GROWTH RATE, BASAL AREA AND VOLUME OF *CORYMBIA CITRIODORA* AND *CUPRESSUS SEMPERVIRENS* IRRIGATED WITH TREATED WASTEWATER AT SERABIUM FOREST

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Abstract

Serabium forest is 15 km. far from Ismailia City at the Northern East of Egypt, which had 25 years old, irrigated by treated wastewater.The Serabium forest (129 ha) was realized using different tree species a high wood production. The study was carried out from 2009 to 2013 on four years old of *Corymbia citriodora* Hook. and *Cupressus sempervirens* L. trees planted at 3 x 3 m. spacing and irrigated by drip irrigation system of primary treated wastewater to compare the growth and wood prduction of two species. The results revaled that, the growth of two tree species increased gradually through 5- year affected by treated wastewater. *Corymbia citriodora* had tallest significant trees and biomass as compared to *Cupressus sempervirens***.** The results also showed that, *Corymbia citriodora* trees gave the highest significant annual rate increment of basal area in 2010 (39.03 cm^2 $tree^{-1}$) followed by *Cupressus sempervirens* (25.24 cm^2 $tree^{-1}$). Although, *Cupressus sempervirens* had the highest tree volume at 2009 as compared to *C. citriodora* (12283.6 and 4612.6 cm^3 $tree^{-1}$), respectively. *C. citriodora* showed the highest significant tree volume in 2012 and 2013. At the end of the experiment, *Corymbia citriodora* gave the highest values of total volume per hectare followed by *Cupressus sempervirens* (79.43 and 49.18 m^3 ha^{-1}), respectively. It could be concluded that, *Corymbia citriodora* gave the best growth performance followed by *Cupressus sempervirens***,** which makes these species a valuable in many reforestation programs, especially *Corymbia citriodora* for shortcut rotation and *Cupressus sempervirens* for long cut rotation.

Keywords*: Corymbia, Cupressus,* wastewater, biomass, basal area, stem volume

INTRODUCTION

In arid and semi-arid areas the soil is scarcely productive. In this context, forests can play a crucial role in promoting and restoring water cycle in the regional scale (David *et al.* 2011).

The use of wastewater for land irrigation is usually recommended because it is a low-cost method for the disposal of wastewater and also permits the reclamation and reuse of valuable resource such as water and nutrients (Wang, 1984).Therefore, considering its various potential benefits (protection of water resources, prevention of

coastal pollution, recovery of nutrients for agriculture, savings in wastewater treatment, groundwater recharge, sustainability of water resource management, and reclaimed wastewater is a reliable source of water that must be taken into account in formulating a sustainable water policy, etc.), Angelakis and Bontoux, 2001.

On the other side, the use of primary and secondary effluent in irrigation can improve the quality of soil and plant growth because they are considered as natural conditioners through their content of nutrient elements and organic matter. Also, Onyekwelu, 2007, indicated that, the knowledge of the productivity (especially the stem wood biomass) of the tree species will be essential to justify timber production, which reveals the amount of wood exploitable for timber.

Corymbia citriodora fast growing trees are planted in tree plantations in Asia, Australia, Europe and the United States for fuel wood, poles, timber, lumber, biomass, essential oil and excellent source of nectar for honeybees (Orwa *et al.*, 2009).

Also, Zalesny *et al.,* 2011, indicated that, the stem volume growth rate of *Eucalypts grandis* and *E. camaldulensis* was 20 m^3 ha^{-1} yr^{-1}. While, *Corymbia citriodora* stem volume was 10 to 21 (m^3 ha^{-1} yr^{-1}).

Cupressus sempervirens is a species of cypress native to the eastern Mediterranean region. Establishment of tree plantations for wastewater irrigation has been a common practice for many years. The practice defers ecological degradation by the pollutants in the soil, because trees are long-living organisms that can take up trace elements from the soil, water or air and retain them for a long time. Cypress wood is versatile, easy to work with hand and machine tools, and possible to nail, stain, and polish well. It can be used for structural and nonstructural applications including general construction and furniture making purposes (USDA, 1999).

