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Evaluation of Some Timber Trees Grown under West Delta Environmental Conditions in New Reclaimed Soils

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Abstract: This study was carried out in new reclaimed soil in a private farm in AbouGhalib region, Giza Governorate, Egypt, from 2015 to 2019. Aiming to determine the best tree species grown under these conditions as well as study the success of these tree species in the reclaimed lands under the environmental conditions of the West Delta region, irrigated with underground water. The used tree species were *Cupressus sempervirens, Khaya senegalensis, Swietenia mahagoni, Swietenia macrophylla, Taxodium distichum, Pinus pinea, Pinus halepensis, Populus euramericana, Eucalyptus gomphocephala, Azadirachta indicia* and *Paulownia tomentosa*. The results indicated that, *E.gomphocephala* followed by *K.senegalensis, S.macrophylla*, *P.euramericana* and *S.mahagoni* were the best tree species in total height. However *E.gomphocephala*, *K.senegalensis* and *P. tomentosa* were the best in root collar diameter. *E. gomphocephala*, *K.senegalensis*, *A. indica*, *T. distichum* and *Paulownia tomentosa* were higher in diameter at dbh. On the other hand, the best tree species in total biomass and total wood volume were *E.gomphocephala* followed by *K.senegalensis* and *T.distichum*. The best wood tree species in specific gravity were *K.senegalensis*, *A.indica* and *E. gomphocephala.* As for moisture content, it increased in *C.sempervirens* and *T. distichum*. The results showed also that, the highest mean value of nitrogen % in leaves were recorded with *S. mahagoni*, *K. senegalensis*, *C. sempervirens* and *E. gomphocephala*. The leaves of *A. indica, E. gomphocephala*, *P.tomentosa*, *K. senegalensis* and *C. sempervirens* contained higher phosphorus% than that of all the other tree species, while K% in *P.euramericana, E. gomphocephala*, *K. senegalensis* and *T.distichum* leaves were more than that of the other tree species. It is possible to say that, the trees under study can grow in the reclaimed lands under the environmental conditions of the West Delta region irrigated with underground water and also must be cultivated in the afforestation programs in Egypt for their environmental adaptability, economic and aesthetic importance in particular the trees of *E.gomphocephala*, *K.senegalensis*,*S.mahagoni*, *S.macrophylla, T.distichum* and *P.euramericana*.

Key words: Timber tree · New reclaimed soils · Growth measurements · Total biomass

INTRODUCTION

Egypt has a total area of approximately 1 million km^2, most of which is desert and only 5.5 % inhabited. Settlements are concentrated in and around the Nile Delta and its valley. The total cultivated soil area is about 8.6 million feddans, i.e.3% of the total land area and consists mostly of the old and newly reclaimed lands. Now Egypt needs a wide range of new projects aiming to expand the green stretch in the desert to produce timber trees of highly economic value. Water resources are the critical factor for all production processes and sustainable development in Egypt. Extending agriculture area to desert and maximizing water use efficiency are the two main components of the national agriculture strategy to increase agriculture production in Egypt. The most important objectives of the sustainable agriculture strategy 2030 are improving rural livelihoods

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(social return) and reducing poverty in the rural areas, promoting soil reclamation and developing farming systems, as well as sustainable utilization of natural agricultural resources [1].

The African mahogany (*Khaya senegalensis*), an exotic tree species of Meliaceae Family, stands out for its excellent wood quality, high prices in domestic and international markets, wood appreciated for carpentry, woodwork, shipbuilding and production of decorative veneers. It is one of the most economically important trees and used for high-class furniture, joinery, building and construction purposes. It has also high traditional medicinal values and used as an ornamental tree for gardens and avenues. The leaves are used to for fodder and the seeds have oil content and are rich in oleic acid [2].

Swietenia mahagoni (L.) Lam., an evergreen to semi-evergreen tree, up to 30-35 m. height. It has potential use for large scale timber production plantations, especially in dry areas, due to its excellent timber quality. It is also used in agroforestry, for soil improvement and as an ornamental tree [3].

Swietenia macrophylla King (Honduras or big leaf mahogany) is the most commercially important timber species in tropical America [4]. It is one of the best quality timbers for high class furniture and cabinet work due to its light hardwood quality in the world [5]. *S.macrophylla* become the first widely timber tree species to be listed in Appendix ii of the convention on international trade in endangered species, forests have been cleared from more than 63% of mahogany's range in MesoAmerica and 26% in South America [6].

