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STUDIES ON VEGETATIVE PROPAGATION OF JOJOBA

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ABSTRACT

The present study was carried out on Jojoba plants [*Simmondsia chinensis(link)Schneider*] during two successive seasons, i.e. 2007 & 2008 . Two experiment were designed for the possibility of using leafy soft stem cuttings for propagation of jojoba plants vegetatively . In the first experiment date of collecting leafy stem cuttings, i.e. April, July and November were tested, the cuttings were dipped in NAA or BA either alone or in combination with TIBA**.**. In the second experiment, the cuttings were dipped in IBA 3000 ppm + TIBA100 ppm and Leafy stem cuttings were planted in different media to examine their influence on rooting and vegetative growth. The obtained results showed that dipping of Mid April cuttings in IBA 3000ppm+TIBA 100 ppm solutions significantly increased all rooting and growth measurements, i.e. rooting % numbers and length of developed roots, and average length ,diameter of main shoot and total number of branches compared to the other treatments or the control. With regard to media, it was found that perlite + vermiculite was most suitable since numbers of roots/ cuttings, root length, or root length, or rooting % as well as survival % and length, diameter and number of leaves/ transplant were more than using other media. Therefore, it could be recommended to using soft stem leafy cuttings from selected jojoba trees during April for vegetative propagation after dipping in TIBA at 100 ppm + IBA at 3000 ppm and growing in perlite + vermiculite media. The anatomical study for stem cuttings of jojoba plant was found that was originated from the cambial zone. The cells of cambial zone were divided to from root primordial and continued to develop.

INTRODUCTION

Jojoba plant (*Simmondsia chinensis link Schneider*) which is pronounced as hohoba belongs to family Simmondsiaceae. This plant is native to the arid zone of USA and Mexico. Its natural distribution fall between latitudes 25 and 34 (South) in an area which closely approximates the sonorant desert (Gentry, 1958). Jojoba plant have currently received a special attention .Since, their seeds contain a valuable liquid wax called Jojoba oil which is very similar to that obtained from whale sperm . The liquid wax of Jojoba is used as a nature base for a wide range of cosmetics component, i.e. hair oil, shampoo, soap, face creams, sunscreen compounds and many medical products, i.e. dermatitis in children, sorana for anus,anti-inflammatory for anus ,medicament for pneumonic lung and promote heeling of wounds.. Also, it has a heat resistant lubricating properties and useful materid in chemical industry (Sherbrooke & Hasse, 1974, Wisniak, 1975, Benzioni, 1995 and Weiss, 2000).

It can be used also as antioxidant, antifoaming and fire retardant agents. Due to its high dielectric constant, the oil is suitable as insulator and used as carrier for pesticides, and plant hormones, formations for softing leather paints and adhesives products for sizing and waterproofing. Moreover, Jojoba oil which is waxy in nature may also have a promise in the treatment of industrial wastewater

for elimination of toxic heavy metals. In addition, the final repressed Jojoba meal usually contains about 30% protein and more than 42% carbohydrate; it is suitable as food for animals after eliminating the toxicity simmondesin.

The present study was hopped to enhance vegetative propagation of Jojoba through using the stem cuttings in order to achieve the adequate number of new transplants needed for horizontal extension of planting in newly reclaimed soils with such plant species at the proper time, since its cuttings known as to be difficult to root.

MATERIALS AND METHODS

The present study was carried out in the nursery of the Horticulture Research Institute at Giza, Egypt during two successive seasons of 2007 and 2008 .The different genotypes seedling of Jojoba (*Simmondsia chinensis*) which were carefully selected as mentioned by Abou El-Khashab *et al*., (2007) and devoted as a source for cuttings.

A- First experiment::

In this experiment, leafy semi – hardwood cuttings were collected to study two factors the effected of namely: a- date of collecting cuttings (Mid of April, July and November) and b-dipping in IBA, NAA and TIPA (Triiodo-benzoic acid) solutions beside tab water as control on some rooting and vegetative growth measurements of cuttings and rooted cutting ,respectively.

All investigated pre-planting treatments by dipping the basal portions of cuttings (2-3 cm) long, after scratching their surface layer and then dipped for all studied treatments for 1 minute, The variable pre-planting treatments were as follow:

1- Dipping in water (control).
2- Scratching
3- Dipping in IBA at 2000ppm
4- Dipping in IBA at 3000ppm
5- Dipping in NAA at 1000 ppm
6- Dipping in NAA at 1500 ppm(
7- Dipping in IBA at 2000 ppm +TIPA at 100 ppm
8- Dipping IBA at 3000 ppm +TIPA at 100ppm
9- Dipping in NAA ppm +TIPA at 100ppm (1ppm).
10- Dipping in NAA at 1500 ppm +TIPA at 100 ppm

For each of the above mentioned 10 treatments, 20 cuttings were taken. As soon dipping had been done, cuttings were placed in mist propagation bench in a green house using a mixture of vermiculite and perlite (1:1vol.) These steps were repeated three times, during April, July and November.

Field experiment layout:

Three times in the year during both seasons planting of the cuttings was carried out. The treatments were arranged in a complete randomized blocks design and each treatment was replicated three times and every replicate was represented by 20 cuttings.

Second experiment:

This experiment was devoted for studying the effect of different media on rooting of Jojoba stem cuttings. All used cuttings in the second experiment were prepared from rooting on 15th May cuttings. The tested treatments were:

1- Peat moss + vermiculite (1:1 vol.)
2- Perlite + peat moss (1:1 vol.)
3- Vermiculite + sand (1:1 vol.)
4- Sand + peat moss (1:1 vol.)
5- Sand + sawdust (1:1 vol.).
6- Sand + compost (2:1 vol.).

Cutting of about 15 mm. long 5 mm. in diameter with 2 leaves were taken in 15th April during each season. Such cuttings were prepared by taking the sub-terminal portions from developing shoots of the current growing season since a basal straight cut was done just below a node at the desired length, beside two leaves were left per each cutting, and it contains 4 nodes, after then we scratched, separately planted in an individual plastic box (120 × 120 × 25 cm). The employed boxes were previously filled with a mixture of several media as mentioned before. These planted cuttings were devoting for investigating the different growth characters. The cuttings were then placed in mist propagation bench in a greenhouse. Each treatment contained 3 replicates and each replicate and contained 50 cuttings.

