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Response of three tree species seedlings to irrigation with effluent water

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ABSTRACT

Effect of irrigation with mixed sewage effluent water and fresh water on growth of casuarina, jatropha and khaya tree seedling was evaluated in new Minia city, Minia, Egypt from Jan. 2018 to Dec. 2019. The most studied characters showed significant response for species, water treatments and their interaction. Khaya tree seedling irrigated with the treatment 50% sewage water + 50% freshwater gave the highest plant height. Casuarina seedling irrigated with 50%s+50%f had the highest stem diameter and branches/plant, while those irrigated with 25%s+75%f gave the highest leaves/plant. Casuarina seedling irrigated with each of 100%s or 75%s+25%f gave the highest stem fresh weight and shoot fresh weight without significant difference. Moreover, the highest values for shoot: root ratio and stem dry weight were recorded for casuarina seedling irrigated with 75%s+25%f. Irrigation of jatropha seedling with treatment 100%s gave the highest values for each of branches fresh weight and leaves fresh weight, branches dry weight and leaves dry weight. Also, jatropha seedling irrigated with treatment 100%s and 50%s+50%f gave the highest leaves fresh weight without significant difference. Khaya seedling irrigated with the four water irrigation treatments had the highest chlorophyl B and carotenoids contents without significant difference.

Keywords: sewage, effluent, freshwater, shoot, chlorophyll. carotenoids.

INTRODUCTION

Egypt is located in semi-arid zone of the world. River Nile is the main source of water, which provides the country with more than 95% of all water requirements. At present, the major challenge that faces Egypt is how to meet the increased future development demands for good quality water for all sectors with

almost fixed some amounts of water resources. In 2011, Egypt produced about 7 billion meters^3 of wastewater, while the treated wastewater was accounted by 3.1 billion meters^3 (HCWW 2011). The use of effluent water in irrigation could improve the quality of the soil and plant growth because it was considered as natural conditioners through their contents of nutrient elements and organic matter. Dimitriou and Aronsson (2011) compared the effects of adding municipal wastewater irrigation to willows and poplars and sewage sludge to willows in a two-year experiment. They found that wastewater irrigation enhanced plant growth. Sewage effluents water is a source for nutrients for cultivating jatropha. Effective irrigation with sewage effluents needs for controlling salinity build-up in the topsoil of grown with Jatropha Rajaona *et al* (2012). Significant increase in nutrient content in growth parameters when *Khaya senegalensis* was irrigated with sewage Ali *et al*. (2013). The growth of *Leucaena leucocephala* seedlings was decreased with wastewater, the decrease was more pronounced with 50% wastewater from the eastern sewage treatment station (Hassan and Ali, 2013). Farahat and Linderholm (2015) found that under wastewater irrigation, *C. sempervirens* transferred most of nutrients, especially heavy metals, from green to senesced leaves. This could be a self-protecting mechanism under continuous irrigation with wastewater. Many investigators observed better growth of trees organs; increase in water and nutrient availability through effluent application influenced the growth of trees such as *Casuarina equisetifolia* (Kumar and Reddy, 2010), *Pinus eldarica* (Tabari *et al*. 2011), and *Eucalyptus. tereticornis* (Minhas *et al*. 2015). Positive results for all growth parameters were observed with the use of swine farm wastewater in seedling growth of *Corymbia citriodora,* this could be explained by the chemical composition of the treated effluents (Coelho *et al.,* 2017). The growth and quality of *Acacia mangium* Wild seedlings did not differ with the use of SFW or fresh water in irrigation, which suggests that the use of this effluent is a viable alternative for the production of quality seedlings (Araújo *et al.,* 2018). The objective of the study was to estimate the effect of irrigation with mixed sewage effluent and fresh water on seedlings growth parameters of three tree species seedlings: Casuarina, Jatropha and Khaya.

