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ENVIRONMENTAL MANAGEMENT OF HEAVY METAL CHARACTERIZATION IN CALCAREOUS SOILS FOR CROP PRODUCTION

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ABSTRACT

The amount of water is considered as the restrictive factor for the growth of plants and the productivity of yields. Plant growth is directly influenced by soil water stress, which depends on different soil potentials. Faba bean and Zea maize are considered from the most important irrigated arable crop in Egypt. The total cultivated area of bean and maize during the growing season is 306626 and 1623201, respectively. In the absence of irrigation, variation in the supply of soil water is known to be the primary cause of variation in yield. The aim of the work was to study physical and chemical characterization in order to manage heavy metals in calcareous soil and improve quality of soil in situ.

Heavy metal measurements were performed for samples of calcareous soils from Abu Massoud village in Maryout area Cairo-Alexandria Highway. Two field experiments were conducted, to study the impact of two tillage depths (20, 60 cm) on heavy metal accumulation, growth parameters yield and yield value of bean and maize.

The results obtained showed higher environmental and economic values for growth and yield parameters, with increased tillage depth for both crops during both growing seasons. Bean and Maize yield were increased with an increased tillage (at 60 Cm depth).

This study concluded that toxic heavy metals in the soil should be taken into consideration as pollutants, as well as their biological availability and potential toxicity to plants, and then its transfer to ecosystems and the possibility of treating it in-situ.

1. INTRODUCTION

Water shortage is considered a key risk for the twenty-first century **(UNESCO 2012)**. It is the most limiting crop production factor as well as it is a vital and important resource in Egypt. So, productivity increasing raises the level of economic prosperity and protecting natural resources **{Koç, 2019}.**

Identification of yield-limiting constraints in the plant–soil–atmosphere continuum is the key to improved management of plant water stress that targeted management of both plant–soil interactions is still at infancy (**Gernot etal., 2015**).

Therefore, the reason for reducing yields is the small amount of moisture content provided to crop roots in the arid and semiarid areas. If rooting depth increases, the available moisture will increase and some instances showed deep tillage can enhance water penetration to deeper depth. **(Muqaddas *et al.,* 2005)**.

Sub soiling can beneficial, either to increase soil porosity or to split the hard pans that reduce soil permeability. Also, tillage is considered the soil in order to establish soil physical conditions that are appropriate for plant growth **(Muqaddas *et al.,* 2005)**. On the other hand, **Agodzo and Adama, (2003),** refer to the essential function of tillage in reducing soil mechanical resistance and also, tillage help earths worms in producing many bio channels and micro pore continuity which were considered strongly helpful in crop growth.

Jabro, 2010 has recently used deep tillage practice to enhance plant growth due to its reducing soil density, lowering soil resistance to root elongation, improving soil permeability to enhance water permeation and increase the availability in the B Horizon by sub soiling **(Khurshid *et al.,* 2006)**.

Gregor and Christoph, 2009 studied the impact of different soil tillage on the density, biomass, and community composition of earthworms that they showed density, biomass, and community composition of earthworm populations varied in relation to the type of soil tillage used, modifications in the vertical distribution of SOC and varying potentials for mechanical damage of earthworms by tillage.

In calcareous soils, carbonate may also be involved as a cementing agent or resulting in causing of chemical environment to be undesirable for root growth. However, unless the composition of the carbonate varies in the proportion of carbonate between the various layers, it would seem difficult to be involved because the roots are capable of growing in the calcareous soil of gravel and stones where the levels of carbonate are relatively high. In order to define the root restriction mechanisms in the soil, more studies focused on the upper levels of the soil profile were necessary **(Munoz-Romero et al., 2010)**.

Zhang and Fang, 2007, suggested that the bulk density of the (0-10 cm) soil layer was slightly decreased by sub-soiling (0.04-0.09 g.cm-3) and that of the (10-30 cm) soil layer by (0.19-0.32 g.cm-3). Due to sub-soiling, the accumulated moisture in the 60 cm soil profile was increased by 15-30 % and led to an increase in wheat grain yield. As a consequence of increasing rooting volume after deep tillage, they attributed the increase in grain yield to the improvement in nutrient and moisture utilization.

The texture and physicochemical characteristics of the soil influence the quality of their heavy metals and directly or indirectly regulate the form of the reactions on the surfaces of their constituent particles **(Salman et al., 2019)**.

