Journal of University of Duhok.,Vol.22, No.1(Agri. and Vet. Sciences), Pp 277-291, 2019
https://doi.org/10.26682/avuod.2019.22.1.26

GROWTH RESPONSE OF *Eucalyptus Camaldulensis* DHENH. AND *Melia Azedarach* L. SEEDLINGS TO PRIMARY TREATED WASTEWATER OF AVROCITY IN DUHOK GOVERNORATE

BAYAN HAZIM AHMED* and RAMADHAN OMER HUSSAIN**
*Dept. of Forestry, College of Agricultural, University of Duhok, Kurdistan Region-Iraq.
**Dept. of Horticulture, College of Agricultural, University of Duhok, Kurdistan Region-Iraq.

(Received: May 2, 2019; Accepted for Publication: July 10, 2019)

ABSTRACT

An experiment was conducted during April to the beginning of November ,2018, in the lath house of the University of Duhok, College of Agricultural Engineering Sciences, Duhok city. This research was carried out to study the effect of primary treated wastewater (PTWW) of Avro city in Duhok governorate ,Iraq, on *Eucalyptus camaldulensis* and *Melia azedarach* one- and two-years old seedlings, and some growth parameters (seedlings biomass, diameter and height) were investigated at the beginning and at the end of the study, the total chlorophyll content measured, ,concentration of (Cd and Cu) and some chemical and physical properties of soil and water were determined. Chlorophyll content show significant effect for PTWW applied on *Melia* seedlings for both ages and the highest value was 49.90 (SPAD) in *Melia* seedling of one year irrigated with PTWW. Irrigation with PTWW increased significantly the growth parameters (seedlings height, diameter, and biomass) in *Melia*. The obtained results show that PTWW effects on the biomass of 1-year old *Melia* seedlings followed by 2-years old *Melia* seedlings, while for *Eucalyptus*, comparable results shown for the 2-years old seedling treated with the both types of water, while for the smaller seedlings (in age) the tap water (TW) was more effective. Concerning the heavy metals, surprisingly, Cu was higher in plants parts irrigated with TW compared with that of PTWW. The highest Cu concentration found in the roots of 2-years old *Melia* seedlings (23.93 mg.kg^{-1} d.wt), with the lowest concentration in 1-year old *Eucalyptus* seedlings (12.02 mg.kg^{-1} d.wt). In general, highest Cd concentration detected in roots and shoots treated with PTWW, whereas the uppermost (mean) Cd concentration was found in two-years old roots of *Eucalyptus* seedlings (1.16 mg.kg^{-1} d.wt) besides the lowest results noted in two- years old shoots of *Melia* seedlings that stands on (0.20 mg.kg^{-1} d.wt). As a result, *Melia* was more resistance to PTWW than *Eucalyptus*.

KEYWORDS: *Eucalyptus camaldulensis, Melia azedarach,* Primary treated wastewater, Biomass, Chlorophyll, Heavy metals.

1. INTRODUCTION

Environmental pollution is taking place on an unprecedented and rapid scale around the globe. Today's pollution is integrally correlated to the extents of human and animal populations, economic production, recent technology, lifestyles, fossil fuel combustion, dumping solid wastes, urbanisation, industrialisation and agricultural wastes (Bernhardt *et al*., 2019). The aforementioned sources are the main reasons for different types of pollution regarding air, soil, noise, radioactive, light and water pollution (Smith *et al*., 1999; Pathak & Mandalia, 2011; Appannagari, 2017). In the last twenty years, many attempts managed to diminish the pollution sources and remedy the polluted water that leads to water shortage (Lone *et al*., 2008). Accordingly, the need for recycling and using low-quality water (drainage and wastewater) for various purposes especially irrigation has increased (Song *et al*., 2006). Irrigation with treated wastewater (primary and secondary) leads to improvement in the plant growth and soil quality, and such effluents are considered as natural sources due to the availability of nutrient elements and organic matter (Ali *et al*., 2012). Primary treated wastewater takes in basic processes in which solid waste settled and removed from the wastewater and whereas the biochemical oxygen demand (BOD) reduced (Sonune & Ghate, 2004; Kiziloglu *et al*., 2008).

Nevertheless, unremitting irrigation with such effluents may result in the accumulation of metals, which can cause adverse effects, such as soil deterioration, inhibition of seed germination, and toxicity to plants (Kumar & Chandra, 2004). Moreover, toxic elements in soil can enter into the food chain, eventually posing severe threat to human beings (Landrigan *et al*., 2018), diminish immunological defense, lessen crucial nutrient in the body, cause malnutrition infirmities, increase gastrointestinal cancer rate, impact the physiological abilities and lead to retardation in growth (Chaoua*et al*., 2018; Bernhardt *et al*., 2019). The use of treated wastewater for forest irrigation has confirmed to be a promising and successful practice for reusing wastewater; it also plays an important role in protecting the environment (Stewart & Flinn, 1984; Guo *et al*., 2002; Sharma & Ashwath, 2006; Sherif *et al*., 2017).

Forest trees may be more tolerated than any other plants to irrigation with wastewater because of its ability to uptake heavy metals into their tissues (Madejón *et al*., 2006). However, trees ' ability to survive and grow under wastewater irrigation conditions appears to vary among species because wastewater usually contains undesirable components such as salts, trace elements, organic compounds, pathogens and others (Hassan & Ali, 2013).

Eucalyptus and *Melia* species can be irrigated with effluents since these trees are; high transpiring, fast growth rates, adaptable to wide ranges of soil, tolerate contaminants, high biomass production and deep and extensive root systems. (Minglin *et al*., 2005). *Eucalyptus Camaldulensis dehnh*, the river red gum, is an Australian tree species and also planted in many parts of the world (FAO, 1979; Eldridge *et al*., 1993; Farrell *et al*., 1996) and introduced to Iraq as an exotic tree. The tree can be grown across a wide variety of sites and climates (Albaugh *et al*., 2013). It is used for a wide range of purposes around the world, including shelter, agroforestry, ornamental, essential oils, medicine and for industrial wood production (Abo-Hassan *et al*., 1988; Midgley *et al*., 1989; Farrell *et al*., 1996). Likewise, it used for remediation of environmental problems (Assareh *et al*., 2008); since the tree has an extensive root system and they possess the ability to absorb a large amount of heavy metals. *Melia azedarach* L. also known as Chinaberry, Persian lilac, White cedar or Tulip cedar is a small to medium deciduous tree. The tree is native in Pakistan, India, Indochina, Southeast Asia and Australia (AL-Rubae, 2009; Chiffelle *et al*., 2009; Ramya *et al*., 2009; Nahak & Sahu, 2010). The fruit are the poisonous part of the tree (Chudnoff, 1984; Kim *et al*., 1999; Alché *et al*., 2003). It is used as a shading tree and as an ornamental avenue tree (Seth, 2003), it is known for its medicinal and insecticidal properties (Bohnenstengel *et al*., 1999; AL-Rubae, 2009; Nahak & Sahu, 2010) and for industrial wood production (Chudnoff, 1984; Nasser, 2010)**.** It is highly adapted to an extensive range of soil moisture conditions, grow in alkaline soil and highly tolerate heat and drought (Batcher, 2000; Shahbaz, 2010). It is broadly cultivated in Kurdistan on the highway edges, parks, gardens and landscapes. Often used as an ornamental shade (Shahbaz, 2010).

Iraq like many other countries also faces thoughtful environmental issues, ranging from poor water quality, effects of climate changes, struggle pollution to the deterioration of vital ecosystems, soil salinity and the threat of water shortages (Price, 2018). UNDP in 2015 argues that providing humanitarian support to internally displaced person and refugees enlarged the need of water in 2015 almost by 15% in Erbil and Duhok (UNDP, Post-Conflict Impact Assessment on Environment in Kurdistan Region of Iraq, 2015. (Tinti, 2018). In the center of Duhok city, the main source of irrigation water for public gardens and parks is from groundwater, and this put the water under stress of depression especially in drought seasons. Therefore, dependence on primary treated wastewater as a source for irrigation is inevitable. Because of constraints on freshwater availability, primary-treated wastewater has been used in different countries. The untreated wastewater used for irrigation purposes instead of clean water so as to save clean water under conditions of water stress for alternative significant purposes. Therefore, this study set out to assess:

1. The *Eucalyptus camaldulensis* and *Melia azedarach* seedlings ability to grow in pots irrigated with primary treated wastewater of Duhok city.

2. The Effect of irrigation by primary treated waste water on some growth characteristics of tested plant.
3. To study the distribution of Cd and Cu in different plant parts (root and shoot system).

