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EVALUATION OF VEGETATIVE GROWTH AND GENETIC IDENTIFICATION OF SOME MAHOGANY SPECIES (MELIACEAE) ADAPTED IN EGYPT

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ABSTRACT

The present investigation was carried out at the Nursery of the Forestry Department, Horticulture Research Institute, Agricultural Research Centre, Giza during the two successive seasons of 1999/2000 and 2000/2001 to evaluate the vegetative growth of some Mahogany species adapted in Egypt ; i.e., *Swietenia macrophylla*. King, *Swietenia mahogani* (L.) Jacq., *Khaya ivorensis* A. Chev. and *Khaya senegalensis* (Desr.) A. Juss. Also, the percentage of seed germination for each genotype was calculated. Moreover, biochemical analysis was done, in seeds of each studied species, using SDS- polyacrylamide gel electrophoresis separation of total soluble protein method for genetic identification and differentiation among Mahogany species under investigation.

The obtained results indicated that the four studied genotypes of the Mahogany family (Meliaceae) showed significant differences in the percentages of seed germination as well as in their vegetative growth attributes (plant height, number of developed leaves per plant, total leaf area per plant, shoot fresh weight per plant and shoot dry weight per plant) in both studied seasons and *Khaya senegalensis* exceeded significantly all other genotypes in this respect. Data on biochemical analysis revealed that, polyacrylamide gel electrophoresis separation of total soluble proteins can be used as a genetic finger print for identification, differentiation and comparison among the four different species as well as between the two different genera of the Mahogany family under investigation.

Keywords: Evaluation, Vegetative Growth, Genetic Identification, Mahogany, Meliaceae, Electrophoresis.

INTRODUCTION

The family Meliaceae (Mahogany family) consists of some 51 genera and about 550 species, widespread in tropical and subtropical regions, with relatively few species in temperate climates (Cronquist, 1981).

The family includes many important timber species. Mahogany is the wood of *Swietenia mahogani* (L.) Jacq., a native of the West Indies. The related Honduras Mahogany, *Swietenia macrophylla* King (American Mahogany), is the more valuable species in commerce, and requires a fully tropical climate to grow well (F.A.O., 1959 and Dahms, 1989). African Mahogany is the product of *Khaya senegalensis* A. Juss. and other related species such as *Khaya ivorensis* A. Chev. (F.A.O., 1959 and Rendle, 1967).

Mahogany is used for furniture, fixtures, musical instruments, millwork, cars, ships and boats, caskets, airplanes, foundry patterns, veneers, and plywood (Hill, 1952 and Metcalfe and Chalk, 1979).

Egypt and similar arid and semi-arid countries suffer from shortage in wood-raw materials which are necessary for several industrial uses.

Therefore, they depend mainly on the imported woods. The current shortage and price increase created keen interest in exploring the possibility of utilizing the wood of the available windbreak and shelterbelt. Furthermore, the country has focused attention, specially during the last three decades, on establishing forest plantations to meet the acute needs for wood in Egypt (Abou-Gazia *et al*., 1992 and El-Osta and Megahed, 1992).

Many important woody species are available and valuable for afforestation programs from which a selection should be conducted for using and covering the different sectors of Egypt. In this respect, El-Hadidi and Bolous (1979) stated that African Mahogany were found to be grow well in Upper Egypt as shade and avenue trees, where they yielded good, hard, heavy and durable wood. Thus, the Mahoganies may be planted successfully in Egypt, specially in Upper Egypt or Toshka, to be used as wood source for the useful wood works and decrease our needs imported from the foreign countries.

The present investigation was conducted to evaluate vegetative growth of the available Mahogany species in Egypt ; i.e., *Swietenia macrophylla* King , *Swietenia mahogani* (L.) Jacq., *Khaya invorensis (* Desr.) A. Chev. and *Khaya senegalensis* A. Juss. Moreover, biochemical analysis, in seeds of each genotype, was done using SDS-polyacrylamide gel electrophoresis separation of total soluble protein method for genetic identification and differentiation between Mahogany species under investigation.

MATERIALS AND METHODS

The research work presented in this paper was carried out at the Nursery of the Forestry Department, Horticulture Research Institute, Agricultural Research Centre, Giza during the two growing seasons of 1999/2000 and 2000/2001 in order to evaluate the vegetative growth of some Mahogany species adapted in Egypt. Also, electrophoretic identification of the investigated Mahogany species was under consideration.

