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Research Article

Transfer of Heavy Metals from Different Sources of Fertilizers in Wheat Variety (Galaxy-13)

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Abstract

Background and Objective: Wheat (*Triticum aestivum* L.) is staple crop of Pakistan and used as food for humans as well as animals. Due to heavy metals contamination in Pakistan, the aim of this study was to determine the bio-accumulation of heavy metals in edible parts of wheat variety (Galaxy-13) by using various types of organic and inorganic fertilizers. **Materials and Methods:** A field experiment was performed in Jhang, Punjab, Pakistan to evaluate the effect of different soil amendments on uptake of heavy metals in wheat variety (Galaxy-13). Growth parameters of plants were determined. The concentration of heavy metals in soil and different parts of wheat plants were analyzed by Atomic Absorption Spectrophotometer (AA-6300 Shimadzu Japan). **Results:** All morphological parameters were significantly affected by different fertilizers treatments except for leaf width. The concentration of heavy metals (mg kg^{-1}) in grains was Zn (9.15-13.98), Co (1.06-1.19), Fe (16.51-23.05), Cd (0.81-0.95), Pb (0.45-2.08), Cu (2.13-6.87) and Cr (0.476-0.887). Cobalt showed more value for bio-concentration factor(0.995) and daily intake of metal was higher for Fe (0.01) at T4. Cadmium showed the highest values of transfer factor (0.997), health risk index (0.428) and enrichment factor (7.3) at T4. **Conclusion:** Current values of all metals were found within permissible limits suggested by FAO/WHO. So, consumption of fertilizers treated wheat is safe for human consumption.

Key words: Wheat (*Triticum aestivum* L.), atomic absorption spectrophotometer, heavy metal, bio-concentration factor, health risk index

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Wheat is an essential food stuff of the Pakistan as well as the world. It provides us with the grains for human diet used in many ways and wheat straw is used for animals[1]. Wheat provides us an average yield of 2566 kg ha^{-1} in Pakistan grown on irrigated areas[2].

The average yield of 2018 kg ha^{-1} of irrigated wheat is obtained by growing with application of potassium (K) and phosphorous (P). Low average yield of the wheat in Pakistan due to the improper fertilizer supply as compared to other advanced countries[3]. The crop production is increased by increasing nitrogen, zinc, phosphorus and organic matter contents by the fertilizer application because soils of the Pakistan are deficient in these contents such as calcareous and alkaline soils[4].

Poultry industry is producing large amount of waste and fertilizer used for agricultural purpose. When handled correctly, land application is a possible way to recycle the nutrients such as phosphorus, nitrogen and potassium in manure. When fertilizer is applied under unfavorable environmental conditions then it may cause pollution and irritation problems[5].

Poultry manure is rich in organic manure because there is no loss of urine as liquid and solid excreta are excreted together. In fresh poultry waste, uric acid is the richest nitrogen compound (40-70% of total N) while ammonium and urea are present in small amounts[6].

In alkaline and calcareous soils of Pakistan, crop production is increased by the application of mineral fertilizers[7]. Imbalanced use of fertilizers and inappropriate method of their application is resulting in less crop yield per hectare[8]. Chemical fertilizers are the cause of decline in soil health which leads to decrease crop productivity[9].

Organic grains have high economic value which leads to the evolutionary changes in the organic farming because organic manures are inexpensive as compared to the chemical fertilizers[10].

Only use of organic manures was found to be valuable in crop productivity[11]. However, when organic manures are applied in combination with the chemical fertilizers proved to be more worthwhile[12,13].

In ecosystem, heavy metals are poisonous at high concentration and usually non-biodegradable causing their accumulation in food chain[14-16]. Due to this reason, the presence of heavy metals have great biological importance[17,18]. Some heavy metals like Hg, Cd, Pb and Cr are toxic even at their low concentrations[19,20].

