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EFFECT OF WOUNDING AND IBA ON ROOTING OF AERIAL AND GROUND OFFSHOOTS OF DATE PALM *PHOENIX DACTYLIFERA* L. MEDJOOL CULTIVAR

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Abstract

A study was conducted in order to determine the effect of offshoots type and the wounding process and the treatment with different concentrations of IBA on stimulating the rooting of aerial and ground offshoots of the date palm. Medjool cultivar after its separation from the mother plant and its cultivation in pots. The experiment was conducted at the Rashedeya farm that belong the Iraqi Ministry of Agriculture for the seasons 2018 and 2019. A factorial experiment (2 × 2 × 3) was conducted according to Randomized Complete Block Design (RCBD) with four replicates and 12 treatments [wounding treatment (wounding and without wounding), and treatment with the growth regulator IBA (seradix) and three concentrates (0,3 gm of seradix powder (2) at concentration 3000 mg.L^{-1} (IBA) and 3 gm of seradix powder No. 3 at a concentration of 8000 mg.L^{-1} (IBA) by scattering on the bases of offshoots after moisturizing. The results showed the superiority of the ground offshoots in the percentage of survival of the live offshoots, number of roots, root length, number of new palm fronds and percentage of dry matter in leaves, with values of 95.80% and 39.0 root. offshoot^{-1}, 26.38 cm. offshoot^{-1} and 2.88 leave. offshoot^{-1} and 54.60% respectively, the treatment of wounding the aerial and ground offshoots was superior in the percentage of survival of the live offshoots, number of roots, root length, number of new palm fronds and percentage of dry matter in leaves reached 91.70%, 36.38 root. offshoot^{-1}, 26.70 cm.offshoot^{-1}, 3.04 leave. offshoot^{-1} and 55.03%, respectively, compared to non-wounded treatment (control treatment). The best results were found in the treatment of the interaction between the ground offshoot and wounding and IBA at a concentration 8000 mg. L^{-1}, where it gave the highest rate of offshoots growth success reached 100% and the highest rate of root number reached 60.0 root. offshoot^{-1} and number of new palm fronds and percentage of dry matter in leaves reached 4.0 leave. offshoot^{-1} and 62.82%, respectively, followed by the treatment of interaction between aerial offshoots and wounding and IBA at a concentration 8000 mg.L^{-1}, where it gave the best rate of success of offshoots growth , as well as the best rate for the number and length of roots and the number of new palm fronds and percentage of dry matter in leaves reached 100%, 29.75 root.offshoot^{-1}, 29.29 cm.offshoot^{-1} , 3.5 leave. offshoot^{-1} respectively and 55.11%.

***Keyword*:** Date palm, rooting, wounding, IBA, offshoots.

Introduction

The date palms, *Phoenix dactylifera* L., belongs to the Arecaceae family, also they one of the most important fruit trees grown in arid and semi-arid areas. Palm cultivation is widespread throughout the Middle East, Africa, Europe and the United States of America (Jain, 2012 and Pintaud *et al*., 2013). Medjool cultivar is one of the cultivars that appeared in the region of Tafilalet in the Morocco and was exported to the rest of the world. The medjool cultivar is characterized by its fruit quality, size and weight, which reaches (20-40 gm). It is considered one of the most valuable cultivars, as it occupies the top position of the global export market (Zaid and De Wet, 2002).

The propagation of date palms using offshoots is the mainstay of date palms even after the spread of tissue culture techniques. Palm trees also produce other types of offshoots called aerial offshoots, which are usually removed by farmers, resulting in significant economic losses. Researchers recommend investing in this aspect in order to develop and reconstruct palm orchards, particularly in relation to valuable and expensive cultivars (Al-Manzouri *et al*., 2007 and Zirari *et al*., 2010).

