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Lead, Zinc and Chromium Accumulation Effect on the Germination and Growth of Maize (*Zea mays*) Seedlings

***Babale, A.[1], Musa, H.[1], Sale, S.[1], Amina, A. H.[2] and Charles N. A.[3]**

[1]Department of Plant Sciences, Faculty of Science Gombe State University, Gombe; Gombe State Nigeria

[2]Department of Biological Sciences, Faculty of Science Gombe State University, Gombe; Gombe State Nigeria

[3]Department of Zoology and Wildlife Ecology, Faculty of Science Gombe State University, Gombe; Gombe State Nigeria

***Corresponding Author**: aliyubabale64@gmail.com, +2347035695931

Abstract

Population increase has significant impact on agricultural activities, over the past decades; introduction of many large Industries have serious consequences on environmental health. This can lead to dispensing pollutant in the environment. Some of the pollutants can affect crops in terms of germination and growth. Experimental plots of maize crop were established at Gombe State University (GSU) Botanical garden. The experiment started from 3rd April- 3th August, 2023 and laboratory analysis was conducted at biochemistry laboratory, Gombe State University (GSU). Plant height (cm), fresh roots weight (g), dry roots weight (g), fresh stems weight (g), dry stems weight (g), seeds weight (g), accumulated in roots (mg/l), accumulated in stems (mg/l), accumulated in leaves (mg/l) and accumulated in seed (mg/l) were amongst the morphological trait observed. The accumulation of heavy metals on various concentrations of Lead, Zinc and Chromium contributes to decreased and slightly increased in some growth of Maize (*Zea mays*) seedlings when compared with the control. However, Percentage of Maize germination under different concentration of Lead, Zinc and Chromium (25ppm, 50ppm, 75ppm and 100ppm with 0ppm as a control) varies, with increasing concentration. Similarly, germination and growth decreased with increasing concentration. Moreover, roots had the highest accumulation of heavy metals followed by stems, seeds while leaves showed lowest absorption of the metals. Finally, there was a strong relationship between plants (maize seedlings) growth and accumulation of heavy metals in the plants morphology. It shows that when concentrations of heavy metals are increasing, accumulations of the same metals are also increasing with decreased or slightly increased in plants morphological growth performance.

Keywords: Maize germination, Maize growth, heavy metals accumulation, fresh and dry weight biomass

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Introduction

Over the past decades, more heavy metals are being generated by anthropogenic activities discharged into the environment; most of these have increasingly accumulated to potentially harmful levels in soils (Shi *et al*., 2018). In addition, several human activities (such as wastewater irrigation, pesticides, chemical fertilizers, urban wastes, and metal mining) have led to the accumulation and contamination of heavy metals in agricultural soils (Sun *et al*., 2020). Even though heavy metals are obviously current in the soil, geologic and anthropogenic actions increase the absorption of these elements to volumes that are detrimental to both fauna and flora (Shen *at.al*, 2002). Plant growth decrease because of variations in physical and chemical developments in plants growing on polluted soils with heavy metal has been documented (Chatterjee and Chatterjee, 2000). From the report of Oncel *et al.,* (2021) who indicated that Constant decline in plant growth with high content of heavy metals decreases yield production which finally signal to food insecurity.Environmental pollutants are generally spread in air, water, soils and sediment. Among environmental contaminants, metals are of specifically uneasiness due to their potential toxic effect and ability to bio-accumulate in ecosystems (Censi *et al.,* 2006). Accumulation of heavy metals in environmental mediums is a potential threat to living organisms due to their uptake by plants and later introduce into the food chain (Aktaruzzaman *et al*., 2013). Heavy metals are natural constituents of the earth's crust, but when the release exceed normal concentration as a consequence of human activities have severely changed in their geochemical cycles and biochemical balance (Censi *et al*., 2006). This result in accumulation of metals in plant parts having secondary metabolites, which is responsible for a particular pharmacological activity (Hakanson, 2000). Heavy metals accumulate in soils is likely to affect plant roots and then transported to upper sections of the plants like stem, leaves and fruits (Clemens, 2006). The health dangers rising from heavy metals pollution in agricultural soils have attracted global attention (Shiyu *et al*., 2017) and research on the increase of heavy metals in soil which plants take into their systems is likely the basis for human health hazard (Wang *et al*., 2016).