Taxodium distichum (L.) Rich. (bald cypress, white-cypress, red-cypress, Gulf-cypress, or swamp cypress) is a deciduous conifer tree in the Family Cupressaceae that grows on saturated and seasonally inundated soils. The tallest known specimen is 44.00 m tall and the stoutest known has a diameter at breast height of 5.21 m. The oldest known living specimen is over 1.620 years old, rendering it one of the oldest living plants in North America. Although there are specimens estimated to be nearly 2,000 years old. Bald cypress wood is valuable for building construction, fence posts, planking in boats, river pilings, doors, blinds, flooring, shingles, garden boxes, caskets, interior trim and cabinetry [7].

Poplar trees (*Populus euramericana*), the member of the Salicaceae Family, are trees and shrubs with many valuable characteristics which have led to multiple beneficial uses for society and the environment since the dawn of history. The characteristics which have made them so attractive and useful include fast growth, ease of propagation, propensity to hybridize, pleasing appearance and many other uses. As well as providing wood, fiber, fuel wood and other forest products, poplars and willows benefit society in the rehabilitation of degraded land, restoration of forest landscapes and mitigation of climate change. All of these benefits support rural livelihoods and contribute to sustainable development, particularly in developing countries.

Poplar trees grow faster and reach to much greater dimensions within a year compared to many other tree species. In Egypt many *Populus* species grow well in different locations and *Populus euramericana* is one of the most important natural hybrid. The increasing worldwide demand for wood products after World War II and the rising world population growth accelerated the spread of fast-growing poplar hybrids to all corners of the world [8].

The Mediterranean *Cupressus*, *Cupressus sempervirens* L. (Italian Sypress) tree (Family Cupressaceae), it is a multipurpose tree, one of the most important evergreen softwood species. It is widely distributed and cultivated in different regions of Egypt, as growing in calcareous soils and for drought resistance. In addition, this species traditionally planted as windbreaks, making wood poles, sails boat and furniture [9].

Pinus halepensis is Miller (Aleppo pine) Family Pinaceae, are drought tolerant and fast growing coniferous species native of the Mediterranean region. These species have been widely planted for soil protection and wind breaks near the coasts. It is the main source of wood in many Mediterranean countries, it is used for various purposes including firewood as well as raw material for the pulp and paper industry [10].

The stone pine (*Pinus pinea* L.) is a medium-sized tree with a distinctive umbrella shape. It occupies and tolerates a broad range of climate and soil conditions, as it thrives in dry weather, strong direct sunlight and high temperatures. It prefers acidic, siliceous soils but also tolerates calcareous ones. The most important economic products obtained from these pines are the edible seeds (pine nuts), although they are also used for consolidation of sand dunes in coastal areas. This pine species is rarely attacked by pests and diseases [11].

The Neem tree (*Azadirachta indica*) is of Family Meliaceae. It is a tropical evergreen tree native to India. Neem is very valuable N2-fixing trees with multipurpose uses. It works as a good wind breaker and shelter belts in arid and semi arid regions. It has a reputed value for its herbal medicines. Along with the economic aspects likes' production of neem oil, neem cake and neem leaves. It has

a lot of importance in social forestry, agroforestry, reforestation and rehabilitating the waste lands and degraded industrial lands [12].

Paulownia tomentosa is a deciduous tree in the family Paulowniaceae, native to Central and Western China. It has been introduced into many countries including Egypt as an ornamental plant and is still widely used for this purpose, along with the production of energy, paper pulp and wooden building materials [13].

Eucalyptus gomphocephala (Family: Myrtaceae) is one of the best tree species that can be grown as a wind break or sand stabilization, as well as an avenue and shade tree. The wood works nicely and is good for the manufacture of boxes, construction, fence posts, stakes, trucks and wagons. It is an important tree in the honey production in Western Australia. It is also moderately salt tolerant and tolerates salty winds. It prefers a light sandy well-drained soil, open sunny position, drought and frost resistant [14].

This study aiming to evaluate the performance of these tree species in the new reclaimed soils under the environmental conditions of the West Delta region, irrigated with underground water.

MATERIALS AND METHODS

This investigation was carried out during years of 2015, 2016, 2017, 2018 and 2019 in a private farm (new reclaimed soil), AbouGhalib region, Giza governorate, Egypt, aiming to evaluate the performance of these tree species in the new reclaimed soils under the environmental conditions of the West Delta region, irrigated with underground water.

Experiment Design: One year old tree seedlings of the following species *Cupressus sempervirens, Khaya senegalensis, Swietenia mahagoni, S.macrophylla, Taxodium distichum, Pinus pinea, Pinus halepensis, Populus euramericana, Eucalyptus gomphocephala, Azadirachta indica* and *Paulownia tomentosa* and planted in open field in the first of March 2014, at 2.5x2.5m spacing; uniform tree seedlings were selected on the basis of height and stem diameter, ranging from 30- 45 cm height. These seedlings were irrigated with drip irrigation system.

