Ability of some woody trees for growth under the stress of irrigation with wastewater

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Abstract: This experiment was carried out during two successive seasons of 2014 and 2015 at the National Research Centre, Dokki, Giza, Egypt, to investigate the effect of irrigation with two types of water (Tap water and Waste water) on growth, and chemical composition of some seedlings of woody trees (*Terminalia angustifolia*, *Rademachera ignea* and *Ficus mango*). Growth parameter (plant hight (cm), No. of leaves/plant, length of root (cm) and stem dimeter (cm) increased significantly in all seedlings by using waste water than tap water, except in *Rademachera ignea* seedlings irrigated with tap water significantly increased number of leaves compared with wastewater. Irrigation with wastewater significantly increased fresh and dry weight of leaves, stems and roots in all seedlings, except in stems of *Rademarchera ignea* seedlings which wastewater decreased fresh weight of stems compared with tap water. Total carbohydrates increased in leaves and roots in *Terminalia*, in leaves in *Rademarchera ignea* and in stems in *Ficus* seedlings by using wastewater. Chlorophyll a,b increased in *Terminalia angustifolia* and *Rademarcher ignea a* when treated with wastewater, while carotenoids increased by tap water treatment. In *Ficus mango* seedlings chl.a,b and carotenoids increased by using tap water. Treating all seedlings with wastewater increased Zn and Pb in leaves while in stems wastewater increased Zn and Pb in *Rademarchera ignea* and in *Ficus mango* seedlings, while Pb increased by using wastewater in *Terminalia angustifolia* seedlings. *N* content increased in leaves in all seedlings, in stems and roots of *Terminalia angustifolia* by application tap water, but in roots of *Rademarchera ignea* and *Ficus mango* seedlings increased by using wastewater. *P* content increased in *Ficus mango* and *Terminalia angustifolia* seedling in leaves by using tap water, wastewater increased *P* content in *Terminalia angustifolia*, and *Rademarchera ignea* seedling in stem, while tap water increased *P* content in *Rademarchera ignea* and *Ficus mango* seedlings in roots. *K* content increased in all organs in three seedlings by using wastewater.

Keywords: wastewater, tap water, *Terminalia angustifolia*, *Rademachera ignea* and *Ficus mango* seedlings, growth, chemical constituents

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1 Introduction

Treating irrigation water is expected to gain increased importance, requiring careful consideration involving the adequate balance between nutritional inputs via irrigation and optimal plant productivity requirements.

Now, Egypt is witnessing a wide range of new projects aiming at expanding the green stretch in deserts by introducing forest plantation using treated sewage water, to produce timber trees of high economic value.

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Many developing countries, including Egypt does not possess adequate faster reserves to cover its need for fuel wood, industrial wood, saw wood and wood – based composition panels. (Leal et al., 2009).

Planting fast growing trees is one of different strategies used to reduce the annual import of wood product. Many investigators have been concluded that wastewater, in addition to its beneficial nutrients, also contains contaminants disease (bacteria, Protozoa) and toxins (heavy metals) which are toxic to both people and plants. So that, the reuse of wastewater irrigation trees, seems to be the most promising method. The safe use of wastewater after primary treatment is irrigating tree plantation, forest lands, green belts around the cities and non- food crops. (Ali et al., 2012).

Terminalia angustifolia, family Combretaceae, is considered durable evergreen trees it reaches a height of 20 m, the trees have straight stems and narrow peak. It is composed of horizontal branches and their leaves are smooth spear and carries white flowers on inflorescences, trees multiply by seeds and are grown for decorations in a beautiful botanical garden.

Radermachera ignea (KURZ) has a bright orange color which is normally due to the presence of natural substances with antioxidant activity, *R. ignea* steen is belongs to the family Bignoniaceous. The tree is evergreen or partly deciduous with 6-15m height and typically scattered in several areas of the Southeast Asian region.

Ficus mango, family Maraca., Hawaii it is original home as well as Southeast Asia, a permanent evergreen tree with rampant growth of semi- Jaime securities rectangular – like mango leaves and the new shoots are reddish, it is planted in streets and parks.

The objective of this study is to investigate the effect of two types of water irrigation (tap water and wastewater) on vegetative growth and chemical composition of some seedling of woody trees (*Terminalia angustifolia*, *Radermachera ignea* and *Ficus mango*).

