Swapnil Rai al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 2, Issue 1, March 2015, pp. 115-118

Potential usage of sewage water in irrigation for improvement of various soil nutrients

Swapnil Rai[1], S. P. Bajpai[2] and Dinesh Kr. Sharma[3]

[1,2]Department of Environmental Science, Amity University Madhya Pradesh, Gwalior – India - 474005
[3]Department of Chemistry, Mangalayatan University, Beswan – Aligarh – India - 202145

***Abstract*— The available fresh water resources are depleting due to increased demand of different sectors which leads to water scarcity. The increase in the quantity of water used and waste water produced by different communities and industries throughout the world, causing a potential problems to the environment and human health. Sewage water disposal at present is a major problem, causing a pollution of various surface water sources. Many countries are seeking for safe, sound and cost-efficient ways to treat and dispose of waste waters. The present study was planned to evaluate the potential of sewage water for irrigation purposes. The soil samples were collected from two different sites which were irrigated with sewage water and canal water to compare the effect of normal water and sewage water irrigation on soil properties. The results of present study revealed that sewage water irrigated soil was enriched with high concentration of calcium, magnesium organic carbon, potassium, nitrogen and phosphorus whereas bulk density, electrical conductivity, were found lower than canal water irrigated soil. The results showed that sewage water can be used for irrigation purpose after following appropriate water treatment processes.**

***Keywords*— Sewage, Potential, Irrigation, Soil Properties.**

I. Introduction

Soil is one of the important ecological factors and plants depend for the nutrients, water supply and support upon soil. It supports and provides nutrition to the plants and animals directly and indirectly. The properties of agricultural soil partly depend upon the composition of water used for irrigation. The available fresh water is shrinking due to rapid increase in demand by the different sectors like industrial, agricultural and domestic. The quantum of water available for agriculture is decreasing day by day because of increase in demand by industrial sector and urbanization. Utilization of water resources is crucial to agricultural production for meeting the ever increasing demand of irrigation water for producing more and more food. Since resources are limited and a large gap exists between available water supply and the amount required for intensive cropping. The waste water of domestic origin can be used for irrigation purposes. Since the sewage water contains appreciable amounts of essential plant nutrients, the fertility level of soil is expected to increase. Variation in properties of the four soil component mineral matter, organic matter, water and air determine most of the potential usefulness of soil. The interactions among these compounds are of great significance in providing plant with water air and essential nutrients [1]. Use of sewage in farming has importance in several countries because of the economy of the process combined with proper disposal. Sewage water has good nutrient status which is essential for plant growth. It can also be used for reclamation of highly alkali soil [2]. Among the waste water, sewage ranks first, not only due to high abundance but also from relatively less hazardous nature coupled with high plant nutritive values and their use has been found to improve the physical condition of soil as well as increase productivity of both green and blue biomass. One known way of utilizing the sewage and sludge has been to grow vegetable near the cities and towns reported by many workers [3,4]. Domestic sewage is the primary source of nutrients such as Nitrogen, Phosphorus and Potassium [5]. In sub urban areas, the use of municipal waste water for agriculture is common practice now a days in many parts of the world [6-8], and also same type of observations were obtained from India [9]. Uptake of the entire major (N, P, K) and micronutrient is also higher in domestic sewage irrigated soil. Among all waste water sewage water have relatively less hazardous nature coupled with high plant nutritive values and also improve the physical environment of soil. Utilization of the sewage for agriculture is one of the ways of meeting the irrigation requirement of crops [10]. Sewage water is potential source of irrigation for raising vegetables and fodder crops which can be directly or indirectly consumed by human beings. Sewage is a rich source of organic and inorganic nutrients responsible for plant growth. Presently sewage farming is quite common in all urban areas in India. Sewage water improves chemical properties and fertility status in soil as it contains elements essential for plant growth [11].

Keeping the above in view the present study has been undertaken to assess potential of sewage water for the irrigation purposes.

