J. Agric. Sci. Mansoura Univ., 33(8): 6041 – 6051, 2008

EFFECT OF SOME SOIL AMENDMENTS APPLICATION ON HEAVY METAL UPTAKE IN SOME VEGETABLE CROPS

El-lithy, Y.T.; A.Y. Ramadan and H.M. Abd El-All
Vegt. Ras. Dept., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Two field experiments were conducted at the Experimental Farm of Horticultural Research Institute (Qaha Farm) during the two successive winter seasons of 2005 and 2006 to elucidate the effect of some soil amendments application such as farmyard manure at 20m^3/fed, in addition gypsum at 2 ton/fed, sulphur at 500 kg/fed and their combination besides to the check treatment on vegetative growth, heavy metal uptake (lead and cadmium) by edible parts of lettuce plants (*Lactuca sativa* L) "cv dark green" and radish (*Raphanus sativus* L.) "cv white radish" which grown near the Cairo – Alexandria Agriculture road. Traffic densities on the examined road were about 120960 vehicles/day.

The obtained results show that applying farmyard manure, gypsum and/or sulphur reflected the highest values of vegetative growth parameters expressed as fresh and dry weight per plant as well as number of leaves /plant with high significant differences compared with the control treatment (without application). Using soil amendments especially in a mixture form exhibited the highest values of vegetative growth aspects and total yield as well as ascorbic acid content. Heavy metal uptake by edible parts were depressed with the addition of single or mixer application of farmyard manure and gypsum compared with sulphur treatment and the control.

Generally, farmyard manure and gypsum in a single or mixer application gave the best results and are recommended for increasing productivity and improving the quality of lettuce and radish grown near the high densities traffic roads by reduction the heavy metal contents.

INTRODUCTION

Air pollution is found almost all over the world and especially in the big cities. It is serious problem in Egypt as well as many countries over the world. It can affect negatively on plants and animals health and damage buildings and other structures. It so happened that many people died and some are still suffering from neurotoxic effect of the poisonous gas. Air pollution is a major cause of cancer, skin diseases, tuberculosis etc. Factories and vehicles exhaust are major cause of air pollution.

Also, car exhaust contributes to the greenhouse effect and to the formation of acid rain and smog. Motor vehicles are a similar important source of heavy metal pollution on the environment. Petroleum fuels when combusted are a source of heavy metals, as are fuel additives, particularly tetraethyl lead. Antiwear protectants incorporated in lubricants often contain Cd, Cr, Hg, Ni, Pb, and/or Zn (Smith *et. al.,*1975). Ruhling, and Tyier, (1968) illustrated that low levels of environmental Pb enrichment extends from 50 to several hundred meters from the road. Motto *et. al.,* (1970) reported that, motor oil and treat wear from vehicular tires are sources of pollution with Cd and other metals for plants grown near roadside. Quinche, (1971) reported that vegetables growing near roads had high Pb contents, especially those with large leaves such as lettuce and spinach, and those with finely divided leaves such as fennel and parsley.

Cadmium and lead are toxic to animals and humans, making their behavior in soils and plants of principle importance in relation to food chain contamination (Baker *et. al.* 1979). Ochaia (1987) recorded that mechanisms of metal toxicity is the displacement of essential metal ions from biomolecules and other biologically functional units; blocking essential functional groups of biomolecules, including enzymes and polynucleotides; modifying the active conformation of biomolecules especially enzymes and polynucleotides; disrupting the integrity of biomolecules; and modifying other biologically active agents. Lead accumulated on roadside soils are mainly caused by motor vehicles.

The level of heavy metals contamination depended on the location of the experimental plot in relation to the sources of pollution, atmospheric deposition of these elements and some soil properties (Sekara *et. al.,* 2000).