Hartmann *et al*. (2011) reported that there are types of plant cuttings that contain a good number of compounds that stimulate rooting but lack the appropriate level of auxins. Therefore, the addition of auxins to these cuttings greatly improves rooting. The response of the cuttings to the wounding due to the callus creation and then the development of roots along the area of the wound because the tissues prone to wounds stimulate the cellular division, according to the accumulation of natural auxins and carbohydrates, which lead to increased transpiration speed and the formation of ethylene, which plays an important role in the formation of adventitious roots. Hunt *et al*. (2011) reported that Indole butyric acid (IBA) is a growth regulator that stimulates root formation by reducing the time needed for the emergence of adventitious roots in different types of plants as well as improving the number and length of roots as it encourages splitting and elongation the primary roots cells. Abdel-Galeil *et al*. (2012) explained that the compounds that stimulate rooting including IBA and wounding the bases of offshoots, which resulted in a significant increase in the percentage of rooting, number and length of roots, number of new leaves, fresh and dry weight of the first leaf and roots. Haseeb *et al*. (2016) explained the treatment of date palm offshoots (Siwi and omhaat cultivars) with growth regulators IBA and NAA at concentrations (2000, 3000, 4000 mg. L^{-1}) showed that the best treatment was obtained at the concentration (3000 mg.L^{-1} of IBA or NAA), which gave the best rate of success of offshoots growth , as well as the best rate for the number and length of roots and the number of new palm fronds and percentage of dry matter in leaves compared to control treatment. The objective of this study is the need to increase some of excellent and commercially desirable palm cultivars that aim to use some of the treatments that stimulate the aerial and ground offshoots to form a strong root mass to increase the success rate of the seedlings after planting in order to benefit from the propagation and to provide an additional source of income for the farmers. to increase the success rate of offshoots growth after planting in order to benefit from the increase and to secure an additional source of income for palm farmers.

Materials and Methods

The study was conducted at the Rashedeya farm that belong the Iraqi Ministry of Agriculture which is located east of the capital Baghdad on latitude (33.33) and longitude (44.43) and at an altitude of 111 feet above sea level, for the seasons 2018-2019, to study the possibility of stimulating the rooting of aerial and ground offshoots of date palm (Medjool cultivar) which entered Iraq for the first time in 2013., the both types of offshoots were separated by with age of 2-3 years according to the obtained with homogeneity and close weights (8-10 kg) in the beginning of March 2018. The side leaves of the offshoots were removed up to three rows. The leaves of the apical tips were shortened to mid-length except for the central leaf because it is usually short and then packaged to protect the apical tips with the top left open to facilitate the growth of new leaves. The offshoots bases were submerged before planting with a solution of Benomyl fungicide at a concentration of 1.5 gm.L^{-1} for five minutes to avoid contamination. A factorial experiment was conducted according to Randomized Complete Block Design (RCBD) with four replicates and 12 treatments. Included The effect of three factors with their interaction in the stimulation of rooting of both ground and aerial offshoots after the treatment of wounding (wounding and without wounding) of both types by using a sharp knife with 3-4 longitudinal wounds and then treat the separation zone of the ground and aerial offshoots with a substance (IBA) Indole Butyric acid with form Seradix 2 and 3 at concentrations (0, 3000 and 8000 mg.L^{-1} IBA) prophylaxis by spreading 3 g of Seradix 2 and 3 rooting powder using the fermenter on the separation zone of the treated seed. And was added 3 gm of rooting powder Seradix 2 and 3 by scattering them over the separation area of the treated offshoot.

The offshoots were grown after application of the treatments in pots with 50 cm diameter with a depth of 43 cm so that the wide area of the offshoot stem at the soil surface to avoid water entering in it. a mixture of mixed soil with peat moss and perlite was used in 1: 1: 2 ratio to increase the soil's ability to retain moisture. The offshoots were directly irrigated and the daily irrigation continued for 3 days at a rate of 2 liters per offshoot. And then the number of irrigation was reduced by one rate per three days. The following characters were studied in April 2019, more than one year after the planting of the offshoots and the conduct of the treatments: the percentage of the survival of the offshoots: depending on the vegetative and root growth by applying the following equation: (survival percentage = number of live offshoots / the number of total offshoots x 100), the number of roots per offshoot, the length of the root (cm), the number of new leaves, the percentage of dry matter, and the percentage of elements N, P and K in leaves.

Results and Discussion

The percentage of successful growth of offshoots:

The results of Table (1) indicated that the ground offshoot was superior in survival rate and gave the highest percent reached 95.80%, compared to 70.80% of the aerial offshoots. The wounding treatment significantly increased the survival percentage 91.70% compared to the non-wounding that gave 75.0%. The survival of the live offshoot was significant when treated with the IBA growth regulator at a concentration of 8000 mg.L^{-1} which was 100% and without a significant difference from the concentration of 3000 mg.L^{-1}, with a survival rate of 93.80% compared to the control treatment. The reason of the superiority of the above treatments may be due to the fact that the treatment of wounding stimulates the production of ethylene, which is known to encourage the formation of adventitious roots, and that the damaged tissue may be stimulated and divided into primary roots and thus the emergence of adventitious roots intensively along the wound or may due to the accumulation of auxins and carbohydrates and increase speed of transpiration in the area of the wound as well as treatment with the growth regulator IBA has encouraged the rooting of the offshoots and increase the rate of rooting and vegetative growth and thus increase the success rate of the offshoots growth (Qaddoury and Amssa, 2004 and Mervat and El-Dengawy, 2017).