2 Materials and method

This experiment was carried out during two successive seasons of 2014 and 2015 at the National Research Centre, Dokki, Giza, Egypt, to investigate the effect of irrigation with two types of water (Tap water and Waste water) on growth, and chemical composition of some seedlings of woody trees (*Terminalia angustifolia*, *Rademachera ignea* and *Ficus mango*). The experimental soil is characterized by: 38.43% coarse sand, 37% fine sand, 9.85% silt, 14.72% clay, pH 7.4, EC 8.9 dS m^{-1}, $CaCo_3$ 50.91%, OM 0.19%, Ca 37.71%, Mg 13.53%, Na 21.8%, K 1.56%, Cl 42.30%, HCO_3 3.35% and 24.31 meq L^{-1}. The physical and chemical properties of the soil were determined according to Chapman and Pratt (1961).

Plant material: seedlings of a one year old, 20cm height and Carry 5-7 leaf/ plant. *Terminalia angustifolia*, *Rademarchera ignea* and *Ficus mango* were planted in 30cm diameter pots (one seedling/pot) filled with about six kilograms of sandy loam soils. The plants were obtained from the Forestry Department, Horticulture Research Institute, ARC. The seedlings were transplanted on March 1^{st} 2014 and 2015 for 1^{st} and 2^{nd} seasons, respectively.

The available commercial fertilizer used through this experimental works as Kristalon. (N: P: K, 19: 19: 19) produced phayzen company, Holland. The rates of fertilizers were used (5.0 gm/pot) in four doses. The plants were fertilized after 4, 8, 16 and 20 weeks from transplanting.

Treatments: Six treatments included three types of trees were used and two types of water (tap water and waste water).

Data recorded: Plant height (Cm), No of leaves/ plant, stem diameter (Cm), root length (Cm) and fresh and dry weight of leaves, stem and roots (g) were recorded at the end of season.

Chemical analysis: chlorophyll a, b and carotenoids were extracted from fresh leaves (mg gm^{-1}) according to the procedure methods achieved by Saric et al. (1967). Carbohydrates were extracted (Powdered) according to Herbert et al. (1971) and estimated the total carbohydrates calorimetrically by the phenolsulphoric acid method (Mont, 1961). Nitrogen percentage was determined by the modified microkieldahl method and described by Pregl (1945). Phosphorus percentage wase estimated according to King (1951). Potassium percentage was determined by flame photometer Model Car Zeiss according to the method of Richard (1954). Lead was determined by Atomic Absorption described by Chapman and Partt (1961). Chemical characterization and potention toxic elements (PTE' contents of irrigation water used) Tables 1 and 2.

Statistical analysis:

The data were subjected to statistical analysis of variance and the means were compared using the least significant difference (L.S.D.) test at 5% level according to Snedecor and Cochran (1980).

Table 1 Chemical characterization of irrigation water used in the experiments (ppm oven dry basis)*

Type of Water according to Doneen 1954	EC, dS m^{-1}	TSS, ppm	pH	K	Na	Ca	Mg	SAR	*(0.5 SO4^{-}+Cl^{-})
				ppm					
Nile water	0.49	313.6	7.50	0.15	2.35	2.33	1.52	1.60	1.32
Sewaged water irrigation	1.65	1057.8	7.46	0.85	7.77	4.05	3.97	2.77	12.82

Note: * Lepeine canal at Kombera Village.

Table 2 PTE's contents of irrigation water used in the experiments (ppm oven dry basis)*

Type of water	Cd	Cu	Fe	Mn	Pb	Zn	Ni
	mg L^{-1}						
Safe level	0.01	0.20	5.00	0.20	5.00	2.00	0.20
Nile water	-	0.01	0.02	-	-	0.01	-
Sewaged water irrigation	0.05	0.37	2.13	0.26	2.35	2.94	0.17

Note: * Lepeine canal at Kombera Village.

3 Results and Discussions

Vegetative growth:

Data in Table 3 indicated that plant height (cm), No. of leaves/plant, length of root (cm) and stem diameter (cm) increased significantly by using wastewater (75.0, 28.5, 37.0 and 0.75), respectively, in *Terminalia angustifolia* compared with tap water, the same results were found in *Ficus mango* seedlings, while the seedlings of *Radermachera ignea* recorded the highest significant increase in plant height and root length (34.5 and 29.5 cm), respectively, compared with tap water, whereas, irrigation with tap water significantly increased number of leaves compared with wastewater.

Table 3 Response of *Terminalia angustifolia*, *Rademarchera ignea* and *Ficus mango* for tap water and wastewater on vegetative parameters average of two seasons

Treatments	Characters	Plant height, cm	No.of leaves	Length of root, cm	Stem diameter, cm
Terminalia angustifolia	T. W	50.5	18	25.5	0.5
	W. W	75	28.5	37	0.75
Rademarchera ignea	T. W	22.5	18.5	23	1.25
	W. W	34.5	15	29.5	1.25
Ficus mango	T. W	134.5	43	40.5	1.5
	W. W	168	80.5	75.4	1.85
L.S.D at 5%		7.65	3.24	2.96	0.11

Note : T.W: Tap water; W.W: waste water.