In this respect, Davies and Holmes (1992) Studied the inter-relationships between soil properties and the uptake of cadmium, copper, lead and zinc from contaminated soils by radish (*Raphanus sativus* L.). They indicated that there were significant positive relationships between soil pH and leaf or roots Pb and Cd content. The pH term was positive suggesting that raising the soil pH would increase uptake. Guttormsen *et al.,* (1995) recorded that Cd uptake by vegetable crops was significantly higher at pH 5.5 than at pH 6.5. Jauert *et al.,* (2002) reported that the plants with the lowest rhizosphere pH had the highest total plant cadmium and highest tissue cadmium concentrations and those with the highest rhizosphere pH had the lowest total plant cadmium and cadmium concentrations in their tissues. And suggesting that rhizosphere pH may be not it the only factor controlling cadmium uptake in strawberry clover. In this respect, many investigators found that the application of soil amendments such as sulphur and organic manure had a favourable effects on soil pH values and consequently, the availability of certain plant nutrient may be increased (El- Shall *et al.,* 1987, El-Gala *et al.,* 1989, Wassif *et al.,* 1995 and El- Maghraby *et al.,* 1997). In addition, the processes where by the addition of organic matter makes and modifies are numerous. The pH of the soil solution chelates heavy metal ions in it, support microbial life, release carbon dioxide, accelerate the chemical weathering of minerals, and has effects on the physical conditions and water-holding capacity of the soil. These additions of organic matter have general effect on mineral nutrients of making them more mobile available absorption by the plants and for removal via run-off and percolation. (Epstein 1971). Some chemical techniques are available which help immobilize heavy metals in soil, so that they cannot be taken up by plants. These include the application of dolomite, phosphates or organic matter into polluted soil. Such materials can reduce the concentration of heavy metals by precipitation, adsorption, or complexation (Chen and Lee 1997a).

So that, the aim of this research is study the role of soil conditioner such as sulphur, gypsium and organic manure as well as their combination on cadmium and lead concentration in edible parts of two vegetable crops (lettuce and radish)

MATERIALS AND METHODS

Two field experiments were conducted during the two successive winter growing seasons of 2005 and 2006 at Qaha Vegetable Research Station, Horticulture research Institute. The farm located at 30-kilometer North Cairo, on the west of Cairo–Alexandria Agriculture road. Traffic densities on the examined road were about 120960 vehicles/day. These experiments were carried out to investigate the effect of soil amendments, i.e., farmyard manure (20 m^3/feddan), Gypsium (2 ton/feddan), sulpher (500 kg/feddan), and their combination in addition to the control treatment (without additives) on vegetative growth and yield as well as chemical content from lead and cadmium in edible parts of lettuce (*Lactuca sativa* L) cv. dark green and radish (*Raphanus sativus* L.) cv. white radish and compared these concentrations with maximum level or guidelines for maximum limit (ML) of metals by CODEX (2001) alimentarius commission from lead and cadmium in vegetables (were adopted by FAO/WHO).

Seeds of lettuce were sown on 5^{th} and 2^{nd} of October and transplants of 35-days old were planted on 7^{th} and 4^{th} of November for the first and second seasons, respectively. Transplants were planted at 20 cm apart on both sides of rows 70 cm width. Where as, radish seeds were sown directly on 7^{th} and 4^{th} of November for the first and second seasons, respectively. Uniform seeds of radish were sown in hills on the two sides of ridge at 20 cm apart on both sides of rows with 70 cm width. Thinning took place after complete germination (three weeks after planting) leaving one plant per hill.

The treatments were executed in randomized complete block design with three replicates. The plot area was 10.5 m^2 which contained three rows and 5m length. Each treatment was separated by two guard ridges. The used organic manure had C/N ratio of 13.6 & pH of 7.3 and N,P and K contents of 1.64%, 0.93% and 1.48% respectively. Soil conditioners were mixed with the upper 15cm of the top soil during soil preparation and the traditional agricultural practices were separately done for each growing season and the recommended rates of N,P and K were applied at the appropriate times for each growing crop. No pesticides and herbicides were used.

The fresh samples were collected after 90 days from sowing and washed with a deionized water. Data on growth (number of leave and plant fresh and dry weight) were recorded in addition to the edible part weight from lettuce (inner leaves) and white radish (roots). Average of total marketable yield were measured per plot then calculated to ton/fed. Ascorbic acid content was determined using 2, 6 dichlorophenol indophenol for titration method was used to determine ascorbic acid according to the method mentioned in A.O.A.C 1990.

