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Biosystematics and morphometric variability of African mahogany grown from the El-Kassasin Zone

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ABSTRACT

Khaya senegalensis is a highly valuable timber tree. It occurs in a wide range of tropical and humid climatic ecology regions. The present study investigated the growth behavior of some trees under abiotic stress in the El-Kassasin zone and the mild climatic ecology region after 35 years of exotic species afforestation. It was one tree on the farm had better growth parameters than others in the same area. All the trees were marked with T1, and the unexpected super-growth tree was marked with T2. The recorded data illustrates the morphology of the leaves and leaflets of African mahogany. The leaflets of T2 are more oval and wider than those of T1. Conversely, there were variations in the leaflet architecture of *K. senegalensis* T1 had acute and parallel secondary veins, while T2 had short and curved secondary vein leaflets. Tree T2 (23%) had a greater phloem thickness compared to T1. The xylem thickness and pith diameter of T2 are more increment than those of T1. On other side, 13 bands were common (monomorphic) for both genotypes. The (ISSR) analysis primer generated variable band patterns and showed that the polymorphism marker detected T1 and T2 (52.57 and 32.65%), respectively. The recorded data showed that *K. senegalensis* T2 trees had significantly increased growth parameters compared to the T1 trees. Conversely, leaves of *K. senegalensis* T2 have more enhanced photosynthetic pigments and total sugar percentage than T1 trees.

Keywords: *Khaya senegalensis* -Growth parameters- Leaf anatomy.

INTRODUCTION

Afforestation with exotic woody species provides an ecological diversity service, mainly in the form of timber and other secondary tree products. In accounting terms, afforestation directly and indirectly enhances biodiversity by providing forest-wide range and by decrementing a natural compensation noted on forest resources. In several countries, afforestation depends on the planting of exotic tree species. These timber trees provide a very important supply for economic development, but can also promote significant changes in ecosystems. Shaltout et al. (2016).

African mahogany trees are common *Khaya senegalensis* Desr. Fam. Meliaceae. The trees have been observed in the tropical regions of 19 countries in Africa, with the native range recorded from Senegal and its surrounding western countries, between 8°N and 15°N, to about 6°N in Nigeria, Sudan, and Uganda. These trees cover a wide range of environmental conditions from sea level to 1800 m, containing annual rainfall from 700 to 1750 mm under watercourse seasonal followed by 2–8 months of dry season. On this concern, African mahogany occurs on a wide different soil type, gallery forest (trees reach an average height of 35 m) and rocky soil (trees reach heights of 15–20 m). Meanwhile, the greatly expanded K. *senegalensis* is predicted to clear a large provenance variation in genetic and physiological adaptation Nikles et al. (2008) and Danquah et al. (2019). *K. senegalensis* trees are also recognized in the native range of riverine forests woodlands. Natural stands in its native home range have increased the value of exploited timber. Trees are more significantly increment capable of adapting to dry tropical environments and drought tolerance when cultivated as an exotic species. It has become an important and profitable species in several countries. Orwa et al. (2009).

Genetic diversity in the native range of *K. senegalensis* has been documented in molecular genetic studies. Karan et al. (2012) examined 12 microsatellite indicators from Australian, African mahogany and found that in 73 consent domestications, the species home native rang separated two distinct groups, the first dominated by consents from Senegal to Benin region and the second consent from Sudan to Uganda region. This study recorded a higher significant increase in genetic diversity levels between the two groups. Sexton et al. (2015) reported that numerous genetic species varieties were contained between natural range regions, depending on three chloroplast surveys and 13 nuclear microsatellites. Another research found that very different trees of *K. senegalensis* were unclear to have observed genetic differentiation related to environmental or climatic conditions. While molecular genetic examination can be instructive for collecting and monitoring breeding trees, this study provided a brief description of a selection of seed sources that will supply commercial establishment for African mahogany afforestation.

The last century, recorded the highest frosty period Petit et al. (2003) after which frosty reached maxima in the northern earth and extended to lower latitudes Dupont et al. (2000). The previous phytogeographic research trees Dumolin-Lapegue et al. (1997), Taberlet and Cheddadi (2002) and Petit et al. (2002 and 2003), On this concern the frosty period considered refugia regions for tree survived varieties during maximum the frosty period while today harbour of genetic diversity. Many studies considered the postglacial period as refugia areas for Meliaceae tree species. Gillies et al. (1997), Dayanandan et al. (1999), White et al. (1999), Bekessy et al. (2002), Novick et al. (2003), Lowe et al. (2003), Muller et al. (2009), Dick (2010), Cavers et al. (2013). On this concern, the fluctuation of low and high temperatures with dry and wet periods among other climate metrics, the Pleistocene has been able to significantly increase the gene structure within a wide range of tree species. Hewitt (2000), Petit et al. (2003), Hamrick (2004), and Alvarez et al. (2009).

