CATRINA (2020), 20 (1): 31-38

Efficacy of Transfer of Heavy Metals in Wheat Grown in Municipal Solid Waste Amended Soil

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ABSTRACT

Municipal solid waste was considered to contain a variety of toxic metals. The heavy metals accumulate in plants due to extensive use of municipal wastes in crops. The current study was conducted to demonstrate the influence of municipal solid waste treatments on the metal content of soil and wheat crop. In this direction, the seeds of wheat variety (Galaxy-13) were sown and four heavy metals Cd, Fe, Zn, and Co in grown plants were analysed by using Atomic Absorption Spectrophotometer. The level of metals (mg/kg) in wheat grains varied from 1.36 to 1.76, 9.7 to 21.2, 0.6 to 0.9 and 0.58 to 0.72 for Cd, Fe, Zn and Co, respectively. Pollution indices were used to determine pollution and accumulation levels. It was observed that bio concentration factor; pollution load index and enrichment factor values of Cd were high. Finally, it can be said that municipal solid waste must be treated properly before its application on agricultural land to avoid the excessive build-up of heavy metals in the food chain.

Keywords: Bioconcentration factor, Heavy metal, Municipal solid waste, Pollution load index, Soil, *Triticum aestivum*.

INTRODUCTION

In the developing countries there exist no proper system of treating industrial waste and it is directly poured into the rivers and the fresh water without any treatment as a consequence it not only contaminates the rivers but also harms the life of human and the other living beings (Zeb *et al.*, 2011; Khan *et al.*, 2018a). These waste not only stay in one living who has ingested sewage but it travels to the other organism through a process i.e. food chain (Dogan *et al.*, 2010; Khalid *et al.*, 2011; and Ugulu *et al.*, 2012).

As compared to any other crops', wheat is rapidly growing in more than 240 million hectares. Trade of wheat is higher than all cereals such as maize and rice. Production of wheat in 2009 was 682 million tons. It was the most cultivated cereal after maize (817 million tons) and with rice, it is the third one (679 million tons). The normal duration for the cultivation of maize is about 110-130 days. This duration is greatly dependent upon climate type of seed condition of soil and water factor. Among the available nat,ural resources, water is off the critical source which is great being misused (Saleemi, 1993; Ahmad *et al.,* 2018a; Khan *et al.,* 2018b).

Among all the important factors for plant growth, water is of prime importance (Khan *et al.,* 2017; Ahmad *et al.*, 2018b). It is a very precious natural asset and very importance for existence of life (Dogan *et al.,* 2014). It covers an area of about 70% on earth. Addition of the other substances changes the nature of water and brings physical, chemical and biological changes in the nature of water which consequently leads to disturbance of the ecological balance (Caponera and Alheritiere, 1978; Yasar *et al.*, 2012; Leblebici and Kar, 2018). Heavy metals such as Ni, Cd, Pb, As, Se and Hg are causing severe problems throughout the globe (Ahmad and Ashraf, 2011; Ahmad *et al*., 2012; Unver *et al*., 2015).The heavy metals which come from the industrial water and other sources cause hazardous effects on the life of human, plants, and animals (Jarup, 2003; Azevedo and Lea, 2005; Ugulu *et al.*, 2016).

The current study was aimed to determine the impact of municipal solid waste on morphological parameters and metals uptake by various parts of wheat variety (Galaxy-13).

MATERIALS AND METHOD

Study Area

In order to analyse heavy metal content in the *Triticum aestivum* variety (Galaxy-13) using municipal solid waste treatment, a pot experiment was conducted. The present research was held at the Department of Botany, University of Sargodha, Sargodha, during the years 2016-2017. The maximum temperature goes up to 50℃ in summer and minimum up to 12℃ in winter.

