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UTILIZATION OF SEWAGE WATER IN TREATMENT OF SANDY SOIL AND PRODUCTION OF FLAX OIL AND FIBER

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ABSTRACT

This study focused on the most important issues of the 21st century. Water, food security and Energy. Utilizing primary treated sewage water in flax plant irrigation for use their oils product and its fiber as well as improvement of some sandy soil chemical properties

The usage of primary treated sewage water in this study achieve high environmental values which is exploited, it is one of the environmental stress, achieve the economic returns of oil and fibber production. The provision of traditional irrigation water to irrigate food crops, this exchange also has potential environmental benefits, reducing the release of wastewater effluent downstream, and allowing the assimilation of its nutrients into the soil.

The aim of this study is identify the suitability of primary treated sewage water alone or mixed with Nile water and their effects on sandy soil properties as well as oil and fiber yield of flax plant. So, A field experiments with Randomized complete block design were conducted in winter seasons of 2016/2017 for flax plant (*Linum usitatissium* L.), to study the effect of different water irrigation quality i.e. 100% Nile water (T_1), 50% Nile water + 50% treated sewage water (T_2) and 100% treated sewage water ((T_3) on soil properties as well as flax oil and fiber production.

Results revealed that 100% sewage water improve in most soil properties as decrease soil pH than initial soil, increase soil organic matter contents. Slight increase of soil salinity (E.C) as compared to the soil irrigated with freshwater. Increasing in nutrient elements, total and available N, P and K (mg kg^{-1}) compared with those irrigated by freshwater. Also, increase of micronutrients and heavy metals. It is worthy to mention that the contents of all values of total and available heavy metals in studied soil presented within safe or permissible limits and possible using these water sources for irrigation .

Also usage of 100% sewage water in soil irrigation resulting in increased most morphological flax characters, as well as seeds yield, straw yield, fiber yield, weight of 1000 seeds, oil yield, fiber (%) and seed oil (%).

Key words : environmental stress, flax characters, flax plant, irrigate food crops, morphological, sandy soil chemical properties, sewage water

INTRODUCTION

Currently, Egypt produces an estimated 5.5–6.5 Billion Cubic meters (BCM^3) of sewage water per year. Of that amount, about 2.97 BCM^3per year is treated, but only 0.7 BCM^3 per year is utilized for agriculture. Where, 0.26 BCM^3 is undergoing secondary treatment and 0.44 BCM^3 undergoing primary treatment, mainly in direct reuse in desert areas or indirect reuse through mixing with agricultural drainage water (**Abdel-Shafy and Abdel-Sabour,2006).**

Flax is the second important fiber crop after cotton in Egypt. It is grown for producing fibers only or seeds only, but in Egypt it is grown as dual purpose crop. Flax is the oldest fiber crop in Egypt. Flax is grown during winter season. In Egypt, the flax cultivated area was about 35700 fedd. Yearly. Water is often the primary limiting factor in any crop production. Therefore irrigation management is very important nowadays in Egypt due to the shortage in water resources as well as the expansion of agriculture in newly reclaimed lands **(Hamada *et al*., 2009)**.

Flax (*Linum usitatissimum L.*) is ranked second plant after cotton as a fiber crop regarding the cultivated area or its importance in industry. Flax is one of the ancient important crop grown for fiber and oil locally used in textile industry. Linseed oil is one of the oldest commercial oils used in food painting and varnish industry. Flax is considered one of the most important dual purpose crops for oil and fiber production in Egypt and the world, flax seeds are rich in oil (41%), protein (20%), and dietary fiber (28%) **(Ibrahim, 2009).**

The current study aims at gaining more information about the effects and suitability of primary treated sewage water alone or mixed with different rates of Nile water on sandy soil improvement as well as flax plant characteristics, fiber productivity and quality and oil yield.

MATERIALS AND METHODS

Field experiment:

To evaluate the effect of water qualities on some soil properties as well as flax plant characteristics. A field experiment was carried out in Khalid Ebn El-Walid village, El-Behera Governorate, during winter 2016 and summer 2017. Soil was chosen near to the traditional source of irrigation water (control) and sewage water source. Both of the fresh water and primary treated sewage water are analyzed. Soil samples were analyzed before and after planting and discuss the impact of treated sewage water primarily on some soil properties and flax plant.

