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Tolerance of Some Plants to Heavy Metal

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Abstract: A field experiment was carried out at El-Bustan area-west Nile Delta, Egypt for two successive seasons (summer season 2007 and winter season 2007/2008) using peanut and wheat plants, respectively to study the tolerance of both plants to heavy metal (lead) in the presence of different rates of N, P, and K and their contents in different organs of the plants. Lead was applied as foliar application by rates of 0, 5, 10 and 20 mg l^{-1}. The treatments of NPK were applied to soil at rates of 30 and 45 kg N/fed, 30 and 45 kg P_2O_5/fed for P, and 24 and 36 kg K_2O/fed in the first season, while in the second season, they were applied at rates of 80 and 120 kg N/fed, 15 and 20 kg P_2O_5/fed, and 24 and 36 kg K_2O/fed.The results showed that the best yield of pods and weight of 100 seeds of peanut were obtained when NPK were added at rates of 45+45+36 kg/fed, respectively, combined with foliar of Pb by rate of 20 mg l^{-1}. The contents of NPK in different parts of peanut take similar trends with that obtained in the yield. In the second season, wheat yield (grain and straw) and its N, P, K and Pb contents were enhanced by treating the soil with 120+20+36 kg/fed for N+P_2O_5+K_2O, respectively especially with foliar application of Pb at rate of 20 mg l^{-1}. The concentration of lead in peanut seeds and wheat grains or straw was less than the permissible limits, which affect plant growth, animals and humans.

Key words: Lead · NPK fertilizers · Peanut · Wheat · Sandy soils

INTRODUCTION

Soil contaminated by heavy metals from industrial wastes, agricultural fertilizers and roadways and automobiles now are considered to be one of the largest sources of heavy metals. In Egypt, many of industrial activities were either established on agricultural lands or adjacent to the Nile branches or their irrigation network canals. Hence, the discharge of these activities is pumped into the River Nile, irrigation canals or directly to the surrounding soils. From an environmental point of view, all heavy metals are very important because they cannot be biodegraded in soils, so they tend to accumulate and persist in soils for a very long time [1]. Thus, pollution with heavy metals, especially Pb would be expected for the irrigated soils which enter the food chain and produce unhealthy food that consumed by human beings.

Abd El-Aziz *et al.* [2] demonstrated the tolerance of corn, wheat, clover, soybean and sunflower plants to Pb uptake and found that the response of the tested plant species to heavy metals were differed, since the highest amounts of Pb were recorded in corn, clover and soybean, while the lowest ones were associated with sunflower and wheat. Verma and Dubery [3] reported that the retention of Pb in roots involves binding to the cell wall and extra cellular precipitation, mainly in the form of lead carbonate, which is deposited in the cell wall. The endoderm acts as a partial barrier to the translocation of Pb through the roots to the shoots. On the other hand, many researchers studied the stimulating effect of Pb salts, especially Pb $(NO_3)_2$ when it was added with minor concentration combined with different essential elements on plant growth. In this concern, Sainl and Gupta [4] found that the initial level of Pb (5 mg kg^{-1} soil) in the soils enhanced grains and straw yields of wheat, however, higher rates of Pb had a significant depressing effect on yield. Application of 80 mg Pb/kg soil alleviated mean grain yield by 20.23 and 14.06% and straw yield by 12.53 and 6.87% in sand and clay soils, respectively. Dahdoh *et al.* [5] showed that Pb has a significant effect on the dry matter yield of shoots and roots of both alfalfa and rocket in sandy soil. Aery and Jagetiya [6] found that a slight increase (4.87% and 9.9%) was observed at the 10 μg g^{-1} Pb addition only in root and shoot dry weights, respectively, over the control of barley plant. However, further increase in Pb concentrations resulted in significant decrease in dry matter yield.

Salem [7] recorded that application of Pb levels up to 100 mg kg^{-1} to sandy soil significantly increased the dry matter yields of shoots and roots of kenaf over

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that of control. The optimum growth was observed at 50 mg Pb kg^{-1} soil, indicating a favorable effect of Pb in the form of Pb $(NO_3)_2$ on plants grown in sandy soil. This stimulation effect reached 34.0% and 51.4% for shoots and roots, respectively. Misra and Pandy [8] also obtained similar results.

