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Effect of Sewage Water Irrigation on Macro Nutrients, Heavy Metals and Frequency Percentage of Fungi in Soil Cultivated with Woody Trees

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Abstract: This investigation was carried out at Egyptian-Chinese Friendship Forest, Sadat city, Menoufia Governorate during the period from March 2010 to November 2011 (21 months). This work aimed to study the effect of sewage water irrigation on macro nutrient, heavy metals concentrations and frequency percentage of fungi in the soil cultivated with six woody tree species namely *Eucalyptus camaldulensis, E. citriodora, Pinus halepensis, P. brutia, P. pinea* and *Cupressus sempervirens*. The obtained results pertaining irrigation water analysis indicated that sewage water had elevated the concentrations of such metals compared to well water, the concentrations of these metals in these two sources of irrigation water were within the permissible limits for their use as irrigation water. Also, heavy metals such as lead, cobalt and cadmium concentration were low and far below the critical level in sewage water. On the other hand, data showed that macro elements N, P and K at 30 and 60 cm soil depths were clearly increased as a result of irrigation with sewage water compared with virgin soil. Also, *Pinus* had less N and P with sewage water followed by *Eucalyptus* for P, while the highest values of K were obtained with *Eucalyptus* and *Pinus halepensis* trees (at 60 cm soil depth). On the other hand, data showed that concentration of available Pb, Co, Cd and Ni in Sadat forest soil were clearly increased as a result of irrigation with sewage water and there were differences among the studied tree species in their absorption either macro nutrients or heavy metals. Also, the most frequent fungi were those belongimg to genus *Fusarium*, their frequency percentage ranged from 45.6 to 93.3% and they only associated with *Pinus halepensis*, *P. brutia* and *C. sempervirens*. Genus *Penicillium* was found in all plantations of woody trees. Data also showed that irrigation with sewage water affected the presence of some fungal species at the two isolation depths.

Key words: Forest trees · Heavy metals · Macro elements · Sewage water irrigation · Fungal species

INTRODUCTION

In arid and semi-arid countries such as Egypt, water is becoming scarce resource to consider any sources of water, which might be used economically and effectively to promote further development. Rapid increases in population and industrial growth have led to use low quality water such as drainage and saline water as well as wastewater or sewage water for irrigation. Irrigation of forests with sewage water for fuel and timber production is an approach which helps to overcome health hazards associated with sewage farming. The use of primary and secondary effluent in irrigation can improve the quality of the soil and plant growth because they are considered as natural conditioners through their nutrient elements and organic matter. However, the direct application of wastewater on agricultural land is limited by the extent of contamination with heavy metals, toxic organic chemicals and pathogens [1-5]. Egypt is now witnessing a wide range of new projects aiming at expanding the green stretch in the desert by introducing forest plantations using treated sewage water, to produce timber trees of high economic value.

At present, application of waste water is considered the best solution for disposal problems [2]. The use of waste water for land irrigation is usually recommended for

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two main reasons: a) It is an allowable method for the disposal of waste water; b) It permits the reclamation and reuse of valuable resource such as water and nutrients [6]. Therefore, the objectives of this study were: (i) to study the chemical composition of sewage effluents and ground well water; (ii) to assess the effects of long-term irrigation with sewage effluents on soil properties cultivated with woody trees at Egyptian-Chinese Friendship Forest, Sadat city, Menoufia Governorate, Egypt.

MATERIALS AND METHODS

This investigation was carried out at Egyptian-Chinese Friendship Forest, Sadat city, Menoufia Governorate (Fig. 1) during the period from March 2010 to November 2011 (21 months). This work aimed to study the effect of sewage water irrigation on macro nutrients, heavy metals concentrations and frequency percentage of fungi in the soil cultivated with six woody tree species and their effects on growth of the trees.

Study Area and Samples Collection: The study site is located in Sadat City about 100 km North-West of Cairo; the trees cultivated in the forest were irrigated by treated sewage water from Sadat city.

Fig. 1: Maps showing the location of forest in Sadat city

Water samples were periodically collected from the drainage, dripper and ground water from the studying area. Soil samples were taken under each selected tree species from two depths (0-30 and 30-60 cm) by digging profiles. Soil samples were dried, ground, thoroughly mixed and passed through a 2 mm sieve and kept for chemical analysis.