Source of seeds and procedure of the experiment

Seeds of *Swietenia macrophylla* King and those of *Swietenia mahogani* (L.) Jacq. were collected during May 1999 and May 2000 from marked mother plus trees, about 70 years old, grown in Zoological Garden at Giza. Whereas, seeds of *Khaya ivorensis* A. Chev. and those of *Khaya senegalensis* (Desr.) A. Juss. were collected during June 1999 and June 2000 from marked mother plus trees, about 28 years old, grown in the Farm of Agricultural Research Centre at Kom Ombo, Aswan.

The seeds of each genotype were soaked in tap water for 24 hours and then sown in plastic trays, 40x60 cm, filled with peatmoss and clean sand at the ratio of 1:1 by volume. Seeds were sown on first July, 1999 in the first season and replicated on fourth July, 2000 in the second one to provid the experimental plant materials. Three weeks from sowing date, germinated seeds were counted and germination percentage of each entry was estimated. At the age of two months, the emerged seedlings were

transplanted to plastic pots, one seedling per pot , (25 cm diameter) filled with clay and sand at the ratio of 1:1 by weight. The experiment was made in a randomized complete block design with four replicates. The replicate contained 40 pots, each 10 pots were assigned for one genotype. At the age of ten months from sowing date (eight months from transplanting), plants were lifted from pots for recording the characters of vegetative growth. For each genotype, the recorded data were:

1- Plant height (cm).
2- Number of leaves per plant.
3- Total leaf area (cm^2) per plant.
4- Fresh weight of shoot (g) per plant.
5- Dry weight of shoot (g) per plant.

Data on seed germination percentage and on vegetative growth characters were subjected to conventional methods of analysis of variance according to Snedecor and Cochran (1982). The least significant difference (L.S.D.) at 0.05 level was calculated for each investigated character.

Protein extraction and polyacrylamide gel electrophoresis

It could be isolated total soluble proteins from seeds of each genotype according to the method described by Harborne (1984) with the following modification:

The dried seeds were ground to a fine powder. Finely ground sample (0.1g) was mixed with 10.0 ml of tris-HCl buffer solution (0.1M, pH 8.1) and then mechanically shaken for one hour. The extract was centrifuged at 3000 rpm for 15 min. The obtained supermatent, which containing total soluble protein (albumins and globulins), was stored at 20°C for subsequent polyacrylamide gel electrophoresis.

polyacrylamide gel electrophoresis method was used to detect the protein fractionations (Weber and Osborn, 1969). The gel contained 7.5% acrylamide, 0.2 M tris citric acid buffer pH 8.3. TEMED and freshly prepared ammonium per sulphate solution. Extracts of seed proteins were saturated with sucrose crystals and 0.05 ml samples were put on the tops of the gel tubes using a micropipette. Electrophoresis was performed for 10 min., at 2.5 mA/tube, then continued at 12 mA for 6 hours. The gels were gently extruded by water surrounding using a syringe and stained with 7% Amido-Black solution for 10 min. Stained gels were transferred into the destaining solution (7.5% acetic acid) for 10 min. with several changes until the background gels became clear. The position of protein bands on the gel tubes is expressed as the Rf value calculated as the distance migrated by the band/total length of gel tube of each sample.

RESULTS AND DISCUSSION

I- Percentage of seed germination

The percentages of seed germination for different Mahogany species in two successive seasons and the results of their statistical analysis are given in Table (1).

It is obvious that the differences among genotypes proved significant in both seasons. The maximum percentage was recorded by *Khaya*

senegalensis (44.1 and 43.5% in the first and second season; respectively), being significantly higher when compared with any of the other genotypes. By contrast, the minimum percentage was detected by *Khaya ivorensis* (33.8% in the first season and 34.9% in the second one), being significantly lower when compared with any of the other genotypes. It is realized that *Swietenia macrophylla* exceeded *Swietenia mahogani* in this respect, and the difference between them was significant in the first season only. The descending order of seed germination percentage was 44.1, 39.9, 36.7 and 33.8% for *Khaya senegalensis, Swietenia macrophylla, Swietenia mahogani* and *Khaya ivorensis* ; respectively in the first season. It is worthy to note that the same order was also observed in the second season, the records were 43.5% for *Khaya senegalensis,* 40.6% for *Swietenia macrophylla,* 38.3% for *Swietenia mahogani* and 34.9% for *Khaya ivorensis.*

