Minufiya J. Agric. Res. Vol.36 No. 3:673-686 (2011) "http://www.mujar.net"

IMPROVING OF POLLUTED SOILS BY USING SOME AMENDMENTS AND PHYTOREMEDIATION

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(Received: Feb. 27, 2011)

ABSTRACT: *A pot experiment was set up to evaluate the effect of gypsm (0, 3 , 6 and 9 ton/ f), super phosphate (0 , 2 , 4 and 6 ton/f) , sulphur (0 , 0.3 , 0.6 and 0.9ton/f) , vermiculite (0 , 4 , 8 and 12 ton/ f) , peatmoss (0 , 4 , 6 and 8 ton/fed) , EDTA (0 , 0.05 , 0.1 and 0.15 ton/f) on available Zn, Fe, Mn and Cu in the soil and the uptake of these heavy metals by the plant Damsisa . Super phosphate and vermiculite decreased the availability of Zn, Fe, Mn and Cu in the soil samples. Such as the uptake of these heavy metals by the plant Damsisa. Although application of gypsum , sulphur , peatmoss and EDTA increased the availability of Zn, Fe , Mn and Cu in the soil samples. No significant changes in the values of the uptake of these heavy metals by the plant Damsisa, were occurred .The results indicated that application of all the amendments were slightly increased the mean values of soluble Ca^{++}, Mg^{++}, Na^{+}, HCO_3^{-}, Cl^{-} and $SO_4^{=}$ .Also there were significant increase in the values of (E.C) as a result of applying 0.9 t/f of sulphur, 8t/f of peatmoss and the rates 0.1 t/f , 0.15 t/f of EDTA. The values of soil pH were decreased significantly as a result of applying all the rates of both sulphur and peatmoss and the rates 0.1 t/f and 0.15 t/f of EDTA.*

Key words: *Pollution, heavy metals , chemical properties .*

INTRODUCTION

Pollution is the most serious of all environmental problems. Remediation of heavy metals in contaminated soils is necessary in order to reduce the risk related to the presence of heavy metals in soil to an environmental unacceptable level. Soil pollution could be regarded as malfunctioning of soil as an environmental component following it's contamination with certain compounds as a result of human activities. Irrigation practices could also be regarded as one of the most important factors of malfunctioning particularly excessive irrigation with poor quality water. Moreover, soil often acts in practice as a purifying filter on water containing dissolved and colloidal constituents. Behel *et al.* (1983) found that the application of sludge increased the concentration of Zn, Mn which exist predominately as free ions in soil solution. Adel (1991) said that sulphur application increased Mn, Cu and Zn in the soils. Ruby *et al.* (1994) suggested that in situ immobilization of heavy metal by phosphate amendment may provide a cost

effective method for reducing the leaching, migration and bioavailability of heavy heavy metal from soils. Chen *et al.* (1997) found that the application of Phosphates into polluted soil, can reduce the concentration of heavy metals by precipitation adsorption, or complexation. El-Koumey *et al.* (1998) reported that Zn , Fe, Mn and Cu increased with the addition of gypsum. El-Koumey *et al.* (1998) reported that Fe, Mn, Zn and Cu were also affected by gypsum and Farm Yard Manure (FYM). These micronutrients increased with the addition of gypsum and FYM. These increases were in following order: FYM>gypsum> control. The extracted amount of these elements increased with increasing the rates of different amendments and decreased with increasing E.S.P levels. These results may be due to the effect of these amendments on soil pH and E.S.P., as well as their content in FYM. El-Koumey (1998) said that, the gypsum application affected the nutrients availability which enhance plant growth. Amgad (2001) found that the highest amounts of heavy metals were obtained as a result of application 2% E.D.T.A. However, all levels of E.D.T.A were significantly decreased dry matter. Abdel-Mottaleb (2003) found that soil pH plays an important role in governing, micronutrients availability and behavior in soil. In general, soil pH should be higher than 6.5 to minimize the micro elements toxicity problems. It is well documented that the solubility and availability of the micro elements increases as pH decreases. Abdel-Hadi (2003) found that heavy metal in agricultural soils may inter the food chain and contaminate human food, not much is known yet about the bathways where by toxic heavy metals enter human food. Gehan (2004) said that, P-rock decreased significantly the available heavy metals (Zn, Cu). Gehan (2004) said that available heavy metals (Zn, Cu, Pb,Cd Ni and Co) decreased significantly for all amended soil by (Fe-oxide., / P-rock) comparing to un amended soil. Emad (2007) showed the important role of vermiculite to retain heavy metals in soil as unavailable form. Remediation of heavy metal in polluted soils is necessary in order to reduce the risk related to presence of heavy metals in soil to an environmental acceptable levels. Therefore this investigation was carried out to monitor the importance of different amendments and plant species in diminishing the heavy metals pollution in the used soil.