Keeping in view the importance of staple crop wheat (*Triticum aestivum* L.) and heavy metal contamination in Pakistan, the aim of the present study was to determine the bio-accumulation of heavy metals in edible parts of wheat variety (Galaxy-13) by using different types of organic and inorganic fertilizers.

MATERIALS AND METHODS

Study area: A field experiment was conducted in district Jhang, Pakistan to analyze heavy metal content in the wheat variety (Galaxy-13) using different sources of organic fertilizers (Fig. 1). The present research work was conducted from 20-11-2016 to 20-04-2017. The climate of this city is very burning and reasonable, cold in winter. In summer, maximum temperature goes up to 47°C and minimum up to 12°C in winter.

Plant cultivation: In this experiment, wheat variety (Galaxy-13) was used and treated with four different treatments. Seeds of wheat were collected from Punjab Seeds Corporation during 2016. A plot experiment was conducted in a natural environment system (20th November-20th April) for 6 months. In current experiment, total 12 plots were prepared. Size of each plot was 8×8 feet. Seeds of wheat were sown at the end of November, 2016. Seeds were cultivated in four treatments such as T1 (Control), T2 (soil amended with 2.5 kg of cow waste), T3 (soil amended with 2.5 kg of poultry waste), T4 (soil amended with 2.5 kg of DAP fertilizer in soil). All plots were irrigated two times in a week with ground water. Seed germination time was recorded. After germination, some plants were removed from each plot for proper growth of remaining plants. Morphological parameters of wheat plants were also observed after maturation period of 5 months. Some parameters like plant height (root, shoot and leaf length) and leaf width were measured with the help of measuring scale. Number of leaves per plant were also counted by visual examination. Harvesting of wheat plants was done during the month of April, 2017.

Sample preparation: After harvesting, the plant samples of wheat were collected from each plot. After drying in the air, samples were oven-dried at 72°C for few days. After removing from the oven, grains were separated from the spikes and ground in an electrical grinder into fine powder, for digestion of samples. About 1 g of each sample was used. For the digestion of samples, wet digestion method was used.