Table (1): Germination percentage and vegetative growth attributes of 10 months old seedlings of four genotypes of the Mahogany family in two successive seasons (1999/2000 and 2000/2001)

First season of 1999/2000					
Genotypes / Characters	***Swietenia macrophylla***	***Swietenia mahogani***	***Khaya ivorensis***	***Khaya senegalensis***	**L.S.D. (0.05)**
Germination %	39.9	36.7	33.8	44.1	2.66
Plant height (cm)	36.2	43.9	24.4	41.1	3.91
Number of leaves/plant	9.1	18.2	10.7	11.9	1.18
Total leaf area (cm^2)/plant	483.2	408.6	941.4	1254.0	53.8
Shoot fresh weight (g)/plant	4.88	6.47	15.53	16.73	0.93
Shoot dry weight (g)/plant	1.65	2.23	5.30	5.94	0.37
Second season of 2000/2001					
Germination %	40.6	38.3	34.9	43.5	2.79
Plant height (cm)	33.4	39.5	22.1	38.2	3.46
Number of leaves/plant	8.3	16.8	10.2	11.5	1.07
Total leaf area (cm^2)/plant	394.7	351.4	815.3	1106.1	47.1
Shoot fresh weight (g)/plant	3.96	5.56	13.85	14.92	0.75
Shoot dry weight (g)/plant	1.35	1.99	4.71	5.23	0.32

II- Vegetative characters:

The amount of vegetative growth of four Mahogany species throughout ten months from sowing date in two successive seasons was followed up. Investigated characters included: plant height, number of developed leaves per plant, total leaf area per plant, shoot fresh weight per plant and shoot dry weight per plant. Data on vegetative characters are given in Table (1).

1- Plant height

It is clear from Table (1) that the maximum height was recorded by *Swietenia mahogani* (43.9 cm in the first season and 39.5 cm in the second one) which in turn being statistically indiferent with that of *Khaya senegalensis* (41.1 cm in the first season and 38.2 cm in the second one) and showed significant difference with any of the other two species in both seasons. Whereas, the minimum height was achived by *Khaya ivorensis* in

both seasons. It was 24.4 cm in the first season and 22.1 cm in the second one, being significantly lower when compared with any of the other genotypes. The descending order of plant height was 43.9, 41.1, 36.2 and 24.4 cm for *Swietenia mahogani, Khaya senegalensis, Swietenia macrophylla* and *Khaya ivorensis* ; respectively in the first season. It is abvious that the four studied genotypes of the Mahogany family showed the same trend of plant height in the second season.

From the above mentioned results, it could be stated that plant height was significantly affected by species and *Swietenia mahogani* as well as *Khaya senegalensis* exceeded the other two genotypes in this respect.

2- Number of developed leaves per plant

Data presented in Table (1) clearly show that the highest number of leaves was recorded by *Swietenia mahogani,* being 18.2 leaves in the first season and 16.8 leaves in the second one. It showed significant increase over any of the other genotypes in both seasons. While, the lowest number was obtained by *Swietenia macrophylla* (9.1 leaves in the first season and 8.3 leaves in the second one), being significantly lower when compared with any of the other genotypes in both seasons. The descending order of number of leaves was 18.2, 11.9, 10.7 and 9.1 leaves for *Swietenia mahogani, Khaya senegalensis, Khaya ivorensis* and *Swietenia macrophylla ;* respectively in the first season. It is clear that the same order was also observed in the second season, the records were 16.8 leaves for *Swietenia mahogani,* 11.5 leaves for *Khaya senegalensis*, 10.2 leaves for *Khaya ivorensis* and 8.3 leaves for *Swietenia macrophylla.*

As inferred earlier, it could be stated that the number of leaves was significantly affected by species and *Swietenia mahogani* exceeded all other genotypes in this respect. It is worthy to note that *Khaya senegalensis* surpassed *Khaya ivorensis* in number of developed leaves per plant in both studied seasons.

