

## Impact of Indole Butyric Acid and Paclobutrazol on Rooting of Date Palm (*Phoenix dactylifera* L.) Off-Shoots Cultivar Zaghloul

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**Abstract:** Date palm (*Phoenix dactylifera* L.) cultivar Zaghloul is a commonly fruits in arid and semi arid region. The common method of increasing planting areas of date palm by off-shoots in date palm nursery. Off-shoots are the axillary buds on the trunk of mother palm, is the true to type to the parent palm. Limited numbers of off-shoots (20-30) are produced during juvenile stage (10 – 15) years from date plant. The lowest survival for the transplanting of these off-shoots needs to improve new rooting at the trunk base. Therefore this work was design to increase the survival of transplanting off-shoots by three levels of IBA at 1000, 2000 and 4000 ppm singly and in combination with 0.4 mg/l pbz in the date palm nursery of the Central Laboratory for Research and Development of Date Palm, Agriculture Research Center (ARC). Three categories of off-shoots weights (4, 8 and 12 kg) were subjected to different growth regulators (IBA alone and in combination with 0.4 pbz). The main results of this study were, 72.2% of off-shoots successfully rooted with 4000 ppm IBA furthermore 77.7 and 86.1% successfully rooted with 2000 and 4000 ppm/l IBA + 0.4 mg/l pbz. Using IBA at 4000 ppm/l alone and combined with 0.4 mg/l pbz increased leaf length (cm), numbers of new leaves/ off-shoots, number of new off-shoots/ off-shoots, roots numbers/offshoot and root length (cm). Regard to the treatments of 1000, 2000 and 4000 ppm IBA + 0.4 pbz significantly increased all growth parameters compared to control (tap water). The off-shoots of 12 kg recorded the highest significant rooting 83.3 % treated with 4000 ppm IBA, while 91.7 % resulted for 4000 ppm IBA + 0.4 mg/l pbz treatments with 8 and 12 kg/offshoot. Based on these results, it seemed reasonable to conclude that, treatment with IBA at 4000 ppm/l singly, IBA at 4000 ppm/l in combination with 0.4 mg/l pbz for off-shoots weights 8-12kg/offshoot resulted in the highest rooting percentage of transplanting off-shoots in date palm nursery.

**Key words:** Date palm nursery • Off-shoots • IBA • Paclobutrazol • Rooting

### INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is a monocotyledonous and dioecious fruit tree with a high degree of heterozygosity. Conventional vegetative propagation, made through off-shoots, is very slow and laborious. In addition, the number of off-shoots is complicated, time consuming and the percentage of off-shoots successfully established in soil is highly variable (30 – 80 %) and cultivar dependent [1]. The date palm is an income generating source having potential of staple food qualities as its fruit is enriched with higher mineral contents, its cultivation might be suitable in marginal areas owing to wider adoptability and tolerance

against stress conditions [2, 3]. The root system of palms is adventitious and composed of numerous, small-to medium-sized, non woody roots. All primary roots are of a more or less constant diameter and arise independently from an area at or near the base of the stem called the root initiation zone (RIZ). Because of these root system characteristics and the ability of their trunks to store water and carbohydrates palms are relatively easy to transplant [4]. Three different sizes of date palm cv Hillawi, viz., small (1-4 kg), medium (5-11 kg) and large (12-20 kg) were treated with 0, 500, 1000 and 2000 mg/l concentrations of IBA using quick-dip method, the supremacy of large sized rooted ones over medium and small sizes [5]. Adventitious root development in *Eucalyptus* cultivar

*saligna* and *globules* with application of IAA and IBA [6]. Overall root regeneration of juvenile plants was found to be abundant in transplanted date palm (*Phoenix canariensis*) canary Island [7]. Root length and numbers, root hairs and root thickness of date palm cv Hillawi were improved with different levels of IBA and NAA at 1000, 2000 and 3000 mg/l [8, 9]. Exogenous IBA induced significant rooting of date palm cultivar Najda off-shoots, more than 96% of off-shoots rooted if treated with 10 or 15 mg/l IBA solutions, while only 50% rooting was obtained with 2 mg/l IBA treated and control off-shoots. These rooted off-shoots produced an average of 12 visible roots per offshoot. Furthermore, 90% of off-shoots of less than 2 kg rooted well if treated with 10 or 15 mg/l IBA solutions [10]. Two types of date palm (*Phoenix dactylifera* L.) off-shoots occur on a date palm tree: the lower and older ones and the upper and younger ones. It is believed that low off-shoots are more active physiologically than high ones; they probably grow faster (the number of leaves produced increases with age). In fact, the high off-shoots have less carbohydrate than low off-shoots, resulting in low roots production and consequently low survival rate. It is advisable that an offshoot never be planted into the field directly after removal from the mother plant. A rooting period of one to two years in a nursery is essential in order to ensure an optimum survival rate and to avoid uneven development of the plantation [11]. Keeping these facts in view, therefore, the objective of this investigation was to study the effect of IBA (Indole Butyric Acid) alone and combination with pbz (Paclobutrazol) with three weights of off-shoots 4, 8 and 12 kg (*Phoenix dactylifera* L. cultivar Zaghloul) for increasing rooting percentage to utilize them successfully for propagation in the large areas.