Judel and Stelte[9] concluded that no toxicity symptoms or yield reduction of radish, carrot and spinach plants occurred even at 500 ppm Pb. Abd El-Aziz [10] reported that the first visible symptoms of Pb toxicity are common at 100 mg Pb/kg for soybean and 300 mg/kg for sunflower. Stmad *et al.* [11] found that changes in the luminescen spectra of leaf mesophyll cells of potatoes, maize and *Medicago sativa* was noted at 100 mg Pb/kg.

Abd El-Malak [12] added that the response of Cd, Pb and Ni to uptake and accumulate in root and shoot tissues of lettuce showed a closely relationship to their corresponding bioavailable content in the soil, which were more attributed to the added levels of the studied heavy metals to the soil.

Therefore, the aim of this investigation is to study the effect of lead and some essential elements (NPK) on plant growth of peanut and wheat, and plant tolerance to heavy metal and their uptake by plants.

MATERIALS AND METHODS

A field experiment was carried out at El-Bustan area, representing sandy soil for two successive seasons (summer season of 2007 and winter season 2007/2008) using peanut and wheat plants, respectively to study the combined effect of lead and mineral fertilizers i.e. nitrogen, phosphorus and potassium on the yield of peanut and wheat as well as their contents of N, P, K and Pb.

Some physical and chemical characteristics of the studied soil are presented in Table 1 which were determined according to Klute [13] and Page *et al.* [14].

The experimental design was a complete randomized block design with three replicates. The plot area was 10.5 m^3 (3 m width and 3.5 m length). The plots were ploughed twice in two ways and received superphosphate (15.5% P_2O_5) at a rates of 30 and 45 kg P_2O_5/fed in the first season and 15 and 20 kg P_2O_5/fed in the second one. Nitrogen and potassium fertilizers were added also to the plots in two equal doses during the growing period (after 15 and 40 days of planting) in the form of ammonium nitrate (33.5% N) and potassium sulphate (48% K_2O) at rates of 30 and 45 kg N/fed and 24 and 36 kg K_2O/fed, respectively in the first season. While, in the second season, they were added at rates of 80 and 120 kg N/fed and 24 and 36 kg K_2O/fed. Lead solution was sprayed on the plants in the form of Pb $(NO_3)_2$ at rates of 0, 5, 10 and 20 mg l^{-1}. After 21 and 45 day from peanut planting, and after 45 and 90 days from wheat planting.

For the two seasons, plant samples were analyzed for N, P, K and Pb according to Cottenie *et al.* [15]. The obtained data were statistically analyzed according to S.A.S [16].

Table 1: Some physical and chemical properties of the studied soil

Characteristics	Value
• Particle size distribution (%):	
Sand	98
Silt	1.3
Clay	0.7
Texture class	Sand
• Chemical analysis:	
pH (1: 2.5, soil suspension)	7.9
Total carbonates (%)	4.5
Organic matter (%)	0.27
EC dS m^{-1}, soil paste	0.12
Soluble cations (meq/l)	
Ca^{++}	6.96
Mg^{++}	4.76
Na^{+}	14.60
K^{+}	0.62
Soluble anions (meq/l)	
$CO_3^{=}$	----
HCO_3^{-}	2.74
Cl^{-}	15.4
$SO_4^{=}$	8.80
Available N (µg g^{-1})	12.80
Available P (µg g^{-1})	5.60
Available K (µg g^{-1})	114
Available Pb (µg g^{-1})	0.20

RESULTS AND DISCUSSION

Content of N, P, K and Pb at Tillering Stage of Peanut: Data in Table 2 show the effect of different rates of lead with different rates of N, P and K on the content of N, P, K and Pb in peanut at tillering stage. Data indicated that the increasing the rate of N, P and K fertilizers tended to a slight increase of N, P and K percentages in peanut plants. Data also show a slight increase in Pb content in the plants. The highest values of N, P, K and Pb were achieved, upon treating the soil with 45+45+36 kg/fed for $N+P_2O_5+K_2O$ respectively, combined with foliar application of Pb at the rate of 20 µg g^{-1}. The corresponding values were 3.71, 0.29, 3.99 (%) and

Table 2: Effect of lead and mineral fertilizers on the contents of N, P, K and Pb at tillering stage of peanut plant