Seeds of flax (*Linum usitatissium L*) were sown in 15 November 2016. The experimental plot area was 10 X 4 meters. The harvest was recorded in 15 May 2017. Each parts of plant samples were washed, then dried at 70^0C .The dry materials were finely ground and kept in polyethylene bags for analysis.

Water analyses:

- Treated sewage water was mixed with Nile water with rate (1:1), where 100% Nile water (T_1), 50% Nile water + 50% treated sewage water (T_2) and 100% treated sewage water ((T_3).
- pH values of different irrigation water samples were determined **(USDA, 1969).**
- Electrical conductivity (EC) of the irrigation water samples were measured using a conductivity bridge meter **(USDA, 1969).**
- Determination of Soluble ions (cations and anions) in the saturated soil paste extract according to the methods described by **(Black, 1965).**

-Determination of soluble heavy metals in irrigation water samples, according to the standard procedures **(Greenberg *et al*.,1985).**

- Determination of ammonia (NH_4^+)and nitrate(NO_3^-) in irrigation water samples. by Auto analyzer (Technicon All) Instrument according to **(Tel, 1982)**. **Table (1)** showed the mean values of chemical analysis of Nile water and **Table (2)** showed macro and micronutrients and heavy metals during flax cultivation

Table (1): Mean values of chemical analysis of Nile water and sewage water before the experiment and mixing .

Parameters	pH	EC (dS/m)	Cations (meq l^{-1})				Anions (meq l^{-1})			
			Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$
sewage water	7.99	2.73	8.24	7.95	11.17	0.03	---	2.0	10.5	14.89
Nile water	7.57	0.4	1.55	1.25	1.1	0.30	---	1.0	2.5	1.20

	Macronutrients (mg/l)			Micronutrients and heavy metals (mg/l)					
	N	P	K	Fe	Mn	Zn	Pb	Ni	Cd
sewage water	20.46	4.38	9.33	0.87	0.36	1.18	1.05	0.043	0.40
Nile water	9.86	2.79	7.50	0.23	0.20	0.021	0.06	0.017	0.01

Each value is a mean of three replicates.

Table (2): Mean values of Macronutrients, Micronutrients and heavy metals (mg/l) for different water qualities during Flax cultivation.

water qualities	EC dSm^{-1}	pH	Macronutrients (mg/l)			Micronutrients and heavy metals (mg/l)					
			N	P	K	Fe	Mn	Zn	Pb	Ni	Cd
(T_1)	0.38	7.67	14.34	4.35	7.22	0.23	0.15	0.08	0.11	0.057	0.005
(T_2)	1.78	7.79	17.67	5.13	8.21	0.49	0.27	0.33	0.68	0.160	0.035
(T_3)	2.73	7.88	23.58	6.36	10.04	0.86	0.39	1.26	1.11	0.265	0.059

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)

Each value is a mean of three replicates.

Soil analyses:

The collected surface soil samples before and after the planting were air dried, crushed and ground gently by a rod, sieved through a 2 mm sieve to get the fine particles, then kept in plastic bottles for analyses.**Table (3)** showed Physical and chemical properties of soil

- Particle size distribution by the international pipette method according to **(USDA, 1969).**

- Soil texture classes were determined using the texture triangle diagram **(Soil Survey Staff, 1962)**.

- Saturated soil paste & saturation percentage (SP),**(USDA, 1969).**

- Soil reaction (pH) of saturated soil paste **(Jackson, 1973).**

- Soil water extract**: (USDA, 1969)**.

- Electrical conductivity (EC): **(USDA, 1969).**

- Soluble cations (Ca^{+2}, Mg^{+2}, Na^{+} and K^{+}) and anions (Cl^{-} ,$CO_3^{-2,}$ HCO_3^{-} and SO_4^{-2}) were determined in soil paste extract according to **(Black, 1965).**.

- Determination of organic matter contents according to **(Walkley, 1947)**.

- Determination of calcium carbonate contents: were determined using Collin's calcimeter, **(Wright, 1939)**.

- Available nitrogen was extracted from soil using 2N KCl solution and measured according to the modified Kjeldahal method **((Black, 1965).**.