## MATERIALS AND METHODS

The experiment was accomplished in 2012-2013 seasons in date palm nursery of the Central laboratory for Research and Development of Date palm, Agriculture Research Center (ARC), Giza, Egypt. The main purpose of this work to impact of different treatments of growth regulators (IBA alone and in combination with 0.4 pbz) on rooting of off-shoots of date palm (*Phoenix dactylifera* L. cultivar Zaghloul). All leaves were removed from off-shoots except 8-12 leaves which were tied together and fold up, the off-shoots weights, numbers of old and new leaves were recorded before culture. The off-shoots were cultured during March 2012 in the clay soil, each offshoot

planted singly in the soil. These off-shoots were divided to three weights 4, 8 and 12 kg for tested under the treatments of IBA (Indole Butyric Acid) for three treatments as single treatment and combination with treatment of pbz (Paclobutrazol). Each treatment was replicated three times with four off-shoots for each replicate.

**Treatments:** Control (tap water), 1000 ppm IBA, 2000 ppm IBA, 4000 ppm IBA, 1000 ppm IBA + 0.4 mg/l pbz, 2000 ppm IBA + 0.4 mg/l pbz and 4000 ppm IBA + 0.4 mg/l pbz.

All these treatments were added at the first culture of planting off-shoots in the nursery date palm. Off-shoots were irrigated 3 days at week in the first 2 months and 2 days at week for 3 months and 1 day at week till the end of experiment. After 3 months from started of experiment the successful off-shoots were fertilized with 2.5 g/l NPK one time for a week.

After one year (Mach 2013) the following data determinations were recorded:

Percentage of off-shoots survived, leaf length (cm), number of new leaves/ off-shoot, number of new off-shoots/ off-shoots, roots numbers/ off-shoots and root length (cm) / off-shoots.

The experiment was performed utilizing complete randomized block design with factorial arrangement. The results were subject to analyzed for variance and the means were compared using L.S.D at 5% level according to Snedecor and Cochran [12].

## RESULTS AND DISCUSSION

Apparently there were differences in response by off-shoots of date palm (*Phoenix dactylifera* L. cultivar Zaghloul) treated with IBA at 1000, 2000 and 4000 ppm/l singly and in combination with 0.4 mg/l pbz, these treatments caused positive and variable response to different parameters in survival percentage of off-shoots, leaf length (cm), number of new leaves, number of new off-shoots, roots numbers/offshoot and root length (cm).

The data concerning survival percent % of date palm off-shoots in Table (1) under three levels of IBA, showed significant deferens for survival percent, level 4000 ppm IBA significantly increased percent of offshoot (72.2%) sequenced by 2000 and 1000 ppm 55.5 % and 33.3 % respectively, in compared to control treatment which gave the lowest rooting percent 16.7%. As far as treatments combinations are concerned, the highest dose of IBA proved a higher percent 86.1% when combined with 0.4 mg/l pbz, moreover, application of 1000 ppm IBA with

Table 1: Effect of IBA alone and in combination with 0.4 pbz treatments on survival % and leaf length (cm) of date palm off-shoots cultivar Zaghloul.

Treatments	Survival %				Leaf length (cm)			
	4 kg	8 kg	12 kg	Mean	4 kg	8 kg	12 kg	Mean (A)
Control	0.0	0.0	50.0	16.7	0.0	0.0	150.0	50.0
IBA 1000 ppm	0.0	33.3	66.7	33.3	0.0	75.0	120.0	65.0
IBA 2000 ppm	33.3	58.3	75.0	55.5	100.0	120.0	152.0	124.0
IBA 4000 ppm	58.3	75.0	83.3	72.2	110.0	130.0	250.0	163.3
IBA 1000 ppm + pbz 0.4 mg/l	33.3	66.7	83.3	61.1	80.0	120.0	135.0	111.7
IBA 2000 ppm + pbz 0.4 mg/l	66.7	83.3	83.3	77.7	120.0	125.0	150.0	131.7
IBA 4000 ppm + pbz 0.4 mg/l	75.0	91.7	91.7	86.1	115.0	140.0	238.0	164.3
Mean (B)	43.8	60.4	77.1		78.8	96.3	168.3	
L.S.D.					A= 1.2	B= 0.8		AB= 2.1

Table 2: Effect of IBA alone and in combination with 0.4 pbz treatments on number of new leaves and number of new off-shoots/ off-shoots of date palm cultivar Zaghloul.