Egypt is now witnessing a wide range of new projects aiming to expanding the green stretch in the desert by introducing forest plantations (man- made forests) making use of treated sewage water, not only for produce timber trees of high economic value but also to prevent further pollution of ecosystems. So, the main objective of this study to evaluate the growth and wood productivity of *Corymbia citriodora* and *Cupressus sempervirens* which were irrigated by wastewater in the desert lands.

MATERIALS AND METHODS

The experiment was carried out in Serabium forest 15 km. far from Ismailia City, Egypt, irrigated with treated wastewater. The experiment was conducted out from 2009 to 2013 on four years old of *Corymbia citriodora* Hook. and *Cupressus sempervirens* L. trees planted at 3 x 3 m. spacing and irrigated by drip irrigation

system of primary treated wastewater to evaluate growth and wood production of two species.

Soil physical and chemical properties were determined as shown in Table (1). The mean values of the available nitrogen, posphorus and potasium of control in 2009 was 6.13, 0.32 and 52.1 mg Kg^{-1}, respectively. While, it were 105.7, 14.92 and 88.14 mg Kg^{-1}, respectively, at the end of the experiment in 2013. Available nitrogen was determined by kjelahl method (Page *et al.*, 1982). Available phosphoruse was detemined colorimetrically by spectrophtometer. Available potassium was measured by flame photometer. Available Fe, Mn, Zn, Cu, Pb, Ni, Cd and Cr were extracted by DTPA- reagent and measured by atomic absorption spectrophotometer, these data are shown in Table (1).

Irrigation water:

The water used for irrigation was primary treated wastewater collected from the oxidation ponds of Serabium and it consists of a mixture of domestic and industrial wastewater. Each tree species was irrigated three times weekly by drip irrigation system (spaghetti tubing) with 6 litter / hour discharge rate since the time of planting trees from 4 years till the end of experiment.

Water analysis:

The mean values of the available nitrogen, phosphorus and potasium was 28.0, 1.523 and 17.55 mg Kg^{-1}, respectively. The available nitrogen was determined by the steam distillation method (Page *et al.*, 1982). Available phosphorus was determined by ascorbic acid colorimetric method. Available potassium was determined by flame photometer. The concentration of total heavy metals (Fe, Mn, Zn, Cu, Pb, Ni, Cd and Cr) was measured by atomic absorption spectrophotometer after acidifying with nitric acid, Table (2) shows analysis of irrigation water.

Harvesting and sampling :

In September 2012 and 2013, three homogenous the two species were randomly selected and cut. Each tree was saparated into stem, branches and leaves. Fresh weights of these components were recorded in the field using balance and representative samples from each component were taken for air dry and then dried at 70^0C to constant weight to dry matter detremination.

Recorded data :

In September annually during 5 years the following data were recorded and culculated the annual rate increment for each parameter: tree height (m), stem diameter at breast height (cm), basal area (cm^2) and tree volume (m^3).

Tree volume of the individual standing trees = 1/4 π d^2· h·f (Laar and Akça, 2007). Where: d = diameter at breast height(130 cm), h = tree's total height and f: is *C. sempervirens* and *C. citriodora* form factor = 0.50 and 0.54, respectively.

Statistical design and analysis :

The design was a completely randomized block (RCBD) with three replicates. The whole area was 180 x 75 m. for each species and it contained 1500 tree. Factors were (1) trees (2 species) and (2) periods (5 years). Least significant differences (LSD) was used for testing the differences among the means of each parameter.

Table 1. The main chemical and physical properties of Serabium soil of the current study.

Soil Depth (cm)	PH	EC (ds m^{-1})	Water soluble cations (m mole L^{-1})				Water soluble anions (m mole L^{-1})				Available heavy metals (mg Kg^{-1}) DTPA-extract							
			Ca^{++}	Mg^{+}	Na^{+}	K^{+}	$Co_3^{=}$	Hco_3^{-}	$C1^{-}$	$So_4^{=}$	Fe	Mn	Zn	Cu	Pb	Ni	Cr	Cd
0 - 50	7.88	1.1	2.5	3.5	4.2	0.7	——	0.5	7.5	2.9	3.34	0.57	0.38	0.33	0.14	0.08	.006	0.01

Table 2. Analysis of primary treated wastewater used for irrigation of the trees.

