

Improvement of the Rooting Efficiency and Vegetative Growth in Date Palm Offshoots by Licorice Root Extract and Auxins Mixture Applications.

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ABSTRACT

Date palm offshoots culture is still the most common way for date palm propagation. So it's very necessary to getting methods for increasing offshoot survival rate. There are several factors that affecting offshoot rooting such as, duration of separating to planting time, offshoot weight, age, pests and diseases. This study was carried out on the date palm offshoots cultivar "Hayany" during the two successive seasons 2014/2015 and 2015/2016 in a private nursery of Om El-Reda area in Damietta governorate, Egypt. The aim of the current research was to increase the efficiency of the rooting process and to improve the percentage of success in the separated offshoots after planting. The effects of spraying root ball and leaves of offshoots with 500ml of auxins mixture (500ppm IBA + 500ppm NAA) and 2.5g/l licorice root extract alone or in combination and distilled water (control) on improving offshoots rooting were studied. The results showed that all treatments significantly improved rooting percentage, growth characteristics of roots and vegetative growth characteristics of the tested offshoots compared to the control. Anatomical studies indicated that there were obviously differences in the measured characters of cross section of root. Where the roots of the treated offshoots significantly increased the number and area of sclerenchyma bundles, diameter and length of phloem and diameter of the vascular region and significantly decreased the thickness of the cortex, the diameter of the pith and the length of xylem compared to the roots of the control. The combination treatment of 2.5g/l licorice root extract and auxin mixture (NAA & IBA) gave the highest responses.

Keywords: *Phoenix dactylifera*, offshoots rooting, licorice root extract, auxins, anatomical studies.

INTRODUCTION

In Egypt, the date palm (*Phoenix dactylifera* L.) is one of the major fruit crops which rank among the five leading producers worldwide. World dates production is approximately 7.51 million tons which created large commercial activities. The top 5 production countries in 2001 were Egypt, Iran, Saudi Arabia, Pakistan, and Iraq (FAO, 2002). They represent 69 % of total world production.

The successful formation of adventitious root is an obligatory phase in date palm offshoots propagation, this being related to the presence of auxins. According to the previous reports, about 30-70% of the planted offshoots for vegetative propagation were died because of ecological incompatibilities, physiological problems or lack of suitable care (Rahnama and Rahkhodaei, 2013). Offshoots successfully established in soil is highly variable (30-80 %) and cultivar dependent (Saaidi *et al.*, 1979). In Hayany offshoots, survival rate was less than 60% (Al Khateeb *et al.*, 2006).

The transplantation of palm off shoots cause in a significant decrease in their root system. It requires special handling practices to getting successful survival and establishment. Palm root and leaf growth are high correlated with soil and air temperature (Broschat and Meerow, 2000) and are more developed during the warmer seasons (Hodel *et al.*, 2005). The root of licorice (*Glycyrrhiza glabra*) is one of the richest sources of biological active compounds, such as phenolics and flavonoids. The Phenolics belong to a class of antioxidant compounds which act as free radicals inhibitors and they are very essential for plants due to their quenching ability because of the existence of hydroxyl groups (Elmastas *et al.*, 2006). Spraying plant with 6.0g/l of licorice root extract produced a significant increase in total chlorophyll content of the leaves, plant height, total leaves number, total soluble carbohydrates and shoot dry weight comparing with those of the control (Ebrahim zadeh *et al.*, 2010 and Faraj and Ghaloom, 2012). This may be due to that licorice extract contains more than 100

different components, most important of them are glycyrrhizin, phenolic compounds, mevalonic acid which has similar effect to GA3 in reducing complex compounds to simple substance used by plants to build new Proteins are essential for the growth, polysaccharide (glucose, fructose, sucrose, maltose), lignin, protein amino acid (asparagin), vitamins such as B6, B3, B2, B1, E and C, biotin, folic acid and pantothenic acid which play an effective role in improvement of the plant growth (Fukai *et al.*, 1998; Rossi, 1999 and Arystanova *et al.*, 2001).

Most commercial vegetative propagation is done by rooting with indole butyric acid (IBA); other auxins often used are naphthalene acetic acid (NAA) and indole acetic acid (IAA). Auxin type efficacy depends on the affinity for free auxin concentration that reaches target competent cells, on the amount of endogenous auxin and on metabolic stability, higher in NAA, intermediate in IBA and lower in IAA (De klerk *et al.*, 1999). Rooting responses are also strongly affected by the endogenous auxin content and its transport rate. Apexes of shoots are the main sources of endogenous auxin. Auxins action includes binding to a receptor protein and triggering of a signal transduction cascade which probably involves gene de-repression by proteolysis of transcriptional regulator (AUX/IAA) within the ubiquitin-proteasome pathway (Dharmasiri and Estelle, 2004). While the application of plant growth regulators to enhance root growth is a common practice for many woody plants, their use on palms during transplanting has little or no merit. Although, Study of Broschat and Donselman, (1990) showed that the use of growth regulators for rooting of transplanted parlor palms, and pygmy dates had no effect on root growth, because stresses of transplanting palms and other secondary problems, such as abiotic disorders, diseases, pest infestations and treat appropriately. Some recent studies using auxins (IBA and NAA) alone or in combinations at range of 1000 to 6000 ppm concentrations on cuttings of grape (Galavi *et al.*, 2013), honeysuckle (Alikarimian and Bidarnamani, 2015) and

Lobostemon fruticosus (Lodama *et al.*, 2016) showed significantly improving in the rooting percentage as well as the dry weight, length, number and anatomical development of roots.