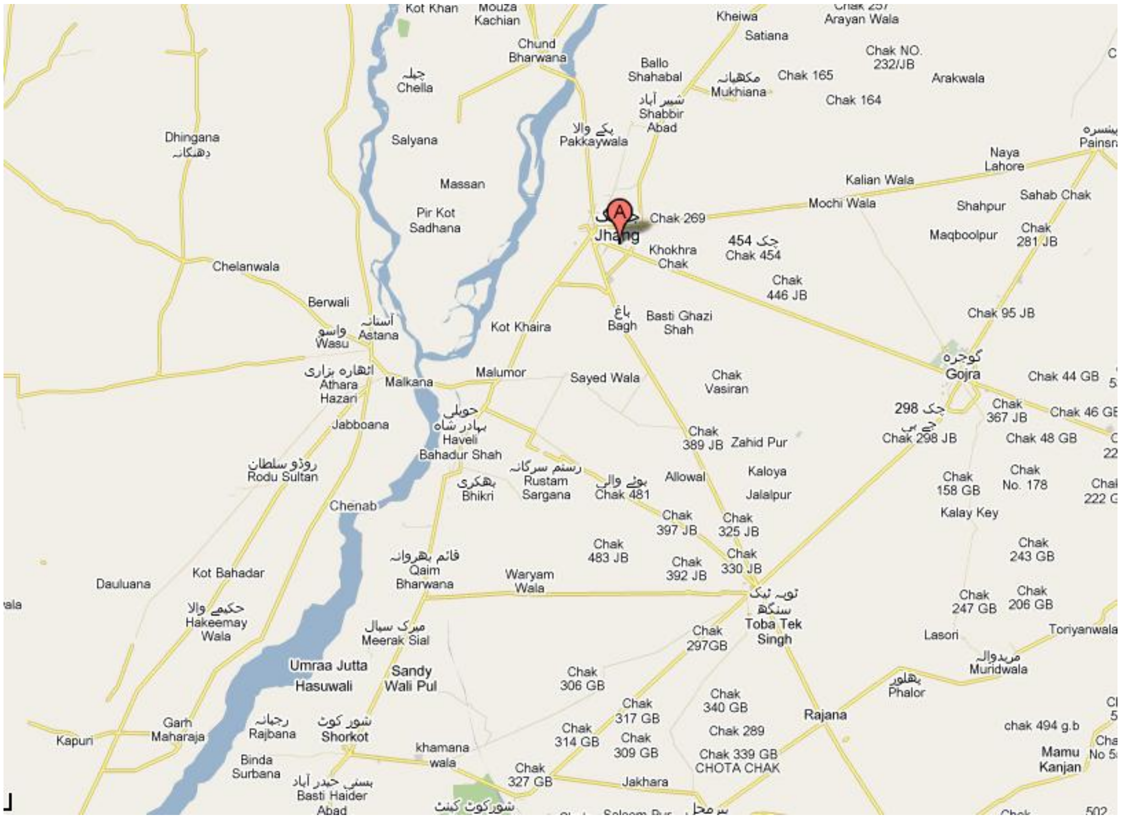

Fig 1: Location map of study area

Metals analysis: All the digested samples were then subjected to Atomic Absorption Spectrophotometer (AA-6300 Shimadzu Japan) to detect heavy metals in them. Heavy metals such as cobalt (Co), zinc (Zn), iron (Fe), cadmium (Cd), lead (Pb), copper (Cu) and chromium (Cr) were also analyzed. The standard solutions of different metals were also prepared for detection from the stock solution to obtain a calibration curve. All data was subjected to analysis of variance (ANOVA) using SPSS software version 16.0 (Statistical Sciences for Social Sciences).

Transfer of metals from soil to wheat grains was determined in terms of bio-concentration factor (BCF) and transfer factor (TF) by given method[21]. Pollution load index (PLI) was calculated by method[22]. Daily intake of metals (DIM) was calculated as proposed[23].

RESULTS

Morphological parameters of wheat variety (Galaxy-13): The analysis of variance showed a significant effect ($p<0.05$) of four treatments on root length, shoot length, leaf length and leaf area in wheat variety (Galaxy-13). While non-significant effect ($p>0.05$) of treatments on leaf width was observed (Table 1). The highest values of all these parameters were observed after application of T4 while the lowest values of all parameters were observed in T2. Results showed that use of DAP fertilizers significantly increased the concentration of metals in soil, leading to increase in toxicity of plants which exerts toxic effects in plants as well as in humans. The following order for effect of different treatments on growth parameters was observed: T4>T3>T1>T2 (Table 2).

Analysis of variance of heavy metals in soil and different parts of wheat plant: The results from analysis of variance of the data (Table 3) showed significant effect ($p<0.05$) of four different treatments on concentrations of Co, Zn, Cd, Fe, Pb, Cu and Cr in the soil used for growing wheat variety (Galaxy-13). The analysis of variance of data in root showed significant effect ($p<0.05$) on concentrations of Zn, Cd, Fe, Pb, Cu and Cr in root and non-significant effect ($p>0.05$) on Co concentration in roots collected from four treatments used for growing wheat variety (Table 3). Analysis of variance of data showed non-significant effect ($p>0.05$) of treatments on concentration of Co and Cd in shoots of four treatments

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

Source of variations	Degree of freedom	Mean square				
		Root length (cm)	Shoot length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)
Treatments	3	4.583*	45.622*	18.834*	0.036^{ns}	32.55*
Error	11	0.874	6.889	3.635	0.010	5.90

*Significant at 0.05 level, ns: Non-significant

Table 2: Morphological parameters of wheat variety (Galaxy-13)