MATERIALS AND METHODS

Disturbed surface soil samples 0-30 (cm.) were randomly collected from contaminated soil, irrigated by industrial waste water in Borg El-Arab, Alexandria. Samples, carefully air-dried, crushed, passed through 2.0 mm sieve. The samples were physically and chemically analyzed according to standard methods of determinations according to (Black 1965 , Jackson 1967 and 1973, Cottenie 1982) as shown in Table (1). Six types of amendments were used. Gypsum, Super phosphate, Sulphur, Vermiculite, Peatmoss and Ethylene diamine tetraacetic acid (EDTA). Damsisa (Ambrosia maritime L.) plant species represents the hyperaccumulating plant was

selected for this study. This plant used as a summer annual herb belongs to the family compositae. Pot experiment was conducted in the greenhouse of soil salinity laboratory, El-Sabahia Research Station, Alexandria city, during the summer growing season 2005 to study the effect of some amendments for improving some properties of polluted soil, 72 plastic pots used in this study. (30 cm diameter, 30 cm. depth). Each pot was filled by 8 kg of the polluted soil, and six treatments of the abovementioned amendments with four rates are applied and arranged in completely randomized design with three replicates as shown in Table (2).

Seeds of plant were obtained from Medical and Aromatic Plant Research Department, Sabahia Station, Alexandria . The pots were planted with three plants and then thinned to two plants. Moisture content of the pots was at the field capacity along the period of growth using tab water for irrigation.

Table (1): Some chemical and physical properties of the soil under investigation.

Particle size distribution		Value
% Sand		72.13
% Silt		18.7
% Clay		9.02
Texture class		Sandy loam
O.M %		0.83 %
pH (soil paste extract)		7.62
E.C (soil paste extract)		5.53 ds/m
$CaCO_3$		11.74%
Cations and Anions meq/ L		
Ca^{++}		27.5
Mg^{++}		10.61
Na^{+}		17.40
K^{+}		1.19
CO_3^{--}		0.00
HCO_3^{-}		2.32
Cl^{-}		23.25
SO_4^{--}		31.13
Heavy metal (ppm)		
	Available	Total
Zn	5.05	64.05
Fe	22.27	178.64
Mn	28.75	182.42
Cu	4.02	107.12

Table (2): Treatments which were used :

No.	Treatment	Rate (Ton/fed)			
		Control	A	B	C
1	Gypsum	0	3	6	9
2	Super Phosphate	0	2	4	6
3	Sulphur	0	0.3	0.6	0.9
4	Vermiculite	0	4	8	12
5	Peatmoss	0	4	6	8
6	* E.D.T.A	0	0.05	0.1	0.15

After plants harvesting (60 days from cultivation) at the flowering stadge , the plants carefully cleaned by dipping twice in tap water, washed by distilled water, then oil percentage was determined, according to (British Pharmacopeia, 1968 and Guenther, 1961). Plant samples (shoots and roots) were oven dried at 70 C for 24 hours and dry weight was determined. D.T.P.A extractable Fe, Mn, Cu and Zn were measured by the atomic absorption spectrophotometer according to Lindsay and Norvell (1978). 0.25 gm of dry plant material were wet digested using mixture of H_2SO_4 and H_2O_2 (Lowther, 1980) . Micronutrients (Zn, Fe, Mn , and Cu) in the digested plants were determined using atomic absorption spectrophotometer (Jackson, 1967).