Growth Measurements: Total height (cm), stem diameter (root collar diameter and diameter at breast height dbh(cm))were recorded after one, two, three, four and five years from planting in field, whereas, stem, branches and total biomass fresh and dry weight (kg), total wood volume (m^3 /tree) were recorded in the fifth year of planting. The content of nitrogen (N %) was determined using micro-Kjeldahl method, phosphorus (P%)was determined by using colorimetric determination and potassium (K%) were determined by flame photometer in leaves after five years according to Pregl [15]; Piper [16] and Brown and Lilliland [17], respectively.

In addition, three disks about 5 cm. in thickness at breast height (130 cm above -ground level) were removed from each tree for specific gravity and moisture content.

Specific gravity (gm/cm^3) and moisture content % were estimated according to American Society for Testing Materials (ASTMD) [18].

Soil and Water Analysis: Soil mechanical and chemical properties was determined before planting and after5years, according to Page *et al*. [19], as shown in Table (1). The chemical analysis of underground water according to APHA [20], are shown in Table (2).

Table 1: Mechanical and chemical analysis of soil before and after 5 years planting the tested tree species.

Mechanical analysis	Before planting 2014	After 5 years 2019
Course sand%	92.0	45.1
Find sand%	4.0	33.6
Silt%	1.9	18.3
Clay%	2.1	3.0
Texture grade of soil	Sandy	Loamy sand
Chemical analysis		
E.C. (dS/m)	2.30	7.18
pH (1:2.5)	7.80	7.10
SP %	20	30
Soluble cations (meq/l)		
Ca++	13.0	17.90
Mg++	5.30	15.30
Na+	1.60	36.90
K+	0.20	0.62
Soluble anions (meq/l)		
SO_4=	15.4	1.36
Cl-	3.70	68.70
HCO_3-	1.00	0.66
CO_3=	-----	-----

Table 2: Chemical analysis of underground water

Total soluble salts	
E.C.(ds/m)	2.5 (1600 ppm)
pH	7.60
Soluble anions	
CO_3=	--
HCO_3-	3.1
Cl-	15.7
SO_4=	6.2
Soluble cations	
Ca++	6.5
Mg++	6.0
Na+	11.3
K+	1.2
SAR	4.52
RSC	-----

Statistical Analysis: The experiment was carried out using a completely randomized design where each species contained three replicates and each replicate contained 4 seedlings.

Data of the growth measurements as well as specific gravity and moisture content, were statistically analyzed and means were performed according to Snedecor and Cochran [21]. Differences between treatments were compared by Duncan's multiple range test at 5% level according to Duncan [22].

RESULTS

Height Growth of Planted Tree Species During Study Period (cm.): Data on tree height (cm) of the different species after 1,2,3,4 and 5 years from planting in sandy soil and irrigated with underground water (1600ppm) are presented in Table (3). The data indicated that, there were significant differences between the different tree species in total height after one, two, three, four and five years from planting. Where, the total height of *Taxodium distichum* and *Khaya senegalensis* significantly increased (87.00 and 86.67cm) after one year from planting, respectively as compared to the other tree species, with non- significant differences in between. The total height of *Eucalyptus gomphocephala* and *Swietenia mahagoni* significantly increased (340.33 and 335.67 cm) after two years from planting, while after three years total height of *Populus euramericana* and *E.gomphocephala* significantly increased (513.33 and 512.67cm). After four years *E.gomphocephala* significantly gave the tallest tree (736.67 cm) as compared to other tree species. On the other hand, after 4 years from planting 6 tree species significantly gave the shortest tree height (553.67,538.67,518.00,505.67,505.00 and 498.00 cm.) for *S. macrophylla, P. euramericana, Paulownia tomentosa, S. mahagoni, Azadirachta indica* and *K. senegalensis*, respectively as compared to *E. gomphocephala* (736.67 cm), while the differences among themselves were insignificant. At least coniferous planted species significantly gave the shortest height, *T. distichum* (425.33 cm), *C. sempervirens* (424.33 cm), *P. halepensis* (330.67) and *P. pinea* (72.33 cm) after 4 years from planting as compared to broad leaves plant species. The differences between *C. sempervirens* and *T. distichum* were insignificant, but they significantly increased as compared to the two *Pinus* species. Also, *P. halepensis* significantly gave the tallest stem height as compared to *P.pinea*. Regarding stem height after 5 years from planting,data presented in Table (3) indicated that, it took the same trend of the forth years. i.e. *E.gomphocephala* was the dominant in stem height followed by 6 broad leaves tree species at least the coniferous tree take the end order.