The accumulation of heavy metals in plants causes physiological and biochemical changes (Fisher, 2008). Heavy metals occur naturally in soils that are formed by geological processes, such as alteration and erosion of the geological underground materials (Mohan et *al.,* 2011). Besides the parent material, the sources of contamination in soils are multifarious, and include agricultural and industrial pollution (Kabir *et al.,* 2009). High rate of run-off and soil losses are the main driving forces to transport the pollutants (Bashir e*t al.,* 2018).

Heavy metals such as Lead and Nickel are highly toxic pollutants, which inhibits germination and retardation of plant growth (Singh *et al*., 2011). These are commonly observed heavy metal toxicity signs (Singh *et al*., 2011). High concentrations of heavy metals in soils represent a potential threat to human health. This is because it is incorporated in food chain mainly by plant uptake (Morzeck and Funicelli, 1992). Influence of heavy metal toxicity on germination and growth of some plants is a common trait in India (Iqbal & Mehmood, 1999). The researchers indicated that the environment of Karachi city is deteriorating rapidly since the last couple of decades (Rashid *et al*., 2012). This is due to various types of pollutants emitted from various types of anthropogenic activities affecting plants growth (Rashid *et al.*, 2012). Metals are of special interest with respect to the toxicological importance to human health, plants and animals (Barcelo, 2004; Ali, *et al*., 2003). Several revisions about the reaction of crop species to heavy metals, recording devices used indicated that heavy metals are responsible for plant tolerance or sensitivity to show signs (Chatterjee and Chatterjee, 2000; Ertani *et al*., 2017; Lijima *et al*., 2007; Munzuroglu & Geckil, 2002). Avoidance of metal uptake or its accumulation in plant tissues without developing any toxicity symptoms is considered as metal tolerance in plants (Munzuroglu and Geckil, 2002). In addition, same authors indicated that Sensitive species might have this mechanism and display harmful signs and poor growth (Munzuroglu and Geckil, 2002). Heavy metals tolerance were tested at germination and seedling growth on corn as these are the main trials for the creation of plants under any basic environment conditions (Mahmood *et al*., 2005).

Lead and cadmium are the toxic elements of primary importance (Idrees *et al*., 2017). Heavy metals with atomic densities higher than 4 g/cm^3, such as lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag), chromium (Cr), copper (Cu), iron (Fe), and platinum (Pt) are likely to show negative impact on diverse organisms (Shen *et al*., 2002). The high level of environmental contamination by these Heavy metals is dangerous. Humans may later consume heavy metals uptake by plants and subsequent accumulation in food crops and animals this may be harmful or deleterious to health (Schat *et al*., 1997). Whether acute or chronic, has deleterious effects on agricultural lands and hence significant effects on plant growth (Azom *et al*., 2013). Pollution tend to change the physical, biological and chemical properties of soil consequently, affecting plant growth and later yield production (Bashir *et al*., 2020). The work is targeted at comparing among the heavy metal contamination on maize more cost effective on the growth and yield of Maize.