Field experiment layout:

In both seasons, the treatments were arranged in a complete randomized block design as each treatment was replicated three times and one replicate was represented by 50 cuttings studying growth parameters and histological examinations..

Vegetative growth characters:

Rooting parameters:

All succeeded rooted cuttings were counted and data on some rooting measurements of jojoba genotypes characters are included Percentage of rooted cuttings, number of roots per cuttings and length of root developed per cutting which were recorded 12 weeks after planting the cuttings.

The rooted cuttings were transplanted individually in polyethylene bags filled with a mixture of perlite +vermiculite at equal portions and such rooted cuttings were allowed to grow in the green house for one year.

Survival percentage:

It was estimated on the number of rooted cuttings that remained alive one year latter from recording the rooting measurements and growing in the green house.

Fresh and dry weights:

Each rooted cutting was divided into three portions (leaves, shoot and root). These portions were washed and dried in a electrical oven at 80^{o}C till reaching to a constant weight, then the dry weight was recorded.

Chemical analysis:

Sampling for chemical analysis of cuttings was carried out three times in (June, May, October) in the first experiment and one time the second experiment for determination of total carbohydrates and nitrogen, three samples for each treatment were taken at every sampling dates, (10 g) fresh weight was taken

from the tissues of the basal 3 cm. of cuttings and oven dried at 70 ºC then fine grounded and stored in paper bags. A dried sample of 0.1g was subjected to acid hydrolysis for six hours in boiling water bath using H_2so_4 .Total carbohydrates were assayed using the phenol sulfuric acid method and calculated as 1g glucose per 100g dry matter Dubois(1956) .Total nitrogen was estimated by using the modified microkjeldahl method as described by Pregel (1945).As for determining of total phenols and indoles, three samples for each treatment (each of 10 g fresh weight) were also excised from the basal portions of prepared cuttings and placed in 80 % ethanol at °C for 72 hours as described by Daniel &George, (1972) was concentrated ethanol at 30±2 ºC under vacuum. Thereafter, it was diluted to a known volume for determination of the total indoles and phenols. Total phenols was determined by using folin denis colorimetric method (A.O.O.C.,1970) at 730 wave length. The concentration was calculated from a standard curve of pyrogallol as mg/100g weigh .

P-dimethyl amino benzaldehyde test (Ethrich regent) described by Larson *et al*. (1962), and modified by Selim *et al*. (1978) was used to determine the total indoles, and estimated calorimetrically at 530.

Anatomical studies:

A transverse section from the 4th node of plant type was sampled for this purpose. Samples of two cuttings per each treatment were periodically taken at one week interval from planting date, till root formation, i.e. continued 6 weeks later. The basal portion (5cm) of Jojoba cuttings was mainly used for anatomical studies. Samples were immediately killed and fixed in FAA solution for softening; samples were soaked in tap water for two days before preparation of sections.

Sections of about 18-20 microns in thickness were prepared by using a sledge microtome. The sections were stained by the safranine .Pecro-amily – blue method (Johansen, 1940).

Sections were dehydrated, cleared in xylol and mounted in canda balsam. Then sections were microscoplly examined and photographed.

Statistical analysis:

All data obtained during two experimental seasons for both factorial experiments included in this work were subjected to analysis of variance according to the method described by Snedecor & Cochran (1980). Meanwhile, the significant differences among means were calculated by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

First experiments:

Effect of plant hormone on root growth parameters.

Results presented in Table (1) revealed that all root growth parameters, i.e. average root length, number of roots and rooting (%) were significantly affected by conducted treatments as compared to the control.

Average root length.

It was found that the highest values of root length obtained by application of IBA 3000 + TIBA 100 treatment and dual application of IBA

2000 + TIBA 100 treatment followed in a descending order as follows: NAA 1000 + TIBA 100, NAA 1500 + TIBA 100 ,NAA 1500, NAA 1000 and IBA 3000 in both seasons. However, the lowest values were obtained from control in both seasons.

In regard to the effect of collection date, it was clear that the average root length increments were more pronounced with the early collection, date (15-April) in the first season and medium date (15-July) in the second season.

As for interaction between effect of treatments and date of application, it was found that early application date (15-April) and IBA 3000 + TIBA 100 treatment recorded the highest value, whereas medium or late date with all treatments recorded the lowest values in the first season, However, the early date (15-April) of IBA 2000 treatment recorded the highest value, in the second one.

Number of roots.

It was found that the highest number of roots was obtained in a descending order as follows by dual application of IBA 2000 + TIBA 100, NAA 1000, IBA 3000, NAA 1500 and IBA 3000 + TIBA 100 in the first season. In the second season dual application of IBA 3000 + TIBA 100, followed by NAA 1000, IBA 3000 and finally NAA 1500 were obtained.

With regard to the effect of collection date, it was clear that the number of roots increments were more pronounced with the early collection date (15-April) in the first season and with the medium date (15-Jully) in the second one.

As for interaction between effect of treatments and collection date, it was found that early date (15-April) and NAA 1000 treatment, IBA 3000; IBA 2000 + TIBA 100 treatment recorded the highest values. Or however, medium date (15-July) of dual application of IBA 3000 + TIBA 100 treatment recorded the highest values in the second season.

Rooting %

It was found that the highest rooting percentage was obtained by application of NAA 1000 treatment followed by application of IBA 3000 treatment in the first season, and application of IBA 2000 treatment followed by dual application of IBA 3000 + TIBA 100 treatment in the second season, whereas, the lowest value was obtained from control in both seasons.

With regard to the effect of collection date, it was clear that the percentage of rooting increments were more pronounced with the early date (15-April) followed by medium date (15-July) while late application (15-November) recorded the lowest rooting percentage in both seasons.

As for interaction between effect of treatments and collecting date it was found that early date (15-April) with IBA 3000 treatment in both seasons recorded the highest rooting percentage whereas late date (15-Nov.) with all treatments recorded the lowest one in both seasons.