2. MATERIALS AND METHODS

2.1 Location

The present study was assessed during seven successive months through the year 2018 (from April till the end of October) in the lath house of the University of Duhok, College of Agriculture, in Duhok city, elevation (473m) (Latitude: 36°51 '32.39"N) and Longitude: 42°52'58.95"E).

2.2 Selection of Seedlings

The seedlings of two different plant species (*Eucalyptus camaldulensis* dehnh and *Melia azedarach* L.) with two different ages (one year old and two years old) were brought from Zakho nursery to the Agricultural Engineering Sciences college lath house area. Height and diameter for all tested seedlings measured before planting, and planted in pots contained 10 kg of soil mixture (3 loam:1 soil) ratio. Also, extra 5 plants for each plant type (including the two ages) were selected randomly, dried, and the dry weight of roots and shoots was recorded in order to determine the increase in biomass, diameter and height.

2.3 Design of the experiment

A factorial Randomized Completely Block Design (RCBD) was used, to study two plant species (*Eucalyptus camaldulensis and Melia azedarach*), two ages (one year old and two years old), two water types (primary treated waste water and tap water) and using four replicates with five plants for each experimental unit.

Therefore, number of experimental units = 2 **(plant species)** X 2 **(two ages)** X 2 **(water types)** X 4 **(replicates)** = 32 **(experimental units)** X **5** **(plants in each experimental unit)** =160 seedlings.

2.4 Analysis of Soil

The determination of physical and chemical properties and the total heavy metals in the soil were assessed (at the beginning and at the end of the study) in Duhok Environmental Directorate Soil Lab. Following the protocol of (Martens & Lindsay, 1990). The result shown in table (1).

2.5 Analysis of Irrigation Water

The Chemical and physical properties of irrigation water analyzed in Duhok Environmental Directorate Chemical lab. according to (APHA, 1998). The results shown in table (2).

2.6 Measurement of Total chlorophyll

Total chlorophyll determined by using chlorophyll meter SPAD-502, four times during the study; first time chlorophyll was measured at the end of June, then August after that in September and the last time measures taken in October. The indicated results represent the mean of the four measurements.

2.7 Measurement of Seedlings Diameter (increase in seedlings dimeter)

At the beginning and at the end of the study all the seedlings diameter was measured directly above the soil surface by using digital caliper. An increase in seedlings dimeter calculated by subtracting the first measured diameter form the second.

2.8 Measurement of Seedlings Height (increase in seedlings height)

At the beginning and at the end of the study the height of all seedlings was determined directly above the soil surface till the top of the seedling, by using diameter tape. The increase in seedlings height calculated by subtracting the first height measuring form the second measuring.

2.9 Seedlings Rooting Up

At the 1st of November, the rooting up of all the seedlings was taken place, each plant carefully was moved off from each pot and the plant root system was detached from the shoot system by using plant pruning scissors. Gently the attached soil removed from the root system, the root and shoot systems each was washed separately and carefully placed over a flat surface for 24-48 hours for air drying. After drying, the plants were oven dried for 72 hours at 70°C. Each experimental unit placed in paper bags individually.

2.10 Biomass measurement (increasing in dry weight)

At the beginning of the experiment, dry weight of shoots and roots were measured, the plants were oven dried for 72 hours at 70°C, until a constant weight attained. The weights of plants from both species and both ages were measured. The increase in shoots and roots dry weight was measured by subtracting the mean of the five plants that measured before the study, from the dry weight that measured at the end of the study.

2.11 Digestion of Roots and Shoots Samples

The plants were grinded by using SOLE Large 1000 Grams Grinder Commercial Home Crusher. The shoot system and root systems were all powdered for chemical analysis. According to the protocol of Ryan & Astafan (2003). 10ml of the acid ($HNO_3/HClO_4$) nitric acid: perchloric acid 4/2 (v/v) added to 0.5 grams of the plant powder in a conical flask (100ml). The conical flasks placed on hot plate under low temperature, later the flasks' cover was opened to let the NO_2 fume release out. This process continued until it changed to colorless. Afterward it evaporated until the volume reached to 3-5 ml. Lastly, by using distilled deionized water, the digested samples diluted to the final volume 50 ml (in a volumetric flask) (Tandon, 1999).

2.12 Determination of Cd and Cu in roots and shoots

Cd and Cu were measured by Atomic Absorption Spectrophotometer and the given results calculated by the following formula to get mg.L-1 (Martens & Lindsay, 1990):

$$Heavy\ Metals(ppm) = ppm\ HM(from\ calibration\ curve) \times \frac{V}{Wt}$$

Table (1): Some Physical and Chemical Properties of the Mixture (Soil + Loam)

Characteristics	Measurement units	Value	
		Beginning of the study	End of study
pH	---	7.79	7.95
Moisture content	%	1.98	----
Total Nitrogen	%	0.14	0.17
Total Carbonate	%	4	2.902
Organic matter	%	2.76	5.022
Dissolved Potassium	mg.l-1	7.1	7.9
Extractable Potassium	mg.l-1	113	125
Phosphate (Total)	mg.l-1	8.4	29.5
Cadmium (Total)	mg.l-1	1.241	0.95
Copper (Total)	mg.l-1	46.6	18.23
Clay	%	13.48	
Silt	%	40	
Sand	%	46.53	
Texture		Loam	

Table (2): Some Physical and Chemical Analysis of Wastewater and Tap Water

Characteristics	Measurement units	Results	
		PTWW	TW
Turbidity	NTU	11.8	0.1
pH	-----	7.47	7.27
Electrical conductivity	(µS)	870.2	791.7
Total dissolved Solids	mg.l-1	556.9	506.7
Total Alkalinity	mg.l-1	302.0	386.0
Total Hardness	mg.l-1	272.2	461.2
Calcium	mg.l-1	68.2	77.9
Magnesium	mg.l-1	24.8	65.0
Chloride	mg.l-1	52.0	22.4
Sulfate	mg.l-1	106.7	13.2
Nitrate	mg.l-1	15.9	4.8
Sodium	mg.l-1	59.5	38.3
Potassium	mg.l-1	12.5	1.1
Nitrogen	mg.l-1	31	8

Journal of University of Duhok.,Vol.22, No.1(Agri. and Vet. Sciences), Pp 277-291, 2019
https://doi.org/10.26682/avuod.2019.22.1.26

Phosphate	mg.l-1	2.58	3.18
Copper	mg.l-1	0.286	0.264
Cadmium	mg.l-1	0.0007	0.0009

3. RESULTS

In the present study, the total chlorophyll content, the vegetative growth parameters (increase in height, diameter and biomass), and the values of heavy metals (Copper and Cadmium) in the root and shoot systems were measured. The obtained results show the effect of primary treated wastewater (PTWW) and the tap water (TW) on *Eucalyptus camaldulensis* Dhenh. and *Melia azedarach* L. of one- and two-years old seedlings.

The results of chlorophyll content in leaves are set out in figure 1. The maximum chlorophyll content found in *Melia* seedlings irrigated with PTWW of the 1-year old (49.9) which was differed significantly from all other treatments except both of 2- years old seedlings of *Eucalyptus* and *Melia* irrigated with PTWW. The amount of chlorophyll content found in *Melia* treated with TW was 36.64 for 1-year old seedlings, which differed non-significantly with the same type of water for the 2 years old seedlings (34.58). Overall, concerning the mean content of greenness, *Melia* seedlings treated with PTWW contain the largest chlorophyll content.

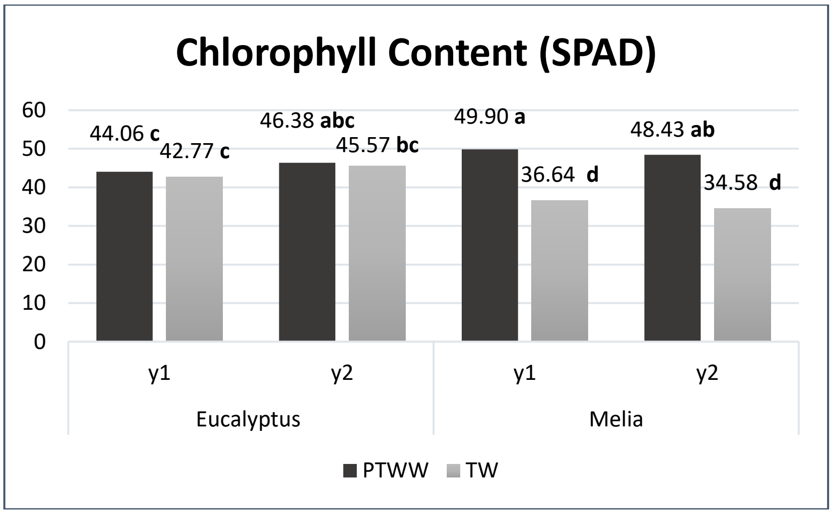

Fig. (1): Effect of PTWW on chlorophyll content in one- and two-years old seedlings of *Eucalyptus* and *Melia*.