Plant Cultivation

Healthy seeds of wheat were collected during 2015. The conducted experiment consists of four treatments, with three replicates for the selected crop, in which, twelve pots were filled with soil. The seeds were sown in the pots for different treatment groups. The treatment groups were control group (T-I), no treatment was applied; the remaining three were treated with different percentages of municipal solid waste (T-II, III and IV, respectively). Eight seeds were sowed in each pot. In T-II group, 25% municipal solid waste and 75% ground soil were mixed. In T-III group, 50% municipal solid waste and 50% ground soil were mixed, however, in group T-IV, 75% municipal solid waste was used, and the rest was 25% ground soil. Pot trials were conducted in a natural environment system (November to April) for six months. The experimental pots were irrigated with groundwater. Pots were irrigated with the effluent two times in a week. The data of seed germination was recorded. After germination, for proper

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growth, four plants remained in each pot. Harvesting was done in April 2017, 5 months following the maturation period. Different morphological parameters of were also observed. Growth parameters of different treatment groups compared to control were carried including plant height, the number of leaves per plant and leaf area (Quarrie and Jones 1975) as the following equation:

Leaf area= length X width X 0.75

Sample Preparation

After harvesting, the whole plant samples were collected from each pot. The samples after drying in the air were then oven-dried at 72℃ for few days. After removing from the oven, grains were separated from the spikes and grind in electrical grinder into fine powder, for heavy metal detection 1 g of each sample was taken. For the digestion of samples, wet digestion method was used.

The dried samples were placed in a small conical flask and digested with conc. HNO_3 and H_2O_2 (1:2) on a hot plate. When fumes disappear, samples were removed from the heat and H_2O_2 was further added to attain transparent solution and again placed on the hot plate. Digestion continued until a colourless solution appears and allow cooling. After cooling, dilute all the samples in a measuring flask up to 50 mL as final volume. The samples were then filtered through what man filter paper No. 42. The soil samples were collected from the upper 3-5 cm layer of the soil from each pot. After drying in the air, soil samples were placed in the oven for two days at 65℃. The samples were digested in the same manner.

Metals Concentration

All the digested samples were then subjected to Atomic Absorption Spectrophotometer (Perkin-Elmer Corp., 1980) to detect heavy metals (mg/kg) in them. The metals to be analysed were: cobalt (Co), zinc (Zn), iron (Fe), and cadmium (Cd). For detection, the standard solution of different metals was also prepared from the stock solution, to obtain a calibration curve. To assess the reliability and assurance of the data, such measures were taken and compared with the interaction standards.

Metal concentration transferred from soil to wheat grains was determined through the bioconcentration factor (BCF) and health risk index (HRI) by following Cui *et al.*, (2004). The pollution load index (PLI) was calculated by the method described by Liu *et al.*, (2005). Daily intake of metals (DIM) was determined using methodology reported by Sajjad *et al.*, (2009) was followed for the calculation of enrichment factor (EF).

Statistical Analysis

All the results were subjected to analysis of variance (ANOVA) using SPSS software, Version 16.0 (Statistical Package for Social Sciences). Using the software package SPSS (version 16.0), the correlation results were obtained. To assess soil-plant interaction, Pearson's correlation coefficient was calculated. The significant correlation was at 0.5, 0.01 and 0.001 probability levels (Steel and Torrie, 1980).

RESULTS

Morphological Parameters

The data recorded (Table 1) for four treatment groups of wheat (Galaxy-13), on root length, leaf length, shoot length, leaf width and leaf area, were significantly different (p>0.05). The maximum values of all these parameters were seen after application of T-4 while the lowest values of these parameters were recorded with T-1. Results showed that sewage sludge significantly increased the concentration of heavy metals in the soil, which exerts toxic effects on cultivated plants. The order for the impact of different municipal treatments on measured morphological parameters was as follow: T-4>T-3>T-2>T-1 (Table 2).

Concentration of Cadmium in Soil and Grain

The results obtained from ANOVA exhibited non-significant impact (p>0.05) of treatments on the concentration of Cd in soil on which wheat variety

Table (1): Analysis of variance for morphological parameters of wheat variety (Galaxy-13).