- Total content of micronutrients (Fe, Mn and Zn) and heavy metals (Pb, Ni and Cd) in soils were digested in mixture of (HF, $HCLO_4$) acids as described by **Jackson (1973)** and measured by Inductively Coupled Plasma Emission Spectrometer (ICP – 400) and Atomic Absorption Spectrophotometer (GBC- 932 AA).

- Available contents of Fe, Mn, Zn, Pb, Ni, and Cd in soils samples were extracted by ammonium bicarbonate diethylene triamine penta acetic acid (AB- DTPA). (1 N NH_4HCO_3 + 0.005 M DTPA) buffered at pH 7.6 and 1: 2 soil: extracting solution ratio according to **(Soltanpour and Schwab, 1977),**

Table (3): Physical and chemical properties of studied surface soil before Flax planting.

pH (1:2:5)	EC (dS/m)	Cations (meq/l)				Anions (meq/l)				$CaCO_3$ %
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	
7.89	2.88	13.93	7.93	2.88	13.93	0.0	2.0	10.0	18.95	2.19

Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Texture	S.P (%)	O.M (%)
10.39	65.28	10.30	14.03	Sandy loam	22	0.44

Macronutrients (mg/kg)					
N		P		K	
Total	Avai.	Total	Avai.	Total	Avai.
65.94	37.89	12.88	3.75	482	180

Micronutrients and heavy metal contents (mg/kg)											
Fe		Mn		Zn		Pb		Ni		Cd	
To.	Avai.	To.	Avai.	To.	Avai.	To.	Avai.	To.	Avai.	To.	Avai.
784	2.25	280	1.39	23.78	4.87	19.79	2.13	17.34	1.23	4.85	0.23

Each value is a mean of three replicates.

Plant analysis:

- Seeds and straw Parts of the dry flax plant samples were wet digested using H_2SO_4 and $HClO_4$ **(Jackson, 1967).**

- Contents of (N, P, K, Fe, Mn, Zn, Pb, Ni and Cd) were determined upon plant digestion using the methods described by **Jackson (1973)** and **(Page and Chang,1981).**

- Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 6.25 **(Hymowitz *et al*.,1972).**

- Nitrogen was determined by Kjedahl method **(Chapman and Pratt, 1961).**

- Phosphorus and microelements were determined by **(Page and Chang,1981).**

- Potassium was determined using Flam Photometer.

- Seed oil % was determined by using Soxhlet apparatus and petroleum ether (40-60°C) as a solvent according to **(A.O.A.C. 1990).**

- Oil yield (ton/fed) was calculated by seed yield (ton/fed) x seed oil (%).

- Total plant length (cm) was measured from soil surface to the highest point of plant.

- Technical length (cm) was determined from soil surface to the first branch..

Retting process

To separate fiber bundles from flax stem it must be submerging flax straw in water at the ratio of 1: 13(straw: water).This process take about 10-12 days, where the fiber become easy for separation from the stem.

- Fiber percentage was calculated by (weight of total fiber (g) /weight of straw after retting (g) x 100.

- Fiber yield (ton/fed) was calculated by straw yield (ton/fed) x fiber (%).

- Fiber fineness (Nm) was calculated by = NxL / G . Where N= number of fibers(20 fibers each 10 cm) , L= length of fibers in mm, G= weigh of fibers in mgs

Oil analysis:

- Oil percent (%) = (oil weight)/(weight of seeds) x 100)

- Iodine value (IV) for crude oil according to **(A.O.C.S., 1998).**

- Oil analyzed according to American Oil Chemists' Society methods and was compared results with Standards of the EU "EN 14214",U.S."ASTM D6751" standard, and specifications for the German "DIN 51606" production of biodiesel.

- The obtained results were subjected to statistical analysis of variance according to method described by **(Snedecor and Cochran 1982)**.

RESULTS AND DISCUSSION

1. Effect of different irrigation water qualities on soil properties:

Soil pH:

The application of either sewage water or mimed water in irrigated of soil had decrease soil pH than initial soil. Data given in **Table (4)** reported that, soil pH values after flax harvest were 7.82, 7.78 and 7.72 for (T_1), (T_2) and (T_3), respectively. The application of 100% sewage water (T_3) had decreased soil pH value with 2.15% compared with the initial one, while the application of mimed water (T_2) had decrease initial soil pH by 1.39%.