For both of *Eucalyptus* and *Melia* separately, means with same letter are not significantly different at 5% based on Duncan’s Multiple Range test.

The outcomes in figure 2 show that the increase in height of *Eucalyptus* seedlings did not affected significantly by PTWW, 1- year old seedlings treated with PTWW got a little more height than those of the TW, and nearly the same results revealed for 2-years old seedlings treated with both types of water (35 cm). The top influence on the plants’ height found with those treated with PTWW on 1-year old *Melia* seedlings with (90.12 cm), which was different significantly from all other treatments.

https://doi.org/10.26682/avuod.2019.22.1.26

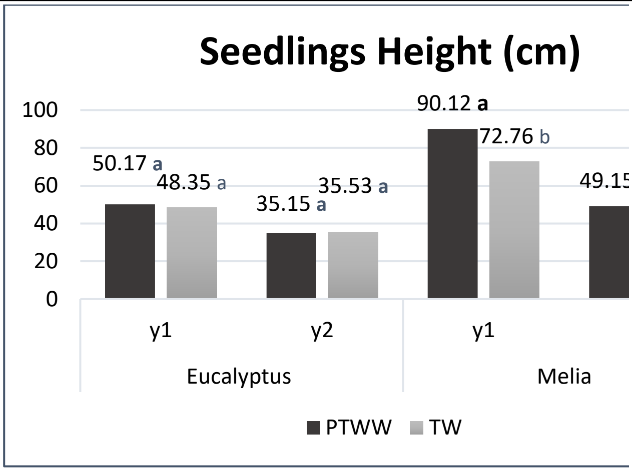

Fig. (2): Effect of PTWW on increasing in height of one- and two-years old seedlings of *Eucalyptus* and *Melia*.

For both of *Eucalyptus* and *Melia* separately, means with same letter are not significantly different at 5% based on Duncan's Multiple Range test.

It is appeared in figure 3, however 1-year *Eucalyptus* seedling treated with TW achieved greater diameter (4.22mm) but no significant differences recorded between the plants irrigated with PTWW and TW. It has been found in the same figure, the maximum diameter achieved in *Melia* seedlings of the smaller age (6.01mm), for the plants treated with PTWW; and the 2-years old *Melia* seedling irrigated with TW recorded the smallest diameter (1.85 mm) which was different significantly from all other *Melia* treatments.

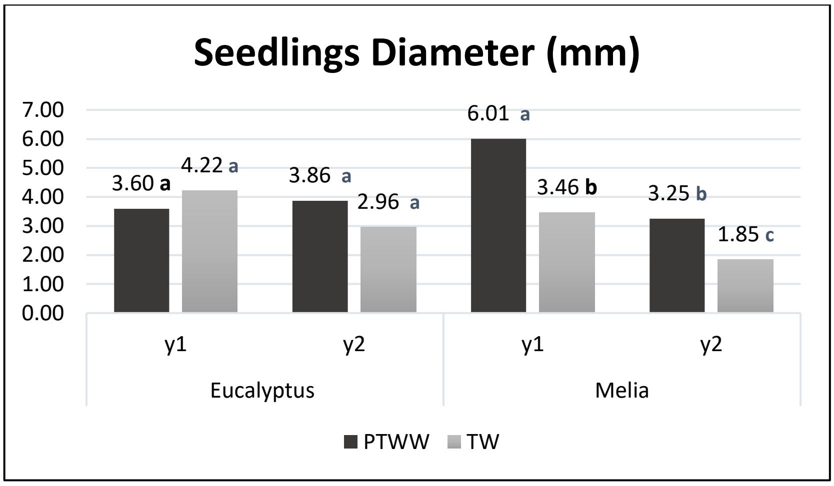

Fig. (3): Effect of PTWW on increasing in diameter of one- and two-years old seedlings of *Eucalyptus* and *Melia*.

For both of *Eucalyptus* and *Melia* separately, means with same letter are not significantly different at 5% based on Duncan's Multiple Range test.

From the data in figure 4, for *Eucalyptus* species, the seedlings irrigated with PTWW demonstrate non-significant influence on the 2 and 1-years old seedlings. It is found that the PTWW has significant influence on *Melia* seedlings and particularly for those of 1-year old, the highest result obtained was 82.79 g. It is clear that 1- and 2- years old *Melia* seedlings irrigated with PTWW got twice biomass of those treated with TW.

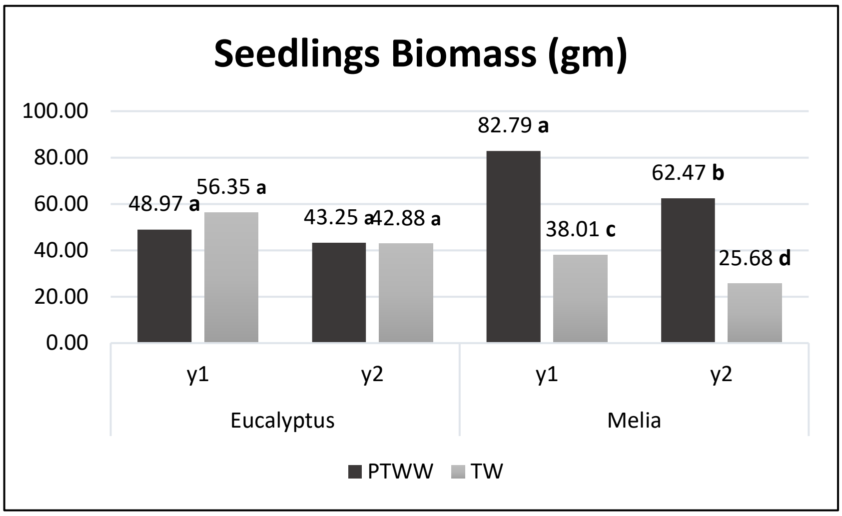

Fig. (4): Effect of PTWW on increasing biomass of one- and two-years old seedlings of *Eucalyptus* and *Melia*.

For both of *Eucalyptus* and *Melia* separately, means with same letter are not significantly different at 5% based on Duncan's Multiple Range test.

From the data in table 3, we can see that in the roots system, interestingly the maximum concentration of Cu presented in 2- years old *Melia* seedlings (23.93 mg.kg^{-1} d.wt) for those irrigated with TW, that differed significantly from all other treatments. As a mean, significant differences show with greatest amount of Cu found in 2-years old seedlings of *Melia* with (18.96 mg.kg^{-1} d.wt) compared with the others. Correspondingly, in general, the seedlings irrigated with TW contained higher concentration of Cu compared with those of PTWW.

For the shoot system, maximum concentration of Cu detected in 2- years old *Melia* seedlings (18.38 mg.kg^{-1} d.wt) treated with TW, which was non-significantly differed from all the other treatments except the 1-year old *Eucalyptus* seedlings irrigated with PTWW which was significantly differed with (11.36 mg.kg^{-1} d.wt). Largely, no significant differences recorded concerning the seedlings species and ages. Regarding the Cu in the shoots no significant differences found between seedlings treated with TW (15.54 mg.kg^{-1} d.wt) compared with those treated with PTWW (13.95 mg.kg^{-1} d.wt).

Table (3): Concentration of Cu in Roots and Shoots Systems of *Eucalyptus* and *Melia* Seedlings (mg.kg^{-1} d.wt)

Seedlings species	Seedlings Age	Roots		Mean	Shoots		Mean
		PTWW	TW		PTWW	TW	
Eucalyptus	Y1	14.23 c	12.02 d	13.12 c	11.36 b	13.80 ab	12.58 a
	Y2	14.05 cd	12.15 d	13.10 c	16.15 ab	13.60 ab	14.88 a
Melia	Y1	12.53 cd	19.73 b	16.13 b	14.58 ab	16.40 ab	15.49 a
	y2	14.00 cd	23.93 a	18.96 a	13.73 ab	18.38 a	16.05 a
	Mean	13.7 b	16.95 a		13.95 a	15.54 a	

For both of roots and shoots separately, means with same letter are not significantly difference at 5% Duncan Multiple Range test.