Parameter / Years	pH	Ec ds m^{-1}	SAR	Elements mg L^{-1} Fe	Mn	Zn	Cu	Pb	Ni	Cd	Cr
2009	6.6	1.55	5.38	0.55	0.25	0.14	0.70	0.09	0.06	0.04	0.08
2010	6.6	1.77	4.36	7.50	3.15	1.05	0.35	1.15	0.38	0.23	0.26
2012	6.6	1.65	4.87	4.50	2.10	1.39	0.30	0.08	0.03	0.004	0.006
Recommended by FAO 1992	6.5- 6	0.7-3.0	0.7-0.2	5.00	0.20	2.00	0.20	5.00	0.20	0.01	0.10

RESULTS AND DISCUSSION

Tree height

The mean values of tree height and annual rate tree height increment for two species are shown in Table (3). The analysis of variance for these parameters revealed that, there were highly significant differences between two species, five periods and the interaction between them. Although, there were no significant differences between the species, periods and the interaction between them of the height annual rate increment.

Corymbia citriodora trees had the highest mean values for height recording (8.48 m.), followed by *C. sempervirens* recording (6.18 m.), Table, (3) and fig. (1). It is clear that, 2010 year gave the highest height rate with insignificant increment for *C. citriodora* and *C. sempervirens* (2.87 and 0.82 m. $year^{-1}$, respectively). However, the

lowest values of height rate increment for *C. citriodora* and *C. sempervirens* was 0.88 and 0.38 m year^{-1}, respectively in year 2011 as compared with other years.

The growth of tree species was markedly growing under primary treated wastewater irrigation for five years, this may be due to high concentration of NPK and organic matter in wastewater, which reflected photosynthetic area, assimilated substances and consequently the growth increases. While, the annual rate increment varied yearly, that may be as caused climate change or irregular irrigation. *El*-Khateeb *et al.*, 2012 showed that macro elements N, P and K at 30 and 60 cm. soil depths were clearly increased as a result of irrigation with sewage water compared with virgin soil.

Stem diameter at breast height (dbh)

The highest diameter at breast height (dbh) growth was exhibited by *C. sempervirens* with an average of (10.33 cm.) in five years. But, there were no significant differences between the two species in this trait. While, the highest significant diameter annual rate increment was exhibited by *C. citriodora* with an average of (1.73 cm), as shown in Table (3) and fig. (2). But there were highly significant differences in diameter growth in five years. The final diameter of *C. sempervirens* in 2013 (12.40 cm.) was significantly larger than *C. citriodora* (11.67cm.), as shown in Table (3) and fig. (2).

On the other hand, diameter annual rate increment were high significantly different in species, periods (years) and the interaction between them, Table (3). It is clear that, the highest diameter increment was in 2010 period (2.78 cm.) as compared with other periods. While, the diameter annual rate increment of tree in 2012 (0.75cm) was significantly by lower increment compared to other periods. Also, the interaction between species and periods gave the highest annual rate diameter increment for *C. citriodora* and *C. sempervirens* in 2010 it was (3.75 and 1.82 cm), respectively, Table (3). This results is agreeable with Mohamed and Zahran, 2014 they showed that, dbh and annual increment mean values of *C. sempervirens* after 11 years were 13.5 ± 3.2 cm and 1.2 cm. Generally, many studies were reported on application of wastewater to woody biomass plantation. These studies reported significant tree growth in terms of height and diameter, (Hesse *et al.*, 1998). On the other side, Marecos do Monte *et al.,* 1989, indicated that, wastewater is typically rich in nitrogen and phosphorus and can replace commercial fertilizers.

It can be concluded that, treated wastewater positively affected the growth of *C. sempervirens* and *C. citriodora* and increased diameter in the period of measurements due to the fertilization properties of treated wastewater.

Basal area

Obtained data in Table (3) revealed that, the differences between two species and the interaction between species and periods were non- significant concerning basal area. But, there were highly significant differences between periods concerning basal area. That, the maximum effective year for basal area increment rate was after one year in 2010 (32.13 cm^2 $tree^{-1}$), as compared with other periods. While, year 2011 was the minimum effective year for the increment rate (11.68 cm^2 $tree^{-1}$). *C. citriodora* trees gave the highest basal area increment rate (39.03 cm^2 $tree^{-1}$) in 2010, as compared with C. *sempervirens* (25.24 cm^2 $tree^{-1}$). However, at the end of the 5-years period (2013), *C. sempervirens* gave the highest basal area per hectare (13.43 m^2 ha^{-1}) followed by *C. citriodora* (11.94 m^2 ha^{-1}), as shown in Table (5). These results may be related to the high level of NPK in treated wastewater. *C. sempervirens* was more responded for increased diameter and basal area more than *C. citriodora.* These results are in the line with those of Hillman and Takyi (1998) who revealed that, nitrogen significantly increased diameter, height, basal area and volume growth of black spruce.