Effect of plant hormones on vegetative growth parameters

Positive effects were attributed to applied treatments were evident on vegetative growth parameters; average plant length, number of leaves and number of branches as compared to the control (Table 2).

1

2

Average plant length

It was found that the highest values of average plant length were obtained in descending orders follow application of NAA 1500, IBA 3000, IBA 3000 + TIBA 100 and IBA 2000 + TIBA 100 in the first season. Dual application of IBA 2000+ TIBA 100 followed by NAA 1000+ TIBA 100 treatment were the highest in the second season,

With regard to the effect of collecting date, it was clear that the average plant length increments were more pronounced with the early date (15-April) followed by medium date (15-Jul) while late date(15-Nov.) recorded the lowest one.

As for interaction between effect of treatments and collection date it was found that late application date (15-November) and IBA 3000 treatment recorded the highest values in the first season. However, late date (15-Nov.)with dual application of IBA 2000 + TIBA 100 recorded the highest values in the second season.

Number of leaves.

It was found that the highest number of leaves were obtained by dual application of IBA 2000 + TIBA 100 and IBA 3000 + TIBA 100 followed by application of IBA 3000 treatment in the first season .Application of IBA 3000 followed in Ascending order by NAA 1500, NAA 1000 + TIBA 100 IBA 2000 + TIBA 100 and finally scrape off treatment in the second season.

With regard to the effect of collecting date, it was clear that the number of leaves increments were more pronounced with the early date (15-April) in the first season and both early and medium dates in the second season.

As for interaction between effect of treatments and collecting date it was found that early date (15-April) with dual application of IBA 2000 + TIBA 100 treatment recorded the highest value, in both seasons.

Number of branches

It was found that the highest number of branches was obtained by dual application of IBA 2000 + TIBA 100 treatment followed by application of NAA 1000 treatment in the first season. Application of IBA 3000 treatment followed by NAA 1500 treatment in the second one, whereas, the lowest values were obtained from the control for both seasons.

With regard to the effect of collecting date, it was clear that the number of branches increments were more pronounced with the early date (15-April) followed by late date (15-Nov.) and in the first season. Medium date (15-July) followed by early application date (15-April) were recorded in the second season.

As for interaction between effect of treatments and collecting date, it was found that early date (15-April) with dual application of IBA 2000 + TIBA 100 treatment in the first season, whereas, medium date (15-July) with IBA 3000 treatment in the second season recorded the highest number of branches.

Effect of some plant hormones on survival (%):

It was evident from the data in Table (3) that, survival % was markedly increased by the conducted treatments as compared to control.

It was found that the highest survival percentage was obtained by dual of IBA 2000 + TIBA 100 treatment and NAA 1000 followed by IBA 3000 +

TIBA 100 in the first season. Application of IBA 3000, NAA 1000 IBA 2000 + TIBA 100 treatment then application of NAA 1000 recoded the highest percentage treatment in the second season.

With regard to the effect of collecting date, it was clear that the percentage of survival increments were more pronounced with the early date (15-April) followed by late date (15- Nov.)) in the first season, whereas medium date (15-July) followed by early date in the second one.

Table (3): Effect of some growth regulators and time of preparing of cutting on survival %.

Characters / Dates / Treatments	Survival %			
	15-Apr	15-Jul	15-Nov	Mean**
1st season				
Control	0.00h	0.00h	0.00h	**0.00G**
Scrape off	80.67g	0.00h	0.00h	**26.89F**
IBA 2000	85.33e	0.00h	0.00h	**28.44E**
IBA 3000	90.00c	0.00h	0.00h	**30.00D**
NAA 1000	95.00a	80.67g	80.7g	**85.44A**
NAA 1500	93.00b	0.00h	0.00h	**31.00C**
IBA 2000 + TIBA 100	90.00c	83.33f	83.33f	**85.56A**
IBA 3000 + TIBA 100	87.67d	80.67g	80.67g	**83.00B**
NAA 1000 + TIBA 100	80.00g	0.00h	0.00h	**26.76F**
NAA 1500 + TIBA 100	85.50e	0.00h	0.00h	**28.50E**
Mean*	**78.72A**	**24.47B**	**24.47B**	
2nd season				
Control	0.00l	0.00l	0.00l	**0.00H**
Scrape off	80.67k	84.33ij	80.67k	**81.89D**
IBA 2000	93.67a-d	85.00hi	0.00l	**59.56F**
IBA 3000	94.67ab	94.33a-c	91.67c-e	**93.56A**
NAA 1000	96.00a	93.67a-d	90.67ef	**93.44A**
NAA 1500	91.33de	87.67g	91.67c-e	**90.22B**
IBA 2000 + TIBA 100	93.33a-e	92.67b-e	88.67fg	**91.56B**
IBA 3000 + TIBA 100	87.00gh	96.00a	0.00l	**61.00E**
NAA 1000 + TIBA 100	82.33jk	88.67fg	90.67ef	**87.22C**
NAA 1500 + TIBA 100	83.33ij	90.67ef	0.00l	**58.00G**
Mean*	**80.23B**	**81.30A**	**53.40C**	

*** Means of collecting dates.** **** Mean of treatments.**

Capital and small letter/s were used for distinguishing between values of specific and interacted treatments, respectively. Means followed by the same letters were not significantly different at 5% level.

As for interaction between effect of treatments and collecting date, it was found that early date (15-April) with NAA 1000 treatment in the first season, and medium date (15-July) with IBA 3000 + TIBA 100 treatment in the second one recorded that the highest percentage of survival.

Chemical compositions

Results presented in Table(4) revealed that all chemical constituents of cutting, i.e. indoles, phenols, nitrogen (%), carbohydrates (%) and C/N ratio were significantly affected by date of sampling.

Indoles concentration:

It was found that the highest values of indoles concentration was obtained from early date (15-April) in the first season, medium and late dates in the second one.

Phenols concentration:

It was evident that phenols concentration increments were more pronounced with the early date (15-April) in the first season, and medium date (15-July) and late dates in the second season.

