J. Plant Production, Mansoura Univ., Vol. 9 (8): 637 - 640, 2018

Biomass and some Mechanical Properties for *Cupressus sempervirens* and *Corymbia citriodora* Planted in Serabium Sewage Station

Maha F. M. Ismail; Safaa A. S. Ghorab and Mona M. Abbas

Forestry and Timber Trees Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt

(dr.mahafarouk@yahoo.com, safaaahmed4242@gmail.com, Monaabbas@yahoo.com)

ABSTRACT

The present study was conducted during 2012 and 2013 in Serabium forest. The aim of this study was to estimate tree biomass and some wood mechanical properties of *Cupressus sempervirens* L and *Corymbia citriodora* Hook. 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 weight and total above-ground biomass) at the age of 5 and 7 years. However, the increment percentage of biomass from 5 to 7 years of age was higher in *C. sempervirens* than *C. citriodora*. Mechanical properties obtained from the static bending test, Modulus of Elasticity (MOE), Modulus of rupture (MOR), and Tensile strength recorded higher mean values as the trees get older while they recorded lower mean values from base to top within the tree for both species. Mean values of MOE, MOR and Ten.st. for *C. sempervirens* at age of 7 years old at DBH were 8128.5, 83.0 and 64.4 N/mm^2; respectively, while, these values were 15503.5, 158.8 and 149.0 N/mm^2; respectively for *C. citriodora*. These results revealed that, wood mechanical properties for *C. citriodora* were higher than *C. sempervirens*.

Keywords: biomass, mechanical properties, wood, Corymbia citriodora, Cupressus sempervirens.

INTRODUCTION

Timber trees in Egypt, are not directed to wood processing, may be due to the lack of sufficient quantities for manufacturing, lack of knowledge of the potential for most species and limited research on the utilization of wood. For these reasons, most timber trees were used as fuel wood, charcoal and manufacture of some modest tools or furniture in rural areas. This present study is focused on the tree biomass production and some wood mechanical properties of *Corymbia citriodora* Hook (*Eucalyptus citriodora*) and *Cupressus sempervirens* L. Whereas, Eucalyptus spp. becomes a subject of interest as raw material for wood composite panels in many tropical and sub tropical countries including Thailand, Chile, Brazil and Malaysia, (Nacar *et al.,* 2005).

Both species under this study are grown in most ecological zones in Egypt, and in a wide range of soil including infertile sands and heavy clays. In the 1990's and early 2000's, they were cultivated widely on sewage water in desert lands (land designated for Sewage Treatment Stations).

Ye (2011) suggested that *Corymbia citriodora* sub sp. *variegata* could be a good commercial species for Eucalypt plantations managed for solid wood products. Some Australian hardwood *Eucalyptus* species can be easily dried whereas other species of high commercial value are considered to be some of the most difficult to dry in the world (Vermaas, 1995).

The wood of cypress (*Cupressus* spp.) have medium texture, straight grain and show soft resistance to manual cross-cutting. It has a characteristic odor, very agreeable smell and the natural protective oil gives it an aromatic and durable scent.

Its light color, anatomical characteristics and easy processing, makes it comparable to some common and commercial hardwood and softwood species, mainly *Pinus* spp., (Okino *et al*., 2010).

Most of the mechanical properties commonly measured and represented as "strength properties" for design include modulus of rupture in bending, maximum stress in compression parallel to grain, compressive stress perpendicular to grain, and shear strength parallel to grain. Wood properties related to solid wood uses or structural applications are modulus of rupture, modulus of elasticity, percentage of tension, dimensional stability, grain and texture (Hoadley 2000, Wiedenhoeft 2010). *Corymbia citriodora* has a good mechanical properties such as compression perpendicular to the grain strength had the average values higher than that determined for *Pinus taeda* L. (17.00 MPa and 3.60 MPa) ,respectively, Almeida *et al.* (2017).

Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) are important properties for the use of wood as structural material. MOE is an indication of stiffness of board or structural member, while MOR is an indication of strength (Johnson and Gartner, 2006). Timber does not have consistent, predictable, reproducible and uniform properties, as the properties vary with species, age, site and environmental conditions (Kliger, 2000).

The purpose of this study was to determine the tree biomass and some wood mechanical properties for *Corymbia citriodora* Hook and *Cupressus sempervirens* L, to be used as a raw material in wood composites such as particleboard and plywood.The Egyptian market is in urgent need for these industries.

MATERIALS AND METHODS

Biomass and some wood mechanical properties of *Cupressus sempervirens* L as a softwood species and *Corymbia citriodora* Hook as a hardwood species, were determined. *Cupressus* and *Corymbia* timber trees samples had an average age of 5 and 7 years were collected from Serabium forest (15 km of Ismailia, Egypt). The distances between trees were 3×3 m. The trees were irrigated three times weekly using a drip irrigation system with primary treated sewage water collected from the oxidation ponds of Serabium station.

Tree measurements and selection

The diameter at breast high (130 cm above-ground level) for the trees grown in the sector under this study was measured to calculate the trees average diameters, then three trees were selected (according to the calculated average diameter) were cut from both species and the two ages (5 and 7 years). The total number of the sampled tree was 12 (2 species × 2 ages × 3 trees).

Tree height:

Total tree height (from stump to the tree top) and merchantable tree height (from the stump up to 4 cm stem diameter) were measured by a measuring tape (m/tree).

Above-ground biomass

Trees were felled and the aboveground portion processed into stem wood, branches and foliage at the field. Total height was measured from stump height (20 -30 cm from ground level) to the tree top. The stem at the top was cut at about 4 cm diameter to measure the merchantable height and the part smaller than 4 cm was included as branches.

Leaves that were removed from the branches by hand and branches less than 4 cm combined as foliage.

Stem volume calculation:

Stem volume of each tree was measured using a measuring tape and recording the stem diameter at the certain points intervals along tree stem, and length between these points. The volume of each section was determined and they were summed to give the total volume.

Green and dry weight determination:

The stem was divided into the base ground up to 130 cm diameter (DBH), and the distance between DBH and merchantable tree height (4 cm diameter) divided to four sections. Green weights were measured using digital scale (0.1 kg) in the field for stem, branches and foliage (Kg/ tree). From each section of stem, a disk with 50 cm length was cut and all of them were oven dried until constant weight at 70^{O}C for foliage and 102±3 ^{O}C for stem and branches. Dry weight was determined and recorded to calculate total oven-dry weight of tree. The percentages of green and dry weight for each component to the total above-ground weight were calculated.

Basal area:

Basal area at 130 cm above-ground level (DBH) was calculated (cm^2 / tree).

Wooden samples: Two disks of 40 centimeters length were sectioned, one was taken at DBH (diameter at breast height) and the other disk at 50 % of total height tree after DBH, and they were dried at 105^{O}C to constant weight.

Mechanical wood properties:

Modulus of elasticity (MOE) and modulus of rupture (MOR) were measured following the three point bending test by using universal testing machine IMAL-IB600 according to the ASTM-D 1037 (1987). Wood samples were cut into rectangular sections for determining MOE and MOR. The dimensions of each wood sample were 25 × 25 × 320 mm for MOE and MOR, while for tensile strength (Ten. St) were 5 × 6 × 200 mm. Modulus of elasticity, modulus of rupture and tensile strength were calculated using the following equation:

$$\boldsymbol{MOE = P'.L^3/4\Delta\, b.d^3}$$

$$\boldsymbol{MOR = 3\,P.L/2b.d^2}$$

$$\textbf{Ten.St.} = \boldsymbol{P/A}$$

Where:

MOE is the modulus of elasticity (N/mm^2)

MOR is the modulus of rupture (N/mm^2)

P = maximum load (N) P'= the load at proportional limit (N)

L = length of the span (mm)

Δ = center deflection at proportional limit load (mm)

b = width of the specimen (mm)

d = thickness (depth) of the specimen (mm)

A = area of the specimen (mm^2)

Statistical Analysis: For the different parameters of biomass and wood properties, general statistical description including average and standard deviation were determined by using the SPSS software package. Biomass distribution among the components (leaves, limbs and stems) of the stand is calculated as a percentage. Increment percentage of biomass during two years (from 5 to 7 years of age) was calculated. Distribution of the biomass components (stem, branches and leaves) as a percentage from the total of green and dry above-ground biomass was calculated.

