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Amelioration of lead (Pb) from contaminated soil using organic amendments

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Abstract

Pot experiments were conducted at the department of Soil, Water and Environment, University of Dhaka to evaluate the effect of used tea leaves and poultry litter in ameliorating lead uptake and to alleviate toxicity of lead in Red amaranth (*Amaranthus tricolor* L.). The length, fresh weight and dry weight of shoot was decreased significantly by 34.83, 34.69 and 36.48%, respectively, in 200 mg kg^{-1} Pb treated pots compared to the control. The similar significant decreasing trend in case of macro nutrient concentration in shoot and root samples were also observed. %N, P, K, S, Mg and Ca concentration in edible parts (shoots) decreased by 66.3, 5.27, 52.17, 30.32, 61.54 and 62.87% in 200 mg kg^{1} lead (Pb) treated pots compared to the control. On the other hand Pb concentration in shoot and root was the highest at 200 mg kg^{-1}Pb treated pots (55 and 189 mg kg^{-1} pot^{-1}) and the lowest was in the control treatment (0.45 and 20 mg kg^{-1} pot^{-1}). Biomass production were positively influenced by the application of organic amendments as well as lead uptake was significantly ameliorated into Red amaranth shoot and root due to application of used tea leaves and poultry litter which reduced soil to plant transfer (TrF) of Pb by 47.39, 56.34 and 16.67, 22.22% in shoots and roots of red amaranth, respectively, compared to the untreated pots.

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Introduction

Pollution control issues are relatively recent in Bangladesh, as the country over the last twenty years has been slowly shifting from agricultural economy to one more dependent on urban commerce and industry. Bangladesh has at present about 30,000 large and small industrial units. They are discharging their wastes and effluents into the natural ecosystems in most cases without any treatment, thus causing environmental pollution especially with heavy metals and organic toxins (Chamon *et al.*, 2005).

Among heavy metals, lead is one of the major contaminants found in soil, sediments, air and water. Lead (Pb) pollution in Bangladesh soils has increased because of increased disposal of municipal and industrial solid and liquid wastes, vehicle exhausts to the soils. Lead is a toxic element that can be harmful to plants, but plants usually show the ability to accumulate large amounts of Pb without visible changes in their appearance or yield (Kashem and Singh, 1998).

Heavy metals when present at an elevated level in soil are absorbed by the root system, accumulate in different parts of plants, reduce their growth and impair metabolism (Seregin and Ivanov, 2001). Lead concentrations in many turmeric samples of Bangladesh has been reported to be elevated, with concentrations as high as 483mgkg^{-1} (Gleason *et al.,* 2014). Rice seed germination rate and the amount of chlorophyll decreased remarkably with increasing Pb concentration. Excess of Pd reduced the dry weight of rice pronouncedly at harvest when the grain yield also decreased (Chatterjee and Dube, 2004). Pb toxicity causes oxidative stress and enzyme inactivation in rice plants (Zeng *et al.,* 2007; Chamon *et al*., 2005). Its remediation should be undertaken for protecting our environment as well as human life (Chamon *et al*., 2005; Jasmin, 2016).

Lead enters into the atmosphere and into food chain through the use of leaded gasoline in automobiles, indiscriminate disposal

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of industrial wastes and effluents (battery, mining, petroleum, pesticide industries specially). Ullah *et al.* (1999) reported higher metal concentrations in soils of different sites around Dhaka, Bangladesh, are of growing concern and there is a strong need for remediation of these sites. Remediation/Ameliorations is the process involves dissolving or immobilizing the heavy metals, present as particles or adsorbed on to the soil matrix by using various agents, such as chemical, physical or organic agents.

Remediation aims at protecting humans, animals and the environment from exposure to hazards and interrupting the pathways of pollutants (Tadesse *et al.,* 1994). Considerable research has been directed towards less expensive remediation in-situ technologies that remove metal contaminants from soils. Organic Matter amendment is preferred because of its effectiveness, inexpensive availability, and additional benefits for plant growth and soil structure. The addition of organic matter substantially reduces Pb uptake (Bassuk, 1986). Significant reduction in Pb availability was also seen in some of the compost amended and iron rich amended soil treatments (Brown *et al.,* 1999; Chamon *et al*., 2005).