The aim of the present study was to stimulate and improve rooting and survival rate of Hayany date palm offshoots by using anti-stress licorice root extract) as well as auxins mixture (IBA and NAA), alone or in combinations.

MATERIALS AND METHODS

The current studies were carried out during two successive seasons (2014/2015 and 2015/2016) on the selected offshoots of date palm cv. Hayany. The date palm mothers are grown in sandy soil of private orchard at Om El-Reda village, Damietta governorate, Egypt. Offshoots have nearly 4 years old and positioned low on the mother palm at the soil line were selected. The selected offshoots were manually separated by skilled labors using sledgehammer and a heavy broad-bladed chisel. Once the offshoot was free, all old leaves were removed except the newest leaves which were tied tightly together, the tied up leaves were cut at a common point, removing about the upper half of their length. The separated offshoots were kept under shade and their roots were cut to about 2-10cm long. Similar 64 offshoots were selected and divided to 4 groups (16 offshoots for each). Each group was divided into 4 replicates (4 offshoots per each) and subjected to one of the following treatments, spraying 500ml on root ball and leaves: Distilled water (T₁), auxins mixture "T₂" (AM = 500ppm IBA + 500ppm NAA), licorice root extract (LRE) at 2.5g/l (T₃) and licorice root extract followed with AM (T₄). The treated offshoots were planted in the sandy soil of nursery in open field condition. All common agricultural practices like irrigation, fertilization and control of weeds, insects/pests and diseases were applied uniformly to all experimental offshoots. These treatments were arranged in randomized complete blocks design (RCBD) with four replicates each one four offshoots.

Offshoot vegetative characteristics

After one year from plantation, the vegetative characteristics which include leaf length (cm), new leaf number "nLN", pair leaflets number "PLtN", rachis diameter (cm) at the base of spines region, and new total leaf area "nTLA" in m² were measured.

Leaf pigments determination

Five square pieces (each with an area of 0.5 cm²) were taken from a third pair leaflets at the leaf tip. The pigments were extracted from the pieces by submerging them in 5 ml of N,N-dimethylformamide in the dark for 72 h. The absorbance was spectrophotometrically measured at 446, 647 and 665nm. The contents of chlorophylls and carotenoid as mg/100cm² were calculated according to equations of Moran (1982).

Rooting behavior

After a year of plantation, the tested offshoots were uprooted from the soil carefully, and then the root characteristics included rooting percentage and number, length (cm), and diameters (cm) of generated roots as well as the number of secondary roots were recorded.

Anatomical measurements.

A root sample was collected from each treatment immediately placed in polythene bags. Root pieces of 2cm-length were killed and fixed in FAA solution. For preparing permanent slides of root transverse sections, cross sectioned (15 µm thick) using a rotary microtome was done. The sections were passed through a series of ethanol grades for dehydration (Ruzin 1999). Safranin and fast green were applied for staining. Finally, the sections were mounted in Canada balsam for permanent slides. Camera-equipped microscope was used for examining and photographing the cross-sections. The measurements of anatomical parameters were taken with the help of ocular micrometer under a compound microscope. All the studied anatomical parameters; thickness (µm) of epidermis, cortical region and endodermis, area (µm²) of sclerenchyma bundle and aerenchyma, diameter of phloem, xylem, pith and stele region as well as sclerenchyma bundle number were measured randomly from three different sites. Area of different cells and tissues were calculated by using the formula of Fatima (2011):

Maximum width x Maximum length

$$\text{Area} = \frac{\text{Maximum width} \times \text{Maximum length}}{14} \times 11$$

Statistical analysis

A completely randomized design with four replicates using the statistical package software SAS (2008) was applied for statistically analyze of the present data. Comparisons between means were made by F-test and Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Offshoot vegetative characteristics