On the other side, as pollutants, heavy metals in the soil are allowed their bioavailability and toxic effects to plants, ecosystems and humans **(Brian, 2013)**. Many of the heavy metals, however, are actually micronutrients that are necessary (in small amounts) for normal plant and/or animal growth. Such metals are the trace elements which are important for higher plants: copper, manganese, iron, aluminum, molybdenum, nickel, and zinc (**Farooq, 2013)**.

Deficiencies and toxicity of micronutrients adversely affecting the plant cause decreases in the rate of growth (and yield) and death of the plant in extreme cases. The adverse effects of deficiencies in critical heavy metals are more economically significant in many areas of the world than pollution caused by soil contamination. **(Brian, 2013)**.

The research aimed to study the effect of tillage (20 and 60 cm) and deep tillage (60 cm) depths on some heavy metal’s accumulations on plant parts and yield parameters for bean and maize crops.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out is located at Abu Massoud village (figure 1) in Maryout area - about 170 Km from Cairo, 5 Km to the west of Cairo – Alexandria Desert Highway.

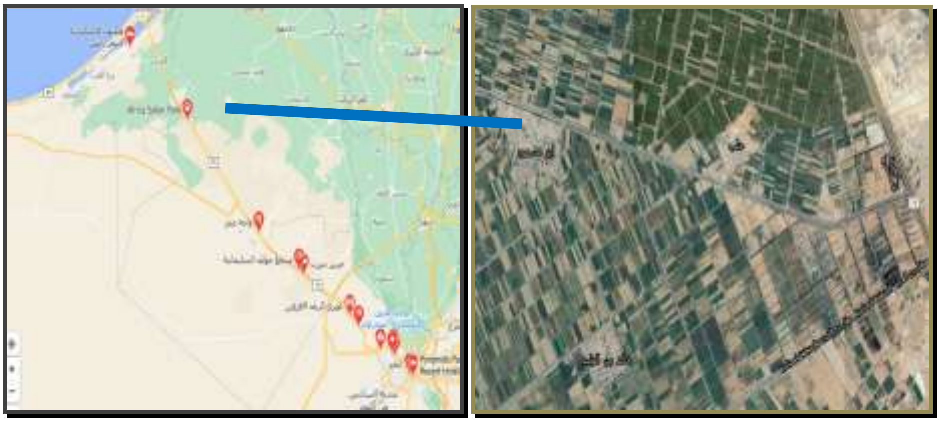

Fig. (1). Location of Abu Massoud village in Maryout area.

2.2 Sampling Program

Soil samples were collected at sites corresponding to tillage depth treatments (three replicates). Sampling procedure was carried out for two tillage depths in the beginning of the season (2017/2018). All possible sources of contamination were taken into consideration while performing the analysis.

Soil samples of about 500 g were collected from cultivated fields at a depth of (0-20 cm) and (0-60 cm) cm near the rhizosphere into polypropylene plastic bags sterilized by autoclave. The soil samples were collected in two experiment using separated containers. Preservation, processing and storage for all the parameters including chemical and physical measurements were carried out in accordance with Handbook of Techniques for Aquatic Soil Sampling **(Mudroch and Mackinght, 1994)**.

Surface soil layer samples (0-20 cm) and (0-60 cm) were obtained from calcareous soil using a clean hand corer sampler to prevent contamination. All soil samples were stored in an ice cooler box and transported immediately for subsequent physical and chemical analysis to the Central Laboratory for Environmental Quality Monitoring, National Water Research Center “CLEQM-NWRC” to be analyzed.

2.2 Analytical Procedures

Soil samples were air dried, ground in an agate mortar, and then sieved with nylon mesh to pass through a 2mm sieve screen.

2.2.1 Physical analysis

Mechanical analyses (Pipette method) was used for the determination of soil texture and particle size distribution after the dispersion of the sample in a sodium hexa-metaphosphate and sodium carbonate solution **(Avery and Bascomb 1982)**.

On other hand, Soil texture was performed and determined on the basis of soil – dry samples which are free of organic matter (oxidized by heating with hydrogen peroxide 30%) and calcium carbonate (dissolved by heating with diluted 2N HCl) and the texture was calculated using the texture triangle according to **Jackson and Lombard, 1991**.

2.2.2 Chemical Analysis

The pH and electrical conductivity values represent the significant changes associated with the electro-chemical properties of soil and water. Soil pH and electrical conductivity were determined in water and 0.01M calcium chloride extracts of soil. Soil reaction (pH-1:2.5 water suspension) was measured by pH electrode model WTW 305, electrical conductivity (E.C) in soil paste was measured by E.C electrode model WTW 301, organic matter by Walkely – Black process tat described by **Hussain and Jabbar, 1985 and Hamza, 2008**.

