MICRONUTRIENTS ANALYSIS OF SOILS IRRIGATED BY SEWAGE AND UNDERGROUND WATER

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ABSTRACT: *Due to decline in the availability of freshwater in Pakistan as a result of increased food demand for growing population, the use of sewage water for agricultural lands in peri-urban areas is on the rise. Although, sewage water is good source of many nutrients, the use of this sewage water gets accumulated in the soil results in rise in the build-up of heavy metal level in the soil which gets transferred to growing vegetable and causing health hazard to human and animal health. In this scenario, the study was conducted to assess the micronutrients (Mn, Fe, Cu and Zn) status of the sandy to sandy loam soils from Arid Zone Research Institute, Umerkot irrigated with different sources of water such as underground water (UGW), sewage water (SW) and underground + sewage water (UGSW). The water samples analysed revealed that the average Zn, Fe, Cu and Mn concentration was much higher in sewage water than underground water and mixed water (underground and sewage), which clearly indicates the availability of heavy metals in sewage water. While the average Zn, Fe, Cu and Mn concentration was much less in underground water than sewage and conjuctive water. While the soil samples collected from depths of 0-20 cm, 20-40 cm for anlysis revealed that the average Zn, Fe, Cu and Mn concentration was higher in upper layer (0-20 cm) than in the lower layer (20-40 cm). The concentration in lower layer was almost half of the upper layer. The total Fe, Cu and Zn concentration were much less in underground irrigated soils whereas Zn, Fe and Mn concentration was much higher in sewage water irrigated soils followed by conjuctive irrigated soil. It is anticipated that the accumulation of enhanced heavy metals concentration in the soil by the use of sewage water may cause serious threat to human and animal health.*

Keywords: Micronutrients, Soils, Irrigation, Underground water, Sewage water.

INTRODUCTION

Pakistan has an arid and semi-arid climate, and is largely dependent on surface and groundwater, without which the country would turn into saline desrt land. Pakistan is blessed with fresh water resources, fertile land and suitable climate year round. Water, both in quantity and quality is vital for agricultural production. Due to ever increasing demand of food and fiber by ever increasing population of the country, the pressure on fresh water resources is increasing. It is expected to be doubled by the year 2025, putting available water resources at risk. It is pertinent to note that the available water resources of the country do not commensurate with population growth and the sustainability of food security is at threat [1]. According to World standard criteria, the country is termed as water short if its water resources fall well below 1200 m^3/person. The current water status indicate that per person availability has declined from 5600 cubic meters at the time of partition to threshold value of 1000 cubic meters and soon would approach to 500 cubic meters by the year 2025 [2]. They further reported that the water availability of USA, Australia and China was 6000, 5,500 and 2200 cubic meters respectively. The current water situation indicates that Pakistan consumes 98% fresh water resources for agriculture unlike other countries whose water use for agriculture estimates in the range of 70-80%.

In quest of looming situation of fresh water availability, indiscriminate use of sewage water for crop irrigation especially in the peri-urban areas continues is being used. Apart from adverse effects of sewage water irrigation on soil, crop foliage and seed, its impacts on groundwater are far more dangerous than can be readily conceived. Use of untreated waste water is an act of criminal negligence and the defaulters need to be properly impounded [3]. Leafy vegetables like cauliflower, cabbage and spinach grow quite well in the presence of sewage water whereas; vegetables such as radish are sensitive to sewage water. Vegetables grown by the use of sewage water contain many heavy metals causing serious health hazards to the community and animals as well [4].

The attempts have been made to use and re-use the huge quantities of waste water generated daily by human and industrial activities to determine adverse effect on the environment, soil, crop yield and human health [5]. The use of pollutant contaminated waste waters caused soil pollution and deterioration in the quality of crop products, edible portions of vegetables, fruits and fodders. Though it increased crop yields of vegetables having better supply of nitrogen and phosphorus but it enhanced risks for consumer's (animal and human) health [6].