RESULTS AND DISCUSSION

Growth characteristics

Data presented in Table (1) shows the mean values and standard deviation of total and merchantable height, diameter at breast height (DBH), basal area (BA) and total volume. All parameters showed remarkable increase as the age increased in both species. *Corymbia citriodora* showed superior mean values over *Cupressus. sempervirens* in all parameters, except for DBH (cm) and BA (cm^2) at 7 year age which were higher in *C. sempervirens* (16.56 ± 0.640 cm and 215.47 ± 16.64 cm^2) while in *C. citriodora* were (14.76 ± 0.185 cm and 170.96 ± 4.30 cm^2); respectively.

Data presented in Table (2) shows the mean values and standard deviation of green and dry weight of stem, branches, foliage of *C. citriodora* and *C. sempervirens* at age 5 and 7 years. Stem green and dry weights at age 5 and 7 years of *C. citriodora* are higher (89.97±7.64 and 52.45 ± 6.42 kg) and (160.75 ± 8.50 and 90.66 ± 1.33 kg), respectively, compared with *C. sempervirens* (46.55 ± 0.92 and 21.61 ± 0.64 kg) and (117.38 ± 28.51 and 61.94 ± 12.17 kg); respectively. However, green and dry weight of branches and foliage of *C. sempervirens* are higher (13.70 ± 2.70 and 7.68 ±1.58 kg) and (26.13 ± 1.79 and 14.80 ± 0.62 kg); respectively, at age 5 year, (18.70 ± 6.09 and 11.17 ± 3.74 kg) and (25.18 ± 7.57 and 14.37 ± 3.78 kg); respectively, at age 7 year.

Table 1. Biomass parameters of *Cupresus sempervirens* and *Corymbia citriodora* grown in Serabium forest during 2012.

Species	Age (year)	Total height (m)	Merchantable Height (m)	diameter at breast height (DBH (cm)	BA (cm2)	Total St Volume (m3/tree)
C. sempervirens	5	7.20 ± 0.458	6.48 ± 0.515	11.04 ± 0.733	95.90 ± 12.46	0.0439 ± 0.004
	7	12.90 ± 1.473	11.73 ± 1.553	16.56 ± 0.640	215.47 ± 16.64	0.142 ± 0.026
C. citriodora	5	13.52 ± 0.782	12.28 ± 0.765	12.26 ± 0.423	118.09 ± 8.08	0.0868 ± 0.01
	7	17.94 ± 0.425	16.45 ± 0.390	14.76 ± 0.185	170.96 ± 4.30	0.1591 ± 0.004

Mean values ± standard deviation

Table 2. Green and dry weight of stem, branches, foliage and total above ground biomass (Kg/ tree) of *Cupresus sempervirens* and *Corymbia citriodora* grown in Serabium forest during 2012.

Species	Stand age (year)	Green weight (Kg / tree)			Dry weight (Kg / tree)		
		Stem	Branches	Foliage	Stem	Branches	Foliage
C. sempervirens	5	46.55±0.92	13.70± 2.70	26.13±1.79	21.61± 0.64	7.68± 1.58	14.80± 0.62
	7	117.38±28.51	18.70± 6.09	25.18± 7.57	61.94± 12.17	11.17± 3.74	14.37± 3.78
C. citriodora	5	89. 97 ±7.64	10.22±2.59	13.17± 1.25	52.45± 6.42	5.17± 0.55	7.12± 1.40
	7	160.75±8.50	13.60± 3.66	14.47± 3.58	90.66± 1.33	8.09± 2.21	7.18± 1.02