The soil: solution ratio was 1:2. For available trace metals analysis, the soil samples were digested in aqua regia using microwave digestion technique for 25 min (including 5min ventilation) and measured using ICP-MS for total trace metals analysis

The digestion of soil samples using microwave digestion techniques, in which 0.5 gm of air-dry samples were put in a Teflon vessel and heated after adding of 3ml HNO_3 65% and 3ml HF 40% for 30 minutes **(Littlejohn, *et al*., 1991)**. The MILESTONE MLS-1200 MEGA microwave digestion device with MDR (microwave digestion rotor) system is used for this treatment. The digestion of samples was carried out for determination of total heavy metals. Values were recorded as mg/ kg^{-1}dry weight.

Trace metals have been measured using Inductively Coupled Plasma - Emission Spectrometry (ICP-OES) and USN (Ultra Sonic Nebulizer) Model Perkin Elmer Optima 3000. Acidified samples have been filtered using filtration system through 0.45 μm pore sized membrane. Cd, Ni, Co, Cu, Mn, Mo, Cr, Pb, and Zn in samples have been determined and 11355 ICP Multi element standard ± 0.2% 1000 mg±10/L concentration (Merck reference) were used for instrumental calibration, standards solutions and measurement. The detection limits were (0.002, 0.003, 0.002, 0.006, 0.004, 0.004, 0.004, 0.007, and 0.005 for Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, and Zn respectively for blank water **(APHA, 2017)**.

Plant samples were doubly washed with distilled water and then by using deionized water, swabbed with clean tissue paper and sheared into pieces, and then finally dried in 70 °C oven until constant weights were acquired **(AOAC 1984)** to calculate growth parameters, total yield and yield parameters as described by **Yash, 1998**. Enough individual plants (Bean and Maize plants) were collected to overcome the factor of plant variability and analyzed according to **Chapman, H. D.and P. F., Pratt, 1961** and identified according to **Tackholm,1974**. In the laboratory sorting of roots, stems and leaves was done and then washed before heavy metals analysis.

Quality Control and Quality Assurance

All measurements were based on approved standard methods with adequate quality assurance and quality control (QA/QC) determinations of heavy metals in soil and plants samples.

Some of the measures accept as following:

- The de-ionized water used for preparing all standard solutions that obtained using a thermo Scientific, Barnstead Smart2 Pure, Water Purification Systems (water type I: Resistivity (MΩ-cm) > 18, Conductivity (μS/cm) < 0.056, pH at 25˚C- N/A, Total Organic Carbon< 50µg/l, Sodium< 1µg/l, Chloride< 1 µg/l, Silica< 3 µg/l) **(Mendes etal., 2011)**.
- Performing blank sample of de-ionized water (free organic) for analysis to protect ICP instrument from contamination according

to ASTM Standards for Laboratory Water Reagent (ASTM D1193-91) **(Mendes etal., 2011)**

- Detection limit: mean blank plus three times the standard deviation of replicate blank determination. Detection limit were 0.05 µg/l for water.
- All tools wash and rinsed with distilled water and de-ionized water before use
- Labeling was done on the field

2.3 Experiments

Two experiments were carried out in two stages for calcareous soils as following:

Field Measurements

Two field experiments have been performed to study the impact of two tillage depths: (0-20 cm) then (0–60 cm) using subsoil equipment which prepared for a deep soil depth. The tillage depths were 20cm (farmer practice) that apply for only the top layer of the soil; 0–60 cm. Tillage depth treatments with three replicates were done each one time on the beginning of the season, 2017/2018. Each treatment represented two crops included three replicates. Faba bean plant was sown on 15 November and harvested on 30 April while Zea maize planted in 10 May and harvested on 15 September.

Laboratory Analysis

Laboratory analysis was carried out for physical and chemical characterization for represented two tillage depths samples as well as growth parameters, yield and yield components value of Bean and Maize.

2.4 Statistical Analysis

Statistical analysis was performed using Microsoft Office Excel 2010 for standard deviation calculation.

2.5 Assessment of Soil Quality

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health **(CCME, 2007)** provide screening tool that are guidelines for successful assessing various performance or contaminated sites soil to report soil quality.