Chemical Analysis of Water and Soil

Water Analysis: Water system used in forest site was drip irrigation system, disposal energy of the stations 18000 M3/Day [7]. The collected water samples were subjected to the following analysis:

- Electrical conductivity (EC) and pH values were determined according to Chapman and Pratt methods [8].
- The water contents of Na, Ca, K and Cl were determined according to Jackson [9]. Carbonate and bicarbonate contents were determined by titration with HCl. sulphate was calculated by difference between anions and cations.
- Soluble N was determined by using Technicion Auto Analyzer [10].
- The contents of soluble P, K, Fe, Mn, Zn, Cu, Pb, Co, Cd, Ni and B in water were determined using Inductively Coupled Plasma (ICP) Spectrometry, K was determined by flame photometer [11].
- The SAR, RSC values of the used water were calculated according to Page *et al.* [12] using the following equations:

$$RSC = (CO_2^{2-} + HCO^-_3) - (Ca^{2+} + Mg^{2+})$$

SAR= Na /vCa+Mg/2.

Soil Analysis: Soil samples were taken under each selected tree species from two depths (0-30 and 30-60 cm) by digging profiles.

The collected soil samples were subjected to the following analysis:

- Electrical conductivity (EC) and pH values were determined according to Chapman and Pratt methods [8].
- The following determinations were carried out in saturated soil paste extract (1:2.5 v/v) according to Jackson [9].
- Sodium and potassium by flame photometer.
- Calcium and magnesium by titration with versenat (EDTA).

Table 1: Chemical analysis of the soil before irrigation with sewage effluents

	Depth (cm)	
Parameters	0-30	30-60
pH	8.000	8.270
EC (dS/m)	3.860	7.450
S.P. %	18.000	19.000
OM %	0.030	0.030
Soluble anions (meq/l)		
Ca^{2+}	14.700	49.350
Mg^{+2}	9.450	21.950
Na^{+}	27.990	34.940
K^{+}	1.010	0.930
Soluble cations (meq/l)		
CO_3^{2+}	0.000	0.000
HCO_3^{-}	1.710	0.950
Cl^{-}	13.050	47.700
SO_4^{-}	38.390	58.520
Available N (ppm)	70.000	70.000
Available P (ppm)	12.000	11.100
Available K (ppm)	108.360	75.140
DTPA-extractable-heavy metals (ppm)		
Pb	0.118	0.100
Co	0.000	0.000
Cd	0.000	0.000
Ni	0.000	0.000

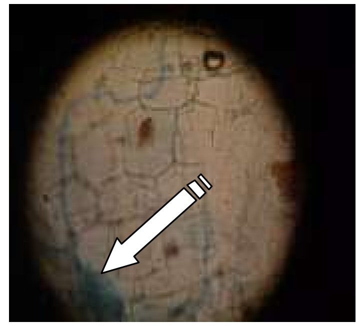
- Chloride by titration with $AgNO_3$.
- Carbonate and bicarbonate by titration with HCl.
- Sulphate was calculated by difference between anions and cations.
- Soluble nitrogen was determined using Kjeldahl method according to Chapman and Pratt [8].
- Available P in soil samples was digested by 0.5 N $NaHCO_3$ according to Watanabe and Olsen [13] and determined by Inductively Coupled Plasma Spectrometry.
- Available K was determined by flame photometer [14].
- Available heavy metals (Pb, Co, Cd and Ni) in soil samples were extracted by DPTA solution according to Lindsay and Norvell [15] and were determined by Inductively Coupled Plasma Spectrometry.

Table 1 shows the chemical analysis of the soil before irrigation with sewage effluents.

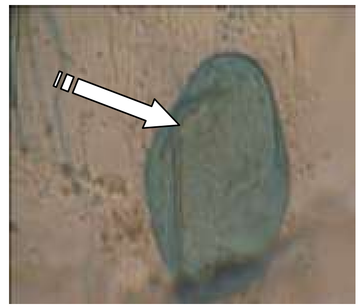
Isolation of Microorganisms from the Soil

Fungi: Soil samples were taken from two depths (0-30 and 30-60 cm). Ten grams from soil samples were added to 90 ml sterile distilled water in a 250 ml. conical flask and shaken thoroughly on a mechanical shaker for 15 minutes. This approximately gave a dilution of 1/10 concentration [16], in order to investigate frequency percentage of fungi, serial dilution of soil suspension were conducted 1/1000 concentration. One ml of the latter suspension was placed in a sterilized Petri-dish before pouring, Martins medium. The dishes were shaken gently to spread the soil suspension all over the medium. Dishes were incubated at 27±2°C for 7 days. Fungal colonies were transferred on to PDA medium in Petri-dishes.