Source of variety	Degree of freedom	Mean squares				
		Root length (cm)	Shoot length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)
Treatments	3	19.459^{ns}	57.327^{ns}	34.010^{ns}	$.030^{ns}$	38.42^{ns}
Standard Error	8	21.424	54.708	6.695	.018	11.565

ns, No significant differences were detected among treatments

Table (2): Morphological parameters of wheat variety. All data are in means±SE (Galaxy-13).

Treatment	Root length (cm)	Shoot length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)
T-1	11.60±19	6.83±1.5	24.27±3.2	0.67±0.009	12.06±1.8
T-2	12.0±2.8	51.2±5.5	29.83±3.4	0.90±0.080	20.14±2.8
T-3	6.83±1.8	57.67±5.8	29.23±3.6	0.83±0.078	18.25±1.9
T-4	8.17±1.9	60.67±6.7	32.3±4.2	0.77±0.010	18.78±2.5

(Galaxy-2013) was grown (Table 3). The results revealed that the concentration of Cd was highest in T-IV and was lowest in T-I. The concentration of heavy metal in all treatments ranged from 2.89 to 3.7 mg/kg respectively (Table 4). Comparison of four different treatments, the mean concentration of Cd was highest in T-4 while the least concentration was found in T-1.

The results obtained from ANOVA demonstrated the non-significant effect (p>0.05) of treatments on the concentration of Cd in the grain of wheat variety (Galaxy-2013) (Table 3). The results indicated that the concentration of Cd was highest in T-II and was lowest in T-I. The concentration of heavy metal in all treatments ranged from 1.36 to 1.76 mg/kg correspondingly (Table 4).

Concentration of Iron in Soil and Grain

The results obtained from ANOVA exhibited significant influence (p>0.05) of treatments on the concentration of Fe in soil on which wheat variety (Galaxy-2013) was grown (Table 3). The results revealed that the concentration of Fe was highest in T-IV and was lowest in T-I. The concentration of heavy metal in all treatments ranged from 32.26 to 43.76 mg/kg respectively (Table 4). Comparison of four different treatments, the mean concentration of Fe was highest in T-3 while the least concentration was found in T-I.

The results obtained from ANOVA depicted significant impact (p>0.05) of treatments on the concentration of Fe in the grain of wheat variety (Galaxy-2013) (Table 3). The results showed that the concentration of Fe was highest in T-II and was lowest in T-III. The concentration of heavy metal in all treatments ranged from 12.16 to 21.26 mg/kg correspondingly (Table 4).

Concentration of Zinc in Soil and Grain

The results obtained from ANOVA demonstrated non-significant impact (p>0.05) of treatments on the concentration of Zn in soil on which wheat variety (Galaxy-2013) was grown (Table 3). The results revealed that the concentration of Zn was highest in T-III and was lowest in T-I. The concentration of heavy metal in all treatments ranged from 2.16 to 3.12 mg/kg respectively (Table 4). Comparison of four different treatments, the mean concentration of Zn was highest in T-4 while the least concentration was found in T-I.

The results obtained from ANOVA exhibited non-significant impact (p>0.05) of treatments on the concentration of Co in the grain of wheat variety (Galaxy-2013) (Table 3). The results showed that the concentration of Co was highest in T-III and was lowest in T-I. The concentration of heavy metal in all treatments ranged from 0.66 to 0.72 mg/kg correspondingly (Table 4).

The results obtained for the concentration of Zn in the grain of wheat variety (Galaxy-2013), showed non-significant influence (p>0.05) of different treatments (Table 3). The concentration of Zn was recorded in T-III, however, the lowest value was obtained with T-I. The level of heavy metal in all treatments ranged from 0.62 to 0.96 mg/kg, respectively (Table 4). Comparison of four different treatments, the mean concentration of Zn was highest in T-3, while the least concentration was found in T-I.

Table (3): Analysis of variance for metals in soil and various parts of wheat variety (Galaxy-13).