	Pb treatment (µ g^{-1})				Pb treatment (µ g^{-1})			
	0	5	10	20	0	5	10	20
NPK* (kg fed^{-1})	N%				P%			
30 – 30 – 24	3.10	3.18	3.20	3.26	0.17	0.18	0.19	0.20
30 – 30 – 36	3.10	3.20	3.28	3.28	0.18	0.19	0.21	0.21
30 – 45 – 24	3.20	3.21	3.31	3.33	0.19	0.18	0.20	0.20
30 – 45 – 36	3.21	3.26	3.40	3.38	0.20	0.20	0.22	0.23
45 – 30 – 24	3.24	3.28	3.51	3.48	0.22	0.23	0.22	0.22
45 – 30 – 36	3.23	3.31	3.60	3.62	0.22	0.25	0.24	0.26
45 – 45 – 24	3.30	3.45	3.61	3.64	0.24	0.25	0.26	0.28
45 – 45 – 36	3.30	3.50	3.66	3.71	0.25	0.26	0.27	0.29
L.S.D0.05 for Mineral (M)	0.07				0.019			
L.S.D0.05 for Lead (L)	0.06				0.019			
L.S.D0.05 for (M × L)	0.12				N.S			
	Pb treatment (µ g^{-1})				Pb treatment (µ g^{-1})			
	0	5	10	20	0	5	10	20
NPK* (kg fed^{-1})	K%				Pb (µ g^{-1})			
30 – 30 – 24	2.22	3.00	3.31	3.50	1.00	1.30	1.42	1.80
30 – 30 – 36	2.26	3.10	3.40	3.71	1.10	1.50	1.50	1.92
30 – 45 – 24	2.29	3.30	3.52	3.80	1.11	1.53	1.52	2.00
30 – 45 – 36	2.36	3.32	3.60	3.90	1.20	1.58	1.60	2.20
45 – 30 – 24	2.49	3.40	3.68	3.91	1.21	1.70	1.72	2.21
45 – 30 – 36	2.51	3.49	3.80	3.89	1.22	1.76	1.80	2.60
45 – 45 – 24	2.60	3.51	3.88	3.92	1.23	1.82	1.86	2.66
45 – 45 – 36	2.61	3.60	3.90	3.99	1.23	1.90	1.98	2.80
L.S.D0.05 for Mineral (M)	0.109				0.08			
L.S.D0.05 for Lead (L)	0.104				0.078			
L.S.D0.05 for (M × L)	N.S				0.14			

*As N, P_2O_5 and K_2O, respectively, one feddan = 4200m^2

2.8 (µg g^{-1}) for N, P K, and Pb, respectively. This increase of N, P and K in peanut may be attributed to the effect of lead on plant growth, especially at low concentration and sprayed in the form of Pb $(NO_3)_2$. This finding stands in well agreement with those of Salem [7]. The statistical analysis for the data indicated that the contents of N, P, K and Pb at tillering stage of peanut were significantly affected by applied treatments except that of P% and K% for M×L.

Peanut Yield and its Macronutrients and Lead Contents: The effect of foliar application of Pb with mineral fertilizers (NPK) on the yield of peanut and its N, P, K and Pb contents is recorded in Tables 3 and 4. Data in Table 3 show that the pods yield of peanut (Ardab/fed) and weight of 100 seeds (g), increased with application of lead especially when the rate of N, P and K increases. The highest yield was achieved upon treating the soil with 45+45+36 kg/fed for N+P_2O_5+K_2O, respectively with foliar application of lead solution at rate of 20 (µg g^{-1}). A comparison of the highest pods yield and weight of 100 seeds under with or without lead application showed that their values were 35.60 (Ardab/fed) and 100.6 (g) without Pb application, while they were 37.2 (Ardab/fed) and 109.99 (g) when Pb was sprayed at 20 (µg g^{-1}). So, application of lead slightly increased pods yield and weight of 100 seeds by about 4.5 and 9.3% over that of the treatments without Pb application, respectively.

Table 3: Effect of lead and mineral fertilizers on the yield of peanut

	Pb treatment ($\mu g\ g^{-1}$)				Pb treatment ($\mu g\ g^{-1}$)			
	0	5	10	20	0	5	10	20
NPK* (kg fed^{-1})	Pods (Ardab/fed)* *				Weight of 100 seeds (g)			
30 – 30 – 24	31.95	35.00	35.60	35.90	94.94	96.10	97.20	99.30
30 – 30 – 36	31.90	36.04	36.05	36.20	94.90	100.00	100.00	102.00
30 – 45 – 24	32.00	36.20	36.00	36.82	95.10	100.20	101.90	104.65
30 – 45 – 36	32.20	36.60	36.69	36.81	95.30	100.40	102.00	105.00
45 – 30 – 24	33.00	36.90	36.70	36.73	97.00	100.60	102.80	109.81
45 – 30 – 36	34.20	36.91	36.95	36.96	99.10	100.80	105.20	109.88
45 – 45 – 24	35.43	36.99	37.00	37.10	100.20	101.00	105.90	109.80
45 – 45 – 36	35.60	36.99	37.10	37.20	100.60	102.10	107.44	109.99
L.S.D0.05 for Mineral (M)	0.40				0.82			
L.S.D0.05 for Lead (L)	0.38				0.78			
L.S.D0.05 for (M × L)	0.71				1.45			