Mycorrhiza Fungi: Roots were removed from soil, under *Eucalyptus camaldulensis* and *E. citriodora trees,* washed by tap water and cut into 1 cm length pieces. Root pieces were prepared for microscopic observation [17]. Root pieces were placed on slide with few drops of lactic acid for microscopic examination. Ten pieces were represented for each replicate. Photographs were taken to show hypha and vesicles of VAM (Fig. 2).



Eucalyptus citriodora



E. camaldulensis

Fig. 2: Hypha and vesicles of VAM

RESULTS AND DISCUSSION

Properties of the Used Sewage Effluents and Ground Water: Data presented in Tables 2 and 3 show the characteristics of sewage water from (drainage and drubber) and ground water which used for irrigation the site. Results indicated that the water was alkaline. pH of the sewage water in various months during this study,

Table 2: Chemical characteristics of water samples from sewage water and ground water during the period of the study (pH value, EC, Soluble ions, SAR, RSC)

Water type	pH	EC dS/m	Anions (meq/L) $CO_3^{=}$	$HCO_3^{=}$	Cl^-	$SO_4^{=}$	Cations (meq/L) Ca^{2+}	Mg^{2+}	Na^+	K^+	SAR meq/L	RSC meq/L
March 2010												
Ground water	7.88	1.55	0.00	2.88	6.14	6.53	3.96	2.16	8.93	0.50	5.10	0.00
Sewage water from drainage	8.01	1.85	0.00	8.81	5.37	4.37	2.80	2.21	13.04	0.50	8.25	3.80
Sewage water from dripper	8.39	1.80	0.00	8.77	5.37	3.92	2.72	1.31	13.55	0.48	9.54	4.74
July 2010												
Ground water	6.64	0.68	0.00	2.09	1.62	2.48	1.90	1.82	1.70	0.77	1.25	0.00
Sewage water from drainage	8.40	1.68	0.00	6.91	5.76	3.54	1.23	2.93	11.20	0.85	7.78	2.75
Sewage water from dripper	8.06	1.69	0.00	6.84	5.85	3.42	1.44	2.62	11.20	0.85	7.89	2.78
Nov. 2010												
Ground water	7.56	0.56	0.00	2.12	1.98	1.31	2.37	1.34	1.62	0.12	0.93	0.00
Sewage water from drainage	8.12	1.75	0.00	5.44	7.82	4.20	3.33	1.80	11.50	0.83	5.59	0.31
Sewage water from dripper	8.03	1.76	0.00	4.85	7.71	5.09	3.57	1.85	11.60	0.63	5.47	0.00

SAR: Sodium Adsorption Ratio.

RSC: Residual Sodium Carbonate

Table 3: Soluble macro and micronutrients (mg/L) in water samples from sewage water and ground water during the period of study

Water type	Elements (mg/L) N	P	Fe	Mn	Zn	Cu	B	Pb	Cd	Cr	Co	Ni
March 2010												
Ground water	7.030	0.365	0.007	0.028	0.009	0.005	0.345	0.000	0.000	0.006	0.000	0.000
Sewage water from drainage	15.490	1.500	0.192	0.122	0.078	0.028	0.191	0.000	0.000	0.015	0.000	0.000
Sewage water from dripper	6.030	3.000	0.216	0.118	0.096	0.018	0.230	0.000	0.000	0.013	0.003	0.000
July 2010												
Ground water	9.020	2.652	0.014	0.001	0.001	0.008	0.074	0.000	0.000	0.001	0.001	0.022
Sewage water from drainage	9.200	2.880	0.042	0.003	0.049	0.030	0.147	0.014	0.001	0.000	0.009	0.011
Sewage water from dripper	8.900	2.011	0.064	0.005	0.022	0.038	0.273	0.015	0.001	0.001	0.001	0.023
Nov. 2010												
Ground water	3.220	0.085	0.016	0.180	0.000	0.007	0.070	0.001	0.000	0.000	0.001	0.023
Sewage water from drainage	9.200	0.638	0.096	0.004	0.039	0.014	0.223	0.014	0.001	0.002	0.009	0.013
Sewage water from dripper	8.900	2.392	0.072	0.003	0.041	0.028	0.243	0.015	0.002	0.004	0.001	0.026

