Usage of Some Woody Tree species to Remediate Contaminants in Agricultural Drainage Water
2- Effect of Tree Species and Agricultural Drain Locations on Chemical Composition of Some Woody Tree Species

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ABSTRACT

This study was carried out at the Kalyobia Governorate, for three years to study the ability of four trees species (*Eucalyptus camaldulensis*, *Salix vemenalis*, *Morus alba* and *Ficus nitida*) growing at one side of the three agricultural drains (Toukh, Shebine and Batanda) in addition to Shebine irrigation canal which used as a control treatment for absorption and accumulation of some heavy metals in different trees parts to decrease the pollution rates in agricultural drains. The following data were recorded; Zn, Ni, B, Cr, Cu, Mn and Fe in leaves, branches and roots in all tested tree species at the beginning and ending of study. Results showed that, leaves, branches and roots of *Ficus nitida* showed significantly increased in Zn content in comparison with the other tree species. Moreover, *Morus alba* contain the highest values of Cu, Cr and B in leaves, branches and roots as compared to the other tree species. In addtion, *Eucalyptus camaldulensis* trees contained the highest concentration of Ni during study period. In addition, *Salix vemenalis* trees significantly augmented of Fe and Mn content in different tested parts in comparison with the other tree species. On other hand, Toukh drain showed the highest concentration of Ni and B during the study period, while Batanda drain contains the highest values of Fe and Ni as compared to the other locations. Also, Shebine drain contains the highest concentration of Mn, Cu and Cr as compared the other treatments.

Keywords: Phytoremedition- Eucalyptus- Salix-Morus- Ficus.

INTRODUCTION

One of the major challenges, In Egypt, the sustainable requirements for agricultural development is the limited resources of water. The drainage water quality does not meet the local standards for the direct reuse of drainage water in irrigation. Mixing the drainage water with fresh irrigation water or applying in-stream treatment system recommended for improving the drainage water quality to avert the excessive deterioration of soil, plant productivity and water drainage (Allam and Negm, 2013).

Agricultural drainage is required to remove excess soil water in the plant root zone. In irrigated agriculture, drainage is of critical importance in controlling salinity and waterlogging. In many regions where irrigation water is scarce, drainage water used to meet crop water requirements. The drainage water can be contaminated with trace elements, toxic organic substances, industrial waste and municipal waste in open main drains. Contaminated drainage water could lead to various problems including: impairment of soil physical and chemical properties, water related health problems, and possible contamination of food products (FAO, 1997). Rapid and unorganized urbanization and industrialization has elevated the levels of heavy metals in the environment of developing countries (Sharma et al., 2009). The TWW can constitute a debatable water and nutrients source for crops and its use for irrigation reduces the amount of nutrient-rich waters returned to rivers or sea but its use can have controversial impacts, because of the possibility risk of heavy metals on the physical and chemical properties of the soils, plant growth and agriculture products (Tarchouna et al., 2010). In plants, heavy metals can play different roles that can be roughly divided into the following, essential (i.e., Zn, Cu, and Ni), which are required for a variety of metabolic processes; non-essential (i.e., Cr and Cd). However, Cr and an essential element at low levels (Sahmoune et al., 2008). Independent from their biological function, both essential and non-essential heavy metals can be toxic above a certain threshold (McGee et al., 2006). Phytoremediation is process, which allows plants to assimilate the contaminants into their organs. This process has been used to clean up xenobiotic, toxic aromatic pollutants (Singh and Jain, 2003) heavy metals and pesticides (Suresh and Ravishankar, 2004) organic compounds (Newman and Reynolds, 2004) and acid mine drainage (Archer and Caldwell, 2004).

The objective of this work was to study the efficiency of some tree species growing at side of agricultural drains on removal some contaminants from the drainage water to increase its suitability for irrigation.

MATERIALS AND METHODS

This study was carried out at the Kalyobia Governorate during three years since March 2014 to March 2017 to study the ability of four trees species (*Eucalyptus camaldulensis*, *Salix vemenalis*, *Morus alba* and *Ficus nitida*) which planted at one side of three agricultural drains (Toukh, Shebine and Batanda) for accumulation of some heavy metals in different tree parts in comparison with the same trees which planted at one side of Shebine irrigation canal which used as a control treatment. Four tree species were planted in 1995. Distance planted 5 x 5 m.

Determination of Zn, Cu, Cr, Fe, Mn, Ni and B in the leaves, branches and roots in all tested tree species at the beginning and the end of study period by Inductively Coupled Plasma Spectrometry (ICP) (Ultima 2 JY Plasma and (Chapman and Pratt, 1961). Representative samples from the used irrigation sewage effluent were determined according to **(**Soltanpour, 1985) as shown in **Table (a).** In addition, the soil under growing tree species were collected from the studying areas at the beginning and the end of study and determined according to American Public Health Association (APHA, 1992), soil particle size distribution and Ca CO_3 were determined according to (Piper, 1950) as shown in **Tables (b, c and d).**

Experiment design:

The layout of the experiment was a complete randomized design, the experiment included 16 treatments, 4 tree species, 3 agricultural drainage in addition irrigation canal, each treatment included 3 replicates; each replicate consisted of five trees.

Table (a). Analysis of agriculture drainage water at beginning and ending of study.