RESULTS AND DISCUSSION

Table (3) revealed that, all the amendments except phosphate slightly decreased the mean values of soil pH in comparison with the control. However sulphur and peatmoss showed a significant effect, this may be attributed to converting the applied sulphur to sulphuric acid by biological oxidation in the soil, then decrease soil pH (Hausenbuiller, 1985) Likewise, the release of organic acids from the peatmoss decomposition caused a reduction in soil pH (Taha, 1993) .

Morerover, the results are in a good harmony with each of El-Koumey *et al.* (1998) and Emad (2007). The data showed that, the addition of all the amendments increased the mean values of soil E.C in comparison with the control. Whereas a significant increase was occurred by applying 0.9 t/f of sulphur, 8 t/f of peatmoss and the rates 0.1 , 0.15 t/f of EDTA

El-Housseiny *et al.* (2000), Badawi (2003) and Desoki (2004), noted that electrical conductivity values increased as a result of added gypsum and organic matter. They attributed this increase to the released soluble inorganic ions during mineralization of organic materials. Wherever, Emad, (2007) reported that, lower values of available heavy metals could be obtained as a result of application of vermiculite, so the addition of vermiculite was not effective on increasing the values of E.C. This result

could be attributed to the effect of these amendments on the other soluble ions. Also, gypsum and organic matter react in the soil with other compounds to produce such ions. The presented data in Table (4a and b) appeared that, application of all the amendments were slightly raised the values of soluble Ca^{++}, Mg^{++}, Na^{+}, HCO_3^{-}, Cl^{-} and SO_4^{--}, in comparison with the control , however it was no significant with all cases of application . These results were in a good harmony with Adel (1991) and El-Koumey *et al.* (1998) who reported that, the addition of gypsum and organic matter increased Ca^{++}, Mg^{++}, K^{+}, Cl^{-} and SO_4^{--} at soil extract. This result could be attributed to the reacting of these amendments in the soil with other compounds to produce such ions.

Table (3): E.C and pH of the soil as affected by the different applied amendments

Amendments		pH	E.C
Control		7.62	5.53
Gypsum	A	7.55	5.58
	B	7.51	5.61
	C	7.47	5.66
Super Phosphate	A	7.77	5.65
	B	7.81	5.67
	C	7.86	5.68
Sulphur	A	6.90	5.68
	B	6.86	5.71
	C	6.70	5.77
Vermiculite	A	7.54	5.57
	B	7.49	5.63
	C	7.44	5.65
Peatmoss	A	7.16	5.62
	B	7.15	5.71
	C	7.08	5.83
EDTA	A	7.47	5.68
	B	7.31	5.73
	C	7.28	5.83
$LSD_{0.05}$		0.28	0.19

A , B , C : rates of applications

Table (4a): Soluble cations as affected by the different applied amendments

Amendments		Cations			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Control		27.50	10.61	17.40	1.19
Gypsum	A	27.90	11.01	18.11	1.19
	B	28.10	10.71	18.31	1.19
	C	28.91	11.13	18.49	1.19
Super Phosphate	A	29.30	10.70	18.11	1.19
	B	28.70	10.84	18.41	1.19
	C	29.31	11.15	17.92	1.19
Sulphur	A	28.13	11.04	18.61	1.19
	B	27.70	10.70	18.19	1.19
	C	28.15	11.35	18.79	1.19
Vermiculite	A	28.60	11.60	17.71	1.19
	B	29.40	11.43	17.69	1.19
	C	30.20	11.77	19.31	1.19
Peatmoss	A	28.11	11.53	17.80	1.19
	B	27.70	10.94	18.30	1.19
	C	29.30	11.39	18.81	1.19
EDTA	A	29.00	10.92	17.90	1.19
	B	29.00	11.60	17.50	1.19
	C	28.20	10.71	18.85	1.19
$LSD_{0.05}$	-	n.s	n.s	n.s	n.s

A , B , C : rates of applications

Table (4b): Soluble anions as affected by the different applied amendments.

