Usage of Some Woody Tree species to Remediate Contaminants in Agricultural Drainage Water

1- Effect of Tree Species and Agricultural Drain Locations on Vegetative Growth Characteristics and Specific Gravity 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 effect of agricultural drainage water on vegetative growth and specific gravity for four tree species (*Eucalyptus camaldulensis*, *Salix vemenalis*, *Morus alba* and *Ficus nitida*) grown at one side both of the three agricultural drains (Touch, Shebine and Batanda) and Shebine irrigation canal which used as a control treatment. The following data were recorded; stem height, stem diameter, fresh and dry weight of leaves, branches and roots in addition to specific gravity. Results showed that, *E. camaldulensis* significantly increased in stem height and stem diameter as compared to the other species. Ficus and Salix trees showed significantly increased in leaves, branches and roots fresh and dry weight as compared to the other tested tree species from beginning to ending of study with the exception of roots dry weight of Salix trees which superior the rest of tree species. Moreover, the control treatments significantly increased in all tested vegetative growth characteristics as compared to the treatments with the exception of the stem diameter. Ficus and willow trees produced the highest values of specific gravity in comparison with the other two species. The growing willow trees on the side of Shebein drain produced the highest values of the specific gravity as compared to the rest of treatments. The irrigation canal (control treatments) showed significantly decreased in the specific gravity as compared to the three tested drains.

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

INTRODUCTION

In several countries throughout the world, at the beginning of the last century, reuse of wastewater has been started. The acute shortage of water necessitates the development of new water sources. One of the best solution for covering the shortage of water is considered the application of wastewater (Selim, 2006 and Al-Othman, 2009). The use of treated wastewater as a new resource of irrigation has been encouraged, in some countries, from several decades to increase the efficient use of water irrigation in crop production (Alderfasi et al., 2002) and forest trees (Nasser et al., 2010). Using wastewater for irrigation after primary treatment of woody tree plantations, green belts around the cities and non-food crops are safe. Irrigating with sewage effluent improved the soil properties because it is considered as a rich source of nutrients (Hassan et al., 2006 and Tabari and Salehi, 2009). Using septic tanks is the traditional method of discharging and collecting wastewater- causing lead to leak of wastewater, which severely effect of groundwater and soil properties (Orr, 1997 and Zang et al., 2006). Wastewater-contaminated groundwater and soil is located and noticed in residential districts and industrial in many countries especially in the third world. It is clear that, the wastewater properties depending on its source, contains dissolved salts, organic matter, toxicity, oil, detergents, grease and many types of metals and heavy metals (Abdel-Nasser, 1993, Crawford and Burn, 1998 and Lykins and Clark, 1998). The Treated Waste Water (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 and plant growth, agriculture products (Yadav et al., 2002 and Tarchouna et al., 2010). Phytoremediation technology although, it is cheaper than the classic methods but it is not an easy technic that consists of planting some hyper accumulating trees and plants in contaminated sites. Phytoremediation technology although it is cheaper than the classic methods, however, it is not an easy technique that consists of planting some hyper accumulating trees and plants in contaminated sites (Alkorta et al., 2004). It is requiring designers with highly experience to choose the suitable species for the contaminated region. It can be concluded that, traditional methods to clean-up of heavy metals from soil and water are costly so difficult hence application of plants in order to reduce soil and water pollution which is practical and economic is necessary (Salahi, 2015).

The objective of this work was to study the effect of agricultural drainage water on vegetative growth characteristics and specific gravity of some woody tree species as compared with those grown on the agricultural canal water, which used for irrigation.

MATERIALS AND METHODS

This study was carried out at Qaliubiya Governorate during three years since March 2014 to March 2017. Four trees species (*Eucalyptus camaldulensis*, *Salix viminalis*, *Morus alba* and *Ficus microcarpa*) were planted in 1995 at one side of the three agricultural drains, Toukh (Abo Alakkdar), Shebein and Batanda (Abo Rahma). The same trees planted at the same time in one side of Shebein irrigation canal used as a control treatment.