3. RESULTS AND DISCUSSIONS

Soil Characterizations

The data demonstrated in Table 1 showed that soils samples collected from the cultivated fields (Bean and Maize) were of normal pH (8.02 and 8.3) and EC (1.2 and 1.8 dS/m) values for two tillage depths respectively. EC is measure of the salinity hazards, as by increasing them, the osmotic activity is reduced and consequently will interfere with the plant uptake of water and nutrients from the soil **(de Le_on et al. 2017)**. Decreasing available water as result of the increasing of EC values causes salinity risk.

Figure (2) confirmed the physical data that reported the sand particles constituted the highest portion than silt and clay. The classification of two tillage depths samples showed the texture class to be sandy loam that could be the selection factor of water leaching.

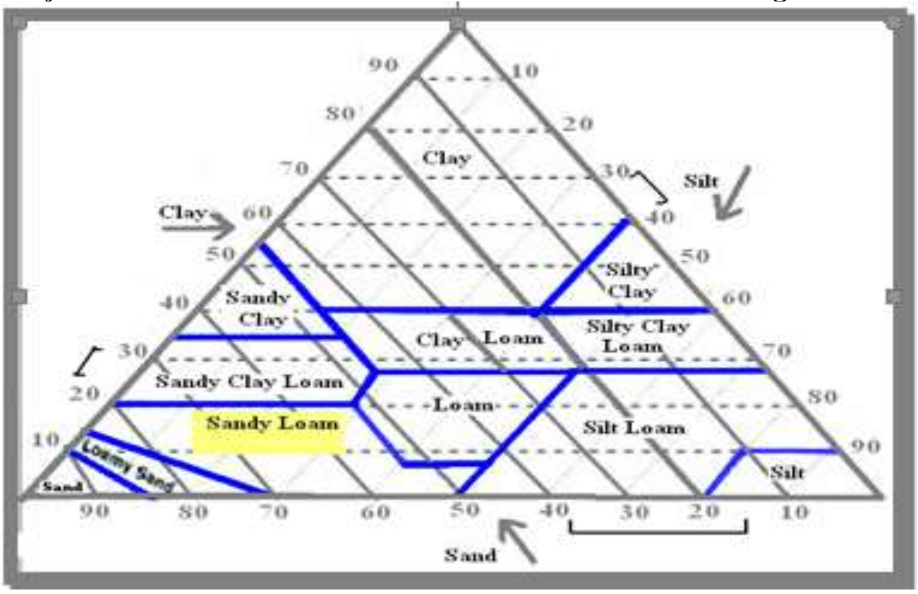

Fig.(2) Classification of Soil Samples Using Soil Texture Triangle.

Table (1) presented the environmental data of physical and chemical characteristics for the calcareous soil samples Theses data showed the change of soil characterization at different depths in calcareous soil. Furthermore, the varieties clarified the ability to eliminate or reduce several contaminants to levels that cause no/slight adverse effects on calcareous soil environment in the area.

Table 1:Physical and Chemical Properties of Calcareous Soil Samples

Physical Properties	*Tillage 0-20 Cm*	*Tillage 0-60 Cm*	*Texture Class*
Particle Size Distribution %			
Coarse Sand	**17.51**	**17.14**	**Sandy clay loam**
Fine Sand	**19.76**	**26.41**	
Silt	**35.20**	**27.53**	
Clay	**31.14**	**25.31**	
Chemical Properties			
pH 1:2.5	**8.02**	**8.30**	
E.C dS/m	**1.21**	**1.80**	
$CaCO_3$	**17.3**	**19.4**	
Organic Matter %	**0.97**	**1.99**	

3.1 Chemical Characterizations of Soil

The chemical results of soil analyses employing microwave digestion procedure **(Littlejohn, *et al.*, 1991)** for measurement of trace elements were reported in mg/kg dry weight (Table 2) that based on high concentrations of dissolved Zn, Mn, Al, and Fe. Precipitation of substances of high molecular weight, hydrous oxides of Mn, Al, Fe, and adsorption of binding inorganic contaminants of varying strength to the surfaces by soil colloids are demobilised these elements into the soil. The reactions of these mechanisms rely on each other, thus making the whole process of heavy metal removal mechanisms very complex in soil **(Abd El-Gawad, *et al*., 2007)**.