Treatments	Number of new leaves/off-shoots				Number of new off-shoots/off-shoots			
	4 kg	8 kg	12 kg	Mean (A)	4 kg	8 kg	12 kg	Mean (A)
Control	0.0	0.0	6.0	2.0	0.0	0.0	2.0	0.7
IBA 1000 ppm	0.0	4.0	7.0	3.7	0.0	1.0	2.0	1.0
IBA 2000 ppm	3.0	5.0	8.0	5.3	1.0	2.0	3.0	2.0
IBA 4000 ppm	2.0	5.0	13.0	6.7	2.0	3.0	4.0	3.0
IBA 1000 ppm + pbz 0.4 mg/l	5.0	5.0	5.0	5.0	1.0	1.0	2.0	1.3
IBA 2000 ppm + pbz 0.4 mg/l	5.0	5.0	5.0	5.0	1.0	2.0	3.0	2.0
IBA 4000 ppm + pbz 0.4 mg/l	3.0	7.0	10	6.7	2.0	3.0	4.0	3.0
Mean (B)	3.3	4.3	6.5		1.0	1.5	2.8	
L.S.D.	A= 0.9	B= 0.6		AB= 1.6	A= 0.4	B= 0.3		AB=0.8

0.4 mg/l had 61.1%, Significant results were observed with different weights of off-shoots, the off-shoots at 12 kg realized upper percent of successful rooting 66.7% in case of singly IBA treatments, meanwhile both of off-shoots weights of 4 and 8 kg produced 22.9 and 41.7% respectively, moreover 12 kg/offshoot with the combination of IBA + 0.4 mg/l pbz recorded 77.1%, while 66.7% with singly treatment of IBA, the weight of 4 kg/offshoot gave 43.8%. The off-shoots of 8 and 12 kg showed a positive response in survival percent 91.7 % and 91.7 % when treated at 4000 ppm IBA combined with 0.4 mg/l pbz. Higher percentage of date palm offshoots in response to application of IBA with pbz were like those already observed in, Al-Ghamdi [13] and El-Henawy [14] they found that certain age from 3-4 years and the weight 12-20 kg/offshoot to increasing percentage of date palm cvs. Khalas, Ruziz and Shishi,, Bhatt and Tomar [15] found that, IBA at 1500 ppm increased success rate of *Citrus aurantifolia*, recently, Chandy [16] found that 12-16 kg/offshoot proved better percentage than those of low weight of date palm different cvs.

Significant differences in leaf length (cm) were detected when the offshoot treated with different doses of IBA 1000,2000 and 4000 ppm as a single application

(Table 1), the most significant length of leaf were obtained under 4000 ppm/l IBA 163.3 cm, contently the shortest length recorded with the control treatment 50.0 cm, the combination of IBA 1000,2000 and 4000 ppm + 0.4 mg/l pbz revealed that, leaf length were increased with different levels of IBA + 0.4 pbz 164.3 cm particularly. The treatment 4000 ppm + 0.4 mg/l pbz performed most significant length of leaf (164.3 cm) followed by 2000 and 1000 ppm IBA + 0.4 mg/l pbz 131.7 cm and 111.7 cm respectively. Regard to the effect of different offshoot weight on the leaf length, significant length of leaf 168.0 cm was to recorded with offshoot at 12 kg/offshoot while shortest length of leaf (52.5 cm) were recorded with the offshoot at 4 kg/offshoot with single application of IBA, in a significant differences between singly application of 4000 ppm IBA and 4000 ppm/l + 0.4 mg/l pbz 168.0 and 168.3 cm were detected respectively. The results revealed that the application of high level of IBA application and in combined with 0.4 mg/l PBZ with 12 kg/offshoot is linked high length of leaf (250.0 and 238.0cm respectively).

Data in Table 2 are represent the mean value of number of new leaves/offshoot seems to be associated with higher levels of IBA 4000 ppm 6.7, meanwhile the levels 1000 and 2000 ppm IBA recorded 3.7 and 5.3 new

Table 3: Effect of IBA alone and in combination with 0.4 pbz treatments on weight (kg) and diameter (cm) of date palm off-shoots cultivar Zaghloul.