II. Material And Methods

Sampling Site

In present study two sampling sites of Aligarh district were selected for investigation (Figure 1). Site-I is situated at Aligarh – Mathura state highway at Sasni gate Chauraha 10 km from Aligarh Railway Station. It is being irrigated with sewage water and agricultural practices were done in the different plots. Site - II is situated at Iglas (Site- II), Aligarh-Mathura state

highway, 25 Km from Aligarh Railway Station and it is being irrigated with canal water. Site II was taken as control site as it is being irrigated with normal water of Canal.

Sampling and Analysis

The soil samples were collected from 10 different plots of each site with the help of auger. Approximately about 500 gm soil was collected from a depth a 0-15 cm from each site. The soil samples were taken and placed in a clean polythene bag. All the soil samples were analysed by following standard methods reported in various literature [12-14].

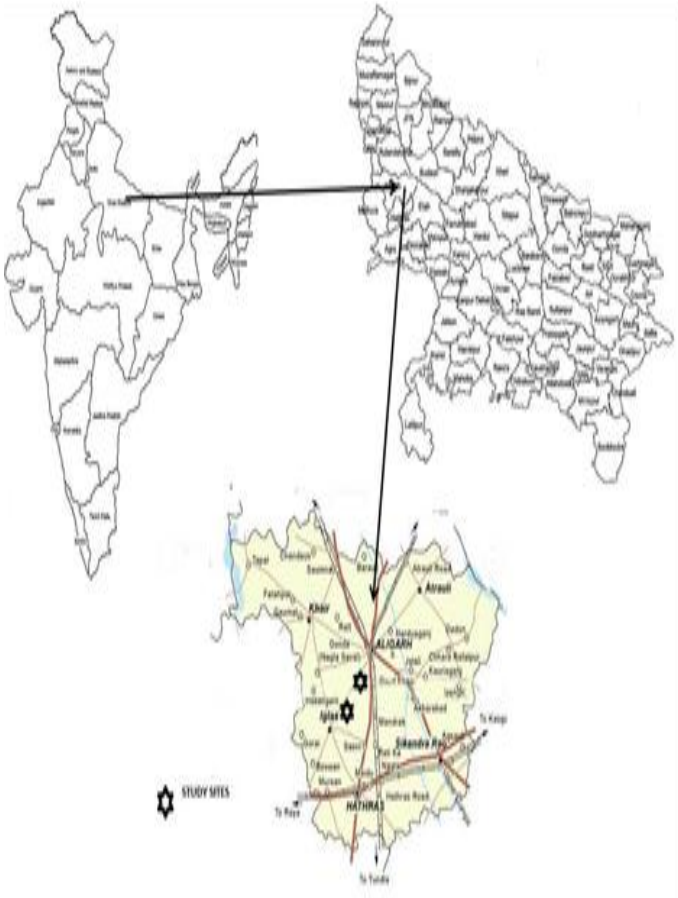

Figure 1. Study Area

III. Results And Discussion

The mean values ±S.E. of different parameters like temperature, water holding capacity, Bulk density, pH, Phosphorus, Potassium Calcium, Magnesium and total nitrogen of soil at two sites are represented in Table 1. Comparative result analyses of both the sites for various parameters are represented in the form of graph in Figure 2.

Temperature stimulates assimilation and transfer of water and ions of many nutrients in higher plants Temperature plays a key role in various metabolic activities of plants and animals. Seed germination partly depends upon the temperature of soil and it also affects physical, chemical and biological processes of soil [1]. Mean temperature of 17.33 °C was recorded in sewage ater irrigated soil which is more in comparison to control site.

Electrical conductivity of the soil is used as an indicator of a number of soil physical and chemical properties. The electrical conductivity is a measurement of salt concentration in soil and high electrical conductivity can cause toxicity of a particular ion. High concentration of salts in soil also affects osmotic pressure around the roots and prevents water absorption in plants. Plants are specific and susceptible for electrical conductivity of soil and many species have an electrical conductivity threshold limit. Electrical conductivity in the soil sample of Site-I and Site-II was 0.309 dsm-1 and 0.456 dsm-1 respectively which show the less concentration of salts in sewage irrigated soil. The effects of high electrical conductivity on growth, development and production of Solanum lycopersicum were observed in greenhouse at Pachino (Southern-East Sicily) [15]. Bulk density of soil improves with the amendment of sewage sludge in soil [16]. Electrical conductivity were also reported low in sewage water irrigated soil as compare to well water irrigated soil in Saudi Arabia [17]. The bulk density of soil shows compactness of the soil and high bulk density hinders the root penetration in the soil. In present study bulk density was 1±0.03 gm/cm3 in the soil irrigated with sewage water which is low as compare to control. The bulk density was also reported low in the sewage water irrigated soil of Dehradun city [5].