The use of sewage water for long period may change the chemical properties of soil [2]. The concentration and composition of salts in water determine the speed and nature of changes in soil quality; ECe has increased linearly with EC_{iW} and the number of irrigations. According to one estimate, 8 percent to 90 percent of ECe variability of soil is accounted for by EC_{iW} applied to crops grown on medium-textured soil. The remaining variability in ECe may result from soil texture, drainage conditions and initial salt levels. A linear relationship has been observed between ECe to a depth of 150 cm during the first three years in a clay loam soil with EC_{iW} 3.6 dS m^{-1}, SAR_{iW} 15.8 and RSC 6.8 mmol L^{-1}. After that, the rate of salt accumulation declined. The average ECe of soil down to 150 cm rose from 1.23 to > 4. 0 dSm^{-1} during this period [7]. On the contrary, [8] from India reported that domestic sewage is suitable for growing vegetables.

Very few studies have been conducted on conjuctive use of water and its effect on micronutrient effect. Therefor, this study was designed to examine the effect of micronutrients leaching in the soil profile of Taluka Umerkot under different sources of irrigation.

MATERIALS AND METHODS

The experiment was conducted on vegetable and grafted ber plots at Arid Zone Research Institute (PARC) Umerkot Farm in 2013. These plots were irrigated with (i) underground water, (ii) sewage water and (iii) conjunctive use of underground water and sewage water at equal ratio. There wer about 6 plots from which then soil samples from each plot were collected at two soil depths (0-20 cm and 20-40 cm) that makes total of 60 samples for analysi. . In addition, three water samples from each type of irrigation water were secured to evaluate the micronutrient content in irrigation water. The composite soil and water samples were kept in well labeled bags and transported to soil science department laboratory at Sindh Agriculture University Tandojam. In the laboratory, the soil samples were dried, crushed, seived and then stored in labeled plastic bags. Samples were air dried, grinded and passed through 2 mm sieve and stored in plastic sacks.

The soil texture was determined by using mechanical method [9] and soil is classified as loamy sand to sandy (Table 1). For the analysis of micronutrients in soil and water, AB-DTPA method developed by [10] was used throughAtomic Absorbtion Spectrometer.

Table-1 Categorization of soil on the basis of textural class.

Sr. No.	Textural class	Depth 0-20 cm	%	Depth 20-40 cm	%
Underground water					
1	Sandy clay laom	1	3.33	1	3.33
2	Sandy loam	6	20.00	6	20.00
3	Laomy sand	3	10.00	3	10.00
Sewage water					
1	Sandy clay laom	1	3.33	1	3.33
2	Sandy loam	2	6.66	1	3.33
3	Laomy sand	7	23.33	8	26.66
Underground + sewage water					
1	Sandy clay laom	2	6.66	2	6.66
2	Sandy loam	2	6.66	2	6.66
3	Laomy sand	6	20.00	6	20.00

RESULTS & DISCUSSION

1. Micronutrients status in water

Micronutrients content of water applied in the soil are calculated and found that an average Zn, Fe, Cu and Mn contents were 362, 681, 31 and 457 ppm in sewage water samples respectively, whereas corresponding values for underground effluent were 78, 404, 12 and 197 ppm respectively. The corresponding values of mixed water of sewage and underground were 195, 586, 21 and 334 respectively. The average Zn, Fe, Cu and Mn concentration was much higher in sewage water than underground water and mixed water (underground and sewage), which clearly indicates the availability of heavy metals in sewage water. While the average Zn, Fe, Cu and Mn concentration was much less in underground water than sewage and conjuctive water. The results further revealed that Fe concentration level was much higher in all irrigation waters than other micronutrient elements. The concentration level of micronutrient was in order of Cu<Zn<Mn<Fe.

Further analysis water shows availability of less micronutrient such as Fe, Zn, Cu and Mn in underground would result less accumulation of heavy metals in soils, whereas high heavy metal content in sewage water would increase the concentration of these elements in sewage and mixed water soils.