Source	Metal measured			
	Cd	Fe	Zn	Co
Soil	58.11^{***}	213.08^{ns}	137.70^{ns}	$.108^{ns}$
Root	331.67^{***}	111.68^{ns}	$.009^{ns}$	$.012^{ns}$
Shoot	0.17^{ns}	89.19^{***}	0.013^{***}	0.013^{ns}
Grain	$.088^{ns}$	87.043^{ns}	$.069^{***}$	$.011^{ns}$

***: Significant at 0.001 level, ns: non-significant

Table (4): Mean concentration (mg/kg) of Cd, Fe, Zn and Co in soil, root, shoot, and grain (Galaxy-13).

Treat-ment	Soil	Root	Shoot	Grain
		Cadmium		
T-1	2.89±0.2	2.87±0.2	2.178±0.3	1.367±0.4
T-2	2.90±0.4	2.98±0.4	2.367±0.4	1.767±0.2
T-3	3.20±0.4	3.20±0.3	2.733±0.3	1.467±0.3
T-4	3.70±0.4	2.97±0.4	2.275±0.5	1.487±0.2
		Iron		
T-1	32.267±3.2	29.277±3.1	24.773±2.5	12.167±1.6
T-2	35.615±3.1	31.367±3.7	27.027±3.1	21.267±3.1
T-3	43.765±4.1	40.77±4	36.27±3.5	9.735±1.4
T-4	43.763±4.2	36.283±3.1	27.44±3.6	18.667±1.6
		Zinc		
T-1	2.1633±0.2	1.767±0.3	1.44±0.2	0.625±0.09
T-2	2.1867±0.4	1.767±0.2	1.4667±0.2	0.867±0.1
T-3	3.12±0.2	1.77±0.3	1.4967±0.2	0.967±0.1
T-4	2.275±0.2	1.867±0.2	1.5866±0.2	0.94±0.07
		Cobalt		
T-1	1.0633±0.05	0.867±0.03	0.76±0.05	0.583±0.06
T-2	1.5083±0.06	0.967±0.04	0.867±0.07	0.667±0.09
T-3	1.17±0.07	0.965±0.05	0.867±0.09	0.667±0.07
T-4	1.267±0.09	1.01±0.07	0.916±0.09	0.7283±0.09

Concentration of Cobalt in Soil and Grain

The results obtained from ANOVA depicted non-significant effect (p>0.05) of treatments on the concentration of Co in soil on which wheat variety (Galaxy-2013) was grown (Table 3). The results showed that the concentration of Co was the highest in T-II and was the lowest in T-I. The concentration of heavy metal in all treatments ranged from 1.06 to 1.50 mg/kg respectively (Table 4). Comparison of four different treatments, the mean concentration of Co was highest in T-2 while the least concentration was found in T-I.

Bioconcentration Factor, Pollution Load Index and Enrichment Factor of Wheat Variety (Galaxy-13)

Among different metals of four treatments, Cd showed maximum values for BCF and it was minimum for Zn. The sequence of BCF at T-I and T-II was: Cd>Fe>Zn>Co, at T-III was: Cd>Fe>Co>Zn, while at T-IV it was found in following the decreasing order: Fe>Zn>Cd>Co (Table 5).

The sequence of pollution load index at all treatments was: Cd>Fe>Zn>Co (Table 5). The pollution level or contamination factor of Cd was higher in all the four treatments while Zn and Co were the lowest in all of the four treatments. Heavy metals are hazardous to health if PLI value is (>1). In the present investigation, Cd was (>1). And Fe, Co, and Zn were lower than 1.

The sequence of EF at T-I, T-III and T-IV were: Zn>Co>Cd>Fe, while at T-II was: Zn>Cd>Co>Fe. When EF was (>1) it indicates higher availability and distribution of metals (Table 5).

Table (5): Bioconcentration factor, pollution load index and enrichment factor for wheat variety (Galaxy13).