MATERIALS AND METHODS

The experiment was conducted in New Minia city, Minia, Egypt from Jan. 2018 to Dec. 2019 to evaluate the effect of irrigation with different percentage of mixed sewage water and fresh water on growth characters of three tree species seedlings i.e. *Casuarina equistifolia*, *Jatropha curcas* and *Khaya senegalensis*.

Two months old seedlings of the three tree species were used, the seedlings of casuarina, khaya and jetropha were averaged 30, 20 and 15 cm. in height, 4.5, 4 and 2.5 mm in diameter, respectively. The seedlings

were planted on first of January 2018 in sandy soil. The chemical analysis of the soil used in the experiment are presented in Table (1).

The seedlings were planted directly in the field in one row 1 m. apart with 1 m. distance within the row between the plants in each plot. The split plot design with three replicates was used with 3 plants per replicate. The main plot was the three tree species and the sub plots were the four different percentage of mixed sewage water with freshwater treatments; 100% sewage water without fresh water (100%S), 75% sewage water + 25% fresh water (75%S+25%F), 50% sewage water + 50% fresh water (50%S+50%F) and 25% sewage water + 75% fresh water (25%S+75%F). All seedlings of the three tree species were irrigated with the four water treatments according to the regular irrigation schedule for the 24 months. In addition, weeding and other agricultural practices were done as usual.

Table (1). The chemical and physical characteristics of sandy soil used in the study.

pH	EC	Cations (meq/l)			K	Anions (meq/l)			
	dSm -1	Ca	Mg	Na	ppm	Cl	CO_3	HCO_3	SO_4
8.58	75	0.36	0.17	0.23	5	0.36	0.00	0.75	0.12
Sand%	88.00	Silt%	8.30	Clay%	3.70				

Table (2). The chemical analysis of the sewage water used in the experiment.

Parameter	Type of water		Limits of wastewater for agric. reuse FAO (1992)
	Sewage effluent	Fresh water	
pH	6 - 9	7-8.5	6.5-8.4
Soluble anions (mg/l)			
$SO4^{-2}$	< 2.00	200	-
NO3	< 3.00	40	-
CL^{-1}	< 0.50	200	-
AL	< 1.00	-	-
Oils & grease	< 5.00	-	-
BOD5 (mg/l)	< 30.00	6	40-500
COD (mg/l)	< 40.00	10	80-600
TSS (mg/l)	< 120.00	500	1920-44880
Coliforms 10 / cm3	< 2500.00		1000
Heavy metals (mg/l)			
Fe^{-1}	< 1.00	0.3	5.00
Mn	< 0.50	0.1	0.20
Cd	< 0.10	0.01	0.01
As	< 0.05	0.2	0.05
Cu	< 1.00	1	0.01
Total suspended solids (mg/l)	< 30.00	-	-

Biochemical oxygen demand (BOD_5) and chemical oxygen demand (COD).

After two years from beginning planting the seedlings, and, in the third week of Dec. 2019 the following data were recorded: plant height (P.H.) in cm, stem diameter (S.D.) in cm, number of branches per plant (N.B./P.), number of leaves per plant (N.L./P.), stem fresh weight (St.F.W.) in gm, branches fresh weight (B.F.W.) in gm, leaves fresh weight (L.F.W.) in gm, shoot fresh weight (Sh.F.W.) in gm, root fresh weight (R.F.W.) in gm, shoot fresh weight/root fresh weight ratio (Sh.F.W./Ro.F.W. ratio), stem dry weight (St.D.W.) in gm, branches dry weight (BDW) in gm, leaves dry weight (LDW) in gm, shoot dry weight (ShDW) in gm, root dry weight (R.D.W.) in gm, leaf area (L.A.) in cm, Chlorophyll a, Chlorophyll b and Carotenoids in the leaves (mg/g F.W.) were estimated according to Nagata and Yamashita (1992). Chlorophyll a (Ca) = 9.784 Ea – 0.99 Eb = mg/l,

Chlorophyll b (Cb) = 21.426 Eb – 4.65 Ea = mg/l,

Carotenoids = 4.695 – 0.386 (Ca + Cb) = mg/l

Data were subjected to the proper statistical analysis of variance of split plot design mentioned of by Gomez and Gomes (1984). In addition, F-test and the least significant differences at 95% level of confidence (L.S.D 0.05) were calculated and used to determine the significant differences between means of each trait using analysis of variance technique by MSTAT-C (1986) software package.