The following data were recorded:

A- Vegetative growth characteristics:

- Stem height (m)
- Stem diameter (cm) at breast height (DBH), 1.3 m above the ground.
- Leaves fresh and dry weight (gm).
- Branches fresh and dry weight (gm).
- Roots fresh and dry weight (gm).

B - Physical properties Specific gravity

Determination of specific gravity was based on the fresh volume and oven dry weight. The specimen for specific gravity (SG) was obtained by removing cubes of 20 × 20 × 20 mm from the upper part of each test specimen, free from any natural defects was machine cut from the stem bases of each seedling and used in the analysis, Specimens were coded, debarked and aspirated under vacuum until water logged. They were subjected to a gravimetric procedure developed by (Smith, 1954) in which specimens were completely saturated with water by boiling from initial moisture content of 17%.

Each cube was removed from the water, blotted to remove excess water, weighed and oven dried to a constant weight at 103 °C. The oven dried weight was then obtained and the maximum moisture content was calculated.

The specific gravity of each specimen was determined using the following equation:

$$\text{Specific gravity} = \frac{1}{Ws - Wo/Wo + 1/Gso\ (1.53)}$$

Where: Ws = saturated weight of wood specimen,
WO= oven dried weight of wood specimen,
and Gso = average density of wood substance (1.53).

1-Waste effluent:

The collected samples were filtered and stored in polyethylene bottles and kept near freezing (4° C) to analyze in the Laboratory. Chemical oxygen demand (COD) determined by dichromate oxidation method five-day, biochemical oxygen demand BOD_5) was determined by amount of oxygen lost after incubation for five days in the dark at 200°C). The drainage water samples were analyzed for Ec, PH, soluble cation and anions. Content of Zn, Cu, Fe, Cr, Mn, B and Ni in the drainages water which were used as sources of irrigation as well as their available content s in soil were extracted according to (Soltanpour, 1985) and were measured using the Inductively coupled plasma spectrometry (plasma 400) at beginning and ending of study as shown in **Table (a).**

2- Soil:

Thirty-two soil profiles were chosen to represent under four tree tested species, both control treatment (canal irrigation) and three drains locations at beginning and ending of study, soil samples were taken under each selected tree species from a depth of 0-30 cm by digging profiles. Soil samples were air-dried, ground, thoroughly mixed and passed through a 2 mm sieve and kept for analysis. Soil particle size distribution and Ca CO_3 were determined according to (Piper, 1950). Following (Black et al., 1965) and (Page, 1984). Fe, Mn, Zn, Cu, B, Cr, and Ni were determined according to American Public Health Association (APHA, 1992) at beginning and ending of study as shown in **Tables (b and c).**

3- Trees:

Four tree species were planted in 1995. Distance planted 5X5 m. For chemical analysis, five samples of each tree organs in each location were taken (5 gm of each) and oven dried at 70° C until a constant weight, and then ground and stored for analysis. Plant sample were wet digested according to (Chapman and Pratt, 1961).

Trees species which were used in this experimental i.e.:

3-1. *Eucalyptus camaldulensis* is a tree of the genus Eucalyptus. It is one of 800 around in the genus. It is a plantation species in many parts of the world, but is native to Australia, a moderately fast growing tree with high biomass production and wide adaptability to climatic and edaphic conditions and falls at the bottom of food chain. The species is best suited for plantation of degraded lands - waterlogged and saline soils - and disposal of untreated industrial wastewater safety and economically to tree plantation, which helps to recapitulate the soil status and quality (Bhati and Singh, 2003).

3-2. Morus genus contains approximately 16 members of family Moraceae, occurring primarily in northern temperate regions with some extending into tropical areas of Africa and the South American Andes. There are 11 species distributed widely in China. Genus Morus (mulberry) is one of such example that consists of over 150 species, among these, *Morus alba* L. is dominant (Srivastava et al., 2006). Generally, it used as foliage to feed the silkworms (*Bmbyx mori* L.) and ruminants (Arabshahi-Delouee and Urooj, 2007). In many countries like Turkey and Greece, *Morus alba* and other mulberries are grown for fruit production that have certain application in some traditional foodstuffs (Anonymous, 2001). Also, this species is suitable for planting around highways and landscaping in settlements (Zhao et al., 2012).