Nitrogen %:

It was clear that differences in N (%) were not significant among sampling date in the first season, while the highest percentage of nitrogen was obtained from late date (15-Nov. followed by medium and early dates in the second season.

Carbohydrates %:

It was found that differences in carbohydrate (%) were not significant among sampling dates for carbohydrates % in the first season, while the highest percentage of carbohydrates was obtained by late date (15-Nov.) followed by medium and early dates in the second season.

C/N ratio:

It was evident that differences in C/N ratio were not significant among sampling dates in the first season, while the highest percentage of C/N ratio was obtained by late date (15-Nov.) followed by medium and early dates in the second season.

Table (4): Effect of time of preparing cutting on concentrations of indoles, mg/100g d.wt. Phenols, mg/100g d.wt. nitrogen carbohydrates (%) and C/N ratio of Jojoba plant.

Chemical constituents	Date	15-April	15-July	15- Nov.
Indoles	2007	0.467A	0.093C	0.362B
	2008	0.849B	1.037A	1.025A
Phenols	2007	0.097A	0.024C	0.059B
	2008	0.045B	0.062AB	0.069A
Nitrogen %	2007	1.990A	2.673A	2.400A
	2008	2.510A	1.767AB	1.687B
Carbohydrates (%)	2007	44.17A	49.76A	42.17A
	2008	42.30B	46.47AB	47.69A
C / N ratio	2007	22.22A	18.97A	17.88A
	2008	16.82B	26.32AB	30.63A

Means followed by the same letters were not significantly different at 5% level.

The obtained results indicated that root growth parameters, i.e. rooting percentage, root length and number of main roots per cutting and vegetative growth parameters, i.e. survival percentage, shoot length and number of branches and leaves per cutting were significantly affected by rooting media hormone, the concentration and timing of taking the cutting. Control cuttings rooted poorly, while the rooting percentage with the best growth parameters obtained with early date (15-April) with dual application of IBA 2000 + TIBA 100 followed by dual application of IBA 3000 + TIBA 100 then NAA 1000 which appeared to be optimal.

These results were in the same line with those obtained by Bing and Dong (2003) who showed that the rooting ratio of semi-hardwood cuttings was increased by plant hormone treatment, especially treated by IBA 1000 ppm for "*Simmondisa chinensis*". In addition, Ttirkoglu &Durmus (2005) found that, IBA hormone usage increased the rooting and the best performance according to root number, root length, leaf number and shoot length, as hormone intake increased. The increase was especially significant in higher concentrations (5000 ppm). The cuttings taken out in the spring at 10th of February and 7th of April has high percentage of producing roots compared with the cuttings taken out in the summer at 16th of June for Gemlik and Manzanilla olive varieties. Also, Ercisli *et al*. (2005) showed that IBA application improved overall rooting capacity; 3500 ppm IBA was optimal for rooting on hardwood cuttings of *Rosa dumalis*. Recently, Oliveira *et al*. (2009) found that the cuttings collected in April and treated with 3000 mg IBA/liter showed increased percentage of rooting and average number of roots.

Second experiments:

Effect of media type on root growth parameters

Results presented in Table 5 revealed that all root growth parameters i.e. rooting %, average root length and number of roots were significantly affected by conducted treatments.

Rooting (%):

It was found that the application of perlite + peat moss treatment followed by perlite + vermiculite recorded the highest percentage of rooting, whereas the application of sand + compost treatment recorded the lowest values in both seasons.

Average root length:

It was found that the highest average root length were obtained by the application of perlite + vermiculite, vermiculite+ sand treatment and sand + peat moss in the first season. Application of sand + peat moss and perlite + peat moss treatments recorded the highest values in the second season.

Number of roots:

It was clear that the number of roots increments were more pronounced with the application of perlite + peat moss treatment followed by perlite + vermiculite treatment in the first season, whereas of sand + peat moss treatment and perlite + peat moss treatment in the second season, recorded the highest number of roots.

One of the most important prerequisites for successful rooting of cuttings is a suitable rooting medium. The performance of cuttings was seen to vary substantially between different media type. Both rooting % and roots number were, increased which could be explained by increasing of water retention capacity of media at low tensions. Rooting percentage and performance of growth parameters per cutting were the highest in perlite + vermiculite and perlite + peat moss media, respectively. This might imply that those media had better water retention capacity.

The results were in agreement with those obtained from Palzkill and Feldman, (1993) who reported that the Peat moss/ perlite/vermiculite medium would be the best of the three media tested because it holds together well developed root systems for Jojoba stem cuttings. Also, Singh *et al*. (2003)

showed that perlite: peat mixture was the most suitable rooting medium for adventitious root formation. However, Gerakakis & Ozkaya (2005) found that the Perlite/sand/silt medium recorded the highest rooting for Domat and Ayvalik olive cultivars. Also, Ercisli *et al*. (2005) showed that the highest rooting percentage, root length and root number were obtained in peat moss + perlite; peat moss + sawdust; sawdust and peat moss + perlite substrates, respectively. Recently, Oliveira, *et al*., (2009) found that Perlite + Vermiculite (1:1 v/v) enhanced the average length of the roots. Also, Isfendiyaroglul et al. (2009) mentioned that perlite: vermiculite (1:1) might be the best medium for ensuring a high rooting percentage and good root production in Ayvalik olive cuttings.

Effect of media type on survival and vegetative growth parameters:

Positive effects attributed to type of media were evident on survival and vegetative growth parameters, i.e. average shoot length, number of leaves and number of branches (Table 5).

Table (5): Effect of media type on some rooting parameters of Jojoba plant.

Characters	Rooting (%)		Average root length (cm)		Number of roots	
Season / Media type	2007	2008	2007	2008	2007	2008
perlite + vermiculite	33.17b	31.00b	26.30a	15.00b	22.33b	7.03e
perlite + peat moss	47.83a	50.87a	22.07b	20.37a	28.67a	9.90c
vermoklit + sand	16.17d	12.17e	25.83A	15.00b	17.00c	14.77a
Sand + peat moss	20.67c	21.17c	25.40A	20.80a	15.50c	12.83b
Sand + sawdust	11.00e	14.67d	10.00C	9.70c	9.500d	8.50d
Sand + compost	0.00f	0.00f	0.00D	0.00d	0.00e	0.00f

Means followed by the same letters were not significantly different at 5% level.