The last time, *K. senegalensis* was brought from its native home region and cultivated as landscape trees in the zoo garden and old botanical gardens distributed in Egypt after that some of these trees were able and adapted to have better growth than flowering and seed production under Egypt environment. Ebeid et al. (2011) and Shaalan et al. (2006). Egypt suffers from a shortage of wood raw materials, which are required for various manufacturing applications. Consequently, it is mainly dependent on the imported wood. The existing shortage and the increase in price have created an enthusiastic curiosity to search for source genotypes more suitable for our northern zone. Many woody tree species are available and valuable for afforestation programs, from which a selection should be made for use and coverage of the various Egyptian sectors. Reda et al. (2010) investigated the fact that it found African mahogany trees to grow well in Upper Egypt as shade trees wherever they produce good and durable wood.

On this side, trees have been an essential multipurpose resource in the African homeland. It is valued for its extensive range of non- timber products. It also had a high value for timber, more than the last decade demand. Khaya timbers have increased due to growing demand and the increasing insufficiency for export in some African countries Arnold (2004). In its native environment, Khaya is considered a medium to large tree Arnold et al. (2004).

The wood is highly valued on the world market. Based on import and export records for various Khaya wood products, one cubic metre of natural logs can sell for approximately USD 1403. Barbier et al. (2021). The wood of Khaya trees is of immense economic value on the local and global markets, and it can be used in the manufacture of furniture and marine equipment, in construction, and for panels and laminates, among other uses. In several regions, *K. senegalensis* is also valued for its seed oil; which can yield approximately 67% oil by weight. The seed oil is relatively high in oleic acid (66%), and West Africa prefers to use it in cooking as an ingredient in cosmetics Arnold (2004) and Orwa et al. (2009).

The present investigation was aimed to study the biosystematics and morphometric variability growth of *K. senegalensis* under El-Kassasin after more than 30 years of cultivation to find and describe suitable more adapted genotypes in this Egyptian zone. On this side, vegetative growth parameters, anatomical studies, photosynthetic pigments, and total sugars analysis, soil characteristics analysis, and gel electrophoresis were carried out.

(T1) Normal trees growth

(T2) Superior growth parameters

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of El-Kassasin Horticulture Research Station, Horticulture Research Institute, and Agricultural Research Center (ARC) on 35 years old *K. senegalensis*. African mahogany seed source cultivated from mother trees grown in the Egyptian environment.

Study location: The Kassasin Station of the Agricultural Research Centre of the Horticultural Research Institute served as the site for the current study. El-Salhia Rod is located near Kassasin Station, Ismailia governorate and 10m above sea level. The average climatic data recorded by the Ismailia Agro-metrological Station from 2000 to 2020, as shown in **Figure (1)** and **Table (1)**

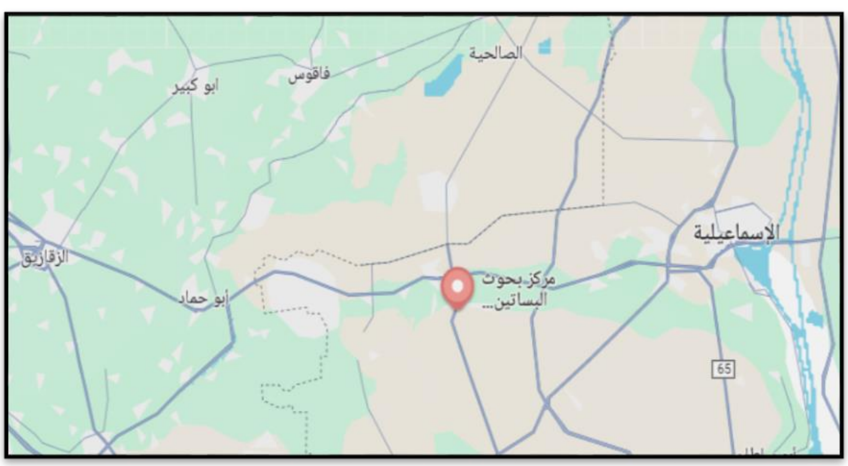

Figure (1). The site of the current study

Table (1). Monthly average climatic parameters for Ismailia governorate in 2000-2020.