Stem Diameter of Planted Tree Species During Study Period (cm.): Data in Table (4) show the annual growth of stem diameter (root collar diameter and diameter at breast height) from planting up to 5 years, the data illustrated that, *E.gomphocephala* and *K.senegalensis* recorded the highest value of root collar diameter (2.07 and 4.47) and (1.70 and 3.60 cm),respectively after one and two years from planting as compared to the other tree species with non significant differences between themselves with the exception of the differences between *K.senegalensis* and *E.gomphocephala* in root collar diameter after one year from planting. However, *K.senegalensis*, *T.distichum, P.tomentosa* and *S.macrophylla* significantly gave the highest root collar diameter (10.00, 9.00, 8.83 and 8.50 cm), respectively after three years from planting with non-significant differences among themselves,while the differences between *S. macrophylla* and *T. distichum* in one side and *S. mahagoni* and *E.gomphocephala* on the other side were non- significant at the same stage. After 4 and 5 years from planting, *E.gomphocephala* significantly gave the highest value of root collar diameter

Table 3: Height growth of planted tree species during study period (cm.)

Tree species	1st	2nd	3rd	4th	5th
Cupressus sempervirens	68.33 c	203.00ef	308.33 c	424.33 c	492.33 cd
Khaya senegalensis	86.67ab	257.67 cd	391.67 b	498.00 b	616.67 b
Swietenia mahagoni	62.00 cd	335.67 a	397.33 b	505.67 b	582.00 b
Swietenia macrophylla	36.33 f	266.00bc	405.67 b	553.67 b	609.00 b
Taxodium distichum	87.00 a	206.33 def	296.67 c	425.33 c	460.33 d
Pinus pinea	43.67ef	52.00 g	61.33 d	72.33 e	114.33 f
Pinus halepensis	73.33bc	177.67 f	259.67 c	330.67 d	372.33 e
Populus euramericana	53.67 de	312.67ab	513.33 a	538.67 b	600.00 b
Eucalyptus gomphocephala	44.33ef	340.33 a	512.67 a	736.67 a	856.67 a
Azadirachta indica	51.67 de	266.67bc	394.33 b	505.00 b	558.00bc
Paulownia tomentosa	69.33 c	234.00cde	435.67 b	518.00 b	580.00 b

Within a column the values having the same letters are not significantly different according to Duncan's multiple range test at 5%level.

Table 4: Stem diameter of planted tree species during study period (cm.)

	Stem diameter (cm)									
	Root collar diameter					Diameter at breast height (dbh)				
Tree species	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Cupressus sempervirens	0.70fg	1.47 e	4.33 e	9.50 de	12.00 e	-*	0.80 cd	3.43 d	4.73ef	8.20d
Khaya senegalensis	1.70 b	3.60ab	10.00 a	14.33 b	16.67 b	-	2.10 a	7.27 a	8.70 b	11.33b
Swietenia mahagoni	1.03cdef	2.70bc	8.17bc	10.53cde	12.00e	-	0.90 cd	5.30bc	7.00c	8.03de
Swietenia macrophylla	1.10 cd	2.40 cd	8.50ab	11.00 cd	12.33de	-	1.30 b	4.70 cd	6.20cd	8.20d
Taxodium distichum	1.23 cd	2.50 cd	9.00ab	12.33bc	14.33 cd	-	1.07bc	6.83 a	7.77bc	9.77c
Pinus pinea	0.73efg	1.47 e	2.13 f	3.63 f	5.07g	-	-	-	-	-
Pinus halepensis	0.90defg	2.27cde	4.03 e	10.27de	11.67ef	-	0.60 d	1.43 e	3.73 f	5.73 f
Populus euramericana	1.07cde	2.57 c	5.63de	8.40 e	9.77 f	-	1.07bc	4.43 cd	5.37de	6.73ef
Eucalyptu gomphocephala	2.07 a	4.47 a	7.73bc	18.67 a	20.67 a	-	1.80 a	4.27 cd	10.33a	14.33a
Azadirachta indica	1.33 c	2.70bc	6.60cd	11.67 cd	13.00de	-	1.10bc	5.17bc	7.77bc	10.13bc
Paulownia tomentosa	0.60 g	1.60 de	8.83ab	13.00bc	15.33bc	-	0.83cd	6.50ab	7.63bc	8.83cd

Within a column the values having the same letters are not significantly different according to Duncan's multiple range test at 5%level.

*No dbh was taken where trees is not reach to minimum height to measure dbh at 130 cm.

as compared to all other tree species. On the other hand, all broad leaves tree species gave higher significantly root collar diameter than the coniferous tree species. *P. euramericana* which root collar diameter was significantly smaller than *C. sempervirens* and *T.distichum* especially after 5 years from planting. Regarding the differences among coniferous species. Table (4) data indicated that, root collar diameter, were significantly decreased in a descending order as follows *T.distichum*, *P.halepensis*, *C.sempervirens* and *P.pinea* as the values were 12.33, 10.27,9.50 and 3.63 cm after four years and 14.33,11.67,12.00 and 5.07 cm after 5 years, respectively, with the exception of the difference between *C.sempervirens* and *P.halepensis* in the two stages.

