Environment Conservation Journal 16(1&2) 129-132, 2015
ISSN 0972-3099 (Print) 2278-5124 (Online)
Abstracted and Indexed

Combined industrial effluent effect on physico-chemical characteristics of soil cultivated with *Phaseolus vulgaris*

Megha Gupta and Raj Kumar Rampal ✉

Received: 18.02.2015 **Accepted: 22.04.2015**

Abstract

The impact of combined industrial effluent on the physico-chemical properties of soil cultivated with *Phaseolus vulgaris* was studied in pots experiment. The soil was irrigated with four concentrations (i.e. 25%, 50%, 75% and 100%) of the combined industrial effluent collected from the drain of industrial area of Kathua and one control set in which tap water was used for irrigation. The physico–chemical properties of soil were determined before i.e. at time of sowing and at the end of the experiment i.e. after harvesting of crop, in the two months study period. Results revealed that among various experimental sets of soil pH, EC, phosphorus and potassium showed the increasing trend whereas nitrogen and organic carbon showed the decreasing trend with increase in the concentration of the effluent.

Keywords: Combined industrial effluent, irrigation, *Phaseolus vulgaris*, soil characteristics

Introduction

Quality of irrigated water is believed to have effects on the soil and agricultural crops. The use of saline water may result in the reduction of crop yield and it may deteriorate the physical properties of soil with consequent reduction in crop yield. However irrigation with waste water transfers a wide variety of elements into the soil environment. Some of these elements such as Nitrogen, phosphorus and potassium are important plant nutrients and may contribute to higher crop yield. Effluents from industries contain appreciable amount of cations like zinc, copper, lead, manganese, iron etc. and anions like chloride, nitrate, sulphate, phosphate etc. Long term irrigation with such effluents increases organic carbon content as well as heavy metal accumulation in soil thereby increasing chances of their entrance in food chain and ultimately causing significant bioaccumulation.The nature of the soil is one of the most important factors in determining the heavy metal content of food plants. However the heavy metals content in plants can also be affected by other factors such as the application of fertilizers, sewage sludge or irrigation with waste water. Thus the effect of water on soil and crops are of major concern when waste water is used for irrigation. Waste water is also the resource that can be applied for productive uses since waste water contains nutrients that have the potential for use in agriculture, aquaculture and other activities. The various elements introduced through the irrigation of combined industrial effluent not only affect the crop growth and soil properties but also their relative mobility in the soil profile. Raza *et al.* (1987) worked on the effect of combined industrial effluents on soil and natural vegetation of industrial complex and assessed soil toxicity and physiological responses of various plants. Rani *et al.* (2005) studied effect of effluents from a medium sized dye house on plant growth and soil characteristics and concluded that the effluents were not suitable for irrigation. In present study the pot experiment has been conducted to study the effect of combined industrial effluent on the physico-chemical properties of the soil cultivated with *Phaseolus vulgaris*.

Material and methods

The combined industrial effluent collected from a big drain receiving effluent from textiles, paper mill, metallurgical industries etc. in the Hatli more industrial area of Kathua was brought to the

Author's Address
Department of Environmental Sciences
University of Jammu, Jammu, J&K
E-mail: meghag230@gmail.com

Copyright by ASEA
All rights of reproduction in any form reserved

laboratory and analyzed for various physico-chemical parameters following standard methods. The pH was measured using digital pH meter (pH meter 700). EC was measured using digital conductivity meter (Model 1601). Cations, anions and heavy metals (Cu, Zn, Ni, Co) were determined by using 850 professional Ion Chromatograph system (Metrohm Switzerland). The five experimental sets (Four effluent treatment sets and one control set) were designed in the Department of Environmental Sciences, University of Jammu for studying the irrigational effect of combined industrial effluent on soil characteristics. In each experimental set 10 bags were used.Each Polythene bag was filled 3/4th with air dried clayey loam soil mixed with Farmyard Manure in the ratio of 3:1. The soil samples were dried and then digested with Nitric acid. Digested samples were diluted with Millipore water and filtered with Micro syringe filters. Then the sample was made up to 10 ml. The ready samples were then analyzed for heavy metals using Ion chromatograph. The various physico-chemical parameters of soil like pH (pH meter 700), EC (Model 1601), Organic carbon (Walkley and Black's rapid titration method; Allen *et al*., 1986), Total potassium (Flame photometer 128), Total phosphorus (Spectrophotometric method) and nitrogen (Kjeldahl method) were determined by using standard methods.

Results and Discussion

Temperature, pH, turbidity, EC of the effluent were found to be 55ºC, 8.7, 20NTU and 3.9mS/cm respectively. The various chemical parameters DO, BOD, chloride, nitrate, sodium, potassium, calcium, magnesium, copper, nickel, zinc and cobalt in 100% effluent concentration were recorded to be 0.79 mg/l, 47 mg/l, 248.6 mg/l, 7.16 mg/l, 1563 mg/l, 114.7 mg/l, 158.4 mg/l, 72.7 mg/l, 37.1 mg/l, 17 mg/l, 67.22 mg/l, 43.18 mg/l and 40.20 mg/l respectively (Table I). The values of pH, EC, organic carbon, phosphorus, potassium, nitrogen, copper, zinc, nickel and cobalt in the soil with no effluent treatment as well as in Control set were found to be 7.09, 0.970 mS/cm, 2.4%, 147.5ppm, 332ppm, 0.20%, 0.00 mg/l, 1.24 mg/l, 4.33 mg/l

Table I: Physico-chemical characteristics of combined industrial effluent from Kathua industrial area