RESULTS AND DISCUSSION

The three tree species seedlings, four water treatments and their interaction showed significant ($p \leq 0.05$ or 0.01) differences for all characters except root dry weight of tree species and leaf area, chlorophyl a, b and carotenoids of water treatments and leaf area, chlorophyl a of tree species-water treatments interaction and root fresh weight of trees and the interaction that showed insignificant difference (Table 3).

Growth parameters

All growth parameters (plant height, stem diameter, no. of branches/plant and no. of leaves / plant) were affected by the three tree species, irrigation treatments and the interaction as indicated from values of LSD (Table, 4).

Khaya seedlings had the highest plant height (142.75 cm.). The irrigation with 50% sewage + 50% freshwater gave the highest plant height (148.11 cm.), stem diameter (5.70 cm.), branches/plant (10.11). Furthermore, treatments of 50%s+50%, 75%s+25%f and 25%s+75%f gave the highest no. of leaves without significant between them. Khaya seedlings irrigated with the same water treatment gave the highest plant height (158.33 cm.). The same trend was found for casuarina seedlings and jatropha seedlings irrigated with 50%s+50%f treatment (Table, 4). Casuarina seedlings had the highest stem diameter (5.65 cm.), no. of branches (18.00) and no. of leaves per plant (56.17). Casuarina seedlings irrigated with 50%s+50%f had the highest stem diameter (6.17 cm.) and the highest branches/plant (21.33), while those irrigated with 25%s+75%f gave the highest

leaves/plant (63.67) as shown in Table (4). The results obtained by many researchers, showed that sewage effluent had a stimulatory effect on plant height of trees as *Populus deltoides* (poplar) Tanvir and Siddiqui (2010) and *Swietenia mahagoni* L. Similar results were obtained by Pelissari *et al.* (2009) who evaluated irrigation with swine farm wastewater in the production of *Eucalyptus grandis* seedlings. They found that wastewater had the greatest positive effect on diameter. Ali *et al.* (2011) found that the primary effluent treatment was superior compared to other treatments in improving stem diameter *of Swietenia mahagoni* (L.) Jacq.

All fresh weight characters (stem, branches, leaves, shoot, root and shoot/root ratio) showed significant response for three tree species, irrigation treatments and the interaction as indicated from the values of LSD except root fresh weight of water treatments and the interaction (Table, 5).

Casuarina seedling had the highest fresh weight for stem (2284.63), shoot (2692.00), root (294.33 gm.) and shoot/root ratio (9.20). While, jatropha seedling was the highest one for branches fresh weight (443.50) and leaves fresh weight (333.37gm.).

Irrigation with sewage water alone (100% S) gave the highest values of stem fresh weight (1451.00), branches fresh weight (389.83), leaves fresh weight (291.50), shoot fresh weight (2132.33 gm.) and shoot/root ratio (9.04). In contrast, the water treatment that contained low sewage water (25%s+75%f) gave the lowest values of these traits. This positive effect may be explained by the positive effect of the organic components presented in sewage water on fresh weight parameters. Ali *et al.* (2011) reported that sewage effluent provided the soil with plant nutrients and organic matter that improved the soil physical characteristics, that were reflected on the growth by enhancing the cell elongation and division.