Months	Mean air temperature Max. ºC	Min. ºC	Mean ºC	Mean relative humidity (%)	Mean wind speed (km h^{-1})	Rain full (mm/ month)	Possible Sunshine (hrs)	Radiation (Mj m^{-2} h^{-1})	Eto (mm h^{-1}
January	18.54	7.07	12.81	62.75	7.33	2.73	9.30	0.66	0.10
February	20.41	8.05	14.23	58.76	8.38	2.17	9.95	0.80	0.14
March	22.19	11.50	16.85	56.65	9.38	1.00	11.80	0.99	0.19
April	24.30	15.97	20.14	53.20	8.92	1.25	12.50	1.15	0.23
May	32.29	18.38	25.34	54.26	8.42	0.62	13.80	1.25	0.28
June	34.51	20.64	27.58	55.96	7.54	0.00	14.10	1.29	0.29
July	36.77	23.44	30.11	59.33	8.21	0.00	13.80	1.26	0.31
August	35.00	23.46	29.23	59.72	7.71	0.00	13.50	1.18	0.29
September	33.73	21.52	27.63	58.79	7.17	0.00	12.30	1.04	0.25
October	31.55	18.03	24.79	68.35	6.75	0.10	11.51	0.86	0.19
November	25.29	13.32	19.31	60.93	5.92	0.42	10.66	0.70	0.13
December	21.16	9.79	15.48	61.83	6.63	3.65	10.12	0.62	0.10

Morphological study:

The following morphological parameters were measured

- Total height of trees (m).
- Number of branches.
- Diameter at breast height (cm).
- Leaves fresh weight (g).
- Leaves dry weight (g).

Sample Collection:

The study was conducted on African mahogany trees distributed within their respective ecological locations. Populations of trees were sampled before physical parameters, morphology, and anatomy at an average of leaves in all directions at 2 m height then some leaves as samples were found in the middle of the branches of each tree on the T1 and T2 trees had selected. All samples from T1 and T2 were mixed separately according to tree type to obtain two representative samples. Then, all the samples were divided into two groups. The first group was dried at 60 °C until a constant weight was reached and ground for chemical analysis. Meanwhile, the second fresh sample includes physical parameters, morphology, and anatomy.

Anatomical studies: The middle leaflets of *K. senegalensis* leaves materials were selected and fixed in F.A.A. 48 hours after the leaflets were killed. The leaflet materials were dehydrated in a regular alcohol series after being rinsed in 50% ethyl alcohol. They were then embedded in paraffin wax at 56 C. They were sectioned at 20 microns using a Leica RM2125, embedded in Canada Balsam after clearing from xylene and double stained with safranin and quick green (Micro-techniques a laboratory guide). The Slides were examined under the microscope and photographed. Nasser and El-Sahhar (1998).

Characterization of different genotypes of *K. senegalensis*:

Typically, *K. senegalensis* small leaves were grown at the farm of the El-Kassasin Research Station. White and Powell (1997) recorded (MAC59) as the best primer for *K. senegalensis*. The (MAC59) repeat motif was $(AAT)_5$ $(CAT)_3$, primers (5'-3') (TGGAGTAAAGTCGAGGGCTG GGCTGGATATGGCACTT GTT) and product size (215 bp) Karan et al. (2012). Utilizing the Techni TC-512 System was used for PCR amplification. Conditions carried out as follow a cycle of 94 C^o for 3 min was followed by steps touchdown of 94 C^o for 30 seconds, 60 C^o for 30 seconds, and 56 C^o for 30 sec., a final cycle of 72 C^o for 5 min. PCR products were separated on 1.5% agarose gel, and the sizes were estimated using the 100-bp ladder marker.

Chemical analyses:

Photosynthetic pigments and total sugars: Pigments and total sugars were determined quantitatively in T1 and T2 African mahogany leaves in all directions at 2 m height then some leaves as samples were found in the middle of the branches of each tree on the T1 and T2 trees had selected. Chlorophyll a, chlorophyll b, and carotenoids were extracted with dimethyl formamide and determined according to Moran (1982). Total sugars were determined by using the phenolsulphoric method according to Dubois et al. (1956) as mg/g fresh weight of Mahogany leaves.

Soil characteristics:

In each of the orchards studied, soil samples were taken at a depth of 40 cm from soil type 1 and then mixed to obtain a representative sample. In this case, samples were taken from soil type 2. Physical analysis was performed according to Gee and Bauder (1986). Chemical and nutrient analysis: Soil pH was measured, and the gypsum concentration was determined by precipitation with acetone. Rice et al. (2012) and Rakotondrabe et al. (2018) measured the ECs, CEC, EPS, and soluble ions of the soil. Available N and K, Sparks et al. (2020). **Table (2).**

Table (2). Physical properties of the soil in 2023

Sample depth (cm)	Particle size distribution (%)					O.M (%)	Textural class
	Coarse Sand	Fine sand	Silt	Clay	Gravels		
				T1			
0-40	68.53	24.60	1.42	3.15	2.00	0.30	Sandy
				T2			
0-40	65.30	23.75	6.35	2.90	1.00	0.70	Sandy

OM = organic Matter.