** Ardab= 75 Kg peanut pods

*As N, P_2O_5 and K_2O, respectively

Table 4: Effect of lead and mineral fertilizers on the content of N, P, K and Pb in peanut seeds

	Pb treatment ($\mu\ g^{-1}$)				Pb treatment ($\mu\ g^{-1}$)			
	0	5	10	20	0	5	10	20
NPK* (kg fed^{-1})	N%				P%			
30 – 30 – 24	3.71	4.10	4.12	4.50	0.35	0.37	0.39	0.42
30 – 30 – 36	3.73	4.13	4.20	4.63	0.35	0.46	0.39	0.45
30 – 45 – 24	3.81	4.15	4.21	4.71	0.37	0.48	0.41	0.47
30 – 45 – 36	3.84	4.16	4.62	4.71	0.39	0.49	0.42	0.47
45 – 30 – 24	3.88	4.21	5.12	4.76	0.39	0.49	0.43	0.49
45 – 30 – 36	3.89	4.26	5.67	5.71	0.40	0.50	0.48	0.49
45 – 45 – 24	3.99	4.29	5.68	5.77	0.41	0.51	0.49	0.51
45 – 45 – 36	3.99	4.34	5.71	5.91	0.43	0.51	0.52	0.53
L.S.D0.05 for Mineral (M)	0.08				0.01			
L.S.D0.05 for Lead (L)	0.08				0.01			
L.S.D0.05 for (M × L)	0.15				0.02			
	Pb treatment ($\mu\ g^{-1}$)				Pb treatment ($\mu\ g^{-1}$)			
	0	5	10	20	0	5	10	20
NPK* (kg fed^{-1})	K%				Pb ($\mu\ g^{-1}$)			
30 – 30 – 24	2.3	2.35	2.40	2.53	1.10	1.60	1.70	1.91
30 – 30 – 36	2.3	2.41	2.49	2.58	1.10	1.80	1.89	2.20
30 – 45 – 24	2.36	2.42	2.58	2.60	1.12	1.88	1.94	2.50
30 – 45 – 36	2.38	2.44	2.61	2.67	1.14	1.92	2.00	2.54
45 – 30 – 24	2.42	2.51	2.63	2.68	1.14	1.96	2.22	2.60
45 – 30 – 36	2.47	2.57	2.68	2.69	1.19	2.00	2.3	2.62
45 – 45 – 24	2.52	2.59	2.68	2.70	1.20	2.10	2.31	2.62
45 – 45 – 36	2.55	2.67	2.69	2.71	1.20	2.30	2.33	2.64
L.S.D0.05 for Mineral (M)	0.029				0.106			
L.S.D0.05 for Lead (L)	0.027				0.101			
L.S.D0.05 for (M × L)	0.051				0.187			

*As N, P_2O_5 and K_2O, respectively

Table 5: Effect of lead and mineral fertilizers in wheat yield

	Pb treatment (μ g^{-1})				Pb treatment (μ g^{-1})			
	0	5	10	20	0	5	10	20
NPK* (kg fed^{-1})	Grains (Ardab/fed)**				Straw (Mg fed^{-1})			
80 – 15 – 24	11.40	16.60	17.00	17.20	4.90	5.30	5.60	6.10
80 – 15 – 36	11.80	17.60	17.61	17.60	4.90	6.00	6.00	6.80
80 – 20 – 24	12.10	17.70	17.76	17.70	5.00	6.30	6.90	7.00
80 – 20 – 36	14.90	17.80	17.80	17.90	5.20	6.80	7.00	7.10
120 – 15 – 24	15.50	17.91	18.20	17.90	5.50	7.00	7.10	7.20
120 – 15 – 36	15.80	18.10	18.31	18.60	5.80	7.10	7.10	7.20
120 – 20 – 24	16.00	18.20	18.81	18.83	6.40	7.20	7.30	7.30
120 – 20 – 36	16.20	18.40	18.82	18.90	6.60	7.30	7.40	7.50
L.S.D0.05 for Mineral (M)	0.184				0.133			
L.S.D0.05 for Lead (L)	0.175				0.126			
L.S.D0.05 for (M × L)	0.324				0.234			