3- Total leaf area per plant

It is realized from Table (1) that the differences in total leaf area among the different studied genotypes of the Mahogany family proved significant in both seasons. The maximum area of leaves per plant was recorded by *Khaya senegalensis,* being 1254.0 cm^2 in the first season and 1106.1 cm^2 in the second one. It showed significant increase over any of the other genotypes in both seasons. On the other hand, the minimum area of leaves per plant was obtained by *Swietenia mahogani* (408.6 cm^2 in the first season and 351.4 cm^2 in the second one), being significantly lower when compared with any of the other genotypes. In this respect, it is worthy to note that *Swietenia mahogani*, which recorded the minimum area of leaves per plant, had highest number of leaves per plant. This means that the leaves of *Swietenia mahogani* had smaller leaf blades when compared with any of the other genotypes of the Mahogany family under investigation. The descending order of total leaf area per plant was 1254.0, 941.4, 483.2 and 408.6 cm^2 for *Khaya senegalensis, Khaya ivorensis, Swietenia macrophylla* and *Swietenia mahogani ;* respectively in the first season. It is obvious that the four studied genotypes showed the same trend of total leaf area in the second season.

4- Shoot fresh weight

Data on shoot fresh weight of ten month old plants of four different genotypes of the Mahogany family in two successive seasons are shown in Table (1). It is obvious that the maximum fresh weight of shoot was achieved by *Khaya senegalensis,* being *16.73 g* in the first season and 14.92 g in the second one. It showed significant increase over any of the other genotypes in both seasons. In contrast, the minimum fresh weight of shoot was recorded by *Swietenia macrophylla,* being 4.88g in the first season and 3.96g in the second one and showed significant decrease below any of the other genotypes in both seasons. The descending order of shoot fresh weight was 16.73, 15.53, 6.47 and 4.88g for *Khaya senegalensis, Khaya ivorensis, Swietenia mahogani* and *Swietenia macrophylla* ; respectively in the first season. It is clear that the same order was also observed in the second season, the records were 14.92g for *Khaya senegalensis,* 13.85g for *Khaya ivorensis*, 5.56g for *Swietenia mahogani* and 3.96g for *Swietenia macrophylla*.

From the aforementioned results, it could be stated that the fresh weight of plant shoot was significantly affected by species and *Khaya senegalensis* exceeded all other genotypes in this respect with significant difference in both seasons.

5- Shoot dry weight

Results in Table (1) clearly show that the differences in shoot dry weight among the four investigated genotypes of the Mahogany family proved significant in both studied seasons. The maximum dry weight was recorded by *Khaya senegalensis* (5.94g in the first season and 5.23g in the second one), being significantly higher when compared with any of the other genotypes in both seasons. On the other hand, the lowest dry weight of shoot was obtained by *Swietenia macrophylla* (1.65 g in the first season and 1.35 g in the second one), being significantly lower when compared with any of the other genotypes in both seasons. The descending order of shoot dry weight was 5.94, 5.30, 2.23 and 1.65g for *Khaya senegalensis, Khaya ivorensis, Swietenia mahogani* and *Swietenia macrophylla* ; respectively in the first season. It is obvious that the four studied genotypes of the Mahogany family showed the same trend of shoot dry weight in the second season, the records were 5.23g for *Khaya senegalensis,* 4.71 g for *Khaya ivorensis,* 1.99 g for *Swietenia mahogani* and 1.35g for *Swietenia macrophylla.*

As inferred earlier, it could be stated that the dry weight of plant shoot was significantly affected by species and *Khaya senegalensis* exceeded all other genotypes in this respect with significant difference in both seasons. Within the genus *Swietenia,* it was found that *Swietenia mahogani* surpassed *Swietenia macrophylla* in shoot dry weight with significant difference in both studied seasons.

From the aforementioned results concerning the vegetative characters of the four Mahogany species under investigation, it could be stated that the four studied genotypes of the Mahogany family showed significant differences in their vegetative growth attributes due to the effect of species. Similar

results were also recorded by Sun and Dickinson (1997) on Mahoganies as well as by Abdel – Dayem (1998) on Poplars.

III- Electrophoretic identification of Mahogany species:

It is clear from Figures (1 and 2) and Table (2) that the sample represent genotype number 1 (*Swietenia macrophylla*) have a number of ten protein bands with molecular weight (MW) ranging from 7.4 to 100.0 KDa. At the same time, the sample represent genotype number 2 (*Swietenia mahogani)* have 13 protein bands with the same range of molecular weight as found in the sample number 1 ; i.e., 7.4 to 100.0 KDa.