Treatments	Root length (cm)	Shoot length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)
T1	7.8467	26.00	18.340	0.82	11.4233
T2	6.1000	25.467	17.3933	0.68	8.3403
T3	9.1133	32.94	22.4967	0.92	15.5393
T4	7.7667	31.94	21.7467	0.90	14.7023

Table 3: Analysis of variance of heavy metal concentration in soil and different parts of Galaxy-13

Sources	Mean square						
	Co	Zn	Cd	Fe	Pb	Cu	Cr
Soil	0.01***	10.67*	0.009***	12.88***	14.814***	16.934***	10.810***
Root	0.009^{ns}	49.30*	0.010***	7.13***	20.214***	28.734***	14.039***
Shoot	0.01^{ns}	18.35*	0.020^{ns}	24.93***	31.611***	33.971***	0.385***
Grains	0.01*	1.23**	0.003*	27.81**	2.429***	12.340***	0.009***

*, **, ***Significant at 0.05, 0.01, 0.001 levels, ns: Non-significant

treatments while the significant effect ($p<0.05$) of treatments on concentration of Zn, Fe, Pb, Cu and Cr in shoot of wheat (Table 3). In this study, the results obtained from analysis of variance of the data exhibited non-significant effect ($p>0.05$) of treatments on concentration of Zn, Co, Pb, Cd, Fe, Cu and Cr revealed non-significant effect ($p>0.05$) in the grains of wheat variety (Galaxy-13) collected from 4 treatments (Table 3).

Concentration of heavy metals in soil: The mean concentration of metals in soil collected from four different treatments is given in Table 4. The concentration (mg kg^{-1}) of metals in soil ranged from 1.85 to 1.988, 22.33 to 25.83 mg kg^{-1} for Zn, 0.967-1.87 mg kg^{-1} for Cd, 45.105-49.8167 mg kg^{-1} for Fe, 17.5893-22.774 mg kg^{-1} for Pb, 20.003-25.589 mg kg^{-1} for Cu and 12.0046-16.956 mg kg^{-1} for Cr. The highest concentration of Fe in soil was 49.81 mg kg^{-1} at T3 while the lowest value 0.967 mg kg^{-1} for Cd was also detected at T1.

Concentration of Heavy metals: In current findings, the known concentration (mg kg^{-1}) of Co ranged from 1.5233 to 1.9787 in root, 1.09 to 1.285 in shoot and 1.066-1.197 for grains (Table 4). The same order of response of different treatments on Co uptake in roots and shoot of wheat was observed: T3>T4>T2>T1. In grains of wheat variety (Galaxy 13), following order of response on Co accumulation was observed: T3>T2>T4>T1.

In roots, the mean concentration of studied Zn was present in range of 14.98-22.67 mg kg^{-1}. Zinc was found to be in range of 10.47-16.67 mg kg^{-1} in shoot of wheat plant (Table 4). The value of Zn was found to be from 9.15-13.98 mg kg^{-1} in grains of wheat variety (Galaxy 13). The response of treatments in metal accumulation in root showed following order: T2>T4>T3>T1. The effect of different treatments on shoot and grains of wheat was given as: T4>T2>T3>T1. In present study, the order of accumulation of heavy metals such as Cd in different parts of wheat plant was different. The concentration of Cd (mg kg^{-1}) ranged from 0.94-0.994 in root, 0.84-0.98 in shoot and 0.81-0.95 in grains of wheat variety (Galaxy 13) (Table 4). The same order of accumulation of Cd in root and wheat grains were same (T4>T2>T3>T1). While in shoot, T4>T3>T2>T1 order was observed. In current study, the range of concentration in Fe was found to be 41.965-44.83 mg kg^{-1} in root of wheat plant. While in shoot, its concentration was decreased ranging from 24.67-30.013 mg kg^{-1}. In grains, the concentration of Fe was found to be in range of 16.73 to 23.05 mg kg^{-1} (Table 4). Fe accumulation response in root and shoot of wheat variety was similar (T4>T2>T3>T1). While in grains, iron accumulation order was: T4>T2>T1>T3. In our study, accumulation of Pb in root and shoot was 13.497-19.5387 and 9.194-16.7483 (mg kg^{-1}) while in grains, least value was observed from 0.4513-2.0813 mg kg^{-1} (Table 4). The order for the effect of four treatments in all parts of plant (root, shoot and grains) was same that is T4>T2>T3>T1. In our study, the mean concentration of Cu in root, shoot and grains of wheat variety (Galaxy-13) was in ranges such as 8.866 to 16.275 mg kg^{-1}, 6.113-13.434 and 2.134-6.8753 mg kg^{-1}, respectively (Table 4). While the order of effect of four