It can be seen from the data in table 4, that maximum Cd content (1.65 mg.kg^{-1}d.wt) was found in 1-year seedlings roots of *Melia* irrigated with PTWW; while no Cd content was detected in the same seedlings that irrigated with the TW (it refers to low Cd concentration that could not be detected by the Atomic Absorption Spectrophotometer). As a mean, the uppermost Cd concentration was found in the roots of two-years old *Eucalyptus* seedlings (1.16 mg.kg^{-1} d.wt) besides the lowest mean result noted in two- years old *Melia* seedlings that stands on (0.48 mg.kg^{-1} d.wt). In general, the plants roots treated with

https://doi.org/10.26682/avuod.2019.22.1.26

PTWW significantly accumulated higher Cd than those irrigated with TW.

In shoots, the maximum Cd concentration (1.50 $mg.kg^{-1}$ d.wt) was found in 1-year old seedlings of *Melia* irrigated with PTWW, while the minimum range (0.25 $mg.kg^{-1}$ d.wt) was found in of 1 and 2-years old *Melia* seedlings irrigated with TW. Concerning the tree species and ages, the mean highest Cd concentration (1.25 $mg.kg^{-1}$ d.wt) observed in 1-year old *Eucalyptus* seedlings while the lowest amount of Cd (0.20 $mg.kg^{-1}$ d.wt) found in two- years old *Melia* seedlings. Overall, the shoots treated with PTWW accumulated higher Cd than those irrigated with TW with non-significant differences.

Table 4: Concentration of Cd in Roots and Shoots Systems of *Eucalyptus* and *Melia* Seedlings ($mg.kg^{-1}$ d.wt)

Seedlings species	Seedlings Age	Roots		Mean	Shoots		Mean
		PTWW	TW		PTWW	TW	
Eucalyptus	Y1	1.00 b	0.95 b	0.98 a	1.25 a	1.25 a	1.25 a
	Y2	1.30 ab	1.03 ab	1.16 a	0.75 ab	0.70 ab	0.73 ab
Melia	Y1	1.65 a	N.D d	0.83 ab	1.50 a	0.25 b	0.88 a
	Y2	0.70 bc	0.25 cd	0.48 b	0.15 b	0.25 b	0.20 b
	Mean	1.16 a	0.56 b		0.91 c	0.61 c	

For both of roots and shoots separately, means with same letter are not significantly difference at 5% Duncan Multiple Range test.

4. DISCUSSION

4.1 Chlorophyll Content

Chlorophyll, it is an important chelate made up of carbon, nitrogen and magnesium. It is the green pigment in plants, via photosynthesis process the chlorophyll changes energy of sunlight to stored chemical energy, it let the floras to capture energy from light. Through the photosynthesis, the solar energy that the plant receives converted to usable form(glucose) that lead to the establishment of some food chain basis (Hynninen & Leppäkases, 2002; İnanç, 2011; Pareek *et al*., 2018). Our results of chlorophyll content for the seedlings treated with PTWW was more than those treated with TW are in agreement with those of (Shah *et al*., 2010), who demonstrate that total chlorophyll content for *E. camaldulensis* treated with 50% effluent mixed with tap water was more than those treated with tap water. Also, (Al-Mefarrej, 2013) show that seedlings of *Tamarix aphylla* irrigated with primary treated wastewater contain higher chlorophyll content. The nutrients have a significant role on the biochemical process, and the high results of chlorophyll may be related to the high nutrients (Evans, 1989; Ramana *et al*., 2002; Ali, 2005). Nearly all of the nitrogen of leaf is included in chlorophyll so the chlorophyll can give secondary estimation of nutrient (Moran *et al*., 2000). Reduction in chlorophyll contents may be caused by declining in the activity of enzyme that is responsible for chlorophyll biosynthesis as a result of toxicity of metals (Zengin & Munzuroglu, 2005). Likewise, the change in chlorophyll content can be related to the time of irrigation as Al-Mefarrej, (2013) indicated in his study that content of chlorophyll has declined from the first week to the five weeks that came after, as the period of irrigation expands. High chlorophyll content in the leaves of tested plants may be due to high nitrogen content in PTWW that used for irrigation because nitrogen is one of the essential macronutrients that plants cannot complete its life cycle with its absence, it combines with carbonic compounds to form hundreds of organic compounds such as chlorophyll, protoplast, proteins, nucleic acids, vitamins, and different enzymes; also another reason of increasing chlorophyll is the presence of high sulfate in PTWW compared with TW, because sulfur in plants enters in formation of proteins especially chloroplast protein, therefor one symptom of sulfur deficiency is the pale color of leaves (El-Beshbeshy & Sheris, 1998).

4.2 Height, Diameter and Biomass

The results of our study indicated that PTWW effect more on the diameter, height and biomass of seedlings, an increase in height and diameter lead to increase in biomass, the high biomass in plants may also be the result of high chlorophyll content (as shown for *Melia* seedlings), the high growth may be due to the presence of organic compounds and nutrients. But the *Eucalyptus* seedling were more sensitive to PTWW as there was not a clear difference shown for those irrigated with PTWW to those treated with TW. A study on the effect of different waters on *Eucalyptus camaldulensis* and *Melia azedarach* seedlings which done by Sabr & Younis (2017) was found that highest plants achieved for *Eucalyptus camaldulensis* treated with 0% sewage water than those treated with 50% and 100% sewage water. It is pointed out that species reflect differently to effluents. Noticeable differences in growth parameters when variable effluents applied probably be the results of different chemical components, especially metals (Singh & Bhati, 2003).

Shah *et al*., (2010) demonstrated in their study that Cd is toxic for *Eucalyptus* species thus cause reduction in plant growth. The reduction in the growth parameters of *Eucalyptus* may be owing to the high sodicity, salinity and heavy metals concentration in the effluents that effects on the activity of enzymes (Singh & Bhati, 2003; Shah *et al.*, 2008), this leads to decreasing in the water potential and also growth of plant (Peralta *et al*., 2001). Correspondingly, the study investigated by (Shah *et al*., 2010) on *Eucalyptus camaldulensis* seedlings express that the plants height, diameter and weight altogether increase while using 50% effluents diluted with tap water compared to the plants treated with tap water. Similar observation has been described by Al-Mefarrej, (2013) who stated that the growth characteristics of *Tamarix aphylla*, all enhanced by using primary treated wastewater compared to well water. The present findings also supported Shetta, (2016) which concluded that primary treated waste water has increased the growth parameters of *Acacia* species. (Ali *et al.*, 2011) show in their study that the effect of primary treated wastewater was more effective for the growth parameters of *Swietenia mahagoni* L. seedlings compared to tap water and secondary treated wastewater. Other studies by (Bedbabis, Rouina, & Boukhris, 2010; Kiziloglu *et al*., 2008; Selahvarzi & Hosseini, 2012) were good agreements with the results of the present study. Heavy metals may be the reason of reduction in plant growth, since they cause stress in plant that also reduce the photosynthesis activity (Maksymiec, 2007).

Growth defined as an increase in the dry weight of plant, the dry weight resulted mainly from increasing of carbohydrates, the glucose (outcome of the photosynthesis process) is the main block unit of carbohydrates. Therefore, the increasing of plant biomass (which represented by increasing of plant height and diameter) attended by improvement of photosynthesis process due to enhancement of chlorophyll in plants irrigated by PTWW. In another hand, enrichment of PTWW by several nutritional elements such as nitrogen (very important element in composition of all proteins), potassium (have important role in formation and translocation of carbohydrates, controlling plant osmosis), sulfur (in plants enter in formation of hormones and proteins especially chloroplast protein) (El-Beshbeshy & Sheris, 1998). All of these factors play important role for growth enhancement of plants irrigated by PTWW. (Singh & Bhati, 2003; Guo *et al.,* 2006) come to an end that better biomass and growth production attained possibly because of the enough obtainability of essential elements and water through sewage effluents. And plants that show elevated biomass may be the result of extra phosphorous and nitrogen that plant receive from the waste water.

4.3 Concentration of Cu and Cd in Roots and Shoots

Heavy metals are elements that have metallic properties and possess an atomic number greater than twenty; they available in the environment in very little concentration and with few quantities (µg. Kg^{-1}) (Peralta *et al*., 2001; Duruibe *et al*., 2007). They have specific gravity five times that of the water (Lentini *et al*., 2019). Metal pollution has harmful effect on biological systems and does not undergo biodegradation, it is difficult to remediate, it is persistent and cannot be easily detected (Dudka & Adriano, 1997; Lucho-Constantino *et al*., 2005; Pehlivan *et al*., 2009; Hamad *et al*., 2016; Ezzeddine *et al*., 2017; Pu *et al*., 2019). The most common heavy metal contaminants are Hg, Cr, Cd, Cu, Pb, and Zn; Belong them, some are micronutrients that the plant needs for growth; such as Cu, whereas other found with indefinite biological function such as Cd (Duruibe *et al*., 2007; Gaur & Adholeya, 2004).