Treatments	Off-shoots weight (Kg)				Off-shoots diameter (cm)			
	4 kg	8 kg	12 kg	Mean (A)	4 kg	8 kg	12 kg	Mean (A)
Control	0.0	0.0	16.4	5.5	0.0	0.0	35.0	11.7
IBA 1000 ppm	0.0	6.3	24.7	10.3	0.0	30.0	40.0	23.3
IBA 2000 ppm	5.9	10.8	20.5	12.4	25.0	25.0	50.0	33.3
IBA 4000 ppm	6.9	11.7	26.5	15.0	25.0	25.0	50.0	33.3
IBA 1000 ppm + pbz 0.4 mg/l	6.6	8.8	20.4	10.6	20.0	31.0	40.0	30.3
IBA 2000 ppm + pbz 0.4 mg/l	6.8	10.9	23.9	13.5	25.0	26.0	50.0	33.7
IBA 4000 ppm + pbz 0.4 mg/l	8.0	14.8	29.7	17.5	25.0	35.0	55.0	38.3
Mean (B)	5.4	8.6	22.6		20.7	21.0	43.6	
L.S.D.	A= 1.2	B= 0.8		AB= 2.2	A= 1.1	B= 0.7		AB=1.8

leaves/offshoot comparison with control treatment 2.0 new leaves/offshoot. The combination between levels of IBA and 0.4 mg/l pbz exhibited positive effect on number of new leaves/off-shoots 6.7, large numbers of new leaves/offshoot was improved by 4000 ppm IBA+0.4 mg/l pbz 6.7 with no significant differs with in between 4000 ppm as singly treatment of IBA. Also, no significant variable between 1000 and 2000 ppm IBA+ 0.4 mg/l pbz on numbers of new leaves/offshoot (5.0 and 5.0 respectively) was noted. In case the different of weights of offshoot on the numbers of new leaves/offshoot, data revealed that large numbers of new leaves/offshoot 6.5 new leaves /offshoot was to be related with 12 kg/offshoot, fewer numbers of new leaf/offshoot caused by 4 kg/offshoot (3.3). Higher interaction was found at 4000 ppm IBA (13.0). Similar results on the effect of IBA and weight of off-shoots on the leaf length and new leaves/offshoot were supported by, Rizk [17] who treating the date palm off-shoots cultivar Sewy weighing 5-10 kg with IBA at 3000ppm gave the highest significant rooting percentage, number of leaves, number of roots/offshoot, Bakr, *et al.* [18] best survival percentages, length of developed leaves, roots number, length for date palm cultivars Hayani, Sewy and Zaghloul with IBA at 3000 ppm, Zirari and Ichir [10] more than 96% off-shoots and 90% off-shoots of less 2 kg rooted if treated with 10-15 mg/l IBA as well as produced new leaves and increased leaf length of date palm cultivar Najda. Srivastava *et al.* [19] found high levels of IBA increased survival percentage 95.4% of cuttings of kiwi fruit and increased numbers of new leaves and shoot length.

Mean values of number of new off-shoots/offshoot significantly affected by different treatments of IBA and pbz were described at (Table 2), large numbers of new off-shoots/offshoot (2.0 and 3.0 new off-shoots/offshoot) were obtained with 2000 and 4000 ppm IBA as singly treatment and the combination with 0.4 mg/l pbz with no

varying in between, fewer results at control treatment 0.7 new off-shoots/offshoot, more numbers of new off-shoots/offshoot at 12 kg/offshoot with IBA as singly treatment 2.8 and at combination with 0.4 mg/l pbz 2.8 new offshoot/offshoot with no significant differs, same trend at 8 kg/offshoot at singly treatment of IBA 1.5 and with combination of 0.4 mg/l PBZ 1.5 new offshoot/offshoot, 4 kg/offshoot gave fewer results 0.8 and 1.0 new offshoot/offshoot respectively at singly treatment of IBA and IBA with combination of 0.4 mg/l pbz. Higher interaction was produced 4.0 new offshoot/offshoot at 12 kg/offshoot with 4000 ppm IBA and with the combination of 4000 ppm IBA + 0.4 mg/l pbz with no significant various in between.

Our data are consistent with the later ones of El-Hodairi *et al.* [20] who found that paclobutrazol at 100 mg/l increased number of offshoot, number of shoots/tree of date palm (*Phoenix dactylifera* L.).