Red amaranth (*Amaranthus tricolor* L.), a popular vegetable grown in Bangladesh, is considered to be excellent source of essential nutrients, vitamins, minerals and fibers that are essential for human health. Red amaranth was used because of its high and fast biomass production capacity and ability of translocation of contaminants like Pb into the plant shoots (Gleason *et al.,* 2014; Seregin and Ivanov, 2001).

Considering the nutritional benefits of used tea leaves and poultry litter on plant growth, a research work was performed to reduce lead (Pb) uptake into Red amaranth and thus to minimize their entry into the food chain and to test the effectiveness of organic amendments (Used tea leaves and Poultry litter).

Materials and methods

Pot experiments were conducted with soils (0-15 cm depth) collected from Dhamrai soil series. The characteristics of Dhamrai soil were; texture- silty loam; pH- 6.0; % organic carbon- 0.81; % organic matter-1.40, total nutrient concentrations were; %N- 0.24; %P - 0.004; %K - 0.02; %S- 0.02, %Ca-0.03, % Mg-0.21, CEC- 6.29 meq/100g and toxic metal i.e. Pb–89 mg kg^{-1}(close to critical level of Pb concentration for soil i.e. 100 mg kg^{-1} according to Kloke, 1980). The source of this elevated concentration of Pb in soil may be seasonal flooding with contaminated water containing industrial wastes and effluents or deposition of atmospheric emission of Pb from automobiles around road side areas.

Plastic pots were filled with 4 kg soil. The soil was artificially contaminated by applying 200 mg $kg^{-1}pot^{-1}$ Pb as Lead Chloride ($PbCl_2$), as because of very alarming and high concentration of Pb around Dhaka city areas were reported (Ullah *et al.,* 1999) (Table I). Basal dose of fertilizer was added at medium rate for red amaranth (3 plants/pot) (BARC, 1989) and different types of organic matter such as poultry litter and used tea (*Camellia sinensis*) leaves(40 g pot^{-1}) (10 ton/ha)were added as remedial measures having 3 replications. The treatment combinations were as follows (Table II).

The pots were arranged in a completely randomized design. The plants were irrigated with distilled water whenever required. The crops were harvested after 35 days of sowing and the shoot and root samples were prepared for analyses after recording growth and yield parameters.

Soil samples were digested with $HCl:HNO_3$ (3:1) (Blum *et al.,* 1996) and plant samples were digested with a $HNO_3:HClO_4$ (1:2) mixture in closed systems (Chamon *et al.,* 2005).

Determination of soil physical, chemical and physicochemical properties

The particle size distribution of the soil was carried out by hydrometer method as described by Black (1965).

The pH of the soil was measured by using a pH meter. The ratio of the soil to water was 1: 2.5 as suggested by Jackson (1962).The electrical conductivity of the soil was measured at a soil: water ratio of 1:2 by an EC meter as described by Jackson (1962). Soil organic carbon was determined volumetrically by wet oxidation method of Walkley and Black as described by Piper (1950) and Jackson (1962).The organic matter content of the soil was determined by multiplying the percentage of organic carbon with conventional Van-Bemmelen's factor of 1.724 (Piper, 1950).

The cation exchange capacity of the soil was determined by extracting the soil with 1N NH_4OAC solution (pH-7) followed by replacing ammonium or from the exchange complex by 2M KCl. The displaced ammonium (NH_4^+) was distilled with 40 % NaOH and ammonia gas (NH_3) evolved was adsorbed in 2% boric acid containing mixed indicator. The absorbed ammonium (NH_4^+) was titrated against H_2SO_4 solution (Black, 1965).