Table 2. Mean Concentration of Trace Elements (mg·kg^{-1}) in Soil Samples

Tillage Depth		*Cd*	*Cr*	*Co*	*Cu*	*Pd*	*Ni*	*Zn*
0-20 Cm	**Total**	**1.1**	**61**	**40**	**47**	**42**	**59**	**77**
	Available	**0.1**	**<0.005**	**< 0.005**	**7.00**	**0.76**	**< 0.005**	**29.00**
0 – 60 Cm	**Total**	**0.9**	**61**	**31**	**41**	**33**	**46**	**56**
	Available	**0.06**	**<0.005**	**< 0.005**	**4.8**	**0.58**	**< 0.005**	**18.7**
CCME Limits,2007		**1.4**	**64**	**40**	**63**	**70**	**50**	**200**

Figure 3 clarified selected risk elements in soils for two stages averages of heavy metals concentrations in two tillage's depths that are total and available content. In According to Canadian Environmental Quality Guidelines – CCME offers maximum allowable hazard element contents in soil as following: 1.4 mg.kg^{-1} Cd, 64 mg.kg^{-1} Cr, 40 mg.kg^{-1} Co, 63 mg.kg^{-1} Cu, 50 mg.kg^{-1} Ni, 70 mg.kg^{-1} Pb and 200 mg.kg^{-1} Zn.

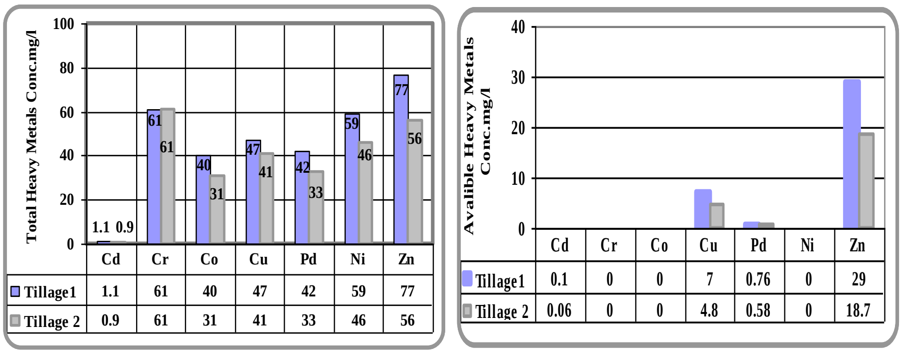

Fig.(3) Total and Available Heavy Metals in Soil Samples

The Nickel concentration in the soil samples the overall soil content. Lead, Chromium, Copper, and Zinc did not increase the permissible content. The highest concentration of the hazard elements selected had been in the region of deep 20 cm than the other region with 60 cm in depth.

The overall concentration of metal was high, but only a small portion of them (35% of Zn, 20% of Cu, 10% of Cd, 0.5 % of Pb, and less than 0.005 % of Ni) were available for plants. The results that obtained can be demonstrated by taking into account the chemical properties soil (**Kacalkova et al., 2009)**, particularly the heterogeneous contamination of soil. The total concentration of soil heavy metals is widely used to denote the level of pollution, while extractable concentration presents more appropriate chemical measure of quantity of metals which available for plant uptake.

Solubility of the metal in soil is mainly regulated by pH, the quantity of metals, the ability of cation exchange, the oxidation state, and organic carbon content of the mineral composition. In comparison to overall Cd, the concentration of bioavailable soil Cd is the key factor for uptake and may be proportional to cumulative Cd at certain concentrations levels.

From our results, in the case of Copper, Nickel, cadmium, Zinc and lead, we observed that, increasing pH induced an increase in the soil's available content of Cd and Pb (soil tillage 20 cm with pH = 8.02 and soil tillage 60 cm with pH = 8.30). This is in accordance with Shuman, who clarified that increasing pH decreases metal availability. (**Lada K., 2014).**

3.2 Accumulation of Copper, Nickel, cadmium, Zinc and lead in Bean and Maize crops

The bean and maize studied in the research were grown on the tested soil by two 20 cm and 60 cm tillage systems with different soil element concentrations, having no noticeable toxicity symptoms. Table 3 show different concentrations of elements in specific parts of cultivated bean and Maize crops.

Zinc and Copper showing an identical pattern, respectively, highest values of concentrations have been observed for maize roots (36.57 $mg.kg^{-1}$ dry weight Zn in 20 cm treatment) and in bean shoots (120 $mg.kg^{-1}$ dry weight Copper in 60 cm treatment). Higher ability to accumulate zinc has been showing in maize grain in compared to bean grains.