Average shoots length:

It was found that the highest average shoot length was obtained by sand + sawdust treatment followed in a descending order as follows: perlite + vermiculite treatment, perlite + peat moss and sand + peat moss in the first season. Application of perlite + vermiculite followed by perlite + peat moss then vermiculite + sand recorded the highest values in the second season.

Number of leaves:

It was clear that the number of leaves increments were more pronounced with perlite + vermiculite treatment, followed by perlite + peat moss then vermiculite + sand treatment in both seasons.

Number of branches

It was found that perlite + vermiculite treatment followed by perlite + peat moss, and vermiculite + sand recorded that the highest number of branches in both seasons.

Survival %:

It was clear that the survival % increments were more pronounced with perlite + peat moss treatment, followed by vermiculite + sand and perlite + vermiculite in both seasons.

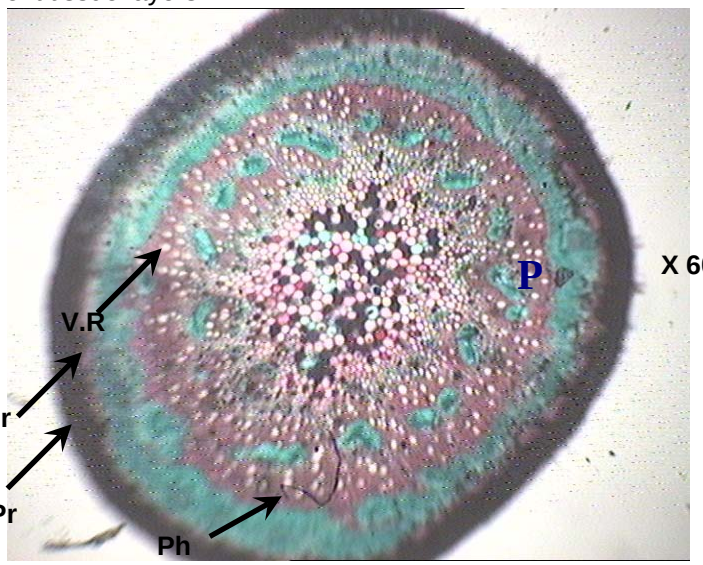
Table (6): Effect of media type on some vegetative growth of Jojoba plant.

Characters	Average shoot length		Number of leaves		Number of branches		% Survival	
Season / Media type	2007	2008	2007	2008	2007	2008	2007	2008
Perlite + vermiculite	14.30ab	31.00a	7.07a	7.20a	1.93a	2.00a	90.67b	96.00ab
Perlit + peat moss	14.13ab	18.07b	4.30b	5.83b	1.23b	1.93a	93.67a	98.33a
Vermiculite + sand	12.33b	17.67b	4.17b	3.67c	1.00b	2.00a	91.33ab	94.00b
Sand + peat moss	13.50ab	13.17c	3.50b	3.50c	1.33b	1.00c	90.00b	94.00b
Sand + sawdust	15.50a	11.00d	3.83b	2.83c	1.00b	1.23b	71.67c	72.33c
Sand + compost	0.00c	0.00e	0.00c	0.00d	0.00c	0.00d	0.00d	0.00d

Means followed by the same letters were not significantly different at 5% level.

Anatomy of adventitedous root origin:

Figure (1) showed cross section in Jojoba plant which showed different tissue layers.



Control

Fig. (1): A cross section in Jojoba plant stem cutting showing the different tissues.

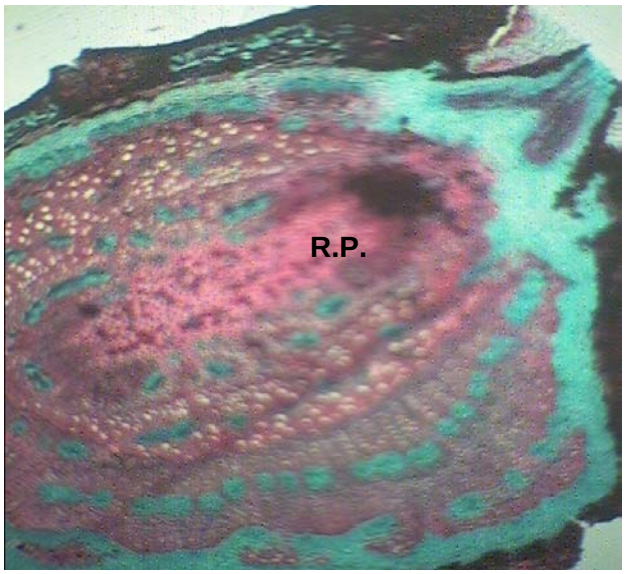
Pr = periderm. **Ph = Phloem.** **P = Pith**
Cor = Cortex **V.R. Vascular ray.**

The periderm is consisting of a limited number of layers followed by the cortex which often consists of several layers of paranchy, matic cells. The phloem is composed of sieve tubes, companion cells, phloem parenchyma and fibers. A complete cambium ring between the phloem and xylem. The pith is located in the core of stem.It is divided into two zones and composed

of parenchymatic cells. The cells of the outer zone are small and compact with narrow intercellular spaces, whereas, those of the inner zone are large with intercellular spaces.

The offer mentioned anatomical structure of Jojoba is nearly the same as what had been previously reported for different members of rosaceae family (Metcalf and Chalk, 1950). Furthermore, Fig (2) showed that root initials started from cambial and pith zones of Jojoba. Satoo (1955) stated that in most plants adventitious roots are originated in the vicinity of differentiating vascular tissue. These places are root close to xylem, phloem and facilitates rapid establishment of vascular connection He added that roots formed on cuttings are initiated in four different ways:

1- From cambium and regions of tissues.
2- From leaf and branch traces.
3- From irregularly arranged patches of parenchyma.
4- From callus tissues.