Amendments		Anions			
		CO_3^-	HCO_3^-	Cl^-	SO_4^-
Control		0	2.32	23.25	31.13
Gypsum	A	0	2.48	23.91	31.82
	B	0	2.41	23.81	32.09
	C	0	2.50	24.69	32.53
Super Phosphate	A	0	2.39	23.71	33.20
	B	0	2.41	24.50	32.23
	C	0	2.43	24.67	32.47
Sulphur	A	0	2.44	23.10	33.43
	B	0	2.38	22.90	32.50
	C	0	2.45	22.51	34.52
Vermiculite	A	0	2.51	23.50	33.09
	B	0	2.58	25.40	31.73
	C	0	2.62	26.04	33.81
Peatmoss	A	0	2.41	22.91	33.31
	B	0	2.50	22.70	32.93
	C	0	2.57	22.41	35.71
EDTA	A	0	2.38	23.10	33.53
	B	0	2.44	23.14	33.71
	C	0	2.53	22.91	33.51
$LSD_{0.05}$	-	n.s	n.s	n.s	3.16

A , B , C : rates of applications

Table (5) appeared that, application of each of super phosphate and vermiculite generally decreased the mean values of soluble heavy metals (Zn, Fe, Mn and Cu) in the soil, in comparison with the control . On the other hand, application of each gypsum, sulphur, peatmoss and EDTA generally increased the solubility of the heavy metals in the soil, in comparison with the control. The data also showed that addition of 6 t/f of super phosphate significantly decreased soluble Zn. 6 t/f of super phosphate and 8 t/f, 12 t/f of vermiculite significantly decreased soluble Fe. All the rates of applied super phosphate and vermiculite significantly decreased soluble Mn. There was no significant decrease in soluble Cu. On the other hand, the results showed that, 9 t/f of gypsum significantly increased soluble Zn. All the rates of gypsum and the rates 0.15 t/f, 0.1 t/f of EDTA significantly increased soluble Fe. All the rates of gypsum and the rate 0.15 t/f of EDTA increased significantly soluble Mn. The rate 8 t/f of peatmoss significantly increased soluble Cu. Also, the results in a good harmony with Chen *et al.* (1997) who

reported that, application of phosphate into polluted soil can reduce the concentration of heavy metals by precipitation, adsorption, or complexation. Also, the results were in agreement with Emad (2007) who showed the important role of vermiculite to retain heavy metals in soil as unavailable form, and the important role of applied vermiculite for improving soil physical and chemical properties. Moreover, the data were conformed with El-Koumey *et al.* (1998) who reported that, organic matter and gypsum increased the released ions in the soil extract after plant harvesting. These results could be attributed to the effects of these amendments on the other soluble ions. Gypsum and organic matter react in the soil with other compounds to produce such ions.

Also, the results are in a good harmony with Amgad (2001) who said that, organic matter was the main source for Fe, Zn and Cu in the soil samples. Increasing the available Fe, Zn and Cu may be due either to its release from the decomposed organic matter or to the effect of the released organic acids on the availability of those elements. And he added that, application of EDTA highly increased available heavy metals.

Table (5): Soluble Heavy metals in the soil as affected by the different applied amendments.

Amendments		Heavy metals (ppm)			
		Zn	Fe	Mn	Cu
Control		5.05	22.27	28.75	4.02
Gypsum	A	5.13	25.40	32.21	4.17
	B	5.72	27.24	34.92	4.83
	C	6.05	27.51	35.15	4.61
Super Phosphate	A	4.70	20.92	26.18	4.00
	B	4.41	20.74	24.91	3.92
	C	4.15	17.04	22.34	3.83
Sulphur	A	4.94	22.39	28.91	4.01
	B	5.12	22.73	30.15	4.37
	C	5.31	23.31	30.54	4.39
Vermiculite	A	4.94	21.27	25.76	4.00
	B	4.76	19.18	24.84	4.00
	C	4.62	16.96	23.68	3.98
Peatmoss	A	5.28	22.68	28.78	4.85
	B	5.34	22.93	29.03	4.88
	C	5.48	23.95	29.64	5.15
EDTA	A	5.14	23.01	29.56	4.09
	B	5.17	28.27	30.54	4.13
	C	5.22	36.28	34.43	4.70
$LSD_{0.05}$		0.81	2.05	2.29	0.94