Data presented in Table 1 show that spraying date palm off shoots with auxins mixture (AM) solution at 500ppm or licorice root extract (LRE) at 2.5 g/l alone or in combination significantly improved leaf growth characteristics. The highest responses for all leaf growth characteristics of offshoots were obtained by applying the combination of LRE (as anti-stress) and AM solution. Moreover, applying licorice root extract at concentration of 2.5 g/l gave significantly increases in leaf length (190.3 and 162.0 cm), New leaf number "nLN" (5.3 and 6.0), pair leaflet number "PLtN" (65.5 and 78.9), rachis diameter (1.4 and 1.5 cm), and New total leaf area "nTLA" (4.4 and 5.9 m²) compared with control which gave the lowest values (162.4 and 150.5 cm), (3.3 and 3.7), (60 and 58), (1.2 and 1.3cm), and (1.4 and 1.3 m²), respectively in the two seasons. This increases refer to LRE contents of some nutrients such as magnesium, potassium, phosphorus, zinc and iron (Moses *et al.*, 2002), and these nutrients play an important role in the stimulation of different enzymes that increase the photosynthetic activity. Phosphorus plays an essential role in most biological processes such as transfer energy to all plant parts, cell division and the formation of chloroplasts membranes and composition of amino and nucleic acids. Moreover, this extract contains glyceyrrhizin as material acts like gibberellins roles in the plant, and increases cell division and elongation (Moses *et al.*, 2002). Also, potassium stimulates the formation of carbohydrates,

proteins and energy components (ATP) which affect all activities of plant growth (Al-Naimi, 1985).

Spraying date palm offshoots with AM solution at 500ppm concentration (Table 1) showed significantly increase in leaf length (189 and 152 cm), nLN (5.0 and 5.0), PLtN (87 and 80), rachis diameter (1.3 and 1.3 cm), and nTLA (4.0 and 3.5 m²), in both tested seasons,

respectively compared with the control. Such results can be attributed to the biological role of auxins that regulates the permeability of plasma membranes which control transporting auxins, sugars, amino acids, inorganic ions, and induces cell division and elongation, which finally leads to the growth and development of the leaf (Goldsmith, 1977 and Sieburth, 1999).

Table 1. Effect of Auxin mixture and licorice root extract on Leaf growth characteristics of the Hayany date offshoots after one year from the plantation during two seasons

Treatments	leaf growth characteristics									
	Leaf length (cm)		New leaf No.		Pair leaflet No.		Rachis diameter [@] (cm)		New total leaf area (m ²)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	162c	151c	3.3c	3.7c	60c	58c	1.2c	1.3b	1.4c	1.3d
AM	189b	152c	5.0b	5.0b	87a	80b	1.3b	1.3b	4.0b	3.5c
LRE	190b	162a	5.3ab	6.0a	66b	79b	1.4a	1.5a	4.4b	5.9ab
LRE+AM	201ab	159ab	5.7a	6.3a	90a	96a	1.4a	1.5a	5.3a	6.3a
F test	***	***	***	**	***	***	***	***	***	***

[@]= Rachis diameter (cm) at the top of spines region, S1= first season, S2 = second season, AM= Auxins mixture (500ppm IBA + 500ppm NAA), LRE = 2.5g/l of Licorice root extract. In each column values have the same letter are not significantly different at 5% level. **, Significant at $p = 0.001$. ***, Significant at $p = 0.001$.

Leaf pigments

Result in Table 2 show that spraying date palm offshoots, before planting, with AM at 500 ppm concentration gave the highest average values for chlorophyll (a) (8.5 mg/cm²), total chlorophyll (13.6 mg/cm²) and carotene (1.3) comparing with other treatments. The next treatment in this respect was the combination of LRE at 2.5 g/l followed by AM at 500ppm. While the lowest values (6.9 mg/cm², 4.0 mg/cm² and 11.7 mg/cm² for chlorophyll (a), chlorophyll (b) and total

chlorophyll, respectively were obtained with applying LRE at 2.5 g/l alone. The present results disagreement with those of Al Jebouri *et al.*, (2010) which indicated that spraying cucumber plant with licorice root extract gave a significant increasing in total chlorophyll content of leaves. They added that licorice extract contains mevalonic acid that is the initiator in the synthesis of GA3 acid in the plants; therefore, spraying the plant with licorice extract promotes the vegetative growth of many plants.

Table 2. Effect of Auxin mixture and licorice root extract on Leaf pigments of the Hayany date offshoots after one year from the plantation during two seasons

Treatments	Leaf pigments (mg/100cm ²)											
	Chlorophyll (a)			Chlorophyll (b)			Total chlorophyll			Carotene		
	S1	S2	Av	S1	S2	Av	S1	S2	Av	S1	S2	Av
Control	7.2bc	8.5a	7.8ab	4.4ab	4.0bc	4.1b	12.2abc	13.2ab	12.7ab	0.8b	0.8b	0.8b
AM	8.5a	8.5a	8.5a	4.1ab	4.7b	4.4b	13.3a	14.0a	13.6a	1.1a	1.4a	1.3a
LRE	7.5ab	6.5b	6.9c	4.5a	3.4bc	4.0b	12.8ab	10.6c	11.7c	0.9b	1.1ab	1.0ab
LRE+AM	6.8c	8.8a	7.5bc	4.0ab	5.9a	4.9a	11.4c	14.8a	13.1ab	0.9b	1.1ab	1.0ab
F test	**	**	**	*	***	**	**	***	**	**	***	**

S1= first season, S2 = second season. Auxins mixture (500ppm IBA + 500ppm NAA), LRE = 2.5g/l of Licorice root extract. In each column values have the same letter are not significantly different at 5% level. *, Significant at $p = 0.05$. **, Significant at $p = 0.001$. ***, Significant at $p = 0.001$.

