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Nitrogen Fixed by Pea Plant as Affected by Lead, Cadmium and Rates of N-Fertilizer Using ^{15}N Tracer Technique.

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ABSTRACT

A pot experiment was carried out in greenhouse to investigate the effect Pb and
Cd applied on growth, yield and the amount of fixed nitrogen by pea's plants. ^{15}N-labelled (5 % atom excess) ammonium nitrate was applied at three levels (0, 20 and 40 mg N^{-1} kg soil). The legume pea seeds were inoculated with *Rhizobium Leguminesarum*. Lead was applied as lead sulfate at rates of 0, 50 and 200 mg Pb kg^{-1} soil, while the cadmium applied as cadmium sulfate at rates of 0, 5 and 10 mg Cd kg^{-1} soil. Results indicated that the highest values of Pb-uptake were 540,11.55 and 552 mg^{-1} pot for pea shoot, pods and whole plant at the rate of 200 mg Pb^{-1} kg soil + 40 mg N^{-1} kg soil, respectively, While, the highest values of Cd-uptake were 13.90, 6.54 and 20 mg^{-1} pot at the rate of 10 mg Cd kg^{-1} + 20 mg N kg^{-1} soil for the same sequence. The values of Ndff and Ndfa were 43.74 and 278.2 while Ndfs recorded 164.1 mg pot^{-1} at rate of 5 mg Cd kg^{-1}soil + 40mg N kg^{-1} soil compared to the control.

INTRODUCTION

Use of chemical fertilizers is now widespread for supplementing the plant nutrition. Addition of heavy metals present as impurities in varying amounts whose content, after continued fertilizer application, may increase significantly in soil. Phosphate fertilizers are the greatest sources of heavy metals as these occur naturally in rock phosphate. Other inorganic fertilizers, such as urea, zinc sulphate, gypsum, etc, also may cause heavy metal contamination of soils and its uptake by plants. Other agriculture sources of heavy metals in soils are cattle manure, poultry manure and sewage sludge (**Rahman et al., 2007**).

Plants exposed to Pb ions showed a considerable decrease in dry weight of different plant parts **(Kosobrukhov**, **2004)** and decline in the total chlorophyll and that photosynthetic efficiency **(Heckathorn et al., 2004; Kambhampati et al**. **2005)**. **Sharma and Dubey (2005)** reported that plants exposed to Pb ions showed a decline in the photosynthetic rate as a result of distorted chloroplast, restrained synthesis of chlorophyll, obstructed of electron transport, inhibited activities of Calvin cycle enzymes, as well as deficiency of CO_2 as a result of stomatal closing.

In plants, exposure to Cd causes reductions in biomass production and nutritional quality, and inhibition of photosynthesis stomal conductance, transpiration rate **(Shi and Cai, 2008)**. Cadmium is easily taken up by plant roots and can be loaded into the xylem for its transport into leaves. A number of studies have demonstrated a toxic effect of Cd on plant metabolism such as decrease in the uptake of nutrient elements **(Sandalio et al., 2001)**. Cd stress effects photosynthesis in various ways. It inhibits the synthesis of chlorophylls **(Azevedo et al., 2005; Shukla et al., 2008). Wang et al. (2009)** stated that decreasing the accumulation of pigment lipoprotein complexes, particularly photo system was occurred. Cadmium also produces alterations in functionality of membranes by inducing changes in their lipid composition **(Foder et al., 1995)**. **Sajwan et al. (1996)** and **Aranjo do Nascimento and Pereira (1997)** ascertained that Cd was accumulated to a greater extent in the roots than in the stems of beans. According to **Rashed and Awadallah (1998)** the highest was the contents of Ni, Co, Pb and Cd in the leaves of beans while seeds showed the highest values in terms of Cu and Zn. **Leifa et al. (1993)** ascertained that beans accumulated Cd more than peas. According to **Dziamba et al. (1996**) the seeds of peas accumulated more Fe and Zn and the lowest was contents of Pb in the seeds of lentils.

The aim of this study was to investigate the effect of applied of Pb and Cd in soil on growth, yield, chemicals nutrients and the amount of fixed nitrogen by pea plants.