A , B , C : rates of applications

Data in Table (6) showed that application of all amendments significantly augmented the oil percentage in the plant, that may attributed to the beneficial effect of these materials on the oil metabolism in the plant . On the other hand , super phosphate and the higher rates of vermiculite and peatmoss significantly enhanced the plant dry matter weight, that may be attributed to the influence of these materials on the availability of the nutrients in the soil consequently dry matter yield of plants. These results are in agreement with El-Koumey (1998) said that, the gypsum application affected the nutrients availability which enhance plant growth. Sulphur and EDTA appeared a depressive influence on the dry matter yield of plants , that may be ascribed to its enhancing effect in the solubility of heavy metals in the soil , consequently its toxicity on plant growth. Also the results were in a good harmony with Narwal *et al.* (1983) who observed that the application of sludge increased the total dry matter yield of rape plants.

Table (6): Plant oil content and dry matter yield as affected by the different applied amendments

Amendments		Oil percentage (%)	Dry weight (gm)
Control		1.72	59.55
Gypsum	A	2.46	61.46
	B	2.42	63.13
	C	2.44	64.63
Super Phosphate	A	2.07	67.40
	B	2.16	69.86
	C	2.12	75.80
Sulphur	A	2.16	46.70
	B	2.23	44.40
	C	2.29	41.20
Vermiculite	A	2.09	64.80
	B	1.99	64.90
	C	1.86	67.20
Peatmoss	A	2.15	61.50
	B	2.35	70.90
	C	2.05	71.20
EDTA	A	2.24	52.20
	B	2.1	47.00
	C	2.24	43.00
$LSD_{0.05}$		0.08	6.39

A , B , C : rates of applications

The data in Table (7), showed the values of the uptake in the plants tissues. The presented data in Table (7) showed that, the uptake of heavy metals decreased by applying amendments super phosphate and vermiculite as compared by control, wherever, the uptake of heavy metals increased as a result of applying gypsum , sulphur, peatmoss and EDTA.

There was no significant changes in the values of the uptake for the heavy metals by the plant. Also, these results are in agreement with Ruby *et al.* (1994) who suggested that in situ immobilization of heavy metal by phosphate amendment may provide a most effective method for reducing the leaching, migration and bioavailability of heavy metal from soils, consequently reducing its uptake by plants.

Table (7): Uptake of heavy metals by plants as affected by the different amendments

Amendments		Heavy metals uptake (mg/pot)			
		Zn	Fe	Mn	Cu
Control		2.19	8.03	6.29	1.04
Gypsum	A	2.43	8.55	7.04	1.19
	B	2.67	9.93	7.18	1.20
	C	2.78	10.05	7.49	1.25
Super Phosphate	A	2.24	8.39	6.36	1.07
	B	1.94	8.11	5.53	0.93
	C	1.93	7.95	5.49	0.92
Sulphur	A	2.37	9.27	6.87	1.14
	B	2.74	9.71	7.35	1.34
	C	2.79	10.47	7.73	1.41
Vermiculite	A	2.00	8.20	6.03	0.96
	B	1.82	7.04	5.56	0.88
	C	1.69	6.96	5.26	0.82
Peatmoss	A	2.50	8.80	6.54	1.13
	B	2.53	9.46	7.56	1.18
	C	2.63	10.04	7.65	1.26
EDTA	A	2.65	9.72	7.55	1.23
	B	2.90	10.40	8.15	1.28
	C	3.22	11.73	9.06	1.40
$LSD_{0.05}$		1.21	4.16	2.74	1.17

A , B , C : rates of applications

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تحسين الاراضي الملوثه بواسطه استخدام بعض المحسنات والمعالجه النباتيه

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الملخص العربي

لقد تم اجراء هذا البحث لدراسة تأثير بعض المواد المختلفة لتحسين بعض خواص الاراضي الملوثة والتي تروي بواسطة مياة الصرف الصحي في مدينة برج العرب– محافظة الاسكندرية.