3-3. *Ficus nitida* is one of about 850 species of Ficus genus, which contains woody trees, shrubs, vines, epiphytes and hemiepiphytes in the family Moraceae. Collectively known as fig trees or figs, they are native throughout the tropics with a few species extending into the semi-warm temperate zone. The wood of fig trees is often soft; it was used to make mummy caskets in Ancient Egypt. *Ficus nitida* plants used in traditional medicine in India, Malaysia, China and Japan, against pain and fever, flu, malaria, bronchitis and rheumatism. (Bailey and Bailey, 1976, Berg, 2003 and Berg and Corner, 2005).

3-4. *Salix viminalis* is known as a possible bio-filter for extraction of soil and water contamination. Willows can be used as a vegetative filter in the process of bioremediation of wastewater or contaminated land, and for increasing the content of organic material in soil (Argus, 1997, McCracken and Dawson, 1998 and Nejad, 2005). Salix species have been used for phytoremediation of wetlands in temperate countries, being a largely temperate genus; its usefulness is probably limited in the tropical context, while there has a search for tropical hyper accumulators (Reeves, 2003).

Experimental design:

The layout of the experiment was a factorial in complete randomized design, the main factor was tree species and the sub factor was agricultural drains. The experiment included 16 treatments, 4 tree species, 3 agricultural drainage in addition to 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	37.1	82.17	84.86	84.03	85.1	32.2	31.15	27.26	30.54
Cu mg/l	0.89	0.095	1.55	1.49	75	74.91	75.36	75.78	56.21	53.2	53.99	56.12	25.8	25.15	23.83	24.99
Cr mg/l	0.02	0.02	0.05	0.05	28.81	29.6	29.98	27.03	46.7	45.1	46.81	48.3	27.13	28.1	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	380.6	388.11	366.1	555.17	543.3	559.22	550.33	370.13	386.8	365.4	384.18
Ni mg/l	0.21	0.32	0.87	0.54	19.9	19.17	19.15	19.73	35.92	37.1	38.18	37.19	18.17	20.6	21.32	20.43
Bo mg/l	0.21	0.42	0.23	0.98	12.8	12.44	11.87	12.98	54.1	53.13	52.34	52.56	9.3	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
Bo 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

A- Effect of tree species and agricultural drain locations on some vegetative growth traits

1- Stem height:

It is evident from data presented in **Table (1)** that, there were significant differences among the four woody tree species in their stem height. In this concern, *Eucalyptus camaldulensis* was the highest (17.48 m), while *Salix viminalis* was the lowest (9.18 m) at the ending of the study period. As regard to the effect of drains locations, the control treatments (canal irrigation) produced the tallest trees (13.65 to 13.99 m) in comparison with (11.56 to 12.05, 10.58 to 10.95 and 10.29 to 10.82 m), respectively for Toukh, Shebein and Batanda drains from begging to ending of study. For the interaction between the two studied factors, *Eucalyptus camaldulensis* significantly increased tree height (24.42 m) in control treatments (canal irrigation) in comparison the other tree species in the different treatments.

2- Stem diameter:

Concerning the differences among the four tested tree species on stem diameter, data presented in **Table (2)** showed that, there were significant differences in stem diameter among the tree species. In this regard, *Morus alba* produced the thinnest diameter (21.60 to 22.19 cm), while *Eucalyptus camaldulensis* gave the thickest diameter (38.22 to 38.40 cm) from beginning to end of the study period. In addition, there were non-significant differences among different drains location and control treatments in this regard. Concerning the interaction between two factors of study, *Eucalyptus camaldulensis* produced the highest values of stem diameter (43.95 cm) in control treatments as compared to the same species growing in the three drains, Toukh, Shebein and Batanda, (34.29, 36.09 and 39.28 cm, respectively) and the other tree species in the different locations at the ending of study.