Water holding capacity is the amount of maximum moisture present in soil and it is important for the good crop yield. As due to mismanaged agricultural practice many soils lose its water moisture and use of different soil conditioners have increased in recent years to retain the soil moisture. In the present study water holding capacity was found high in sewage water irrigated soil which shows that sewage water may retain moisture in soil [18]. Many workers also reported that sewage water improves the physical environment of soil. Application of sewage increases the water retention of soil [16].

The acidity and alkalinity of soil is expressed on a pH scale. Plants cannot grow in acidic or alkali soil because many soil nutrients leach out due to highly acidic or alkaline conditions. For the favourable crop yield pH above 5.6 and below 8.4 is required. The various studies also reported that soils controlled by pH value in between 6.0 - 8.2 are bacteria predominate [19]. The present findings showed that there is slight increase in the pH of sewage irrigated soil as compared to control site.

Nitrogen is an essential major element necessary for plant growth and crop yield. In the present study nitrogen concentration was higher at Site II than the control i.e. Site I. Most of the soils are often deficient in the type of N that plants can use, therefore organic residuals such as manure or bio-solids are added annually to agricultural soils. Sewage sludge application increase the nitrogen in soil and a good source for smooth Brome grass production [20, 21]. High concentration of Nitrogen was also observed in soil amended with sewage [22].

Table 1. Concentration of different physico-chemical parameters of soil samples.

S. No.	Parameters	Site I (Sewage water)	Site II (Canal water)
1	Bulk density (gm/cm^3)	1.0±0.03	1.56±0.07
2	Water holding capacity (%)	72.60±1.09	49.58±1.41
3	Temperature (^0C)	17.33±1.15	13.50±1.08
4	Electrical conductivity (dSm^{-1})	0.309±0.07	0.456±0.10
5	pH	7.62±0.00	6.70±0.00
6	Organic Carbon (%)	8.95±0.00	3.27±0.04
7	Phosphorous (mg/kg)	148.44±1.28	78.43±0.44
8	Available potassium (mg/kg)	124.66±6.23	93.66±4.71
9	Total Nitrogen (%)	13.22±0.57	4.61±0.12
10	Available Calcium (%)	5.18±0.14	3.15±0.49
11	Available Magnesium (%)	1.09±0.03	0.57±0.01

(All values are Mean±S.E. of 5 observations for each parameter)

The source of organic carbon in the cultivated soil includes crop residue, animal manure and green manure etc. Sewage sludge contains organic matter and is rich in macro and micronutrients, so the agricultural and forestry disposal is widely recommended. Sewage water increases the available carbon in soil and stimulates soil microbial activity [17, 23,]. In the present study site-I showed reasonably high percentage of organic carbon whereas control site showed relatively less percentage of organic carbon.

Phosphorus plays important role in the cell of plant and the various metabolic activities like growth respiration and reproduction depends upon phosphorous levels in the soil. During present study Site –I contains more phosphorous in comparison to control site. Sewage irrigation of agricultural soil increases the concentration of phosphorus in soil [23].