Number of Roots

The results of the statistical analysis indicated that the ground offshoots gave the highest root number rate reached 39.00 root.offshoot^{-1} compared to aerial offshoots which gave 20.67 root. offshoot^{-1}. The treatment of wounding led to an increase in the number of roots with a significant difference reached 36.38 root.offshoot^{-1} compared to control treatment, which gave the lowest number of roots was 23.29 root. offshoot^{-1}. The treatment of IBA significantly increased the number of roots per offshoot. The best treatment was the treatment with a concentration of 8000 mg.L^{-1} compared to the control treatment, which gave the lowest number of roots reached 15.69 root.offshoot^{-1}. The effect of the triple interaction among the three study factors was significant in the studied characters. The grounded and wounding offshoot and treated with growth regulator (IBA) at concentration of 8000 mg.L^{-1} gave the highest number of roots per offshoot reached 60.00 root. However, it did not differ significantly from the treatment of ground offshoot and wounding and (IBA) at concentration of 3000 mg.L^{-1}. the treatment of interaction among aerial offshoot and wounding and IBA at a concentration of 3000 mg.L^{-1} gave highest root number reached 30.50 root.offshoot^{-1} compared to the interaction among non-wounding and aerial offshoot and IBA at a concentration of 0 mg.L^{-1}, which gave the lowest root number was 3.50 1, which did not differ significantly from the treatment of interaction between aerial offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1}.

Root Length

The soil offshoots gave the highest roots length reached 26.38 cm per offshoot compared to the aerial offshoot which reached 20.72 cm per offshoot. The wounding treatment exceeded the root length reached 26.70 cm per offshoot compared to the non- wounded treatment which gave the lowest root length that was 20.40 cm per offshoot. The treatment of IBA at concentration of 8000 mg.L^{-1} gave the highest root length reached 30.64 cm per offshoot compared to non-treated offshoots which gave the lowest root length reached 13.26 cm per offshoot, the interaction between the ground offshoot that treated with IBA at a concentration of 8000 mg.L^{-1} gave the highest root length was 39.69 cm per offshoot compared to the interaction between non- wounded and non-treated with the IBA regulator, which gave the lowest value of 16.03 cm per offshoot, the interaction between the treatment of aerial offshoot and wounded and IBA at a concentration of 8000 mg.L^{-1} gave the highest root length reached 29.29 cm per singular offshoot compared to

aerial offshoots which non wounded and non-treated with IBA gave the lowest value of root length reached 3.30 cm per offshoot.

Root Diameter

The results of the statistical analysis in table 2 indicated that treatment of IBA at concentration 3000 mg.L^{-1} resulted in a significant increase in the root diameter of 0.69 mm.offshoot^{-1} compared to the untreated offshoots which gave the lowest value reached 0.42 mm.offshoot^{-1} and did not differ significantly from the treatment at the concentration of 8000 mg.L^{-1} (IBA), and there were no significant differences for the type of offshoot and the process of wounding and interaction among the three factors in their effect in the diameter of the roots.

Number of new leaves (leaf.offshoot^{-1})

The results indicated in Table 2 indicate that the ground offshoots was significantly higher in the number of leaves that reached 2.88 frond.offshoot^{-1} compared to the aerial offshoots which gave 2.50 frond.offshoot^{-1}, the wounding treatment showed a significant increase in the number of new leaves with a value of 3.04 frond.offshoot^{-1} compared to the non-wounded offshoots, which gave the lowest value of new frond reached 2.33 per offshoot. The treatment of the growth regulator IBA at a concentration of 8000 mg.L^{-1} to a significant increase in the number of new fronds amounted to 3.31 frond.offshoot^{-1} compared to untreated offshoots which gave the lowest rate of the number of leaves amounted to 1.75 frond.offshoot^{-1}, which did not differ significantly from the IBA treatment at concentration 3000 mg.L^{-1}, the results of the statistical analysis indicated that the treatment of interaction between ground offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1} was superior to the rest treatments and gave the highest rate of new fronds which reached 4.00 frond.offshoot^{-1} followed by the interaction treatment among the ground offshoot and wounding and the IBA at a concentration of 3000 mg.L^{-1} and the treatment of aerial offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1} which gave both 3.50 frond.offshoot^{-1} without significant differences.