Materials and Method

Description of the study area

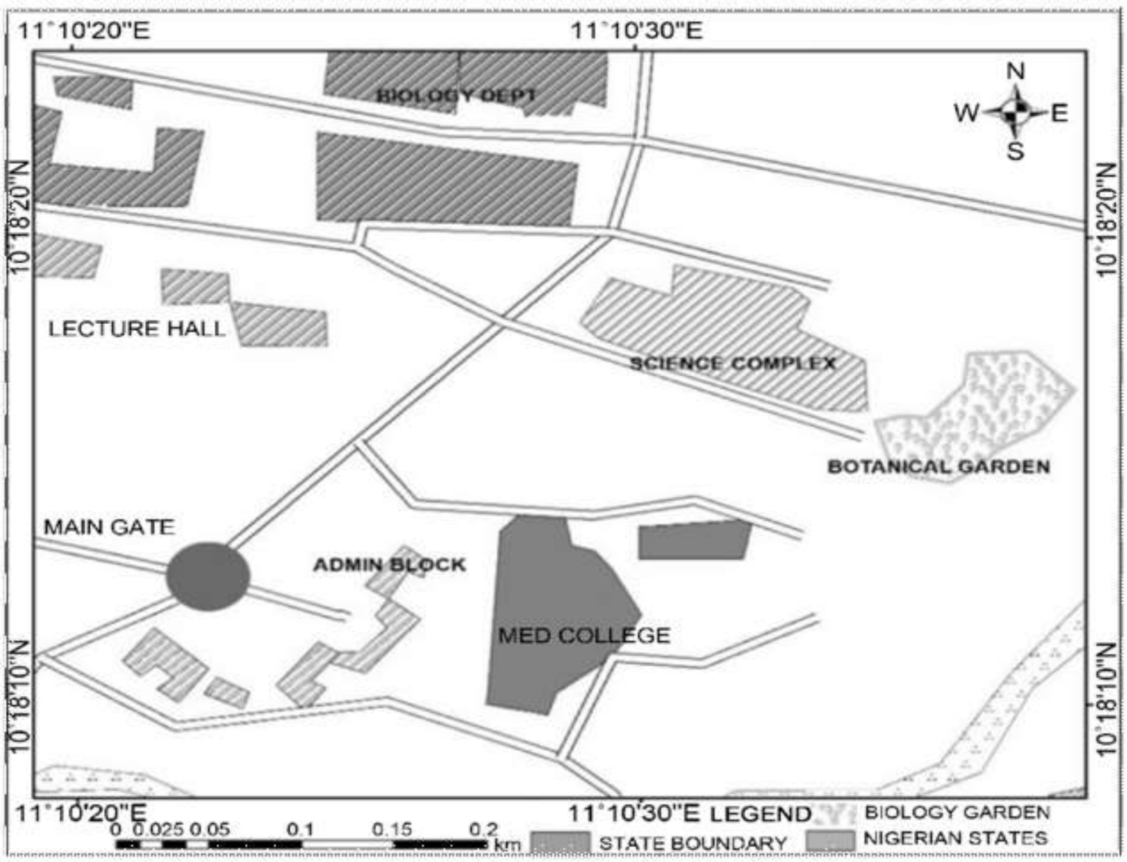

Figure 1: Map of Gombe state university showing the location of botanical garden and experimental plots

Experimental protocol and Seed collection

Experiment protocols were conducted for two consecutive years in the rainy seasons (May-September) of 2023- 2024 at the Botanical garden waste incineration plant with heterogeneous soil contamination in Botanical Garden, Gombe State University, Gombe. Planting seeds were obtained at Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSALs) seed bank Gombe office.

Experimental pre-treatment

The collected seeds were washed with running tap water and rinsed with distilled water before sowing it in the soil to remove any dusted particle that may altered seed germination. The 10 kilogram of soil was set in polythene viva bags. The set soil contain in each bag of. Zinc ($Zncl_2$), Lead ($Pdcl_2$) and Chromium ($crcl_2$) were diluted separately, at different concentrations of 100%, 75%, 50%, 25% and 0% (control) was formed respectively. These concentrations were the treatment that was administered in the soil before planting the seeds and watered for about 72 hours. Seeds were kept in moist environment and condition, in a water holding capacity bags (Mustafa *et al*., 2019). In each compound, four different treatments were formed, in each treatment three replications were made and the control. However, six (6) seeds were sown in each bag.

Determination of heavy metal in the soil using AAS (atomic absorption spectrophotometry):

Apparatus: balance machine, drying oven, funnel, filter paper, volumetric flask, beaker, burette, spatula, Kjeldahl flask, AAS machine, hot plate, Kjeldahls digestion assembling, conical flask were used (Shafea, 2011). Chemicals/reagent used were nitric acid HNO_3, hydro chloric acid HCL (Pan *et al*., 2013).

Soil digestion:

The sample was dried in an oven for 48hours. One gram (1g) of sample was weighed and transferred in to Kjeldahl flask. 10ml of nitric acid was added into the sample followed by 5ml of HCL, the mixture was shake slowly to mix with the sample. It was kept for 1hr to rest; the kjeldahl flask containing the sample was turn into the Kjeldahl digestion assemblage and heated for 1hr as demonstrated by Igbal (1999). If the sample generate brown in colour after heating then another 10ml of nitric acid will be added and heated again until the sample turn to pale yellow. Another solution will be formed but without the sample. Only the acids at 10ml was added and heated at same degree and minutes with the diluted sample, which was labeled as blank sample.

