts of the world. There is a gradual decline in availability of fresh water to be used for irrigation in India. As a consequence, the use of sewage and other industrial effluents for irrigating agricultural lands is on the rise particularly in peri-urban areas of developing countries. The crops grown in and around many cities for example, musi river in Hydereabad are continuously irrigated with sewage water owing to which heavy metals have been accumulating in soils to toxic levels. Hence, the present investigation entitled effects of sewage water irrigation on physico chemical properties of soil with the objective to study the effect of sewage water irrigation on soil properties.

Shankhadarwar (2015) reported that electrical conductivity was found to be highest in agricultural unpolluted soil, 658 $dsm^{-1}$ in water and lowest 395 $dsm^{-1}$ in disposed waste soil from treatment pond. Kumawat *et al.* (2015) reported that the organic carbon content was more in sewage water irrigated soil compared to tube well water irrigated soil. Pavan *et al.* (2013) also reported that the sewage water have high nutrient load which increases available N, P and K to soil and the sewage water can be used as a fertilizer substitute to reduce cost. Kumawat *et al.* (2015) reported that the content of micronutrients such as Zn, Fe, Cu and Mn was 13.52,10.90, 15.88 and 19.86 mg $kg^{-1}$ respectively in sewage irrigated soils. Ani khare *et al.* (2016) reported that the average contents of Ni, Cr and Pb in sewage irrigated soil were 0.697, 6.160 and 0.115 in 2010-11.

## MATERIAL AND METHODS

The soil samples were collected from eight locations in polythene bags at sewage flowing areas from a depth of 10-15 cm along the sewage flowing area. The samples were dried in shade, pounded using wooden mortar and pestle .The sample passed through 2 mm sieve was used for estimation of pH, EC, macronutrients, micronutrients and heavy metals.

The soil reaction was determined in 1 : 2.5 soil water extract i.e.20g of soil in 50 mL of distilled water using combined glass electrode and pH meter. EC of soils was measured in the supernatant collected from 1: 2.5 ratio soil water suspension with EC bridge(Jackson,1973) Organic carbon content of the soil was estimated by the wet digestion method (Walkey and Black, 1934). Available Nitrogen content of the soil was estimated by alkaline permanganate method (Subbaiah and Asija, 1956) was expressed in kg $ha^{-1}$.Available phosphorus was extracted from soil by using Olsen's extractant was expressed in kg $ha^{-1}$. Available potassium was extracted from the soil using neutral normal ammonium acetate (Muhr *et al.* 1965) was expressed as kg $ha^{-1}$. The sulphur content was estimated by using calcium chloride as extractant and expressed as kg ha$^{-1}$. Method developed by Lindsay and Norvell (1978) was used for micronutrients analysis of soils. One gram of air dried soil was taken in 125mL conical flask to which 5 mL of concentrated nitric acid was used. The contents were kept on hot plate for 4 hours until the vapours are evolved and then filtered through whatmann no. 1 filter paper. The contents were made up to 50mL and was used for estimation of heavy metals using Atomic Absorption Spectrop hotometer.

## RESULTS AND DISCUSSION

### Physico- chemical properties

The soil pH value is a measure of soil acidity or alkalinity and directly affects nutrient availability. In the present study the pH ranged between 7.5 to 8.1. These values were in normal range. The soils were neutral to slightly alkaline in nature. Similar findings were also reported by Anita Singh *et al.*(2009). Electrical conductivity indicates the salinity of the soil. In the present study conductivity of soil ranged between 0.73 and 1.87. The soils was non saline. This indicates that movement of charge particles are more which is a good indicator for the growth of plants (Tripati and Misra,2012). The organic carbon content ranged between 0.6 and 0.8 which indicated that the soils were with medium organic matter content. An increased organic carbon content in soils irrigated with sewage water was also reported by Bhat *et al.* (2011).

### Macronutrients

Available nitrogen content in the soil ranged between 293 and 376 kg ha$^{-1}$. The soil has a medium content of nitrogen. The normal range for phosphorous is 22.5 kg/ha to 56 kg ha$^{-1}$. Phosphorous content of soils ranged from 10.75 to 21.79 kg ha$^{-1}$ which was in the medium range. The potassium content varied between 759 and 1196. The soils has high content of potassium in all the areas of the Guntur. Pavan *et al.* (2013) also reported that the sewage water have high nutrient load which increases available N, P and K to soil and the sewage water can be used as a fertilizer substitute to reduce cost. Sulphur is the secondary nutrients it requires in the smaller amount than the primary nutrient. The sulphur content was low in the soils of Guntur. The content ranged from 5.49 to 8.23 ppm.