The total nitrogen of the soil was determined by Micro-Kjeldahl's method following H_2SO_4 acid digestion as suggested by Jackson (1962). The total phosphorous content of the soil samples were determined spectrophotometrically

Table I. Lead (Pb) concentration in soils (mg kg-1) around Dhaka

Location	Lead (Pb)
Hazaribagh	44.2
Tongi	19.6
Tejgaon	70.0
Narayangang	174.0
Kanak	171.0
Enayetnagar	185.0
Bholail	183.0
Pagla	725.0

Table II. Treatment combinations

Denotations	Treatment
T0	Control
T1	200 mg kg^{-1}Pb
T2	200 mg kg^{-1}Pb+ used Tea leaves
T3	200 mg kg^{-1} Pb+Poultry litter

from hydrochloric-nitric acid digested extract by spectrophotometer at 420 nm wavelength after developing the yellow color with vanadomolybdate as described by Jackson (1962). The total potassium concentration in the soil sample in hydrochloric-nitric acid digested extract was determined by Flame Analyzer at 767 nm wavelength (Jackson, 1962). Total Ca, Mg, Fe and Pb concentration of the soil (digested with aqua regia) were determined by Atomic Absorption Spectrophotometer (AAS) as described by Blum *et al.* (1996).

Plant sample analyses

After digestion of the Plant samples, the total content of N, P, K, S, Ca, Mg and Pb were determined by using the procedures as described for total soil analysis previously.

Translocation Factor (TrF)

The Translocation Factor (TrF) of Pb in red amaranth crops were calculated. The study served its importance due to the dietary importance of the vegetables to humans. The root to the edible part translocation factor and its remediation by applying different amendments were calculated by the following formula (Rangnekar *et al.,* 2013):

Translocation Factor (TrF) = Pb conc. in shoot / Pb conc. in root

The results of the experiment were statistically evaluated by using ANOVA (Analysis of Variance) and Duncan's Multiple Range Test in IBM SPSS statistics version 20 as outlined by Gomez and Gomez (1984). The letter was used for testing the significance of differences between mean values. The 0.05 level of probability was chosen for the statistical judgment.

Results and discussion

Growth and yield parameters

Organic amendments (used tea leaves and poultry liter) ameliorated red amaranth growth and yield parameters significantly (Table III). The shoot and root lengths, fresh and dry weight of red amaranth as affected by different amendments along with 200 mg/kg Pb are presented in Table III. Fresh weight of root varied significantly by the different treatments. The highest value of fresh weight of shoot was 16.23 g pot^{-1} in the control (T_0) treatment where no lead was applied and the lowest value was 10.60 g pot^{-1} were obtained in the 200 mg/kg Pb treated pots (T1).

The length, fresh weight and dry weight of shoot decreased significantly by 34.83,34.69 and 36.48%, respectively, in 200 mg kg^{-1}Pb treated pots (T1) compared to control (T0) with visual symptoms of serious chlorosis and necrosis. A similar significant decreasing trend was also observed in case of root which were 53.22, 28.57 and 43.24%, respectively, for root length, fresh weight and dry weight, in Pb treated pots (T1) compared to control (Table III). The negative growth response of rice and vegetables due to Pb toxicity was reported by many authors (Chamon *et al*., 2005; Jasmin, 2016). Batti *et al.* (2013) conducted a pot experiment to study the adverse effects of lead (Pb) on two wheat varieties i.e. Chakwal-97 and Sehar-2006. Plants were treated with Pb at 0, 40 and 60 ppm solution levels. Pb reduced the morphological parameters such as shoot/root length, shoot fresh/dry weights, number of tillers. Pb stress also decreases the photosynthetic pigments such as chlorophyll a, chlorophyll b but carotene contents were increased. Na^+, K^+ ion contents were also decreased by Pb. So Pb as a heavy metal has detrimental effect on plant growth and development.

The ameliorative effect of used tea leaves and poultry litter was clearly observed in the shoot samples of red amaranth. Application of used tea leaves and poultry litter increased the shoot length, shoot fresh weight and shoot dry weight 6.59, 6.32, 60.81and 12.99, 32.36, 53.79%, respectively, compared

Table III. Influence of used tea leaves and poultry litter application on the growth and yield parameters of red amaranth

Treatment	Shoot			Root		
	length (cm/plant)	FW (g/pot)	DW	length (cm/plant)	FW (g/pot)	DW
T0 (Control)	31.2 c	16.23 c	2.33 b	11.97 c	2.31 ab	0.37 b
T1 (200 $mgkg^{-1}$Pb)	20.33 a	10.60 a	1.48 a	5.60 a	1.65 a	0.21 a
T2 (200$mgkg^{-1}$Pb + used tea leaves)	21.67 ab	11.27 a	2.38 b	5.87 a	2.08 ab	0.28 ab
T3 (200 $mgkg^{-1}$Pb + poultry litter)	22.97 b	14.03 b	2.33 b	6.93 b	2.68 b	0.33 b