The results obtained in Table 4 mentioned that using wastewater on terminally seedlings gave no significant increase compared with tap water in fresh and dry weight of all plant organs, except fresh weight of stems.

Table 4 Response of *Terminalia angustifolia*, *Rademarchera ignea* and *Ficus mango* for tap water and wastewater on vegetative growth average of two seasons

Treatments	Characters	leaves	stems	roots
Terminalia angustifolia	T. W	34.42	38.62	34.5
	W.W	34.62	33.7	37.26
Rademarchera ignea	T. W	34.96	35.98	35.42
	W.W	35.88	35.16	34.16
Ficus mango	T. W	36.92	34.96	40.02
	W.W	35.19	42.9	35.42

Note: T.W: Tap water; W.W: waste water.

With regard to the effect of wastewater on Radermachera seedlings, data indicated that irrigation with wastewater increased fresh and dry weight of leaves (33.22 and 9.14 gm), fresh and dry weight of roots (49.69 and 18.29 gm). On the other hand, fresh and dry weight of stems recorded the highest increase when seedlings were irrigated with tap water compared with wastewater giving (32.6 and 10.69 gm). Irrigated ficus seedlings with wastewater gave the highest significant increase in fresh and dry weight of leaves (188.86 and 54.39 gm), stems (318.35 and 106.65 gm) and roots (139.01 and 47.54 gm), respectively. The best results in all previous parameters were found when ficus seedlings irrigated by wastewater, while the tap water gave the lowest values, our results are in harmony with hose obtained by Guo and Sims (2000) on *Eucalyptus globules* and Singh and Bhati (2005) on *Delbergia Sissoo.*

The results are explained by many investigators, they found that sewage effluent had a stimulatory effect on vegetative growth of trees, provided that the soil with plant nutrients and organic matter and improved the soils physical characteristics that reflected on growth by enhancing the cell elongation and cell division (Abbaas, 2002; Ali et al., 2010).

Chemical constituents:

Total carbohydrates%:

The results in Table 5 revealed that irrigation the seedlings of *Terminalia angustifolia* with wastewater increased the total carbohydrates in leaves and roots (34.62% and 37.26%) compared with tap water, while in stems tap water increased carbohydrates content than wastewater (38.62%). Regarding the effect of waste water in the seedling of *Rademarchera ignea* data showed that wastewater increased total carbohydrates in leaves compared with tap water, while in stems and roots tap water gave the best results (35.98% and 35.42%), respectively, compared with wastewater.Irrigated *Ficus mango* seedlings with waste water indicated that carbohydrates content increased in stems (42.90%) compared with tap water, while in leaves and roots carbohydrates content increased when seedlings irrigated with tap water (36.92% and 40.02%), respectively, compared with wastewater.

Table 5 Response of *Terminalia angustifolia, Rademarchera ignea* and *Ficus mango* for tap water and wastewater on Carbohydrates (%) average of two seasons

Treatments \ Characters		F.W of leaves	F.W of stems	F.W of roots	D.W of leaves	D.W of stems	D.W of roots
Terminalia angustifolia	T.W	11.53	8.89	10.78	3.07	2.75	3.83
	W.W	13.27	18.7	15.63	3.91	5.93	5.63
Rademarchera ignea	T.W	30.69	32.6	42.97	7.89	10.69	15.56
	W.W	33.22	26.87	49.69	9.14	8.49	18.29
Ficus mango	T.W	106.16	185.38	137.54	28.98	61.18	46.49
	W.W	188.86	318.35	139.01	54.39	106.65	47.54
L.S.D at 5%		6.02	8.23	6.21	1.32	3.23	2.36

Note: T.W: Tap water; W.W: waste water.

Chlorophylls (mg gm^{-1} F.W.):

Data recorded in Table 6 mentioned that irrigated *Terminalia angustifolia* seedlings with waste water increased chl. a and b (0.98 and 0.51 mg gm^{-1} F.W.) compared with tap water. On the other hand tap water increased carotenoids content (0.91 mg gm^{-1} F.W.) compared with wastewater .Irrigated *Rademarchera ignea* seedlings with wastewater increased the content of chl. a and b (1.01 and 0.55 mg gm^{-1} F.W.) than tap water, while carotenoids content (0.73 mg gm^{-1} F.W.) when seedlings irrigated with tap water. Treated *Ficus mango* seedlings with wastewater decreased the content of chl. a,b and carotenoids, while irrigated the seedlings with tap water gave the best results in chl. a,b and carotenoids content.