Tree volume

The average values of various tree volumes and the annual rate increment of tree volumes of two species are given in Table (3) along with the comparison of five periods. It was found that, highly significant differences in tree volume and annual rate increment of tree volume of five periods and the interaction between species and periods. This difference can be attributed to the fact that tree volume was significantly increased gradually through the five periods.

At the end of 5-year, in 2013 *C. citriodora* was significantly increased tree volume (71565.3 cm^3 $tree^{-1}$) than *C. sempervirens* (44313.6 cm^3 $tree^{-1}$) as shown in Table (3). However, at the beginning of the study, in 2009 *C. sempervirens* tree volume was more than two folds of the volume of *C. citriodora* (12283.6 and 4612.6 cm^3 $tree^{-1}$), respectively. Although, the volume of *C. citriodora* was insignificantly surpassed the volume of *C. sempervirens* in 2010 (23175.0 and 21522.6 cm^3 $tree^{-1}$), respectively. *C. citriodora* significantly increased in an ascending order from 2009 tell the end of the experiment in 2013. This may be due to *C. citriodora* tree is an indication to more adaptation to region environmental condition and it is fast growing species or the amount of water which it reached to *C. sempervirens* trees not enough to fasten growth . However, the annual rate increment of tree volume for the two species were insignificant, but there were highly significant different between 5-years for the annual rate increment especially at 2013 (20736.8 cm^3 $tree^{-1}$) as showed in Table (3). So, the two species did not seem to have an effect on the annual increment

of tree volume when compared to the five periods and the interaction between species and periods. On the other side, at the end of 5-years, *C. citriodora* had the greatest total volume per hectare (79.43 m^3 h^{-1}), while, *C. sempervirens* had the lowest total volume per hectare (49.18m^3 h^{-1}), Table (5). Mohamed and Zahran, 2014 found that, the mean values of volume and annual increment of *Cupressus sempervirens* were 0.07, ± 0.04 m^3 and 2.4 m^3/f. While, Almeida *et al*., 2007 showed that *E. grandis* hybrid grown in Brazil for pulpwood had a peak growth of 95 m^3 h^{-1} y^{-1} on a 6 to 7 year wastewater rotation.

Generally, municipal water contains plant nutrients and organic matter; it may improve the properties of soil for increasing growth and biomass production (Lopez *et al.,* 2006).

Tree biomass

Data in Table (4) represents the average of total tree fresh and dry biomass for the two species. It is clear that, *C. citriodora* trees significantly accumulated more total fresh and dry biomass than *C. sempervirens*. *C. citriodora* trees recorded (124.74 and 80.54 kg $tree^{-1}$) for total fresh and dry weight, respectively. While *C. sempervirens* recorded (102.85 and 60.34 kg $tree^{-1}$), respectively. On the other hand, there was a highly significant difference between the two years 2012 and 2013. The total fresh and dry weight was increased significantly in 2013 (126.1 and 77.98 kg $tree^{-1}$), respectively as compared to 2012 (101.5 and 62.90 kg $tree^{-1}$), respectively. In 2013, *C. citriodora* trees recorded (139.38 and 87.24 kg $tree^{-1}$), respectively for total fresh and dry weight followed by *C. sempervirens* (112.81 and 68.73 kg $tree^{-1}$), respectively with insignificantly differences.

On the other side, in 2013, *C. citriodora* accumulated the highest total dry mass (96.75 ton ha^{-1}) at the age 8-yr-old, at a density of 1110 tree ha^{-1}. While, *C. sempervirens* accumulated (76.22 ton ha^{-1}) of total dry biomass under the same conditions, as shown in Table (5).

