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# EFFECT OF SOME DIFFERENT GROWING SOIL MEDIA ON THE GROWTH AND ANATOMICAL CHARACTERISTICS OF *Ceratonia siliqua* L. (CAROB) SAPLINGS.

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## ABSTRACT

This study was conducted at the nursery of Timber Trees Research Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt and at the Agriculture Botany Department, Faculty of Agriculture, Cairo Univ., during seasons of 2003/2004 and 2004/2005. The aim of this study was to investigate the effect of some different media [sand, clay and mixture of clay and compost at the ratio of 1: 2 (V/V)] on the growth and anatomical characteristics of *Ceratonia siliqua* plant (Carob). Data indicated that the most effective growing soil medium was clay + compost at the ratio of 1 : 2 (V/V), which gave the highest values for all recorded growth, and anatomical characteristics, whereas the least effective medium was sand, while clay soil medium showed an intermediate values.

## INTRODUCTION

Some plants of Fabaceae family are a slow growing evergreen. These trees are used for erosion control and the pods for stock feed, human consumptions and in the manufacture of commercial thickness, pet food consumetics and pharmaceuticals (Tous and Ferguson, 1996). *Ceratonia siliqua* L, (Carob) is a highly versatile and useful tree for human, as there is a wide range of products derived from their fruits and timber. The carob plants grow slowly during the first years after sawing and then the trees can tolerate drought, strong wind (but not maritime exposure) and temperature., nearly up to 50ºC and down to about 5ºC. The effect of the used cultivated media on growth of many tree plants belongs to different species were early studied by many workers. As mixture of sand + caly + farmyard manure (1:1:1) (V/V) gave the best plant growth of *Eucalyptus camaldulensis*, *Pinus brutia* and *Casurina equistifolia*, (Shafik et al., 1979). Plant height was also effected by cultivation medium where the recommended mixture of 1:1 sand and peatmoss showed well developed plants of *Eucalyptus camaldulensis* plants, (El-Afaghani 1981). Moreover, Hammad and El-Kobisy (2006) on *Swietenia mahogany* and *Cupressus sempervirens* reported that the growth values of sapling increased with increasing organic waste added to sandy soil at the ratio of 1:4 (V/V) and the effect of the organic fertilizer on the total dry weight was highly significant.

The aim of this study was to investigate the effect of some different growing soil media on the growth and anatomical characteristics of *Ceratonia siliqua*.

## MATERIALS AND METHODS

This study was conducted at the nursery of the Timber Trees Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt. and at anatomical laboratory of the Agricultural, Botany Department, Faculty of Agriculture, Cairo University, during seasons 2003/2004 and 2004/2005. As it is obvious that Carob plants showed different response toward its cultivation medium after 30 months. The age of *Cerationia siliqua* seedlings used in this study were six months old, with an average height 8 cm and 4 leaves. On the first of August 2003 the seedlings were transplanted into plastic pots (25 cm diameter). Sand, clay, and a mixture of clay + compost [at ratio of 1:2 (v/v)], were used as potting media. The layout of this experiment was a randomized complete block design with 3 replicates each of 5 seedlings. The physical and chemical characteristics of the sand and clay soil used in the study were shown in Table (A), while that of the compost were represented in Table (B).

**Table (A): Physical and chemical characteristics of sand and clay soil used for growing *Ceratonia siliqua* seedlings.**

| Soil Characteristics | Sand | Clay |
|---|---|---|
| **Physical** | | |
| Course Sand % | 65.50 | 3.45 |
| Fine Sand | 31.50 | 37.03 |
| Silt% | 0.77 | 27.75 |
| Clay % | 2.50 | 27.25 |
| Organic matte | 0.30 | 0.33 |
| **Texture** | **Sand** | **Clay** |
| **Chemical** | | |
| PH | 6.70 | 8.10 |
| E.C. (ds/m) | 0.56 | 2.13 |
| Na (ppm) | 3.45 | 13.40 |
| K (ppm) | 0.58 | 0.85 |
| Biocarbonated (ppm) | 1.95 | 4.00 |
| Chloride (ppm) | 2.80 | 16.50 |
| Sulphur (ppm) | 2.28 | 0.83 |
| Calcium carbonate (ppm) | 28.00 | 3.77 |
| $Ca^{++}$(ppm) | 2.12 | 5.25 |
| $Mg^{++}$(PPM) | 0.88 | 1.79 |
| C.E.C. (Meg/100g) | 5.50 | 32.60 |