100ml of volumetric flask and a funnel was used, a filter paper and funnel were set. 2-3 dropped of distilled water was poured to wet the filter paper, 30ml of distilled water was added to the digested sample and to the blank solution, it was poured into the flask using funnel and it was rinsed to insured no any residue was left, the same was done to that of blank solution. Distilled water was added to make the volume of the sample at exactly 100ml together with the sample containing the blank solution.

Procedure for AAS determination

The AAS machine and the flame was turned on. Hollow cathode lamp was set to the specific metal that was determined. The capillary tube was inserted into the blank sample and the reading was adjusted to 0.00. The blank sample was removed at exactly 0.00. The tube was inserted into the distillate and the result was recorded (Tangahu *et al*., 2011).

Percentage of germination

Percentage frequency was used in determining seeds germination which was calculated as

$$\text{Frequency of Germination } \% = \frac{\text{number of seeds sprouded}}{\text{number of seeds sown}} \times 100$$

Statistical analyses

All the reported values in this study were mean of 3 replications. The data obtained were analyzed using SPSS version 21 at $p \leq 0.05$ significant difference. One way ANOVA was used to obtained mean performance followed by Duncan's multiple range test to determine the significant difference between mean of the concentrations of heavy metals (Hedeker 2003).

Results

Germination of maize under different concentration of heavy metals

Percentage of maize seedlings germinated in the soil contaminated with some heavy metals (Lead, Zinc and Chromium) at different concentration was carried out and the results obtained shows that the rate of germination varied with type of heavy metal and concentration (see Table 1).

Effect of heavy metals on morphology of Maize

Maize were grown under different heavy metals concentrations (Lead, Zinc and Chromium) and their effects on the morphology of the plants (Maize) were observed. The morphology of Maize observed were height, fresh root weight, dry root weight, fresh stem weight, dry stem weight and seed weight under different heavy metals concentration. The mean of the morphological characters were recorded (see Table 2.0) and there was significant difference for each metals at different concentration (see Table 3)

Table 1: Percentage of Maize germination under different concentrations of heavy metals

Concentration (ppm)	Lead (Pb) %	Zinc (Zn) %	Chromium (Cr) %
0.00	100	100	100
25.0	100	94.44	88.89
50.0	83.33	77.76	72.22
75.0	66.6	33.33	55.56
100.0	61.11	44.45	33.33

Table 2: Mean performance of maize morphology were measured and weighted at 16 weeks of harvest

Pb	PH(cm)	FRW(g)	DRW(g)	FSW(g)	DSW(g)	SDWS(g)
0	104.97±3.60	16.47±2.17	4.52±1.18	33.05±1.61	8.42±0.60	1.46±0.16
25	96.57±3.43	5.26±0.97	1.36±0.13	16.63±1.91	3.73±0.53	2.08±0.16
50	98.17±3.25	5.70±2.50	1.38±0.43	19.96±3.06	4.04±0.79	2.57±0.15
75	111.03±4.54	8.51±1.73	2.0±0.72	18.98±2.43	3.90±1.35	2.75±0.31
100	94.33±4.51	15.65±1.19	3.73±0.76	28.09±1.67	7.40±2.22	2.62±0.32
Zn						
0	110.20±2.81	15.01±2.85	3.67±1.24	22.85±2.51	4.45±1.08	1.42±0.08
25	87.83±1.04	5.86±2.58	1.69±0.88	17.67±1.19	4.28±0.58	1.64±0.32
50	101.83±3.55	6.36±0.65	1.87±0.26	30.07±3.89	6.35±1.41	1.69±0.11
75	75.73±1.86	3.66±0.67	1.48±0.53	11.45±3.57	2.55±0.57	1.55±0.25
100	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Cr						
0	117.30±1.11	18.64±1.94	5.21±0.96	24.99±1.78	5.62±0.78	1.41±0.17
25	106.03±1.50	11.04±1.39	3.09±0.78	31.59±1.39	7.00±1.03	1.77±0.26
50	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
75	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
100	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Note that: PH=plant height, FRW= fresh root weight, DRW=dry root weight, FSW=fresh stem weight, DSW=dry stem weight, SDW=seed weight. And symbol± =standard deviation.