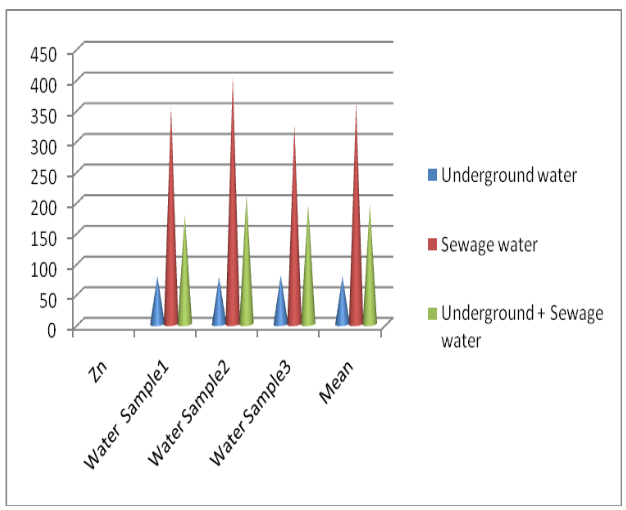

Fig. 1 Zinc (Zn)

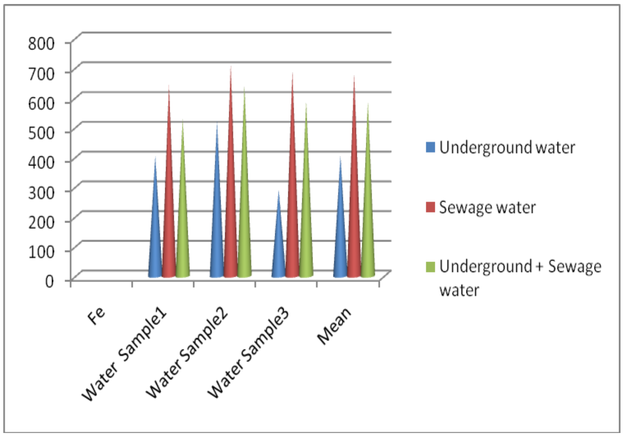

Fig. 2: Iron (Fe)

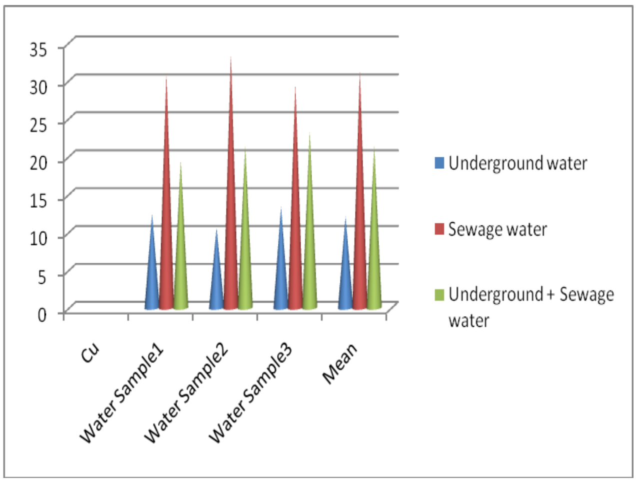

Fig. 3: Copper (Cu)

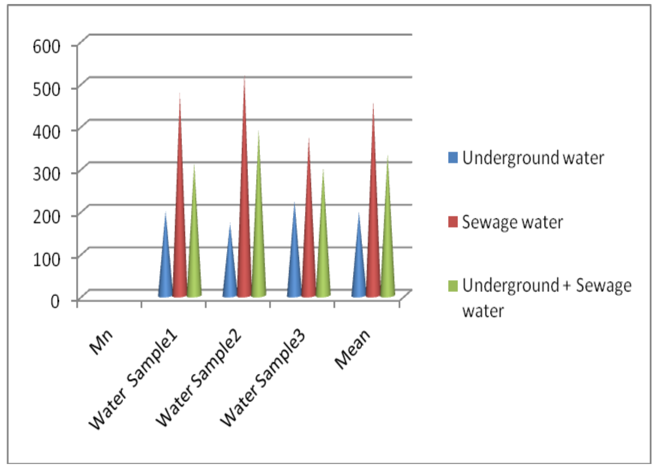

Fig. 4: Mangnese (Mn)

2. Micronutrient status in soil

Zinc (Zn)-Fig. 1

The results of Zinc concentration in soil profile revealed that sewage water irrigation treatment released 3 times more concentration (286 ppm) than conjuctive use of underground and sewage water irrigation treatment (94 ppm). Whereas, underground water irrigation treatment indicated very minimum leaching of 2ppm into soil profile. The leaching of Zinc concentration was higher in the upper soil Layer (0-20cm depth) than in the lower soil layer (20-40 cm depth). This shows that sewage water contains more Zinc contents than underground water. Ghaffor and Arif 1996 [14] conducted experiment on waste water usage and found in his study that Fe, Mn and Zn ions were higher in soils irrigated with sewage water.