**Table (B) : Physical and Chemical characteristics of the compost used as a soil amendment for growing *Ceratonia siliqua* seedlings.**

| Compost characteristics | Value |
|---|---|
| pH | 6.93 |
| E.C. (ds.m) | 4.23 |
| Organic matte % | 19.65 |
| Total N (%) | 1.10 |
| C/N ratio | 17.86 |
| Total soluble N (ppm) | 135.00 |
| Total P (%) | 0.78 |
| Total K (%) | 1.23 |

The vegetative growth characters were recorded, including: plant height(cm), stem diameter at 10 cm above soil surface, average plant leaf area. ($cm^2$), number of leaves/ plant and fresh and dry weights of the whole shoot (stem + leaves). Chemical analysis of growing media using the methods described by Piper (1947) was also performed. The data were subjected to statistical analysis of variance and means were compared using the Least Significant Difference (L.S.D) test at the 5% level, as described by Steel and Torrie (1980). The anatomical studies were intended to carry out a comparative microscope examination on different plant organs (stem, leaf and root) which showed the most prominent response of plant growth to investigate treatments. Specimens of 30 months old, were taken from the medium internodes of the main stem, leaf and root. Specimens were killed and fixed for at least 48 hrs. in 10 ml formalin, 5 ml glacial acetic acid, 50 ml ethanol 95% and 35ml distilled water (F.A.A.). Then washed in 50% ethyl alcohol, dehydrated in a normal butyl alcohol series, embedded in paraffin wax if melting point 56ºC, sectioned to a thickness of 20 micron, double stained with crystal-violet-erythrosine, cleared in xylene and mounted in Canada balsam, Willey (1971). Sections were read to detect histological manifestations of noticeable responses resulted from using different growing media.

## RESULTS AND DISCUSSION

**Effect of different growing soil media on:**

**I- Growth characters:**

Data shown in Tables (1 and 2) and figure (1) indicated that in both seasons, medium which contain clay + compost at the ratio of 1: 2 (V/V) gave highest significant values for the different investigated growth used traits compared to plants grown on sand or clay media, while plants grown on sand soil gave the lowest values for different investigated characteristics. It is obvious from Table (1) that plants grown in mixture media showed significant increaments by 323.3% and 273.3% for plant height, 66.66% and 66.66% for stem diameter as compared between the mixture cultivated media and other used medium sand and clay respectively.


**Fig. (1): A photograph of carob planted in three media as following:**

**1- Mixture medium**
**2- Clay**
**3- Sand**

**Table (1): Effect of some different growing media on the growth of *Ceratonia siliqua* seedling after 18 months from planting. Season (2003/2004).**

| Growing media | Plant height (cm) | Stem diameter (mm) | Leaf area ($cm^2$) | Number of leaflets / plant | Fresh weight (gm) | Dry weight (gm) |
|---|---|---|---|---|---|---|
| Sand | 20.20 | 0.60 | 22.80 | 12.00 | 10.20 | 3.40 |
| Clay | 22.90 | 0.60 | 33.30 | 12.00 | 14.80 | 5.30 |
| Clay + compost 1: 2 (v/v) | 85.50 | 1.00 | 85.70 | 30.00 | 82.30 | 34.30 |
| L.S.D. at 5% | 4.4 | 0.12 | 2.18 | 6.6 | 5.5 | 2.1 |

Same trends of increased values were observed in case of average plant leaf area and number of leaves per plant, where their average significantly increased by 275.8%, 157.3% and 150%, 150% for both traits as compared with those grown in sand and clay medium, respectively. However plants grown in mixture media showed significant elevation by 706.8, 456.0% and 908.8, 547.1% for fresh and dry weight as compared with those grown in sand and clay medium respectively. In the second season the studied saplings showed same trend in their morphological and growth characteristics. As the mixture soil medium showed a superior effects on plant height, average stem thickness, average leaf area, number of leaves per plant as well as fresh and dry weight.