Dry weight percentage of leaves and mineral contents were calculated from determined dry matter of leaves dried at 70°C and weighed. Samples were digested to determine cadmium and lead by using Perian-Elemer Model

3300 Atomic Absorption Spectrometer according to the method described by Rawe (1973).

Soil sample were taken before sowing for the depth 0-30 cm. and analyzed at Central Lab Unit Soil and Water Research Institute. The chemical and mechanical characteristics and heavy metal concentration (lead and cadmium content) were determined in the soil as shown in Table (1).

Table (1). Chemical and physical properties of soil samples from Qaha farm.

Distance from the road (m)	Depth (cm)	Textural class			pH in 1:2.5 soil: water suspen-sion	Organic Matter%	E.C m mhos/cm at 25° 1:5 soil:	$CaCO_3$ %	CEC meq/ 100 gm soil	Heavy metal			
		sand%	silt%	clay %						Available		Total	
		15.44	36.80	47.26						Pb	Cd	Pb	Cd
150-200	0-30	Clay loam			8.639	2.07	0.66	1.79	40.9	8.1	0.0	40.2	5.0

The irrigation water samples were collected from under-ground water. Volumes of each sample equal to 5 liters were taken to analyzed at Central Lab Unit Soil and Water Research Institute. Chemical analysis were tabulated in Table (2).

Data obtained was subjected to statistical analysis by the technique of analysis of variance (ANOVA) for randomized complete blocks design. The treatment means were compared using least significant difference (LSD) method as mentioned by Gomez and Gomez (1984) A randomized complete block design with three replicates was adopted.

Table (2). Chemical analysis of water irrigation at Qaha farm for under ground water

pH	E.C mmos/cm	E.C ppm	Cation me. q/liter				Anion me.q/liter				Heavy metal	
			Ca_2^+	Mg_2^+	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Pb	Cd
7.88	1.442	923	4.27	1.83	2.58	0.39	0.00	4.18	2.36	2.53	0.052	0.003

RESULT AND DISCUSSION

Results of this research well be considered under the following headings:

Lettuce:

Data in Table (3) show the number of leaves and plant fresh weight and edible part fresh weight values as affected by soil amendments applications. Obviously, the growth characters values were increased with different magnitude under any of the applied treatments as compared with the control treatment. The rate of increment was varied according to the type of conditioner and their combination. It evident that the applications of organic manure with gypsum or sulphur caused a remarkable increase in number of leave and fresh weight plant as well as edible part fresh and dry weight.

Table (3): Effect of soil amendments on number of leaves, plant fresh weight, weight of edible part and yield of lettuce plants during 2005, 2006

Treatments	Number of leaves		Plant fresh weight (g)		Edible part weight (g)		Edible part dry weight (g)		Yield (ton/ feddan)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Organic	37.01	35.52	846.52	703.67	405.05	401.66	38.03	37.71	14.90	14.91
Sulphur	26.00	32.36	634.83	689.33	373.12	391.67	35.02	36.77	13.59	14.55
Gypsum	33.00	38.41	758.33	793.67	383.15	425.33	35.96	39.93	13.72	15.63
Organic+Gypsum	43.33	46.16	890.67	916.67	459.33	467.67	43.13	43.91	16.89	17.60
Organic+Sulphur	42.61	41.00	870.53	820.67	429.66	440.00	40.34	41.31	15.74	16.90
Without	23.31	25.66	623.67	618.67	326.33	376.33	30.64	35.33	15.61	14.24
L.S.D 5%	7.26	3.98	96.31	35.56	30.43	38.38	2.85	3.60	2.77	1.28

Also, the same data indicate that the plant growth measurements were significantly increased with the application of organic manure and gypsum. The highest values from number of leaves and plant fresh weight as well as edible part weight were detected with the addition of the combination from organic manure and gypsum, while the lowest values were obtained with the control treatment (without application).

The increase of characters mentioned above may be attributed to the improvement of the aeration conditions which tended to induce more oxidation and mineralization of nutrients-organic compounds (El-Sayed, 1998).