Offshoot rooting percentage and new offshoots number

Data presented in Table 3 proved that spraying date palm offshoots with 500ppm AM or 2.5g/l of LRE, alone or in combination, improved rooting percentage and formation of new offshoots in the treated offshoots by 46.1 - 69.2% and 26.4 – 45.3%, respectively over the control. The lowest values of offshoot rooting (54.2%) and new offshoots number (2.7) were obtained by the control treatment. Whereas, the combination treatment of 500ppm AM proceeded with 2.5g/l of LRE gave the highest values of offshoot rooting (91.7%) and new offshoots number (3.7). The present result is strengthened by the findings of Qaddoury and Amssa (2004) who indicated that root formation in date palm offshoots was significantly improved by 25 mM of IBA. Such result could be attributed to auxin acts primary role in root formation by its participating in successive and interdependent phases (Bellamine *et al.*, 1998). Auxin also play essential role in rooting response where

its activity may lead to hydrolysis and transport of nitrogenous materials and carbohydrates in the base of offshoot which itself leads to cell division and elongation in this part. Induction of root in the plants depends on the presence of endogenous auxin inside the tissues of plant and its synergistic effect with the exogenous auxin leads to the biosynthesis of ribonucleic acid and as a result the primordial root has been induced (Hartman *et al.*, 2002). Another possible reason may be due to the formation of initial roots and consumption of more stored nutrients in the treated offshoot (Ajaykumar, 2007). This may be refer to that licorice extract contains more than 100 different components, some of which existed in large amounts, most important of them are triterpene saponins (glycyrrhizin), phenolic compounds, various saccharides (maltose, sucrose, glucose, fructose), lignin ,vitamins such as B1, B2, B3, B6, C, mevalonic acid, protein amino acid and E, biotin, folic acid and pantothenic acid which play an important

role in energizing the plant growth (Fukai *et al.*, 1998; Rossi, 1999 and Arystanova *et al.*, 2001). The stimulative effects of licorice root extract on improvement of rooting process are in line with Al Ma'athid (2010) who found

that treating chrysanthemum cuttings with licorice root extract significantly increased rooting percentage and dry weight of roots.

Table 3. Effect of Auxin mixture and licorice root extract on offshoot rooting percentage and new offshoots number of the tested date offshoots after one year from the plantation during two seasons

Treatments	Offshoot rooting%				New offshoots number/ treated offshoot			
	S1	S2	Av	Increase over control	S1	S2	Av	Increase over control
Control	50.0c	58.3b	54.2c	00.0%	3.0c	2.3b	2.65b	00.0%
AM	75.0b	83.4a	79.2b	46.1%	3.7bc	3.0ab	3.35ab	26.4%
LRE	83.3ab	91.7a	87.5a	61.4%	4.0ab	3.7a	3.85a	45.3%
LRE+AM	91.7a	91.7a	91.7a	69.2%	4.3a	3.0ab	3.65a	37.7%
F test	***	***	***		***	***	**	

S1= first season, S2 = second season. Auxins mixture (500ppm IBA + 500ppm NAA), LRE = 2.5g/l of Licorice root extract. In each column values have the same letter are not significantly different at 5% level. **, Significant at $p = 0.001$. ***, Significant at $p = 0.001$.

Root characteristics of the tested date offshoots

Results in Table 4 showed that root characteristics clearly affected by AM and LRE. All treatments significantly increased the primary root numbers (Average of 176 -196), length (average of 90 – 217cm), diameter (average of 7 – 8mm) and secondary root numbers (average of 16 - 19) comparing to the control which recorded the lowest averages of 103, 36cm, 6.5mm and 13.5 for the numbers, length and diameter of primary root and secondary root numbers, respectively. Moreover, there are non-significant differences in primary root characteristics between applying 2.5g/l of LRE alone and its spraying in combination with AM. The stimulative effect of NAA on plant rooting has been reported by many researchers, and promoting adventitious root formation has been considered as one of the activities of auxin (Rout 2006). There is considerable evidence that IAA is involved in developing

adventitious roots. Liu and Reid (1992) reported that high levels of IAA were associated with the formation of adventitious root. In Arabidopsis, high concentration of exogenous IAA triggered pericycle cells adjacent to protoxylem poles to become part of a lateral root primordium (Laskowski *et al.*, 1995). In addition, IAA oxidase activity might be plays an important role in regulation endogenous IAA levels (Nag *et al.*, 2001), where the level of IAA-oxidase activity was negatively correlated with IAA concentration (Wiesman *et al.*, 1988). Induction of root in the plants depends on the presence of endogenous auxin inside the tissues of plant and its synergistic effect with the exogenous auxin leads to the biosynthesis of ribonucleic acid and as a result the primordial root has been induced (Hartman *et al.*, 2002). The activities of enzyme in rooting zone of plant provided an easy, fast and reliable means of cellular differentiation into roots (Husen and pal, 2007).