**Table (2): Effect of some different growing media on the growth of *Ceratonia siliqua* sapling after 30 months from planting. Season (2004/2005).**

| Growing media | Plant height (cm) | Stem diameter (mm) | Leaf area ($cm^2$) | Number of leaflets / plant | Fresh weight (gm) | Dry weight (gm) |
|---|---|---|---|---|---|---|
| Sand | 36.00 | 1.00 | 26.50 | 18.00 | 17.30 | 6.20 |
| Clay | 40.70 | 1.10 | 35.20 | 20.00 | 22.20 | 7.70 |
| Clay + compost 1: 2 (v/v) | 121.50 | 1.60 | 87.00 | 42.00 | 113.70 | 44.30 |
| L.S.D. at 5% | 5.3 | 0.18 | 3.1 | 8.8 | 2.4 | 1.8 |

The percentages increased amounts were significant as compared with the used sand soil medium. These increased percentages were 237.5%, 60%, 228.3%, 133.3%, 557.2% and 614.5% respectively, whereas these values compared to the values obtained with clay were significantly increased by 198.5%, 45.4%, 147.16%, 110.0%, 412.1% and 475.3% for the same traits in the same order.

The superior effect of the mixture of clay+ compost at the ratio 1: 2 (v/v) compared to the sand or clay media may be attributed to the ability of negatively charged particles of clay and organic matter to attract and hold the positively charged cations (i.e. this medium has a high cation exchange capacity). Also both clay and compost have a high water holding capacity, which allows high availability of water and nutrients to the roots Hartman et al., (1981). The favorable effect of the compost on morphological and growth

compared to the use of sand alone, may be attributed to an improvement in soil water rentention and consequently, to its indirect on increasing the uptake of water and nutrients by the plant roots. As a general observation, it could be stated that adding compost was useful to growth *Cerationia siliqua* sapling and that the effective media in promoting the growth and can be recommended for use was clay + compost at the rate of ( 1: 2 v/v). These results are in agreement with the finding of Shafik et al., (1979) and El – Afghani (1981) on *Eucalyptus camaldulensis*, Poole and Conover (1986) on *Brassia actinophlla* and Hammad et al., (2005) on *Cerationia siliqua* .

**II- Anatomical studies:**

**1- The main stem.**

It is obvious from Table (3) Figure (2) that the mixture media increased the diameter of the main stem by 47.77% and 20.47% over the sand and clay media respectively. These increments were reached maximum in diameter of cortex cell which was 125% over both sand and clay media, respectively. Vascular bundle thickness was increased by 17.6 and 27.5% over sand and clay media, respectively. These increments mainly due to the thickness of xylem by 20 and 33.3% over sand and clay media, respectively. Wherease phloem thickness reached 9.09% increments for both sand and clay media. Thickness of pith exhibited an increase by 65.7 and 18.85% over sand and clay media, respectively. In mixture media, cortex thickness and number of layers shared in increasing the stem diameter by 75 and 16.6% for cortex thickness and 62.50 and 30%

**Table (3): Effect of some different growing media on the stem of *Ceratonia siliqua* saplings after 30 months from planting.**

| Characteristics (µ) | Sand | Mixture media | Clay |
|---|---|---|---|
| Epidermis thickness | 36.00 | 36.00 | 36.00 |
| Stem diameter | 2.700 | 3.99 | 3.312 |
| Cortex thickness | 144 | 252 | 216 |
| Fibrous thickness | 72.00 | 108 | 90.00 |
| Phloem thickness | 99.00 | 108 | 99.00 |
| Xylem thickness | 360 | 432 | 324 |
| V. bundle thickness | 460 | 541 | 424 |
| Pith thickness | 1278 | 2118 | 1782 |
| Cortex layers No. | 8.00 | 13.00 | 10.00 |
| Diameter of cortex cell | 18.00 | 40.50 | 18.00 |