Percentage of dry matter

The results in Table 2 showed a significant increase of ground offshoots in dry matter by 54.60% compared with aerial offshoots which gave 52.47%. %, the wounding treatment helped to increase the percentage of dry matter by 55.03% compared to the non-wounded, which gave the lowest rate of dry matter amounted to 52.04%, and the results indicated that the IBA treatment was superior at concentration of 8000 mg.L^{-1} compared to the rest of the treatment by 56.96% followed by IBA treatment at concentration of 3000 mg.L^{-1}, while the control treatment gave the lowest rate of dry matter percentage of 50.70%, the interaction treatment among ground offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1} compared to rest treatment in giving the highest percentage of dry matter reached 62.82% followed by interaction treatment of aerial offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1} which gave 55.11%.

Concentration of nitrogen in leaves (%)

The results shown in Table 3 indicate that the ground offshoot gave a significant increase in the percentage of leaves nitrogen, where it was 0.75% compared to the aerial offshoots which gave 0.71%, the wounding treatment gave a significant increase in the percentage of nitrogen with a value of 0.782% compared to non-wounded treatment that gave 0.68%. The treatment of IBA growth regulator at a concentration of 8000 mg.L^{-1} resulted in a significant increase in the percentage of nitrogen reached 0.79% compared to the non-treated offshoots which gave the lowest nitrogen percent reached 0.64%. The results of the statistical analysis showed superiority of the interaction treatment among the ground offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1} compared to rest treatments with the highest percentage of nitrogen percentage of 0.89% followed by the interaction treatment among the ground offshoot and wounding and IBA at a concentration of 3000 mg.L^{-1} that gave 0.85%, with no significant differences from the treatment of aerial offshoot and wounding and IBA at a concentration of 8000 mg.L^{-1}, which gave a nitrogen rate reached 0.82%.

Concentration of phosphorus in leaves (%)

The results in Table 3 showed a significant increase in phosphorus in the leaves of the ground offshoots reached 0.17% compared to the aerial offshoots which gave 0.16%. The wounding treatment resulted in an increase in the phosphorus percentage of 0.18% compared to the control treatment which gave 0.15%. the growth regulator IBA treatment at a concentration of 8000 mg.L^{-1} resulted in significant increase in the phosphorus percentage of 0.19% compared to the non-treated treatment which gave 0.14%. The best results obtained from interaction treatment among the ground offshoot and wounding and the IBA treatment at a concentration of 8000 mg.L^{-1} which gave percentage of 0.23% followed by the treatment of ground offshoot and wounding and the IBA treatment at a concentration of 3000 mg.L^{-1} which gave 0.19% and did not differ significantly from the interaction treatment among the aerial offshoot and wounding and growth regulator IBA at concentration 8000 mg.L^{-1}, which gave 0.19%.

Concentration of potassium in leaves (%)

Table 3 shows the superiority of the ground offshoot treatment in the potassium percentage in leaves that gave 1.85% compared to the aerial offshoots which gave 1.70%. The wounding treatment showed significant increase in the percentage of potassium by 1.90% compared to the untreated offshoots which gave 1.65% while the treatment of growth regulator (IBA) at a concentration of 8000 mg.L^{-1} gave a significant increase in the percentage of potassium by 1.95% compared to non-treated offshoots which gave 1.55%, the interaction treatment among ground offshoot and wounding and growth regulator IBA at concentration of 8000 mg.L^{-1} which gave the highest percent reached 2.37 followed by the interaction treatment of the interstitial interferon and IBA at a concentration of 3000 mg.L^{-1}, which gave 1.90% followed by interaction treatment among ground offshoot and wounding and growth regulator IBA at concentration of 8000 mg.L^{-1}, which gave a potassium percent reached 1.86%.