Table 6 Response of *Terminalia angustifolia, Rademarchera ignea* and *Ficus mango* for tap water and wastewater on photosynthetic pigments (mg gm^{-1} F.W) average of two seasons

Treatments \ Characters		Chl.a mg gm^{-1} F.W	Chl.b, mg gm^{-1} F.W	Carot, mg gm^{-1} F.W
Terminalia angustifolia	T. W	0.86	0.38	0.91
	W.W	0.98	0.51	0.77
Rademarchera ignea	T. W	0.92	0.46	0.73
	W.W	1.01	0.55	0.59
Ficus mango	T. W	1.45	0.68	0.68
	W.W	1.11	0.61	0.6

Note: T.W: Tap water; W.W: waste water.

Heavy metals (ppm):

The results in Table 7 showed that the concentrations of Zn in leaves were higher in three types of seedlings when irrigated with wastewater compared with tap water, while in stems irrigated *Rademarchera* and *Ficus mango* seedlings with wastewater increased Zn content than tap water but decreased Zn content in *Terminalia angustifolia* seedlings when treated with the wastewater. Irrigated *Terminalia angustifolia* and *Rademarch ignea* seedlings with wastewater increased the content of Zn in roots compared with tap water on the other hand tap water gave the best result in Zn content in *Ficus mango* seedlings. Application of wastewater in three seedlings increased the content of Pb compared with tap water in leaves and stems, while in roots wastewater increased Pb compared with tap water in *Terminali angustifolia* seedlings, while in *Rademarchera ignea* and *Ficus mango* seedlings the two types of water gave the same results in the content of Pb.

Macronutrients elements:

Data presented in Table 8 noticed that *N* percentage in leaves was higher when all types of seedlings irrigated with tap water than wastewater, while in stems the same results were found in *Terminalia angustifolia* and *Ficus mango* seedlings but in *Rademarchera ignea* there is no difference results when seedlings irrigated with the two types of water. In roots *Rademarchera ignea* and *Ficus* *mango* seedlings increased *N*% when treated with wastewater. On the other hand, tap water increased *N*% of *Terminalia angustifolia* seedlings. Data presented in Table 8 mentioned that *P* percentage in leaves was higher in *Terminal angustifolia* and *Ficus mango* seedlings by using tap water while in *Rademarchera ignea* seedling *P* content increased by application wastewater. In stem, *P* content increased in *Terminalia angustifolia* and *Rademarcher ignea* seedlings by using wastewater, whereas, *P*% decreased when *Ficus mango* seedlings irrigation with wastewater compared with tap water. In roots using tap water increased *P* content in *Rademarchera ignea* and *Ficus mango* seedlings,while in *Terminalia angustifolia* seedling *P* content increased by using wastewater.

Table 7 Response of *Terminalia angustifolia, Rademarchera ignea* and *Ficus mango* for tap water and wastewater on Zn, and Pb (ppm) average of two seasons

Treatments \ Characters		Leaves, ppm		Stems, ppm		Roots, ppm	
		Zn	Pb	Zn	Pb	Zn	Pb
Terminalia angustifolia	T. W	55.8	72	48.6	143	52.2	126
	W.W	62.1	120	47.7	288	66.8	156
Rademarchera ignea	T. W	66.6	132	55.8	143	47.7	96
	W.W	67.5	180	67.5	153	51.3	96
Ficus mango	T. W	44.1	95	53.1	204	63.9	120
	W.W	54.1	144	54.9	264	47.7	120

Note: T.W: Tap water; W.W: waste water.

Table 8 Response of *Terminalia angustifolia, Rademarchera ignea* and *Ficus mango* for tap water and wastewater on Nitrogen, phosphorus and Potassium (%) average of two seasons

Treatments \ Characters		leaves			stems			roots		
		N%	P%	K%	N%	P%	K%	N%	P%	K%
Terminalia angustifolia	T. W	1.9	0.15	0.4	1.3	0.08	0.58	1.9	0.07	0.39
	W.W	1.4	0.08	0.41	1	0.09	0.71	1.75	0.08	0.59
Rademarchera ignea	T. W	2.15	0.11	0.5	1.5	0.23	0.76	1.6	0.13	0.88
	W.W	1.6	0.18	0.66	1.5	0.34	0.79	1.8	0.09	1.57
Ficus mango	T. W	2.4	0.13	1.06	1.65	0.26	0.84	1.7	0.12	0.46
	W.W	1.55	0.11	1.96	1.6	0.14	1.87	2.05	0.11	0.54

Note: T.W: Tap water; W.W: waste water.

The *K* percentage in leaves, stems and roots were much higher in *Terminalia angustifolia, Rademarchera ignea* and *Ficus mango* seedlings when irrigated with wastewater compared with tap water.

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