Mean values ± standard deviation

Total green and dry above-ground biomass Kg / tree (Table, 3) of *C. citriodora* are higher at age 5 and 7 year (113.35 ± 9.95 and 64.75 ± 5.88 kg) and (188.82 ± 11.36 and 105.94 ± 4.40 kg) as compared with *C. sempervirens* were (86.38 ± 4.19 and 44.09 ± 2.10 kg) and (161.27 ± 40.69 and 87.49 ±18.73 kg); respectively. Many authors have concluded that the tree biomass is primarily a function of DBH and that biomass is relatively insensitive to tree height; consequently, DBH is widely used in biomass functions (Rapp *et al.* 1999; Onyekwelu 2004, 2007).

Results in table (4) show that mean increment during two years in both species were high. Increment percentage of total height in *C. sempervirens* and *C. citriodora* was (79.17 and 32.69 %); respectively. Increment percentage of volume and stem green and dry weight of *C. sempervirens* and *C. citriodora* were (223.46, 152.17 and 186.69 %) and

(83.29, 78.68 and 72.85 %); respectively. However, the percentage of foliage green and dry weight in *C. sempervirens* decreased as the age increased (- 3.63 and - 2.88 %); respectively. Increment percentage of total dry biomass was higher than total green biomass for *C. sempervirens*. At the same time, increment percentage of total green and dry biomass was higher in *C. sempervirens* (86.69 and 98.44 %) compared with *C. citriodora* (66.58 and 63.61 %); respectively.

Table 3. Total green and dry above ground biomass of *Cupresus sempervirens* and *Corymbia citriodora* at ages 5 and 7 years in Serabium forest during 2012.

Species	Stand age (year)	Above-ground biomass (Kg/ tree)	
		Green	Dry
C. sempervirens	5	86.38 ± 4.19	44.09 ± 2.10
	7	161.27± 0.69	87.49 ± 18.73
C. citriodora	5	113.35± 9.95	64.75 ± 5.88
	7	188.82± 11.36	105.94 ± 4.40

Mean values ± standard deviation

Table 4. Increment percentage of biomass parameters for *Cupresus sempervirens* and *Corymbia citriodora* during two years (from 5 to 7 year age).

Species Parameter	Increment percentage of biomass from 5 to7year age (%)	
	C. sempervirens	*C. citriodora*
Total height	79.17	32.69
Merchantable height	81.06	33.96
Diameter at breast height (DBH)	50	20.36
Basal area (BA)	124.6	44.78
Volume	223.46	83.29
Stem green weight	152.17	78.68
Stem dry weight	186.69	72.85
Branches green weight	36.5	33.12
Branches dry weight	45.41	56.42
Foliage green weight	-3.63	9.87
Foliage dry weight	-2.88	0.89
Total green biomass	86.69	66.58
Total dry biomass	98.44	63.61

These results are in agreement with the results reported by Guo *et al*., 2002; Egiarte *et al*., 2005; Lopez *et al*., 2006, who reported that municipal wastewater contains plant nutrients and organic matter, which may improve the properties of soil for increase in growth and biomass production.

Distribution of biomass components

Data presented in table (5) revealed that, the distribution of the biomass component (stem, branches and leaves) as a percentage from the total of green and dry above-ground biomass for *C. sempervirens* and *C. citriodora* had the same trend at 5 and 7 age. Hence, the highest percentage was the stem, next foliage, then branches.