Casuarina seedlings irrigated either with 100%s or 75%s+25%f gave the highest stem fresh weight and shoot fresh weight without significant difference between them. Moreover, the highest shoot/root ratio (10.75) was recorded for casuarina seedlings irrigated with 75%s+25%f. Jatropha seedlings irrigated with treatment 100%s alone gave the highest branches fresh weight (640.50) and leaves fresh weight (383.50 gm.). Also, jatropha seedlings irrigated with treatment 50%s+50%f gave similar value of leaves fresh weight of treatment 100%s without significant difference. Similar result was found by Ali *et al.* (2011) on *Swietenia mahagoni* (L.) Jacq.). Adrover *et al.* (2008) found that most of the species, treated with wastewater had a positive effect on final biomass. Adrover *et al.* (2008) found that most of the species, treated with wastewater had a positive effect on shoot:root ratio compared to that of nutrient solution.

Significant effects of the three tree species, irrigation treatments and the interaction were observed for dry weigh characters (stem, branches,

leaves, shoot and root) as indicated from LSD values except root dry weight of tree species and the interaction in addition to leaf area of water treatments and the interaction (Table 6).

Casuarina seedlings recorded the highest values for stem dry weight (1569.00) and shoot dry weight (1752.25 gm.). While jatropha had the highest value for branches dry weight, leaves dry weight and leaf area. The highest value for branches and shoot dry weight were recorded from irrigation with only sewage water 100%s compared to 25%s+75%f which gave the lowest values of these traits.

Application of irrigation with both 75%s+25%f and 50%s+50%f treatments gave the highest stem dry weight and leaves dry weight without significant difference. Treatment 25%s+75%f recorded the lowest values for stem, branches leaves and shoot dry weight. While the same treatment in addition to 75%s+25%f and 50%s+50%f gave the highest root dry weight without significant difference between them. Similar result was found by Ali *et al.* (2011) on *Swietenia mahagoni* (L.) Jacq.).

The interaction between casuarina and the water treatment 75%s+25%f had the highest stem dry weight (1809.00) and the highest shoot dry weight (1989.00 gm.). Jatropha irrigated with 100% sewage water gave the highest branches and leaves dry weight (Table, 6). Pandey and Srivastava (2010) evaluated different tree species irrigated with the treatment of effluents from domestic origin. They found statistically significant harvestable dry biomass difference in the species with 7.3, 8.8, 3.8 and 8.5 Kg for *Eucalyptus hybrid, Populus deltoides, Salix alba* and *Melia azedarach*, respectively in wastewater plot compared to 3.0, 5.7, 1.0 and 2.0, respectively in the control trial.

Significant effect of the three tree species was observed for chlorophyl A, B and carotenoids and chlorophyl B and carotenoids of the interaction as indicated from LSD values (Table, 7).

Khaya seedlings recorded the highest chlorophyl A, B and carotenoids followed by jatropha then casuarina. Khaya irrigated with the four water treatments gave the highest chlorophyl B and carotenoids without significant difference (Table, 7).

Table (3) Analysis of variance of three tree species, water treatments and their interaction for all characters.

S.V.	Rep	Trees (A)	Error A	Water (B)	A.B	Error
d.f.	2	2	4	3	6	18
P.H.	34.03	596.36**	4.53	798.74**	131.77**	11.29
S.D.	0.01	1.55*	0.12	1.33**	0.37**	0.07
N.B./P.	0.33	786.08**	0.42	12.07**	5.71**	0.39
N.L./P.	7.11	3270.11**	10.19	84.63**	64.63**	10.46
St.F.W.	8.33	11716528.69**	898.9	96184.67**	1441188.35**	2364.04
B.F.W.	75	201463.56**	149.31	56940.75**	15562.06**	521.71
L.F.W.	275.52	92825.68**	12.9	13890.73**	7118.85**	103.1
Sh.F.W.	792.19	7764472.56**	321.81	409066.39**	126434.15**	3424.22
R.F.W.	3809.78	46438.86**	787.36	3339.81	3176.86	1308.54
Sh.F.W./Ro.FW	0.92	25.43**	0.48	9.97**	2.87**	0.12
St.D.W.	2523	6217018.75**	708.25	78813.42**	82841.17**	1567.5
B.D.W.	285.19	22327.75**	4.75	9202.39**	6620.83**	34.51
L.D.W.	105.02	43636.19**	27.9	5006.91**	1917.52**	20.33
Sh.D.W.	5985.33	4731706.69**	559.15	149680.42**	65205.11**	1569.21
R.D.W.	1254.11	12747.5	2774.57	1472.77*	742.269	258.16
L.A.	9.53	26250.60**	12.44	32.43	10.36	7.42
Ch A	4.12	252.40**	12.61	4.33	6.67	5.82
Ch B	4.14	1617.91**	4.44	20.38	131.85**	16.61
Carotenoids	84.38	58434.40**	507.24	474.81	3768.80**	420.57