Concerning the diameter at breast height (dbh) the same data cleared that, *K.senegalensis* and *E.gomphocephala* significantly increased dbh (2.10 and 1.80 cm), respectively after two years from planting as compared to all other tree species. However, *K.senegalensis*, *T.distichum* and *P.tomentosa* significantly increased dbh (7.27,6.83 and 6.50 cm), respectively after three years from planting as compared to other tree species, with the exception of the differences among *P.tomentosa*, *A. indica* and *S.mahagoni*. On the other hand, *E.gomphocephala* significantly increased dbh (10.33 and 14.33 cm) after four and five years, respectively from planting as compared to all other tree species.

Fresh and Dry Weights of Stem, Branches and Total Biomass: After 5 years from planting the seedlings of the different tree species in the sandy soil and irrigated with underground water (1600ppm), the fresh weights of stem, branches and total biomass as well as dry weights, were determined. The data obtained (Table 5) indicated that, tree stem fresh weights significantly decreased in a descending order as the tree species were *Eucalyptus gomphocephala*, *Khaya senegalensis*, *Azadirachta indica*, *Taxodium distichum*, *Populus euramericana*, *Cupressus sempervirens*, *Swietenia mahagoni*, *S. macrophylla*, *Paulownia tomentosa*, *Pinus halepensis* and *P.pinea*, with the exception of the differences between *P.tomentosa* and *S.macrophylla* which were insignificant. For stem dry weight the same data showed that, most of tree species took the same trend of stem fresh weights arrangement which the arrangement of tree species were *E.gomphocephala* (56.50 kg), *K.senegalensis* (34.80 kg), *A.indica* (30.60 kg), *P. euramericana* (22.91 kg), *S.mahagoni* (21.20 kg), *T.distichum* (20.37 kg), *C.sempervirens* (17.00 kg), *S.macrophylla* (14.60 kg), *P.tomentosa* (13.00 kg), *P.halepensis* (9.47 kg) and *P. pinea* (0.69 kg). However the differences between *S.mahagoni* and *T.distichum* were non- significant also, the differences between *T. distichum* and *C.sempervirens* were also insignificant.

As forbranches fresh and dry weights data presented in Table (5) indicated that, *E .gomphocephala* significantly increased branches fresh and dry weights (103.00 and 57.10 kg), respectively as compared to all other tree species, followed by *K.senegalensis* branches fresh weights (45.00 kg) and *C.sempervirens* dry weight (21.79 kg)as compared to all other tree species, with significant differences between them.

Table 5: Fresh and dry weights of stem, branches and total biomass (After 5 years from planting)

Tree species	Stem fresh weight (kg)/tree	Stem dry weight (kg)/tree	Branches fresh weight (kg)/tree	Branches dry weight (kg)/tree	Total biomass fresh weight (kg)/tree	Total biomass dry weight (kg)/tree
Cupressus sempervirens	35.15 f	17.00 f	36.00 c	21.79 b	71.15 e	38.79 d
Khaya senegalensis	60.08 b	34.80 b	45.00 b	17.30 c	105.08 b	52.10 b
Swietenia mahagoni	34.23 g	21.20 e	13.73 f	6.25 i	47.97 g	27.45 f
Swietenia macrophylla	25.00 h	14.60 g	17.67 e	7.41 h	42.67 h	22.01 g
Taxodium distichum	41.27 d	20.37ef	37.50 c	14.40 d	78.77 c	34.77 e
Pinus pinea	1.17 j	0.69 j	4.33 h	1.50 k	5.51 k	2.19 i
Pinus halepensis	17.20 i	9.47 i	19.00 e	11.00 f	36.20 i	20.47 g
Populus euramericana	39.00 e	22.91 d	18.67 e	9.00 g	57.67 f	31.91 e
Eucalyptus gomphocephala	97.08 a	56.50 a	103.00 a	57.10 a	200.08 a	113.60 a
Azadirachta indica	46.00 c	30.60 c	28.00 d	13.33 e	74.00 d	43.93 c
Paulownia tomentosa	24.33 h	13.00 h	8.73 g	4.47 j	33.06 j	17.47 h

Within a column the values having the same letters are not significantly different according to Duncan's multiple range test at 5%level.