The decrease in the pH value may be due to the decomposition of organic matter and the activities of microorganisms which produce organic acids causing a decrease of soil pH. These results are in agreement with those reported by several investigators such as **Mohammed *et al.* (2014)**. The decrease in soil pH made the micronutrients more soluble and available for plant uptake. The soils of all experimental are characterized by slightly to moderately alkaline condition, according to **Ayers and Westcot, (1985) and Shaban (2005).**

Electrical conductivity (EC):

Irrigation of soil with sewage water led to slight increase of soil salinity (electrical conductivity) as compared to the soil irrigated with freshwater. Data present in **Table (2)** showed that, (EC) of different water qualities were 0.38, 1.78 and 2.73 dS/m for T_1, T_2 and T_3, Respectively. Data in **Table (4)** showed that (EC) values of the surface soil were 2.75, 3.02 and 3.35 *d*S/m due to soil irrigated with (T_1), (T_2) and (T_3), respectively. The application of 100 % sewage water (T_3) in irrigated tested soil caused in increase soil salinity by 10.91 % compared with the same soil irrigated with freshwater (T_1).**El- Gazzar, (1996)** came to the same conclusion.

Soil organic matter %:

Organic matter is the most important indicator of soil quality which playing a major role in nutrient cycling. . Data in **Table (4)** observed that increase soil organic matter % were 2.27, 11.36 and 20..45% due to soil irrigated with freshwater (T_1), mixed water (T_2) and 100 % sewage water (T_3), respectively.; this is most likely to the higher organic matter content of waste water. Organic matter contents of soils in this study are still low due to their quick decomposition; this is a natural characteristic feature of semi-arid regions.

Soil calcium carbonate %:

Date presented in **Table (4)** indicated that, soil irrigation with 100 %waste water (T_3) or mixed water (T_2) led to increase $CaCO_3$% of the studied soil. These results are in agreement by **Tabari** and **Salehi (2009)**. Who reported that, the use of municipal wastewater of soil irrigated caused in increase $CaCO_3$%.

Macronutrients contents in the studied soils:

Data in **Table (4)** showed that the soil irrigation with 100 %waste water (T_3) or mixed water (T_2) led to increase total and available N, P and K (mg kg^{-1}) compared with the same soil irrigated with freshwater (T_1), especially in surface layer (0-15 cm). This is a true; the sewage water had more enrichment in organic materials as well as N, P and K.

Data present in **Table (2)** recorded that the values of N, P and K concentration in 100 % sewage water (T_3) were 23.58, 6.36 and 10.04 mg/l**.,** respectively. While these concentrations were 14.34, 4.35 and 7.22 mg/l in freshwater (T_1), respectively. The highest increasing % of total and available soil N by using 100% sewage water (T_3) compared with the same soils before the experiment were 13.63 and 21.85 %, respectively. While the highest increasing % of total and available soil P were 14.05 and 21.33 %.

In the same context, the highest increasing % of total and available soil K for the surface layers irrigated by 100% sewage water (T_3) compared with those soils before flax cultivation were 9.12 and 12.78 compared with those soils before %, respectively.

These results are in agreement by **Kholdabakhsh *et al*., (2013)** and **Amin (2011)** who indicated that the soil irrigated with wastewater caused an increase of total and available N, P and K, this can be attributed to the high concentrations of N, P and K for wastewater.

Table (4): Effect of different irrigation water qualities on some surface soil properties:

water qualities	pH 1:2.5	EC *d*S/m	O.M (%)	$CaCO_3$ (%)	Macronutrients mg/kg					
					N		P		K	
					Total	Avai.	Total	Avai.	Total	Avai.
T_1	7.88	2.75	0.45	2.05	65.71	38.55	12.88	3.80	486	187
T_2	7.78	3.02	0.49	2.31	69.98	42.52	13.26	3.92	513	191
T_3	7.72	3.35	0.53	2.65	74.93	46.17	14.69	4.55	546	203

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)
Each value is a mean of three replicates

Micronutrients and heavy metals content in the studied soils:

The obtained data in **Table (5)** showed that irrigation of tested soil with 100% sewage water (T_3) or mixed (T_2) caused in increase micronutrients and heavy metals contents ($mgkg^{-1}$) compared with the same soil layers before the experiment.