Parameters		At Beginning Of Study				At Ending of Study			
	Unit	Control	Toukh	Shebein	Batanda	Control	Toukh	Shebein	Batanda
PH		7.39	7.92	8.01	7.93	7.81	8.09	8.12	8.00
Ec	dsm	0.33	1.74	1.09	0.99	0.37	1.80	1.31	1.08
SAR		1.49	1.74	1.09	0.99	1.60	1.80	2.61	2.49
Ca	mg/l	0.53	1.68	1.77	1.77	0.60	1.93	2.00	2.13
Mg	mg/l	0.18	0.36	0.48	0.47	0.20	0.48	0.50	0.54
Na	mg/l	0.97	4.96	5.15	5.20	1.00	5.49	5.20	5.53
K	mg/l	0.20	0.33	0.33	0.32	0.21	0.39	0.39	0.37
CO_3	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO_3	mg/l	0.09	0.12	0.16	0.17	0.10	0.19	0.20	0.20
Cl	mg/l	1.57	5.97	6.57	6.42	1.60	6.43c	6.80	6.97
SO_4	mg/l	0.29	0.72	0.83	0.81	0.30	1.07	1.00	1.06
Zn	mg/l	0.01	0.26	0.25	0.31	0.02	0.29	0.26	0.35
Cu	mg/l	0.02	0.09	0.14	0.13	0.03	0.16	0.25	0.22
Cr	mg/l	0.02	0.10	0.13	0.12	0.04	0.18	0.20	0.20
Fe	mg/l	0.98	2.61	2.79	1.19	1.87	2.88	2.97	1.47
Mn	mg/l	0.03	2.40	1.12	0.88	0.06	2.48	1.47	0.95
Ni	mg/l	0.03	0.17	0.36	0.18	0.05	0.18	0.44	0.19
B	mg/l	0.02	0.08	0.03	0.03	0.02	0.09	0.04	0.05
COD	mg/l	10.98	15.16	17.93	17.10	12.29	19.83	22.12	21.92
BOD5	mg/l	21.75	88.11	98.12	86.13	26.11	94.41	99.87	96.53

Table (b). Concentration of heavy metal in soil under trees in different locations at beginning of study 2014.

Parameters	At Beginning of Study															
	Control				Toukh				Shebein				Batanda			
	E	M	F	S	E	M	F	S	E	M	F	S	E	M	F	S
Zn mg/l	1.23	1.87	2.05	2.85	34.93	35.01	38.17	37.10	82.17	84.86	84.03	85.10	32.20	31.15	27.26	30.54
Cu mg/l	0.89	0.095	1.55	1.49	75.00	74.91	75.36	75.78	56.21	53.20	53.99	56.12	25.80	25.15	23.83	24.99
Cr mg/l	0.02	0.02	0.05	0.05	28.81	29.60	29.98	27.03	46.70	45.10	46.81	48.30	27.13	28.10	28.95	29.55
Fe mg/l	14.22	16.25	11.62	10.42	20017	20360	20336	20139	34381	33985	33770	33612	20470	20312	20713	20393
Mn mg/l	9.97	11.09	11.76	9.87	363017	380.60	388.11	366.10	555.17	543.30	559.22	550.33	370.13	386.80	365.4	384.18
Ni mg/l	0.21	0.32	0.87	0.54	19.90	19.17	19.15	19.73	35.92	37.10	38.18	37.19	18.17	20.60	21.32	20.43
B mg/l	0.21	0.42	0.23	0.98	12.80	12.44	11.87	12.98	54.10	53.13	52.34	52.56	9.30	8.65	7.87	9.16

E= *Eucalyptus camaldulensis* , **M**= *Morus alba*, **F=** *Ficus nitida*, **S** = *Salix vemenalis*

Table (c) . Concentration of heavy metal in soil under trees in different locations at ending of study 2017.

Parameters	At ending of Study															
	Control				Toukh				Shebein				Batanda			
	E	M	F	S	E	M	F	S	E	M	F	S	E	M	F	S
Zn mg/l	10.21	9.23	12.30	6.09	132.35	37.20	69.20	97.50	109.40	121.05	120.06	97.84	55.17	55.43	56.50	56.40
Cu mg/l	12.45	10.65	10.98	10.28	62.40	30.70	53.25	47.76	72.75	64.10	61.25	70.74	33.20	34.90	34.71	31.28
Cr mg/l	9.25	15.76	12.45	12.05	225.3	110.5	175.5	113.9	214.6	138.3	197.1	190.0	122.4	83.3	96.0	113.7
Fe mg/l	19.96	11.80	16.66	19.23	49400	33000	35876	37900	24500	28400	23698	24984	64500	56300	58796	59908
Mn mg/l	13.5	14.9	25.9	23.1	312.6	321.8	343.3	341.1	474.9	490.5	499.0	513.0	304.1	313.1	287.6	291.9
Ni mg/l	11.26	9.25	8.30	12.03	139.40	88.30	129.97	116.86	67.75	64.85	67.91	73.50	53.25	42.65	45.45	51.22
B mg/l	1.23	0.78	1.07	1.04	9.15	6.50	11.90	10.76	40.75	61.95	60.85	43.98	8.90	26.65	19.41	11.98

E= *Eucalyptus camaldulensis* , **M**= *Morus alba*, **F=** *Ficus nitida*, **S** = *Salix vemenalis*

Table (d): Chemical analysis of the studied soil under trees at the ending of study 2017.

Soil properties	Control	Toukh	Shebein	Batanda
pH	7.39	7.58	7.66	7.71
S.P.%	21	21.15	21.68	21.74
EC (ds /m)	1.16	1.27	1.32	1.28
	Soluble anions (meq/l)			
CO_3^-	-	-	-	-
HCO_3	2.2	2.27	2.35	2.36
Cl	1.52	1.68	1.79	1.75
SO_4	5.21	5.34	5.26	5.38
	Soluble cations (meq /l)			
Ca	1.72	2.47	2.48	2.51
Mg	5.39	1.52	1.44	1.47
Na	2.58	4.63	4.76	4.67
K	1.53	0.67	0.72	0.75

Statistical analysis:

The obtained results were subjected to statistical analysis of variance (ANOVA) according to the method described by **(**Snedecor and Cochran, 1982**)** using M STAT program. Least significant ranges (LSR) were used to compare between means of treatments according to (Duncan, 1955).