Chemical properties of the soil in 2023

pH	EC dS/m	SP (%)	Ion concentration in paste extract (meq/100gm)								SAR Meq/L	EPS^+
			Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$		
7.76	1.80	22.00	8.71	7.79	3.00	0.48	0.00	3.00	5.00	11.98	1.04	0.28
7.45	5.86	23.00	40.43	9.27	11.84	1.52	0.00	6.40	21.00	35.66	2.38	2.25

EC= Electrical conductivity, pH Acidity algorithm, ds/m= descisiemen/m, SP= saturation percentage. SAR= Sodium Adsorption Ratio. EPS = Extra-cellular polymeric substances

Statistical analysis:

The investigated data was analyzed using the T-test one-way SPSS software package, comparing parameter means from normal trees T1 and super growth for T2. A one-sample T-test is a statistical hypothesis test used to determine whether the T2 measurements are different from the T1 measurement means. Okoye and Hosseini (2024).

RESULTS

The Morphological leaves describe two types of *K. senegalensis*:

Morpho group T1 corresponds to the African mahogany, characterized by its elliptic leaflets, acute base and acuminate apex. On the other side, the morpho group T2 corresponds to African mahogany which is characterized by its width and a rounded apex and ending abruptly with a very short insight. **Figure (2).** According to **Figure (3)** (1-T1 and 1-T2) leaflets petiolule of T2 are shorter than T1. Meanwhile, the terminal pair of T1 leaflets is always more falcate than T2 while the T2 terminal pair is always more obovate-oblong than T1 Figure 3 (2-T1 and T2). The leaflet lamina of T2 had taken an acute angle with rachis leaves while taken obtuse on T1 Figure 3 (3-T1 and T2). Generally, the lamina leaflet of T2 is very wide and obovate compared to the T2 leaflet Figure 3 (4- T1 and T2).

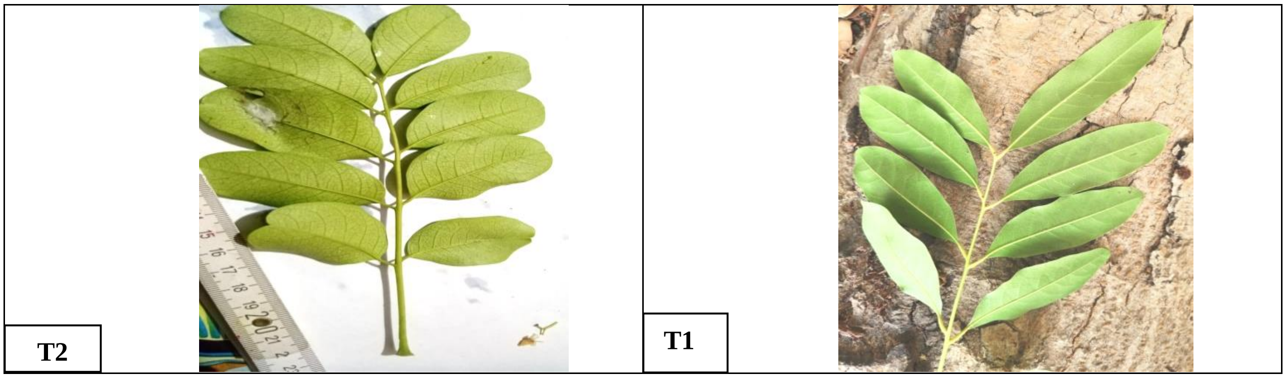

Figure (2). Circumscription leaves of *K. senegalensis* T1 and T2 have their morphological traits.