MATERIALS AND METHODS

A pot experiment was carried out in the greenhouse of the Soil and Water Research Department, Nuclear Research Center, Egypt. Pots were divided into two groups, the first group were planted with the reference crop (wheat) and the second group with the legume (pea), N-15 labelled (5% atom excess) ammonium nitrate was applied at three levels (0, 20 and 40 mg Nkg^{-1} soil). The pea seeds were inoculated with Rhizobium. Leguminesarum. Lead was applied at the rate of 0, 50 and 200 mg Pb kg^{-1} soil. A fixed rate of phosphorus (30 Kg p/Fed.) as supper phosphate was applied. Unfertilized control was also involved. The experiment was duplicated, the first spiked with Pb and the other one with cadmium as cadmium sulfate at levels of 0, 5, 10 mg Cd kg^{-1} soil). Soil samples from Bahteem area were packed in plastic pots (4 kg each), their physical and chemical characteristics was shown in Table (1). Wheat and pea seeds were sown (5 seeds pot^{-1}) and soil moisture was maintained at 60% of soil water holding capacity. After 56 days of growth, shoot, spikes and pods for both plant were collected separately, washed by distilled water, dried at 70 ^{0}C, weighed, ground and kept for analysis. Plant samples were digested and analyzed according to **Page, *et al.*, (1982).** Total Pb and Cd was determined using Atomic Absorption Spectrometry model GBC 902. Total P assayed colorimetrically using stannous chloride ammonium molybdate. Plant N was determined using kjeldahl method, ^{15}N-analyzed by an automated emission spectrometer (NOI-6PC) following the description of **IAEA, (2001).** The legume yield (g/pot), %Ndff, %Ndfs, %NUE, and the amount of fixed N (g N pot^{-1}) were estimated wheat yield (g pot^{-1}), %Ndff, %Ndfs and %NUE were calculated. Results in this work were subjected to ANOVA analysis followed by Duncan's multiple range test (DMRT) according to SAS software program (1995).

Table (1): Some physical and chemical properties of the experimental soil

a – Physical properties

Soil (Bahteem)	Partical size distribution (%)				Texture	$CaCO_3$ (%)
	Course sand	Fine sand	Silt	Clay		
	9.50	14.2	32.9	43.4	Clayey	3.73

b – Chemical properties

Soil (Bahteem)	OM. (%)	EC dS/m	pH 1-2.5 Soil suspension	Soluble cations and anions (meq/L)								Avaliable elements (ug/g)			
				Cations				Anions							
				Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO^{3-}	Cl^{-}	SO_4^{2+}	N	P	Pb	Cd
	1.81	0.79	8.09	2.4	3.89	1.20	0.45	---	2.85	1.86	3.23	31.5	21.6	7.4	1.3

RESULTS AND DISCUSSION

1. Effect of lead and nitrogen

1.1 Dry matter yield of pea and wheat plants

Dry matter yield of pea and wheat plants as affected by lead and nitrogen fertilizer applications is shown in table (2). At zero level of lead, the dry matter yield of different parts of wheat and pea plants was significantly increased with increasing nitrogen fertilizer levels as compared to the unfertilized control. In this respect, there was no significant difference between the two different levels of nitrogen application.

Application of lead at 50 or 200 mg kg^{-1} soil did not reflect significant difference in dry matter yield of pea plants when the combined with different rates of N fertilizer addition. Similar trends was noticed with wheat plant treated with different rates of both lead and nitrogen fertilizer. In this respect, Sainl and Gupta (1991) showed that 5 mg Pb kg^{-1} soil had enhanced grain and straw yield of wheat, while increasing the rate of lead had significantly decreased yield.