Table 4: Concentration of heavy metals (mg kg^{-1}) in soils, root, shoot and grains of wheat variety (Galaxy-13)

	Metals						
Treatments	Co	Zn	Cd	Fe	Pb	Cu	Cr
Soil							
T1	1.85	22.33	0.967	47.3667	17.5893	20.0003	12.0046
T2	1.967	25.83	1.8333	48.3333	21.31967	23.1836	15.2816
T3	1.988	22.90	1.0467	49.8167	19.7363	21.6516	14.3780
T4	1.967	25.83	1.870	45.105	22.7740	25.5890	16.9566
Root							
T1	1.5233	14.98	0.940	41.965	13.4970	8.8660	1.5360
T2	1.5417	22.67	0.985	44.845	17.8570	13.3733	4.9816
T3	1.9787	16.43	0.967	42.783	15.9490	11.7690	3.5153
T4	1.915	21.20	0.994	44.883	19.5387	16.2750	6.6223
Shoot							
T1	1.09	10.47	0.840	24.670	9.1940	6.1113	1.187
T2	1.1467	14.50	0.940	26.733	14.4960	10.6753	1.7943
T3	1.285	14.21	0.965	25.167	12.0527	7.1033	1.5106
T4	1.215	16.67	0.98	30.013	16.7483	13.4340	2.0143
Grains							
T1	1.0667	9.15	0.810	16.733	0.4513	2.1340	0.4760
T2	1.1333	13.86	0.925	18.167	1.6663	5.1080	0.7350
T3	1.197	10.25	0.920	16.516	0.7476	3.6370	0.5970
T4	1.107	13.98	0.950	23.050	2.0813	6.8753	0.8870

Table 5: Bio-concentration factor, enrichment factor and pollution load index of wheat variety (Galaxy-13)

	Metals						
Treatments	Co	Zn	Cd	Fe	Pb	Cu	Cr
Bio-concentration factor							
T1	0.833351	0.670846	0.972079	0.88596	0.767342	0.443293	0.127951
T2	0.774428	0.877662	0.537282	0.927828	0.837583	0.576843	0.325987
T3	0.995322	0.717467	0.923856	0.858808	0.808105	0.543563	0.244492
T4	0.973564	0.820751	0.531551	0.995078	0.857939	0.636015	0.390544

treatments on the accumulation of Cu in different parts of wheat such as root, shoot and grains were same: T4>T2>T3>T1. The concentration of Cr uptake in root of wheat variety (Galaxy-13) was 6.6233 to 1.536 mg kg^{-1}. From root to shoot, uptake of Cr was decreased to 1.187-2.0143 mg kg^{-1} while uptake of Cr by grains was 0.476-0.887 mg kg^{-1} (Table 4). Same order was observed by four treatments for the accumulations of Cr in root, shoot and grains of wheat plant: T4>T2>T3>T1. The highest uptake in all parts of plant was observed by T4.