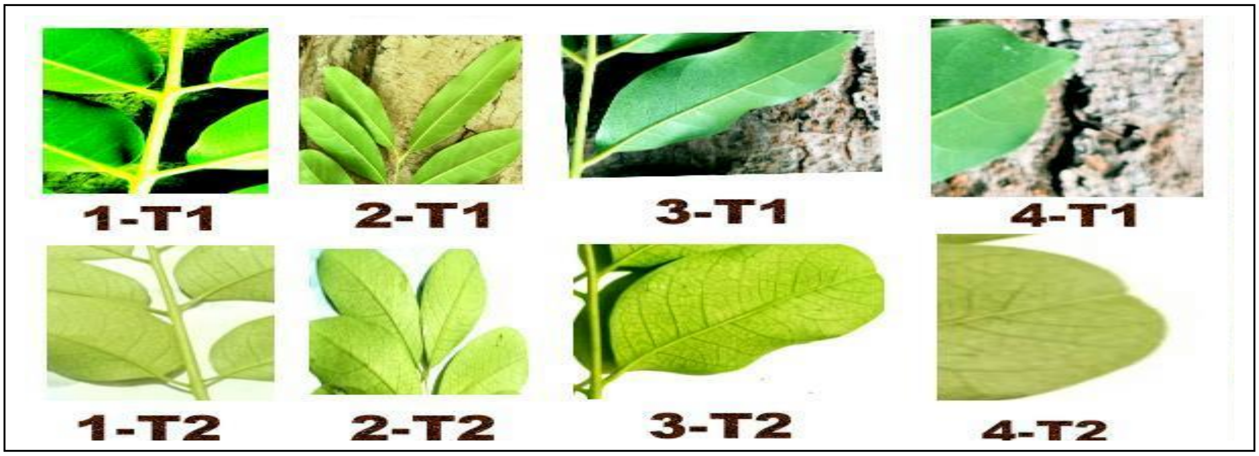

Figure (3). Circumscription leaflet of *K. senegalensis* T1 and T2 have their morphological traits.

Describe *K. senegalensis* two types of margin leaflets: Leaflet T1 of *K. senegalensis* showed that the natural size of the middle vein on the adaxial side was slightly higher than that of T2. While T1 had a primary vein size of moderately stout straight, it was larger than T2. The angle of divergence of the secondary vein in T1 is acute moderate; otherwise, T2 has a slightly moderate angle. On this side, the secondary veins of T1 straightly reached the near end of the lamina and curved with it. Meanwhile, the T2 secondary leaflet veins are shorter and curved at the distant lamina ends. The T2 marginal ultimate venation is more fimbriate than T1. The predominant tertiary venation of T1 and T2 is acute on the right and obtuse on the right respectively. The subtype venation is brochiodo-dromous in all types. According to Figure 4.

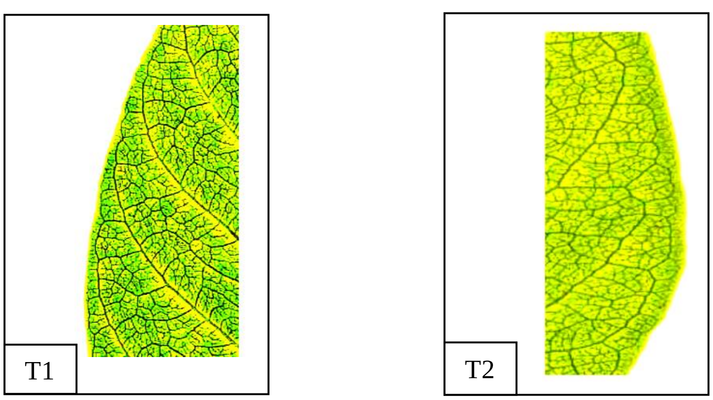

Figure (4). Laminar margins of *K. senegalensis* T1 and T2.

Anatomical studies:

T2 had a significant promotive effect on vegetative growth characteristics and induced vigorous African mahogany. This may justify a further study of the effect of tree type on the internal structure of African mahogany leaflets. Microscopic measurements of certain histological characteristics in transverse sections through the median leaflet of the African mahogany leaves, 35 years old, in **Table (3).** The microphotographs illustrating T1 are also shown in **Figures (3 and 4).** It is clear from **Table (3)** and **Figure (5)** that T2 although a negligible decrease of 5.07% in the thickness of the cortex was observed below the T2, the increase in the leaflets of the African mahogany tree could be attributed to the considerable increase in the thickness of the phloem and xylem tissues as well as the diameter of the vessel and pith by 23.04, 19.07, 28.57, and 17.79% respectively.

Table (3). Measurements in microns of some histological characteristics in transverse sections through the leaflets of *K. senegalensis* trees T1 and T2 .

Histological characters	T1	T2	Percentage ± in T2 to T1
Cortex thickness	580	552	- 5.07
Phloem tissue thickness	364	473	+ 23.04
Xylem tissue thickness	510	615	+ 17.07
Vessel diameter	35	49	+ 28.57
Pith diameter	1488	1810	+ 17.79