*and ** are the significant at 0.05 and 0.01 of level of probability.

Table (4). Effect of three tree species seedlings, water treatments and their interaction on growth parameters

Parameter	Tree\treat	100%S	75%S+ 25%F	50%S+ 50%F	25%S+ 75%F	Mean (A)
P.H. cm.	Casuarina	122.67 e	124.33 e	140.33 cd	128.00 e	128.83 a
	Jatropha	136.00 d	143.67 c	145.67 bc	125.67 e	137.75 b
	Khaya	134.67 d	151.00 b	158.33 a	127.00 e	142.75 c
	Mean (B)	131.11 c	139.67 b	148.11 a	126.89 d	
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	2.42	3.33	5.76		
S.D. cm.	Casuarina	5.17 cd	5.50 bc	6.17 a	5.75 ab	5.65 a
	Jatropha	4.67 e	4.83 de	4.85 de	5.42 bc	4.94 b
	Khaya	4.67 e	4.83 de	6.08 a	5.08 cde	5.17 b
	Mean (B)	4.84 c	5.05 c	5.70 a	5.42 b	
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	0.39	0.26	0.45		
N.B./P.	Casuarina	14.67 c	18.33 b	21.33 a	17.67 b	18.00 a
	Jatropha	4.00 def	4.67 de	5.00 d	4.00 def	4.42 b
	Khaya	3.33 f	3.67 ef	4.00 def	3.33 f	3.58 c
	Mean (B)	7.33 c	8.89 b	10.11 a	8.33 b	
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	0.74	0.62	1.07		
N.L./P.	Casuarina	46.33 c	58.00 b	56.67 b	63.67 a	56.17 a
	Jatropha	29.00 efg	34.33 de	36.33 d	31.00 def	32.67 b
	Khaya	24.33 gh	27.00 fg	25.67 fgh	20.33 h	24.33 c
	Mean (B)	33.22 b	39.78 a	39.56 a	38.33 a	
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	3.62	3.2	5.55		

a-g Means in the same column (within) or under the same trait followed by different letters significantly different ($P < 0.05$).

Table (5). Effect of three tree species seedlings, water treatments and their interaction on fresh weight traits of different parts of trees