Treatment	Bioconcentration factor			
	Heavy metal measured			
	Cd	Fe	Zn	Co
T-1	0.9941	0.907	0.817	0.815
T-2	1.0275	0.881	0.808	0.641
T-3	1.000	0.932	0.567	0.825
T-4	0.802	0.829	0.821	0.797
	Pollution load index			
T-1	27.009	0.567	0.048	0.203
T-2	27.103	0.626	0.049	0.288
T-3	29.907	0.769	0.070	0.224
T-4	34.580	0.769	0.051	0.242
	Enrichment factor			
T-1	0.0844	0.0504	0.1284	0.100
T-2	0.1479	0.0798	0.1762	0.080
T-3	0.1001	0.0297	0.1377	0.104
T-4	0.0703	0.0570	0.1836	0.105

Transfer Factor (Root-Shoot and Shoot-Grain) of Wheat Variety (Galaxy-13)

Among different metals, Co showed higher values for TF and it was lower for Fe. The order of TF at T-I, T-II and T-III was: Co>Fe>Zn>Cd, while at T-IV was: Co>Zn>Cd>Fe (Table 6).

The transfer factor from shoot to grain for all metals and metalloids showing the following results, the sequence of TF at T-I was: Co>Cd>Fe>Zn, at T-II was: Fe>Co>Cd>Zn, at T-III was: Co>Zn>Cd>Fe, while at T-IV was: Co>Fe>Cd>Zn (Table 6).

Daily Intake of Metal and Health Risk Index in Wheat Variety (Galaxy-13)

Among four treatments, DIM for Fe and Cd was higher in all the treatments while lower for Zn and Co. The sequence of DIM at all treatments was: Fe>Cd>Zn>Co (Table 7).

This result demonstrated that HRI of Cd was (>1) in all the four treatments above the possible limit. The sequence of HRI at T-I was: Cd >Fe>Zn>Co, while at T-II, T-III and T-IV it was: Cd >Fe>Co>Zn (Table 7).

Table (6): Transfer factor for all heavy metals of wheat variety (Galaxy-13).

Treatment	Heavy metal measured			
	Cd	Fe	Zn	Co
	Root-Shoot			
T-1	0.7581	0.8461	0.8149	0.8765
T-2	0.7941	0.8616	0.8300	0.8965
T-3	0.8540	0.8896	0.8455	0.8984
T-4	0.7667	0.7562	0.8498	0.9076
	Shoot-Grain			
T-1	0.6274	0.4911	0.4340	0.7671
T-2	0.7464	0.7868	0.5911	0.7693
T-3	0.5366	0.2684	0.6460	0.7693
T-4	0.6534	0.6802	0.5924	0.7944

Table (7): Daily intake of metal and health risk index via intake of wheat variety (Galaxy-13).

Treatment	Heavy metal measured			
	Cd	Fe	Zn	Co
	Daily intake of metals			
T-1	0.008	0.0699	0.0049	0.0038
T-2	0.0101	0.1222	0.0055	0.0038
T-3	0.008	0.0559	0.0054	0.0041
T-4	0.009	0.1073	0.0054	0.0041
	Health risk index			
T-1	7.859	0.699	0.009	0.077
T-2	10.159	1.222	0.013	0.089
T-3	8.434	0.559	0.015	0.089
T-4	8.549	1.073	0.014	0.097

Correlation of Wheat Variety (Galaxy-13)

The result showed that from root to shoot, Fe and Co exhibited positive and non-significant correlation, and Cd and Zn showed negative and non-significant correlation. In present investigation from root to shoot the Co exhibited positive and highly significant correlation while Cd, Fe, and Zn showed positive and non-significant correlation. The results of correlation among grains of wheat give highly significant and positive correlation of and Co while positive and non-significant effect showed by Cd, Fe, and Zn (Table 8).

Table (8): Metal correlation between different levels of wheat variety (Galaxy-13).

Metal measured	Soil-Root	Root-Shoot	Shoot-Grain
Cd	-0.274	0.071	0.098
Fe	0.044	0.345	0.107
Zn	-0.300	0.941	0.683
Co	0.571	1.000**	0.990**

** Significant at 0.01 level.

DISCUSSION

The influence of municipal treatment on wheat as a cultivated plant in the present study was evaluated through growth measurement including leaf length, root, shoot lengths and leaf area, which reflect the significant differences in all treatment compared to control. These results were in agreement with data obtained by Metwali *et al*., (2013).