Means followed by the same letter (s) in a column do not differ significantly from each other at 5% level by DMRT

to 200 mg kg^{-1}Pb treated pots (T1) (Table III). Root length, root fresh weight and root dry weight in tea leaves and poultry litter treated pots were increased by 4.82, 27.56, 33.33 and 23.75, 63.58, 57.14% respectively, compared to 200 mg kg^{-1}Pb treated pots (T1) (Table III). The positive influence of organic substances on plant growth is a well-known phenomenon, which is due to indirect effects of humic substances acting as suppliers and regulators of plant nutrients and due to direct effects of humic substances e.g. as respiratory catalysts (Schnitzer and Khan, 1978; Vaughan and Malccolm, 1985). The results obtained from the Table-III indicates that, shoot and root biomass was decreased by the application of Pb but increased by the addition of the amendments. Between the two amendments poultry litter ameliorated more than used tea leaves. The results of the present investigation were in agreement with the earlier findings of Patrick and Bisessar (1981) who reported that the dry matter production of onion, potatoes, cabbage and lettuce was inhibited severely by Pb toxicity. Many researchers reported the importance of increased cation exchange capacity and organic matter in reducing Pb uptake (Chamon *et al*., 2005). Compost tea organic farming is a popular traditional way to boost plant productivity. Parisa *et al.* (2015) reported a positive correlation between lead levels in root of some plants and in the tea added soil in some research studies because of its high macro and micro nutrient contents that will help to enrich the soil.

Macro nutrients and heavy metals

Due to lead (Pb) application macro nutrients concentration in red amaranth shoots decreased significantly compared to the control (T0) (Table IV). %N,P,K,S, Mg and Ca concentration decreased by 66.3,5.26,52.17,28.72, 61.54 and 62.87% in 200 $mgkg^{-1}$ lead (Pb) treated pots (T1) compared to the control (T0). From the results, it was evident that due to application of 200 mg/kg Pb lowers the concentration of macro nutrients in root and shoot of the plant. Many authors reported an antagonistic effect on macro nutrient uptake by rice plants due to application of Pb (Jasmin, 2016; Chamon *et al*., 2005). In most cases, Pb blocks the entry of nutrients in the root system.

Heavy metal uptake was significantly ameliorated in red amaranth shoot samples by applying used tea leaves and poultry litter. Used tea leaves increased the percentage of N, P, K, S, Mg and Ca in red amaranth shoot by 138.95, 11.11, 89.39, 48.51, 138.67, and 34.21%, and poultry litter increased 160, 155.56, 104.55, 159.70, 201.67 and 201.33%, respectively (Table IV).

% N, P, K, S, Mg and Ca concentration decreased by 68.60, 53.33, 45.45, 13.43, 59.38, and 91.38% respectively, in roots of Pb treated pots compared with the untreated pots (control) (T0). The decrease in macro nutrient conc. might be due to the interference of Pb with the physiological function of the plant and in most cases, Pb blocks the entry of macro nutrient in the root system (Chamon *et al.,* 2005). Similar results were also reported (Jasmin, 2016).

The ameliorative effect of used tea leaves and poultry litter application were also clearly observed in the root samples of red amaranth. Used tea leaves increased the % N, P, K, S, Mg and Ca in red amaranth root by 80.25, 328.57, 83.33, 18.10, 146.15, 88.0% and poultry litter increased by 97.53, 442.86, 125, 83.62, 292.90, 1440%, respectively (Table IV). Tea leaves had suitable ability in transmitting more lead from soil to plants and had the significant effect on the enhancing cleaning up the soil from heavy metals (Parisa *et al.,* 2015).