Copper is one components of reduction-oxidation enzymes and it is necessary in formation of different proteins. Concentration of Cu in plants range from 5-20 mg.l^{-1}. Also, copper is very important in chlorophyll formation, it is found that about 70% of Cu in plants detected in chlorophyll (El-Beshbeshy & Sheris, 1998). EL-Sayed, (2005) stated that Cu in roots, stem and leaves of *A.*

saligna, *C. siliqua* and *A. stenopyhlla* were high for those treated with secondary effluents compared to the those of tap water. (Singh & Bhati, 2003) findings for Cu concentration in *Eucalyptus camaldulensis* roots reveals 9.71 mg.kg^{-1} and 5.79 mg.kg^{-1} for municipal effluents and good water respectively; and in leaves, 23.67 mg.kg^{-1} and 16.79 mg.kg^{-1} for municipal effluents and good water respectively. In the same study and mortality of seedlings shown while irrigation done with various forms of mixed effluents (textile, steel and municipal), this may be possible as a result of toxicity of heavy metals (Woolhouse, 1983; Macnair, 1993). Clarkson & Lüttge, 1989 state the balance, distribution and mobilization of the elements on the various potions of plants affected by the elevated metal concentration.

Cadmium (Cd) considered the third most dangerous metal in the environment after mercury and lead and the concentrations of Cd that are not toxic to plant are hazardous to both of human and animals (Ismael *et al*., 2019; Tomza-Marciniak *et al*., 2019). It reaches the soil, water and plants through anthropogenic activities, it is accessible for plant absorption since it is more soluble than the other heavy metals, and its uptake process by plants through the soil is enhanced while the pH is acidic (Järup, 2003), those gathered in different plant parts (Farid *et al*., 2015). Similarly, cigarette smoking and food are the major causes of Cd amelioration (Järup, 2003; Lentini *et al*., 2019) besides the manure, lime and sewage sludge (Nriagu & Pacyna, 1988).

Cd affects plants in different ways such as nitrate uptake inhibition, inhibition of enzymes that contribute in assimilation of N and S, chlorophyll reduction, and disturb mechanism of antioxidant work (Bagheri *et al*., 2016). The increase in pH of soil, decrease the Cd concentration in soil solution and accordingly Cd uptake by plants (MacLean, 1976; McBride, 2003). EL-Sayed, (2005) state that Cd in roots, stem and leaves of *A. saligna*, *C. siliqua* and *A. stenopyhlla* were high for those treated with secondary effluents compared to the those of tap water. Highest concentration of Cd in roots, shoots and leaves of *Sweietnia mahagoni* was found for the seedlings irrigated with primary effluents than the seedlings treated with tap water (Ali *et al*., 2011). High level of heavy metals in plants may be due to high organic compound (Rupa *et al*., 2003).

(Gothberg *et al*., 2004 & Sinha, 2006) summarized that different concentration of metals available to plants, and this may be as a result of different in individuals' ions uptake mechanism and the competitions for absorption between the heavy metals. The translocation and uptake of heavy metals affected by the plant type, age and the interaction among various metals that happens within the plants and at the surface of roots (Sharma *et al.*, 2007).

Shah *et al*., (2010) show in the results of their study on *Eucalyptus camaldulensis* that by increasing the effluent percentages (0% to 100%) the Cd in shoots increase as well (from 2.13 mg.kg^{-1} to 3.78 mg.kg^{-1}). For roots the Cd concentration also increase with increasing the effluents concentration, but gradually (from 1.67 mg.kg^{-1} to 3.17 mg.kg^{-1}). Same conclusion achieved in earlier study by (Sabr & Younis, 2017) who work on the effect of sewage water on *Melia* and *Eucalyptus* seedling growth, found that Cd concentration increase with increasing the concentration of sewage.

CONCLUSION

The findings of these study concluded that PTWW have a positive influence on *Melia* seedlings in contrast to *Eucalyptus* seedlings as confirmed in increasing in the height, diameter, biomass and chlorophyll content of *Melia*, specifically for the 1-year old seedlings that show higher influence compared with the 2-years old seedlings. Besides that, PTWW did not increase significantly the Cu and Cd concentration in both plants except Cd concentration in the roots.

5. REFERENCES

- Abo-Hassan, A., Kandeel, S. A., & Kherallah, I. E. (1988). New eucalyt species introduction in the Saudi Arabia central zone. *Proceedings of the International Forestry Conference, Australian Bicentenary*, *5*, 1–16.
- Albaugh, J. M., Dye, P. J., & King, J. S. (2013). *Eucalyptus* and Water Use in South Africa. *International Journal of Forestry Research*.
- Albaugh, J. M., Dye, P. J., & King, J. S. (2013). Eucalyptus and water use in South Africa.
- Alché, L. E., Assad Ferek, G., Meo, M., Coto, C. E., & Maier, M. S. (2003). An Antiviral Meliacarpin from Leaves of *Melia azedarach* L. *Zeitschrift Für Naturforschung C*, *58*(3–4), 215–219. https://doi.org/10.1515/znc-2003-3-413
- Ali, H.M.,. (2005). *Effects of Irrigation With Sewage Effluent on Some Trees* (M.Sc Thesis). Faculty of Agriculture of Kafr El-Sheikh, Tanta University, Eygpt.