The data of statistical analysis indicate that there is a good liner relationship and high significant effect between yield and either of farmyard manure, gypsum and sulphur application in a single or mixture. Single application gave less values than mixture of them, however, application of farmyard manure with gypsum or sulphur gave the highest yield compared with other treatments and the control (without application).

Results in Table (4) clearly indicate that application of soil conditioner increased the ascorbic acid content in leaves and the differences were reached to the level of significant in both seasons of study. Since, application of the mixture of farmyard manure with gypsum or sulphur increase ascorbic acid content compared with single application of them or the control treatment

Regarding, the effect of soil amendments on Pb and Cd concentration in inner leaves of lettuce, data in Table (4) show that the concentration of lead and cadmium were reduced by the application of soil amendments especially with treatments of farmyard manure and gypsum, while the treatments which included sulphur increased the concentration of two metals in inner leaves of lettuce. In this respect, De Pieri *et.al.,* (1996) found that heavy metal contents in potato was coincided with high extractable soil sulphur and sodium contents.

Table (4): Effect of soil amendments on vitamin C. (mg/100g fresh weight) as well as Pb and Cd concentration (ppm) in edible part from lettuce plants during seasons (2005 and 2006) compared with maximum level or guidelines for maximum limit (ML) of metals in vegetables were adopted from FAO/WHO.

Treatments	vitamin C. (mg/100g fresh weight)		Lead concentration (ppm)		Cadmium concentration (ppm)		Recommended Max. L. for Vegetables	
	2005	2006	2005	2006	2005	2006	Lead	Cadmium
Organic	68.10	75.48	0.271	0.134	0.064	0.061	0.3	0.1
Sulphur	59.48	69.08	0.398*	0.300*	0.102*	0.095		
Gypsum	72.23	79.43	0.296	0.211	0.071	0.070		
Organic + Gypsum	81.38	80.61	0.253	0.106	0.051	0.043		
Organic+ Sulphur	77.32	89.18	0.366*	0.285	0.085	0.081		
Without	55.89	68.60	0.327*	0.226	0.083	0.075		
L.S.D 5%	8.04	6.88	0.06	0.06	0.02	0.02	-	-

Source: FAO/WHO - Codex alimentarius commission, 2001.
[*] > Recommended Maximum Level for Vegetables.

Radish:

The influence of the soil conditioners on leaves number, plant fresh weight, root fresh and dry weight were listed in Tables (5). Data indicate that, there was a significant effect between combination of farmyard manure with gypsum or sulphur and single application from the same materials on these characters in both seasons. The highest values from all characteristics were detected at the combination of farmyard manure with gypsum, while the combination of farmyard manure with sulphur came in the second order. the lowest values were obtained with the control treatment.

Table (5): Effect of soil amendments on number of leaves, Plant fresh weight, weight of edible part and yield of white radish plants during 2005, 2006

Treatments	Leaves Number		Plant fresh weight (g)		Edible part weight (g)		Edible part dry weight (g)		Yield (ton/ feddan)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Organic	20.05	22.31	1009.33	981.00	645.67	608.02	52.70	49.63	14.75	13.89
Sulphur	16.36	22.05	969.33	954.33	565.33	564.67	46.14	46.09	12.92	12.90
Gypsum	17.67	28.36	1027.67	1001.33	624.21	627.66	50.93	51.23	14.26	14.34
Organic+Gypsum	28.69	29.11	1177.67	1212.67	703.60	691.66	57.44	56.46	16.08	15.80
Organic+Sulphur	24.34	29.11	1039.67	1133.67	678.00	636.00	55.34	51.91	15.49	14.53
Without	15.60	21.67	946.33	933.67	542.67	558.67	44.29	45.60	12.40	12.76
L.S.D 5%	7.61	3.23	300.7	35.56	50.55	53.02	4.12	4.32	1.16	1.21

Table (5) shows the response of yield to the effect of different soil amendments. In this respect, there was significant increment in yield with the application of farmyard manure combined with each of gypsum or sulphur, while single application of farmyard manure, gypsum or sulphur gave the less values for yield, but, it was higher than the control (without application). These result due to the application of gypsum or sulphur supported the role of farmyard manure in improving the soil chemical and physical properties and consequently increased the availability of nutrients in rhizosphere zone.