Table (2): Dry matter yield of wheat and pea plants as affected by lead and nitrogen application

Lead levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Wheat			Nitrogen levels mg kg^{-1} soil	Pea		
		Shoot	Spike	Whole plant		Shoot	Pods	Whole plant
0	0	16.3	8.81	25.1	0	13.3	5.94	19.3
	50	21.6	8.93	30.5	20	14.8	6.84	21.7
	100	21.5	8.03	29.6	40	14.3	6.78	21.1
Mean		19.8	8.59	28.4		14.2	6.52	20.7
50	0	22.1	8.25	30.4	0	12.7	7.26	19.9
	50	23.4	9.66	33.1	20	15.1	7.22	22.3
	100	23.7	9.55	33.3	40	15.6	6.63	22.2
Mean		23.1	9.15	32.2		14.4	7.04	21.5
200	0	22.4	9.61	32.0	0	14.6	7.13	21.8
	50	21.7	9.11	30.8	20	14.9	7.05	22.0
	100	20.3	8.60	28.9	40	14.8	6.74	21.5
Mean		21.5	9.10	30.6		14.8	6.97	21.8
L.S.D.(5%) Pb		1.86	0.91	2.40		1.48	0.52	1.80
N		1.74	0.69	1.68		1.04	0.66	1.13
Pb * N		3.02	1.20	2.91		1.81	1.15	1.96

1.2 N-uptake by wheat and pea plants

Nitrogen uptake by wheat and pea plants was significantly increased by increasing fertilizer-N rates up to 100 and 40 mg N kg^{-1} soil, for wheat and pea, respectively under the absence of lead (Table 3). This holds true with the different parts as well as the whole crop. Furthermore, the highest values of nitrogen accumulated in shoot, pods and whole pea plants were detected at the rate of 20 mg N kg^{-1} soil and relatively increased by 53.65%, 23% and 39.2% over control, respectively.

Table (3): N-uptake by wheat and pea plants as affected by lead and fertilizer nitrogen application

Lead levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Wheat			Nitrogen levels mg kg^{-1} soil	Pea		
		Shoot	Spike	Whole plant		Shoot	Pods	Whole plant
0	0	78.2	102	180	0	233	213	446
	50	134	105	239	20	358	262	621
	100	174	144	318	40	352	259	611
Mean		129	117	246		314	245	559
50	0	111	92.4	204	0	218	214	431
	50	133	158	292	20	280	237	517
	100	197	174	371	40	308	212	520
Mean		147	142	289		269	221	489
200	0	117	110	226	0	266	211	477
	50	167	139	307	20	272	222	494
	100	177	139	316	40	284	209	493
Mean		153	129	283		274	214	488
L.S.D. (5%) Pb		13.1	13.9	22.8		28.1	17.1	39.7
N		12.4	10.2	12.9		19.8	21.2	25.9
Pb * N		21.4	17.7	22.4		34.3	36.7	44.9

N-uptake by different parts of wheat plants was significantly increased with increasing nitrogen fertilizer application. The highest values of N-uptake were detected at rate of 100 mg N kg^{-1} soil and relatively increased by 122.5 %, 41.18 % and 76.7 % for shoot, spike and whole wheat plants, respectively. However, lead additions resulted in decrease of N-uptake by different parts of pea plant in spite of increasing fertilizer-N rate up to 40 mg N kg^{-1} soil. Pea plants treated with 50 mg Pb kg^{-1} soil plus 40 mg N kg^{-1} soil reflected relative increase in N-uptake by shoot and whole pea plants by about 32.19% and 16.6%, respectively over the untreated control.

Regarding N-uptake by wheat plants, was observed a significant increase in nitrogen accumulated into different parts of wheat plant with increasing nitrogen fertilizer application at two rates of 50 and 100 mg N^{-1} kg soil. However the highest values of N-uptake were detected at rate of 100 mg N kg^{-1} soil plus 50 mg Pb kg^{-1} soil and relatively increased by 151.92, 70.59 and 106.11% for shoot, spike and whole plants, respectively over untreated control.

1.3 Pb-uptake by wheat and pea plants:

Lead content in pea plants, data revealed that, generally, the concentration of lead in different parts of pea plants, was increased due to the application of lead at 50 and 200 mg Pb kg^{-1} soil + 20 and 40 mg N kg^{-1} soil. There is no positive effect on Pb content compared to untreated soil (Table 4). The highest values of Pb content were, 54.0, 11.55 and 55.2 mg pot^{-1} for pea shoots, pods and whole plants, respectively under treatment of 200 mg Pb kg^{-1} soil + 40 mg N kg^{-1} soil.

Table (4): Lead uptake by wheat and pea plants as affected by lead and nitrogen application.