** Ardab= 150 Kg of wheat grains

*As N, P_2O_5 and K_2O, respectively

Data in Table 4 showed that there were marked increase in the content of N, P, K and Pb of peanut seeds by increasing their rates from 30 to 45 kg/fed for N, 30 to 45 kg/fed for P_2O_5 and 24 to 36 kg/fed for K_2O. These increases were more obvious with increasing the rate of lead from 0 to 20 (μg g^{-1}).The highest values for N, P and K content were 3.99, 0.43 and 2.55%, respectively without Pb application and reached to 5.91, 0.53 and 2.71% with 20 (μg g^{-1}) Pb application. On the other hand, the highest Pb content (2.64 μg g^{-1}) was obtained when N, P and K were applied at high rates combined with Pb foliar application by 20 (μg g^{-1}). This value of lead was less than the permissible limit of Pb toxicity. These results are in agreement with that obtained by Judel and Stelte, [9] Abd El-Aziz [10] and Stmad *et al.* [11]. The statistical analysis for the data indicated that peanut yield and its seeds content of N, P, K and Pb were significantly affected by all treatments.

Wheat Yield and its N, P, K and Pb Contents: The effect of lead application and mineral fertilizers on the yield of wheat and its N, P, K and Pb content was shown in Tables 5, 6 and 7. Data in Table 5 revealed that the yield of wheat grains (Ardab/fed) and straw (ton/fed) increased by increasing rate of N, P and K especially when the rate of Pb application was increased from zero to 20 (μg g^{-1}). With this respect, increasing the rate of Pb from zero to 20 (μg g^{-1}), increased the grains yield by 16.6% and the straw yield by 13.6%. These results are in agreement with those obtained by Sainl and Gupta [4].

Data in Table 6 showed increments in the concentration of N, P and K in wheat grains and straw with increasing their addition rates from 80 to 120, 15 to 20 and 24 to 36 kg/fed for N, P_2O_5 and K_2O, respectively, especially with foliar application of Pb. Generally, these increments were more obvious when Pb application was increased from zero to 20 (μg g^{-1}). The highest values of N, P and K concentration were 3.0, 0.39 and 2.46%, for grain and 1.88, 0.24 and 1.99% for straw respectively, which recorded under treatment at rates of 120+20+36 kg N, P_2O_5 and K_2O/fed, with foliar application of Pb at rate of 20 (μg g^{-1}).

The highest concentration of Pb was 4.5 and 4.99 (μg g^{-1}) for grain and straw, respectively (Table 7). This concentration was shown at the highest rates of N, P and K with foliar application of Pb with rate of 20 (μg g^{-1}). The concentration of Pb that recorded in wheat yield (grains and straw) was less than the permissible limit of Pb toxicity. In this connection, Abd-Aziz *et al.* [2] recoded that low amounts of Pb were associated with wheat yield. Lead was retained in the roots, due to its less translocation to the shoots.

Therefore, in this experiment Pb concentration in peanut and wheat was lying inside the permissible range according to Abd El-Aziz [10] and Stmad *et al.* [11]. In this connection, Judel and Stelte [9] concluded that no toxicity symptoms or yield reduction of radish, carrot and spinach plants occurred even at 500 (μg g^{-1}) Pb. On other hand, Kabata Pendias and Pendias [17] recorded that the toxic limits of Pb was

Table 6: Effect of lead and mineral fertilizers on the content of N, P and K in the grains and straw of wheat