Trait	Tree\treat	100%S	75%S+ 25%F	50%S+ 50%F	25%S+ 75%F	Mean (A)
St.F.W. gm.	Casuarina	2575.50a	2550.50a	1982.50b	2030.00b	2284.63a
	Jatropha	400.00f	280.00g	241.00g	315.00g	309.00c
	Khaya	1377.50d	1150.50e	1488.50c	1341.00d	1339.37b
	Mean (B)	1451.00a	1327.00b	1237.33c	1228.67c	1311
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	33.98	48.16	83.41		
B.F.W. gm.	Casuarina	253.00e	294.50d	249.00e	194.00fg	247.63b
	Jatropha	640.50a	491.00b	355.00c	287.50de	443.50a
	Khaya	276.00de	205.50f	165.00gh	148.00h	198.62c
	Mean (B)	389.83a	330.33b	256.33c	209.83d	296.58
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	13.87	22.62	39.18		
L.F.W. gm.	Casuarina	158.00f	165.00f	153.00f	163.00f	159.75c
	Jatropha	383.50a	348.50b	393.50a	208.00e	333.37a
	Khaya	333.00b	265.50c	258.50c	227.00d	271.00b
	Mean (B)	291.50a	259.66b	268.33b	199.33c	254.71
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	4.08	10.06	17.42		
Sh.F.W. gm.	Casuarina	2986.50a	3010.00a	2384.50b	2387.00b	2692.00a
	Jatropha	1424.00e	1119.50f	989.50g	810.50h	1085.87c
	Khaya	1986.50c	1621.50d	1912.00c	1716.00d	1809.00b
	Mean (B)	2132.33a	1917.00b	1762.00c	1637.83d	1862.29
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	20.36	57.96	100.38		
R.F.W. gm.	Casuarina	295.67	280.33	300.33	301	294.33a
	Jatropha	170.33	181.67	177.67	151	170.17b
	Khaya	162.67	271.67	283.33	238.67	239.09c
	Mean (B)	209.56	244.56	253.78	230.22	234.53
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	31.85	N.S.	N.S.		
Sh.F.W./Ro.F.W. ratio	Casuarina	10.13b	10.75a	7.96d	7.95d	9.20a
	Jatropha	8.40cd	6.18fg	5.59gh	5.30h	6.37b
	Khaya	8.59c	5.98g	6.75ef	7.22e	7.14b
	Mean (B)	9.04a	7.64b	6.77c	6.82c	7.57
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	0.79	0.34	0.59		

a-g Means in the same column (within) or under the same trait followed by different letters significantly different ($P < 0.05$).

Table (6). Effect of three tree species seedlings, water treatments and their interaction on dry weight characters of different parts of trees.

Trait	Tree\treat	100%S	75%S+ 25%F	50%S+ 50%F	25%S+ 75%F	Mean
St.D.W. gm.	Casuarina	1595.00c	1809.00a	1697.00b	1175.00d	1569.00a
	Jatropha	115.00g	109.00g	146.50g	150.50g	130.25c
	Khaya	955.50e	820.00f	940.00e	850.50f	891.50b
	Mean	888.50b	912.67ab	927.83a	725.33c	863.58
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	30.17	39.21	67.92		
B.D.W. gm.	Casuarina	105.50d	92.50e	108.50d	125.00c	107.88b
	Jatropha	272.00a	202.50b	107.50d	99.50de	170.38a
	Khaya	108.50d	105.50d	74.00f	62.50g	87.63c
	Mean	162.00a	133.50b	96.67c	95.67c	121.96
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	2.47	5.82	10.08		
L.D.W. gm.	Casuarina	79.00h	87.50g	63.50i	71.50h	75.38c
	Jatropha	227.00a	205.50b	195.00c	155.50d	195.75a
	Khaya	202.50bc	108.00f	147.00e	110.50f	142.00b
	Mean	169.50a	133.67b	135.17b	112.50c	137.71
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	5.99	4.47	7.73		
Sh.D.W. gm.	Casuarina	1779.50c	1989.00a	1869.00b	1371.50d	1752.25a
	Jatropha	614.00h	517.00i	449.00j	405.50j	496.38c
	Khaya	1266.50e	1033.50g	1161.00f	1023.50g	1121.13b
	Mean	1220.00a	1179.83b	1159.67b	933.50c	1123.25
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	26.8	39.23	67.95		
R.D.W gm.	Casuarina	148.67	145.33	159	187.67	160.17
	Jatropha	82.33	116.33	85.67	98.33	95.67
	Khaya	109.67	133.67	153.33	147.67	136.09
	Mean	113.56b	131.78a	132.67a	144.56a	130.64
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	N.S.	26.98	V		
L.A. cm.	Casuarina	28.57	30.17	28.5	29.13	29.09a
	Jatropha	106.67	114.67	108.67	106.33	109.09b
	Khaya	27.68	28.75	26.67	25.27	27.09a
	Mean	54.31	57.86	54.61	53.58	55.09
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	4	N.S.	N.S.		