3- Leaves fresh weight:

It is clear from date presented in **Table (3)** that *Ficus nitida* and *Salix viminalis* trees were significantly superior in leaves fresh weight (74.34 and 79.62 gm) than the other two tree species (72.65 and 61.70 gm) at the end of study. These results are in agreement with (Othman et al., 2016) on *Pinus brutia*. As regard to the effect of agricultural drains locations or irrigation canal, the irrigation canal significantly increased the leaves fresh weight (101.34 gm) in comparison with the other treatments which contained the lowest values in this regard (64.95, 50.12 and 71.90 gm) respectively. At the same time, *Ficus nitida* and *Salix viminalis* trees grown at side of irrigation canal significantly increased fresh weight of leaves during the study period.

Table (1). Effect of woody tree species and agricultural drain locations on stem height (m) during three years from 2014 – 2017.

Drain locations / Tree species	Stem height (m)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean	Control	Toukh	Shebein	Batanda	Mean
***E**. camaldulensis*	24.33 a	16.50 b	14.33 bc	13.17 cd	17.08 a	24.42 a	19.20 b	14.92 bc	13.67 cd	17.48 a
***M.** alba*	11.43 c-e	11.17 de	8.90 ef	10.08 d-f	10.40 b	12.08 c-e	11.60 d-f	9.22 ef	10.48 df	10.84 b
***F**. nitida*	9.25 ef	10.40 d-f	10.17 d-f	9.83 ef	9.91 b	9.58 ef	10.83 d-f	10.42 ef	10.33 ef	10.29 bc
***S.** viminalis*	9.58 ef	8.17 f	8.90 ef	8.08 f	8.68 c	9.87 ef	8.83 f	9.25 ef	8.78 f	9.18 c
Mean	13.65 a	11.56 b	10.58 bc	10.29 c		13.99 a	12.05 b	10.95 bc	10.82 c	

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 stem diameter (cm) during three years from 2014 – 2017.

Drain locations / Tree species	Stem diameter (cm)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
***E**. camaldulensis*	43.95 a	33.76 bc	35.88 b	39.28 ab	38.22 a	43.95 a	34.29 b	36.09 b	39.28 ab	38.40 a
***M.** alba*	18.47 ef	23.99 de	23.46 de	20.49 de	21.60 b	19.11 de	24.74 cd	24.31 cd	20.60 d	22.19 b
***F**. nitida*	20.17 de	19.96 e	23.67 de	27.81 d	22.90 b	20.81 d	20.38 d	24.52 cd	29.09 c	23.69 b
***S.** viminalis*	30.44 c	32.06 bc	31.42 bc	15.29 f	27.30 b	30.41 bc	32.56 bc	31.86 bc	16.09 e	27.82 b
Mean A	28.24 a	27.45 a	28.60 a	25.73 a		28.66 a	27.99 a	29.20 a	26.27 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 drains location on leaves fresh weight (gm) during three years from 2014 – 2017.

Drain locations / Tree species	Leaves fresh weight (gm)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
***E**. camaldulensis*	70.32 b- d	109.87 b	57.18 b-d	80.04 b-d	79.35 ab	103.18 ab	50.81 b-e	52.83 de	83.78 a-d	72.65 ab
***M.** alba*	96.52 bc	46.07 cd	33.01 d	96.54 bc	68.03 b	72.83 b-e	66.56 c-e	49.13 de	58.26 de	61.70 b
***F**. nitida*	174.32 a	74.63 b-d	46..08 cd	69.91 b-d	91.23 a	114.15 a	64.68 c-e	46.66 e	71.85 b-e	74.34 a
***S.** viminalis*	174.31 a	67.96 b-d	51.04 b-d	69.90 b-d	90.81 a	115.21 a	77.73 b-e	51.84 de	73.69 b-e	79.62 a
Mean A	128.90 a	74.60 b	46.80 c	79.10 b		101.34 a	64.95 b	50.12 c	71.90 b	