– Ali, H. M., EL-Mahrouk, E.-S. M., Hassan, F. A., & EL-Tarawy, M. A. (2011). Usage of sewage effluent in irrigation of some woody tree seedlings. Part 3: *Swietenia mahagoni* (L.) Jacq. *Saudi Journal of Biological Sciences*, *18*(2), 201–207. https://doi.org/10.1016/j.sjbs.2010.08.001
– Ali, H. M., Khamis, M. H., & Hassan, F. A. (2012). Growth, chemical composition and soil properties of *Tipuana speciosa* (Benth.) Kuntze seedlings irrigated with sewage effluent. *Applied Water Science*, *2*(2), 101–108.
– Al-Mefarrej, H. A. (2013). Growth characteristics and some wood quality of *Tamarix aphylla* seedlings irrigated with primary treated wastewater under drought stress. *Asian J. Plant Sci*, *12*(3), 109–118.
– AL-Rubaе, A. Y. (2009). *The Potential Uses of Melia Azedarach L. as Pesticidal and Medicinal Plant, Review*. 10.
– American Public Health Association, A. (1998). *Standard methods for the examination of water and wastewater*.
– Appannagari, R. R. (2017). *Environmental pollution causes and consequences*. *3*(8).
– Assareh, M. H., Shariat, A., & Ghamari-Zare, A. (2008). *Seedling response of three Eucalyptus species to copper and zinc toxic concentrations*. *6*(2), 91–103.
– Bagheri, H., Asgharinezhad, A. A., & Ebrahimzadeh, H. (2016). Determination of trace amounts of Cd (II), Cu (II), and Ni (II) in food samples using a novel functionalized magnetic nanosorbent. *Food Analytical Methods*, *9*(4), 876–888.
– Batcher, M. S. (2000). Element stewardship abstract for *Melia azedarach*. *The Nature Conservancy*.
– Bedbabis, S., Rouina, B. B., & Boukhris, M. (2010). The effect of waste water irrigation on the extra virgin olive oil quality from the Tunisian cultivar Chemlali. *Scientia Horticulturae*, *125*(4), 556–561.
– Bernhardt, A., Caravanos, D. J., Fuller, R., & Leahy, S. (2019). *POLLUTION KNOWS NO BORDERS* (p. 54). Retrieved from www.gahp.net www.pureearth.org
– Bohnenstengel, F. I., Wray, V., Witte, L., Srivastava, R. P., & Proksch, P. (1999). Insecticidal meliacarpins *(C-seco limonoids)* from *Melia azedarach*. *Phytochemistry*, *50*(6), 977–982. https://doi.org/10.1016/S0031-9422(98)00644-X
– Chaoua, S., Boussaa, S., El Gharmali, A., & Boumezzough, A. (2018). Impact of irrigation with wastewater on accumulation of heavy metals in soil and crops in the region of Marrakech in Morocco. *Journal of the Saudi Society of Agricultural Sciences*. https://doi.org/10.1016/j.jssas.2018.02.003
– Chiffelle G, I., Huerta F, A., & Lizana R, D. (2009). Physical and Chemical Characterization of *Melia azedarach* L. Fruit and Leaf for Use as Botanical Insecticide. *Chilean Journal of Agricultural Research*, *69*(1). https://doi.org/10.4067/S0718-58392009000100005
– Chudnoff, M. (1984). *Tropical Timbers of the World* (Handbook number 607). Forest Service Agriculture.
– Clarkson, D. T., & Lüttge, U. (1989). Mineral nutrition: divalent cations, transport and compartmentation. In *Progress in Botany* (pp. 93–112). Springer.
– Dudka, S., & Adriano, D. C. (1997). Environmental impacts of metal ore mining and processing: a review. *Journal of Environmental Quality*, *26*(3), 590–602.
– Duruibe, J. O., Ogwuegbu, M. O. C., & Egwurugwu, J. N. (2007). Heavy metal pollution and human biotoxic effects. *International Journal of Physical Sciences*, *2*(5), 112–118.
– El-Beshbeshy, T. R., & Sheris, M. A. (1998). *Principles of plant nutrition* (1st edition). House of Egyptian Universities- Cairo.
– Eldridge, K., Davidson, J., Harwood, C., & Van Wyk, G. (1993). *Eucalypt Domestication and Breeding.,(Oxford University Press: New York)*.
– EL-Sayed, N. A. A. (2005). *The impact of irrigation with treated wastewater effluent on soil bio-physicochemical properties and on growth and heavy metals content of some fodder trees grown on calcareous soil* (PhD Thesis). Ph. D. thesis, Fac. Agric., Tanta Univ.
– Evans, J. R. (1989). Photosynthesis and nitrogen relationships in leaves of C3 plants. *Oecologia*, *78*(1), 9–19. https://doi.org/10.1007/BF00377192
– Ezzeddine, Z., Sayed, E. A., Rammal, H., Hijazi, A., Hamad, H., & Akhdar, H. (2017). Bioadsorption of Pb^{2+} and Cu^{2+} on *Eucalyptus Camaldulensis* Leaves. *International Journal of Environment, Agriculture and Biotechnology*, *2*(3), 2569–2572. https://doi.org/10.22161/ijeab/2.5.38
– FAO. (1979). *Eucalypts for planting*. Rome: Food and Agriculture Organization of the United Nations.
– Farid, G., Sarwar, N., Saifullah, A. A., Ghafoor, A., & Rehman, M. (2015). Heavy Metals (Cd, Ni and Pb) contamination of soils, plants and waters in Madina Town of Faisalabad Metropolitan and preparation of Gis Based Maps. *Adv Crop Sci Tech*, *4*(2).
– Farrell, R. C. C., Bell, D. T., Akilan, K., & Marshall, J. K. (1996). Morphological and Physiological Comparisons of Clonal Lines of *Eucalyptus camaldulensis.* I. Responses to Drought and Waterlogging. *AUSTRALIAN JOURNAL OF PLANT PHYSIOLOGY*, *23*(4), 497–507.
– Gaur, A., & Adholeya, A. (2004). Prospects of arbuscular mycorrhizal fungi in phytoremediation of heavy metal contaminated soils. *Current Science*, 528–534.
– Gothberg, A., Greger, M., Holm, K., & Bengtsson, B.-E. (2004). *Heavy Metals in the Environment Influence of Nutrient Levels on Uptake and Effects of Mercury, Cadmium, and Lead in Water Spinach*.
– Guo, L. B., Sims, R. E. H., & Horne, D. J. (2002). Biomass production and nutrient cycling in *Eucalyptus* short rotation energy forests in New Zealand.: I: biomass and nutrient accumulation. *Bioresource Technology*, *85*(3), 273–283.

– Guo, L. B., Sims, R. E. H., & Horne, D. J. (2006). Biomass production and nutrient cycling in *Eucalyptus* short rotation energy forests in New Zealand: II. Litter fall and nutrient return. *Biomass and Bioenergy*, *30*(5), 393–404.
– Hamad, H., Ezzeddine, Z., Kanaan, S., Lakis, F., Hijazi, A., & Moussawi, M.-A. (2016). A novel modification and selective route for the adsorption of Pb^{2+} by oak charcoal functionalized with glutaraldehyde. *Advanced Powder Technology*, *27*(2), 631–637.
– Hassan, F. A., & Ali, H. M. (2013). Impact of irrigation with Sewage effluent on the growth and wood properties of two forest tree seedlings. *J. For. Prod. Ind*, *2*, 40–44.
– Hynninen, P. H., & Leppäkases, T. S. (2002). The Functions of Chlorophylls in Photosynthesis. *EOLSS: Oxford, UK.*, *5*, 1–9.
– İnanç, A. L. (2011). Chlorophyll: Structural Properties, Health Benefits and Its Occurrence in Virgin Olive Oils. *Academic Food Journal/Akademik GIDA*.
– Ismael, M. A., Elyamine, A. M., Moussa, M. G., Cai, M., Zhao, X., & Hu, C. (2019). Cadmium in plants: uptake, toxicity, and its interactions with selenium fertilizers. *Metallomics*, *11*(2), 255–277.
– Järup, L. (2003). Hazards of heavy metal contamination. *British Medical Bulletin*, *68*(1), 167–182. https://doi.org/10.1093/bmb/ldg032
– Kim, M., Kim, S. K., Park, B. N., Lee, K. H., Min, G. H., Seoh, J. Y., … Kook, Y. H. (1999). Antiviral effects of 28-deacetylsendanin on herpes simplex virus-1 replication. *Antiviral Research*, *43*(2), 103–112. https://doi.org/10.1016/S0166-3542(99)00037-6
– Kiziloglu, F. M., Turan, M., Sahin, U., Kuslu, Y., & Dursun, A. (2008). Effects of untreated and treated wastewater irrigation on some chemical properties of cauliflower (*Brassica olerecea* L. var. botrytis) and red cabbage (*Brassica olerecea* L. var. rubra) grown on calcareous soil in Turkey. *Agricultural Water Management*, *95*(6), 716–724.
– Kumar, P., & Chandra, R. (2004). Detoxification of distillery effluent through Bacillus thuringiensis (MTCC 4714) enhanced phytoremediation potential of *Spirodela polyrrhiza* (L.) Schliden. *Bulletin of Environmental Contamination and Toxicology*, *73*(5), 903–910.
– Landrigan, P. J., Fuller, R., Acosta, N. J. R., Adeyi, O., Arnold, R., Basu, N. (Nil), … Zhong, M. (2018). The Lancet Commission on pollution and health. *The Lancet*, *391*(10119), 462–512. https://doi.org/10.1016/S0140-6736(17)32345-0
– Lentini, P., Zanoli, L., de Cal, M., Granata, A., & Dell'Aquila, R. (2019). Chapter 222 - Lead and Heavy Metals and the Kidney. In C. Ronco, R. Bellomo, J. A. Kellum, & Z. Ricci (Eds.), *Critical Care Nephrology (Third Edition)* (pp. 1324-1330.e1). https://doi.org/10.1016/B978-0-323-44942-7.00222-3
– Lone, M. I., He, Z., Stoffella, P. J., & Yang, X. (2008). Phytoremediation of heavy metal polluted soils and water: Progresses and perspectives. *Journal of Zhejiang University SCIENCE B*, *9*(3), 210–220. https://doi.org/10.1631/jzus.B0710633
– Lucho-Constantino, C. A., Prieto-García, F., Del Razo, L. M., Rodríguez-Vázquez, R., & Poggi-Varaldo, H. M. (2005). Chemical fractionation of boron and heavy metals in soils irrigated with wastewater in central Mexico. *Agriculture, Ecosystems & Environment*, *108*(1), 57–71.
– MacLean, A. J. (1976). Cadmium in different plant species and its availability in soils as influenced by organic matter and additions of lime, P, Cd and Zn. *Canadian Journal of Soil Science*, *56*(3), 129–138.
– Macnair, M. R. (1993). The genetics of metal tolerance in vascular plants. *New Phytologist*, *124*(4), 541–559.
– Madejón, P., Marañón, T., & Murillo, J. M. (2006). Biomonitoring of trace elements in the leaves and fruits of wild olive and holm oak trees. *Science of the Total Environment*, *355*(1–3), 187–203.
– Maksymiec, W. (2007). Signaling responses in plants to heavy metal stress. *Acta Physiologiae Plantarum*, *29*(3), 177.
– Martens, D. C., & Lindsay, W. L. (1990). Testing soils for copper, iron, manganese, and zinc. *Testing Soils for Copper, Iron, Manganese, and Zinc.*, 229–264.
– McBride, M. B. (2003). Cadmium concentration limits in agricultural soils: Weaknesses in USEPA's risk assessment and the 503 rule. *Human and Ecological Risk Assessment*, *9*(3), 661–674.
– Midgley, S. J., Eldridge, K. G., & Doran, J. C. (1989). GENETIC RESOURCES OF *EUCALYPTUS CAMALDULENSIS*. *The Commonwealth Forestry Review*, *68*(4 (217)), 295–308. Retrieved from JSTOR.
– Minglin, L., Yuxiu, Z., & Tuanyao, C. (2005). Identification of genes up-regulated in response to Cd exposure in Brassica juncea L. *Gene*, *363*, 151–158. https://doi.org/10.1016/j.gene.2005.07.037
– Moran, J. A., Mitchell, A. K., Goodmanson, G., & Stockburger, K. A. (2000). Differentiation among effects of nitrogen fertilization treatments on conifer seedlings by foliar reflectance: a comparison of methods. *Tree Physiology*, *20*(16), 1113–1120. https://doi.org/10.1093/treephys/20.16.1113
– Nahak, G., & Sahu, R. K. (2010). In vitro antioxidative acitivity of Azadirachta indica and *Melia azedarach* Leaves by DPPH scavenging assay. *Nat Sci*, *8*(4), 22–28.
– Nasser, R. A. (2010). EFFECTS OF SEWAGE EFFLUENT IRRIGATION ON THE CHEMICAL COMPONENTS AND MECHANICAL PROPERTIES OF *MELIA AZEDARACH* L WOOD. *IDOSI*, *7*(6), 29.
– Nriagu, J. O., & Pacyna, J. M. (1988). Quantitative assessment of worldwide contamination of air, water and soils by trace metals. *Nature*, *333*(6169), 134.
– Pareek, S., Sagar, N. A., Sharma, S., Kumar, V., Agarwal, T., González-Aguilar, G. A., & Yahia, E. M. (2018).