Table 4. Effect of Auxin mixture and licorice root extract on Root characteristics of the tested date offshoots after one year from the plantation during two seasons

Treatments	Root characteristics											
	Primary root length (cm)			Primary root number			Primary root diameter (mm)			Secondary Root number		
	S1	S2	Av	S1	S2	Av	S1	S2	Av	S1	S2	Av
Control	33.6c	38.4c	35.6c	110.0c	96.7c	103.3c	6.0b	6.8b	6.4c	14.3c	12.7c	13.5c
AM	95.8b	83.4b	89.6b	168.7b	183.3b	176.0b	7.3a	7.1b	7.2b	20.7a	16.7a	18.7a
LRE	203.4a	220.9a	212.2a	193.3a	198.3a	195.5a	6.9a	9.3a	8.1a	17.3b	15.0b	16.2b
LRE+AM	201.9a	233.3a	217.2a	188.3a	193.3a	190.8a	6.3ab	9.0a	7.7a	20.0a	17.0a	18.5a
F-test	***	***	***	***	***	***	**	**	**	***	***	***

S1= first season, S2 = second season. Auxins mixture (500ppm IBA + 500ppm NAA), LRE = 2.5g/l of Licorice root extract. In each column values have the same letter are not significantly different at 5% level. **, Significant at $p = 0.001$. ***, Significant at $p = 0.001$.

Anatomical characteristics of roots in the tested date offshoots:

Root dermal region anatomical characteristics

The obtained results (Table 5 and Fig. 1) revealed that spraying 500ppm AM or 2.5g/l of LRE alone or in combination on Hayany date palm offshoots bases showed obviously anatomical variations of roots formation in thickness (μm) of epidermis, cortical region and endodermis, area (μm^2) of sclerenchyma bundles and aerenchyma, and number of sclerenchyma bundles compared to those of the control. All treated offshoots produced roots significantly surpassed in area and number of sclerenchyma bundles and significantly reduced in cortical region thickness compared to those of untreated offshoot. The highest thickness of epidermis (30.3 μm) and endodermis (4.0 μm) and highest area of sclerenchyma bundle (100 μm^2) and aerenchyma (588 μm^2) were obtained with RLE at 2.5 g/l. Thick epidermis with intensive sclerification in the cortical region

provides mechanical strength to the root, prevents the water loss from the roots and is extremely important under environmental stresses such as drought (Reinoso *et al.*, 2004; Breckle, 2004). The combination which includes 2.5g/l of LRE followed with 500ppm of AM resulted in the lowest epidermis thickness (21 μm) and aerenchyma area (171 μm^2) of developing roots comparing to the other treatments. The untreated offshoots "control" gave new roots have the lowest values of area and number of sclerenchyma bundles (56 μm^2 and 12, respectively) compared to other tested treatments (84.5 - 100 μm^2 and 18 – 26, respectively).

Anatomical modifications are necessary in assessing tolerance degree in plant species against various environmental stresses in addition to other biochemical and physiological processes (Hameed *et al.*, 2009). In root, most internal layer is differentiated into endodermis that is crucial apoplastic barrier for selective transport in the root stele through the symplast (Clarkson and Robards, 1975).

Sclerenchyma bundle is useful to the high tolerance level of environmental condition (Nadia *et al.*, 2010), better moisture storage and indicate water conservation particularly under scarcity, and even toxic ion compartmentalization (Brekle 2004). The root epidermis functions in uptake nutrients which are either carried across the cortex into the xylem, where they are transported via the transpiration stream to the shoot or metabolized in the cortex of the root (Marschner, 2003). The development of root cortex differentiation is a control factor in the transport of nutrients and water to and from the root and thus to

other parts of the plant. Moreover, increasing aerenchyma area is necessary for various environmental stresses. Although aerenchyma is characteristic of the roots of aquatic plants, it may be associated with plant tolerances of salt and drought stresses (Dennis *et al.*, 2000). Compactness of hypodermal and exodermal layers in the roots can play an effective role in inhibiting the breakdown of the cortex and proving the important structural framework for the formation of aerenchyma (Seago and Marsh, 1989).

Table 5. Effect of Auxin mixture and licorice root extract on Root dermal region anatomical characteristics of the Hayany date offshoots after one year from the plantation during two seasons

Treatments	Root dermal region anatomical characters					
	Epidermis thickness (µm)	Cortical region thickness (µm)	Aerenchyma area (µm ²)	Sclerenchyma bundle area (µm ²)	Sclerenchyma bundle number (µm)	Endodermis thickness (µm)
Control	25.0b	238.8a	364.5b	56.0c	12.0d	1.0c
AM	21.8c	142.3d	336.0c	84.4b	26.0a	1.0c
LRE	30.3a	230.0b	588.0a	100.0a	20.0b	4.0a
LRE+AM	21.0c	194.9c	171.0d	85.0b	18.0c	2.0b
F-test	**	***	***	***	***	***

Auxins mixture (500ppm IBA + 500ppm NAA), LRE = 2.5g/l of Licorice root extract. In each column values have the same letter are not significantly different at 5% level. **, Significant at $p = 0.001$. ***, Significant at $p = 0.001$.