Bio-concentration factor: The bio-concentration factor was determined from ratio of transfer of heavy metals in root from soil in which they were grown. The values of bio-concentration factor of Fe, Zn, Cu, Pb, Cr, Cd and Co of wheat plant were given in Table 5. At T1, order of BCF was: Cd>Fe>Co>Pb>Zn>Cu>Cr. At T2, BCF values were in order: Fe>Zn>Pb>Co>Cu>Cd>Cr. The BCF values were found to be in Co>Cd>Fe>Pb>Zn>Cu>Cr order at T3 while at T4, order Fe>Co>Pb>Zn>Cu>Cd>Cr was found. The highest value of BCF 1.0145 was found for Co at T3 while lowest concentration for Cr 0.1278 at T1.

Transfer factor: The transfer factor was calculated as the ratio of transfer of heavy metals from root to shoot and shoot to grains (Table 6). Shoot was contaminated with Cd at T1 and T2. 0.9979 was highest value observed for Cd at T3 and lowest value for Cr was 0.3041 at T4 during metal transfer from root to shoot. Metal transfer from shoot to grain was Co>Cd>Zn>Fe>Cr>Cu>Pb at T1 and at T2, the order was: Co>Cd>Zn>Fe>Cu>Cr>Pb. At T3, the sequence for metal transfer was: Cd>Co>Zn>Fe>Cu>Cr>Pb while at T4, metals transfer from shoot to grain was in order: Cd>Co>Zn>Fe>Cu>Cr>Pb.

Daily intake of metals: The highest daily intake of Fe was estimated as 0.01 mg kg^{-1}/day at T4 and lowest was calculated for Pb as 0.0002 at T1 (Table 7). The daily intake of metal at T1 was found in following order: Fe>Zn>Cu>Co>Cd>Cr>Pb, at T2, was Fe>Zn>Cu>Pb>Co>Cd>Cr, while at T3 and T4 order for DIM was: Fe>Zn>Cu>Co>Cd>Pb>Cr and Fe>Zn>Cu>Pb>Co>Cd>Cr, respectively.

Health risk index: Health risk index was calculated to evaluate human health risks arising due to the contamination

Table 6: Transfer factor from root to shoot and shoot to grain in wheat variety (Galaxy-13)

	Metal						
Treatments	Co	Zn	Cd	Fe	Pb	Cu	Cr
Root to shoot							
T1	0.707012	0.698932	0.893617	0.587871	0.681188	0.689296	0.772786
T2	0.752774	0.639612	0.954315	0.596120	0.811782	0.798255	0.360185
T3	0.649416	0.864881	0.997932	0.588248	0.755703	0.603560	0.429722
T4	0.634465	0.786321	0.985915	0.668694	0.857186	0.825438	0.304169
Shoot to grain							
T1	0.978624	0.873926	0.964286	0.678273	0.049086	0.349189	0.401011
T2	0.988314	0.955862	0.984043	0.679572	0.114949	0.478488	0.409630
T3	0.931518	0.721323	0.953368	0.656256	0.062028	0.512016	0.395207
T4	0.911111	0.838632	0.969388	0.768001	0.124269	0.511784	0.440351

Table 7: Daily intake of metals and health risk index in wheat variety (Galaxy-13)

	Metal						
Treatments	Co	Zn	Cd	Fe	Pb	Cu	Cr
Daily intake of metals							
T1	0.000481	0.004122	0.000365	0.007538	0.000203	0.000961	0.000214
T2	0.000511	0.006244	0.000417	0.008184	0.000751	0.002301	0.000331
T3	0.000539	0.004618	0.000414	0.00744	0.000337	0.001638	0.000269
T4	0.000499	0.006298	0.000428	0.010384	0.000938	0.003097	0.00040
Health risk index							
T1	0.011186	0.011141	0.365	0.010769	0.058000	0.024025	0.000143
T2	0.011884	0.016876	0.417	0.011691	0.214571	0.057525	0.000221
T3	0.012535	0.012481	0.414	0.010629	0.096286	0.040950	0.000179
T4	0.011605	0.017022	0.428	0.014834	0.268000	0.077425	0.000267

of food with heavy metals. At T1 and T3, following trend was seen for HRI: Cd>Pb>Cu>Co>Zn>Fe>Cr, at T2 was: Cd>Pb>Cu>Zn>Co>Fe>Cr while at T4, was: Cd>Pb>Cu>Zn>Fe>Co>Cr. The highest value for HRI was noticed for Cd as 0.428 at T4 while lowest value for Cr as 0.000143 at T1 (Table 7). The HRI greater than 1 had a potential to cause serious threats on human health.