كذلك تأثيرها علي تثبيت بعض العناصر الثقيلة المتاحة للامتصاص بواسطة النبات وقد تم استخدام نبات الدمسيسه من نباتات العائله المركبه في قياس مدي صلاحيه عناصر الزنك والمنجنيز والحديد والنحاس وكانت المعاملات المستخدمه من هذه المواد كالتالي :

صفر و ٣ و ٦ و ٩ طن/ فدان من الجبس صفر و ٢ و ٤ و ٦ طن/ فدان من السوبر فوسفات و صفر و ٠.٣ و ٠.٦ و ٠.٩ طن/فدان من الكبريت و صفر و ٤ و ٨ و ١٢ طن/فدان من الفيرميكيوليت و صفر و ٤ و ٦ و ٨ طن/فدان من البيتموس و صفر و ٠.٠٥ و ٠.١ و ٠.١٥ طن/فدان من EDTA

و اوضحت النتائج ان استخدام كل من السوبر فوسفات و الفيرميكيوليت قللت من تيسر كل من الزنك و الحديد و المنجنيز و النحاس في عينات التربه كما قللت بدرجه غير معنويه من امتصاص هذه العناصر بواسطه نبات الدمسيسه ومن جهة اخري ادي استخدام الجبس و الكبريت و البيتموس و ال EDTA الي زياده صلاحية الزنك و الحديد و المنجنيز و النحاس في عينات التربه كما ادت الي زيادة امتصاص هذه العناصر بواسطه نبات الدمسيسه بدرجه غير معنوية كما اوضحت النتائج ان كل المعاملات ادت الي زياده طفيفه في متوسط قيم كل من (الكالسيوم و المغنيسيوم والصوديوم والبيكربونات والكلور والكبريتات) الذائبه بالمقارنه بالكنترول و لم يكن هناك ارتفاع معنوي للانيونات والكاتيونات الذائبه. كان هناك ارتفاع معنوي

في قيم التوصيل الكهربائي (E.C) كنتيجه لاستخدام المعدلات الاتيه ٠.٩ طن/فدان من الكبريت و ٨ طن/فدان من البيتموس والمعدلات ٠.١ و ٠.١٥ طن/فدان من ال EDTA كما ادي استخدام المعدلات الاتيه الكبريت والبيتموس والمعدلين ٠.١ طن/فدان و ٠.١٥ طن/فدان من ال EDTA الي تقليل قيم ال (pH) معنويا .

و توصي نتائج الدراسه بما يلي :

١) اهمية استخدام بعض المعالجات مثل (السوبر فوسفات و الفيرميكيوليت) في الحد او التقليل من صلاحية بعض العناصر الثقيله الملوثه مثل الزنك والحديد والمنجنيز والنحاس في التربه وبالتالي تقليل الكميه الصالحه منها للامتصاص بواسطة النبات

٢) زراعة المحاصيل المستخدمه في الزينه اوالتي تستخدم لانتاج الاخشاب (الاشجار الخشبيه) في الاراضي الملوثة بكميات كبيرة من العناصر الثقيلة.

٣) اهمية بعض المعالجات في زيادة امتصاص العناصر الثقيله بواسطة احد انواع النباتات كطريقه حيويه نباتيه للتخلص من الملوثات من الارض والتخلص منها في انسجة النبات واهمية نبات الدمسيسه في التخلص من الملوثات كمعالجه نباتيه لتراكم الملوثات في التربه.

٤) مما لا شك فية ان النتائج المتحصل عليها أظهرت أهمية المعاملات المستخدمه في معالجة التلوث في الأرض لذلك توصي الدراسه بعمل حقل ارشادي وتطبيق هذه المعدلات علي نطاق حقلي لكي توضح مدي تأثير هذه المعاملات علي الأراضي المصرية التي تعاني من التلوث .