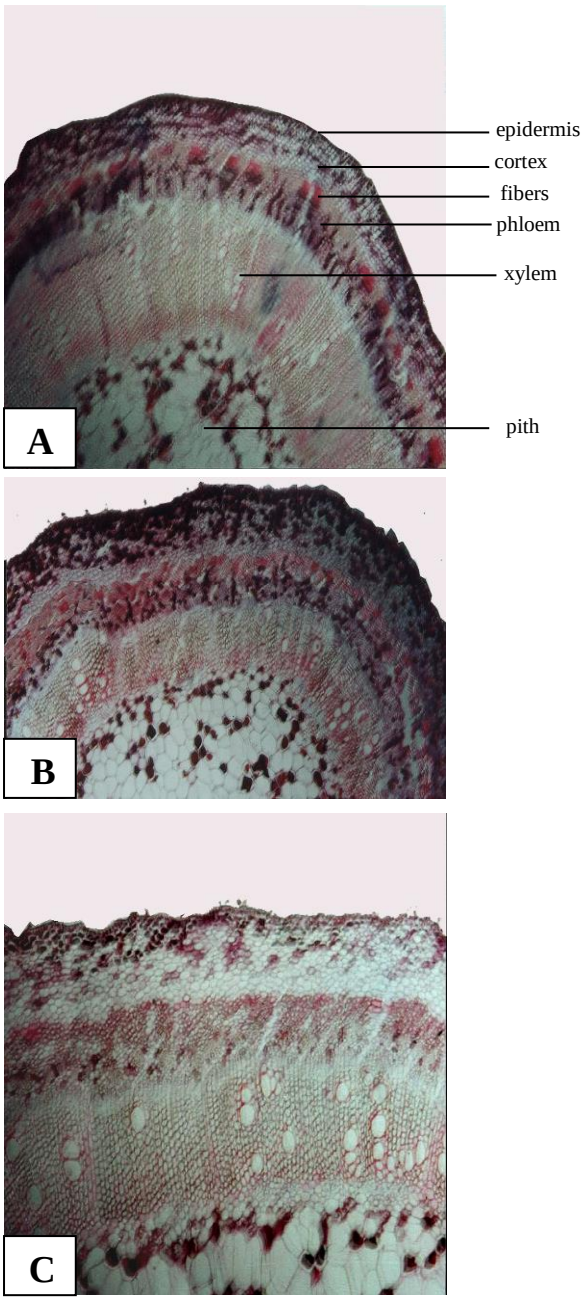


**Fig. (2): Transverse sections of carob stem growing in three media (40X)**

**A- Sand.**
**B- Clay.**
**C- Mixture medium**

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For number of cortex layers over sand and clay media respectively. Fibrous thickness represented the same increasing which reached 50 and 20% over sand and clay soil medium, respectively. The only exception was occurred with the thickness of epidermis, which was equal at all treatments under studies; sand, mixture and clay media.

On the other hand comparing the effect of clay media with that of sand, it is obvious that clay media caused an increments in the values of most studies characters over sand media i.e. cortex thickness by 50%, stem diameter by 22.66%, pith thickness by 39.42%, fibrous thickness and number of cortex layers by 25% each. The decrease obtained with vascular bundle thickness and xylem thickness were -7.8 and -10% below sandy media. Equal values were noticed on the values of phloem thickness and diameter of cortex cell.