DISCUSSION

Our results for leaf area and plant height were lower than investigation[24]. In present study, stem length was found to be similar to suggestion[25]. The mean concentration of all heavy metals in soil found within the permissible limit of Co (100 mg kg^{-1}), Zn (300 mg kg^{-1}), Cd (3 mg kg^{-1}), Fe (50000 mg kg^{-1}), Pb (100 mg kg^{-1}), Cu (100 mg kg^{-1}) and Cr (50 mg kg^{-1}) recommended values[26]. Present value for Co was lower than investigation[27]. Present concentrations of Cd, Cu and Pb found within range and concentration of Zn and Cr were lower as compared to heavy metals[28]. The mean concentration of Fe, Cu, Zn, Cd, Pb and Cr were lower in present study than the findings[29]. The mean concentration values (mg kg^{-1}) of Fe, Zn, Cu, Cd and Pd in soil were equal to limits and level of Cr was higher than investigation[30]. Higher concentrations of Cd and Cr and lower of Zn[31] were found as compared to present findings. It also reported equal values for Pb and Cu as compared with present study. Poultry waste contains large content of organic matter but also has some toxic metals Zn, Pb, Cd, Cu and Fe[32-34]. Poultry waste is considered as most important among all other animal wastes used as amendments as it increases soil fertility and crop production. In agricultural soils, application of poultry waste improves amount of essential nutrients[35]. Vitamin-B12 contains cobalt as an essential component. It also helps in prevention of anemia because it is vital component in manufacturing of red blood cells. Higher intake of cobalt results in overproduction of red blood cells. The concentration of Co was found to be within the permissible limits[26] 50 mg kg^{-1}. In current study, range of cobalt was found to be within the range[36]. In this investigation, the accumulation of cobalt in wheat was higher than value[27]. Zinc uptake of regular basis prevents body from zinc deficiency resulting in delayed sexual maturation. Zinc plays important role in synthesis of protein and nucleic acid metabolism[37-39]. In the present study, the concentration for Zn was found to be within permissible limit (99.4 mg kg^{-1}) reported[26]. Results of our study showed lower values for Zn as compared to investigation[30]. The reported concentration[40] of Zn was found to be within the range in this investigation. In this study, our value for concentration of zinc was higher than results[31,41]. Cadmium is a very toxic metal and also known as carcinogens. Smokers are usually exposed to higher level of Cd than non-smokers. High level of cadmium causes lung damage, kidney disease, diarrhea, vomiting and breathing problems. The result of this experiment indicated that cadmium content in wheat grains was below the permissible limit[42] 0.2 mg kg^{-1}. Our results of this study found within the range investigation[43-44]. In this investigation, our value for Cd concentration was lower than results[29]. Given values of Cd[28,30,31] were lower as compared to present investigation. Iron is an important element considered for both micro and macro-nutrients found in all living organisms. In plants, Fe is necessary for the activation of many respiratory enzymes and chlorophyll synthesis. Iron deficiency causes chlorosis of leaves. Higher exposure to atmospheric Fe causes ventilation problems and respiratory diseases. But Fe plays an important role in the maintenance of healthy central nervous system and prevents anemia[39,45]. In this study, the concentration of Fe was present within the safe limit[26] (425.5 mg kg^{-1}). Value of Fe[30] (28.5 mg kg^{-1}) was higher as compared to the present study. The reported values[46,47] of Fe were lower than this investigation. Lead is very toxic heavy metal that can accumulate in large amount in body without any visible change. Higher uptake of lead in diet also causes anemia and neurological disorders. Lead contamination in food may be due to its higher level in water stream from industries that is used for irrigation purposes[38,48]. The present value for the Pb was higher than the permissible limits[42] (0.30 mg kg^{-1}). The present value for lead was lower than the findings[44] (22.6). In the present study, investigated value of lead was higher than values[28,30]. Mean concentration of Pb[31] was almost equal to present investigation. In plants, Cu is essential trace element which serves as biocatalyst. Copper plays an important role in prevention of anemia. It is required for maintenance of body pigmentation and healthy central nervous system[49,50]. The mean concentration of Cu was higher than tolerance limit[42] (73.30 mg kg^{-1}). In current study, Cu concentration is almost similar to the value[41] but high value[44] of Cu (11.8 mg kg^{-1}) as compared to the present study. The level[46] of Cu (0.002) was lower than our investigation. Chromium (III) is an essential nutrient but Cr compounds such as (VI) are very toxic and carcinogenic to humans. Breathing in high levels of Cr causes skin ulcer, allergic reactions and many respiratory problems such as cough, shortness of breath asthma etc. Long term exposure causes damage to kidney, nerve tissues, liver and circulatory systems. The present value for the Cr was below the permissible limits[42] (2.30 mg kg^{-1}). The present value for Cr was lower than the findings[29] (8.16). In present study, investigated value of Cr was higher than values reported[31]. According to report Yu *et al.*[41], mean concentration of Cr was equal to present investigation. The results obtained from present investigation indicate that concentration of all heavy metals in all parts of wheat plant was higher in cow manure, poultry manure and DAP treatments as compared to control. Poultry manure and cow manure seems to supply large amount of micronutrients[51].