Results in Table (6) indicate clearly that there was significant effect of soil amendments on ascorbic acid content during both seasons of study. It was showed a gradual increase in ascorbic acid content of roots with source of amenders. Values of relative increase of ascorbic acid as affected by farmyard manure, gypsum, sulphur and their combination of applied can be arranged as follow: FYM+gypsium>FYM+S>FYM>gypsium>sulphur.

Concerning with heavy metal content in radish root, data in Table (6) indicate clearly that positive effect of gypsum and farmyard manure on Pb and Cd content were found in both seasons of study. The mixture of farmyard manure and gypsum or single application reduced the contents of heavy metal content. In this respect, Sekara *et. al.,* (2000) observed a significant correlation coefficients were established between the level of heavy metals, atmospheric deposition of these elements and some soil properties. The reduction in heavy metal content due to gypsum and farmyard manure application may be related to increasing the infiltration rate of the soil. Consequently more soluble salts will have the chance to be leached out by the following irrigation water. Also, the reduction occurs in heavy metal content values may be due to farmyard manure and gypsum which rendered to the structure with improvement physical properties of soil and consequent increase in the soluble salts leachability by the following irrigation (Wassif *et al.,* 1997).

Table (6): Effect of soil amendments on vitamin C. (mg/100gm fresh weight) as well as Pb and Cd concentration in edible part from white radish plants during seasons (2005 and 2006) compared with maximum level or guidelines for maximum limit (ML) of metals in vegetables were adopted from FAO/WHO.

Treatments	vitamin C. (mg/100gm fresh weight)		Lead concentration (ppm)		Cadmium concentration (ppm)		Recommended Max. L. for Vegetables	
	2005	2006	2005	2006	2005	2006	Lead	Cadmium
Organic	50.62	43.77	0.176	0.110	0.045	0.043	0.3	0.1
Sulphur	49.04	38.63	0.286	0.214	0.085	0.081		
Gypsum	54.10	42.55	0.205	0.124	0.055	0.052		
Organic + Gypsum	62.70	53.62	0.166	0.104	0.036	0.035		
Organic+ Sulphur	58.02	44.87	0.248	0.162	0.062	0.062		
Without	41.65	35.04	0.217	0.132	0.058	0.055		
L.S.D 5%	4.81	7.83	0.057	0.057	0.02	0.02		

Source: FAO/WHO - Codex alimentarius commission, 2001.
*** > Recommended Maximum Level for Vegetables.**

Heavy metal uptake by edible parts of lettuce and white radish

Fig (1 and 2) show that lettuce inner leaves contain higher concentration of lead and cadmium than radish root in both seasons. These results are in harmony with John (1973), Pattersson (1977), Page *et al.,* (1981), Chumbley and Unwin (1982), Kuboi *et. al.,* (1986) and Feng, *et. al.,* (1993) they observed that, relative Cd uptake by range of different crop plants growing in contaminated soils were taken lettuce > radish > carrot > spinach > cauliflower > oats > pea.

Lettuce inner leaves included higher concentration from lead and cadmium contamination. Everywhere, the highest value was detected in lettuce leaves follows by radish root, this findings were attributed to the exposed plant parts (the leaves) accumulate larger quantities of air-derived metals than do unexposed plant parts e.g., roots (Ross 1994).

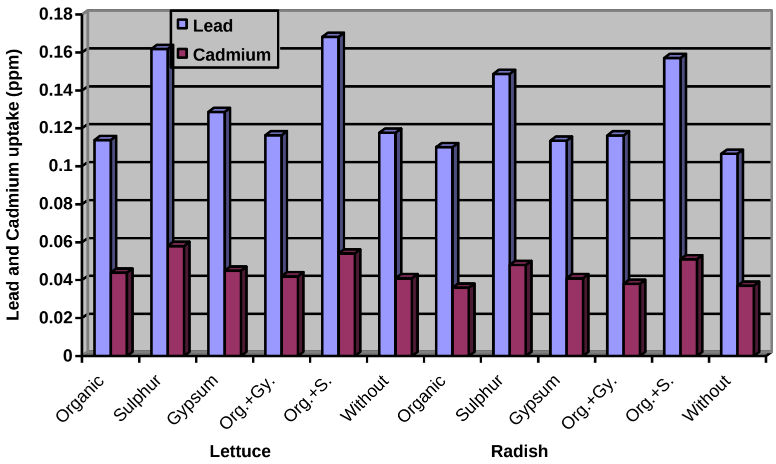

Fig (1): Effect of some soil amendments on Pb and Cd uptake by edible parts of lettuce and white radish plants during season 2005/2006.