**Table 1. Physicochemical and chemical properties of soils irrigated with sewage water expressed in kg ha$^{-1}$ Except pH, EC (dSm$^{-1}$) OC (%) S (ppm).**

| Site | pH | EC | OC | N | $P_2O_5$ | $K_2O$ | $SO_4$-S |
|---|---|---|---|---|---|---|---|
| 1 | 8.0 | 0.73 | 0.7 | 303 | 10.75 | 759 | 7.52 |
| 2 | 8.1 | 0.86 | 0.7 | 293 | 14.63 | 767 | 7.30 |
| 3 | 7.6 | 0.74 | 0.8 | 376 | 20.56 | 984 | 6.89 |
| 4 | 7.6 | 1.49 | 0.7 | 314 | 21.79 | 1039 | 8.23 |
| 5 | 7.6 | 1.87 | 0.6 | 397 | 18.32 | 1179 | 7.14 |
| 6 | 7.5 | 1.69 | 0.7 | 366 | 21.45 | 991 | 6.89 |
| 7 | 7.8 | 1.79 | 0.7 | 334 | 15.17 | 1196 | 5.49 |
| 8 | 8.0 | 0.94 | 0.6 | 376 | 20.19 | 1037 | 7.68 |
| Control | 8.1 | 0.6 | 0.4 | 238 | 13.63 | 742 | 4.13 |

**Table 2. Heavy metal (ppm) content of soils irrigated with sewage water.**

| Site | Fe | Zn | Mn | Cu | Ni | Cr | Pb |
|---|---|---|---|---|---|---|---|
| 1 | 6.74 | 0.62 | 4.69 | 3.30 | 6.2 | 0.6 | 2.9 |
| 2 | 12.80 | 0.93 | 5.98 | 3.50 | 12.5 | 0.7 | 11.0 |
| 3 | 9.36 | 1.55 | 4.11 | 2.04 | 12.2 | 0.5 | 6.8 |
| 4 | 8.55 | 0.43 | 3.17 | 2.30 | 13.4 | 0.6 | 3.2 |
| 5 | 10.37 | 0.97 | 5.27 | 2.39 | 5.8 | 0.5 | 3.2 |
| 6 | 10.17 | 0.46 | 5.34 | 2.87 | 18.2 | 0.7 | 4.2 |
| 7 | 8.77 | 0.66 | 3.58 | 5.25 | 5.3 | 0.6 | 7.2 |
| 8 | 7.29 | 0.49 | 5.09 | 2.72 | 9.0 | 0.6 | 10.4 |
| Control | 4.8 | 0.37 | 2.26 | 1.22 | 3.7 | 0.2 | 2.3 |

**Heavy metals**

The content of Fe, Mn, Zn, Cu, Pb, Cr and Ni in contaminated soil was 4.8, 2.26, 0.37, 1.22, 2.3, 0.2 and 3.7 respectively. The obtained results showed an improvement of micronutrients such as Zn, Mn, Fe, and Cu content in soils irrigated with sewage water compared to soils not irrigated with sewage water. Even though the heavy metal content exceeded the permissible level, there was no toxicity in the soils irrigated with sewage water. The similar results were reported by Dheri *et al.* (2007).

The reuse of wastewaters for purposes such as agricultural irrigation reduces the amount of water that needs to be extracted from environmental water sources. Using large-scale wastewater irrigation on agricultural lands can be a synergistic management practice. Sewage water contains high amount of organic matter, nutrients and some heavy metals. Application of sewage water increased the N, P, K, S, organic carbon and heavy metals content of soil. Soil fertility and productivity can be enhanced with properly managed wastewater irrigation, through increasing levels of soil organic matter. Based on these results, It can be concluded that proper management of wastewater irrigation and periodic monitoring of soil fertility and quality parameters are required to ensure successful, safe and long term reuse of wastewater for irrigation.

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