Chlorophylls: Chemistry and Biological Functions. *Fruit and Vegetable Phytochemicals: Chemistry and Human Health...., 2*, 269.

- Pathak, C., & Mandalia, H. C. (2011). Impact of Environmental Pollution on Human Future. *World J. of Environmental Pollution, IDOSI Publication, UAE*, *1*(2), 8–10.
- Pehlivan, E., Özkan, A. M., Dinç, S., & Parlayici, Ş. (2009). Adsorption of Cu2+ and Pb2+ ion on dolomite powder. *Journal of Hazardous Materials*, *167*(1–3), 1044–1049.
- Peralta, J. R., Gardea-Torresdey, J. L., Tiemann, K. J., Gomez, E., Arteaga, S., Rascon, E., & Parsons, J. G. (2001). Uptake and effects of five heavy metals on seed germination and plant growth in alfalfa (Medicago sativa L.). *Bulletin of Environmental Contamination and Toxicology*, *66*(6), 727–734.
- Price, R. (2018). *Environmental risks in Iraq.*
- https://assets.publishing.service.gov.uk/media/5b3b63a3e527 4a6ff466faa5/Environmental_risks_in_Iraq.pdf
- Pu, W., Sun, J., Zhang, F., Wen, X., Liu, W., & Huang, C. (2019). Effects of copper mining on heavy metal contamination in a rice agrosystem in the Xiaojiang River Basin, southwest China. *Acta Geochimica*, 1–21.
- Ramana, S., Biswas, A. K., & Singh, A. B. (2002). Effect of distillery effluents on some physiological aspects in maize. *Bioresource Technology*, *84*(3), 295–297.
- Ramya, S., Jepachanderamohan, P. J., Kalayanasundaram, M., & Jayakumararaj, R. (2009). In vitro antibacterial prospective of crude leaf extracts of *Melia azedarach* Linn. against selected bacterial strains. *Ethnobotanical Leaflets*, *2009*(1), 32.
- Rupa, T. R., Rao, C. S., Rao, A. S., & Singh, M. (2003). Effects of farmyard manure and phosphorus on zinc transformations and phyto-availability in two Alfisols of India. *Bioresource Technology*, *87*(3), 279–288.
- Ryan J & Astafan G. (2003). Soil and Plant Analysis Laboratory Guide. *International Center for Agricultural Research in the Dry Areas (ICARDA).* Islamabad.
- Sabr, H. A., & Younis, A. M. (2017). Impact of sewage water on growth of *Eucalyptus camadulensis* Dhen. and *Melia azedarach* L. Seedlings. *Polytechnic*, *7*(1). Retrieved from https://docplayer.net/103445474-Camadulensis-dhen-and-melia-azedarach-l-seedlings.html
- Selahvarzi, B., & Hosseini, S. M. (2012). Survival, growth and mineral accumulation in ash (*Fraxinus excelsior* L.) seedlings irrigated with water treatment effluent. *Folia Forestalia Polonica*, *54*, 10.
- Seth, M. K. (2003). Trees and their economic importance. *The Botanical Review*, *69*(4), 321–376.
- Shah, F. R., Ahmad, N., Masood, K. R., & Zahid, D. M. (2008). The influence of cadmium and chromium on the biomass production of shisham (Dalbergia sissoo ROXB.) seedlings. *Pak. J. Bot*, *40*(4), 1341–1348.
- Shah, F. U. R., Ahmad, N., Masood, K. R., Peralta-Videa, J. R., Zahid, D. M., & Zubair, M. (2010). Response of *Eucalyptus camaldulensis* to irrigation with the Hudiara drain effluent. *International Journal of Phytoremediation*, *12*(4), 343–357.
- Shahbaz, S. E. (2010). *Trees and Shrubs, A field guide to the trees and shrubs of Kurdistan region of Iraq*. Duhok University Press.
- Sharma, A., & Ashwath, N. (2006). Land disposal of municipal effluents: importance of choosing agroforestry systems. *Desalination*, *187*(1–3), 361–374.
- Sharma, R. K., Agrawal, M., & Marshall, F. (2007). Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India. *Ecotoxicology and Environmental Safety*, *66*(2), 258–266.
- Sherif, A., Rabie, A., R., & Abdelhafez, A. A. (2017). Accumulation Trends of Heavy Metals in *Cupressus sempervirens* and *Eucalyptus camaldulensis* Trees Grown in Treated Wastewater Irrigated Soil. *Alexandria Science Exchange Journal: An International Quarterly Journal of Science Agricultural Environments*, *38*(April-June), 220–230. https://doi.org/10.21608/asejaiqjsae.2017.3414
- Shetta, N. D. (2016). Treated Wastewater Irrigation Promotes the Growth and Nodulation of Acacia Species. *Alexandria Science Exchange Journal: An International Quarterly Journal of Science Agricultural Environments*, *37*(October-December), 606–617. https://doi.org/10.21608/asejaiqjsae.2016.2535
- Singh, G., & Bhati, M. (2003). Mineral accumulation, growth, and physiological functions in *Dalbergia sissoo* seedlings irrigated with different effluents. *Journal of Environmental Science and Health, Part A*, *38*(11), 2679–2695.
- Sinha, P., Dube, B. K., Srivastava, P., & Chatterjee, C. (2006). Alteration in uptake and translocation of essential nutrients in cabbage by excess lead. *Chemosphere*, *65*(4), 651–656.
- Smith, V. H., Tilman, G. D., & Nekola, J. C. (1999). Eutrophication: impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems. *Environmental Pollution*, *100*(1–3), 179–196.
- Song, Y. F., Wilke, B.-M., Song, X. Y., Gong, P., Zhou, Q. X., & Yang, G. F. (2006). Polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and heavy metals (HMs) as well as their genotoxicity in soil after long-term wastewater irrigation. *Chemosphere*, *65*(10), 1859–1868.
- Sonune, A., & Ghate, R. (2004). Developments in wastewater treatment methods. *Desalination*, *167*, 55–63. https://doi.org/10.1016/j.desal.2004.06.113
- Stewart, H. T. L., & Flinn, D. W. (1984). Establishment and early growth of trees irrigated with wastewater at four sites in Victoria, Australia. *Forest Ecology and Management*, *8*(3–4), 243–256.