Iron (Fe)-Fig.2

Similar results were obtained for Fe concentration in soil profile. The upper soil profile contained more concentration than the lower soil profile. Though the magnitude of Fe concentration was lower than the Zinc concentration, the soil profile concentration of iron (140 ppm) was 2times more than the soil profile concentration of conjuctive use irrigation treatment which was about 67 ppm. The soil profile concentration of iron in underground irrigated treatment was the least, i.e. 10 ppm but was higher than the Zinc concentration. This shows that underground water contains more iron than zinc. Nonethless sewage water contained higher Fe concentration than underground water. Same results were reported by Ghaffor and Arif 1996 [14] who found that micronutrients status were higher in soils irrigated with sewage water.

Copper (Cu)-Fig. 3

The result indicates that the soil profile concentration of copper in sewage irrigated treatment (29 ppm) remained twice as high than the conjuctive irrigated treatment (15 ppm). This is because the cu concentration in sewage water was more than the cu concentration of underground water. Overall soil profile concentration of copper was less than the soil profile concentration of both Iron and Zinc. Similarly cu concentration release was higher in upper soil layer than lower soil layer. Same findings were reported by Sattar *et al.* 1990. [15] and found that the soils of Peshawar Pakistan irrigated with sewage water were found higher level of Cu, Cd and Zn concentration. Paliwal *et al*. 1998. [16] elucidated that at the higher concentration of sewage water application, the accumulation of micronutrients resulting from application of sewage water was Mn>Zn>Pb>Cu.

The results of Mn concentration in the soil profile of all irrigated treatments are not different except the magnitude of concentration. Concentration in upper soil layer is more than the lower soil profile because there is maximum leaching in the surface layer than in the subsurface layer. Sewage irrigated treatment again shows 2 times higher soil profile concentration of manganese than conjuctive irrigation treatment. The magnitude of soil concentration in all the treatment was lmost the same as Fe soil profile concentration. This may be because both Fe and Mn concentration in sewage and underground water is almost similar in magnitude. Results shows that the Mn concentration in soil profile under underground, sewage and conjuctive use

Manganese (Mn)-Fig-4

of underground and sewage tretments was 8, 145 and 71 ppm respectively. On the other hand contradicting the present results Brar *et al.* 2000. [17] concluded that Cu, Fe, Zn and Al accumulate in soils and crops which may become health hazard to human and animals. *Yousufzai et al.* 2001 [18] concluded that maximum

Table-2. Status of micronutrients in the soils of Umerkot as affected by different sources of irrigation.

Micronutrient	Soil Depth (cm)	Sources of irrigation		
		Underground water	Sewage water	Underground +Sewage water
Zn	00-20	1.824	167	69.583
	20-40	0.491	119.29	23.915
Fe	00-20	6.456	103.659	46.975
	20-40	3.785	35.799	19.635
Cu	00-20	1.559	19.968	10.533
	20-40	1.423	9.279	4.519
Mn	00-20	4.9	96.091	46.914
	20-40	2.939	49.578	24.387

concentration of micronutrients found in the vegetables grown in area was due to continuous use of untreated sewage and industrial effluents.

CONCLUSIONS

The results of this study revealed that the sewage water contained much higher concentration of Zn, Fe, Cu and Mn, while the total concentration of Zn, Fe and Cu was was much less in underground water. Total concentration of Fe, Cu, Zn and Mn in both sewage and underground water was more than the admissible threshold values of irrigation water that may pose threat to soil degradation and phototoxicity problems in food chains which in turn may cause serious health hazard to human and animal health. Fe concentration level was much higher in all irrigation waters than other micronutrient elements. The concentration level of micronutrient was in order of Cu<Zn<Mn<Fe. The results of soil analysis of uppersoil layer (0-20 cm) indicated higher concentration values of Fe, Zn, Cu and Mn than the lower layer (20-40 cm). The concentration values of lower layer were almost the half of the upper layer. It is recommended to include analysis of micronutrient concentration in plant for evaluation of phototoxity effects on use of untreated or treated sewage water.

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