Lead levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Wheat			Nitrogen levels mg kg^{-1} soil	Pea		
		Shoot	Spike	Whole plant		Shoot	Pods	Whole plant
0	0	22.7	11.0	33.7	0	24.5	8.39	32.9
	50	32.4	8.89	41.3	20	37.8	7.54	45.3
	100	34.2	10.5	44.7	40	36.6	9.61	46.2
Mean		29.8	10.1	86.0		33.0	8.52	41.5
50	0	44.4	9.57	45.4	0	25.8	8.43	26.6
	50	41.7	9.37	42.6	20	26.8	7.01	27.5
	100	49.7	7.49	50.5	40	32.7	6.53	33.3
Mean		45.3	8.81	46.2		28.4	7.32	29.2
200	0	78.0	8.02	78.8	0	50.9	5.96	51.5
	50	76.8	15.6	78.4	20	52.8	9.73	53.8
	100	71.6	11.9	72.7	40	54.0	11.55	55.2
Mean		75.5	11.8	76.7		52.6	9.08	53.5
L.S.D. (5%) Pb		67.0	0.77	67.2		55.4	0.75	55.8
N		51.6	0.91	51.4		23.4	0.76	23.4
Pb * N		89.4	1.58	89.1		40.6	1.32	40.6

Regarding Pb-uptake by wheat plants, a similar trend was observed at two rates of 50 and 200 mg Pb kg^{-1} soil plus 50 and 100 mg N kg^{-1} soil as compared to the untreated soil (control). The highest values of Pb contents in wheat plants were 78.0 and 78.8 mg Pb pot^{-1} at rate of 200 mg Pb kg^{-1} soil without N application for shoot and whole plants, respectively, while for spike it was 15.6 mg Pb pot^{-1} at rate 200 mg Pb kg^{-1} soil plus 50 mg N$^{/}$ kg soil. `In this respect, **Rui Yu-Kui et al., (2009)** stated that Pb content in corn grain was negatively correlated to nitrogen fertilizer input. **Abd El-Aziz et al., (2009)** demonstrated the tolerance of corn, wheat, clover, soybean and sunflower plants to Pb concentration where the highest amounts of Pb were recorded in corn, clover and soybean, while, the lowest ones were associated with sunflower and wheat. Also, **Kobata Pendias and Pindias (1992)** recorded that the toxic limit of Pb was 30-300 mg^{-1} kg in plant. **Malkowski et al., (2002)** showed that the Pb concentration in the roots of corn seedlings increased with increasing Pb concentration in the solution.

2. Effect of cadmium and nitrogen

2.1 Dry matter yield of wheat and pea plants

Without cadmium, wheat and pea plants showed slight increase of dry matter yield with increasing nitrogen fertilizer rate up to 100 and 40 mg kg^{-1} soil for wheat and pea, respectively. It seems that dry matter yield of both plants was slightly high at the low rate of fertilizer – N as compared to high rate. Application of cadmium at rate of 5 mg kg^{-1} soil induced an increase of wheat dry matter yield comparable to those recorded with the untreated control in absence of nitrogen fertilization. Reversible trend was noticed with pea plant. Combination of 5 mg Cd kg^{-1} soil and different rates of nitrogen fertilizer showed, in general, slight reduction of dry matter yield of both plants. Raising the cadmium application rate up to 10 mg kg^{-1} soil with or without nitrogen fertilizer, resulted in an increase of wheat dry matter as compared to the untreated control or to the low rate of cadmium (5 mg kg^{-1} soil). In case of pea plants, there is no significant difference between the two rates of cadmium addition when dry matter yield was concerned. This holds true with different nitrogen fertilizer rates combined with cadmium application. Pea dry matter yield tended to decrease with increasing cadmium rate as compared to the untreated control either with or without nitrogen fertilizer.

The obtained results refute those of **Januskaitiene (2010**) who found that pea treated with 1 m M Cd have shown a slight ($P > 0.05$) increase in dry biomass accumulation. Also, the same exposure of dry over-ground biomass of barley has decreased by 5% compared to the reference treatment, but we are in agreement with **Chizzola (1997)** stated that the heavy metals had negative influence on the growth and development of the leguminous crops and did not recommend their growing in polluted regions.

Table (5): Dry matter yield of wheat and pea plants as affected by cadmium and nitrogen application rates.