This means that the first two samples are genetically close to each other and belongs to the same genus. But, they found to be different in some protein bands. It is obvious that the genotype number1 lack in protein bands with MW of 75.7, 56.3, 23.3 and 22.4 KDa which were found in the genotype number 2. Also, it has a protein band of MW 70.0 KDa which was not found in the genotype number 2. At the same time, both genotypes (*Swietenia macrophylla and Swietenia mahogani)* were found to have the other protein bands with the same molecular weight and intensity on the gel. These results prove that they are genetically two different species belongs to one genus.

Meanwhile, sample represent genotype number3 (*Khaya ivorensis*) was found to have a number of 17 protein bands with molecular weight ranging from 10.1 to 106.0 KDa. Likewise, sample represent genotype number 4 (*Khaya senegalensis*) have 16 protein bands with the same range of molecular weight as found in the sample number 3 (10.1 to 106.0 KDa).

However, sample number3 was found to be different than sample number 4 in lacking the protein band of 86.1 KDa and have another two protein bands with MW of 28.7 and 25.0 KDa which were lacking in sample number 4 . At the same time, the other protein bands of these two samples (represents *Khaya ivorensis* and *Khaya senegalensis*) were found to have the same molecular weight and intensity in the gel. Therefore, it could be stated that these two samples are genetically close to each other ; i.e., belongs to the same genus but they are two different species.

Data also indicated that samples number 1 and 2 are belongs to different genus other than samples number 3 and 4.

From the aforementioned results, it could be concluded that such method of analysis (SDS-polyacrylamide gel electrophoresis separation of total soluble proteins) can be used for identification, differentiation and comparison between the different species as well as between different genera of the Mahogany family (Meliaceae) under investigation. The previous report of Lager crantz *et al.* (1988) reached to similar conclusion on Norway spruce. Likewise, these results agree also with those of Cheliak and Pitel (1984) as well as of Abdel-Dayem (1998) on Poplar species.

Fig1

fig2

table2

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تقييم النمو الخضرى لبعض أنواع عائلة الماهوجنى المتأقلمة فى مصر وتعريفها وراثياً.

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قسم الغابات – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر

أجرى هذا البحث فى مشتل قسم الغابات بمعهد بحوث البساتين بمركز البحوث الزراعية بالجيزة خلال موسمين متتاليين هما 2000/1999 و 2001/2000 بهدف تقييم الإنبات والنمو الخضرى لبعض أنواع عائلة الماهوجنى المتأقلمة فى مصر، وتعريفها وراثياً بإستخدام طريقة التفريد الكهربائى للبروتينات الذائبة الكلية فى بذورها. والأنواع التى تم دراستها هى:

1- الماهوجنى الأمريكى (الماهوجنى كبيرة الأوراق)
Swietenia macrophylla King (American mahogany or big-leaf mahogany).

2- الماهوجنى الأسبانى (الماهوجنى صغيرة الأوراق)
Swietenia mahogani (L.) Jacq. (Spanish mahogany or small-leaf mahogany).

3- الماهوجنى الأفريقى
Khaya ivorensis A. Chev. (African mahogany).

4- الماهوجنى السنغالى أو السوادنى(الماهوجنى الأفريقى)
Khaya senegalensis (Desr.)A. Juss (Senegal or Sudan mahogany).

أوضحت النتائج المتحصل عليها ظهور إختلافات معنوية فى نسبة الإنبات وكذلك فى جميع صفات النمو الخضرى (إرتفاع النبات، عدد الأوراق المتكونة على النبات، المساحة الكلية للأوراق على النبات، الوزن الطازج والجاف للمجموع الخضرى للنبات) بين أنواع عائلة الماهوجنى تحت الدراسة مما يؤكد تأثير النوع على هذه الصفات مع تفوق الماهوجنى السنغالى معنوياً على جميع الأنواع الأخرى فى هذا الصدد، لذا يوصى بإكثار ونشر هذا النوع فى مصر للحد من مشكلة نقص الأخشاب واستيرادها . كما أمكن عن طريق التفريد الكهربائى للبروتينات الذائبة الكلية فى البذور من تحديد البصمة الوراثية لأنواع الماهوجنى المختلفة التى تم دراسته وبالتالى يمكن إستخدام هذه الطريقة فى التمييز بين الأجناس والأنواع داخل الأجناس تحت الدراسة.