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

4- Branches fresh weight:

Data presented in **Table (4)** reveal that, *Ficus nitida* and *Salix viminalis* trees produced the highest values of branches fresh weight (82.66 and 79.70 gm) as compared to *Eucalyptus camaldulensis* (68.74 gm/100 gm) and *Morus alba* trees (71.60 gm). In addition, the control treatments and Toukh drain significantly increased fresh weight of branches when compared to Shebein and Batanda drains. In this respect, the same data showed that *Eucalyptus camaldulensis* trees planted in Toukh drain significantly increased fresh weight of branches (109.84 gm) in addition to *Ficus nitida* and *Salix viminalis* trees planted at Toukh drain (113.77 and 109.84 gm) as compared to the other tree species planted at the side of other locations. These finding are in agreement with (Hassan, 1996) on *Acacia saligna* and *Leucaena leucocephala* and (Bhati and Singh 2003) on *Eucalyptus camaldulensis* that application of sewage water significantly increased the vegetative growth parameters that reflected on the growth by enhancing the cell elongation and division.

5- Roots fresh weight:

As for roots fresh weight **(Table 5)** *Ficus nitida* and *Salix viminalis* roots were the highest in this respect (51.69 and 52.35 gm), respectively. These finding are in agreement with (Luo et al., 2018) on *Ficus microcarpa.* On the other hand, the control treatment showed significant increase fresh weight of roots (65.58 gm) when compared to the other treatments during the study period. For the interaction between the two studied factors, in comparison with *Eucalyptus camaldulensis*, *Morus alba* and *Salix viminalis* which were planted at the sides of Toukh, Shebein and Batanda drains, *Ficus nitida* planted at side of Shebein irrigation canal produced the highest values of roots fresh weight.

6- Leaves dry weight:

Data presented in **Table (6)** indicated that, *Salix viminalis* and *Ficus nitida* trees significantly increased in leaves dry weight (35.23 and 32.72 gm), respectively in comparison with the other two tested trees. Regarding the effect of drains locations, the control treatment significantly increased dry weight of leaves (41.37 gm) as compared to the three tested drains which were the lowest (29.09, 28.78 and 18.11 gm), respectively. As regard to the interaction between two study factors, *Salix viminalis* and *Ficus nitida* trees grown at side of irrigation canal produced the highest values of leaves dry weight (50.98 and 51.59 gm), while the same trees grown at sides of the tested drains showed the adverse direction. These results are in accordance to those obtained by (Kumar and Reddy 2010) on casuarina equestifolia and (Ali et al., 2010) on Swietenia *mahogoni*.

Table (4). Effect of woody tree species and agricultural drain locations on branches fresh weight (gm) during three years from 2014 – 2017.

Drain locations / Tree species	Branches fresh weight (gm)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
***E**. camaldulensis*	56.48 cd	130.79 a	62.71 b-d	51.75 d	75.43 b	55.81 c-e	109.64 a	63.31 c-f	46.18 f	68.74 b
***M.** alba*	104.69 ab	66.43 b-d	89.49 a-d	45.29 d	76.48 b	88.56 ab	84.97 b	73.94 c-e	65.61 c-f	71.60 b
***F**. nitida*	111.25 ac	81.59 b-d	80.59 b-d	52.49 d	81.48 a	113.77 a	79.55 bc	82.49 d-f	54.82 d-f	82.66 a
***S.** viminalis*	103.25 ac	80.59 b-d	80.55 b-d	73.77 b-d	84.54 a	109.84 a	76.74 cd	81.87 d-f	50.33 d-f	79.70 a
Mean A	93.92 a	89.40 a	77.80 b	55.80 c		92.00 a	87.73 a	75.40 b	54.24 c	

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 drains location on roots fresh weight (gm) during three years from 2014 – 2017.