Table IV. Influence of organic amendments on macro-nutrient concentration in red amaranth

Treatment	Shoot					
	%N	%P	%K	%S	%Mg	%Ca
T0 (Control)	2.82 c	0.19 a	1.38	1.88 ab	1.56 b	2.02 c
T1(200 mgkg^{-1}Pb)	0.95 a	0.18 a	0.66	1.34 a	0.6 a	0.75 a
T2(200mgkg^{-1}Pb+used tea leaves)	2.27 b	0.20 a	1.25	1.99 b	1.42 b	1.01 b
T3(200 mgkg^{-1}Pb+poultry litter)	2.47 bc	0.46 b	1.35	3.48 c	1.81 c	2.26 d
Treatment	Root					
T0 (Control)	2.58 c	0.15b	0.22	1.34 a	0.32 a	0.58 b
T1 (200 mgkg^{-1}Pb)	0.81 a	0.07 a	0.12	1.16 a	0.13 a	0.05 a
T2 (200 mgkg^{-1}Pb+used tea leaves)	1.46 b	0.3 c	0.22	1.37 a	0.32 a	0.49 b
T3 (200 mgkg^{-1}Pb+poultry litter)	1.60 b	0.38 d	0.27	2.13 b	0.51 a	0.77 c

Means followed by the same letter (s) in a column do not differ significantly from each other at 5% level by DMRT

The results obtained from Table-IV shows that both amendments increased macro nutrients concentration in red amaranth. Between the two amendments, poultry litter had the greater ability to increase the nutrient concentrations. This might be due to the effects of organic manure to reduce Pb toxicity hence increased nutrient concentration. Chamon *et al*. (2005) and Jasmin (2016) reported that application of organic amendments in soil enhanced macro nutrient contents in wheat and different varieties of rice.

Poultry litter amendment increased macro nutrient concentration in root and shoot of wheat as compared with the control was reported earlier by Jasmin (2016) and Chamon *et al.* (2005). Jasmin (2016) reported an increased concentrations of nitrogen in rice grains which were 14.2 and 1.1% in cow dung and poultry litter treatments compared with control and 25.8 and 11.3% compared with only 100 ppm of Pb treatments.

Addition of organic wastes (cowdung, poultry litter, oil cake, water hyacinth compost, city waste compost, plant residue compost etc.) (Chamon *et al.,* 2005) and used tea (*Cameliasinensis*) leaves (Banozir *et al.,* 2015) to agricultural lands has received considerable attention in recent years because of their beneficial effects on soil properties and functions, on plant nutrition and suppression, on heavy metal remediation and on several environmental concerns (El-Hanafi, 2005).

The reduced nutrient concentration in Pb treated wheat plant might be due to the antagonistic effect of Pb with macro nutrient reported by many authors (Jasmin, 2016; Chamon *et al*., 2005). Application of organic amendments (cow dung and water hyacinth) increased the nitrogen concentration in polluted soil was reported earlier (Chamon *et al*., 2005). The use of organic additives caused an increase in nitrogen content in and investigated soils (zinc smelter and lignite mine dumping site) (Grobelak, 2016). This might be due to the effects of organic manure to reduce heavy metal toxicity hence increased N concentration. Chamon *et al*. (2005) reported that application of organic amendments in soil enhanced the macronutrient contents in wheat.

Lead (Pb) concentration

The average lead concentration in shoot and root of red amaranth as affected by different levels of lead are presented in Fig. 1. The test of significance of different treatment means was computed by Duncan's New Multiple Range Test (DMRT).

The concentration of lead in root was the highest at 200 mg kg^{-1} Pb treated pots(189 mg kg^{-1} pot^{-1}) and the lowest was in the control treatment (20 mg kg^{-1} pot^{-1}). In comparison to lead treated pots and the control pots the average percentage of lead concentration was increased by 845% in roots due to Pb pollution.

Accumulation and distribution of heavy metals in the plant depend on the plant species, the leaves of the metals in the