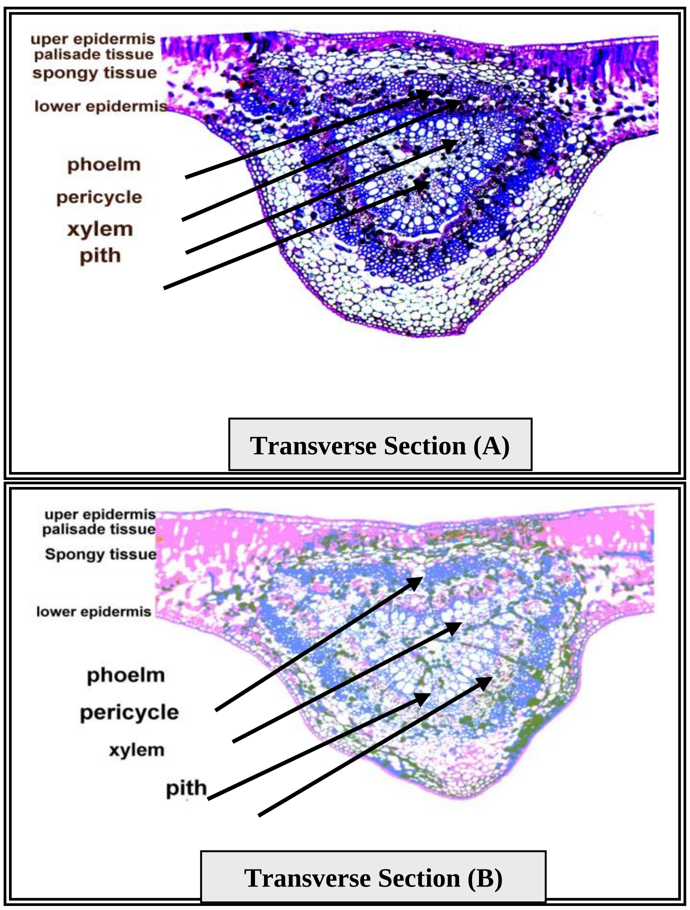

Figure (4). Transverse sections through the median part of the leaflets of *K. senegalensis* (Desr.) A. Juss., more 30 years old.

A- From the leaves of T1 trees. B- From the leaves of T2 tree.

PCR analysis of two genotypes of *K. sengalensis*: The experimental data showed that DNA fragments with molecular sizes ranging from 258 to 956 bp were positive specific markers at 956, 852, 810, 723, 703, 549, 483, and 300 bp for the African mahogany tree genotype T1. On the other hand, the T2 genotype had DNA fragments with molecularly positive specific markers at 956, 852, 810, 723, and 497 bp. In this work, we compared the applicability of the genetic marker ISSR to characterize the two genotypes of *K. senegalensis.* The polymorphism ISSR marker detected T1 and T2 (52.57 and 32.65%), respectively. **Figure (6).**

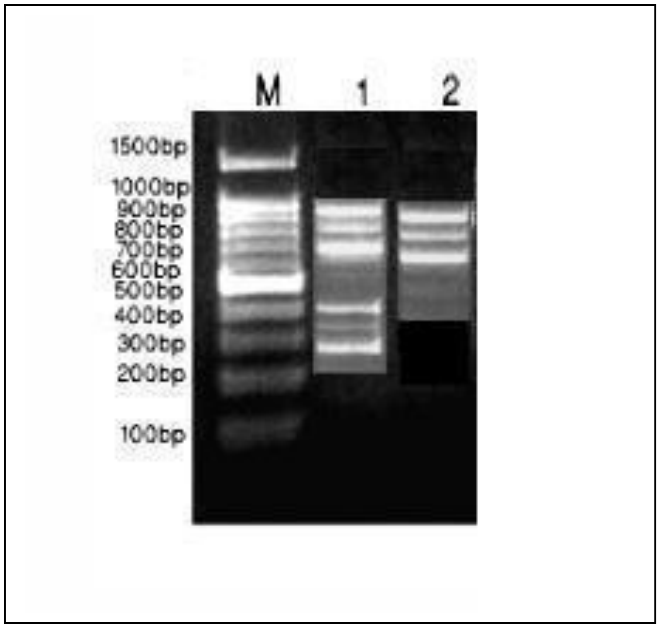

Figure (6). PCR implicates of two genotypes of *K. senegalensis* obtained
1= T1 trees 2= T2 tree

Morphological characters of African Mahogany: The morphological characteristics of *K. senegalensis* under the conditions of the El-Kassasin Research Station are presented in **Table (4).**

Total height of the tree (m): The recorded data showed a significant increase in the total height of African mahogany on T2 (16.00 m). Meanwhile, trees on T1 had an average height of (6.44 m.)

Number of branches: African mahogany grown on T2 had six branches with a significant increase when compared to the mean of *K. senegalensis*, which was grown on T1 (2.83), according to **Table. (4).**

Diameter at breast height: From **Table (4),** it can be seen that T1 trees had a mean diameter at breast height of 23.37 cm, which showed a significant difference from T2 which recorded 78.03 cm. The T1 showed a significant decrease in the diameter at breast height of African Mahogany trees at 35 years of age.