**2- The leaflet**

Counts and measurements of the anatomical leaflet structure as show in transverse sections are presented in Table (4) and fig (3). It is obvious that, mesophyll thickness as affected by growing soil media showed that the sand medium exhibited the thicker mesophyll as compared with the other two used media, which recorded increased by 45.86% and 6.88 % over clay and mixture media, respectively. This increase was mainly due to the increased occurred in the spongy mesophyll thickness of the leaflet of plant grown in sand medium than other medium by 75.0% and 40.0% over clay and mixture media, respectively. Unless the increased values found in the mesophyll thickness of the leaflets, the midrib region was relatively thicker in the leaflet of plants grown in the mixture media. Plant leaflets that grown in mixture media showed relatively high measurements (except the average spongy tissue thickness) for all studied traits as compared either the leaflets of plants grown in sand or clay media.

**Table (4): Effect of some different growing media on the leaflet of *Ceratonia siliqua* saplings after 30 month from planting.**

| Characteristics (µ) | Sand | Mixture media | Clay |
|---|---|---|---|
| Upper epidermis thickness | 38.50 | 42.00 | 42.00 |
| Lower epidermis thickness | 28.00 | 41.00 | 21.00 |
| Mesophyll thickness | 388 | 363 | 266 |
| Paslisad thickness | 126 | 140.00 | 91.00 |
| No. palisade | 3.00 | 3.00 | 3.00 |
| Spongy thickness | 196 | 140 | 112 |
| Midarib thickness | 616 | 828 | 611 |
| Vascular bundle thickness | 207 | 296 | 253 |
| Fibrous thickness | 84 | 98 | 84 |
| Phloem thickness | 38.50 | 56.00 | 56.00 |
| Xylem thickness | 168 | 238 | 196 |