Cadmium accumulation in bean grains was close to Ni, Cu and Pb. However the maximum concentration of Cd was found in bean shoots (5.86 $mg.kg^{-1}$), and the lowest Cd concentration was found in maize grain (0.032 $mg.kg^{-1}$ dry weight). In the case of beans, the translocation from plant roots to stems and leaves (shoots) was higher. Cadmium transfer to aboveground parts of several plants has also been stated by **Fuzhong et al., (2010)**. Concentrations of this element were higher under 20 cm depth than the other treatment with 60cm in depth for both plants. The quantity of cadmium uptake in plant parts is decreased in the order: shoots > roots > grains in beans and maize.

Table 3. Cadmium, Nickel, Lead, Zinc and Copper mean concentrations and ± Standard deviation in both Maize and Bean crops (mg.kg$^{-1.}$ Dry weight) under tillage depths 20 cm and 60 cm.

Crop	Tillage Depth (cm)	Roots	Shoots	Grains
Cd				
Bean	20	3.1±2.28	5.86±1.54	2.36±0.77
	60	2.73±0.47	3.91±1.57	1.71±0.95
Maize	20	0.26±0.14	0.18±0.04	0.041±0.005
	60	0.16±0.026	0.09±0.036	0.032±0.008
Ni				
Bean	20	2.25±0.78	8.48±0.85	4.92±0.29
	60	1.88±0.33	6.42±0.61	2.78±0.58
Maize	20	0.013±0.003	0.0055±0.4	0.003±0.65
	60	0.01±0.001	0.005±0.002	0.0025±0.002
Pb				
Bean	20	3.33±0.93	4.22±0.62	0.55±0.17
	60	1.41±0.7	1.67±0.57	0.34±0.095
Maize	20	3.138±0.28	2.44±0.87	0.514±0.079
	60	1.18±0.27	1.79±0.22	0.22±0.049
Zn				
Bean	20	0.23±0.045	0.62±0.19	0.58±0.036
	60	0.18±0.036	0.483±0.07	0.43±0.14
Maize	20	36.57±4.74	19.15±1.9	33.39±2.89
	60	24.25±2.73	10.83±1.63	21.11±2.83
Cu				
Bean	20	27±1.69	120±5.66	53.21±7.44
	60	22.73±2.42	84.25±10.96	39.54±0.98
Maize	20	11.03±2.27	4.82±0.4	10.15±0.65
	60	9.18±0.85	3.77±0.29	7.68±0.55

Nickel was translocated to roots and, particular, to shoot parts and grains (Table 3). A slightly higher quantity of nickel was detected in bean shoots (8.48 mg.kg-1) below 20 cm of soil depth. Bean shoots have shown the ability to accumulate this element at higher concentrations than in maize plants. The bean grains accumulated 4.92 mg.kg-1 dry weight of nickel.

The agreed Ni values in plant tissues vary from 0.5 to 5 mg・kg-1 dry weight. Our findings were consistent with this report. Ordering of the plant parts according to decreased concentrations of Ni is: shoots > grains > roots in beans and roots > shoots > grains in maize.

The effect of deep tillage treatment on the distribution of trace elements through the soil layers was clear and it appeared to minimize the accumulation of Ni in both plants used in our research.

In bean shoots below 20 cm of soil (4.22 mg.kg-1 dry weight) and maize roots (3.138 mg.kg-1 dry weight), substantially higher concentrations of lead were found. (Table 3). Maize grains contained a dry weight of up to 0.514 mg.kg-1, rather less than lead accumulated in bean grains (0.55 mg.kg-1 dry weight). It was suggested that Pb uptake is likely to be passive and that translocation from roots to other parts of the plant is poor, but aerial deposition and foliar uptake may significantly contribute to the concentration of leaves. Specific concentrations of Pb in plants are lower, than 10 mg.kg^{-1}. During the growing seasons for both species, lead levels in above-ground plant parts from our experiment increased these values. In both bean and maize plants, the concentration of Pb in plant parts lowers in the order of: shoots > roots > grains.

3.3. Translocation of heavy metals from roots to shoots

The behaviors of bean and maize plant heavy metal accumulation was examined by root-shoot measurement of the metals studied and the data are stated in the Ttable. 4.