	Grains											
	Pb treatment (μg g⁻¹)				Pb treatment (μg g⁻¹)				Pb treatment (μg g⁻¹)			
	0	5	10	20	0	5	10	20	0	5	10	20
NPK* (kg fed⁻¹)	N%				P%				K%			
80 – 15 – 24	1.86	1.92	2.10	2.24	0.26	0.28	0.29	0.30	2.26	2.29	2.30	2.33
80 – 15 – 36	2.00	2.06	2.21	2.41	0.28	0.31	0.32	0.31	2.27	2.31	2.35	2.36
80 – 20 – 24	2.20	2.22	2.30	2.50	0.29	0.32	0.33	0.31	2.29	2.33	2.38	2.31
80 – 20 – 36	2.42	2.50	2.71	2.71	0.29	0.34	0.34	0.33	2.29	2.35	2.42	2.40
120 – 15 – 24	2.50	2.55	2.87	2.87	0.30	0.36	0.34	0.35	2.3	2.35	2.42	2.42
120 – 15 – 36	2.61	2.62	2.98	2.99	0.32	0.36	0.36	0.37	2.34	2.36	2.43	2.44
120 – 20 – 24	2.67	2.72	2.98	2.98	0.33	0.37	0.38	0.38	2.36	2.37	2.44	2.45
120 – 20 - 36	2.68	2.87	2.99	3.00	0.33	0.37	0.38	0.39	2.37	2.38	2.45	2.46
L.S.D0.05forMineral (M)	0.082				0.013				0.061			
L.S.D0.05 for Lead (L)	0.078				0.012				0.058			
L.S.D0.05 for (M × L)	N.S				N.S				N.S			
	Straw											
	Pb treatment (μg g⁻¹)				Pb treatment (μg g⁻¹)				Pb treatment (μg g⁻¹)			
	0	5	10	20	0	5	10	20	0	5	10	20
NPK* (kg fed⁻¹)	N%				P%				K%			
80 – 15 – 24	1.10	1.19	1.40	1.51	0.15	0.15	0.16	0.16	1.48	1.48	1.59	1.68
80 – 15 – 36	1.11	1.30	1.62	1.69	0.17	0.12	0.16	0.17	1.49	1.55	1.68	1.68
80 – 20 – 24	1.12	1.51	1.69	1.70	0.17	0.16	0.17	0.18	1.51	1.57	1.77	1.78
80 – 20 – 36	1.22	1.62	1.72	1.72	0.18	0.19	0.19	0.19	1.62	1.75	1.86	1.89
120 – 15 – 24	1.26	1.66	1.77	1.78	0.19	0.21	0.20	0.20	1.77	1.78	1.88	1.89
120 – 15 – 36	1.29	1.68	1.84	1.85	0.20	0.22	0.21	0.22	1.78	1.80	1.95	1.96
120 – 20 – 24	1.36	1.70	1.85	1.86	0.21	0.22	0.22	0.23	1.87	1.89	1.96	1.98
120 – 20 - 36	1.37	1.73	1.86	1.88	0.22	0.23	0.23	0.24	1.88	1.94	1.98	1.99
L.S.D0.05 for Mineral (M)	0.046				0.019				0.032			
L.S.D0.05 for Lead (L)	0.044				0.018				0.031			
L.S.D0.05 for (M × L)	0.081				N.S				0.057			

*As N, P_2O_5 and K_2O, respectively

Table 7: Effect of lead and mineral fertilizers on the content of lead in the yield of wheat

	Pb treatment (μg g⁻¹)				Pb treatment (μg g⁻¹)			
	0	5	10	20	0	5	10	20
NPK* (kg fed⁻¹)	Grains				Straw			
80 – 15 – 24	0.20	1.40	2.30	3.40	1.80	2.00	2.51	3.90
80 – 15 – 36	0.21	2.00	2.40	3.40	1.80	2.20	2.84	4.20
80 – 20 – 24	0.22	2.00	2.60	3.60	1.90	2.40	2.99	4.80
80 – 20 – 36	0.22	2.20	2.60	3.50	2.00	2.90	3.10	4.82
120 – 15 – 24	0.23	2.10	3.20	3.80	2.40	3.10	3.52	4.90
120 – 15 – 36	0.24	2.20	4.10	4.00	2.60	3.40	3.60	4.92
120 – 20 – 24	0.26	2.30	4.20	4.40	3.00	3.50	3.61	4.94
120 – 20 – 36	0.28	2.30	4.30	4.50	3.10	3.65	3.72	4.99
L.S.D0.05 for Mineral (M)	0.131				0.085			
L.S.D0.05 for Lead (L)	0.124				0.081			
L.S.D0.05 for (M × L)	0.230				0.150			

*As N, P_2O_5 and K_2O, respectively

30-300 mg kg^{-1} in plant. The statistical analysis for data indicated that the wheat yield and its content of N, P, K and Pb were significantly affected by all treatments except that of N%, P% and K% in wheat grains and P% in wheat straw for M × L.

CONCLUSION

From above mentioned, discussion and under the conditions of this experiment, Pb concentration less than 20 mg l^{-1} did not adversely affect plant growth of peanut or wheat. Whereas, the concentration of Pb in different organs of plants did not reach the permissible limits that led to toxic effects on plants and consequently animal and human.

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