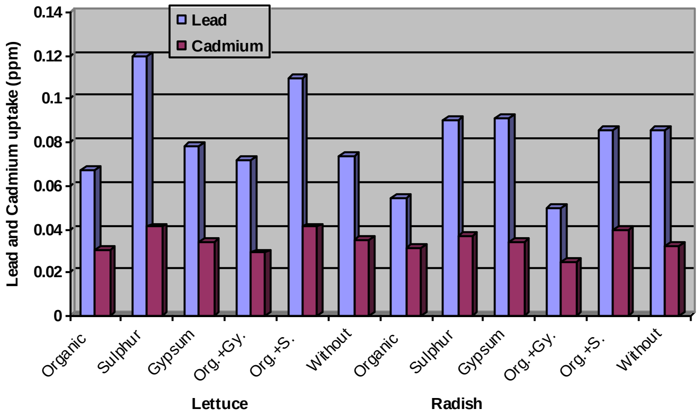

Fig (2): Effect of some soil amendments on Pb and Cd uptake by edible parts of lettuce and white radish plants during season 2006/2007.

Hovmand *et. al.,* (1983) reported that anything from 20 to 60 % of Cd uptake by a range of different edible crops could be air-derived. As the heavy metal contents in edible parts values were greatly decreased in the second season (fig 2) by residual soil amendments treatments.

Generally, lettuce inner leaves and radish roots showed decreases of Cd and Pb content and the values were below the critical limit with farmyard manure and gypsum addition as a soil amendments. On the basis of the FAO/WHO provisional tolerable weekly intake of 0.5 mg Cd and 3 mg Pb/60 kg of man body weight (Guttormsen 1990)

REFERENCES

Association of Official Analytical Chemists. (1990). Official and tentative methods of analysis. The A.O.A.C., Washington D.C., U.S.A.

Baker, D. E., Amacher, M.E. and Leach, R.M. (1979). Sewage sludge as source of cadmium in soil – plant –and animal systems . Environ. Health Persect., 28: 45-49.

Chen, Z.S. and D.Y. Lee. 1997a. Evaluation of remediation techniques on two cadmium polluted soils in Taiwan. In: Remediation of Soils Contaminated with Metals, A. Iskandar, and D.C. Adriano (Eds.). Science Reviews, Northwood, UK, pp. 209-223.

Chumbley, C.G. and Unwin, R.J. (1982). Cadmium and lead content of vegetable crops grown on land with a history of sewage sludge application. Environmental Pollution (Series B)., 4: 231-237.

CODEX Alimentarius Commission, FAO/WHO. (2001). Food Additives And Contaminants. Joint FAO/WHO Food Standards Programme 2001, ALINORM 01/12A:1-289.

Davies, B.E. and Holmes, P.L. (1992). Lead contamination of roadside soil and grass in Birmingham, England, in relation to naturally occurring levels. J. Agric. Sci. Camb., 79 (3): 479-484.

De Pieri, L.A., Buckler, W.T. and Kowalenko, C.G. (1996). Cadmium and lead concentrations of commercially grown vegetables and of soils in the Lower Fraser Valley of British Columbia. Can. J. Soil Sci. 77: 51-57.

El-Gala, A.M., M.A. Mostafa and S.E. El- Maghraby (1989). Influences of sulfur and saline irrigation water on growth and elemental status of barley plant grown on calcareous soils. Egypt. J. Soil Sci., Special Issue, pp: 443-455.

El- Maghraby, S.E., F.A. Hashem and M.M. Wassif (1997). Profitability of using elemental sulphur after two years of application and its relation to organic manure under saline irrigation water. Egy. J. Soil Sci. 37(4) (in press).