Cadmium levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Wheat			Nitrogen levels mg kg^{-1} soil	Pea		
		Shoot	Spike	Whole plant		Shoot	Pods	Whole plant
0	0	16.3	8.80	25.1	0	13.3	5.94	19.3
	50	21.6	8.93	30.5	20	14.8	6.84	21.7
	100	21.5	8.03	29.6	40	14.3	6.78	21.1
Mean		19.8	8.59	28.4		14.2	6.52	20.7
5	0	19.6	9.28	28.9	0	12.3	5.74	18.0
	50	20.4	8.21	28.6	20	14.3	6.60	20.9
	100	20.2	9.80	30.0	40	14.1	6.52	20.6
Mean		20.1	9.09	29.2		13.5	6.28	19.8
10	0	21.6	9.23	30.8	0	11.3	5.69	17.0
	50	22.3	10.4	32.7	20	13.9	6.54	20.5
	100	21.8	10.3	32.1	40	13.8	6.48	20.3
Mean		21.9	9.96	31.9		13.0	6.24	19.2
L.S.D. (5%) Pb		1.83	1.29	2.64		0.77	0.80	1.45
N		2.07	0.81	2.43		1.49	0.33	1.49
Pb * N		3.58	1.40	4.21		2.59	0.57	2.59

2.2 N-uptake by wheat and pea plants as affected by cadmium and nitrogen application:

Data in Table (6) showed that, generally, N-uptake by pea plant was decreased due to the application of cadmium and nitrogen fertilizer. This holds true different levels of cadmium and nitrogen. Furthermore, the highest values were 275, 221 and 496 mg^{-1} pot for pea shoot, pods and whole plant, respectively at rate of 5 mg Cd kg^{-1} soil plus 20 mg N kg^{-1} soil, while under control (without Cd) the highest values recorded 358, 262 and 621 mg pot^{-1} at rate of 20 mg N kg^{-1} soil for the same sequence.

Regarding wheat N-uptake, data showed a significant increase under all treatments was observed. The highest values was 198 mg pot at rate of 5 mg Cd kg^{-1} soil plus 100 mg N kg^{-1} soil, while under control (without Cd), the highest values recorded 174, 144 and 318 mg^{-1} pot at rate of 100 mg N kg^{-1} soil for the same sequence. The obtained results indicated that wheat plants were more tolerant to increasing rates of cadmium where the N-uptake was increasing by increasing the level of cadmium up to 10 mg kg^{-1} soil. Reversible trend was noticed with pea plants which were sensitive to the raise of cadmium levels that depressed the N-uptake by plants. In this regard, the nitrogen absorption in the form of nitrate could be reduced when plants exposed to cadmium addition

(Herandez et al., 1997; Khater et al., 1991 and Petrovec et al., 1991). In addition, cadmium can also reduce the absorption of nitrate and its transport from roots to shoots by inhibiting the nitrate reductase activity in the shoots (Herandez et al., 1997)

Table (6): Nitrogen uptake by wheat and pea plants as affected by Cadmium and nitrogen application.

Cadmium levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Wheat			Nitrogen levels mg kg^{-1} soil	Pea		
		Shoot	Spike	Whole plant		Shoot	Pods	Whole plant
0	0	78.2	102	180	0	233	213	446
	50	134	105	239	20	358	262	621
	100	174	144	318	40	352	259	611
Mean		129	117	246		314	245	559
5	0	131	97	229	0	213	166	379
	50	147	118	265	20	275	221	496
	100	198	144	342	40	273	214	486
Mean		159	120	279		254	200	454
10	0	84.3	80.3	165	0	190	161	350
	50	103	141	244	20	261	212	473
	100	190	161	351	40	254	207	461
Mean		126	128	253		235	193	428
L.S.D.(5%) Pb		17.2	17.8	31.5		14.4	25.2	36.6
N		15.3	11.1	22.5		28.8	10.9	30.1
Pb * N		26.6	19.2	39.0		50.0	18.9	52.1

2.3 Cadmium concentration in wheat and pea plants:

Data in Table (7) showed that, Cd-uptake by pea plants was significantly increased affected by the application of Cd and nitrogen fertilizer. The highest values were 0.0014%, 0.0010% and 0.0021% at rate of 10 mg Cd kg^{-1} soil plus 20 mg N kg^{-1} soil for shoot, pods and whole pea plant compared to the control(without Cd) which recorded 0.0015%, 0.0010% and 0.0022% at the same rate applied.