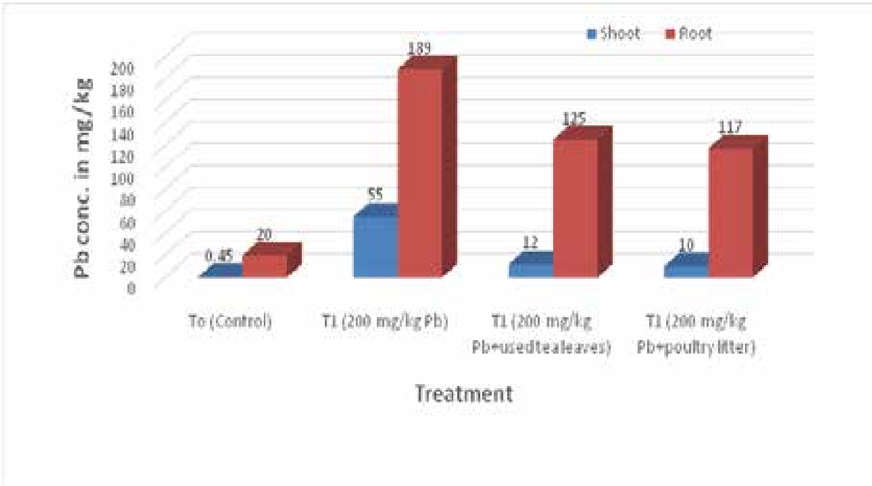

Fig. 1. Lead concentration in red amaranth as influenced by application of organic amendments

soil and air, the element species and bioavailability, pH, cation exchange capacity, climacteric condition, vegetation period and multiple other factors (Chamon *et al.,* 2005). This continuous uptake and translocation can increase the concentrations of metals in plant tissues instead of the soil that has low metal concentrations. Such results might be attributed due to root activity, which seems to act as a barrier for translocation of metals. The green vegetables particularly the leafy vegetables uptake high amounts of heavy metals from the soil ecosystem. Normal concentrations of Pb in plants are 0.1-10 mg/kg according to Kabata-Pendias and Pendias (1992), while toxic concentrations of Pb were found as 20-189 and 0.45-55 mg/kg in roots and shoots of red amaranth, respectively, in this study.

Lead uptake was significantly ameliorated by the application of used tea leaves and poultry litter. Used tea leaves decreased the concentration of lead by 78% in shoot and 34% in root of red amaranth respectively, compared with 200 mg/kg Pb treated pots. On the other hand along with poultry litter the amelioration of the lead concentration in red amaranth shoot and

Lead concentration in roots and shoots ranged between 20-189and 0.45-55 mg/kg/pot which was above the maximum permissible levels (10-20 mg/kg, Lake *et al.,* 1984). The highest being reduced in Pb concentration in poultry litter followed by used tea leaves in shoot and root of red amaranth. Between two amendments poultry litter had the greater ability to reduce Pb toxicity in shoot and root. This might be due to complexes or chelated by higher organic matter content of poultry litter than used tea leaves with Pb reported by Chamon *et al.* (2005). Pb concentrations in all treatment differed significantly from each other in case of root and shoot. From the results it may be concluded that application of lead significantly increased the concentration of Pb in shoot and root of red amaranth (T1), compared with the control (T0). All amendments decreased Pb concentration in red amaranth. Thus, the addition of organic matter to contaminated soil may be decrease the concentration of metal in solution and decrease their leach ability (Brown *et al.,* 1999). Similar results were also observed by many investigators. Madrid *et al.* (1999) reported that the mobility and uptake of Pb tend to decrease by the presence of compost probably due to association with the organic matter present in them. Saini and Gupta (2001) also reported that grain, straw and root Pb concentration increased significantly from 0.19 to 6.23, 2.11 to 11.17 and 4.96 to 21.76 µg g^{-1} when Pb levels were raised from 0 to 80 mg kg^{-1} soil, irrespective of the soil texture. Addition of FYM @ 1% decreased Pb concentration by 18.3 and 18.2% in grain 14.2 and 7.1% in straw and 5.3 and 6.6% in roots when grown in sandy and clay loam soil, respectively (Saini and Gupta, 2001). Lagerwerff (1972) observed that soil organic matter strongly adsorbed the heavy metals and helped in formation of insoluble organo-metal complexes. Chamon *et al.* (2005) reported that cow dung and poultry litter amendment showed a reduction of Pb concentration in rice. Soil organic matter is known to be a predominant factor for binding heavy metals in the soil and for influencing the plant uptake. Many researchers reported the importance of increased cation exchange capacity and organic matter in reducing Pb uptake (Chamon *et al.,* 2005; Jasmin, 2016).

Bassuk (1986) reported the beneficial effect of the addition of organic amendments in contaminated soils on its plant growth and soil structure. It is well known that organic matter is not only an aggregating agent present in soils and sometimes the stability is related better to the "quality" than the quantity of the total soil organic carbon (Oades, 1967).