Total soil Fe values ranged from 785, 807 and 837 mg kg^{-1} by using irrigation with different water qualities (T_1), (T_2) and (T_3), respectively. The corresponding relative increases % of total soil Fe were 0.38, 3.06 and 6.76 % as result of irrigation these soil with (T_1), (T_2) and (T_3) respectively, and compared with the same soil before flax cultivation. In the same context, the highest increasing percentage 0f available soil Fe were 2.67, 6.22 and 12.89 % by using (T_1), (T_2) and (T_3), respectively.

Table (5):Effect of different water qualities on soil micronutrients and heavy metal contents after Flax harvest.

water qualities	Micronutrients and heavy metal contents mg/kg											
	Fe		Mn		Zn		Pb		Ni		Cd	
	To.	Avai.	To.	Avai.	To.	Avai.	To.	Avai.	To.	Avai.	To.	Avai.
T_1	785	2.31	289	1.42	23.94	4.95	19.79	2.12	17.36	1.22	4.84	0.23
T_2	807	2.39	298	1.50	25.19	5.17	20.38	2.28	17.86	1.29	5.04	0.25
T_3	837	2.54	322	1.67	26.65	5.63	21.06	2.52	18.43	1.38	5.26	0.26

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)
Each value is a mean of three replicates

Mean values of total and available Mn in the surface soils were 322 mg/kg and 1.67 mg/kg respectively due to irrigation with 100%waste water (T_3), while with the same soil irrigated by 100% freshwater (T_1) it were 289 mg/kg and 1.42 mg/kg, with corresponding relative increases 11.42 and 17.61 % respectively.

Concerning the effect of different water qualities (T_1), (T_2) and (T_3) on total and available soil Zn, data in **Table (5)** showed that values of soil Zn concentrations were 23.94, 25.19 and 26.65 mg/kg by irrigation with (T_1), (T_2) and (T_3), respectively. With corresponding relative increases percentage by 0.67, 5.93 and 12.07 % respectively, compared with the same soil before the experiment. In the same context, the highest increasing percentage 0f available soil Zn were 1.64, 6.16 and 15.61 % by using (T_1), (T_2) and (T_3), respectively.

Data presented in **Tables (2&5)** showed that, the relative increases percentage of total and available soil Pb were 6.42 and 18.31 % respectively, due to soil irrigated by 100% sewage water (T_3) and compared with the same soil before the experiment.

In case of the relative increases percentage 0f total soil Ni, as a result of soil irrigated by (T_2) and (T_3) were 3.0 and 6.29 %, respectively. While, the relative increases percentage of available soil Ni, due to soil irrigated by (T_2) and (T_3) were 4.88 and 12.20 %, respectively, compared with the same soil before flax cultivation.

As regard to total and available soil Cd contents as a result of irrigation with sewage water (T_3) were 5.26 and 0.26 mg kg^{-1} with relative increases percentage 8.45 and 13.04 % , respectively. While the relative increases percentage as a result of irrigation with mixed water (T_2) were 3.92 and 8.70 % , respectively, compared with the same soil before the experiment.

It is worthy to mention that the contents of all values of total and available heavy metals in studied soil presented within safe or permissible limits and possible using these water sources for irrigation **(FAO, 1992).** These results are in agreement with those reported by **Rashad *et al.*, (1995)** for uncontaminated sandy soils of Egypt,

3- Effect of different irrigation water qualities on flax plant:

Morphological characters of flax Plant:

Data presented in **Table (6)** showed that increases of most morphological characters for flax plant as a result of soil irrigation with wastewater or mixed water than freshwater. The relative increases percentage of total length, technical length, fiber length, No. of capsule/plant, No. of seeds/capsule, No. of Branches/plan and Iodine values due to soil irrigation with 100% sewage water (T_3) and compared with the same soil irrigated with 100% freshwater (T_1) were 15.25, 12.60, 11.43, 13.39, 13.27, 7.66 and 6.67%, respectively. While, the relative increases percentage of the same characters due to soil irrigated by mixed water (T_2) which compared with the soil irrigated with 100% freshwater (T_1) were 4.92, 6.47, 4.85, 5.53, 6.42, 3.39 and 4.12 %, respectively.

