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Metal Contamination in Wheat Crops (*Triticum aestivum* L.) Irrigated with Industrial Effluents

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Abstract: The aim of study was to evaluate the suitability of industrial effluent for irrigation purposes and their possible effects (due to heavy and trace metals) on the germination as well as quality of agricultural crops. The effluents (liquid waste) of five industries like textile mill, oil refinery, soap and detergent, hydrogenated oil and rubber industry were used in this study. The study was carried out during 1998-2000. The results show that effluents from all five industries consist of higher concentration of metals (Cr, Mn, Fe, Cu, Co, Ni, As, Cd and Pb). Furthermore the germination of crops was more effected with the effluents of textile mill followed by soap and detergent, oil refinery and hydrogenated oil , where as less effects were observed from effluents of rubber industry. Therefore it was observed that effluent is not only unfit for irrigation but also for domestic uses due to presence of heavy and toxic metals and other harmful pollutants.

Key words: Industrial effluents, agricultural crops, heavy metals

Introduction

Agriculture is a complex phenomenon and exerts both favorable and unfavorable consequences on environment (Ambreen, 1993) In Pakistan, Agricultural is the mainstay of national economy. It is accorded second priority after defense. Its share in cross domestic product (GDP) is 24 %. It contributes 35% to export earning employs, 51 % of total labor force and provides living hood to 70% of rural population.

Environmental pollution is a matter of great concern and has been accepted as a global problem because of its adverse effects on human health, plants, animals and exposed materials (Irshad ***et al.***, 1997). In the past industrial; units were established without environmental impact assessment (Mastoi ***et al.***, 1997).

Toxic and heavy metals are discharge from almost all industries daily (Ahmad ***et al.***, 1994). The effluent (Industrial and municipal) contained heavy and trace metals like Cr, Mn, Fe, Cu, Co, Zn, Ni, As , Cd and Pb. The effluents from industries are either discharged into water ways (Streams/nullah or rivers) or allowed to spread on agricultural lands (Ghafoor ***et al.***, 1995).

Soil ecosystems throughout the world have been contaminated with heavy metals by various human activities and movement of metals on the food chain has become a human health hazard (Naidu ***et al.***, 1996). Heavy metal contaminated land is increasingly becoming an environmental

health, economic and planning issue in Pakistan (Hussain ***et al.***, 1996). The rapid increase in population together with the unplanned disposal of effluent from industries have increased the threat of soil pollution in Pakistan.(Anonymous, 1990).

Wheat is the most important crop produced in Pakistan. It is stable food for most of people. Total yield of wheat in Pakistan was 2238 kg ha^{-1}; In which production of Punjab is 14477 kg ha^{-1}. Wheat yield could be increase due to better seed varieties and sufficient amount of water during growing period. However, water of river and canal which is being used for irrigation purpose by former is contaminated with industrial waste water, which is also source of heavy and toxic metals in food chain (Ambreen, 1993).

The elements like Iron copper, cobalt, manganese and zinc are considered as essential metals however, if their concentration increases then their permissible limits, might create toxic effects in living organisms. Metal ions move downward in to the soil and mix up with under ground water and makes it contaminated with metal. The contaminated water may causes toxic effects in organism after ingestion. This study was undertaken with the following aims and objectives.

I) to determine the quality of effluents being used for irrigation purposes
ii) To determine the concentration of different metal ions in the effluents discharge from various industries
iii) to assess level of metal ions in wheat grain grown with effluents of various industries

Materials and Methods

The effluents (liquid wastes) samples were collected from five industries namely textile mill, oil refinery, hydrogenated oil, soap & detergent and rubber industries located in the vicinity of Rawalpindi/Islamabad. The samples were collected in prewashed plastic bottles of 2.5 litre (Allen, 1989). The samples were collected once a week for five months during Nov., 1998 to March 1999 and from Nov. 1999 to March 2000

Thirty six pots (30 for five industries and 6 in control) were used for germination of wheat crop (***Triticum aestivum*** L.) and analyzed for their selected heavy and trace metals contents. After harvesting the crops, the grain were dried, powdered and digested in acid mixture (10 ml concentrated HNO_3 and 5 ml $HCLO_4$ per samples). The concentration level of selected heavy and trace metals (Cr, Mn, Fe, Cu, Co, Ni, Zn, As, Cd and Pb) were determined with the help of atomic absorption spectroscopy as described by Qadir ***et al.*** (1997).

Results and Discussion

Data regarding the analysis of industrial effluents and wheat crops are given in tables.1-2.

Data (Table 1) represents the concentration level of heavy and trace metals in effluent samples of five industries used for the germination of seeds. Comparatively higher concentration of Fe, Zn, Cu and Ni were found in effluent samples from textile mill. Where as higher concentration of Ni was obtained from hydrogenated oil and higher concentration of Pb was present in effluent of oil refinery.