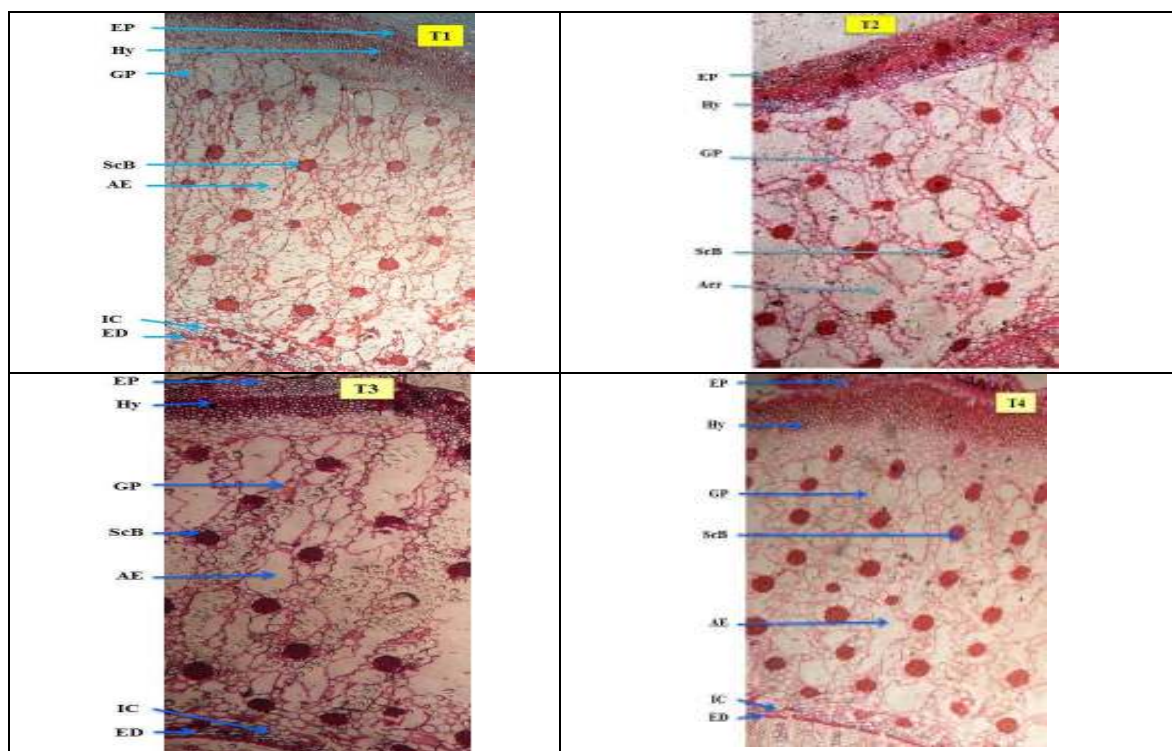


Fig. 1 . Labeled transverse section of date palm offshoot roots showing different tissues of dermal region affected by various treatments. T₁ = Distilled water, T₂ = Auxins mixture (500ppm IBA + 500ppm NAA), T₃ = Licorice root extract (LRE) at 2.5g/l , T₄ = combination of LRE at 2.5g/l followed with Auxin mixture. EP=Epidermis, Hy= Hypodermis, GP = Ground Parenchyma, ScB = Sclerenchyma Bundle, AE = Aerenchyma, IC=Inner Cortex, ED=Endodermis.

Root stele region anatomical characteristics

Data presented in Table 6 and illustrated in Fig 2 show that spraying Hayany date palm offshoots with 500ppm AM or 2.5g/l of LRE alone or in combination gave anatomical changes in diameter of phloem, xylem, stele region and pith. They resulted in significantly

increase in the diameter of phloem and the stele region diameter as well as significantly decrease in the pith diameter compared with those of control (untreated offshoots). The lowest values of xylem diameter (7.0 µm) and the highest values of phloem vessel diameter (8.0 µm) were obtained by applying 500ppm auxin mixture.

All treatments significantly decreased xylem vessels length (105 - 160 μm) comparing to the control (205.3 μm). Moreover, applying 2.5g/l of LRE alone on the offshoots produced roots have the highest diameter values of xylem and stele region (24.5 μm and 126.0 μm , respectively) and the lowest values of pith diameter (140.0 μm) compared with other treatments. The roots contain two types of conductive tissue "phloem and xylem". Phloem tissue transports plant growth regulators and assimilates of photosynthesis and plays an essential role in distributing photo products from source to sink regions. In addition it plays an important vital role in mediating long-distance communication by transporting signaling molecules, such as RNAs, hormones, sucrose, peptides and proteins (Yoo *et al.*; 2013). The efficiency of amino acids and sucrose transport through the phloem affects the growth and quality of sink tissues. The movement of signaling molecules through the phloem is a critical factor of regulation of growth and development and systemic adaptation to the environment (Ruiz-Medrano *et al.*; 2001). The most important functions of the xylem include transport of water and mineral nutrients, mechanical support, secondary metabolic, and storage of nutrients and water in parenchyma cells.