Table 6: Total wood volume (m^3 /tree)

Tree species	Total volume (m^3/ tree)
Cupressus sempervirens	0.0340
Khaya senegalensis	0.0665
Swietenia mahagoni	0.0351
Swietenia macrophylla	0.0586
Taxodium distichum	0.0854
Pinus pinea	0.0036
Pinus halepensis	0.0178
Populus euramericana	0.0419
Eucalyptus gomphocephala	0.1013
Azadirachta indica	0.0499
Paulownia tomentosa	0.0322

Concerning total biomass fresh and dry weights, the same data showed that, *E.gomphocephala* significantly increased total biomass fresh and dry weights (200.08 and 113.60kg, respectively) as compared to all other tree species.

Moreover, there were marked increments in the fresh as well as dry weights of total biomass incase of *K. senegalensis* and *A. indica* (105.08,52.10 and 74.00, 43.93 kg, respectively), as compared with the other tree species, with the exception of total biomass fresh weights in *T. distichum* only, but they were significantly less that of *E.gomphocephala.*

Total Wood Volume (m^3/tree): Data presented in Table (6) revealed that, total wood volume of *E. gomphocephala* recorded the highest value (0.1013 m^3 /tree) as compared to other tree speciesafter five years from planting, followed by *T. distichum* and *K.senegalensis* (0.0854 and 0.0665 m^3 /tree, respectively).

Specific Gravity (g/cm^3) and Moisture Content (%): It is obvious from data presented in Table (7) that, *K. senegalensis* significantly gave the highest value of specific gravity (0.65g/cm^3) as compared to all other trees planted species, with the exception of *A. indica* and *E. gomphocephala* (0.64 and 0.61 g/cm^3), respectively recorded non- significant differences among themselves. On the other side, *P.tomentosa* significantly gave the lowest value of specific gravity (0.40 g/cm^3) as compared to all other planted tree species, with the exception of *T.distichum*, *C. sempervirens* and *P.halepensis* (0.42,0.43 and 0.48 g/cm^3). Also, the same data pointed out that, moisture content significantly increased in *C.sempervirens* and *T. distichum* (106.60 and 106.00%), respectively as compared to all other trees planted species. while the moisture content significantly decreased in *A.indica* (51.65%) as compared to all other tree planted species with the exception of *S. mahagoni* (63.33%).

N, P and K Contents: After 5 years from planting, data presented in Table (8) indicated that, the highest mean values of nitrogen% were recorded in leaves of *S. mahagoni*, *K. senegalensis*, *C. sempervirens, E. gomphocephala* and *T. distichum*, giving 2.76, 2.34, 2.21, 2.12 and 2.07 %, respectively. The leaves of *A.indica, E.gomphocephala*, *P.tomentosa*, *K.senegalensis* and *C.sempervirens* recorded higher phosphorus% than that of all the other species (0.36, 0.33, 0.33, 0.32 and 0.30%, respectively). The K% in leaves of *P. euramericana, E.gomphocephala*, *K.senegalensis* and *T. distichum* leaves were higher than that of the other species (1.92, 1.70, 1.63 and 1.60 %, respectively).

Table 7: Specific gravity (g/cm$^{3)}$ and moisture content (%)

Tree species	Specific gravity(g/cm^3)	Moisture content (%)
Cupressus sempervirens	0.43ef	106.60 a
Khaya senegalensis	0.65 a	74.75 c
Swietenia mahagoni	0.51cde	63.33 de
Swietenia macrophylla	0.54bcd	75.00 c
Taxodium distichum	0.42ef	106.00 a
Pinus pinea	0.51cde	70.00 cd
Pinus halepensis	0.48 def	88.70 b
Populus euramericana	0.51cde	74.80 c
Eucalyptus gomphocephala	0.61abc	71.11 cd
Azadirachta indica	0.64ab	51.65 e
Paulownia tomentosa	0.40 f	92.30 b

Within a column the values having the same letters are not significantly different according to Duncan's multiple range test at 5%level.

Table 8: N, P and K contents

Species	N (%)	P (%)	K (%)
Cupressus sempervirens	2.21	0.30	1.44
Khaya senegalensis	2.34	0.32	1.63
Swietenia mahagoni	2.76	0.19	1.43
Swietenia macrophylla	1.97	0.24	1.56
Taxodium distichum	2.07	0.27	1.60
Pinus pinea	1.42	0.14	1.10
Pinus halepensis	1.73	0.15	1.20
Populus euramericana	1.71	0.27	1.92
Eucalyptus gomphocephala	2.12	0.33	1.70
Azadirachta indica	1.53	0.36	1.30
Paulownia tomentosa	1.85	0.33	1.50