ranged from 8.01 to 8.40 and for ground water from 6.64 to 7.88, such pH values are within the permissible limits, as the tolerance limit of pH for irrigation water ranged from 6.0 to 9.0 as mentioned by Patel *et al*. [18]. On the other hand, the electrical conductivity (EC) of sewage water ranged from 1.68 to 1.85ds/m with the greatest value detected in March 2010 (Table 2). pH and EC values of the sewage water were greater than those of the well water. The values of residual sodium carbonate (RSC) in all the samples were greater than the recommended safe limit for irrigation water which was 25meq/l except samples of water during November 2010 (Table 2) they were below the recommended safe limit for irrigation water which is 1.25meq/l. Therefore this sewage water during November can safely be used for irrigation purposes as far as RSC is concerned.

With respect to heavy metals content of irrigation water, data in Table 3 showed that sewage water had elevated concentrations of such metals compared to well water, the concentrations of these metals in both sources of irrigation water were within the permissible limits for their use as irrigation water. Also, concentrations of heavy metals such as lead, cobalt and cadmium were low and far below the critical level in sewage water. The permissible limits of lead, cobalt and cadmium are 5.0, 0.05 and 0.01 meq/l, respectively. At the same time, Boron concentration was normal under surface irrigation system. As well as chloride and bicarbonate concentration in sewage irrigation water were between slight and moderate levels, they ranged from 5.37 to 7.82 meq/l for chloride. The values of chloride in all the samples were greater than the recommended safe limit for irrigation water which were

Table 4: Effect of sewage water irrigation on distribution of macro elements and heavy metals in soil cultivated with woody trees during July /2010

		Elements (ppm)						
Woody trees species	Depth cm	N	P	K	Pb	Co	Cd	Ni
E. camaldulensis	0-30	140	33.5	195.00	0.216	0.044	0.020	0.010
	30-60	462	22.2	85.80	0.247	0.054	0.026	0.016
E. citriodora	0-30	392	24.1	290.55	0.250	0.016	0.024	n.d
	30-60	196	23.3	120.90	0.258	0.022	n.d	n.d
P. halepensis	0-30	462	23.6	132.60	0.206	n.d	0.036	0.030
	30-60	392	22.3	97.50	0.236	n.d	0.032	0.024
P. brutia	0-30	210	20.2	107.25	0.228	0.030	0.042	0.020
	30-60	322	21.3	46.80	0.242	0.038	0.026	0.036
P. pinea	0-30	322	34.5	232.05	0.220	0.062	0.046	n.d
	30-60	462	29.4	68.25	0.246	0.076	n.d	n.d
C. sempervirens	0-30	266	27.8	107.25	0.262	0.084	0.030	0.020
	30-60	182	26.5	97.50	0.272	0.094	0.044	0.018

n.d: not detected

Table 5: Effect of sewage water irrigation on distribution of macro elements and heavy metals in soil cultivated with woody trees during Nov. /2010

		Elements (ppm)						
Woody trees species	Depth cm	N	P	K	Pb	Co	Cd	Ni
E. camaldulensis	0-30	182	55.0	79.95	1.780	n.d	0.052	0.084
	30-60	196	52.0	120.90	1.680	n.d	n.d	0.035
E. citriodora	0-30	224	64.0	91.65	1.824	0.014	0.063	0.056
	30-60	182	43.0	46.80	1.880	0.020	0.060	0.079
P.halepensis	0-30	294	48.0	79.95	1.580	0.017	0.043	0.039
	30-60	224	46.0	68.25	1.740	0.032	0.045	0.037
P. brutia	0-30	308	53.0	74.10	1.720	0.022	0.038	n.d
	30-60	252	50.0	101.40	n.d	0.052	0.071	0.050
P. pinea	0-30	196	57.0	91.65	1.700	0.025	n.d	0.037
	30-60	210	48.0	79.95	1.920	0.039	0.049	n.d
C. sempervirens	0-30	168	46.0	107.25	1.920	n.d	0.069	0.035
	30-60	140	53.0	97.50	1.640	0.036	0.082	0.093

n.d: not detected

5 meq/l and 4.84 and 8.8meq/l for bicarbonate. In addition, available mineral nitrogen concentration (6.030 and 15.490 mg/L) was somewhat high in some samples of treated sewage irrigation water as indicated in Table 3. These results are in accordance with those found by FAO [19, 20].