Table (6): Flax plant characters as affected of different irrigation water qualities.

water qualities	Characters						
	Total length (cm)	Technical length (cm)	Fiber length (cm)	No. of Capsules /plant	No. of seeds/ capsule	No. of Branches /plant	Iodine value
T_1	75.13	55.31	63.28	6.87	4.52	11.49	161.67
T_2	78.83	58.89	66.35	7.25	4.81	11.88	168.33
T_3	86.59	62.28	70.51	7.79	5.12	12.37	172.45

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)
Each value is a mean of three replicates

It is worthy to mention that the morphological characters for flax plant increased as a result of soil irrigation with 100% wastewater more than mixed water (T_2) and more than freshwater (T_1). This can be attributed to the high concentrations of nutritive elements for wastewater, which led to increase most of these characters. These results are in agreement by **Abo-Rabeh, (2011).**

Yield components of flax plant:

It was evident of date presented in **Table (7)** that, all of the yield component values of flax plant were increased as a result of soil irrigation by 100% wastewater or mixed water than freshwater.

The highest values of seeds yield, straw yield and fiber yield found in soil irrigated with 100% sewage water (T_3) and were 0.667, 2.530 and 0.308 (ton/fed.), respectively. With increasing percentage 13.22, 15.53 and 18.46 % respectively, comparing with those in soil irrigated with freshwater (T_1).

As regard, the height increase value of weight of 1000 seeds of flax plant was 6.64 (g) which irrigated with (T_3), while this value was 5.69 (g) with freshwater (T_1) with increasing percentage by 16.70 %.

On the other hand the maximum value of oil yield was 0.233 ton/fed., for flax plants found in soil irrigated with (T_3). While this value was 0.198 ton/fed., for the same plants in soil irrigated with (T_1).So, we can say that, soil irrigation with 100% waste water caused in increased oil yield by 17.68 % comparing with those in soil irrigated with freshwater (T_1).

As regard to fiber % increased by 15.51% with the same comparison.

Table (7): Flax plant yield as affected of different irrigation water qualities.

water qualities	Characters							
	Seeds yield ton/fed.	Straw yield ton/fed.	fiber yield ton/fed.	1000 seeds Weight (g)	Oil yield ton/fed.	Fiber (%)	Fiber fineness (Nm)	Seed Oil (%)
T_1	0.590	2.190	0.260	5.69	0.198	11.48	190.4	33.59
T_2	0.610	2.260	0.274	6.05	0.214	12.56	180.6	35.78
T_3	0.668	2.530	0.308	6.64	0.233	13.26	170.3	38.92

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)
Each value is a mean of three replicates

Regarded fiber fineness (Nm) was decreased from 190.4 to 170.3 due to irrigated with100 %waste water (T_3) comparing with those in soil irrigated with freshwater (T_1), the decreased percentage was 10.56 %.

Seed oil percentage were 33.59, 35.78 and 38.92 %, respectively for flax seeds in soil irrigated by freshwater (T_1), mixed water (T_2) and 100 %waste water (T_3), respectively.

It is worthy to mention that, soil irrigated with 100 %waste water (T_3) caused in increase seed oil percentage by 15.87 % comparing with those in soil irrigated with freshwater (T_1)

N,P&K Concentration and uptake of flax seeds plant:

Nutrient contents of flax seeds were affected by soil irrigated with different water qualities, Data presented in **Tables (8)** showed that, the relative increasing percentage of N, P and K concentrations of flax seeds as a result of soil irrigation with (T_3) compared with those in soil irrigated with 100% freshwater (T_1) were 11.34, 8.82 and 10.45 % respectively,

In the other hand, the increasing percentages of N, P and K uptake of flax seeds were 18.87, 12.44 and 14.41 % respectively, as a result of soil irrigation with (T_3) compared with those in soil irrigated with 100% freshwater (T_1). From the observed data, we can concluded that increasing percentages of N, P and K uptake more than increasing percentages of N, P and K concentrations, this may be due to decrease in soil pH values as a result of soil irrigated with waste water, **).** These results are in agreement with those reported by **Tadross (1997)** who showed that a highly significant negative correlation were found between pH values and availability of many nutrients.