However, the enlargement of vascular region may be a crucial factor for conservation of water (Beebe *et al.*, 2008). Furthermore larger metaxylem vessels and phloem cells are useful for increasing transport of water, nutrients and reserve food more efficiently. Most nutrients, except calcium, are imported through the phloem (Patrick and Offler, 2001).

Table 6. Effect of auxin mixture and licorice root extract on root stele region anatomical characters of the tested date offshoots after one year from the plantation during 2014 and 2015 seasons

Treatments	Root stele anatomical characters			
	Phloem diameter (μm)	Xylem diameter (μm)	Stele region diameter (μm)	Pith diameter (μm)
Control	5c	10.0b	36.8d	247.0a
AM	8a	7.0c	44.4c	236.9b
LRE	7b	24.5a	126.0a	140.0c
LRE+AM	7b	10.0b	48.9b	237.5b
F-test	**	***	***	**

Auxins mixture (500ppm IBA + 500ppm NAA), LRE = 2.5g/l of Licorice root extract. In each column values have the same letter are not significantly different at 5% level. **, Significant at $p = 0.001$. ***, Significant at $p = 0.001$.

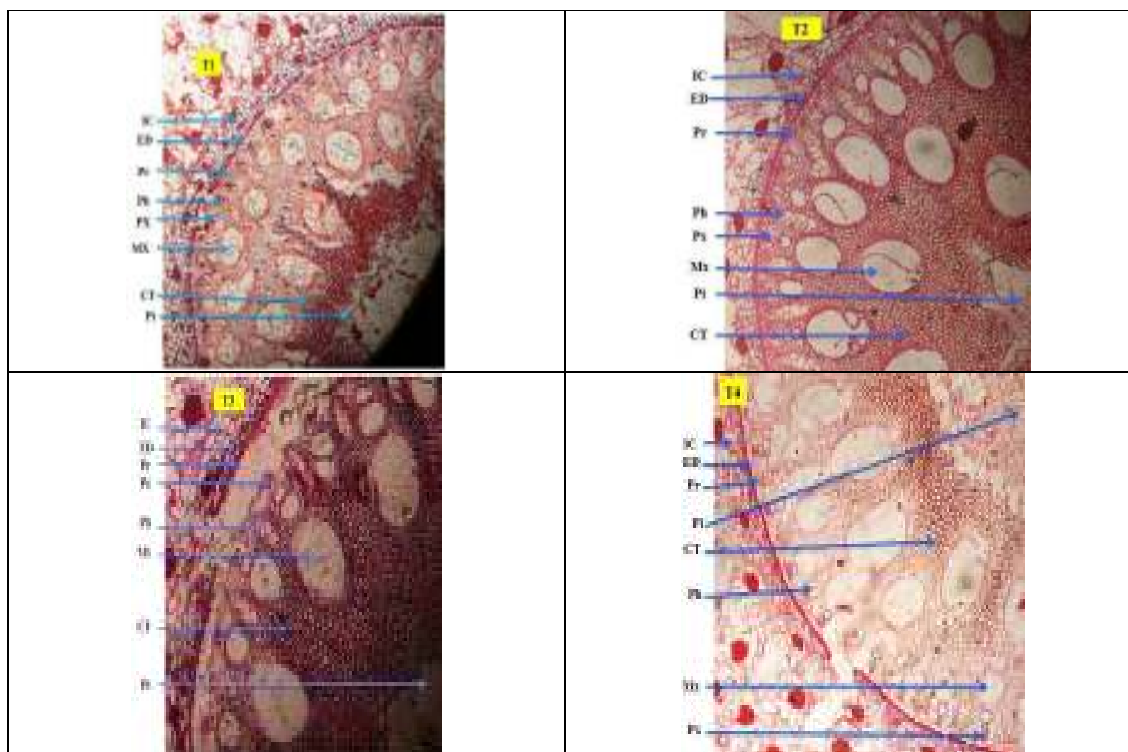


Fig.2. Labeled transverse section of date palm offshoot roots showing different tissues of stele region affected by various treatments. T₁ = Distilled water, T₂ = Auxins mixture (500ppm IBA + 500ppm NAA), T₃ = Licorice root extract (LRE) at 2.5g/l, T₄ = Combination of LRE followed with Auxin mixture. IC=Inner Cortex, Ed=Endodermis, Pr= Pericycle, Ph= Phloem, Px=Proto-xylem, Mx= Meta-xylem, Ct= Conductive Tissue, Pi= Pith.