Lagerwerff (1972) observed that soil organic matter strongly adsorbed the heavy metals and helped in formation of insoluble organo-metal complexes, suggested a possibility. Chamon *et al.* (2005) reported that cowdung and poultry litter amendment showed a reduction of Pb content.

Translocation Factor (TrF)

The Translocation Factor (TrF) of Pb in red amaranth crops were calculated. The study served its importance due to the dietary importance of the vegetables to humans. The root to the edible part translocation factor and its remediation by applying different amendments were calculated by the following formula (Rangnekar *et al.,* 2013):

Translocation Factor (TrF) = Pb conc. in shoot / Pb conc. in root

The translocation factor of Pb is an indicator that helps to understand the mobility of Pb in plants. Translocation factors closer to 0, exhibit higher concentration of the metal retained in the roots instead of being trans located to shoots of the plant. The results showed that, at the un-amended 200 mg kg^{-1}Pb contaminated pots, the highest root to shoot Pb translocation was observed in red amaranth (0.29). Hence, more than 29% of Pb was actively trans located from root to shoot of red amaranth showing serious chlorosis and necrosis but more than 50% was retained in the roots for red amaranth at the 200 mg kg^{-1} Pb treated pots. The translocation factor (TrF) were reduced by 65.51and 68.97% respectively, due to application of used tea leaves and poultry litter along with 200 mg/kg Pb treatment in red amaranth (Table V).

Different plant parts contain different heavy metals quantities: the highest quantities were in roots and leaves, and the lowest were in fruits and seeds reported by Natasa Mirecki *et al.* (2015). Metals concentration in roots indicated the degree of heavy metals accumulation in the polluted soil and shoots concentration suggested the atmospheric pollution degree.

Plant roots work towards selective absorption of materials from soil and function as an obstruction for translocation of metals to above soil parts. This may be due to the reason for root to shoot movement blockage of Pb. The obtained results also indicated that all translocation factor values were less than 1, exhibited higher concentration of the metal retained in the roots instead of being translocated to shoots of the plant. Lead concentration in shoots of control pots were well within permissible limits (10-20mgkg^{-1}, Lake *et al.,* 1984; Sauerbeck, 1982). The highest accumulation of Pb was found in the shoots of red amaranth (edible parts), concentrations frequently exceeded the phytotoxic levels in 200 mg kg^{-1} Pb treated pots (T1) (10-20 mg kg^{-1}, Lake *et al.,* 1984; Sauerbeck, 1982). Some plant species were found to have lower tolerance to toxic metals uptake in polluted soil as they were found to accumulate high concentrations of Ni, Cu, Pb and Zn (Freitas *et al*., 2004). Similarly, different plant species grown in the same soil may contain different levels of the same elements (Ibrahim *et al*., 2014). Some authors have reported the existence of differences in accumulation of heavy metals in plant cultivars (Krstic *et al*., 2007), age of plants (Naser *et al*., 2011), plant organs (Jolly *et al.,* 2013) and tissues (Filipovic *et al.,* 2012).

Table V. Root to shoot Translocation Factor (TrF) for red amaranth of lead (Pb)

Treatment	Pb Conc. in mg/kg		
	Shoot	Root	TrF
To (Control)	0.45	20	0.02
T1 (200 mg/kg Pb)	55	189	0.29
T1 (200 mg/kg Pb+used tea leaves)	12	125	0.10
T1 (200 mg/kg Pb+poultry litter)	10	117	0.09

Conclusion

From this study it can be concluded that the two amendmends taken are suitable to decrease metal concentrations (Pb) in the harvest. Lead concentration which was found above the MPL in shoots of red amaranth was ameliorated significantly by applying poultry litter and used tea leaves which are easy getting, less expensive and have positive influence in improving soil physical and chemical properties. The effectiveness of the different countermeasures is site (soil) and element dependent. This implies that for each given site the optimum treatments have to be evaluated based on the results presented in this study and the specific site characteristics. Hence, at elevated levels of metal concentration in soils, the plant metal concentration may increase beyond the limiting value. Thus it should be taken care that the inflow of metals in agricultural fields need to be avoided, otherwise it will certainly contribute to accumulate metals in human tissues through food chain transfer.

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