RESULTS AND DISCUSSION

It is obvious from data presented in **Tables (1, 2 and 3)** that there were gradually increasing in Zn content of leaves, branches and roots in all tested tree species during the study period. *Ficus nitida* trees produced the highest values from (22.89 to 36.03, 19.48 to 27.82 and 27.83 29.58 mg /l) in leaves, branches and roots, respectively as compared to the other tree Species. On other hand, the effect of agricultural drains location Shebine and Batanda drains, in general, contains the highest values of Zn, while the control treatments (Shebine irrigation canal) contain the lowest values of Zn (3.61, 3.67 and 3.71 mg/l) at the ending of study. Regarding the interaction between tree species and agricultural drains, data indicated that *Ficus nitida* trees produced the highest values of leaves, branches and roots Zn content in Batanda drains (52.47, 52.77 and 45.67 mg/l) followed by Shebine drain. In this concern, (Meyer et al., 2017) indicated that, *Ficus nitida* trees were a suitable candidate for Cd phytoextraction and Cu. In addition, various metals transferred from roots to shoots and the rhizosphere at different levels after transplantation. Metal concentrations in *Ficus nitida* commonly exhibited an increasing trend with the increment of corresponding soil metals. No obvious phytotoxicity symptoms were observed on the species even at the most heavily polluted position.

Table (1). Effect of woody tree species and agricultural drain locations on Zn content (mg /l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves Zn content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	3.90 h	20.03 d-f	14.40 g	18.20 d-f	14.13 c	5.03 h	17.07 fg	23.53 de	37.20 bc	20.07 b
***M.** alba*	3.53 h	21.43 cd	28.63 b	16.57 fg	17.54 b	3.87 h	21.40 ef	31.87 bc	22.02 ef	19.79 b
F. nitida	4.07 h	23.10c	32.27 a	32.10 a	22.89 a	3.53 h	41.57 b	46.53 a	52.47 a	36.03 a
***S.** viminalis*	4.93 h	15.43 g	28.53 b	20.80 d-f	17.42 b	2.00 h	20.67 ef	36.47 b	27.53 de	19.17 b
Mean A	4.11 c	20.00 b	25.96 a	21.92 b		3.61 c	25.18 b	34.60 a	34.81 a	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (2). Effect of woody tree species and agricultural drain locations on Zn content (mg /l) in branches during three years from 2014 – 2017.

Tree species / Drain locations	Branches Zn content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	4.00 f	15.60 e	22.30 cd	17.57 e	14.87 b	4.70 h	28.97 b-e	30.47 b-d	17.90 g	20.51 b
***M.** alba*	2.27 f	16.43 e	18.77 de	16.37 e	13.46 b	5.47 h	22.27e-g	17.07 g	19.07 fg	15.97 c
F. nitida	3.07 f	21.63 cd	24.79ab	28.43 a	19.48 a	2.27 h	22.23 e-g	34.00 b	52.77 a	27.82 a
***S.** viminalis*	2.87 f	17.80 e	18.77 de	22.50 cd	15.48 b	2.23 h	25.67 c-f	32.10 bc	16.43 g	19.11 b
Mean A	3.05 c	17.87 b	21.16 a	21.22 a		3.67 b	24.79 a	28.41 a	26.54 a	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (3). Effect of woody tree species and agricultural drain locations on Zn content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots Zn content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	4.37 e	15.60 d	23.13 bc	19.53 cd	15.66 b	5.23 d	21.53 c	34.87 b	35.87 b	24.38 b
***M.** alba*	3.60 e	17.13 cd	19.87 cd	18.07 cd	14.67 b	3.57 d	24.93 bc	23.87 bc	25.37 bc	19.43 c
F. nitida	3.93 e	29.53 b	38.60 a	39.27 a	27.83 a	2.67 d	35.77 b	34.23 b	45.67 a	29.58 a
***S.** viminalis*	3.47 e	16.33 cd	19.43 cd	21.30 cd	15.13 b	3.37 d	18.27 c	37.10 b	29.63 bc	22.09 b
Mean A	3.84 c	19.65 b	25.26 a	24.54 a		3.71 c	25.13 b	32.52 a	34.14 a	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Data presented in **Tables (4, 5 and 6)** indicated that, *Morus alba* trees produced the highest values of leaves, branches and roots Cu content (20.33, 34.98 and 44.00 mg/l) as compared to the other tree species. Also, accumulation of Cu in different trees parts tend to increase by the time passing, while Cu content tend to decrease in control treatment in the same time. Shebine drain showed significantly increased in Cu content as compared the other treatments (26.53, 36.46 and 42.35 mg/l) at the ending of the study period for leaves, branches and roots, respectively. For the interaction between two study factors the same data showed that, *Morus alba* trees, which planted in Shebine drain significantly increased in Cu content of leaves, branches and roots (50.50 , 78.73 and 93.33 mg/l) in comparison with the other treatments.

It is clear from data in **Tables (7, 8 and 9)** that, *Morus alba* trees were significantly superiority than the other tree species in Cr leaves, branches and roots content (417.12, 471.50 and 499.87 mg/l), respectively at the end of study. As regard to the Cr concentration in agricultural drains or irrigation canal, Shebine drain significantly increased in Cr contain (427.69, 626.67 and 440.18 mg/l), respectively at the end of the study in comparison with the two other drains or Shebine irrigation canal, which contain the lowest Cr content. At the same time *Morus* trees in Shebine drain significantly increased in Cr content from beginning to end of study (441.57 to 741.97 , 693.43 to 888.10 and 477.47 to 692.70 mg/l), respectively as compared to the other two drains or irrigation canal, which contain the lowest values during study period. On other hand, (Ashfa et al., 2009 and Zhao et al., 2012) reported that, *Morus alba* L. extract heavy metals from soil and their concentration grows from the root to the leaves. Accumulated at the top of larger quantities of heavy metals can be easily removed after Cutting and destruction of the branches of the mulberry tree. Plants develop thick root mass in the contaminated soil and rapid and strong growth of the tree creates vertical migration of significant amounts of water from the soil in which substantially reduces the risk of washing heavy metals from groundwater.