Wastewater is one of the significant factors behind low productivity of crops as reported by Konwar and Jha (2010). Due to high toxicity, Cd has a lousy repute and unapproachable to the growth of plants (Iqbal and Mehmood, 1991). The mean level of Cd in soil ranged from 2.8 to 3.7 mg/kg. The value of Cd was similar to the value that is 2.8 mg/kg given by Hassan et al., (2013). The amount of Cd was lower, that was 0.20 mg/kg given by Rattan *et al*., (2005) as compared to the present study. Geochemically Cd was the relatively movable element in soil, and it was quickly taken up by plants. Narwal *et al*., (1993) stated that the concentration of metals such as Cd and Zn in soil and plant increased when municipal solid waste was applied to agricultural land.

Industrial wastewater that has high metal value is dangerous to all living forms. In the present study, the soil level of Fe fluctuated from 32.26 to 43.76 mg/kg. The Fe concentration was lower as compared to the value of 270 mg/kg given by Hassan *et al*., (2013) and the value that was 2.05 mg/kg given by Mojiri and Aziz (2011). Kansal *et al*., (1996) gathered plant samples of various crops from sewage irrigated soils and found that these plants contained a more significant amount of Fe than plants from tube well-irrigated soils. The value of Fe was lower, that was 20.1 mg/kg given by Rattan *et al*., (2005) as compared to the present study. Iron concentration 6205 mg/kg given by Ekmekyapar *et al*., (2012) was higher than the current value.

In the soil level of Zn varied from 2.16 to 3.12 mg/kg in the present study. The value of Zn was higher that was 7.31 mg/kg given by Rattan *et al.*, (2005) as compared to the present study. In the current study, the lower value of zinc was observed as compared to value 129.08 mg/kg given by Yu *et al.*, (2016). Zinc value of the current study was lower by the value of 12.235 mg/kg according to Asdeo (2014). The lower concentration of Zn in the current study was observed as compared to the values given by Hassan *et al.*, (2013) that was 135 mg/kg.

Level of Co fluctuated from 1.06 to 1.26 mg/kg. The value of Co 1.73 mg/kg was given by Ahmad *et al.*, (2014) was close to current value. The 17.63 value of Co was given by Bibi *et al.*, (2014) that was higher to the current study. Cobalt concentration was lower in the present study to value 18.9 mg/kg given by Page *et al.*, (2006).

The level of Cd varied from 1.36 to 1.76 mg/kg in grains of wheat. In the current study, the value of Cd was higher as compared to value 0.062 mg/kg given by Yu *et al.*, (2016). The concentration of Cd was higher in current to value 0.10 mg/kg estimated by Stefanović *et al.*, (2008). Cadmium affects negatively if accumulates in the body of the human and affects several organs: lung, liver, bones, kidney, central nervous system, placenta and brain (Castro-Gonzalez and Mendez-Armenta, 2008). The other damages that have been detected include development toxicity, hematological effects of hepatic and reproductive disorders (Apostoli and Catalani, 2011).

The level of Cd in current findings exceeded the tolerable range (0.2 mg/kg) (Arduini *et al.*, 2014). Kansal *et al.* (1996) also reported that sewage irrigated vegetables contain the high level of Cd and Fe as compared to canal and tube well-irrigated water. The concentration of Fe in grains of wheat in the present study ranged from 9.7 to 21.26 mg/kg. Iron concentration 151 mg/kg given by Ekmekyapar *et al.*, (2012) was higher to present value. The value of Fe in current research was higher than the value 2.28 mg/kg of Fe reported by Nadim *et al.*, (2013) in different varieties of wheat grains. Iron was an essential element because it was existed in all living organisms. Iron was an essential element of haemoglobin, functions in the transport of oxygen. It was usually taken as a border between micro and macro-elements of the living organisms.