Drain locations / Tree species	Roots fresh weight (gm)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
***E**. camaldulensis*	18.27 d	34.04 b-d	60.32 a-c	32.33 cd	36.24 b	49.76 a-d	44.93 b-d	55.26 a-d	26.43 d	44.09 b
***M.** alba*	63.01 ab	38.44 a-d	24.82 de	25.96 de	38.06 b	60.88 a-c	42.91 b-d	47.64 a-d	31.79 cd	45.81 b
***F**. nitida*	67.36 a	35.73 b-d	36.77 b-d	46.23 a-d	46.59 a	78.15 a	41.47 cd	45.35 b-d	41.78 d	51.69 a
***S.** viminalis*	62. 56ab	38.59 a-d	47.69 a-d	38.28 a-d	46.79 a	73.54 ab	40.86 cd	45.62 b-d	49.39 a-d	52.35 a
Mean A	52.80 a	36.70 b	42.40 ab	35.70 b		65.58 a	42.54 b	48.47 b	37.35 c	

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 leaves dry weight (gm) during three years from 2014 – 2017.

Drain locations / Tree species	Leaves dry weight (gm)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
***E**. camaldulensis*	23.56 c-e	39.59 b	25.06 b-e	21.22 de	27.40 c	36.05 b-d	26.75 c-e	22.03 f	15.12 e	24.99 b
***M.** alba*	37.08 bc	18.82 de	23.55 c-e	13.29 de	23.20 c	26.85 c-e	37.70 a-c	19.60 e	13.43 e	24.45 b
***F**. nitida*	67.43 a	28.90 c-e	23.29 de	22.45 e	35.52 a	51.59 a	26.68 de	28.97 c-e	23.65 e	32.72 a
***S.** viminalis*	62.59 a	36.89 bc	28.34 b-d	21.19 de	37.30 a	50.98 a	25.21 c-e	44.50 ab	20.24 e	35.23 a
Mean A	47.70 a	31.05 b	25.06 c	19.54 d		41.37 a	29.09 b	28.78 b	18.11 c	

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

7- Branches dry weight

For effect of tree species on branches dry weight data illustrated in **Table (7)** showed that, *Ficus nitida* and *Salix viminalis* trees produced the highest dry weight of branches (32.51 and 33.98 gm), while *Morus alba* and *Eucalyptus Camaladulensis* significantly decreased in this respect (21.49 and 19.74 gm), respectively. As regard to drains locations, Shebein irrigation canal significantly increased branches dry weight (37.34 gm) in comparison with Batanda, Shebein and Toukh drains, which produced the lowest values in this regard. *Salix viminalis* trees grown at side of Shebein irrigation canal (control treatment) significantly increased branches dry weight during the study period as compared to the other tree species grown at the other locations. Similar results have been found by Kumar and Reddy (2010) on *Casuarina equestifolia* and (Minhas et al., 2015) on *Eucalyptus tereticornis.*

8- Roots dry weight

It is evident from data presented in **Table (8)** that, the highest values of roots dry weight showed in *Salix viminalis* trees (33.50 gm) when compared to other tree species. On other hand, Shebein irrigation canal significantly increased dry weight of roots (32.80 gm) as compared with the three tested agricultural drains. For the interaction between the two studied factors, *Salix viminalis* trees grown at side of Shebein irrigation canal significantly increased dry weight of roots (40.74 gm) as compared to the other tree species grown at sides of drains.