Effect of Sewage Water on Elements Concentration in Soil Cultivated with Woody Trees

Macro Elements: Data presented in Table 4 show that during July 2010, macro elements N, P and K from 30 and 60 cm soil depth in Sadat forest soil were clearly increased as a result of irrigation with sewage water. The obtained results varied due to the type of woody trees species and the period of irrigation.

The highest value of N (462 ppm) was obtained in soil cultivated with *Pinus pinea* in 30-60 cm soil depth, *P. halepnsis* in 0-30 cm soil depth and *Eucalyptus camaldulensis* in 30-60 cm soil depth. It is obvious also that, the highest P concentration (34.5 ppm) in soil was achieved with *Pinus pinea* at 30cm soil depth. Whereas, the highest K level in soil was attained after planting *Eucalyptus citriodora and P. pinea* in 0-30cm soil depth.

During November 2010, data presented in Table 5 show the highest values N concentration from soil cultivated with *Pinus brutia* and *P. halepensis* in 0-30 cm soil depth. While, the lowest value of N was given by *Cupressus* in both soil depth 0-30 and 30-60 cm (168 and 140 ppm), respectively. Whereas, the highest values of P concentration (64, 57 and 55 ppm) in soil were achieved after *Eucalyptus citriodora, Pinus pinea* and *E.camaldulensis* cultivated on 0-30 cm soil depth, respectively. Also, the highest K level (120.90ppm) was found when *E. camaldulensis* trees were cultivated in 30-60 cm soil depth.

During Mrach 2011, data presented in Table 6 show that the highest values of N (462 and 392 ppm) were obtained in soil cultivated with *Pinus brutia* in 0-30 cm

Table 6: Effect of sewage water irrigation on distribution of macro elements and heavy metals in soil cultivated with woody trees during March /2011

		Elements (ppm)						
Woody trees species	Depth cm	N	P	K	Pb	Co	Cd	Ni
E. camaldulensis	0-30	322	29.1	52.65	0.220	0.164	0.042	0.084
	30-60	280	29.8	46.80	0.242	0.120	n.d	n.d
E. citriodora	0-30	364	26.6	46.80	0.286	0.192	0.020	0.090
	30-60	322	26.5	42.90	0.190	0.178	0.028	0.072
P.halepensis	0-30	364	25.9	42.90	0.188	0.156	0.026	n.d
	30-60	308	23.5	68.25	0.200	n.d	0.050	0.026
P. brutia	0-30	462	25.3	58.50	0.266	0.140	n.d	0.116
	30-60	322	25.8	62.40	n.d	0.158	0.036	0.198
P. pinea	0-30	364	24.5	42.90	0.202	0.172	n.d	n.d
	30-60	392	24.7	46.80	0.210	n.d	0.018	0.096
C. sempervirens	0-30	280	24.7	46.80	n.d	n.d	n.d	0.042
	30-60	224	26.6	52.65	0.220	0.128	0.030	0.024

n.d: not detected

soil depth and soil cultivated with *P. pinea* in 30-60 cm soil depth. While the lowest value of N concentration were obtained in soil cultivated with *C. sempervirens* in both soil depth 0-30 and 30-60 cm. It is obvious also that, the highest values of P concentration (29.8 and 29.1 ppm) in soil were achieved after *Eucalyptus camaldulensis* in both soil depth 0-30 and 30-60 cm, respectively. Whereas, the highest K level (68.25 ppm) in soil was attained after planting *P. halepensis* in 30-60 cm soil depth.