It is evident from data presented in **Tables (10, 11 and 12)** that, Fe content in leaves, branches and roots of *Salix viminalis* trees significantly augmented at the end of study (3196.45, 3956.53 and 3268.03 mg/l), respectively as compared to the other tree species at the same drains, while the lowest values of Fe produced by the same tress which planted beside irrigation canal (control treatment). In addition, the highest values of Fe showed in Batanda drain (3471.13, 5117.58 and 3842.83 mg/l) at ending of study period in comparison of the other drains with the exception of Shebine drain in beginning of study. Moreover, *Salix viminalis* trees grown at side of Batanda drain significantly increased in Fe content in different parts as compared to the other tree species grown in Shebine and Toukh drains. On other hand, all tested tree species grown at side of irrigation canal contain the lowest values of Fe content in their different parts.

Table (4). Effect of woody tree species and agricultural drain locations on Cu content (mg/l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves Cu content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	5.87 h	9.63f g	10.13 ef	6.97 gh	8.15 c	1.77 g	9.63 ef	10.13 ef	6.97 f	7.13 d
M. alba	4.03 h	21.40 a	22.80 a	17.87 b	16.53 a	1.57 g	14.26 cd	50.50 a	14.97 c-e	20.33 a
F. nitida	5.27 h	10.57 ef	12.77 de	11.40 de	10.00 b	2.53 g	14.00 cd	16.37 cd	10.17 ef	10.77 c
S. viminalis	4.03 h	14.13 cd	16.37 bc	10.17 ef	11.18 b	3.10 g	17.69 c	29.13 b	12.47 c-e	15.60 b
Mean A	4.80 d	13.93 b	15.52 a	11.60 c		2.24 c	13.90 b	26.53 a	11.15 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (5). Effect of woody tree species and agricultural drain locations on Cu contain (mg/l) in branches during three years from 2014 – 2017.

Drain locations / Tree species	Branches Cu content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	2.53 i	27.67 bc	22.80 c-e	18.97 de	17.99 b	3.07 i	27.67 b	22.80 c	18.97 d-f	18.13 b
M. alba	3.57 hi	39.00 b	58.70 a	35.63 bc	34.23 a	6.57 i	29.07 b	78.73 a	25.53 bc	34.98 a
F. nitida	2.10 i	12.73 f	6.80 g-i	9.13 fg	7.69 c	1.47 i	21.50 c	17.07 d-f	23.40 bc	15.86 b
S. viminalis	3.37 hi	8.37 f-h	10.83 fg	6.43 g-i	7.25 c	1.33 i	8.93 gh	27.23 b	10.63 fg	12.03 c
Mean A	2.89 d	21.94 b	24.78 a	17.54 c		3.11 c	21.79 b	36.46 a	19.63 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (6). Effect of woody tree species and agricultural drain locations on Cu content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots Cu content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	4.83 j	28.44 cd	25.67 de	19.99 ef	19.73 b	4.17 g	29.77 cd	25.67 de	20.73 ef	20.08 b
M. alba	5.67 j	38.77 b	93.33 a	34.36 bc	43.03 a	6.33 g	40.87 b	93.33 a	35.47 bc	44.00 a
F. nitida	4.97 j	14.27 gh	10.77 hi	12.37 hi	10.59 c	2.03 g	31.37 cd	30.70 cd	21.93 e	21.51 b
S. viminalis	4.10 j	17.60 f-h	21.67 ef	17.00 f-h	15.09 b	2.30 g	31.83 cd	19.70 ef	14.20 f	17.08 c
Mean A	4.89 c	24.77 b	37.86 a	20.39 b		3.71 d	33.46 b	42.35 a	23.08 c	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (7). Effect of woody tree species and agricultural drain locations on Cr content (mg/l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves Cr content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	5.67 g	42.30 e	23.60 e	22.83 ef	28.63 d	5.53 h	52.38 g	43.73 g	41.70 g	35.84 d
M. alba	8.87 g	337.70 b	441.57 a	336.73 b	281.22 a	6.90 h	386.83 de	741.97 a	532.77 c	417.12 a
F. nitida	4.67 g	192.70 d	255.57 c	285.10 bc	184.51 b	3.67 h	211.77 ef	243.40 ef	431.20 d	222.51 c
S. viminalis	3.63 g	122.53 de	251.73 c	149.60 de	131.87 c	5.57 h	369.00 de	681.67 b	315.20 e	342.86 b
Mean A	5.71 d	173.80 c	248.15 a	198.57 b		5.42 d	255.00 c	427.69 a	330.22 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (8). Effect of woody tree species and agricultural drain locations on Cr content (mg/l) in branches during three years from 2014 – 2017.