Sachs *et al.* (1980) indicated that, *Eucalyptus* species are prime candidates for woody biomass plantations because of their rapid growth rate, and biomass accumulation being as high as 40 oven dry (OD) t/ha/y on a wide range of sites. However, the growth rate was highly related to species (including cultivar, family and clone), climate, and management (including fertilization, irrigation, rotation length, and site preparation). Wise and Pitman (1981) reported that, above-ground biomass from six *Eucalyptus* species grown in 10-year rotations ranged from 110 to 162 OD t/ha, mean annual increment (MAI) from 11 to 16 OD t/ha/y.

Table 3. Mean values of tree height (m), diameter (cm), basal area ($cm^2 tree^{-1}$), volume (cm^3 $tree^{-1}$) and the annual rate increment for each parameter of *Corymbia citriodora* and *Cupressus sempervirens* irrigated with primary treated wastewater from 2009 till 2013.

Factors	Height (m)	ARIH (m)	Diameter) (cm)	ARID (cm)	Basal area (cm^2 $tree^{-1}$)	ARIBA (cm^2 $tree^{-1}$)	Tree volume (cm^3 $tree^{-1}$)	ARITV (cm^3 $tree^{-1}$)
Tree species								
C. citradora	8.48	1.90	8.86	1.73	66.30	22.46	34389.60	16740.80
C. sempervirans	6.18	0.59	10.33	1.12	85.70	17.96	27509.40	8007.50
F.test	**	N. S	N. S	**	N. S	N.S	N.S	N.S
L.S.D 5%	0.29	–––	–––	0.25	–––	–––	–––	–––
Years								
2009	4.80	–––	6.31	–––	33.47	–––	8448.10	–––
2010	6.65	1.85	9.10	2.78	65.60	32.13	22348.80	13900.60
2011	7.29	0.63	9.88	0.78	77.29	11.68	28803.10	6454.30
2012	8.10	0.81	10.64	0.75	89.33	12.04	37208.00	8404.80
2013	9.81	1.71	12.04	1.40	114.33	25.00	57939.50	20736.80
F.test	**	N. S	**	**	**	**	**	**
L.S.D 5%	0.42	–––	0.35	0.55	7.56	8.03	2889.00	3277.50
Interaction								
***C. citradora**2009**	4.66	–––	4.72	–––	17.76	–––	4612.60	–––
***C. citradora**2010**	7.54	2.87	8.47	3.75	56.80	39.03	23175.00	18562.30
***C. citradora**2011**	8.43	0.88	9.28	0.80	68.00	11.20	30999.00	7824.00
***C. citradora**2012**	9.46	1.03	10.15	0.87	81.35	13.34	41596.30	10597.30
***C. citradora**2013**	12.30	2.84	11.67	1.51	107.62	26.27	71565.30	29979.60
***C. sempervirans**2009**	4.94	–––	7.90	–––	49.17	–––	12283.60	–––
***C. sempervirans**2010**	5.77	0.82	9.73	1.82	74.41	25.24	21522.60	9239.00
***C. sempervirans**2011**	6.15	0.38	10.49	0.76	86.57	12.16	26607.30	5084.60
***C. sempervirans**2012**	6.74	0.59	11.12	0.63	97.31	10.74	32819.60	6212.30
***C. sempervirans**2013**	7.32	0.58	12.40	1.28	121.05	23.73	44313.60	11494.00
F.test	**	N. S	**	**	N.S	**	**	**
L.S.D 5 %	0.60	–––	0.20	0.78	–––	11.36	6460.10	4635.00

** Highly significant * Significant N.S- Non significant

ARIH: Annual rate increment of tree height

ARID: Annual rate increment of stem diameter at breast height

ARIBA: Annual rate increment of basal area

ARITV: Annual rate increment of tree volume

Table 4. Mean values of tree total fresh weight (kg tree^{-1}), dry weight (kg tree^{-1}) and the annual rate increment for each parameter of *Corymbia citriodora* and *Cupressus sempervirens* irrigated with primary treated wastewater from 2009 till 2013.