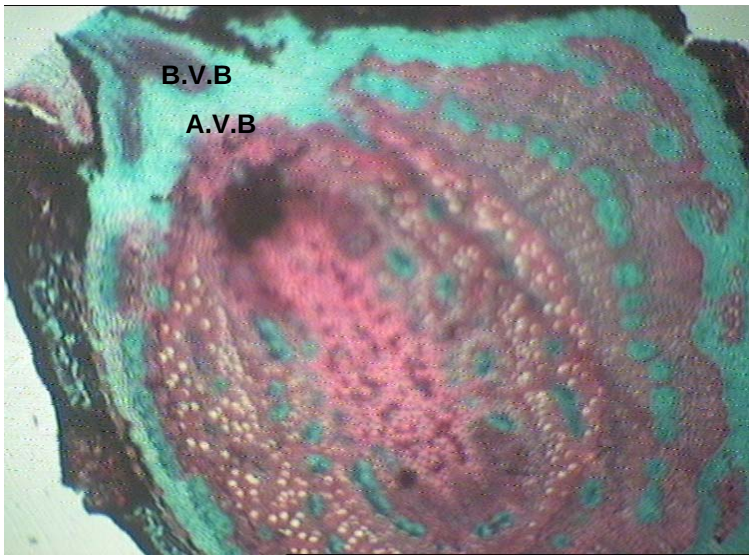


X 150

Fig. (2): A cross section in Jojoba plant stem cutting showing early stage of root primordia periphery initiated from the pith zone.
R.P. = Root primordia.

Concerning the development of adventitious roots, it was clear from Fig (3) that cambium cells were activated by growth regulators treatments to form root primordial particularly by IBA 3000 + TIBA 100 ppm. Meanwhile, untreated cuttings (control) showed no appreciable activity in cambium Fig (1). These results go in line with the findings of Salama *et al*. (1993) on apricot.

The cross section in Jojoba Fig (3) showed the beginning of vascular bundles connection between the adventitious roots and those of the cutting.

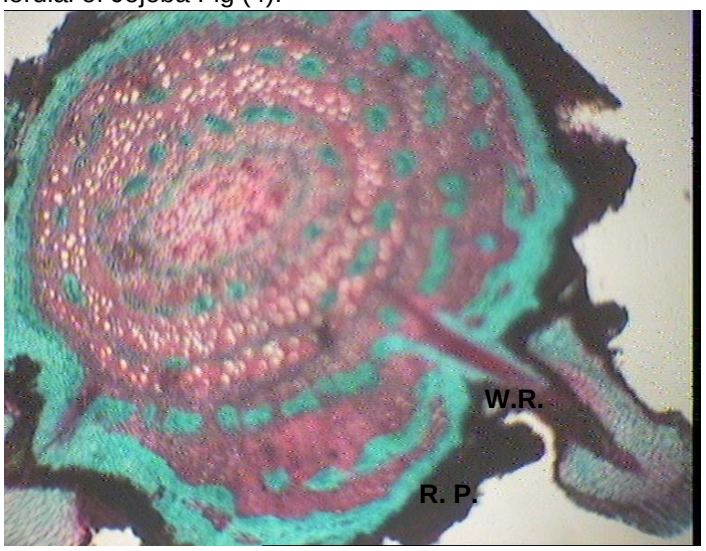


X 150

Fig. (3): A cross section in Jojoba plant stem cutting showing the beginning of vascular bundle connection between the adventitious root and corresponding tissues the cutting.

A.V.B. = Vascular bundles tissues of stem cutting.
B.V.B. = Vascular bundles of Adventitious root.

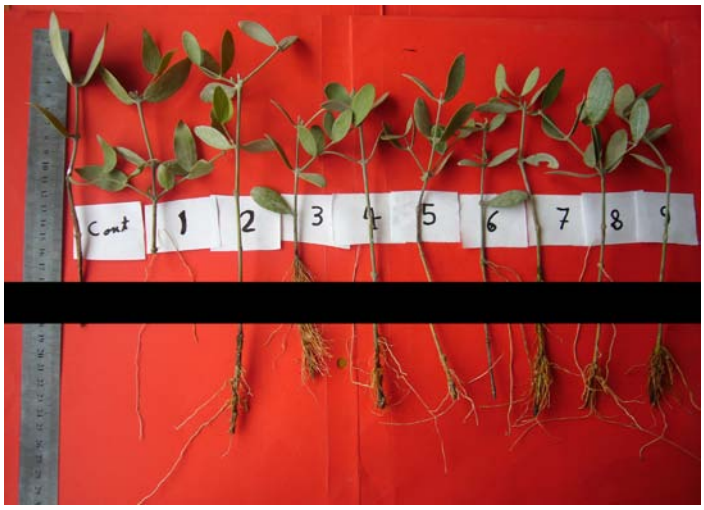
Thereafter, the cambium tissue resumed its activity by cell division and gave rise to the different layers of tissue which formed root initials and primordial of Jojoba Fig (4).



X 150

Fig. (4): A cross section in Jojoba plant stem cutting showing the well developed root .

R.P. = Root primordia.
W.R = Well developed root periphery initiated from combial zone.



The First Experiment.

The Second Experiment.

Shortly after that, root primordial continued development to become more detectable. Thereafter, the development of adventitious root primordial took place through the phloem tissue, Cortex and periderm followed by the development of vascular system of those roots which became in contact with main vessel of these stem.

Finally, the adventitious roots appeared on or near the base of cuttings of Jojoba plant. These results were in agreement with those found by Deidde (1970) on almond, Abou-Amera and (1976) Makarm (1985) on pear, Avanzato and Cappellini (1988) on walnut and Salama *et al*. (1993) on apricot.