Drain locations / Tree species	Branches Cr content (mg/l)									
	Beginning of study					Ending of study				
	Control	**Toukh**	**Shebein**	**Batanda**	**Mean B**	**Control**	**Toukh**	**Shebein**	**Batanda**	**Mean B**
E. camaldulensis	6.83 h	49.85 g	688.57 a	149.98 f	223.81 b	6.80 i	53.87 h	787.57 b	166.43 fg	253.67 b
M. alba	9.33 h	392.47 c	693.43 a	384.83 c	370.02 a	8.07 i	488.77 c	888.10 a	501.07 c	471.50 a
F. nitida	4.47 h	199.17 e	218.47 e	138.03 f	140.04 c	3.97 i	162.83 fg	542.47 c	145.60 g	213.72 b
S. viminalis	5.63 h	273.90 d	210.20 e	407.77 b	224.38 b	4.67 i	225.67 e	288.53 d	230.70 e	187.39 c
Mean A	6.57 d	228.85 b	452.67 a	270.15 b		5.88 d	232.78 c	626.67 a	357.71 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (9). Effect of woody tree species and agricultural drain locations on Cr content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots Cr content (mg/l)									
	Beginning of study					Ending of study				
	Control	**Toukh**	**Shebein**	**Batanda**	**Mean B**	**Control**	**Toukh**	**Shebein**	**Batanda**	**Mean B**
E. camaldulensis	5.03 h	76.37 fg	81.13 f	59.20 g	55.43 c	5.03 h	76.37 fg	99.13 f	59.20 g	59.93 c
M. alba	10.33 h	334.77 b	477.47 a	471.53 a	323.53 a	4.50 h	583.17 b	692.70 a	519.10 c	449.87 a
F. nitida	3.57 h	215.23 d	474.60 a	147.40 e	210.20 b	3.57 h	178.57 de	539.37 de	159.33 e	220.21 b
S. viminalis	6.90 h	293.17 c	357.00 b	278.77 c	233.96 b	6.90 h	256.70 d	429.53 de	265.33 d	239.62 b
Mean A	6.46 c	229.89 b	346.05 a	239.23 b		5.00 c	273.70 b	440.18 a	250.74 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (10). Effect of woody tree species and agricultural drain locations on Fe content (mg/l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves Fe content (mg/l)									
	Beginning of study					Ending of study				
	Control	**Toukh**	**Shebein**	**Batanda**	**Mean B**	**Control**	**Toukh**	**Shebein**	**Batanda**	**Mean B**
E. camaldulensis	16.27 g	807.1 e	852.9 e	635.6 f	578.0 d	12.93 g	1034.1 f	1017.2 f	971.1 f	758.8 d
M. alba	18.03 g	1822.7 d	2027.0 d	2743.6 c	1652.8 c	15.03 g	4240.0 b	2986.8 cd	5140.2 a	3095.5 b
F. nitida	10.40 g	1728.6 d	3666.6 b	1883.7 d	1822.8 b	12.17 g	2054.1 ef	3666.6 c	2607.0 de	2085.0 c
S. viminalis	14.87 g	2005.0 d	3337.8 b	4567.3 a	2481.2 a	11.37 g	4288.1 b	3320.2 d	5166.2 a	3196.5 a
Mean A	12.89 c	1590.8 b	2471.1 a	2457.5 a		12.88 c	2904.1 b	2747.7 b	3471.1 a	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (11). Effect of woody tree species and agricultural drain locations on Fe content (mg/l) in branches during three years from 2014 – 2017.

Drain locations / Tree species	Branches Fe content mg/l)									
	Beginning of study					Ending of study				
	Control	**Toukh**	**Shebein**	**Batanda**	**Mean B**	**Control**	**Toukh**	**Shebein**	**Batanda**	**Mean B**
E. camaldulensis	17.37 j	4276.3 b	1681.6 f-i	2901.4 de	2219.2 b	16.27 e	4608.5 bc	4762.1 bc	4848.4 bc	3558.8 a
M. alba	13.37 j	1893.3 e-h	1217.9 g-i	2445.0 d-f	1392.4 c	12.63 e	2800.3 d	4100.7 cd	4712.6 bc	2906.6 b
F. nitida	11.50 j	786.7 hi	604.4 i	847.3 hi	562.5 d	15.00 e	2861.4 d	4103.0 cd	4732.0 bc	2927.8 b
S. viminalis	16.53 j	4016.9 b	3552.5 cd	8046.1 a	3908.0 a	12.70 e	4079.2 cd	5556.9 ab	6177.3 a	3956.5 a
Mean A	14.69 d	2743.3 b	1764.1 c	3559.9 a		14.15 c	3587.3 c	4630.7 b	5117.6 a	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (12). Effect of woody tree species and agricultural drain locations on Fe content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots Fe content mg/l)									
	Beginning of study					Ending of study				
	Control	**Toukh**	**Shebein**	**Batanda**	**Mean B**	**Control**	**Toukh**	**Shebein**	**Batanda**	**Mean B**
E. camaldulensis	17.80 k	921.6 f-h	1225.4 cd	1027.0 d-g	798.0 c	12.90 g	1650.1 ef	2280.8 d-f	2720.6 c-e	1666.1 b
M. alba	12.47 k	440.1 j	645.5 hi	839.1 f-h	484.3 d	10.87 g	2107.2 d-f	2700.4 c-e	3532.5 bc	2087.7 b
F. nitida	13.80 k	1119.7 cd	1616.1 b	1184.7 cd	983.6 b	12.73 g	2007.2 d-f	2790.4 c-e	3632.5 bc	2110.7 b
S. viminalis	15.9 k	1082.1 d-f	1289.7 c	2224.6 a	1153.1 a	11.53 g	3204.1 b-d	4370.8 ab	5485.7 a	3268.0 a
Mean A	14.99 d	890.9 c	1194.2 b	1318.84 a		12.01 d	2242.1 c	3035.6 b	3842.8 a	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Data presented in **Tables (13, 14 and 15)** indicated that, leaves, branches and roots of *Salix viminalis* trees significantly increased in Mn content from beginning to end the study period (202.53 to 232.79, 64.53 to 127.55 and 91.71 to 171.70 mg/l) as compared to the rest tree species with the exception of leaves Mn content of *Eucalyptus camaldulensis* at the end of study, while *M. alba* trees produced the lowest values of Mn content in this regard. Moreover, Shebine irrigation canal (control treatment) significantly decreased in their Mn contain (6.13, 3.58 4.08 and mg/l) at the end of study in comparison with the other treatments. In addition, *Salix viminalis* leaves produced the highest values Mn content in all tested drains as compared to the other tree species during the study period. Besides, branches and roots of S. *viminalis* which grown at side of Shebein drain were accumulated Mn more than other species in the other two tested drains and control treatment. For Ni content, data illustrated in **Tables (16, 17 and 18)** showed that, *Eucalyptus camaldulensis* significantly increased in Ni content in all tested tree parts when compared the other three species at the end of study (376.90, 411.25 and 416.31 mg/l) in leaves, branches and roots, respectively and the superiority continued during the study period. The accumulation of Ni in Toukh drain were more than the other two drains from beginning to end of study and the differences among them were significantly with the exception of Batanda drain at the end of study. *Eucalyptus camaldulensis* grown at Toukh drain side significantly increased leaves, branches and roots Ni content in comparison with the other three species at the other two drains. On other contrary, all tested tree species grown at irrigation canal side contain the lowest values of Ni in different tree parts during the study period.