Green and dry biomass percentage of stem was increased with the age increase. However, this increase was higher in *C. sempervirens* (53.89 and 49.0 %) at 5 years old and (72.79 and 70.80 %) at 7 years old. While, in *C. citriodora* was (79.37 and 81.01 %) at 5 years old and (85.14 and 85.58 %) at 7 years old. These results agree with those found by Abd El-Kader (2000). The taller stems may be ascribed to the natural species attributes for these trees and/or their growth rates. It can be concluded that each tree species has different biomass distribution, consequently that affected on the quantity of wood production. On the other hand, stem green and dry biomass percentage of *C. citriodora* was higher than *C. sempervirens* at the two ages, indicating that a very high percentage of their wood is merchantable for timber. This may have a potential importance during harvest for the tree plantation. These results approved with the results of Farahat *et al.,* 2012 who indicated that *Eucalyptus citriodora* had the highest stem density and height followed by other tree species.

Mechanical properties

Data presented in Table (6 and (7) showed that, wood stiffness as modulus of elasticity MOE (N/mm^2), strength as modulus of rapture MOR (N/mm^2), and tensile strength Ten.st (N/mm^2) of *Cupressus sempervirens* as a softwood species and *Corymbia citriodora* as a hardwood species had recorded higher mean values as the tree age increased, while they recorded lower mean values from base to the 25% of tree height within the tree. Hermandez, 2007 reported that most mechanical properties of wood are closely correlated to density.

Table 5. Distribution of biomass components as a percentage from the total green and dry above-ground biomass of *Cupresus sempervirens* and *Corymbia citriodora.*

Species	Stand age (year)	From green biomass (%)			From dry biomass (%)		
		Stem	Branches	Foliage	Stem	Branches	Foliage
C. sempervirens	5	53.89	15.86	30.25	49.00	17.43	33.56
	7	72.79	11.60	15.62	70.80	12.77	16.43
C. citriodora	5	79.37	9.01	11.62	81.01	7.99	11.00
	7	85.14	7.20	7.66	85.58	7.64	6.78

Table 6. Modulus of elasticity (MOE), modulus of rapture (MOR) and tensile strength (Ten.st.) of *Cupressus sempervirens* at age 5 and 7 years of DBH and 25 % of tree height

Tree age	At the age of 5 years		At the age of 7 years	
Mechanical properties	At DBH height	At 25 % height	At DBH height	At 25 % height
MOE (N/mm^2)	7946 ± 357.8	6599.3 ± 1700.7	8128.5 ± 256.7	7967.3 ± 689.5
MOR (N/mm^2)	78.6 ± 3.5	47.6 ± 5.7	83.0 ± 12.7	76.7 ± 8.2
Ten.st (N/mm^2)	62.5 ± 0.9	36.1 ± 5.9	64.4 ± 3.5	62.4 ± 1.2

Mean values ± standard deviation DBH: diameter at breast high

Table 7. Modulus of elasticity (MOE), modulus of rapture (MOR) and tensile strength (Ten.st.) of *Corymbia citriodora* at age 5 and 7 years of DBH and 25 % of tree height

Tree age	At the age of 5 years		At the age of 7 years	
Mechanical properties	DBH	25 %	DBH	25 %
MOE (N/mm^2)	14640.0 ± 707.1	14526. 7 ± 2162.2	15503.5 ± 1947.4	15455.0 ± 997.0
MOR (N/mm^2)	147.1 ± 26.7	144.2 ± 22.7	158.8 ± 5.0	152.3 ± 0.8
Ten. St. (N/mm^2)	147. 2 ± 13.93	129.9 ± 13.5	149.0 ± 8.1	143.7 ± 1.8

Mean values ± standard deviation DBH: diameter at breast high

Mean values of MOE, MOR and Ten.st (Table, 6) for *C. sempervirens* at age 5 and 7 years old at DBH were (7946, 78.6 and 62.5) and (8128.5, 83.0 and 64.4), respectively, while at 25% of tree height were (6599.3, 47.6 and 36.1) and (7967.3, 76.7 and 62.4); respectively.