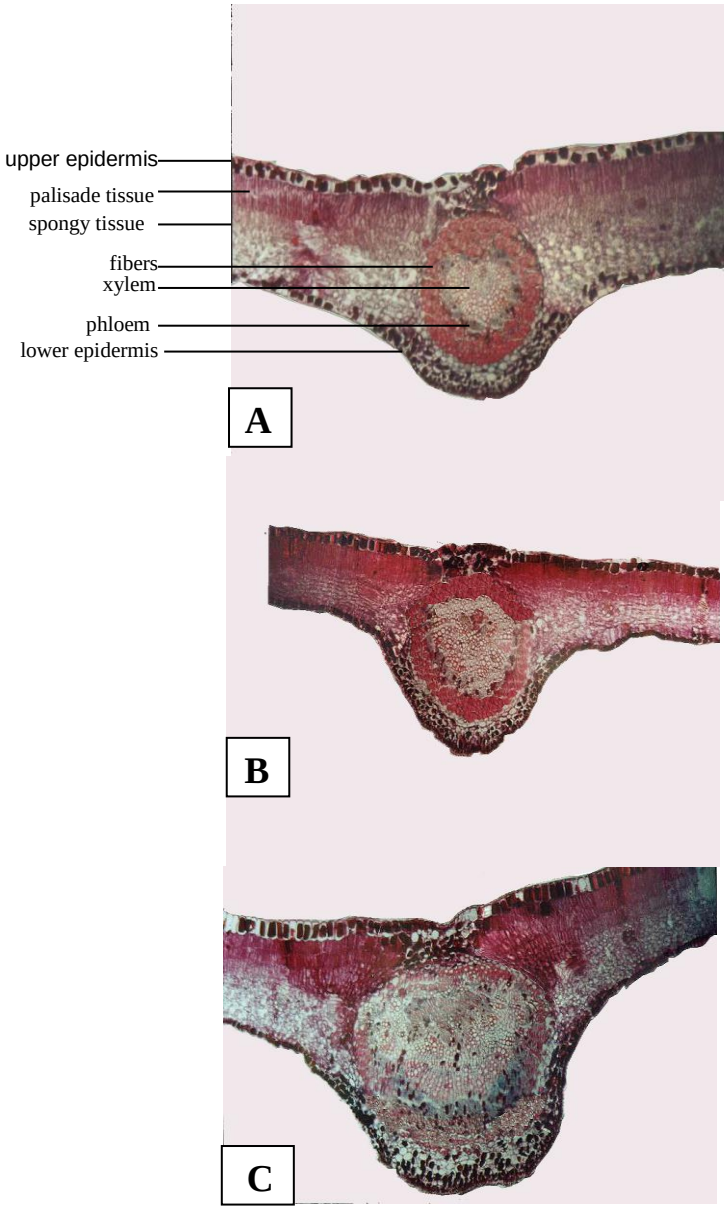


**Fig. (3): Transverse sections of carob leaflets growing in three media (40 X)**

**A- Sand.**
**B- Clay.**
**C- Mixture medium**

These increased amounts reached 9.09, 46.42, 11.11, 34.41, 42.99%, 16.66, 45.45 and 41.66 for thickness upper and lower epidermis, palisade, midrib, vascular bundle, fibrous, phloem and xylem, respectively, of plants grown in sand media. However, the corresponding increased amounts were 95.23, 36.46, 53.84, 25, 35.51, 16.99, 16.66 and 21.42 for lower epidermis, mesophyll, palisade, spongy, midrib, vascularbundle, fibrous and xylem thickness, respectively, for plants grown in clay media.

**3- The root:**

It is clear from Table (5) figure (4) that root diameter as shown in transverse sections were exceeded for the seedling which planting in mixture media than both of sand and clay media which recorded 57.14% and 22.05% respectively. When comparing the plants which grown in mixture media with sand media. It is obvious that plants grown in mixture media showed elevation by 22.09, 73.33, 78.57 and 62.33% for thickness of predermis, fibrous, phloem and xylem over plants grown in sand media, respectively. However comparing plants grown in mixture media with sandy one, it is clear that all measurements of root plants which grown in mixture media was exceeded than root plants grown in clay media by 7.94, 15.55, 33.33 and 38.88% for predermis, fibrous, phloem and xylem thickness respectively.

**Table (5): Effect of some different growing media on the root of *Ceratonia siliqua* seedlings after 30 months from planting.**

| Characteristics (µ) | Sand | Mixture media | Clay |
|---|---|---|---|
| Root diameter | 686 | 1078 | 880 |
| Thick. of predermis | 86 | 105 | 97.5 |
| Thick. of Fibrous | 75 | 130 | 112.5 |
| Thick. of phloem | 28 | 50 | 37.5 |
| Thick. of xylem | 154 | 250 | 180 |

The anatomical results from stem, leaflet and root were in agreement with Hammad and El-Kobisy (2006) on two woody trees seedlings "*Swietenia macrophylla* and *Cupressus sempervirens*" during treatments with different levels of crude olive cake mixed with sandy soil and found an increase for both growth and anatomical characteristics.

From the above mentioned anatomical outcomes results proved that, sapling which planted in mixture media exhibited increase in most anatomical measurements which reflected the importance of using mixture media for growing seedling to obtained the best vigor of growth that cleared in fig (1). This increase may be due to the physical and chemical characters of the composte which caused increasing of most anatomical characters, especially thickness of xylem which related to the activity of combium and that may be led to more absorption of water and minerals which reflected on the vigor of vegetative growth. This emphasized that the anatomical studies are in harmony with the morphgological and growth differences that obtained between the used three cultivated soil medium.