Table (7): Cadmium concentration in wheat and pea plants as affected by cadmium and nitrogen application rates.

Cadmium levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Wheat			Nitrogen levels mg kg^{-1} soil	Pea		
		Shoot	Spike	Whole plant		Shoot	Pods	Whole plant
0	0	0.0010	0.0004	0.0011	0	0.0004	0.0002	0.0006
	50	0.0010	0.0004	0.0013	20	0.0005	0.0002	0.0007
	100	0.0010	0.0004	0.0014	40	0.0003	0.0003	0.0005
Mean		0.0010	0.0004	0.0013		0.0004	0.0002	0.0006
5	0	0.0010	0.0010	0.0016	0	0.0019	0.0002	0.0021
	50	0.0011	0.0010	0.0100	20	0.0015	0.0002	0.0018
	100	0.0022	0.0012	0.0034	40	0.0021	0.0002	0.0023
Mean		0.0014	0.0011	0.0050		0.0020	0.0002	0.0021
10	0	0.0015	0.0010	0.0025	0	0.0023	0.0002	0.0025
	50	0.0030	0.0014	0.0030	20	0.0031	0.0003	0.0034
	100	0.0028	0.0014	0.0042	40	0.0034	0.0002	0.0035
Mean		0.0024	0.0013	0.0032		0.0032	0.0002	0.0031
L.S.D.(5%) Pb		1.66	1.48	3.01		1.56	0.27	1.73
N		2.36	0.89	2.87		1.92	0.11	1.89
Pb * N		4.10	1.54	4.98		3.32	0.18	3.28

For wheat, cadmium uptake by different parts of wheat plants was significantly increased as response to the application of Cd and nitrogen fertilizer under all treatments. The highest values were 0.0028%, 0.0014% and 0.0042% detected at rate of 10 mg Cd kg^{-1} soil plus 100 mg N kg^{-1} soil for shoot, spike and whole wheat plants compared to the control (without Cd), respectively. In this regard, **Landberg and Greger (2003)**, found in one pot study and one hydroponic study that the Cd concentration decreased with increasing N rate. However, under field conditions it seems likely that N fertilization generally causes an increase in grain Cd concentration. Under pot experiment to study the effects of the different concentrations of Cd on accumulation of four cultivars of maize **Liu et al., (2006)** indicated that the Cd levels in roots and shoots of four cultivars increased significantly with increasing Cd concentration. Cadmium ions were concentrated mainly in the roots and small amounts of Cd were transferred to the shoots.

3. Partitioning of pea nitrogen into different sources:

Data presented in Table (8) showed that the nitrogen derived from fertilizer (Ndff) and air (Ndfa) by pea plant were markedly decreased, while, nitrogen derived from soil (Ndfs) was increased, due to the application of nitrogen fertilizer from 20 up to 40 mg N pot $^{-1}$ with or without lead and cadmium levels. Under all treatments of lead, the highest values of Ndff and Ndfa were 36.40 and 231.5 mg N pot^{-1} at rate of 50 mg Pb kg^{-1} soil plus 40 mg N kg^{-1} soil, while, the highest value of Ndfs was 292.2 mg kg^{-1} at rate of 20 mg N kg^{-1} soil plus 200 mg Pb kg^{-1} soil compared to control (without Pb) which recorded 42.77, 378.8 and 183.3 mg N^{-1} pot , respectively. Under all treatment of cadmium, the highest values of Ndff and Ndfa were 43.73 and 278.2 mg N^{-1} pot at rate of 40 mg N kg^{-1} soil plus 5 mg cd kg^{-1} soil, while, the highest values of Ndfs was 266.0 mg N pot^{-1} at rate of 20 mg N kg^{-1} soil plus 5 mg cd kg^{-1} soil compared to control (without Cd) which recorded 43.47, 378.8 and 326.0 mg pot^{-1} for Ndff, Ndfa and Ndfs, respectively.