In grains of wheat, the concentration of Zn in the present study ranged from 0.62 to 0.96 mg/kg. The concentration of Zn was lower in the current study to value 24.13 mg/kg given by Stefanović *et al.*, (2008). Increasing anthropogenic influences on the environment, especially pollution loadings, have caused negative changes in natural ecosystems: decreased biodiversity, simplified structure, and lowered productivity (Durkan *et al.*, 2011). For example, Zn occurs naturally in air, water, and soil, but as a result of human activities, its concentrations are raising unnaturally (Baslar *et al.*, 2009a, b).

In the current research, the Co concentration in grains of wheat variety ranged from 0.58 to 0.728 mg/kg. The value of cobalt was higher to present value 5.340 mg/kg given by Samera *et al.*, (2014). The cobalt concentration was lower in the current study to value 81.1 mg/kg demonstrated by Page *et al.*, (2006). The value was higher was higher to the value reported by Shad *et al.*, (2014) that was 0.15 mg/kg in grains of wheat. Mostly the high Co concentration is present in leafy plants and lower concentration in grasses and cereals.

In the present study, BCF value Zn and Cd were higher than in a work in which concentration of Cd and Zn were 0.08 and 0.25 correspondingly (Puschenreiter *et al.*, 2005). The bioconcentration factor values of Cd and Zn were higher in current research as compared to values of BCF demonstrated by Asdeo (2014). The lower values of BCF in current findings were detected as compared to values given by Khan *et al.*, (2016).

The pollution load index value of Zn and Cd was lower from the values 2.1 and 84.0 respectively. The pollution load index value (>1) demonstrated that soil is contaminated while PLI<1 indicated that soil is unpolluted (Harikumar *et al.*, 2009). In current findings PLI for Fe, Zn and Co were (>1). High PLI was noticed for Cd in T-IV due to the high proportion of municipal solid waste.

The level of metal toxicity in humans depends on their daily intake. The daily intake of metal contaminated food crops direct effect on consumer's health. If DIM>1, the population of the country will be at greater risk (Sajjad *et al.*, 2009). In the current findings, values of DIM for all metals were below 1. The average daily wheat grain intakes for adults and 0-6-year-old children were estimated to be 0.315 and 0.0437 mg/kg/day respectively. While the adult and 0-6-year-old child, average body weights were estimated to be 61.6 and 18.6 kg, respectively demonstrated by Wang *et al.*, (2009).

In the current findings, level of Cd wad very high which exerts the hazardous effect on human health. Our results were similar to the findings of Singh *et al.*, (2010). Our results were similar to Cui *et al.*, (2004) who stated that the accumulation of Fe has the lower health risk. Health risk index of Co was lower and higher value of Zn was observed in the current study as compared to the values of health risk index given by Bibi *et al.*, (2014). The values of HRI of Cd in current research work were lower to value given by Khan and Khan (2010).

The enrichment factor value given by Likuku *et al.*, (2013) was higher while Zn 1.25 was higher as compared to the present value. The enrichment factor of Zn and Cd was higher however other heavy metals have lower as compared to values given by Olubunmi (2010). The heavy metals enrichment factor depends upon metals bioavailability in the soil. The metals bioavailability depends upon their chemical forms, their concentration in the soil, plant species growth rate and difference in uptake capability of plants (Tinker, 1981). In the present research work, the positive and non-significant findings were seen for Fe among the soil and the crop as opposed to the work reported by Khan *et al.*, (2015). Positive and non-significant correlations were also observed by Khan *et al.*, (2013) for metal Zn.

CONCLUSION

In the current investigation, increased concentration of Cd was observed in soil and grains treated with diverse doses of domestic wastewater. Cadmium could be considered potentially dangerous as it exceeded WHO limits and its HRI value was >1. This could be due to the application of untreated wastewater. So, therefore, we must have to pass this solid waste through proper treatment to decrease its harmful effect.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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