Factors	Fresh weight (kg tree^{-1})	ARIFW (kg tree^{-1})	Dry weight (kg tree^{-1})	ARIDW (kg tree^{-1})
Tree species				
C. citradora	124.74	29.28	80.54	13.39
C. sempervirans	102.85	19.91	60.34	16.76
F.test	**	————	**	————
L.S.D 5%	0.66	————	3.89	————
Years				
2012	101.50	————	62.90	————
2013	126.10	24.60	77.98	15.07
F.test	**	————	**	————
L.S.D 5%	5.84	————	4.72	————
Interaction				
*C. citradora**2012	110.10	————	73.85	————
*C. citradora**2013	139.38	29.28	87.24	13.39
*C. sempervirans**2012	92.90	————	51.96	————
*C. sempervirans**2013	112.81	19.91	68.73	16.76
F.test	N. S	————	N. S	————
L.S.D 5 %	————	————	————	————

** Highly significant * Significant NS- Non significant
ARIFW: Annual rate increment of total fresh weight
ARIDW: Annual rate increment of total dry weight

Table 5. Effect of five years irrigation with primary treated wastewater on basal area (m² ha^{-1}), total volume (m³ ha^{-1}) and total dry biomass (ton ha^{-1}) of *Corymbia citriodora* and *Cupressus sempervirens*.

Factors	Basal area m² h^{-1}	Total volume m³ h^{-1}	Total dry biomass Ton h^{-1}
*C. citradora**2009	1.97	5.11	————
*C. citradora**2010	6.30	25.72	————
*C. citradora**2011	7.54	34.40	————
*C. citradora**2012	9.02	46.17	81.90
*C. citradora**2013	11.94	79.43	96.75
*C. sempervirans**2009	5.45	13.63	————
*C. sempervirans**2010	8.26	23.89	————
*C. sempervirans**2011	9.60	29.53	————
*C. sempervirans**2012	10.80	36.42	57.63
*C. sempervirans**2013	13.43	49.18	76.22

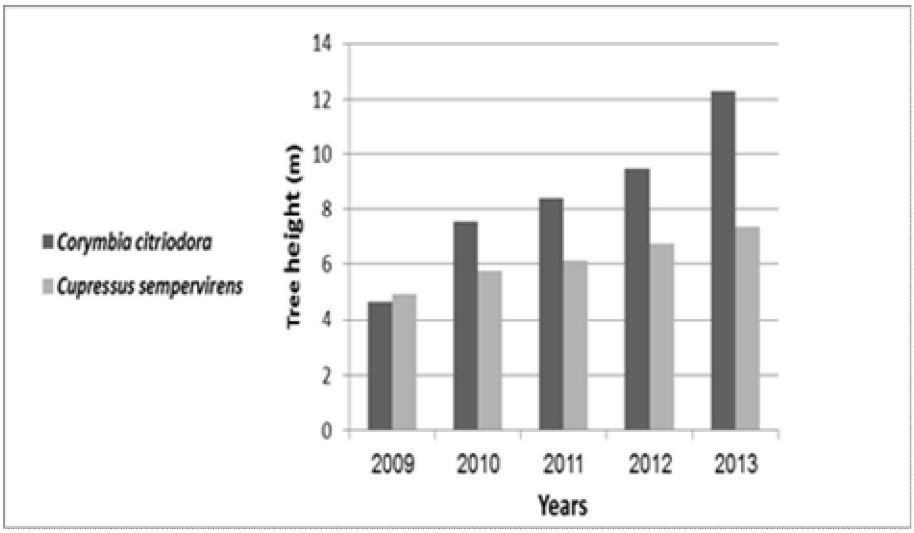

Fig. 1. Height of *Corymbia citriodora* and *Cupressus sempervirens* affected by irrigated with primary treated wastewater from 2009 till 2013.