Table 3: Analysis of variance for morphological traits of Maize harvested at 16 weeks

Pb	PH(cm)	FRW(g)	DRW(g)	FSW(g)	DSW(g)	SDW(g)
0	104.97^{bc}	16.47^{b}	4.52^{b}	33.05^{c}	8.42^{b}	1.46^{a}
25	96.57^{ab}	5.26^{a}	1.36^{a}	16.63^{a}	3.73^{a}	2.08^{b}
50	98.17^{ab}	5.70^{a}	1.38^{a}	19.96^{a}	3.90^{a}	2.57^{c}
75	111.03^{c}	8.51^{a}	2.0^{a}	18.98^{a}	4.04^{a}	2.75^{c}
100	94.33^{a}	15.65^{b}	3.73^{b}	28.09^{b}	7.40^{b}	2.62^{c}
Zn						
0	110.20^{e}	15.01^{c}	3.67^{c}	22.85^{d}	4.45^{c}	1.62^{b}
25	87.83^{c}	6.36^{b}	1.69^{b}	17.67^{c}	4.28^{c}	1.64^{b}
50	101.83^{d}	5.86^{b}	1.87^{b}	30.07^{e}	6.35^{d}	1.69^{b}
75	75.73^{b}	3.66^{b}	1.48^{b}	11.45^{b}	2.55^{b}	1.55^{b}
100	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Cr						
0	117.30^{c}	18.64^{b}	5.21^{c}	24.99^{b}	5.62^{b}	1.77^{c}
25	106.03^{b}	11.04^{c}	3.09^{b}	31.59^{c}	7.00^{c}	1.41^{b}
50	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
75	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
100	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}

Note that: *PH*=plant height, FRW= fresh root weight, DRW=dry root weight, FSW=fresh stem weight, DSW=dry stem weight, SDW=seed weight. $P \leq 0.05\%$ at significant difference. Different alphabet shows significant differences while same alphabet shows no significant difference to each other

Accumulation of Heavy metals on different part of Maize grown

The accumulation of Lead in the morphology of maize harvested at 16weeks shows different level of uptake. As the concentration of lead and Zinc increase, the rate of accumulation increases. However, the accumulation of lead by concentration in leaves and seeds increases up to 75ppm and slightly decrease at 100ppm while in Zinc there was no accumulation of the metal at 100ppm. On the other hand, minute accumulation of Chromium at 0ppm and increase at 25ppm formed while no accumulation was recorded in the remaining concentration in all the morphological parameters observed (see Table 4) Significant difference was recorded among different concentrations of heavy metals on the morphological trait obtained (roots, stems, leave and seeds). See table 5

Table 4: Mean accumulation of lead, zinc and chromium in different morphology of Maize seedlings after harvest (16weeks)

Pb conc. (ppm)	Roots mg/l	Stems (mg/l)	Leaves (mg/l)	Seeds (mg/l)
0	B.D.L	B.D.L	B.D.L	B.D.L
25	177.67±3.79	139.67±3.06	69.00±3.61	135.69±2.08
50	193.67±3.51	157.00±4.36	91.00±1.73	144.33±1.53
75	224.67±0.58	187.33±7.09	95.33±3.06	146.00±3.61
100	257.67±4.16	189.00±2.65	94.67±2.51	145.00±2.00
Zn conc. (ppm)				
0	0.0714±0.0005	0.0267±0.0002	0.0276±0.0022	0.06±0.0012
25	304.33±3.06	180.33±6.03	134.67±4.51	407.33±11.24
50	421.33±1.53	359.33±7.02	264.00±2.65	483.00±2.00
75	487.33±1.53	548.33±3.79	434.67±6.11	524±4.58
100	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Cr. (ppm)				
0	0.0022±0.0003	0.0056±0.0031	0.0039±0.0003	0.0006±0.0001
25	285.00±1.73	78.33±0.58	146.33±6.03	186.33±4.93
50	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
75	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
100	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Note that: BDL=below detection limit, ±=standard deviation

Table 5: Analysis of variance (ANOVA) for the accumulation of Lead, Zinc and Chromium in the morphology of Maize after harvest (16weeks)