It is clear from the previous results that the treated aerial offshoots have given lower values in most characters than the normal ground offshoot However, the survival rates and the studied characters related to the success of their rooting are very high and significant compared to the aerial offshoots untreated. This results is in agreement with results of Afzal (2011) and Abdel-Galeil (2012) Who found that the wounding aerial offshoots and treatment with the growth regulator IBA had encouraged the rooting of the aerial offshoots. In addition, the ground offshoots had very positive results when treated with wounding and growth regulator compared to untreated ground offshoots. These results are in

agreement with results of Macdonald (1993) and Darwesh (2013). That the formation of roots in the areas of wounds on the stem associated with plant hormones, and the treatment the bases of the offshoots with growth regulator IBA led to increase of the rooting rate and root length and number of leaves and this is reflected in general on the vegetative growth and root growth of the offshoots. The results also suggest that the wounding treatment resulting in increase of number and length of roots and increase of new leaves and dry matter. these results are consistent with Hartmann *et al*. (2011) who confirms that the injured tissue stimulates the cellular divide may be due to the accumulation of natural auxins, carbohydrates and other substances in the wound area, which may lead to an increase in transpiration speed and production of ethylene, which has an important role in stimulating the formation of adventitious roots. these results also is in agreement with results of (Abdulqader *et al*., 2017). Who confirmed that the wounding led to an increase in the number, length, diameter of roots and branches of the three cultivars of olive trees. The positive effect of the growth regulator IBA on improving and increasing the above characters may be due to the ability of auxin to promote roots growth (Sourour, 2001). This is in agreement with results of Laaziza and Zirari (2010), Haseeb *et al*. (2016) Who confirmed the number of productive roots and the number of new fronds increased when treated with IBA.

Table 1 : Effect of offshoot type and wounding and IBA on growth success rate of date palm offshoot (Medjool cultivar)

Treatment				Percentage of survival
Offshoot type	Ground			95.80
	Aerial			70.80
LSD5%				14.46
Wounding treatment	Without wounding			75.00
	Wounding			91.70
LSD5%				14.46
IBA concentration	0			56.20
	2			93.80
	3			100.0
LSD5%				17.71
offshoot × wounding × IBA	Ground	Without wounding	0	75.00
			2	100.0
			3	100.0
		wounding	0	100.0
			2	100.0
			3	100.0
	Aerial	Without wounding	0	0.0
			2	75.00
			3	100.0
		wounding	0	50.00
			2	100.0
			3	100.0
LSD 5%				N.S

Table 2 : Effect of offshoot type and wounding and IBA on number of roots.offshoot^{-1}, length of root (cm), root diameter (mm) and number of new fronds.offshoot^{-1} and percent of dry matter % (Medjool cultivar).

Characters Treatments				Roots number	Root length	Root diameter	New leaf number	Dry matter %
Offshoot type	Ground			39.00	26.38	0.63	2.88	54.60
	Aerial			20.67	20.72	0.55	2.50	52.47
LSD 5%				2.60	1.62	N.S	0.30	0.88
Wounding treatment	Without wounding			23.29	20.40	0.55	2.33	52.04
	wounding			36.38	26.70	0.62	3.04	55.03
LSD 5%				2.60	1.62	N.S	0.30	0.88
IBA concentrations	0			15.69	13.26	0.42	1.75	50.70
	2			35.75	26.76	0.69	3.00	53.71
	3			38.06	30.64	0.66	3.31	56.96
LSD 5%				3.18	1.98	0.18	0.37	1.07
Offshoot × wounding × IBA	Ground	Without wounding	0	19.75	16.03	0.43	1.75	50.68
			2	32.00	26.18	0.70	2.75	53.78
			3	37.75	27.20	0.65	3.00	54.13
		Wounding	0	26.00	20.02	0.60	2.25	51.36
			2	58.50	29.16	0.73	3.50	54.84
			3	60.00	39.69	0.68	4.00	62.82
	Aerial	Without wounding	0	3.50	3.30	0.23	1.25	49.47
			2	22.00	23.31	0.63	2.50	51.45
			3	24.75	26.37	0.70	2.75	52.72
		wounding	0	13.50	13.69	0.43	1.75	51.29
			2	30.50	28.38	0.70	3.25	54.78
			3	29.75	29.29	0.60	3.50	55.11
LSD 5%				6.37	3.97	N.S	0.74	2.15

Table 3 : Effect of offshoot type and wounding and IBA on leaves content of nitrogen, phosphorus and potassium (%).