It can be noticed from data presented in **Tables (19, 20 and 21)** that, accumulation of B in different parts of *Morus alba* trees were more than the rest tree species in the same tested parts, the differences among *Morus alba* and the other species were significantly in this regard. For the effect of drain location, Toukh drain significantly increased in B contain as compared to Shebine and Batanda drains, the increasing continued during study period, while irrigation canal contain the lowest values of B from beginning to end of study. Regarding the interaction between tree species and drains location, *Morus alba* trees which grown in Toukh drain side significantly increased in leaves, branches and roots B content as compared to *Eucalyptus camaldulensis*, *Ficus nitida and* and *Salix viminalis*, respectively. The above mentions results may be duo to in some species that, the

Table (13). Effect of woody tree species and agricultural drain locations on Mn content (mg/l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves Mn content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	4.57 f	176.97 b	267.70 a	27.53 ef	119.19 b	10.70 c	192.67 bc	523.90 a	198.23 bc	231.38 a
M. alba	11.53 f	105.10 bc	166.03 b	82.83 b-d	91.37 b	4.83 h	113.29 gh	50.37 g	103.33 ef	61.24 d
F. nitida	5.80 f	42.30 d-f	63.90 c-e	42.73 d-f	38.68 b	3.33 h	106.63 fg	141.90 d	133.43 d	102.07 c
S. viminalis	6.20 f	249.19 a	278.67 a	276.10 a	202.53 a	5.67 h	223.03 e	310.17 a	313.17 a	232.79 a
Mean A	7.03 d	143.39 b	194.08 a	107.30 c		6.13 c	282.96 a	256.59 a	187.04 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (14) . Effect of woody tree species and agricultural drain locations on Mn content (mg/l) in branches during three years from 2014- 2017.

Drain locations / Tree species	Branches Mn content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	10.23 g	34.00 f	41.77 e	37.17 ef	30.79 d	3.87 f	88.27 cd	152.50 b	50.43 e	73.77 b
M. alba	7.27 g	49.17 de	103.03 a	47.70 de	51.79 b	3.70 f	42.63 e	89.63 cd	43.33 e	44.82 c
F. nitida	5.97 g	42.03 e	49.07 d	37.30 ef	33.59 c	2.43 f	85.80 cd	95.63 c	152.90 b	84.19 b
S. viminalis	5.30 g	79.00 bc	91.60 b	82.23 bc	64.53 a	4.30 f	140.57 b	220.43 a	144.90 b	127.55 a
Mean A	7.19 c	51.05 b	71.37 a	51.10 b		3.58 c	89.32 b	139.55 a	97.89 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (15). Effect of woody tree species and agricultural drain locations on Mn content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots Mn content (mg /l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	10.57 gh	59.77 d-f	70.10 cd	80.40 c	55.21 b	3.87 i	152.63cd	170.53de	152.80e	119.96 b
M. alba	6.97 gh	60.65 d-f	122.13ab	50.20ef	59.99 b	3.20 i	40.20h	67.27gh	89.40fg	50.02 c
F. nitida	5.83 h	44.93 f	62.10 de	53.50d-f	41.59 c	5.50 i	198.47b-d	187.70b-d	49.03h	110.17 b
S. viminalis	7.13 gh	107.63 b	131.20 a	120.87ab	91.71 a	3.73 i	214.30ab	259.47a	206.77a-c	171.70 a
Mean A	7.63 c	68.25 b	96.38 a	76.24 b		4.08 c	151.40a	171.24a	124.50 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (16). Effect of woody tree species and agricultural drain locations on Ni content (mg/l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves Ni content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	6.23 h	522.47 a	22.57 g	47.97 fg	149.81 a	5.80 i	834.90 a	213.63 e	453.27 b	376.90 a
M. alba	7.00 h	11.50 g	114.83 d	108.23 cd	60.39 c	1.77 i	103.70 gh	118.50 gh	117.30 gh	85.32 d
F. nitida	5.07 h	53.50 fg	73.63 ef	63.97 f	49.04 c	5.00 i	418.57 c	412.60 c	328.27 d	291.11 b
S. viminalis	7.10 h	105.27 cd	177.47 b	62.13 f	132.89 b	4.73 i	125.20 g	250.93 e	168.27 fg	137.28 c
Mean A	6.35 c	173.19 a	115.49 b	97.11 b		4.33 c	370.59 a	248.92 b	266.78 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT)

Table (17). Effect of woody tree species and agricultural drain locations on Ni content (mg /l) in branches during three years from 2014 – 2017.

Drain locations / Tree species	Branches Ni content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	8.00 j	410.53 a	118.07 de	156.00 b	173.15 a	3.13 i	774.70 a	619.65 b	247.5	411.25 a
M. alba	12.33 j	141.00 bc	151.00 bc	133.93 b-d	109.57 b	4.80 i	483.53 d	168.27 c	594.01 c	312.65 b
F. nitida	5.80 j	31.17 i	34.23 i	32.87 i	26.02 e	2.63 i	70.27 gh	120.23 f	87.00 g	70. 03 d
S. viminalis	4.57 j	41.67 g-i	52.70 fg	42.43 fg	35.34 d	4.63 i	115.73 fg	474.57 d	128.17 f	180.78 c
Mean A	7.68 c	156.09 a	89.00 b	91.31 b		3.80 c	361.06 a	345.68 a	264.17 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (18). Effect of woody tree species and agricultural drain locations on Ni content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots Ni content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	8.20 df	373.77 a	17.43 c-f	33.13 cd	108.13 a	5.73 h	668.87 a	455.37 c	535.26 b	416.31 a
M. alba	7.13 ef	103.37 b	113.30 b	103.77 b	81.89 b	2.53 h	113.29 gh	124.13 fg	122.93 fg	90.72 c
F. nitida	3.10 f	26.50 c-f	33.70 cd	24.63 c-f	21.98 c	2.53 h	106.63 fg	140.67 f	77.23 g	81.77 c
S. viminalis	2.73 f	31.07 c-e	21.07 c-f	20.87 c-f	18.93 c	5.60 h	223.03 e	321.77 d	150.93 ef	175.33 b
Mean A	5.29 c	133.68 a	46.38 b	45.60 b		4.10 c	282.96 a	260.49 a	221.59 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (19). Effect of woody tree species and agricultural drain locations on B content (mg/l) in leaves during three years from 2014 – 2017.