Leaf fresh weight (g): The study showed that the T2 tree had a more significant increase in the T1 mean fresh leaf weight *of* K. *senegalensis* leaf (100.60 and 75.97 g, respectively)**. Table (4).**

Leaf dry weight (g): Leaf biomass of African mahogany trees had a significant decrease under T1 cultivation compared to others (35.15 and 49.82 g, respectively). **Table.(4)**

Table (4). The effect of T1 and T2 on morphological characters of some vegetative growth of *K. senegalensis* trees

Trees code number	Total height of tree (m)	Branches numbers	Diameter at breast height (cm)	Fresh weight (g)	Dry weight (g)
			T1		
1	11.00	6	40.76	95.60	40.10
2	9.00	4	33.12	85.00	40.80
3	12.00	5	37.26	110.80	50.80
4	12.00	4	47.77	106.80	45.20
5	8.00	3	44.59	62.80	26.20
6	4.00	3	24.20	72.60	31.20
7	5.00	3	13.69	80.20	37.80
8	6.00	2	17.83	76.20	32.20
9	5.00	3	20.70	50.21	23.80
10	5.50	1	15.92	74.60	34.20
11	5.90	4	23.25	88.40	38.20
12	6.00	2	20.06	97.40	44.50
13	4.00	1	17.83	67.80	30.80
14	3.00	2	12.74	40.80	18.24
15	5.00	2	14.97	67.60	30.60
16	2.50	1	15.92	45.20	20.20
17	3.00	3	10.51	50.20	46.00
18	9.00	2	9.55	95.30	41.80
Means	6.44**±3.04	2.83**±1.38	23.37**±12.03	75.97**±20.96	35.15**±9.24
			T2		
19	16**	6**	78.03**	100.60**	49.82**

** Significant variation values different at p >0.05. Numbers followed the mean are the standard deviation of the mean

Photosynthetic pigments and total sugars:

Table (5) shows that the relatively severe soil strictures (T1 and T2) had a significant effect on the content of chlorophyll a, chlorophyll b, and carotenoids in the leaves of *K. senegalensis*, which showed a significant promotive effect on photosynthetic pigments. The T2 high concentration percentage of photosynthetic pigments in the leaves of African mahogany was detected in chlorophyll a (2.49 mg/g F. W.), which was 9.64% more than the T1 in the leaves. On the other hand, T2 had 28.92% more chlorophyll b in the leaves of *K. senegalensis* leaves. On this side, T2 had 6.67 % more than the content of carotenoids in leaves. In general, photosynthetic pigments on T2 *K. senegalensis* had a higher than that of T1 trees (45.23%) on the leaves. Total sugars were recorded (7.92 and 8.31 mg/g F.W.) in the leaves of African mahogany trees under T1 and T2, respectively.

Table (5). The effect of T1 and T2 on photosynthetic pigments and total sugars in leaves of *K. senegalensis* trees.

Treatments / Chemical analysis		T1	T2	Percentage + in T2 to T1
Photosynthetic pigments (mg/g F.W.)	Chlorophyll a	2.25	2.49	**+9.64**
	Chlorophyll b	0.59	0.83	+28.92
	Carotenoids	0.98	1.05	+6.67
Total sugars (mg/g F.W.)		7.92	8.31	+4.69

DISCUSSION

The experimental data recorded variation in the leaf vein network between the two tree types; this agreement with the previous study noted the leaf vein network, conceder leaf fingerprint, which is a crucial feature to identify different species Li et al. (2022). Meanwhile, Zhu et al. (2020) recommended the tree network of leaf fast and automatic technique for classification. The data investigated the variation between two types of leaflet lamina anatomy in *K. senegalensis*. On this side, Akinsulire et al. (2018) reported that lamina anatomy should be used as a basis for taxonomy between five species in the genus Terminalia Saheed and Illoh (2010), which included variation in lamina cell area and the characters of an epidermal initial new genus. The data presented showed two types of trees, which is consistent with previous studies expressing naturally significant differences in genetic diversity in *K. senegalensis* seed sources in the home native region. Karan et al. (2011) and Sexton et al. (2015). On this side, the exotic African mahogany afforestation recorded seed genetic variety in new regions. Bandara et al. (2018). In fact, the ISSR has a high capacity to reveal polymorphism and offers great establish intra and inter- genomic diversity as compared to other Zietkiewicz et al. (1994).

The experimental data recorded a low significant decrease in growth without flowering in trees of *K. senegalensis* type T1 under the El-Kassasin zone after 35 years of afforestation. Danquah et al. (2019) found that the native ecological home region of *K. senegalensis* is the tropical zone of African countries. On the other hand, the El-Kassasin site in the Mediterranean zone of eastern North Egypt had a highly significant climatic variation compared to the tropical zone and showed low significant effect on growth parameters. Scherrer and Körner (2011) and Kleckova et al. (2014) argued that unfavorable climatic conditions can change the daily activity of tree patterns**.** Hassan and Ali (2013) express that climatic conditions lead to serious losses to grow successfully away from their natural habitats of *K. senegalensis*. While African mahogany is an exotic afforestation in northern Australia with dry mild climate stress. Data show that leaves of African mahogany trees reduce the total leaf area by reducing evaporative water loss followed by a significant decrease in photosynthetic rate and growth parameters. Arndt et al. (2015).