N.S. = Not significant ($P<0.05$), a-g Means in the same column (within) or under the same trait followed by different letters significantly different ($P<0.05$).

Table (7). Effect of three tree species, water treatments and their interaction on photosynthetic pigments parameters.

Trait	Tree\treat	100%S	75%S+ 25%F	50%S+ 50%F	25%S+ 75%F	Mean (A)
Ch. A. mg./g. F.W.	Casuarina	12.62	15.13	15	14.37	14.28c
	Jatropha	16.85	17.98	20.34	21.04	19.05b
	Khaya	24.3	23.96	23.01	22.53	23.45a
	Mean (B)	17.92	19.02	19.45	19.31	18.93
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	4.03	ns	ns		
Ch. B. mg./g. F.W.	Casuarina	22.92d	23.26d	6.70e	22.99d	18.97c
	Jatropha	28.77d	28.48d	36.10c	27.23d	30.15b
	Khaya	43.56ab	37.16bc	43.34ab	44.69a	42.19a
	Mean	31.75	29.63	28.71	31.64	30.43
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	2.39	ns	6.99		
Carotenoids	Casuarina	153.14d	165.42cd	93.52e	161.00d	143.27c
	Jatropha	196.56bc	178.42bcd	264.21a	208.02b	211.80b
	Khaya	292.44a	263.35a	285.87a	289.65a	282.83a
	Mean	214.05	202.4	214.53	219.56	212.63
	L.S.D	Trees (A)	Treat (B)	AB		
	5%	25.56	ns	35.18		

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استجابة شتلات ثلاثة أنواع شجرية للري بماء الصرف الصحي

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أجري تقييم تأثير الري بخليط من ماء الصرف الصحى والماء العادى على نمو شتلات اشجار الكازوارينا والجاتروفا والكايا فى مدينة المنيا الجديدة بمحافظة المنيا – مصر فى الفترة من يناير 2018 حتى ديسمبر 2019. اظهرت معظم الصفات تحت الدراسة استجابة معنوية لانواع الاشجار ومعاملات ماء الرى والتفاعل بينهم. سجلت شتلات الكايا المروية بالمعاملة 50% ماء صرف + 50% ماء عادى اعلى طول للنبات ، كما سجلت شتلات الكازوارينا المروية بنفس المعاملة اعلى قيم لكل من قطر الساق وعدد الفروع / نبات ، بينما شتلات الكازوارينا المروية بالمعاملة 25% ماء صرف + 75% ماء عادى اعطت اعلى عدد اوراق / نبات ، وسجلت شتلات الكازوارينا المروية بكلا من المعاملتين 100% ماء صرف والمعاملة 75% ماء صرف + 25% ماء عادى اعلى قيم لصفات الوزن الطازج للساق والوزن الطازج للمجموع الخضرى بدون فرق معنوى بين المعاملتين ، علاوة على ان اعلى قيم لصفات نسبة المجموع الخضرى : المجموع الجذرى والوزن الجاف للساق سجلت من رى شتلات الكازوارينا بالمعاملة 75% ماء صرف + 25% ماء عادى ، كما ان رى شتلات الجاتروفا بالمعاملة 100% ماء صرف اعطى اعلى قيمة لكل من الوزن الطازج للفروع والاوراق وكذلك الوزن الجاف للفروع والاوراق ، كذلك فان شتلات الجاتروفا المروية بالمعاملتين 100% ماء صرف والمعاملة 50%ماء صرف + 50% ماء عادى اعطت اعلى وزن طازج بدون فرق معنوي بين المعاملتين ، وسجلت شتلات الكايا المعاملة بالأربعة معاملات ماء رى اعلى قيم لصفات كلوروفيل ب والكاروتينات بدون فروق معنوية بين الاربعة معاملات.

توصى الدراسة برى شتلات الكايا والجاتروفا بالمعاملة 50% ماء صرف + 50% ماء عادى، كذلك توصى برى شتلات الكازوارينا بالمعاملة 25% ماء صرف + 75% ماء عادى