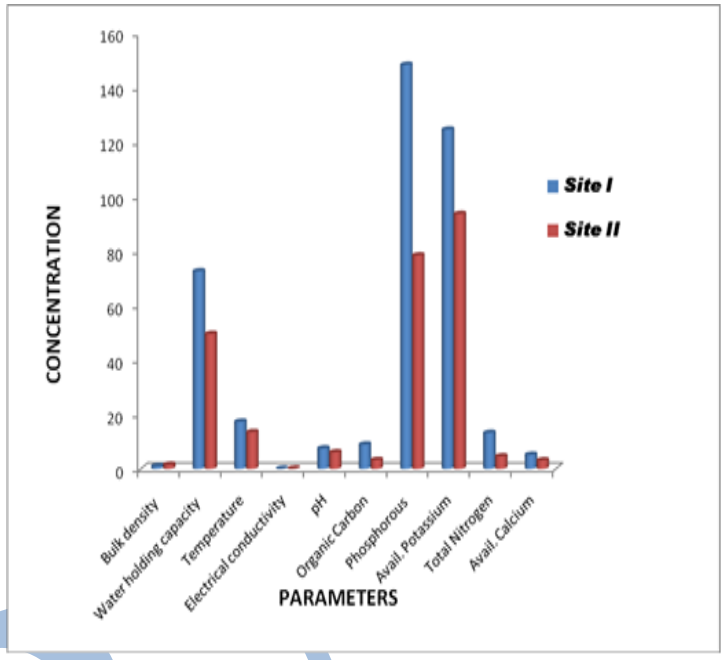

Figure 2. Graph showing the comparison in the concentration of various parameters of study sites I & II.

Potassium is very important macro element required for plant growth and in this study it was found in high concentration in sewage fed soil as compare to normal water irrigated soil. It has an important role in photosynthesis, grain formation, protein synthesis, starch formation, and translocation of sugars. Waste waters irrigation of soil may result in potassium availability in excess to plant requirements [24].

Ca and Mg are naturally present in soil and considered as micro nutrients. These are therefore required in small quantity in plants but these have important role in various metabolic activities [25]. The Ca and Mg concentration were recorded moderately high in sewage water irrigated soil and low in canal water irrigated soil. The concentration of Ca and Mg were also found high in the soil irrigated with sewage as compare to ground water irrigated soil in Karnataka [11].

IV. Conclusion

The results of present study revealed that sewage water have the potential of irrigation and it is a good source of essential nutrients required for plant growth. The concentration of various parameters of present study shows the fertilization strength of sewage water as it enriches the soil with different macro and micro nutrients. Therefore it can be concluded that sewage water is a good source of nutrients for soil and can be used for irrigation purpose after partial treatment. Although further research is needed to check the accumulation status of heavy metals in sewage water irrigated soil.

REFERENCES

[1]. N. C. Brady, In: 'The nature and properties of soil", 10th Edition, Prentice Hall of India Pvt. Limited, New Delhi 1996.

[2]. G.R. Reddy, and K.J. Rao, "Impact of sewage irrigation on macronutrient status of soils", In: Agricultural Abstract, pp 17, 2003.