On the other hand, the data examined revealed high significant increment growth with flowering and seed product on *K. senegalensis* type T2 trees under the El-Kassasin zone after 35 years of afforestation. Bates and Bertelsmeier (2021) noted that an experience niche modifies the tree species by adapting the species to the surrounding climate. At present, there is an inconclusive confirmation of these potential mechanisms. Oliveira and Franca (2020) *K. senegalensis* showed a 68.1% increment adaptation after afforestation in the Brazilian region, whish had limited water availability, although it occurs naturally in warmer and drier climates. The fundamental feature that guarantees the achievement of afforestation is the use of African mahogany species adapted to the climatic conditions. In agreement with da Silveira et al. (2016), *K. senegalensis* trees are adapted to reasonably limited water, as it seems to be improved in the Northeastern environment.

Puntieri et al. (2023) studied the relative anatomical meeting points on leaves in relation to photosynthetic carbon capture and hydraulic balance. While Gamalei (1989) investigated that the minor veins architect and leaf mesophyll related to the phloem. Zhang et al. (2023) observed that veins are essential part that allows plants to grow and develop. They transport water, elements, and products from photosynthetic processes, while also supporting and shielding the leaves. Leaf vein networks are important indicators of growth parameters. It may be capable to control the transport of water, inorganic salts. Konch et al. (2021)and Pan et al. (2022). Leaf vein networks improve morphology and control the rate of photosynthesis. Huang et al. (2022) and Zhang et al. (2022).

African mahogany has a high bioavailability in environmental conditions Sexton et al. (2015) and Soares et al. (2020). The benefits of genetic variability are available in afforestation policies for species conservation and domestication enhancement. Lemes et al. (2011). Thus, it is likely to discover this changeability to maximize the ability of tree species in different climatic and edaphic conditions Chaikaew et al. (2020). In this regard, climate and commercial forests afforestation of wood is the potential assurance of wood supply, capable of supplying all the world's demand for wood Ngome Chisika and Yeom (2020).

Conclusion:

A sample genotype of *K. senegalensis*, T2 showed more adaptation than T1 trees under the El-Kassasin zone. The data recorded a variation in growth parameters after being planted almost 35 years ago. As the T2 tree improved in growth, further studies on propagation and cultivation of T2 trees in this zone are recommended.

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الملخص العربى

النظم الحيوية والتباين المورفومتري للماهوجني الافريقي المنزرعه في منطقة القصاصين

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شجرة الـ *Khaya senegalensis* هي خشبية ثمينة للغاية موطنها الاصلي المناطق الاستوائية والرطبة. تناولت هذه الدراسة سلوك نمو بعض هذه الأشجار تحت الظروف البيئية الغير ملائمة لنموها في منطقة القصاصين بمحافظة الاسماعلية بعد 35 عامًا من تشجيرها بتلك الأشجار. وجد بعد تلك القتره من الزراعة شجرة واحدة في المزرعة تتمتع بمعايير نمو أعلى من غيرها في نفس المنطقة. في هذا الشأن، تم تمييز جميع أشجار بالرمز T1 وقد تم تمييز هذة الشجرة الوحيدة ذات النمو الفائق غير المتوقع بالرمز (T2). أوضحت البيانات المسجلة من الناحية المورفولوجية أن أوراق هذه الشجرة للماهوجني الأفريقي (T2) ذات شكل أكثر بيضاوي وأكبر مساحة من أوراق T1. إضافه إلي ذلك كانت هناك أختلافات كبيره في شكل وطريقة أنتشار العروق الموجودة في نصل وريقات *K. senegalensis* T1. كما أوضحت الدراسة التشريحية للأوراق وجود أختلافات جوهريه في التركيب التشريحي لكلا النوعين T1 وT2، ومن جهة اخري أوضح التحليل الجيني (ISSR) وجود اختلاف إلي حد كبير بينهما. وأظهرت البيانات الخضرية المسجلة أن هذه الشجرة *K. sengalensis* T2 تميزت بزيادة ملحوظة في شتي قياسات وصفات النمو الخضري مقارنة بالأشجارالاخري (T1). وعلى الجانب الآخر، تحتوي أوراق نبات *K. sengalensis* T2 على أصباغ التمثيل الضوئي المحسنة ونسبة السكر الذائبة الكلية مقارنة بأشجار T1 تحت منطقة الدراسة بالقصاصين. لذلك؛ توصي الدراسه بالإكثار من شجرة (T2) في محافظة الاسماعلية لكونها أكثر تلائما مع الظروف البيئية لهذه المنطقة.