Mean values of MOE, MOR and Ten.st (Table, 7) for *C. citriodora* at age 5 and 7 years old in DBH were

(14640.0, 147.1and 147. 2) and (15503.5, 158.8 and 149.0), respectively, while in 25% from height of tree were (14526. 7, 144.2 and 129.9) and (15455.0, 152.3 and 143.7); respectively. These results were in agreed with the results of Missanjo and Matsumura (2016) who reported that, mechanical properties of wood decreased from the butt upwards. In addition to that, Roos *et al.* (1990) indicated that the large change in mechanical properties with increasing age may reflect the combined effects of increasing specific gravity, cell dimensions, and increasing fibril angle in the secondary cell wall. Abd El-Kader (2000) showed that, specific gravity of *Eucalyptus citriodora* ranged from 0.572 to 0.835 with an average of 0.714±0.132, However, *Cupressus sempervirens* ranged from 0.399 to 0.630 with an average of 0.482±0.131. The higher wood SG (or density) may support the higher estimates values of the wood-mechanical properties under this study for *Corymbia citriodora* than *Cupressus sempervirens*.

CONCLUSION

Corymbia citriodora trees are promising source of hardwood raw material due to their good mechanical properties and their suitable biomass production in a short time with a straight pole. Estimation of mechanical properties is important to determine the appropriate use of the wood of each species and what further processing may be necessary. We need to make more efforts for the expansion of the cultivation *C. citriodora* and *Cupressus sempervirens* in the desert irrigated by sewage water for industrial purposes commensurate with the characteristics of their wood.

REFFERENCES

Abd El-Kader, M.M.S. (2000). Physiological studies on some woody plants. Ph.D. Thesis, Fac. of Agric., Hort. Dept., Zagazig Univ.

Almeida, D. H., T. H. Almeida, F. S. Ferro, A.L. Christoforo and F. A. R. Lahr (2017). Compression Strength of Brazilian Exotics Wood Species Perpendicular to the Grain. Journal of Civil Engineering Research, 7(3): 105-107.

ASTM. (1987). American Society for Testing Materials, Standard methods for testing small clear specimens of timber. ASTM D1037-87. West Conshohocken.

Egiarte, G., C.M. Arbestian, M. A. Alonso, E. Rui´Z-Romera and M.Pinto (2005). Effect of repeated applications of waste water sludge on the fate of N in soils under Monterey pine stands. For. Ecol. Manage, 216: 257-269.

Farahat, E., K. Shaltout, H. EL-Kady and A. Shalapy (2012). Allometric equations to predict the total aboveground biomass of tree species in a planted forest in Egypt. Feddes Repertorium 123 (1): 27–36.

Guo, L.B., R.E.H. Sims, D.J. Horne (2002). Biomass production and nutrient cycling in Eucalyptus short rotation energy forests in New Zealand. I: biomass and nutrient accumulation. Bioresource Technol., 85: 273-283.

Hermandez, E.R. (2007). Influence of accessory substances, wood density and interlocked grain on the compressive properties of hardwoods. Wood Sci. and Tech. 41 (2): 249-265.

Hoadley, R. B. (2000). Understanding Wood: A Craftman's Guide to Wood Technology, the Taunton Press, ISBN 1561583588, and Newtown, USA.

Johnson, G.R. and B.L. Gartner (2006). Genetic variation in basic density and modulus of elasticity of coastal Douglas-fir. Tree Genet. Genomes, 3, 25-33.

Kliger, R. (2000). Mechanical properties of timber products required by end-users. Proceedings of World Conference on Timber Engineering, 31st July - 3rd August. Whilstler, Canada.

Lopez, A., A. Pollice, A. Lonigro, S.Masi, A.M. Palese, G.L. Cirelli, A.Toscano and R. Passino (2006). Agricultural wastewater reuse in southern Italy. Desalination. 187: 323- 334.

Missanjo, E. and J. Matsumura (2016). Wood Density and Mechanical Properties of *Pinus kesiya* Royle ex Gordon in Malawi. Forests, 7(7): 135(1-10).

Nacar M., Hiziroglu S. and Kalaycioglu H. (2005). Some of the properties of particleboard panels made from eucalyptus, American J. Applied Sci., (Special Issue): 5-8.