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دراسات على الإكثار الخضري لنبات الهوهوبا

وفاء توفيق سعيد، عبد العزيز أحمد الطويلو مادلين راشد سورسن
قسم بحوث الزيتون وفاكهة المناطق شبه الجافة-معهد بحوث البساتين-مركز البحوث الزراعية - الجيزة

أجريت هذه الدراسة على نبات الهوهوبا خلال موسمين متتاليين هما2007، 2008 بهدف استخدام العقل الساقية الغضة في إكثارها خضريا وقد تم تصميم التجربة حيث انقسمت إلى جزيئين رئيسيين:

أ) موعد أخذ العقل من نبات الأم (منتصف أبريل ويوليو ونوفمبر)، وغمسَّ العقل في محاليل ثلاثة من منظمات النمو (نفتالين حمض الخليك- أندول حامض بيوتريك -حامض ترای أيودوبنزويك) بالإضافة إلى ماء الصنبور كمقارنة لدراسة تأثيرهم على بعض قياسات النمو الخضرى والنمو الجذرى للعقل المجذرة وقد أوضحت النتائج تباينا معنويا للتأثير النوعي لأي من العاملين المختبرين فبالنسبة لموعد أخذ وتجهيز العقلة (كانت الأفضلية لتلك المجهزة في منتصف أبريل والعكس كان صحيحا فى منتصف نوفمبر) أما محاليل منظمات النمو المستخدمة فقد تفوقت جميعها بالمقارنة بالمعاملة بالماء (الكنترول) وقد كان أفضلها الغمس فى محلول حامض ترای أيودوبنزويك بتركيز100جزء فى المليون + حامض أندول بيوتريك بتركيز3000جزء فى المليون.

ب) أما بالنسبة للجزء الثانى من التجربة وهو استخدام بيئات مختلفة من بيرليت + فيرمكيوليت أو بيرليت + بيت موس،أو الرمل + بيت موس وتأثيراتها على نمو المجموع الخضري والجذري والنسبة المئوية للتجذير.وعليه فقد أوضحت النتائج أن ا لعقل الساقية الغضة المجهزة في منتصف أبريل والمأخوذة من الأشجار المنتخبة لإكثار الهوهوبا خضريا بعد غمسها في محلول حامض ترای أيودوبنزويك بتركيز 100جزء في المليون + حامض أندول بيوتريك بتركيز 3000 جزء فى المليون، وعلى بيئة البيرليت + الفيرمكيوليت أعطت أعلى نسبة تجذير.

وبالإشارة إلى الجزء التشريحي فقد أوضحت الدراسة التشريحية أن الجذور العرضية التي تحت الدراسة تنشئ من نسيج الكمبيوم حيث تنشئ هذه الخلايا وتنقسم لتكون مبادئ الجذور العرضية وذلك بتأثير معاملات منظمات النمو.

قام بتحكيم البحث

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Table (1): Effect of some growth regulators and time of preparing cutting on some rooting parameters of Jojoba plant.

Characters	Average root length (cm)				Number of roots				Rooting (%)			
Date / Treatment	15-Apr	15-Jul	15-Nov	Mean**	15-Apr	15-Jul	15-Nov	Mean**	15-Apr	15-Jul	15-Nov	Mean**
1st season												
Control	0.000g	0.00g	0.00g	**0.00E**	0.00i	0.00i	0.00i	**0.00G**	0.00o	0.00o	0.00o	**0.00I**
Scrape off	2.833e	0.00g	0.00g	**0.944D**	3.00g	0.00i	0.00i	**1.00F**	2.50mn	2.00n	0.00o	**1.50H**
IBA 2000	5.133d	0.00g	0.00g	**1.711C**	12.37d	0.00i	0.00i	**4.12D**	25.67d	15.33h	0.00o	**13.67E**
IBA 3000	11.50b	0.00g	0.00g	**3.833B**	16.33a	0.00i	0.00i	**5.44B**	35.67a	22.83e	3.33l	**20.61B**
NAA 1000	9.50c	1.00fg	1.00fg	**3.833B**	16.67a	1.00hi	1.00hi	**6.22A**	32.87b	30.33c	0.00o	**21.07A**
NAA 1500	11.80b	0.00g	0.00g	**3.933B**	15.00b	0.00i	0.00i	**5.00BC**	25.27d	20.33f	2.00n	**15.87C**
IBA 2000 + TIBA 100	11.60b	2.00ef	2.00ef	**5.200A**	15.67ab	2.00gh	2.00gh	**6.56A**	22.53e	18.33g	2.00n	**14.29D**
IBA 3000 + TIBA 100	14.83a	0.00g	2.00ef	**5.611A**	10.67e	2.00gh	2.00gh	**4.89BC**	11.00j	8.33k	3.00lm	**7.44G**
NAA 1000 + TIBA 100	12.07b	0.00g	0.00g	**4.022B**	13.43c	0.00i	0.00i	**4.48CD**	12.83i	10.33j	0.00o	**7.72G**
NAA 1500 + TIBA 100	11.67b	0.00g	0.00g	**3.889B**	8.63f	0.00j	0.00i	**2.88E**	21.00f	15.67h	0.00o	**12.22F**
Mean*	**9.093A**	**0.300B**	**0.500B**		**11.18A**	**0.50B**	**0.50B**		**18.93A**	**14.35B**	**1.03C**	
2nd season												
Control	0.00m	12.33hi	0.00m	**4.11H**	0.00o	1.33n	0.00o	**0.44H**	0.00o	2.00n	0.00o	**0.67J**
Scrape off	16.33de	14.87f	20.33b	**17.18B**	2.17lm	9.67gh	2.00l-n	**4.61G**	8.17l	8.00l	2.00n	**6.06I**
IBA 2000	21.67a	15.37ef	0.00m	**12.34E**	12.67e	7.23j	0.00o	**6.63F**	57.00a	24.67g	0.00o	**27.22A**
IBA 3000	13.43gh	15.77d-f	18.10c	**15.77C**	11.73f	16.17b	1.90mn	**9.93B**	28.33e	22.33h	2.00n	**17.56F**
NAA 1000	18.33c	19.90b	17.67c	**18.63A**	12.67e	15.20c	2.00l-n	**9.96B**	40.33c	27.00f	2.00n	**23.11C**
NAA 1500	11.53i	12.57g-i	11.67i	**11.92EF**	9.00hi	9.77gh	9.90g	**9.56B**	30.33d	18.33j	10.00k	**19,56D**
IBA 2000 + TIBA 100	13.50g	19.67b	2.00l	**11.72EF**	9.33g-i	14.10d	2.73l	**8.72C**	24.67g	30.67d	2.00n	**19.11E**
IBA 3000 + TIBA 100	4.33k	17.90c	0.00m	**7.41G**	15.67bc	20.00a	0.00o	**11.89A**	28.33e	46.67b	0.00o	**25.00B**
NAA 1000 + TIBA 100	14.67f	16.53d	9.33j	**13.51D**	8.67i	9.90g	5.00k	**7.86D**	22.00h	22.33h	6.00m	**16.78G**
NAA 1500 + TIBA 100	13.33gh	20.77ab	0.00m	**11.37F**	7.33j	14.10d	0.00o	**7.14E**	20.00i	22.00h	0.00o	**14.00H**
Mean*	**12.71B**	**16.57A**	**7.91C**		**8.92B**	**11.75A**	**2.35C**		**25.92A**	**22.40B**	**2.40C**	