Physical parameters	**Effluent characteristics**			
Colour	Bluish black			
Odour	Unpleasant			
Temperature (^{0}C)	55			
pH	8.7			
Turbidity (NTU)	20			
EC (mS/cm)	3.9			
Chemical parameters (mg/l)	**25%**	**50%**	**75%**	**100%**
DO	3.9	2.7	1.18	0.79
BOD	23	32	38	47
Chloride	41.5	63.2	139.6	248.6
Nitrate	1.26	6.26	6.97	7.16
Sodium	374	622	1074	1563
Potassium	27.8	45.5	76.2	114.7
Calcium	39.0	63.3	110	158.4
Magnesium	13.6	24.5	47.4	72.7
Ammonium	10.8	14.1	24.3	37.1
Copper	3.21	4.26	10.22	17.0
Zinc	12.12	38.24	57.16	67.22
Nickel	5.06	12.35	36.24	43.18
Cobalt	6.35	15.29	23.16	40.20

and 0.00 mg/l respectively whereas the soil in experimental sets treated with 100% of effluent concentration after harvesting exhibited the values as 8.96, 2.680 mS/cm, 0.54%, 447.6 ppm, 1193.3 ppm, 0.04%, 22.97 mg/l, 27.75 mg/l, 10.30 mg/l and 1.23 mg/l respectively (Table II). The critical analysis of data revealed that among various concentrations of combined industrial effluent DO showed the decreasing trend whereas BOD, chloride, nitrate, sodium, potassium, calcium, magnesium, ammonium, copper, zinc, nickel and cobalt showed the increasing trend with increase in effluent concentration. In the experimental sets pH, EC, phosphorus and potassium of soil showed the

Table II: Physico-chemical characteristics of soil irrigated with combined industrial effluent from Kathua industrial area

Soil Parameters	Control set	Set I-(25%)	Set II- (50%)	Set III-(75%)	Set IV- (100%)
pH	7.09	8.76	8.81	8.94	8.96
EC (mS/cm)	0.970	1.160	1.187	1.295	2.680
Organic carbon (%)	2.40	3.27	2.63	1.96	0.54
Phosphorus (ppm)	147.5	318.04	338.68	391.05	447.62
Potassium (ppm)	332	811	932.9	1152.9	1193.3
Nitrogen (%)	0.20	0.28	0.22	0.16	0.04
Copper	-	5.808	11.83	19.33	22.97
Zinc	1.24	11.19	13.48	18.15	27.75
Nickel	4.33	-	-	4.02	10.30
Cobalt	-	-	-	-	1.23

increasing trend whereas nitrogen and organic carbon showed the decreasing trend with increase in the concentration of the effluent. The soil pH with no effluent treatment was recorded to be neutral (7.09) and it turned to more alkaline (8.96) when treated with 100% effluent concentration. The increase in the concentration of effluent significantly increased the pH and EC of the soil due to increase in salt load. Similar findings were also reported by Chhonkar *et al.* (2000). Organic carbon of soil in the experimental sets decreased from 3.27% (in 25% effluent concentration) to 0.54% (in 100% effluent concentration) whereas that of soil in control set exhibited value of 2.4%. Kumar and Chopra (2011) reported that organic carbon contributes to the cation exchange capacity and temporarily adsorbs heavy metal pollutants (Cu, Zn, Ni, Co) which are usually derived from applied waste water. In the present study decrease in organic carbon concentration led to the accumulation of heavy metal content in the soil. In the soil treated with 100% of effluent concentration nutrients like phosphorus (447 ppm) and potassium (1193.3 ppm) were found to be more than the permissible limits (100 ppm for phosphorus and 300 ppm for potassium) which may have negative impact on soil and plant (Friedel *et al.* 2000).

Conclusion

The combined industrial effluent contained the huge amount of nutrients. The proper dilution of the effluent reduced the strength of nutrients in it and supports its role in land restoration and sustainable plant production. The present study revealed that application of combined industrial effluent caused enrichment of soil nutrients. However continuous application of such effluents could cause salt accumulation in agriculture lands which again need further bioremediations. It is suggested that after 3-4 years application of effluent in

agriculture lands a gap period of normal fertilizer and irrigation water supply should be maintained to avoid environmental hazards of continuous application of industrial effluent in soil.

References

APHA, 1998. Standard method for the examination of waste water (20th edn.). *American Public health Association*., Washington: 234-245.

Allen, S.E., Grimshaw, H.M., Rawland, A.P.,1986. *Chemical analysis methods in plant Ecology*. Blackwell scientific publications.

Chhonkar, P.K., Datta, S.P., Joshi, H.C., Pathak, H., 2000. Impact of industrial effluent on soil health and agriculture. ***Journal of scientific and industrial research***, 59: 350-361.

Friedel, J.K., Langer, T., Siebe, C., Stahr, K., 2000. Effects of long term waste water irrigation on soil organic matter, soil microbial biomass and its activity in central Mexico. ***Biology of Fertilizers in soils***, 31: 414-421.

Kumar, V. and Chopra, A.K., 2011. Alterations in physico-chemical properties of soil after irrigation with paper mill effluent. ***Journal of chemical and pharmaceutical research***, 3 (6): 7-22.

Rani, M., Naresh, P. and Sharma, R.K., 2005. Irrigational impact of dye house effluent on plant growth and soil characteristics. ***Journal of industrial pollution control***, 21(2): 299-304.

Raza, S.H., Nirmala, B., Murthy, M.S.R. and Fatima, N., 1987. Effect of industrial effluents on soil and natural vegetation of Nacharum industrial complex. ***Acta Ecologica***, 9(1): 28-33.