Table 1: Trace metals concentration (mg L^{-1}) in the effluents of various industries located in vicinity of Rawalpindi and Islamabad

Metal	Textile mill		Oil refinery		Hydrogenated Oil		Soap and detergent		Rubber Industry	
	*	**	*	**	*	**	*	**	*	**
Cr	1.151	1.955	1.1594	0.159	0.124	0.120	0.193	0.291	0.292	0.382
Mn	1.944	1.243	0.538	1.113	0.156	0.174	0.317	0.411	0.464	0.264
Fe	5.461	5.064	3.728	2.129	3.645	4.605	5.052	3.052	1.015	2.015
Co	2.571	2.175	0.152	0.192	0.214	0.211	0.156	0.151	0.176	0.196
Ni	3.501	2.611	2.239	3.201	6.211	5.209	1.989	2.189	0.377	1.176
Cu	4.413	3.113	3.771	2.791	1.092	2.189	1.772	1.172	2.263	0.213
Zn	4.691	5.181	1.572	2.512	2.190	0.496	2.430	1.439	0.503	0.312
As	0.812	0.6123	0.191	0.269	-	-	0.078	0.179	0.097	0.196
Cd	1.708	2.715	2.409	3.419	0.157	2.158	0.149	0.189	0.120	0.129
Pb	0.761	1.561	5.132	6.112	0.011	0.181	0.198	0.248	0.763	0.263

Table 2: Trace metals concentration (mg L^{-1}) in wheat crops ***Triticum aestivum*** L.) grown with industrial effluents from five industries

Metal	Textile mill		Oil refinery		Hydrogenated Oil		Soap and detergent		Rubber Industry	
	*	**	*	**	*	**	*	**	*	**
Cr	0.451	0.514	1.046	0.144	0.151	0.467	0.153	1.326	0.152	0.117
Mn.	0.264	0.253	0.467	0.324	0.136	0.235	0.207	0.132	0.354	0. 013
Fe	6.461	4.761	2.964	3.494	3.022	4.605	2.669	3.059	2.016	2.115
Co.	2.674	1.374	0.269	1.246	0.115	0.254	1.159	1.106	0.416	0.186
Ni.	5.361	1.351	0.269	2.494	4.019	5.215	2.081	1.281	1.376	1.307
Cu.	5.403	5.369	3.415	1.361	1.196	2.012	1.572	0.472	1.203	1.668
Zn.	2.131	1.251	2.312	2.344	2.452	1.196	1.439	0.436	1.613	0.131
As.	1.942	0.132	0.367	0.199	0.018	-	-	0.011	0.107	0.051
Cd.	2.148	1.918	1531	1.349	2.454	1.156	0.154	1.146	1.324	1.129
Pb.	2.467	1.491	3.496	4.119	0.319	1.061	1.291	1.593	1.569	2.468

Nov. 1998-March 1999(*) and November 1999 B March 2000 (**)

Data represents the concentration levels of Fe, Mn and Co which were high in wheat crops (***Triticum aestivum*** L.) grown with effluents from textile mill, hydrogenated oil and oil refinery (Table 2) The metals like iron, manganese and cobalt are essential metals and required for many enzymes for the normal functions of body.

Higher concentration of Zn (2.452 mg l^{-1}) was present in wheat crops (***Triticum aestivum*** L.) grown with effluents from hydrogenated oil during 1998 followed by level of Zn (2.344 mg l^{-1}) obtained by wheat crops (***Triticum aestivum*** L.) growth with effluents of oil refinery during 1999.

Zn is essential metal for many metallo-enzymes however, it is toxic to plants at higher concentrations (Irshad ***et al.***, 1997).

Higher concentration of Cu (5.403 mg l^{-1}) was present in wheat crops (***Triticum aestivum*** L.) grown with effluents of textile mills during 1998 followed by Cu concentration (5.369 mg l^{-1}) obtained by wheat crops (***Triticum aestivum*** L.) grown with effluents of similar mill during 1999. Copper is toxic to plants and algae at moderate levels (Stanley, 1991).

The concentration level of Ni (5.403 mg l^{-1}) was obtained in wheat crops (***Triticum aestivum*** L.) grown with effluents of textile mills during 1998 followed by Ni concentration (5.215 mg l^{-1}) obtained by wheat crops grown with effluents of similar mill during 1998. Copper is toxic to plants as low as 1 mg l^{-1}.

Data represents the concentration level of As (1.942 mg l^{-1}) which was maximum in wheat crops grown with effluents from textile mills during 1998 followed by 0.1999 mg l^{-1} wheat crops grown with effluents of oil refinery during 1999 (Table 2).Arsenic is toxic metal and creates a toxicity in digesting a organism (Gulfraz, 2000). The concentration level of Cd (2.148 mg l^{-1}) was present in wheat crops grown with effluents from textile mills during 1998.where as concentration of Cd (1.918 mg l^{-1}) was obtained when wheat grown with effluents of similar mill during 1999. Cd replace Zn biochemically and it is toxic to aquatic biota.

Higher concentration of Pb (3.496 mg l^{-1}) was present in wheat crops grown with effluents of oil refinery during 1998 however, the level of Pb concentration (4.119 mg l^{-1}) was obtained in wheat crops grown with effluents of similar mill during 1999. Where as level of lead obtained in wheat crops in effluents from other industries was low. Similar results of Pb in wheat crops are reported by Thomas ***et al.***, (2002) after conducting a experiment on level of metals in wheat and coffee.

The concentration level of metal ions found in this study were in the order of Fe, Cu, Ni, Pb, Co, Zn, Mn, Cd, As and Cr in both industrial effluents and wheat crops grown with these effluents.

The level of metals found in wheat crops was enough to create phototoxicity. Soltanpur (1985) conducted similar study and reported that phototoxicity of Cu, Fe, Mn and Zn in crops was in the order of 0.5, 5, 1.0 and 0.5 mg l^{-1}. It was observed in this experiment that industrial effluent is not only unfit for irrigation purposes but also for domestic purposes (Gulfraz and Tahira, 2001).

It is therefore recommended that in order to protect the crops in agricultural land, do not discharge industrial waste water into rivers, streams or canals etc. The industries are asked to establish water treatment plants so that the level of metals in industrial effluents could be minimize before their discharge into fresh water resources.

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