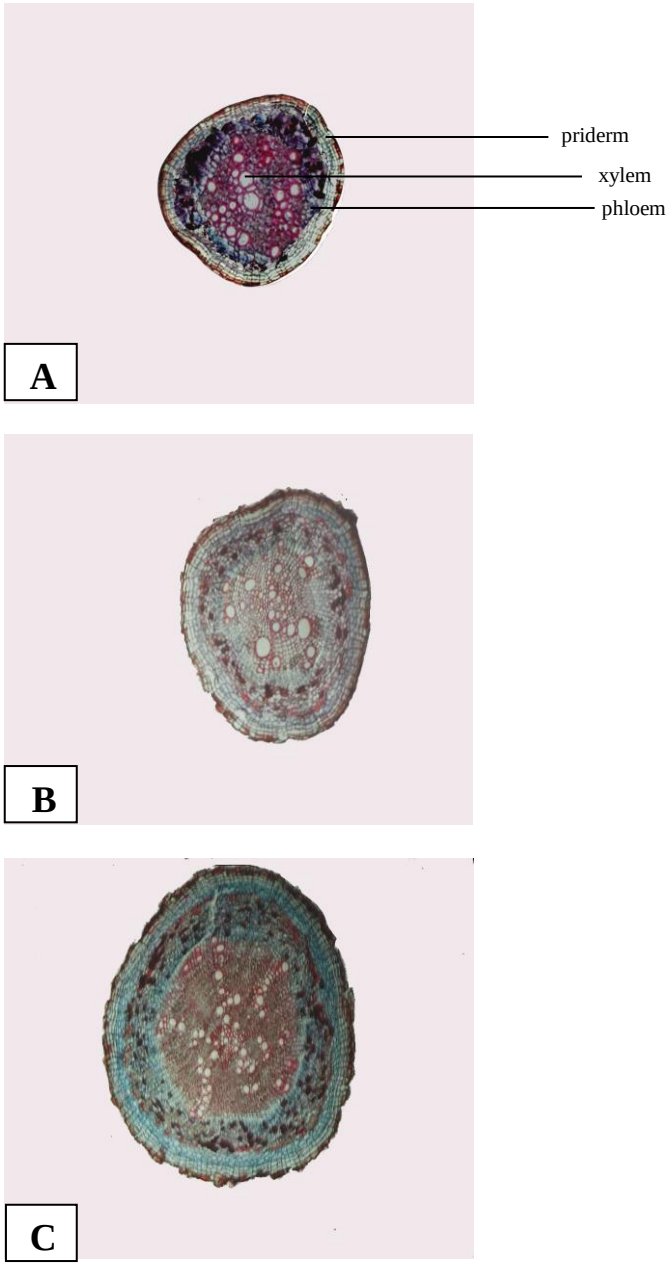


**Fig. (4): Transverse sections in carob root growing in three media (40 X)**

**A- Sand.**
**B- Clay.**
**C- Mixture medium.**

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## تأثير بعض بيئات النمو المختلفة على النمو والصفات التشريحية لشتلات الخروب

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*** قسم بحوث الأشجار الخشبية بمعهد بحوث البساتين – مركز البحوث الزراعية بالجيزة**

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أجري هذا البحث خلال موسمين متتاليين في الزراعة (٢٠٠٣/٢٠٠٤، ٢٠٠٤/٢٠٠٥) بهدف دراسة تأثير بعض بيئات النمو المختلفة (رمل وطين وخليط من الطين والكمبوست بنسبة ١ : ٢ حجما / حجم) على النمو والصفات التشريحية لشتلات نبات الخروب عمر ٦ أشهر حتى عمر ٣٠ شهر وذلك بمشتل قسم بحوث الأشجار الخشبية بمعهد بحوث البساتين مركز البحوث الزراعية بالجيزة وقسم النبات الزراعي بجامعة القاهرة.

**أوضحت النتائج ما يلي:**

(1) استخدام البيئة المكونة من خليط الطمي + الكمبوست بنسبة ١ : ٢ حجما/حجم أظهرت تأثير معنوي واضح في زيادة كل من طول النبات وسمك الساق وعدد الأوراق ومساحة الورقة.

(2) أظهرت كل من الوزن الجاف والرطب زيادة معنوية كناتج للمعاملة لمخلوط الطين + الكمبوست بنسبة ١ : ٢ مقارنة ببيئات النمو الأخرى سواء الطين أو الرمل منفردا.

(3) أكدت النتائج التشريحية جميع الاختلافات المورفولوجية حيث اشتملت النتائج على الزيادة في جميع القراءات وأعداد الأنسجة المكونة للساق بالإضافة إلى ظهور الاختلافات في كل من التركيب التشريحي للوريقة والجذر.