Table 4: Translocation of Heavy Metals from Roots to Shoots (TF) Soil Depths

Crop	Soil tillage depth	TF				
		Cadmium	Nickel	Lead	Zinc	Copper
Bean	20 cm	1.89	3.77	1.27	2.70	4.44
	60 cm	1.43	3.41	1.18	2.69	3.71
Maize	20 cm	0.69	0.50	0.78	0.52	0.43
	60 cm	0.56	0.42	1.51	0.45	0.41

From the metal in the shoot, the translocation factor (TF) was determined divided by that contained in the root. The TF is used to evaluate the root-shoot transfer of metal (Eissa and Ahmed, 2016). The TF values varies from 0.41 to 4.44 in both plants in the present study and these values varied substantially from metal to metal as well as between the plants being studied. Figure () clarified that TF values were found in the order: Cu > Ni > Zn > Cd > Pb in Bean plant and Pb > Cd > Zn > Ni > Cu in maize plant. In the case of Cu and Ni, the highest TF value was registered, whereas in the case of Pb, Cd and Zn, the lowest was found. The TF values of Cu, Zn and Ni were higher for bean plants than for maize plants.

On the other hand, deep tillage treatment (60 cm soil depth) had a great effect to reduce the translocation of trace element from roots to shoots for both plants. It was clear from the current study that TF values were lower in 60 cm soil depth than those values in 20 cm soil depth.

3.4 Yield Components and Growth Variables

Tillage depths have an effect on total grain weight (kg) per fed, 1000-grain weight (gm), plant height (cm) and straw weight (kg/fed) (are presented in table (5). In general, results revealed that tillage depth treatments affected plant height, total grain (kg/fed), and 1000 grain weight, so that, at the 60 tillage depth produced higher value than the same parameters at the 20 cm tillage depth, for the two plants.

Table 5: Yield Components and Growth Variables at Different Tillage Depth

Crop	Tillage Depth (cm)	Grains Kg/fed	Straw Kg/fed	Plant Height (cm)	1000 grains (g)
Bean	**20**	**1735**	**3521**	**99.63**	**54.50**
	60	**1927**	**3751**	**119.6**	**56.50**
Maize	**20**	**2670**	**4221**	**241.6**	**60.70**
	60	**3615**	**4532**	**253.8**	**63.25**

Furthermore, the results showed that the 60 cm depth of tillage provides better edaphic environmental growing conditions compared to other treatments for tillage (20 cm depth, traditional tillage). The results are consistent with those stated (Khan, 1984; Zhang and Fang, 2007). Other scientists Higashida and Yamagami (2003) also noted in another research for Wheat that growth of winter wheat crop was stimulated by deep tillage.

3.4.1 Grain yield

Table (5) presents the impact of tillage depth treatments on bean and maize grain yield. For 20 and 60 cm tillage depth treatments, bean grain yield was 1735 and 1729 kg / fed, respectively. Also for maize grain yield was 2670 and 3615 kg/fed for 20 and 60 cm tillage depth treatments for the growing season, respectively.

The yield of bean grain at 60 cm tillage depth was 11% higher than the yields obtained at 20 cm tillage treatment depth. Similarly, the maize grain yield at 60 cm in depth was 35% higher than the yields obtained at the 20 cm treatment for the growing season.

The higher grain yield may be due to the fact that deep tillage increases the availability of soil water to plants at a tillage depth of 60 cm. In addition, deep tillage, which has a positive impact on grain yield, leads to greater rooting depth and a better growth environment. The results are comparable to those stated by (Zhang and Fang, 2007).

In the other side, there are 1000-grains wt. (g) has been shown to have a higher effect of the 60 depth of tillage than the traditional one (20 depth of tillage), where the results recorded 56.50 (g) and 54.50 (g) for the 60 and 20 depths of tillage, respectively, for the yield of bean. The yield of maize was 60.70 (g) and 63.25 (g) respectively at 60 and 20 depths of tillage. Similar findings have been obtained **(Iqbal, et al., 2005; Patil et al., 2005; Shirani et al . , 2002)**.

3.4.2 Straw yield

The effects of the tillage depths on Faba bean and Zea maize straw yield are shown in the results in table (5). The values indicate that through the growing seasons, there was a variation in the yield between the two treatments. At the 60 cm tillage depth, straw yields were 3751, 4532 kg / fed., for bean and maize plants, respectively. Straw yields for both plants at a tillage depth of 60 cm (sub-soiling treatment) were higher compared to the same values at a tillage depth of 20 cm.