Treatments				Characters		
				N	P	K
Offshoot type	ground			0.75	0.17	1.85
	Aerial			0.71	0.16	1.70
LSD 5%				0.02	0.01	0.01
Wounding treatment	Without wounding			0.68	0.15	1.65
	wounding			0.78	0.18	1.90
LSD 5%				0.02	0.01	0.01
IBA concentration	0			0.64	0.14	1.55
	2			0.76	0.17	1.83
	3			0.79	0.19	1.95
LSD 5%				0.02	0.01	0.01
Offshoot × wounding × IBA	ground	Without wounding	0	0.61	0.14	1.50
			2	0.73	0.17	1.79
			3	0.74	0.18	1.82
		wounding	0	0.68	0.15	1.71
			2	0.85	0.19	1.90
			3	0.89	0.23	2.37
	Aerial	Without wounding	0	0.61	0.13	1.29
			2	0.69	0.15	1.76
			3	0.71	0.16	1.77
		wounding	0	0.67	0.15	1.69
			2	0.78	0.18	1.85
			3	0.82	0.19	1.86
LSD 5%				0.04	0.02	0.02

References

Abdel-Galeil, L.M.; Saber, T.Y. and El-Baky, M.A. (2012). Effect of some activators and wounding on rooting and growth of Phoenix Dactylifera L. Cv. Haiany aerial offshoots. Annals of Agric. Sci. Sp. lssue, 58(1):1-14.

Afzal, M.; Khan, M.A.; Pervez, M.A. and Ahmed, R. (2011). Root induction in the aerial offshoots of date palm (*Phoenix dactylifera* L.) cultivar, Hillawi. Pak. J. Agri. Sci, 48(1): 11-17.

Al-Manzouri, H.S.; Zaid, A. and Bouhouche, N. (2007). Morphological abnormalities in tissue cultured-derived date palm (*Phoenix dactylifera* L.). Proc. 3th. Inter. Date Palm Conference. 329-335.

Darwesh, R.S.; Madbolly, E.A. and Gadalla, E.G. (2013). Impact of indole butyric acid and paclobutrazol on rooting of date palm (*Phoenix dactylifera* L.) off-shoots cultivar Zaghloul. J. Hort. Sci. Orn. Plants, 5(3): 145-150.

El-Dengawy, E.F.A.; Wanas, A.L.E. and Mervat, H.M. Improvement of the Rooting Efficiency and Vegetative Growth in Date Palm Offshoots by Licorice Root Extract and Auxins Mixture Applications.

Hartmann, H.T.; Kester, D.E. and Geneve, R.L. (2011). Hartmann & Kester's plant propagation principles and practices (No. 631.53 H2555p Ej. 1 025385). Prentice Hall.

Haseeb, G.M.M.; El-Kosary, S.E.; Abd Elkareem, H.A. and Bakir, M.A.M. (2016). September. Induction of roots on young date palm offshoots using growth regulators injection. In VI International Symposium on Tropical and Subtropical Fruits 1216: 115-126.

Hunt, M.A.; Trueman, S.J. and Rasmussen, A. (2011). Indole-3-butyric acid accelerates adventitious root formation and impedes shoot growth of Pinus elliottii var. elliottii× P. caribaea var. hondurensis cuttings. New Forests, 41(3): 349-360.

Jain, S.M. (2012). Date palm biotechnology: Current status and prospective-an overview. Emirates Journal of Food and Agriculture, 386-399.

Macdonald, B. (1993). Practical Woody Plant Propagation for Nursery Growers. Vol:1, Timber Press, Portland, Oregon, 656.

Pintaud, J.C.; Luden˜a, B. and Aberlenc-Bertossi, F. (2013). Biogeography of the date palm (*Phoenix dactylifera* L., Arecaceae): insights on the origin and on the structure of modern diversity. Acta Horticulturae, 994: 19–38.

Qaddoury, A. and Amssa, M. (2004). Effect of exogenous indole butyric acid on root formation and peroxidase and indole-3-acetic acid oxidase activities and phenolic contents in date Palm offshoots. Botanical Bulletin of Academia Sinica, 45:127-131.

Sourour, M.M. (2001). Rooting ground and aerial offshoots of Three Date palm cultivars grown in north sinai using IBA and NAA compounds. J. Adv. Agric. Res., 6(4): 883-901.

Zaid, A. and De Wet., P.F. 2002. Date Palm Propagation. FAO Plant Production and Protection, 156: 73-105.

Zirari, A. and Laaziza Ichir, L. (2010). Effect of Exogenous Indole Butyric Acid (IBA) on Rooting and Leaf Growth of Small Date Palm Offshoots (*Phoenix dactylifera* L.) Derived from Adult Vitroplants of 'Najda' Cultivar. In IV International Date Palm Conference 882 (pp. 839-844).