In other words, it can be said according to Tables 4-6 that, *Pinus* was absorbing less N and P from soil irrigated with sewage water followed *Eucalyptus*. Whereas *Cupressus sempevirens* was more effective for absorbing macro elements. N, P and K from 30 and 60 cm soil depth in Sadat forest soil were clearly increased as a result of irrigation with sewage water compared with virgin soil. These results are in accordance with those obtained by El-Nennah *et al.* [1] and Blume *et al.* [21] who found that the use of sewage effluents in irrigation year after year markedly increased available P and total N in the soil. On the other hand, Al- Atrach [22] irrigated the seedling of *Cupressus sempervirens* and *Albizia lebbeck* cultivated in loamy and sandy soil with treated municipal wastewater, drainage water and Nile water the results cleared the macro- and microelements, were increased in both soil types as a result of using municipal wastewater or drainage water over those of Nile water. Hassan *et al.* [23] found that irrigation with sewage effluent did not affect soil physical properties, but increased most of the macro elements and organic matter in the soil cultivated with some tree species(*Acacia saligna*, *Albizia lebbeck*, *Melia azedarach*, *Taxodium distichum* and *Tipuana speciosa*.

Heavy Metals: Data presented in Table 4 showed that concentration of available Pb, Co, Cd and Ni in the surface soil 0-30 cm and subsurface one 30-60 cm in Sadat forest were clearly increased as a result of irrigation with sewage water. The obtained results varied due to the type of woody trees, period of irrigation and seasons. It is evident that, the available Pb values in 60 cm soil depth ranged between (0.216-0.247), (0.250-0.258), (0.206-0.236), (0.228-0.242), (0.220-0.246) and (0.262-0.272 ppm) after *Eucalyptus camaldulensis, E. citriodora, Pinus halepensis, P, brutia, P. pinea* and *Cupresssus sempervirens*, respectively during July 2010. Concentration of Pb increased after planted any woody tree species compared with the virgin soil (non cultivated and non irrigation). At the same time, the average Pb in soil was about 0.206-0.272 ppm after any tree species, While Co, Cd and Ni level in soil was greatly increased after cultivation any of woody trees species. The average Co level in soil was about 0.016-0.094 ppm after any tree species, except after *Pinus halepensis* planting which Co concentration was not detected in the soil, whereas the highest value of Co was found in soil cultivated with *Cupressus sempervirense*, whereas the highest value of Ni were found in soil cultivated with *Pinus brutia* followed by *P. halepensis*.

During November 2010, data presented in Table 5 showed that Pb concentration increased more than any months during this study after cultivated any woody tree species compared with the virgin soil (non cultivated and non irrigated).At the same time, the average Pb in soil was 1.580-1.920 ppm after any plantation. In other words, it can be concluded that, all trees are similar in the absorption of lead from soil. On the other hand, the highest value of

Table 7: Frequency of fungi associated with different woody trees species isolated from two depths (0-30 and 30-60 cm) under sewage water irrigation

	% Frequency percentage of fungi associated with different woody trees species													
	P. halepensis		*Pinus brutia*		*Pinus pinea*		*E. citriodora*		*E. camldulensis*		*C. sempervirens*		Control	
Fungi	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Acremonium strictum	19.2	0.0	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alternaria alternata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	15.0	20.0	15.0
Aspergillus flavus	0.0	0.0	0.0	0.0	0.0	0.0	8.3	5.0	0.0	3.4	6.6	5.0	16.7	20.0
Aspergillus niger	0.0	0.0	0.0	0.0	17.5	6.7	13.3	10.0	46.7	73.3	36.7	15.0	10.0	20.0
A. ochraceous	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	6.7	0.0
Chonaephora sp.	0.0	0.0	0.0	0.0	0.0	36.6	0.0	50.0	23.3	0.0	0.0	0.0	0.0	0.0
Cladosporium herbarum	0.0	0.0	0.0	0.0	32.5	0.0	5.0	0.0	0.0	3.4	13.3	0.0	0.0	0.0
Doratomyces sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusarium acuminatum	0.0	0.0	0.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	6.7	10.0
Fusarium chlamydosporum	0.0	0.0	56.7	0.0	0.0	26.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusarium merismoids	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusarium moniliforme	0.0	93.3	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusarium oxysporum	30.0	0.0	0.0	6.6	27.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusarium solani	45.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0
Mucor sp.	0.0	0.0	0.0	0.0	0.0	0.0	3.3	25.0	20.0	6.7	0.0	0.0	0.0	0.0
Nigrospora sphaerica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	16.7	15.0
Penicillium sp.	5.2	6.7	6.7	3.4	22.5	6.7	63.3	0.0	10.0	10.0	0.0	10.0	3.2	10.0
Rhizopus nigricans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0
Stemphylium sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Verticillium sp.	0.0	0.0	0.0	0.0	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Control: Virgin soil

Co was found in soil cultivated with *Pinus brutia* in 30-60 soil depth, while the highest values of Cd and Ni were found in soil cultivated with *Cupressus sempervirens* in 30-60cm soil depth.