3.4.3 Plant height

Table (5) demonstrates the impact of tillage depths on the height of Faba bean and Zea maize. For the 20 and 60 tillage depth treatments, the bean height was 99.63 and 119.6 cm, respectively. For the 20 and 60 tillage depth treatments, the maize height was both 241.6 and 253.8 cm , respectively. The higher value for plants at a depth of 60 may be attributed to the fact that deep tillage increases the availability of soil moisture to plants. Moreover, deep tillage allows good aeration, so that the environment for plant growth is better and that has a positive impact on height.

From the mentioned above, it could conclude that the water rate together with soil water content decreased with the distance for the irrigation line. Decreasing the soil water depletion (SWD) can attribute to that these sites are far from the irrigation line source and received small amount of water. The total yield showed a clear response to the increase of total irrigation water. These data were found also by (Zhang and Fang, 2007).

4. CONCLUSION

Sub soiling treatment at different depths had a good tool for increasing crop production and economic environmental solution in calcareous soil to meet national goals. The work studied the effect of two tillage depths (0-20 Cm) and (0-60Cm) on physical and chemical variables to reduce soil pollution in calcareous soils at Maryout region. The obtained data indicated tillage depth (0-60cm) improved the hydro-physical properties of calcareous soils that were bulk density, total porosity and soil moisture content decreased with the distance of the irrigation line.

Micronutrient requirements at tillage depth (0-20Cm) were exceeded heavy metal accumulations while tillage depth (0-60Cm) were decrease its concentrations and enhance also its chemical characterization. That treatment was therefore an emerging, inexpensive and easy way of reducing micronutrients, particularly in developing countries. In the Maryout region, calcareous soils existed within crops and soil quality varieties responded to different treatments that led to identifying valuable accessions for total yield and yield components that were increased with the increase of soil tillage depth (sub soiling treatment).

5. RECOMMENDATIONS

It should be mentioned that sub-soil treatment in calcareous soil at Maryout region is recommended that:

- Tillage depth must be increase to 60 cm rather the 20 cm (farmer practice) once every year to maximize the return from the unit of soil at least a yearly. A reduction of pollution efficiency of the system might take place.

- The rate of organic uptake and other constituents must be monitoring continuously for soil.
- Analysis of toxic and other micronutrients for sub-soil treatment in calcareous soil to keep utilization of new lands.
- Study catalytically the roles of sub soiling treatment for bean and maize production and others in the calcareous soils in the area through sound environmental programs to achieve more national goals and decrease the environmental degradation cost in Egypt.

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الإدارة البيئية لتأثير المعادن الثقيلة على إنتاج المحاصيل في الأراضي الجيرية

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تعتبر كمية الماء عاملاً مقيدًا لنمو النباتات وإنتاجية المحاصيل. وبشكل مباشر، يتأثر نمو النبات بالإجهاد المائي للتربة ، والذي يعتمد الى حد كبير على إمكانيات التربة المختلفة. يعتبر الفول والذرة من أهم المحاصيل الصالحة للزراعة في مصر.

يبلغ إجمالي المساحة المزروعة بالفول والذرة خلال موسم النمو 306626 و 1623201 على التوالي. في ظروف ندرة مياه الري ، يعتبر الاختلاف في إمدادات الماء الأرضي هو السبب الرئيسي للتباين في المحصول. وكان الهدف من العمل هو دراسة الخصائص الفيزيائية والكيميائية من أجل إدارة المعادن الثقيلة في التربة الجيرية وتحسين جودة التربة في الموقع.

تم إجراء قياسات المعادن الثقيلة لعينات من الأراضي الجيرية بقرية أبو مسعود بمنطقة مريوط – طريق مصر اسكندرية الصحراوي. تم إجراء تجربتين حقليتين لدراسة تأثير عمقين للحرث (20 ، 60 سم) على تراكم المعادن الثقيلة ، و معاملات نمو المحصول وكمية المحصول لكل من لفول والذرة.

أظهرت النتائج التي تم الحصول عليها قيم بيئية واقتصادية أعلى لمعايير النمو والإنتاجية ، مع زيادة عمق الحرث لكلا المحصولين خلال موسمي النمو. و قد لوحظ أيضا زيادة محصول الفول والذرة مع زيادة الحرث (عند عمق 60 سم).

خلصت هذه الدراسة إلى أنه لابد من أخذ المعادن الثقيلة السامة في التربة بعين الاعتبار كملوثات ، وكذا توافرها البيولوجي والسمية المحتملة منها للنباتات ومن ثم انتقالها للنظم البيئية وبحث إمكانية معالجتها في الموقع.