Table (8): Effect of lead,cadmium and nitrogen levels on nitrogen derived from fertilizer (Ndff), air (Ndfa) and soil (Ndfs) and uptake by pea plants.

Lead levels mg kg^{-1} soil	Nitrogen levels mg kg^{-1} soil	Peas Whole plant			
		Total N	Ndff (mgpot^{-1})	Ndfa (mgpot^{-1})	Ndfs (mgpot^{-1})
0	20	620.97	43.47	251.5	326.0
	40	611.00	42.77	378.8	183.3
50	20	517.00	36.19	209.3	271.5
	40	520.00	36.40	231.5	252.1
200	20	494.00	34.58	167.2	292.2
	40	493.01	34.51	201.5	257.0
Cadmium Levels mg kg^{-1} soil	**Cadmium**				
0	20	620.97	43.47	251.5	326.0
	40	611.00	48.88	378.8	183.3
5	20	496.02	34.72	200.9	260.4
	40	486.04	43.74	278.2	164.1
10	20	473.00	35.50	171.5	266.0
	40	406.99	39.19	228.7	139.1

CONCLUSION

Pb-uptake and accumulated in different organs of pea plant was observably increased due to the application of lead source at two rates applied of (50 and 200 mg Pb^{-1} kg soil) + (20 and 40 mg N^{-1} kg soil) except with pea pods.

Cd concentration in different parts of pea plant, observed that, in general, there were no a positive impact on Cd content due to the application of N-fertilizer + Cd applied at rates of (20 and 40 mg N^{-1} kg soil) + (5 and 10 mg

Cd^{-1} kg soil) compared to control (without Cd).

Ndff and Ndfa in pea plant markedly decreased, while Ndfs markedly increased by increasing N-fertilizer up to 40 mg N kg^{-1} soil plus Pb up to 200 and Cd up to 10 mg kg^{-1} soil, respectively.

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المؤتمر الدولي الثالث
للعلوم الإشعاعية وتطبيقاتها
١٢ – ١٦ نوفمبر ٢٠١٢ – الغردقة - مصر

النتروجين المثبت بواسطة نبات البازلاء المتأثر بالرصاص و الكادميوم ومعدلات السماد النتروجينى باستخدام تقنية النتروجين المستقر(ن-١٥).

مازن مصطفي إسماعيل- شرين محمد الدجوي- حسين أحمد عبد العزيز- سمير إبراهيم الباز.

أجريت تجرب أصص في الصوبة الزراعية لدراسة تأثير عنصري الرصاص والكادميوم علي النمو ، المحصول وكمية النتروجين المثبت بواسطة نبات البازلاء. أضيف سماد نترات الامونيوم المرقم فى ثلاث مستويات (صفر، ٢٠، ٤٠ ملليجرام ن/كجم تربة) كما أضيف الرصاص بمعدل (صفر، ٥٠، ٢٠٠ ملليجرام رصاص /كجم تربة) وكذلك الكادميوم أضيف بمعدل (صفر، ٥، ١٠ ملليجرام كادميوم /كجم تربة). أظهرت النتائج الآتية:

*- أعلي القيم من الرصاص الممتص والمتراكم سجلت ٥٤٠، ١١,٥٥، ٥٥٢ ملليجرام/أصيص لكل من القش و القرون و كامل النبات علي التوالي عند معدل إضافة ٢٠٠ ملليجرام رصاص/كجم تربة + ٢٠ ملليجرام ن/كجم تربة.

*- أعلي القيم من الكادميوم الممتص والمتراكم سجلت ١٣,٩٠، ٦,٥٤، ٢٠ ملليجرام/أصيص عند معدل إضافة ١٠ ملليجرام كادميوم/كجم تربة + ٢٠ ملليجرام ن/كجم تربة لنفس التسلسل السابق.

*- قيم النتروجين المثبت و كذلك الممتص من السماد سجلت ٤٣,٧٤ ، ٢٧٨,٢ ملليجرام/أصيص، بينما النتروجين الممتص من التربة بواسطة نبات البازلاء سجل ١٦٤,١ ملليجرام/أصيص عند معدل إضافة ٥ ملليجرام كادميوم/كجم تربة +٤٠ ملليجرام ن/كجم تربة مقارنة بالكنترول.