Okino, E.Y.A., M. A. E. Santana, M. V. S. Alves, J. E. Melo, V.T. R. Coradin, M. R. Souza D. E. Teixeira and M. E. Sousa (2010). Technological Characterization of *Cupressus* spp. Wood. Floresta e Ambiente jan./jun., 17 (1):1-11.

Onyekwelu, J. C. (2004). Above-ground biomass production and biomass equations for even-aged Gmelina arborea (ROXB) plantations in southwestern Nigeria. Biomass Bioenerg. 26: 39–46.

Onyekwelu, J. C. (2007). Growth, biomass yield and biomass functions for plantation-grown Nauclea diderrichii (de wild) in the humid tropical rainforest zone of south-western Nigeria. Bioresour. Technol. 98: 2679–2687.

Rapp, M., I. S. Regina, M. Rico, and H. A. Gallego (1999). Biomass, nutrient content, litter fall and nutrient return to the soil in Mediterranean oak forests. Forest Ecol. Manage. 119: 39–49.

Roos, K.D., J.E. Shottafer, and R.K. Shepard (1990). The relationship between selected mechanical properties and age in quaking aspen. Forest Prod. J. 40 (7/8): 54-56.

Vermaas, H.F. (1995). Drying eucalypts for quality: Material characteristics, pre-drying treatments, drying methods, schedules and optimisation of drying quality. South African Forestry Journal, 174, 41- 49.

Wiedenhoeft, A. (2010). Structure and function of wood. In: Wood handbook: wood as engineering material, Ross, R. (Ed.), pp. 1-18, USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin, USA.

Xiong, Z.T. (1998). Lead uptake and effect on seed germination and plant growth in a Pb hyper accumulator *Brassica pakinensis* Rupr. Bull Environ. Contam. Toxicol. 60: 285-291.

Ye, L. (2011). 'Growth, crown architecture and wood properties and their responses to thinning in *Corymbia citriodora* subsp. Variegate and *Eucalyptus dunnii* plantations' MSc thesis, Southern Cross University, Lismore, NSW.

الكتلة الحيوية وبعض الصفات الميكانيكية لأشجار السرو والكافور الليموني المزروعة في غابة الصرف الصحي بسرابيوم

مها فاروق محمد إسماعيل ، صفاء أحمد سليمان غراب و منى مصطفى عباس

قسم بحوث الأشجار الخشبية و الغابات ـ معهد بحوث البساتين – مركز البحوث الزراعية

أجريت هذه التجربة خلال عامين 2012، 2013 في غابة الصرف الصحي بسرابيوم – الإسماعيلية – مصر، وقسم بحوث الغابات والأشجار الخشبية بمعهد بحوث البساتين- مركز البحوث الزراعية- الجيزة. تهدف الدراسة إلى تقدير الكتلة الحيوية وبعض الصفات الميكانيكية لأخشاب أشجار الكافور الليموني والسرو. أوضحت النتائج تفوق أشجار الكافور الليموني على أشجار السرو في معظم قياسات الكتلة الحيوية (الارتفاع الكلى والتجاري والوزن الأخضر والجاف والكتلة الحيوية الكلية فوق سطح التربة) في عمر خمس وسبع سنوات. في حين أن النسبة المئوية للزيادة في قياسات الكتلة الحيوية لأشجار السرو من عمر خمس إلى سبع سنوات كانت أعلى من أشجار الكافور الليموني.كما أوضحت النتائج زيادة الصفات الميكانيكية للانحناء متمثلة في معامل المرونة ومعامل الكسر بالإضافة إلى قوة الشد مع الزيادة في العمر وتقل من القاعدة إلى القمة للشجرة الواحدة في كلا النوعين الشجريين. وكانت متوسطات معامل المرونة ومعامل الكسر وقوة الشد عند ارتفاع الصدر لعمر سبع سنوات في أشجار السرو (8128.5, 83.0, 64.4) بينما كانت في الكافور الليموني (15503, 158.8, 149.0)، على التوالي.