DISCUSSION

Egypt suffers from shortage in wood- raw material which is necessary for several industrial uses; which depend mainly on the imported wood. However, there are many important woody species available and valuable for afforestation program in Egypt from which a selection should be conducted for using and cover the different of industrial sectors. Forest plantations are grown to supply raw material for industry and for other uses, such as fuel wood. The potential for forest plantations to partially meet the demand for wood and fiber for industrial uses is increasing. Forest plantations also provide additional non-wood forest products and benefits, from the trees planted or from other elements of the ecosystem that they help to create. They contribute environmental, social and economic benefits. Forest plantations are used in combating desertification, absorbing carbon to offset carbon emissions, protecting soil and water, rehabilitating soils, providing rural employment and if planned effectively, diversifying the rural landscape and maintaining biodiversity. In several countries, a significant portion of the wood supply for industrial uses comes from plantations, rather than natural forest resources. Forest plantations development has positive economic, environmental, social, or cultural impacts, however, without adequate planning and without appropriate management, forest plantations may be grown in the wrong sites, with the wrong species/provenances, by the wrong growers, for the wrong reasons [23]. The cause of the non-existence of forest in Egypt is not only due to the climatic conditions and the scarcity of rainfalls, but also as a result of the urbanisation and the focus on food production for the rapid population increasment. Although the geographical area of Egypt is large, exceeding one million km2, desert land dominates over 96% of the total country area with little scattered shrub vegetation. Most of the country's vegetation grows in the Nile delta and valley "the most extensive oasis worldwide" [24]. The Nile Delta and Valley have a rich variety of tree species, of which some indigenous and some exotic [25]. Hörl [26] showed that, the potential of forest trees growing in Egypt is high: 134 forestry-relevant tree-species that are growing in only two parks in Cairo were found. El Kateb and Mosandl [27] determined the yield of some tree species of the plantations forests in Egypt, which was high and estimated that the yield achieved in Egypt is

approximately attained 4.5 times earlier than in Germany, the leading country in forestry in Europe. Khalifa *et al*. [28] studied the feasibility of the afforestation in Egypt using sewage water and mentioned its environmental, social and economical feasibility.

In Egypt, few studies have been carried out for evaluation of the basic information on the qualification and characterization of some woody tree species which were introduced and grew well under the local environmental conditions. Therefore, the objectives of this study were to evaluate the characters of growth, total biomass, total volume of trees and to evaluate some important traits of wood such as moisture content of the wood and specific gravity for eleven tree species after five years from planting in field, under new reclaimed soils. It can be concluded from the aforementioned results that, some tree species grow well under new reclaimed soils conditions of the West Delta region and irrigated with underground water. After five years from planting data showed that, *Eucalyptus gomphocephala, Khaya senegalensis, Swietenia macrophylla, Populus euramericana, Swietenia mahagoni, Paulownia tomentosa* and *Azadirachta indica* were the best trees in height growth.As for the best trees in root collar diameter *E. gomphocephala, K.senegalensis* and *P.tomentosa*, were the best. While *E. gomphocephala,K. senegalensis*, *A.indica, T.distichum* and *P.tomentosa* were the best in stem diameter.

These results are agreement with those reported by Abd El-Kader and Rabie [29] on *Cupressus sempervirens* and *Swietenia mahagoni* they found that, the statistical difference in total height was recorder highly significant between tree species. Also found Abd El-Dayem [30] and El-Morshedy *et al.* [31] the differences among planted species in growth (dbh and total height) and total stem volume yield were due to many factors, namely; genetic response to such environmental condition and adaptability of such locations. Carle *et al.* [24] and Hassan *et al.* [32] studied growth and wood production of five tree species. Results showed considerable differences in growth parameters (height, diameter, basal area and stem volume) and elements content between tree species under study. *Taxodium distichum* was the most suitable species for irrigated tree plantations on the basis of wood production. Hopmans *et al.* [33] cleared that, height and diameter growth significantly varied between species. At age 4years, mean dominant height of *Eucalyptus grandis, E. saligna and Populus deltoides* × *P. nigra* ranged from 14.3 to 15.0 m compared with 6.6 to 9.8 m for *Casuarina cunninghamiana, E. camaldulensis, P. deltoids* and *Pinus radiata*. Wood production of the faster-growing species (*E. grandis and E. saligna*) was approximately130 m^3ha-1 or around 32 m^3 ha-1 year-1 over a 4-year period. This was nearly three-fold the production of the other native species and twice that of *P. radiata*. Volume growth of *P. deltoides* × *P. nigra* (85 m^3 ha-1) was significantly greater than that of *P. deltoides* (42 m^3 ha-1).Accumulation of nutrients in the above-ground biomass varied significantly between species.