Pb conc. (ppm)	Roots mg/l	Stems (mg/l)	Leaves (mg/l)	Seeds (mg/l)
0	B.D.L ^{a}	B.D.L ^{a}	B.D.L ^{a}	B.D.L ^{a}
25	177.67 ^{b}	139.67 ^{b}	69.00 ^{b}	135.69 ^{b}
50	193.67 ^{c}	157.00 ^{c}	91.00 ^{c}	144.33^{c}
75	224.67 ^{d}	187.33 ^{d}	95.33 ^{c}	146.00^{c}
100	257.67^{e}	189.00^{e}	94.67^{c}	145.00^{c}
Zn conc. (ppm)				
0	0.0714^{a}	0.0267^{a}	0.0276^{a}	0.06^{a}
25	304.33 ^{b}	180.33^{b}	134.67^{b}	407.33^{b}
50	421.33^{c}	359.33^{c}	264.00^{c}	483.00^{c}
75	487.33^{d}	548.33 ^{d}	434.67^{d}	524^{d}
100	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Cr. (ppm)				
0	0.0022^{a}	0.0056^{a}	0.0039^{a}	0.0006^{a}
25	285.00^{b}	78.33^{b}	146.33^{b}	186.33^{b}
50	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
75	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
100	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}

Note that P≤ 0.05% at significant difference. Different alphabet signifies difference while same alphabet shows no significant difference

Relationship between heavy metal accumulation and morphology of Maize

heavy metal increase, plant morphology increase or decrease and vice vasa. The relationship between accumulation of Lead, Zinc and Chromium and plant morphology (Maize) is shown in table 6, 7 and 8 respectively.

Table 6: correlation of lead accumulation and morphology of harvested maize

	PH	FRW	DRW	FSW	DSW	SDW	PbRTS	PbSTMS	PbLVS	PbSDS
PH										
FRW	0.004									
DRW	0.013	0.957								
FSW	0.083	0.909	0.888							
DSW	0.077	0.877	0.882	0.938						
SDW	0.044	-0.378	**-0.462**	**-0.511**	**-0.444**					
PbRTS	-0.261	-0.365	**-0.471**	**-0.552**	**-0.456**	0.868				
PbSTMS	-0.179	-0.432	**-0.529**	-0.613	**-0.523**	0.891	0.992			
PbLVS	-0.19	**-0.484**	**-0.572**	-0.63	**-0.558**	0.903	0.978	0.978		
PbSDS	-0.264	**-0.585**	-0.655	-0.728	0.631	0.838	0.963	0.973	0.978	

Note that: PH=plant height, FRW= fresh root weight, DRW=dry root weight, FSW=fresh stem weight, DSW=dry stem weight, SDW=seed weight, PbRTS=Lead accumulated in roots, PbSTMS=Lead accumulated in stems, PbLVS=Lead accumulated leaves, PbSDS=Lead accumulated in seeds. Bold fonts implies a significant correlation P≤ 0.05% at significant level of correlation.

Table 7: correlation of Zinc accumulation and morphology of harvested maize

	PH	FRW	DRW	FSW	DSW	SDW	ZnRTS	ZnSTMS	ZnLVS	ZnSDS
PH										
FRW	0.746									
DRW	0.766	0.962								
FSW	0.889	0.659	0.692							
DSW	0.855	0.621	0.681	0.98						
SDW	0.904	**0.511**	**0.592**	0.782	0.814					
ZnRTS	0.379	-0.245	-0.066	0.345	0.407	0.647				
ZnSTMS	0.292	-0.268	-0.78	0.216	0.256	**0.549**	0.955			
ZnLVS	0.276	-0.27	-0.81	0.185	0.226	**0.537**	0.944	0.999		
ZnSDS	0.399	-0.62	-0.62	0.368	0.44	0.669	0.992	0.912	0.899	

Note that: PH=plant height, FRW= fresh root weight, DRW=dry root weight, FSW=fresh stem weight, DSW=dry stem weight, SDW=seed weight, ZnRTS=Zinc accumulated in roots, ZnSTMS=Zinc accumulated in stems, ZnLVS=Zinc accumulated leaves, ZnSDS=Zinc accumulated in seeds. Bold fonts implies a significant correlation P≤ 0.05% at significant level of correlation.

Table 8: Correlation of Chromium accumulation and morphology of harvested maize.