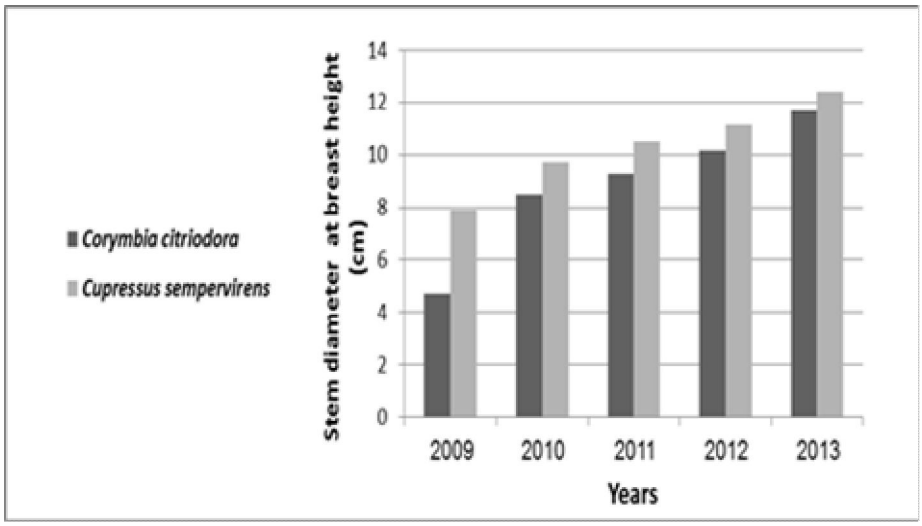

Fig. 2. Stem diameter of *Corymbia citriodora* and *Cupressus sempervirens* affected by irrigated with primary treated wastewater from 2009 till 2013.

CONCLUSION

Corymbia citriodora height significantly increased as compared to *C. sempervirens* during the 4 years period. The primary wastewater irrigation increased biomass, basal area and stem volume of two tree species through 5 years, 2010 year gave the highest increment for all tree parameter. These may be returned to good circumstances; climate and followed irrigation in this year as compared to other years, or the amount of water not enough for trees in the other years. Although, *C. sempervirens* was more than two folds tree volume of *C. citriodora* at 2009. But, *C. citriodora* showed the highest significant tree volume from 2010 till 2013.

Therefore, *C. citriodora* is recommended as a suitable species for afforestation using primary treated wastewater in irrigation followed by *C. sempervirens* species, and *C. sempervirens* evaluated may be suitable in longer rotations. The best growth performance of *C. citriodora* in Serabium forest revealed that growth of trees in desert planation's not correlated only with tree age or water availability but also with site condition and silviculture practices. More investigation on the same forest to the mature stage of the two species for the best use of the wood produced.

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معدل النمو والمساحة القاعدية والحجم لأشجار الكافور الليمونى و السرو التي تروى بمياه الصرف الصحى والصناعى المعالج بغابة سرابيوم

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غابة سرابيوم تبعد 15 كيلو متر عن مدينة الأسماعيلية، شرق القاهرة، والتى تم زراعتها منذ 25 سنة وتروى بمياه الصرف المعالجة لحوالى 129هكتار منزرعة بمختلف الأنواع الشجرية ذات الأنتاج العالى من الأخشاب.

أجريت الدراسة من 2009 حتى 2013 لنوعين من الأشجار، الكافور الليمونى والسرو عند عمر 4 سنوات منزرعة على مسافات زراعة 3× 3م وتروى بنظام الرى بالتنقيط بمياه الصرف الصحى والصناعى المعالجة أوليا لمقارنة النموو الناتج الخشبى لكلا النوعين.

أظهرت النتائج الزيادة التدريجية للنمو لكلا النوعين الشجرين خلال ال5 سنوات نتيجة الرى بمياه الصرف المعالجة. وقد أعطت أشجار الكافور الليمونى أعلى فرق معنوى للأطوال والكتلة الحيوية بالمقارنة بالسرو.

النتائج أظهرت أيضا أن أشجار الكافور الليمونى أعطت أعلى زيادة معنوية فى معدل النمو السنوى للمساحة قاعدية 39.03 سم^2 / شجرة تليها أشجار السرو 25.24سم^2 / شجرة. مع أن السرو أعطى أعلى حجم للشجرة فى2009 بالمقارنة بالكافور الليمونى (12283.6 و 4612.6 سم^3/ شجرة، على التوالى) إلا أن الكافور الليمونى تفوق معنويا على السرو من2010 وحتى 2013 . وفى نهاية التجربة، أشجار الكافور الليمونى أعطت أعلى قيم للحجم الكلى للهكتار تليها السرو (79.43 و 49.18 م^3 / الهكتار،على التوالى).

لذا يمكن استنتاج أن أشجار الكافور الليمونى أعطت أفضل نمو تلتها أشجار السرو، ذلك يجعل هذه الأنواع مناسبة للعديد من برامج التشجير خاصة الكافور الليمونى فى دورات القطع القصيرة والسرو فى دورات القطع الطويلة.