[3]. R.W. Miller, R.L. Donahue"Soil in Our Environment", 7th edition Prentice Hall Englewood clips, Newjersey 07632, 1995.
[4]. N.Chandrasekaran, and B. Rajkannan, "Effect of Continuous application of Sewage effluent on soil physical properties", The Madras Agriculture Journal Vol 90 (46), pp. 211 -215, 2003.
[5]. S. Rai, A.K. Chopra, C. Pathak, D.K. Sharma, R. Sharma and P. M. Gupta, "Comparative study of some physicochemical parameters of soil irrigated with sewage water and canal water of Dehradun city, India", Archives of Applied Science Research, Vol 3 (2), pp 318-325, 2011.
[6]. D.H. Urie, The status of waste water irrigation of forest. In: Cole, D.W., Henry, C.L. and Nutter, W.L. (Eds.), "the forest alternative for treatment and utilization of municipal and industrial wastes", University of Washington Press, Seattle, WA, USA, pp.26-40, 1986.
[7]. A. Feign, I. Ravina, and J. Shalhevet, "Irrigation with treated sewage effluent: management for environmental protection", Springer, Vol 48, pp 1–19, 1991.
[8]. L.N. Sharma and C.K. Kale, "Effect of Sewage and its dilution on the growth of Jowar at different stages", Journal of Environmental Health, Vol 10, pp 120-128, 1968.
[9]. K.P. Singh, D. Mohan, S. Sinha and Dalwani R, "Impact assessment of treated and untreated wastewater toxicants discharge by sewage treatment plants on health, agricultural and environmental quality in wastewater disposal area", Chemosphere, Vol 55, pp 227-255, 2004.
[10]. J.K. Saha, A.K. Biswas, Ajay and M. Singh, "Investigation on the effect of continuous use of sewage water as irrigation on the swell-shrink soil quality", In : Annual report (2002-03), Indian Institute of Soil Science, Bhopal, 2002
[11]. A.A. Mohammed, R. Lathamani, S. Sidduraiah, "Effect of sewage water irrigation on soil properties and evaluation of the accumulation of elements in Grass crop in Mysore city, Karnataka, India", American Journal of Environmental Protection, Vol 3(5): 283-291, 2014.
[12]. H.L.S. Tondon, In : "Methods of Analysis of Soil, Plant Water and Fertilizers", Fertilizer Development and Construction Organisation (FDCO), New Delhi, 1999.
[13]. P.K. Gupta, In: "Soil, water, plant and fertilizer analysis", Agrobios (India) Publishing house, Jodhpur, Rajasthan, 2000.
[14]. U.S.S. Ramulu, "Principles in the Quantitative Analysis of Waters, Fertilizers Plants and Soils", Scientific Publisher Jodhpur, Rajasthan, 2003
[15]. M. Marchese, R. Tuttobene, A. Restuccia, A.M.G. Longo, G. Mauromicale, G. Restuccia in Santini A. (ed.), Lamaddalena N. (ed.), Severino G. (ed.), Palladino M. (ed.). "Irrigation in Mediterranean agriculture: challenges and innovation for the next decades Bari", CIHEAM, Vol 84, pp 311-315, 2008
[16]. O.N. Roudsari and H. Pishdar, "Evaluation of Composted Sewage Sludge (CSS) as a soil amendment for bermudagrass growth", Pakistan Journal of Biological Science, Vol 10 (9), pp 1371-1379, 2007.
[17]. A.M. Al Omron, S.E. El-Maghraby, M.E.A. Nadeem, A.M. El-Eter and H. Al-Mohani, "Long term effect of irrigation with the treated sewage effluent on some soil properties of Al-Hassa Governorate, Saudi Arabia", Journal of the Saudi Society of Agricultural Sciences, Vol 11, pp 15–18, 2012.
[18]. Chandrasekaran and Rajkannan, "Nature and Characteristics of Sewage Effluents of Tamil Nadu," The Madras Agricultural Journal, Vol. 90 (1-3), pp 124-128, 2003
[19]. I.S. Mezhenin, "Magnitute of pH of wate suspension of different soil to water ratio" Journal of Soil Science, Vol 89, pp 159, 1961.
[20]. Bilal Keskin, Mehmet Ali Bozkurt and Hakki Akdeniz "The Effects of Sewage Sludge and Nitrogen Fertilizer Application on Nutrient and (Bromus inermis Leyss.)", Journal of Animal and Veterinary Advances Year, Vol 9(5), pp 896-902, 2010.
[21]. Cheng-Wei Liu, Yu Sung, Bo-Ching Chen, and Hung-Yu Lai, "Effects of Nitrogen Fertilizers on the Growth and Nitrate Content of Lettuce (Lactuca sativa L.)" International Journal of Environmental Research and Public Health, Vol 11(4): pp 4427–4440, 2014.
[22]. S.O Petersen, J. Petersen, G.H. Rubaek, "Dynamics and plant uptake of nitrogen and phosphorus in soil amended with sewage sludge", Applied Soil ecology, Vol 24, pp 187-195, 2003
[23]. Wagner Bettiol and Raquel Ghini, "Impacts of Sewage Sludge in Tropical Soil: A Case Study in Brazil"Applied and Environmental Soil Science, Article ID 212807, 2011 doi:10.1155/2011/212807
[24]. M. Arienzoa, E.W. Christena, W. Quaylea, A. Kumar, "A review of the fate of potassium in the soil–plant system after land application of wastewaters" Journal of Hazardous Materials Vol 164, pp 415–422, 2009.
[25]. I. Iwai, "Influence of the degree of calcium and potassium saturation of soil on growth and chemical composition of plants". Australian Journal of soil Resources, Vol 11, pp:153, 1961.