El-Sayed, S.S. (1998). Levels of cadmium, lead and mercury in some plants growing under some environmental contaminations in Egypt. M. Sc. Thesis, Environmental Science Department of Biology Institute of Environmental Studies and Research, Ain Shams University Egypt.

El- Shall, A., M. Wassif, M. Hilal and I. El-Bagouri (1987). Response of barley to sulfur application in a calcareous soil under saline irrigation water. Desert inst. Bull., A.R.E., 37(1): 117-130.

Epstein, E. (1971). Mineral nutrient of plants: Principles and Perspectives. Univ of California Davis. pp 412.

Feng, G.Y., Chang, J. and Wu, J.P. (1993). Study on heavy metal pollution of vegetables in Boashen district, Shanghai. Journal of Shanghai Agricultural College., 11 (1): 43-50, (C. F. Thabet, W.M. (2001). Monitoring of Heavy Metals in vegetables and fruits. M. Sc. Thesis, Environmental Science, Department of Agricultural Science, Institute of Environmental Studies and research, Ain Shams University, Egypt).

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agricultural research. 2nd ED. Joho Wiley and Sons. Inc. New- York: 680 p.

Guttormsen, G. (1990). Cadmium and lead levels in Norwegian vegetables. Norwegian J. of Agricultural Sci., 4 (2): 95-101,(C. F. Nutrition-Abstracts-and-Reviews.-Series-A 1991 (061-06060)).

Guttormsen, G., Singh, Br. and Jeng, As. (1995). Cadmium concentration in vegetable crops grown in a sandy soil as affected by Cd levels in fertilizer and soil PH. Fertilizer-Research., 41 (1): 27-32.

Hovmand, M.F., Tjell, J.C. and Mosbaek, H. (1983). Plant uptake of airborne cadmium. Environmental Pollution (Series A), 30: 27-38.

Jauert P., T. E. Schumacher., A. Boe. and R. N. Reese (2002) Plant and Environment Interactions. Rhizosphere Addification and Cadmium Uptake by Strawberry Clover. J.Environ. Qual. 31:627-633

John, M.K. (1973). Cadmium uptake by eight food crops as influenced by various soil levels of cadmium. Environmental Pollution., 4: 7-15.

Kuboi, T., Noguchi, A. and Yazaki, J. (1986). Family-dependent cadmium accumulation characteristics in higher plants. Plant and Soil., 92: 405-415.

Motto, H.I., Daines, R.H. Chilko, D.M. and Motto, C.K. (1970). Lead in soil and plants: its relationship to traffic volume and proximity to highways. Environmental Science and Technology. 4: 231-238.

Ochaia, E.I. (1987) General principles of biochemisty of the elements. Plenum Press, New York, (C.F. Toxic metal Soil-Plant System. Ed: Sheila, M. R., Joho Wiley and Sons. 4- The Responses of Plants to Heavy Metals (Andrew, P. T.).

Page, A.L., Bingham, F.T. and Chang, A.C. (1981). Cadmium. In: Lepp, N. W. (Ed.) Effect of Trace Metals on Plant Function, pp. 77-109. Applied Science Publishers, London.

Pattersson, O. (1977). Differences in cadmium uptake between plant species and cultivars. Swedish-Journal-of-Agricultural-Research., 7(1): 21-24. (C.F. Hort.-Abst. 47-10368. 1977.

Quinche, J.P. (1971). Pollution of crops by lead from vehicle exhaust gases. Problemes de l'environnement et agriculture, Berne, 13-14 October, 1971. undated, 139-156,(C. F. Hort.-Abst. 1974, 44 (-) 4397)

Rawe, G.J. (1973). Food Analysis by Atomic Absorption Spectroscopy" Varian. Techtrom. ALisfraTia, U.SA Switzer land pp. 89.

Ross, M.S. (1994). Toxic metal in soil- plant systems. John Wiley and Sons, Ltd., UK.