Drain locations / Tree species	Leaves B content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	5.67 hi	16.23 ef	18.30 e	17.67 e	14.47 d	2.37 f	23.50 d	17.43 de	29.67 cd	18.24 c
M. alba	5.50 hi	78.83 a	74.40 a	26.27 d	46.25 a	3.67 f	96.43 a	65.03 b	43.83 de	52.24 a
F. nitida	6.83 hi	38.33 c	5.93 hi	54.90 b	26.50 b	1.17 f	58.13 bc	53.87 b-d	46.27 c-e	39.86 b
S. viminalis	2.67 i	12.60 fg	9.50 gh	39.83 c	16.15 c	1.60 f	19.60 d-f	20.20 d-f	22.97 d-f	16.09 c
Mean A	5.17 c	36.5 a	27.03 c	34.67 b		2.20 d	49.42 a	39.13 b	35.69 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (20) . Effect of woody tree species and agricultural drain locations on B content (mg/l) in branches during three years from 2014 – 2017.

Drain locations / Tree species	Branches B content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	0.57 h	25.00 d	6.53 fg	4.30 gh	9.10 c	2.50 gh	13.50 ef	16.40 ef	10.80 f	10.80 d
M. alba	5.63 fg	69.60 a	58.33 b	41.30 c	43.72 a	3.63 gh	90.07 a	80.62 b	75.30 bc	62.40 a
F. nitida	2.77 h	57.56 b	11.17 d-f	9.73 ef	20.31 b	0.53 h	66.93 c	2.30 gh	26.17 de	23.98 b
S. viminalis	0.27 h	19.00 de	1.1 h	0.57 h	5.24 c	2.37 gh	15.87 ef	29.17 de	31.27 d	19.67 c
Mean A	2.31 d	42.79 a	19.28 b	13.98 c		2.26 c	46.59 a	32.12 b	35.89 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

Table (21). Effect of woody tree species and agricultural drain locations on B content (mg/l) in roots during three years from 2014 – 2017.

Drain locations / Tree species	Roots B content (mg/l)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	10.57 gh	70.10 cd	59.77 d-f	80.40 c	55.21 b	3.87 i	152.63 cd	170.53 de	152.80 e	119.96 b
M. alba	7.13 gh	131.20 a	107.63 b	120.87 ab	91.71 a	3.73 i	214.30 ab	259.47 a	206.77 a-c	171.07 a
F. nitida	5.83 h	62.10 de	44.93 f	53.5 d-f	41.59 c	5.50 i	198.47 b-d	187.70 b-d	49.03 h	110.17 b
S. viminalis	6.97 gh	122.13 ab	60.65 d-f	50.20 ef	59.99 b	3.20 i	40.20 h	67.27 gh	89.40 fg	50.02 c
Mean A	7.63 c	96.38 a	68.25 b	76.24 b		4.08 c	151.40 a	171.24 a	124.50 b	

Means within a Column having the letters are not significant different according to Duncan's multiple test (DMRT).

levels of treatments were not high enough to force the plants to react and transport the extra Ni and Cd from the root and Branches to the leaves or these plant species are highly resistant to Ni and Cd because they retain a certain amount of these heavy metals in their branches and roots. However, in these species, in addition to the Cr uptake in the green leaves for the 240 and 480 treatments, Cr was transported to the leaves from the roots and branches. This could take place because of the high range of toxicity to Cr in these species at higher concentrations. Therefore, they have tendency to reduce the maximum amount of Cr, which accomplished by Cr transportation from the roots and branches to the leaves of the plants, (Rafati et al., 2011). The roots of plants with microorganisms of the rhizosphere can reduce the bioavailability of the metal and therefore - their phytotoxicity. Membranes of plant cells have some binding properties against metals. Various detoksfikatsionni mechanisms can be distinguished at the cellular level: metallic exclusion, translocation, binding complexes in the cytoplasm (Marschner, 1995).

RECOMMENDATIONS

Planting timber trees beside drainages are necerray for enhanced agricultural drainage water quality.

REFERENCES

Allam, A.E. and Negm, A.M. (2013). "Agricultural drainage water quality analysis and its suitability for direct reuse in irrigation: case study: Kafr El-Sheikh governorate, Egypt". Seventeenth International Water Technology Conference, IWTC17 Istanbul, 5-7 November.

(APHA) American Public Health Association (1992). Standard Methods for the Examination of Water and Wastewater 18th (ed), APHA, AWWA, WPCF. NY. Washington.

Archer, M.J.G. and Caldwell, R.A. (2004). Response of six Australian plant species to heavy metal contamination at an abandoned mine site. Water Air Soil Poll., 1 (57): 257 - 267.

Ashfa, M., Afzal, W. and Hanif, M. (2009). Effect of Zn (II) deposition in soil on mulberry-silk worm food chain. The Journal of Animal & Plant Sciences, 9 (11): 1665-1672.

Chapman, H.D. and Pratt, P.F. (1961). Methods of Analysis for soils, plant and water. Div. of Agric. Sci. Univ. of Calif, pp: 309.