B- Effect of tree species and agricultural drain locations on wood specific gravity

It is evident from data presented in **Table (9)** that, *Ficus mucrocarpa* and *Salix viminalis* produced the highest values for specific gravity (0.56 and 0.57 gm/cm^3), while *Eucalyptus camaldulensis* and *Morus alba* gave the lowest values in this regard. These findings are in accordance with those obtained by (Sheikh et al., 2011) and (Keduolhouvonuo and Kumar, 2017). At the end of study, the irrigation canal (control treatments) significantly decreased in the specific gravity (0.40 gm/cm^3) as compared to the three tested drains. Similar results were obtained by (EL-Juhany, 2011; Hassan and Ali 2013 and Kanawjia et al., 2013). For the interaction between the tree species and drains locations, the same data indicated that, *Ficus mucrocarpa* planted in side of Shebein drain gave the highest values of specific gravity at the end of study (0.61gm/cm^3) when compared with the other tree species in the different locations. The above mention results may be due to the plants have evolved highly specific and very efficient mechanisms to obtain essential micronutrients from the environment, even when present at low ppm levels. Plant roots, aided by plant-produced chelating agents and plant induced pH changes and redox reactions, are able to solubilize and take up micronutrients from very low levels in the soil, even from nearly insoluble precipitates.

Table (7). Effect of woody tree species and agricultural drain locations on branches dry weight (gm) during three years from 2014 – 2017.

Drain locations / Tree species	Branches dry weight (gm)									
	Beginning of study					Ending of study				
	Control	**Toukh**	**Shebein**	**Batanda**	**Mean B**	**Control**	**Toukh**	**Shebein**	**Batanda**	**Mean B**
***E**. camaldulensis*	26.33 bc	35.81 ab	25.07 bc	22.49 c	27.43 b	27.65 cd	15.86 ef	23.45 d-f	11.98 f	19.74 b
***M.** alba*	35.55 ab	31.53 bc	33.05 bc	28.55 bc	32.17 a	21.99 d-f	28.76 cd	20.35 d-f	14.84 ef	21.49 b
***F**. nitida*	36.67 ab	27.98 bc	35.00 b	26.96 bc	31.65 a	44.23 ab	37.90 bc	24.96 de	22.96 d-f	32.51 a
***S.** viminalis*	50.16 a	22.98 c	32.36 bc	20.07 c	31.39 a	55.49 a	38.29 bc	23.16 d-f	18.98 d-f	33.98 a
Mean A	37.20 a	29.60 b	31.40 b	24.50 c		37.34 a	30.20 b	17.20 c	17.19 c	

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 roots dry weight (gm) during three years from 2014 – 2017.

Drain locations / Tree species	Roots dry weight (gm)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
E. camaldulensis	9.59 d	12.65 b-d	19.54 a-d	15.40 a-d	14.29 b	32.15 a-c	17.76 c	24.83 a-c	22.51 bc	24.31 b
M. alba	23.69 ab	9.88 d	11.02 c	18.19 a-d	15.69 b	34.78 a-c	18.78 bc	25.77 a-c	25.50 a-c	26.21 b
F. nitida	22.88 ab	21.09 ab	16.73 a-d	17.00 a-d	19.43 a	29.58 a-c	22.57 bc	21.35 bc	19.04 bc	23.14 b
S. viminalis	26.32 a	16.70 a-d	17.18 a-d	19.60 a-d	19.95 a	40.74 a	24.14 a-c	34.68 ab	34.42 ab	33.50 a
Mean A	20.60 a	15.10 b	16.10 b	17.50 ab		32.80 a	20.80 b	26.66 b	25.37 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 specific gravity (gm/cm^3) during three years from 2014 – 2017.

Drain locations / Tree species	Specific gravity (gm/cm^3)									
	Beginning of study					Ending of study				
	Control	Toukh	Shebein	Batanda	Mean B	Control	Toukh	Shebein	Batanda	Mean B
***E**. camaldulensis*	0.27 d	0.53 a	0.53 ab	0.55 a	0.47 b	0.27 f	0.55 a-c	0.53 a-c	0.50 c-e	0.46 b
***M.** alba*	0.41 c	0.41 c	0.46 bc	0.43 c	0.43 c	0.42 e	0.45 de	0.45 de	0.45 de	0.44 b
***F**. nitida*	0.51 ab	0.55 a	0.53 ab	0.52 ab	0.53 a	0.52 b-d	0.56 a-c	0.61 a	0.60 ab	0.57 a
***S.** viminalis*	0.51 ab	0.46 bc	0.55 a	0.56 a	0.52 a	0.52 cd	0.57 a-c	0.57 a-c	0.57 a-c	0.56 a
Mean A	0.40 c	0.50 b	0.50 a	0.50 a		0.40 b	0.49 a	0.49 a	0.49 a	