When BCF<1, it shows that the plant can only absorb heavy metals but not accumulate them, when BCF>1, it shows that plant can accumulate metals. In present investigation, BCF values for Co, Pb and Cd was higher but lower BCF value was observed for Fe, Cr, Zn and Cu than those reported [48]. The values of Zn and Cr were found to be same while lower values for Cd, Pb, Cu and Co but higher value of Fe[52]. The maximum value 0.9883 was observed for Co at T2 while lowest value was 0.049 for Pb at T1 during metal transfer from shoot to grain. In this experiment, values of transfer factor from shoot to grain for Cd, Zn and Cr was higher but lower value of Cu than investigation[31]. The current values for Pb, Cu, Zn, Cr and Cd were higher than values reported[28]. Present DIM values of Pb, Cd and Cr were lower but Zn and Fe has higher values than values[53]. The current DIM values of Cu, Zn, Cr and Pb were higher and that of Cd was lower than finfings[28]. In this study, the data concealed that all the examined heavy metals were not reported to cause any threat to the consumers. The current values of HRI for Cd, Fe, Pb and Cr were lower than the values reported[53]. In present study, HRI values of Cd, Zn, Pb, Cu and Cr were found to be lower than suggestions[54].

CONCLUSION

Farmers use various organic and inorganic fertilizers to enhance the productivity of their crops. As a result, highest values of all morphological parameters and metal uptake by wheat variety (Galaxy-13) were observed fertilizers treatments as compare to control. Poultry waste provides a lot of nitrogenous compounds to the soil thus enhance fertility of soil. Thus, increased concentration of heavy metals affects human health in different ways. In current investigation, values of all heavy metals such as Co, Zn, Cu, Fe, Pb, Cd and Cr were found to be within the permissible limits given by FAO/WHO. Therefore, the consumption of wheat grown in the soil amended with poultry waste and cow waste is safe for human.

SIGNIFICANCE STATEMENT

This study discovers that organic waste could be used as a source of fertilizer that can be beneficial especially for especially poor farmers to increase yield of crops. It will suggest the farmers to utilize different types of wastes as a source of nitrogenous compounds which helps in increase in productivity of food crops.

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