	PH	FRW	DRW	FSW	DSW	SDW	CrRTS	CrSTMS	CrLVS	CrSDS
PH										
FRW	0.961									
DRW	0.946	0.995								
FSW	0.976	0.881	0.866							
DSW	0.969	0.873	0.856	0.995						
SDW	0.968	0.871	0.85	0.988	0.982					
CrRTS	**0.56**	0.331	0.326	0.988	0.709	0.713				
CrSTMS	**0.56**	0.331	0.327	0.722	0.71	0.712	1			
CrLVS	**0.56**	0.333	0.332	0.721	0.707	0.707	0.999	0.999		
CrSDS	**0.559**	0.329	0.324	0.722	0.709	0.714	1	1	0.998	

At P≤ 0.05% level of significant

Note: bold fonts implies a significant correlation

Note that: PH=plant height, FRW= fresh root weight, DRW=dry root weight, FSW=fresh stem weight, DSW=dry stem weight, SDW=seed weight, CrRTS=Chromium accumulated in roots, CrSTMS=Chromium accumulated in stems, CrLVS=Chromium accumulated leaves, CrSDS=Chromium accumulated in seeds.

Lead, Zinc and Chromium contributes to decreased and slight increase in growth of Maize (*Zea mays*) seedling when compared with the control. However, percentage of Maize germination under different concentration of Lead, Zinc and Chromium (25ppm, 50ppm, 75ppm and 100ppm with 0ppm as a control) varies. Maize germination decreased with an increased in concentrations of all the three named heavy metals. 25ppm had the highest percent of maize germination in $Pbcl_2$ (100%), $Zncl_2$ (94.44%) and CrO_3 (88.89%) respectively, while 100ppm had the least percentage of germination in $Pbcl_2$ (61.11%), $Zncl_2$ (44.45%) and CrO_3 (33.33%). This study correlate with the findings of Okem *et al.,* (2016) and Oncel *et al.,* (2021), where they indicated that higher concentration of heavy metals such as Lead, Zinc, Copper, Cadmium, Chromium inhibited seed germination and seedlings growth. Furthermore, it was revealed that heavy metals under different concentration have effect on the morphology of maize seedlings growth. Plant height, fresh roots weight, dry roots weight, fresh stems weight, dry stems weight and seeds weight were amongst the parameters observed.

Plant height in relation to $Pbcl_2$ 75ppm, $Zncl_2$ 50ppm and CrO_3 25ppm concentrations showed highest growth performance with 111.03cm, 101.83cm and 106.03cm respectively, while $Pbcl_2$ 100ppm and 75ppm showed the lowest growth performance on plant height with 94.33cm and 75.73cm respectively, no growth in other CrO_3 concentration (50ppm, 75ppm and 100ppm) as shown in (table 2.0). This report is in line with the study by Michel-López *et al.,* (2016) which indicated that excess application of chromium content significantly inhibited seed germination and seedling growth.

$Pbcl_2$ 100ppm, $Zncl_2$ 50ppm and CrO_3 25ppm had the highest performance in fresh roots weight and dry roots weight of 6.36g and 1.87g, 6.36g and 1.87g, 11.04g and 3.09g separately while 25ppm $Pbcl_2$ and 75ppm $Zncl_2$ had the lowest performance in fresh roots weight and dry roots weight of 5.26g and 1.36g, 3.66g and 1.48g weight on growth in CrO_3 concentration. $Pbcl_2$ 100ppm, $Zncl_2$ 50ppm and CrO_3 25ppm had the highest fresh stems weight of 28.09g, 30.07g and 31.59g, dry stems weight of 7.40g, 6.35g and 7.00g. 25ppm $Pbcl_2$ and 75ppm $Zncl_2$ showed the lowest performance of fresh stem weight of 16.63g and 11.45g, dry stem weight of 3.73g and 2.55g. Finally, 75ppm $Pbcl_2$, 50ppm $Zncl_2$ and 25ppm CrO_3 showed the highest seed weight of 2.75g, 1.69g and 1.77g while 25ppm$Pbcl_2$ and 75ppm $Zncl_2$ showed the lowest seeds weight of 2.08g and 1.55g (see table 2.0). Nafiseh *et al*, (2012) reported that the seedling dry weights of *V. radiata* also declined with increased in the concentration of chromium treatment.

The relationship between the named heavy metals and growths of maize seedlings showed Negative correlation at $P \leq 0.05$ in the $Pbcl_2$ of fresh root weight and Lead accumulated in leaves and seeds. However, dry root weight showed negative relationship with seeds weight, Lead accumulated in roots, stems and leaves. Fresh stem weight had negative correlation with seeds weight and roots weight. Finally, dry stem weight showed negative relationship with seeds weight, Lead accumulated in roots, stems and leave.