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

Plants have also evolved highly specific mechanisms to translocate and store micronutrients. These same mechanisms are also involved in the uptake, translocation, and storage of toxic elements, whose chemical properties simulate those of essential elements. Thus, micronutrient uptake mechanisms plare of great interest to phytoremediation. Another issue is the form in which toxic metal ions are stored in plants; Storage in the vacuole appears to be a major one (DOE, 1994). In addition, plant roots supply nutrients and important food substrates in the form of exudates and organic carbon to the surrounding microbial populations. Trees may respond by closing stomata and reducing sap flow in order to avoid the uptake of toxicants **(**Ferro et al., 2013).

CONCLUSION

Afforestation agricultural drains sides are very important to decrease heavy metals concentration levels and increasing the suitability of agricultural drainage water for using for irrigation. Select the suitable tree species according to analysis of drainage water before plantation. Plantation *Morus alba* trees on irrigation canal sides only.

RECOMMENDATIONS

We recommended that planting timber trees as a safety use for this water.

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الملخص العربى

استخدام بعض أنواع الأشجارالخشبية لمعالجة ملوثات مياة الصرف الزراعى

1- تأثير نوع الأشجار وموقع المصارف الزراعية على النمو الخضرى والكثافة النوعية لبعض أنواع الأشجارالخشبية

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أجريت هذه الدراسة في محافظة القليوبية لمدة ثلاث سنوات لدراسة تأثير مياه الصرف الزراعي على النمو الخضري والكثافة النوعية لأربعة أنواع من الأشجار (الكافور، الصفصاف، التوت وفيكس نيتيدا) المنزرعة على جانب واحد من ثلاثة مصارف زراعية (طوخ، شبين وبتندا) وقناة ري شبين المستخدمة كمعاملة كنترول. تم تسجيل البيانات التالية: ارتفاع الساق، قطر الساق، الوزن الطازج والجاف للأوراق والأفرع والجذور بالإضافة إلى الكثافة النوعية.

أظهرت النتائج أن أشجار الكافور قد زادت بشكل ملحوظ في أرتفاع الساق وقطر الساق مقارنة بالأنواع الأخرى. أظهرت أشجار الفيكس والصفصاف زيادة كبيرة في الوزن الطازج والجاف للأوراق والأفرع والجذور مقارنة بأنواع الأشجار الأخرى المختبرة من بداية الدراسة إلى نهايتها باستثناء الوزن الجاف للجذور لأشجار الصفصاف التي تفوقت على بقية أنواع الأشجار. علاوة على ذلك، زادت المعاملة الكنترول بشكل ملحوظ في جميع الصفات الخضرية المختبرة مقارنة بباقى المعاملات باستثناء قطر الساق. أظهرت أشجار الفيكس والصفصاف أعلى قيم للوزن النوعي مقارنةً بالنوعين الآخرين. كما أظهرت أشجارالصفصاف النامية على جانب مصرف شبين أعلى قيم للكثافة النوعية مقارنةً ببقية المعاملات. وأظهرت قناة الري (المعاملة الكنترول) انخفاضا معنويا في الكثافة النوعية مقارنة بالمصارف الثلاثة المختبرة.

الخلاصة : يُعد تشجير جوانب قنوات الري الزراعية أمرًا بالغ الأهمية لتقليل تركيز المعادن الثقيلة وزيادة ملاءمة مياه الصرف الزراعي للري . يُراعى اختيار أنواع الأشجار المناسبة بناءً على تحليل مياه الصرف قبل الزراعة. يُنصح بزراعة أشجار التوت الأبيض على جوانب قنوات الري فقط .

التوصية : نوصي بزراعة الأشجار الخشبية كاستخدام آمن لهذه المياه.