During Mrach 2011, data presented in Table 6 showed that the highest value of Pb (0.286 ppm) and Co (0.192 ppm) were found in soil cultivated with *Eucalyptus citriodora* in 0-30 cm soil depth, while the highest value of Ni (0.116-0.198 ppm) was found in 0-30 and 30-60cm soil depth respectively, cultivated with *Pinus brutia*.

In other words, it can be said according to Tables 4-6 that the concentration of heavy metals (Pb, Co, Cd and Ni) increased in all depths of sewage water irrigated soil compared with virgin soil. Similar findings were reported by Hassan *et al*. [23] reported that higher values of Cd, Pb, Cr, Mn and Zn were found in the soils of *Melia azedarach*, *Acacia saligna* and *Taxodium distichum,* respectively under sewage water irrigation. Abd El-Naim and El-Awady [24] who indicated that the soil available Co, Cr, Ni, Cd and Pb slightly increased when irrigated by sewage water. On the other hand, Tabari *et al*. [25] showed that the concentration of heavy metals (Zn, Cu, Pb and Ni) was higher in all depths of wastewater irrigated soil compared to those of well water irrigated soil.

Frequency of Fungi: This experiment was conducted to test the effect of irrigation with sewage water on the frequency of fungi associated with 6 different woody tree species isolated from two depths (0-30 and 30 -60 cm). Data in Table 7 showed that there were differences in fungal species associated with each of the six tested woody trees. The isolated fungi were *Acremonium strictum, Alternaria alternate, Aspergillus flavus, A. niger, A. ochraceous, Chonaephora* sp. *Cladosporium herbarum, Doratomyces sp., Fusarium acuminatum, F. chlamydosporum, F. moniliforme, F. merismoids, F. oxysporum, F. solani, Mucor* sp.*, Nigrospora sphaerica, Penicillium* sp., *Rhizopus nigricans, Stemphylium* sp. and *Veriticillium* sp. The most frequent fungi were those belonged to genus *Fusarium* their frequency percentage ranged from 45.6 to 93.3% and they were only found with *Pinus halepensis*, *P. brutia* and *Cupressus sempervirens*. Genus *Penicillium* was found with all the tested woody trees. Data also showed that, irrigation with sewage water affect the presence of some fungal species that was also shown in case of isolation depth. These results are in accordance with those obtained by Ali-Shtayeh *et al*. [26] who studied 13 field soils receiving either raw city wastewater or normal irrigation, shown to be more efficient in the isolation of pathogenic and potentially pathogenic fungi including dermatophytes. The species most commonly found in those habitats included: *Alternaria alternata, Aspergillus candidus, Geotrichum candidum* and *Paecilomyces lilacinus.* Field soils receiving either raw city wastewater or normal irrigation water, were found to be rich in pathogenic and potentially pathogenic CH-resistant fungi, including dermatophytes, with raw city wastewater yielding the highest percentage (81%), followed by the newly wastewater irrigated field (77.7%), the nonpolluted field (67%) and the heavily polluted field (63.4%). Deshmukh *et al*. [27] studied the soil bacterial and fungal population density in soil layers of 0-15, 15-30, 30-60 and 60-120 cm depths. Resulted indicated that, there was significant increase in bacterial and fungal count in sewage-irrigated soils as compared to their respective control (virgin soil).

CONCLUSION

Long term use of sewage water in irrigation resulted in clearly increased concentrations of macro elements and heavy metals (Pb, Co, Cd and Ni) in soil depths compared with virgin soil and there are differences among the studied tree species in absorption either macro nutrient or heavy metals. Also, the most frequent fungi were those belonged to genus *Fusarium*, their frequency percentage ranged from 45.6 to 93.3% and they only found with *Pinus halepensis*, *P. brutia* and *C. sempervirens*. Genus *Penicillium* was found with all the tested woody trees. Irrigation with sewage water affects the presence of some fungal species that was also shown in case of isolation depth.

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