Ruhling, A. and Tyier, G (1968) An ecological approach to the lead problem, Bof. Not., 121, 321. (C. F. Heavy metal tolerance in plants: Evolutionary aspects (1990) Ed: Jonathan Shaw, A. (Chapter 6 Atmospheric sources of metal pollution and effects on vegetation (Ed: Seaward, M. R. D. and Richardson, D.H.S. Pp 80)

Sekara, A., Poniedzialek, M. and Ciura, J. (2000). Heavy metals content in French beans grown around the Krakow conglomeration. Annales Universitatis Mariae Curie-Sklodowska. Sectio EEE, Horticultura, Vol.8, No.Supplementum, pp.233-243..

Smith, J. C., Ferguson, T. L and Carson, B. L (1975). Metals in new and used petroleum products and by-products. Quantities and consequences, in The Role of Trace Metals in Petroleum. Yen, T. F., Ed. Ann. Arbor Science Publishers, Ann Arbor 123. (C. F. Heavy metal tolerance in plants: Evolutionary aspects (1990) Ed: Jonathan Shaw, A. (Chapter 6 Atmospheric sources of metal pollution and effects on vegetation (Ed: Seaward, M. R. D. and Richardson, D.H.S.))

Wassif, M.M., M.K. Shabana, S.M. Saad, S.E. El-Maghraby and I.A. Ashour (1995). Influence of some soil amendments on calcareous soil properties and its production of wheat under saline irrigation water. Egypt. J. Sci., 35 (4): 439-451.

Wassif, M.M., S.E. El-Maghraby and Farh A. Hashem (1997). Soil amendming as a management practice for sustainable productivity under irrigation with saline water. Annals of Agric. Sci., Moshtohor, vol. 35(3): 1847-1857.

تأثير إضافة بعض محسنات التربة على امتصاص العناصر الثقيلة في بعض محاصيل الخضر

يوسف طلعت إمام الليثي ، عبد المنعم يوسف رمضان و حاتم محمد عبد العال
قسم بحوث الخضر- معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر

أجريت تجربتان حقليتان بمحطة البحوث الزراعية التابعة لمعهد بحوث البساتين (مزرعة قها) ، خلال العروة الشتوية لموسمي الزراعة ٢٠٠٥ ، ٢٠٠٦ لدراسة تأثير الإضافة الأرضية لبعض محسنات التربة مثل السماد البلدي بمعدل ٢٠ م٣/فدان والجبس الزراعي بمعدل ٢ طن /فدان والكبريت الزراعي بمعدل ٥٠٠ كجم/فدان وكذلك مخلوط كل من (السماد البلدي + الجبس ، السماد البلدي + الكبريت) على النمو الخضري والمحصول وكذلك محتوى الأجزاء المأكولة من عنصري الكادميوم والرصاص لمحصولي الخس والفجل المنزرع قريب من طريق القاهرة – الإسكندرية الزراعي والتي بلغت الكثافة المرورية علية خلال فترة الدراسة إلى ١٢٠٩٦٠ سيارة في اليوم.

أوضحت النتائج:

أن إضافة كل من السماد البلدي والجبس الزراعي والكبريت الزراعي كان له تأثير معنوي في زيادة الوزن الطازج والجاف وعدد الأوراق مقارنة بمعاملة الكنترول (بدون إضافة)، كما أدى استخدام مخاليط محسنات التربة (السماد البلدي + الجبس الزراعي ، السماد البلدي + الكبريت الزراعي) إلى زيادة كل من قياسات النمو الخضري وكذلك المحصول وأيضاً محتوى الأجزاء المأكولة من فيتامين ج لكل من نباتات الخس والفجل.

انخفض محتوى الأجزاء المأكولة (الأوراق الداخلية للخس وجذور الفجل) من عنصري الكادميوم والرصاص بإضافة السماد البلدي والجبس الزراعي بصورة منفردة أو مجتمعين مقارنة بمعاملات الكبريت الزراعي سواء منفرداً أو مع السماد البلدي.

وتوصي الدراسة بإضافة كل من السماد البلدي والجبس الزراعي للنباتات المنزرعة بجوار الطرق المرورية لتحسين نموها وزيادة إنتاجها وكذلك تقليل محتواها من العناصر الثقيلة (الكادميوم والرصاص).