Table (8): Macronutrients concentration and uptake in flax seeds plant as affected of different irrigation water qualities.

water qualities	Macronutrients in seeds flax plant					
	N		P		K	
	Conc. (%)	Uptake (kg/fed)	Conc. (%)	Uptake (kg/fed)	Conc. (%)	Uptake (kg/fed)
T_1	2.91	17.17	0.34	2.01	2.20	12.98
T_2	3.02	18.42	0.35	2.14	2.31	13.52
T_3	3.24	20.41	0.37	2.26	2.43	14.85

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)
Each value is a mean of three replicates

Micronutrients concentration and uptake in flax seeds plant:

The relative increase percentage of Fe concentration and uptake of flax seeds irrigated with (T_3) compared with the same seeds irrigated with (T_1) were 15.18 and 17.98%, respectively. While, the highest increase percentage of Mn concentrations and uptake values were 14.25 and 17.82 % respectively, due to the same soil irrigated and the same comparison. **Table (9)**

In the same context, the highest values of Zn concentration and uptake in seeds irrigated with (T_3) were 37.53 mg /kg and 21.54 g/fed., respectively of flax seeds plant with the relative increases percentage by 13.66 % for Zn concentration and 18.61 % for Zn uptake respectively, compared with the same seeds irrigated with (T_1),

Heavy metals concentration and uptake in flax seeds plant:

The highest values of Pb concentration and uptake of flax seeds were 0.79 mg/kg and 19.86 g/fed respectively, as a result of soil irrigated with (T_3). The corresponding relative increasing percentage of Pb concentration and uptake in seeds of flax plants comparing with the same seeds in soil irrigated with freshwater (T_1) were 14.49 and

17.51 %. These results are in agreement by **Bjelkova *et al.*, (2011)** who found that, the application of sewage water caused in increasing heavy metals in flax seeds.

Regarding data presented in **Table (9)** showed that, Ni concentration and uptake of flax seeds due to irrigation applying 100% sewage water (T_3) caused markedly increases in both of Ni concentration and Ni uptake, the increase percentage of Ni concentration was 14.89% compared with those seeds in soil irrigated with (T_1). In the same context, the increase percentage of Ni uptake was 19.38% with the same comparison.

Ni concentration of flax seeds presented in **Table (9)** observed that, it was within the safe or permissible limits **Kabata-Pendias** and **Pendias (1992)** showed that Ni toxic limits ranged from10 -100 ug / g

Table (9): Micronutrients concentration and uptake in flax seeds plant as affected of different irrigation water qualities.

water qualities	Micronutrients in seeds flax plant											
	Fe		Mn		Zn		Pb		Ni		Cd	
	Conc. mg/kg	Uptake g/fed	Conc. mg/kg	Uptake g/fed	Conc. mg/kg	Uptake g/fed	Conc. mg/kg	Uptake g/fed	Conc. mg/kg	Uptake g/fed	Conc. mg/kg	Uptake g/fed
T_1	140.83	74.15	43.30	25.81	33.02	18.16	0.69	16.90	0.94	3.20	0.69	2.21
T_2	149.82	79.83	45.52	27.84	34.98	19.91	0.73	17.20	0.96	3.68	0.76	2.44
T_3	162.21	87.48	49.47	30.41	37.53	21.54	0.79	19.86	1.08	3.82	0.83	2.74

T_1(100%F.W). T_2(50%F.W+50%S.W). T_3(100%S.W)
Each value is a mean of three replicates

Cd concentration of flax seeds were 0.69, 0.74 and 0.83 mg/kg as a result of soil irrigated with (T_1), (T_2) and (T_3) respectively. We can concluded that, soil irrigated with 100% sewage water (T_3) or mixed water (T_2) caused in increased Cd concentration by 20.29 and 11.59 % respectively, comparing with the same seeds in soil irrigated with freshwater (T_1)

While the relative increase percentage of Cd uptake were 23.89 % due to soil irrigated with 100% waste water (T_3) and compared with the same seeds irrigate with 100% freshwater (T_1).