*** Mean of collecting dates.**

**** Mean of treatments.**

Capital and small letter/s were used for distinguishing between values of specific and interacted treatments, respectively. Means followed by the same letters were not significantly different at 5% level.

Table (2): Effect of some growth regulators and time of preparing cutting on some vegetative parameters of Jojoba plant.

Characters	Average plant length (cm)				Number of leaves				Number of branches			
Dates / Treatments	15-Apr	15-Jul	15-Nov	Mean**	15-Apr	15-Jul	15-Nov	Mean**	15-Apr	15-Jul	15-Nov	Mean**
1st season												
Control	1.00h	0.00h	0.00h	**0.00D**	0.00j	0.00j	0.00j	**0.00G**	0.00f	0.00f	0.00f	**0.00G**
Scrape off	14.73bc	12.83b-g	0.00h	**9.19B**	9.83b	4.67gh	0.00j	**4.83C**	1.00e	0.00f	0.00f	**0.33F**
IBA 2000	10.67e-g	10.50fg	0.00h	**7.06C**	7.13d	6.00e	0.00j	**4.38D**	1.67cd	0.00f	0.00f	**0.56D-F**
IBA 3000	10.73e-g	9.90g	19.33a	**13.32A**	9.13b	8.17c	2.67i	**6.66B**	1.77bc	0.00f	0.00f	**0.59DE**
NAA 1000	15.07bc	11.63d-g	0.00h	**8.90B**	4.100h	4.00h	0.00j	**2.70F**	1.10e	1.00e	1.00e	**1.03B**
NAA 1500	15.77b	10.13fg	14.87bc	**13.59A**	3.100i	3.87h	5.67ef	**4.21D**	1.33de	0.00f	0.00f	**0.44EF**
IBA 2000 + TIBA 100	12.97b-g	11.70d-g	14.53b-d	**13.07A**	12.10a	9.57b	5.67ef	**9.11A**	2.20a	1.00e	1.00e	**1.40A**
IBA 3000 + TIBA 100	13.17b-f	12.37c-g	13.73b-e	**13.09A**	8.33c	7.63cd	5.00fg	**6.99A**	1.67cd	0.00f	1.00e	**0.89BC**
NAA 1000 + TIBA 100	11.37e-g	9.87g	0.00h	**7.08C**	7.00d	5.07fg	0.00j	**4.02DE**	1.33de	0.00f	0.00f	**0.44EF**
NAA 1500 + TIBA 100	11.60d-g	10.57fg	0.00h	**7.39C**	5.67ef	5.50ef	0.00j	**3.72E**	2.10ab	0.00f	0.00f	**0.70CD**
Mean*	**11.61A**	**9.95B**	**6.25C**		**6.64A**	**5.45B**	**1.90C**		**1.42A**	**0.20B**	**0.30B**	
2nd season												
Control	0.00m	15.00l	0.00m	**5.00G**	0.00k	4.57g-i	0.00k	**1.52F**	0.00g	1.33c-f	0.00g	**0.44F**
Scrape off	15.33l	15.33l	17.00ij	**15.89E**	5.33ef	4.00i	5.33ef	**4.89B**	1.00f	1.33c-f	1.00f	**1.11DE**
IBA 2000	19.87cd	15.97j-l	0.00m	**11.94F**	5.33ef	6.57cd	0.00k	**3.97D**	1.00f	1.57b-e	0.00g	**0.86E**
IBA 3000	21.00b	16.47jk	19.00d-g	**18.82C**	6.33cd	7.37b	4.33g-i	**6.01A**	1.53b-e	2.10a	2.00ab	**1.88A**
NAA 1000	19.00d-g	15.90kl	18.67e-h	**17.86D**	5.00fg	4.10hi	4.33g-i	**4.48C**	1.30d-f	1.00f	1.00f	**1.10DE**
NAA 1500	17.90hi	15.10l	21.00b	**18.00D**	4.43g-i	4.43g-i	7.00bc	**5.29B**	1.87ab	1.20ef	1.67a-e	**1.58B**
IBA 2000 + TIBA 100	20.53bc	16.67jk	22.90a	**20.03A**	8.33a	4.83g-h	2.00j	**5.06B**	1.87ab	1.00f	1.00f	**1.29CD**
IBA 3000 + TIBA 100	19.10d-f	18.00gh	0.00m	**12.37F**	4.33g-i	7.43b	0.00k	**3.92D**	1.00f	1.80a-c	0.00g	**0.93E**
NAA 1000 + TIBA 100	21.10b	18.20f-h	18.87d-h	**19.39B**	5.53ef	4.00i	6.00de	**5.18B**	1.33c-f	1.00f	1.80a-c	**1.38BC**
NAA 1500 + TIBA 100	19.67c-e	16.77jk	0.00m	**12.14F**	5.53ef	4.33g-i	0.00k	**3.29E**	1.00f	1.73a-d	0.00g	**0.91E**
Mean*	**17.35A**	**16.34B**	**11.74C**		**5.02A**	**5.16A**	**2.90B**		**1.19B**	**1.41A**	**0.85C**	

*** Mean of collecting dates.**

**** Mean of treatments.**

Capital and small letter/s were used for distinguishing between values of specific and interacted treatmentsrespectively. Mans followed by the same letters were not significantly different at 5% level.