On the other hand, our results indicated that the best tree species in total biomass and total wood volume were *Eucalyptus gomphocephala* followed with *Khaya senegalensis* and *T.distichum,* while the best wood tree species in specific gravity were *K.senegalensis*, *A.indica* and *E. gomphocephala.* As for moisture content it increased in *C.sempervirens* and *T. distichum*. Also these results are harmony with that of El-Morshedy *et al*. [23] reported that there was wide range in between *Pinus roxbourghii* and *Pinus halepensis*, also *P.roxbourghii* was superior in the wood productivity than that of *P. halepensis*. Thus, *P.roxbourghii* would be preferable in afforestation program.Also found that the moisture content in *P.roxbourghii* ranged between 83.4 to 143.7%, specific gravity varied from one tree to another and within each tree. Ismail *et al.* [34] estimated biomass production and some properties of *K. senegalensis* wood grown in southern Egypt, they found that, biomass of *K.senegalensis* with planting density of 3.5x3.5 (343 stems/fed) at an age 14-yr.,total biomass (176.70 m^3/fed),wood manufacturing (98.80m^3/fed) and fuel wood (44.40 ton/fed).The average of moisture content (63.38±4.69%) and specific gravity (0.57±0.03g/cm^3). Also, they decided that, the establishment must be performed and follow up of similar studies in different regions of Egypt.

Finally, there is increasing potential for forest plantation investment to offset carbon emissions and contribute significantly to the Clean Development Mechanism of the Kyoto Protocol. Ismail *et al.* [35] estimated tree biomass and some wood mechanical properties of *Cupressus sempervirens* and *Corymbia citriodora*. The results showed that, *C.citriodora* was superior over *C.sempervirens* for most of biomass parameters (total and merchantable height, total volume, green and dry weights and total above ground biomass) at the age of 5 and 7 years. However, the increment percentage of biomass from 5 to7 years of age was higher in *C.sempervirens* than *C. citriodora*. The use of forest biomass as a primary source of energy has decreased in the past century as a result of the massive use of fossil

fuels (coal, natural gas, etc.). However, recognition of the need to reduce our dependence on fossil fuels and to meet emissions commitments in terms of carbon credits has promoted renewed consideration of forest biomass, forest residues and short-rotation biomass plantations as potentially important sources of renewable energy [36, 37]. Forest biomass is thus a potentially significant source of renewable energy for the energy sector, consistent with the ecological and economic importance of forests [38]. Moreover, as current European Union (EU) policy (Directive2009/28/EC) endorses a mandatory target of a 20% share of energy from renewable sources in over all energy consumption in the EU by 2020, woody biomass is expected to be an important energy resource in the near future.

Kanawjia *et al*. [39] investigated the specific gravity of wood samples collected from a total of 31 woody species, consisting of 20 trees, 10 shrubs and one species of bamboo. Results showed that, among these woody species, the specific gravity of trees ranged from 0.34 for *Erythrina suberosa* to 0.83 for *Albizzia procera*. For shrub species the specific gravity of *Ricinus communis* was 0.39 and that of *Dodonaea viscose* 0.93. The average specific gravity of trees was 0.58 and of shrubs 0.66. Kayad *et al*. [40] studied the variation of specific gravity between two of eucalypt, as they found that, specific gravity were values (0.591±0.010) and (0.660± 0.012) for *Eucalyptus camaldulensis* and *Eucalyptus occidentalis*, respectively. Also, they found that the variations between *Eucalyptus* species are very important for chemical technology and wood scientists working on pulp wood quality parameters in hardwoods.

CONCLUSION

Through this study, it can be concluded that, such important tree species can be cultivated under new reclaimed soils conditions of the West Delta region and irrigated with underground water and expanded it in the different afforestation programs and anti-desertificationin Egypt. Also, the perfect tree species in growth under these conditions (*Eucalyptus gomphocephala, Khaya senegalensis, Swietenia macrophylla, Populus euramericana, Swietenia mahagoni and Taxodium distichum*) can be used in afforestation in the same area or another area has the same environmental conditions, as this species of the trees can be used in establishment new plantation forest to get wood or other products from trees. Also it can be used the superior trees as windbreaks around fields and farms to protect them and reduce the wind harms and improvement of the microclimate, thus achieving higher yield of the protected crops because of their adaptability to Egyptian environmental conditions, biomass production and economic importance, especially *E.gomphocephala, K.senegalensis, S.macrophylla, P.euramericana, S.mahagoni, T.distichum, P.tomentosa* and *A.indica*. As for the coniferous tree species, they are among tree species which have a good quality and we need to expand their cultivation in the new reclaimed soils. In addition, they are growing slowly only in the first stage of their life and need to more time to get good growth as compared to the other trees species included in this study.

The superior tree species under this study are suitable for reforestation programs and anti-desertification in Egypt.

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