Finally, it is concluded that the increase of concentrations and uptake of micro and heavy metals in flax seeds plant, reflect their available contents in soil and increase rate of sewage water used. It is worthy to mention that the contents of all values of micronutrients and heavy metals in flax seeds presented within safe or permissible limits and possible using these water sources for irrigation in the studied soils **(FAO, 1992).**

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الاستفادة من مياة الصرف الصحى فى معالجة الاراضى الرملية و أنتاج زيوت والياف الكتان

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تهدف هذه الدراسة الى تقييم صلاحية مياه الصرف الصحى المعالج أوليا فى معالجة الاراضى الرملية وزراعة نبات الكتان لانتاج الزيوت والالياف ومن هنا يمكن ايجاد قيمة أقتصاديه مضافة من استخدام مياه الصرف الصحى وتوفير مياه الرى لاستخدامها فى انتاج المحاصيل الغذائية.

ادى استخدام مياة الصرف الصحى المعالج فى تحسين واضح لمعظم خواص التربة الرمليه تحت الدراسة مثل انخفاض قيمة الرقم الهيدروجينى الامر الذى يزيد من تيسر العناصر الغذائية للنباتات وأمتصاصها كذلك ارتفاع محتواها من المادة العضوية. وزيادة طفيفة فى ملوحة التربة(EC) مع زيادة نسبة كل من النيتروجين والفسفور والبوتاسيوم الكلى

والميسر و كذلك المحتويات الكلية والميسرة من المغذيات الكبرى وأيضا المعادن الثقيلة وبالتالى زيادة قدرتها الانتاجية. ومن الجدير بالذكر أن هذة الزيادات ضمن الحدود الآمنة أو المسموح بها والتي يمكن استخدام مصادر هذه المياه لأغراض الري في مثل هذه الاراضى الرمليه والفقيره فى محتواها للعناصر الغذائيه الضروريه للنباتات. كذلك تضمنت الدراسة بعض الصفات المورفولوجية للنبات الكتان تحت الدراسة حيث لوحظ زيادة معظم هذة الصفات مع استخدام رى بمياه الصرف الصحي 100% . كذلك زيادة جميع قيم مكونات المحصول مثل وزن المحصول (طن / فدان) وزن محصول القش (طن / فدان) ووزن محصول الألياف (طن / فدان) مع زيادة معدلات مياه الصرف الصحي وفي نفس السياق من الزيادات فى وزن 1000حبة (طن / فدان) ومحصول الزيت(طن / فدان) وكذلك النسبة المئوية للالياف وايضا النسبة المئوية لزيت البذور.

ومن الجدير بالزكر, تأثرت تركيزات المحتويات الغذائية من النيتروجين والفسفور والبوتاسيوم لبذور الكتان مع نوعية مياه الري وكذلك امتصاص النبات لهذة العناصر والتى زادت مع تزايد معدل مياه الصرف الصحي. كذلك من الملاحظ ان الزيادة النسبية لتركيزات المعادن الثقيلة والممتص في بذور الكتان كانت أعلى قيم لها فى الأراضى المروية بمياه الصرف الصحي100 %.

ومن الملاحظ للنتائج أن تركيزات المغذيات الدقيقة الصغيرة وكذلك المعادن الثقيلة.وجد انها ضمن الحدود الآمنة أو المسموح بها وبالتالى من الممكن أستخدام مثل هذة المصادر من المياه لأغراض رى الاراضى الرمليه والفقيره فى محتواها الغذائى وأنتاج الزيوت والالياف وبمعايير وتحت دراسات مقننة.

لذلك توصى الدراسه تحت الظروف المشابهة لمثل هذة الاراضى الرملية والفقيرة فى محتواها من المادة العضوية و النيتروجين والزنك باستخدام مثل هذة النوعية من مياة الصرف الصحى المعالج اوليا ليس فقط ليحقق الحد من التاثيرات الضارة لاستخدام ألاسمدة الازوتية بل أيضا ليدعم حالة خصوبة التربة ولتحسين خواصها وأيضا الاستفادة فى الحصول على الزيوت والالياف وتوفير المياة العذبة للمحاصيل الغذائية.