Duncan, D.B. (1955). Multiple Range and Multiple F Tests. Biometrics, 11:1- 42.

FAO (Food and Agriculture Organization of the United Nations) (1997). Management of agricultural drainage water quality. International commission on irrigation and drainage, Water Reports, 13, Roma, Italy.

Marschner, H. (1995). Mineral nutrition of higher plants. 2nd ed. New York, Academic Press, 889 pp.

McGee, C. J., Fernandez, I.J., Norton, S.A. and Stubbs, C. (2006). Cd, Ni, Pb, and Zn concentration in forest vegetation and soils in Maine. Water. Air. Soil. Pollut., 180 : 141- 153.

Meyer, E., Londoño, D.M.M., Armas, R.D., Giachini, A.J., Rossi, M.J., Stoffel, S.C.G. and Soares, C.R.F.S. (2017). Arbuscular mycorrhizal fungi in the growth and extraction of trace elements by *Chrysopogon zizanioides* (vetiver in a substrate containing coal mine wastes. International Journal of Phytoremediation, 19 (2): 113–120.

Newman, L. A. and Reynolds C. M. (2004). Phytodegradation of organic compounds. Curr. Opin. Biotech., 15: 225 - 230.

Piper, C. S. (1950). Soil and Plant Analysis. Inter. Sci. Publishers, Inc. New York.USA.

Rafati, M., N. Khorasani, F. Moattar, A. Shirvany, Moraghebi, F. and Hosseinzadeh, S. (2011). Phytoremediation Potential of *Populus Alba* and *Morus alba* for Cadmium, Chromuim and Nickel Absorption from Polluted Soil. Int. J. Environ. Res., 5 (4): 961 -970.

Sahmoune, M.N.; Louhab, K. and Bukhiar, A. (2008). Biosorption of Cr (III) from aqueous solutions using bacterium biomass Streptomyces rimosus. Int. J. Environ. Res., 3 (2): 229 - 238.

Singh, O.V. and Jain, R.K. (2003). Phytoremediation of toxic aromatic pollutants from soil. Appl. Microbiol. Biotech., 63 :128 - 135.

Snedecor, G.W. and Cochran, W.G. (1982). Statical Methods. Iowa State Univ. Press, USA, pp: 5 C. T. 07.

Soltanpour, P. N. (1985). Use of ammonium bicarbonate DTPA soil tests to evaluate elemental availability and toxicity. Communi, Soil Sci. Plant Anal., 16: 323 – 318.

Suresh, B. and Ravishankar, G.A. (2004). Phytoremediation - A novel and promising approach for environmental clean-up. Crit. Rev. Biotechnol., 24: 97-124.

Tarchouna, L.G., Merdy, P., Raynaud, M., Pfeifer, H.R. and Lucas, Y. (2010). Effects of long-term irrigation with treated wastewater-part I: evolution of soil physico-chemical properties. Applied Geochemistry, 25 (11):1703 – 1710.

Urooj, A. and Delouee, S.A. (2007). Antioxidant properties of various solvent extracts of mulberry (*Morus indica* L.) leaves. Food Chemistry, 102(4):1233-1240

Zhao, S., Shang, Xi. and Duo, L. (2012). Accumulation and spatial distribution of Cd, Cr, and Pb in mulberry from municipal solid waste compost following application of EDTA and (NH4)2SO4. Environmental Science and Pollution Research, 20 (2): 967-975.

Horticulture Research Journal, 3 (4), 62 : 73 - June 2025, ISSN 2974/4474

الملخص العربى

استخدام بعض أنواع الأشجارالخشبية لمعالجة ملوثات مياة الصرف الزراعى

2- تأثير نوع الأشجار وموقع المصارف الزراعية على المكونات الكميائية لبعض أنواع الأشجارالخشبية

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أجريت هذه الدراسة في محافظة القليوبية لمدة ثلاث سنوات لدراسة قدرة أربعة أنواع من الأشجار (الكافور، الصفصاف، توت أبيض، فيكس نيتيدا) النامية على جانب واحد فى ثلاثة من المصارف الزراعية (طوخ، شبين، بتندا) بالإضافة إلى قناة ري شبين التي استخدمت كمعاملة كنترول على امتصاص وتراكم بعض المعادن الثقيلة في أجزاء مختلفة من الأشجار لتقليل معدلات التلوث في المصارف الزراعية. تم أخذ القياسات؛ الزنك، النيكل، البورون، الكروم، النحاس، المنغنيز والحديد في الأوراق والأفرع والجذور في جميع أنواع الأشجار المختبرة في بداية ونهاية الدراسة.

أظهرت النتائج أن أوراق وأفرع وجذور الفيكس نيتيدا أظهرت زيادة كبيرة في محتوى الزنك مقارنة بأنواع الأشجار الأخرى. علاوة على ذلك، احتوى التوت الأبيض على أعلى قيم للنحاس والكروم والبورون في الأوراق والأفرع والجذور مقارنة بأنواع الأشجار الأخرى. من ناحية أخرى، احتوت أشجار الكافور على أعلى تركيز من النيكل خلال فترة الدراسة. بالإضافة إلى ذلك، زاد محتوى الحديد والمنجنيز في أشجار الصفصاف بشكل ملحوظ في الأجزاء المختلفة المختبرة مقارنةً بأنواع الأشجار الأخرى. من ناحية أخرى، أظهر مصرف طوخ أعلى تركيز من النيكل والبورون خلال فترة الدراسة، بينما احتوى مصرف بتندا على أعلى قيم من الحديد والنيكل مقارنةً بالمواقع الأخرى. كما احتوى مصرف شبين على أعلى تركيز من المنغنيز والنحاس والكروم مقارنةً بالمعاملات الأخرى .

التوصيات :

زراعة الأشجار الخشبية بجانب المصارف الزراعية أمرضروري لتحسين جودة مياه الصرف الزراعي.