Journal of University of Duhok.,Vol.22, No.1(Agri. and Vet. Sciences), Pp 277-291, 2019
https://doi.org/10.26682/avuod.2019.22.1.26

- Tinti, A. (2018). *Water Resources Management in the Kurdistan Region of Iraq*. https://doi.org/10.26598/AUIS_IRIS_2017_10_19
- Tomza-Marciniak, A., Pilarczyk, B., Marciniak, A., Udała, J., Bąkowska, M., & Pilarczyk, R. (2019). Cadmium, Cd. In E. Kalisińska (Ed.), *Mammals and Birds as Bioindicators of Trace Element Contaminations in Terrestrial Environments: An Ecotoxicological Assessment of the Northern Hemisphere* (pp. 483–532). https://doi.org/10.1007/978-3-030-00121-6_14
- Woolhouse, H. W. (1983). Toxicity and tolerance in the responses of plants to metals. In *Physiological plant ecology III* (pp. 245–300). Springer.
- Zengin, F. K., & Munzuroglu, O. (2005). Effects of some heavy metals on content of chlorophyll, proline and some antioxidant chemicals in bean (*Phaseolus vulgaris* L.) seedlings. *Acta Biologica Cracoviensia Series Botanica*, *47*(2), 157–16

بەرسڤدانا گەشەپێدانا نەمامکێن یوکالیپتوسێ و سەبەحبەحێ بو ئاڤا ڤەرێژا دهوکێ یا دەسپێکێ هاتیە چارەسەرکرن

پۆختە

ئەڤ ڤەکولینە هاتە ئەنجامدان ل کۆلیژا چاندنێ-زانکویا دهوك بو ماوێ حەفت هەیڤا ل سالا 2018(ژ گولانێ هەتا دەسپێکا چریا دووێ) و ل بن کەپرا داری. مەرەم ژ ڤێ ڤەکولینێ ئەو بوو زانینا کارتێکرنا ئاڤا ڤەرێژ یا دەسپێکی هاتیە چارەسەرکرن یا بازێرێ ئەڤروسیتی-دهوك ل سەر گەشەپێدانا نەمامکێن ئێك سالێ ودوو سالێ یێت یوکالیپتوسێ Eucalyptus camaldulensis و سەبەحبەحێ Melia azedarach وهندەك سیفەتا وەك زێدەبوون د بلنداهیێ و ستویراتییا قەدی مژارێ زێندی و کلوروفیل و توخمێت گران Cd) و .(Cu وهەر وەسا بو زانینا هندەك سالوخەتێت ئاخێ و ئاڤێ یێت فیزیاوی و کیمیاوی.

ئاڤا چارەسەرکری کارتێکرنەك ئەرێنی هەبوو ل سەر کلوروفیلێ نەمامکێت سەبەحبەحێ یێت ئێك سالێ و دوو سالێ و بلندترین کلوروفیل (49.90 سپاد) ل بەلگێت نەمامکێت سەبەحبەحێ یێت ئێك سالی یێت هاتین ئاڤدان ب ئاڤا چارەسەرکری. بەلێ ئاڤا چارەسەرکری چ کارتێکرنا ئەرێنی نەبوو ل سەر نەمامکێت یوکالیپتوسێ.

ئاڤدان ب ئاڤا چارەسەرکری زێدەبوونەك پوسیتیڤ چێکر ل (زێدەبوونا درێژاهیی و ستویۆاتییا قەدی و مژارێ زێندی) یا سەبەحبەحێ، بەس نە ل یوکالیپتوسێ. ئەنجاما دیارکر کۆ کارتێکرنا ئاڤا چارەسەرکری ل سەر بایوماسا نەمامکێت ئێك سالێ یێن سەبەحبەحێ پتر بوو ژ یێت دوو سالێ. سەبارەت یوکالیپتوسێ، چ جیۆازی دناڤبەرا هەردوو ئاڤا دانەبوو ل سەر نەمامکێت دوو سالێ، بەلێ کارتێکرنا ئاڤا حەنەفییێ پتر بوو ژ یا ئاڤا چارەسەرکری ل سەر نەمامکێت ئێك سالی.

سەبارەت توخمێت گران، مس پتر بوو دناڤ رووەکێت هاتینە ئاڤدان ب ئاڤا حەنەفییێ ژ وان رووەکێت هاتینە ئاڤدان ب ئاڤا چارەسەرکری. مەزنترین تیراتیا مسی هاتە دیتن دناڤ نەمامکێت سەبەحبەحێ یێت دوو سالی (23.93 مگ.م.کگم -1) وهەر وەسا کێمترین خەستی یا مسی (12.02 مگ.م.کگم -1) هاتە دیتن دناڤ نەمامکێت ئێك سالی یێت یوکالیپتوسێ. بشێوەیەکێ گشتی بەرزترین خەستی یا کادمیومی هاتە دیتن دناڤ قەد ورهێت وان رووەکادا ئەوێت هاتینە ئاڤدان ب ئاڤا چارەسەرکری، وهەر وەسا بلندترین خەستی یا کادمیومی هاتە دیتن دناڤ رهێت نەمامکێت دوو سالی یێت یوکالپتوسێ (1.16 مگ.م.کگم -1) ل لایەکێ دی کێمترین ئەنجام دیاربوون ل سەر قەدێت نەمامکێت دوو سالێ یێت سەبەحبەحێ کو دبیت (0.20 مگ.م.کگم -

1) وەك ئەنجامەك دوماهییێ دیار بوو کۆ نەمامکێت سەبەحبەحێ پتر بەرهنگاربوون ژ نەمامکێت یوکالیپتوسێ بو کارتێکرنا ئاڤا ڤەرێژ یا دەسپێکی هاتیە چارەسەرکرنێ.

استجابة نمو شتلات اليوكاليبتوس والسبحبح لمياه المجاري المعالجة اوليا في مدينة دهوك

الخلاصه

أجريت تجربة على مدار سبعة أشهر متتالية على مدار عام 2018 (من أبريل إلى بداية نوفمبر) ، تحت ظروف الظلة الخشبية في كلية الزراعة جامعة دهوك ، مدينة دهوك. هدف البحث الى دراسة تأثير مياه الصرف الصحي المعالجة (معالجة أولية) في مدينة أفروسيتي دهوك, على شتلات اليوكالبتوس والسبحبح
Eucalyptus camaldulensis و *Melia azedarach* بعمر سنة وسنتين. وتم دراسة بعض عوامل النمو (زيادة الكتلة الحيوية و القطر والارتفاع) و محتوى الكلوروفيل ، وتركيز المعادن الثقيلة (Cu وCd) وبعض الخصائص الكيميائية والفيزيائية للتربة والمياه.

زاد تركيز الكلوروفيل بشكل معنوي في شتلات السبحبح المروية بالماء المعالج مقارنة بتلك المروية بماء الحنفية بينما لم يظهر الماء المعالج تأثير معنوي على شتلات اليوكاليبتوس. وظهرت أعلى قيم الكلوروفيل (49.90 سباد) في شتلات السبحبح بعمر عام والمروية بالماء المعالج، واقل قيمة للكلوروفيل كانت ايضا في شتلات اليوكاليبتوس لكن بعمر سنتين والمروية بماء الحنفية.

السقي بالماء المعالج ادى الى زيادة معنوية في الأرتفاع و ألطول و الكتلة الحيوية لشتلات السبحبح ولكن ليس في اليوكاليبتوس. ان تأثير الماء المعالج على شتلات السبحبح بعمر سنة واحدة كان اكثر وضوحا منها في الشتلات بعمر سنتين. اما باالنسبة لشتلات اليوكاليبتوس ذات السنتين فلم يكن لنوع الماء عليها تأثير معنوي قي حين ان شتلا ت اليوكاليبتوس ذات السنة واحدة فأن ماء الحنفية كان اكثر تأثيرا. بالنسبة للعناصر الثقيلة، فأن تركيز النحاس كان اكثر في النباتات المروية بماء الحنفية مقارنة بتلك المروية بالماء المعالج. اعلى تركيز للنحاس وجد في نباتات السبحبح ذات السنتين (23.93 ملغم.كغم$^{-1}$ وزن جاف)، واقل تركيز للنحاس كان في شتلات الاليوكاليبتوس بعمر سنة واحدة(12.02 ملغم.كغم$^{-1}$ وزن جاف). على العكس من النحاس فأن تركيز الكادميوم كان اكثر في النباتات المروية بالماء المعالج. ظهر اعلى تركيز للكادميوم في جذور شتلات اليوكاليبتوس ذات السنتين (1.116 ملغم.كغم$^{-1}$ وزن جاف) واقل تركيز للكادميوم وجد في المجموع الخضري لشتلات السبحبح ذات السنتين (0.20 ملغم.كغم$^{-1}$ وزن جاف). وكنتيجة لهذه البيانات فأن شتلات السبحبح كانت اكثر مقاومة للماء المعالج اوليا من شتلات اليوكاليبتوس.