Discussion

The reduction in plant growth is also attributed to excessive accumulation of chromium, zinc and lead in the soils. The decrease in seed germination is ascribed by the heavy metal treatments (Jamal *et al.,* 2006 & Mahmood *et al*., 2005). A study by Singh *et al*., (2016), indicated that essential and non-essential heavy metals generally produce common toxic effects on the production of low biomass, photosynthesis, alteration in water balance and nutrient absorption. It showed that only CrO_3 25ppm had the ability to grow up to maturity due to less concentration of CrO_3. Moreover, as the plant height increase or decrease in growth also the accumulation of chromium increase or decrease in roots, stems, leaves and seeds. There is reduction in dry matter yield of maize due to the presence of $zncl_2$, $pbcl_2$ and cro_2 as reported by Mishra and Choudhari, (1998), Abrar *et al*., (2013) and Mahmood *et al*., (2005). The effects of heavy metals depend often concentration, soil properties, type of soil and plant species as confirmed by Abrar *et al*., (2013). This study also correlated with Sharma *et al*., (2005), who conducted a study involving the growth of spinach variety 'Punjab Green' in a greenhouse on silt clay loam and sandy soils equilibrated with different levels of applied Chromium (0, 1 .25, 2.5, 5, 1 0, 20, 40, 80, 1 60, and 320 mg Cr kg−1 soil). It was observed that there was no germination of spinach when Cr at 320 mg Cr kg−1 rate was applied in silts clay loam soil and at 40 mg Cr kg-1 rate in sandy soil due to Chromium toxicity. Other researches showed that germination of rice cultivars were effectively reduced from 0.86 to 1 00%, and from 10-800 ppm of Cr concentrations in culture medium which negatively limited the seedling growth of rice cultivars (Bhattacharyya *et al*., 2008). Mahmood, *et al*., (2005) in his study confirmed these results, and investigated the effects of heavy metals and showed lease effects on seed germination than seedling growth (more sensitive to various heavy metals stresses). This is because seed is a stage in the plant life cycle that is well protected against various stresses. There was decreased in crop productivity in soils contaminated with lead, zinc and chromium, this poses a serious problem for agriculture. Lead toxicity indicates decreased dry mass of root and shoot, percentage germination (Munzururoglu and Geckil, 2002). Fresh and dry weights of both roots and stems were also reduced at all treatments (Mishra and Choudhrai, 1998). The effects of toxic substances on plants are dependent on the amount of toxic substance taken up from the given environment. The toxicity of some metals may be large enough that plant growth is retarded before large quantities of the element can be translocated (Ghani, 2011). Many of the physiological processes, such as chlorophyll synthesis, photosynthetic rate, respiration, and protein level are inhibited due to heavy metals as evaluated by Iqbal *et al*., (1999). Also from the assessment of same authors the growth inhibition on a previous source, results from damage to physiological and biochemical processes. These implies that negative correlation showed negative relationship with either growth or accumulation level (as one is increasing, the other one is decreasing) vice versa. In this situation, $Zncl_2$ showed strong positive correlation in fresh and dry roots weight with seeds weight. Strong relationship occurred in seeds weight with Zinc accumulated in stems and leaves. These showed strong positive correlation between the parameters that means there are directly proportional to each other. As one increase or decrease, also the other one is increasing or decreasing. CrO_3 on Plant height had shown strong positive correlation with Chromium accumulated in roots, stems, leaves and seeds.

Conclusion

It is concluded that maize seedlings has the potential to accumulate heavy metals in all the four named morphological traits which lead to the high effects of these metals in the plant's parts. This will also affect the well-being of living organisms if maize seeds is planted in contaminated soil (near industrial effluent) or irrigated with waste water which can be consumed after harvest by human or animals due to their uptake by plants and later introduce into the food chain.

Nevertheless, maize seedling has the ability to germinate, grow and accumulate heavy metals in its parts so it is recommended that maize should be used to remedy soil contaminants.

Also since it is a pot experiment, field work (contaminated site) can be used to have a clear result on this matter and it should not be consumed by animals or humans because it might affect the food chain. Future studies should focus on field experiments across a period to validate this assertion of maize potential as a phyto-remediation tool. If this returns in the affirmative, then we could advise that heavy metal laden soils should first be treated with maize plants, the maize harvested before the crop of choice is planted in the same location.

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