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تحسين كفاءة التجذير والنمو الخضري في فسائل النخيل بواسطة استخدام مستخلص جذور العرقسوس وخليط الأوكسينات

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أجريت هذه الدراسة على فسائل نخيل بلح حياني خلال عامين متتاليين هما ٢٠١٤ / ٢٠١٥ و ٢٠١٥ / ٢٠١٦ بمشتل خاص بمنطقة أم الرضا بمحافظة دمياط وكان الهدف من البحث هو زيادة كفاءة عملية التجذير وتحسين النسبة المئوية للنجاح في الفسائل المفصولة بعد زراعتها بالمشتل وقد تمت دراسة تأثير رش (٥٠٠ مل) من أربعة محاليل مختلفة ، على قواعد وأوراق الفسائل المختبرة بعد الفصل وقبل الزراعة ، هي مستخلص جذور العرقسوس بتركيز ٢,٥ جم/لتر و خليط أكسينات من اندول حمض البيوتيريك ونقالتين حمض الخليك بتركيز ٥٠٠ جزء في المليون لكل منهما ومعاملة تداخل محلولي مستخلص العرقسوس وخليط الأوكسينات واستخدام الماء المقطر كمتروك. واستخدمت في هذه الدراسة ٦٤ فسيلة متماثلة تقريبا في الصفات وعمرها حوالي ٤ سنوات وقسمت إلى ٤ مجموعات أخضعت كل منها لأحد المحاليل الأربعة المختبرة. بعد سنة من زراعة الفسائل بالمشتل أخذت قياسات عديدة لصفات النمو الخضري (طول وعدد الأوراق الجديدة وعدد أزواج الوريقات/ورقة وقطر محور الورقة أعلى منطقة الأشواك مباشرة والمساحة الورقية الكلية/فسيلة ومحتوى صبغات الكلوروفيلات والكاروتين في الوريقات وعدد الفسائل الجديدة النامية على كل فسيلة مختبرة). كما تم تسجيل النسبة المئوية لتجذير الفسائل و صفات الجذور النامية عليها (عدد وطول وقطر الجذور الأولية وعدد الجذور الثانوية). كذلك تم دراسة تأثير المعاملات على الصفات التشريحية للجذور والتمثلة في الصفات التشريحية للمنطقة المحيطة في القطاع العرضي للجذر (سمك كل من البشرة ومنطقة القشرة والبشرة الداخلية ومساحة التجاويف الهوائية وعدد ومساحة حزم الألياف الاسكار نكيميية والصفات التشريحية للمنطقة الوعائية في القطاع العرضي للجذر (قطر اللحاء والخشب وسمك كل من النخاع والمنطقة الوعائية). وأوضحت النتائج مايلي: المعاملات المدروسة حسنت معنويا صفات النمو الخضري في الفسائل المختبرة مقارنة بالمتروك. ومعاملة التداخل المشتملة على مستخلص العرقسوس (٢,٥ جم/لتر) وخليط الأوكسينات & (NAA & IBA) أعطت أعلى الاستجابات في كل صفات النمو المدروسة في الأوراق ومحتواها من الصبغات. كما تفوقت المعاملات المختبرة معنويا على المتروك في النسبة المئوية لتجذير الفسائل وكذلك في عدد الفسائل الجديدة النامية على كل فسيلة مختبرة. وقد حققت معاملة التداخل بين الأوكسينات ومستخلص العرقسوس أعلى نسبة تجذير (٩١,٧%) مقارنة بالمتروك (٥٤,٢%). وأثبتت النتائج وجود زيادة معنوية في صفات الجذور (طول وقطر وعدد الجذور الأولية وعدد الجذور الثانوية) في الفسائل المعاملة بخليط الأوكسينات أو مستخلص جذور العرقسوس أو هما معا مقارنة بالمتروك. كما أشارت الدراسات التشريحية إلى وجود إختلافات واضحة في الصفات المدروسة بالقطاعات العرضية للجذور. حيث جذور الفسائل المعاملة زادت معنويا في عدد ومساحة الحزم الاسكار نكيميية وقطر اللحاء وقطر المنطقة الوعائية ونقصت معنويا في سمك منطقة القشرة وقطر النخاع مقارنة بجذور فسائل المتروك. وقد تميزت جذور الفسائل المعاملة بمستخلص العرقسوس بأكبر سمك في كل من البشرة الخارجية والداخلية وأعلى مساحة في كل من الحزم الليفية والتجاويف الهوائية وأكبر قطر للمنطقة الوعائية والخشب. وتوصى النتائج بعاملات الفسائل المفصولة قبل زراعتها بالرش المتداخل (على قاعدتها وأوراقها) بمستخلص جذور العرقسوس بتركيز ٢,٥ جم/لتر يعقبه الرش بخليط الأوكسينات (NAA & IBA) بتركيز ٥٠٠ جزء في المليون لكل منهما للحصول على أعلى نسبة تجذير مع أفضل صفات نمو للجذور والمجموع الخضري.