Data in Table 3 regarding to the offshoot weight indicated that, highly significant variation among singly treatments of IBA, gradually increasing of weights of off-shoots with 1000, 2000 and 4000 ppm/l IBA 10.3, 12.4 and 15.0 kg compared to control treatment 5.5 kg. To the effect of combination of IBA + 0.4 mg/l pbz, biggest weights of off-shoots (17.5 kg) might be due to high level of IBA 4000 ppm IBA+ 0.4 mg/l pbz. Different weights of off-shoots showed positive effect on weights of off-shoots under single treatment of IBA and with combination of 0.4 mg/l pbz, 12 kg/off-shoots produced 22.0 kg under single treatment of IBA and 22.6 kg under combination with no significant variable among them, the weights 4 and 8 kg/offshoot produced 3.2 and 7.2 kg respectively for single application and 5.4 and 8.6 kg respectively for combination of IBA + 0.4 mg/l pbz. More significant interaction was obtained at 12 kg/offshoot with single treatment of IBA at 4000 ppm (26.5 kg) and with combination of 0.4 mg/l pbz (29.7 kg).

Table 4: Effect of IBA alone and in combination with 0.4 pbz treatments on root length (cm) and roots number of date palm off-shoots cultivar Zaghloul.

Treatments	Root length (cm)/ off-shoot				Roots number / off-shoot			
	4 kg	8 kg	12kg	Mean (A)	4 kg	8 kg	12 kg	Mean (A)
Control	0.0	0.0	15.0	5.0	0.0	0.0	10.0	3.3
IBA 1000 ppm	0.0	18.0	25.0	14.3	0.0	3.0	20.0	7.7
IBA 2000 ppm	15.5	20.0	30.9	22.1	4.0	12.0	24.0	13.3
IBA 4000 ppm	15.0	30.6	40.0	28.5	8.0	25.0	25.0	19.3
IBA 1000 ppm + pbz 0.4 mg/l	15.0	15.0	30.0	20.0	6.0	9.0	20	11.7
IBA 2000 ppm + pbz 0.4 mg/l	15.6	21.0	30.0	22.2	9.0	15.0	24.0	16.0
IBA 4000 ppm + pbz 0.4 mg/l	20.0	25.0	40.0	28.3	9.0	25.0	27.0	20.3
Mean (B)	12.9	17.6	30.0		6.0	12.3	20.3	
L.S.D.	A= 0.8	B= 0.5		AB= 1.5	A= 0.9	B= 0.6		AB=1.5

Differences among offshoot diameter and highly significant was exhibited under single treatments of IBA and combination with 0.4 mg/l pbz (Table 3) large offshoot diameter and no significant variation between 2000 and 4000 ppm IBA with the same diameter 33.3 and 33.3 cm. Small diameter 11.7 cm were recorded with control treatment. On the other hand combination application IBA + 0.4 mg/l pbz also showed significant results, large diameter was recorded at 4000 ppm + 0.4 mg/l pbz (38.3 cm) followed by 2000 ppm and 1000 ppm + 0.4 mg/l pbz 33.7 cm and 30.3 cm respectively. Higher values with 12 kg/offshoot with no significant differs between single application of IBA and combination with 0.4 mg/l pbz 43.8 and 43.6 cm respectively. Meanwhile significant results were found between 4 and 8 kg/offshoot with single application of IBA which had 12.5 and 20 cm respectively. Highest significant interaction was found at 4000 ppm IBA + 0.4 mg/l pbz with 12 kg/offshoot 55.0 cm.

Data in Table 4 show that, the longest roots /off-shoots were recorded with IBA at 4000 ppm (28.5 cm) while the lowest root length (5.0 cm) was found with the control treatment. The application of 1000 and 2000 ppm IBA recorded 14.3 and 22.1 cm respectively. The combination of different levels of IBA 1000, 2000 and 4000 ppm + 0.4 mg/l pbz resulted in the longest roots; significant longest roots were proved with 4000 ppm IBA+ 0.4 mg/l pbz 28.3 with insignificant variance with singly application of IBA. Longest roots were achieved in concerning weights of off-shoots 4, 8 and 12 kg/offshoot, the weights of 12 kg/offshoot had 27.7 cm than 7.6 and 17.2 cm for 4 and 8 kg/offshoot respectively for the single application of IBA and 30.0 cm longer than weights 4 and 8 kg/offshoot 12.9 and 17.6 cm respectively for combination with 0.4 mg/l pbz. A significant interaction was realized with 4000 ppm IBA singly and with combination with 0.4 mg/l pbz 40.0 cm.

Results in Table 4 show more number of roots were produced in direct relation with higher levels of IBA 4000

ppm and 2000 ppm 19.3 and 13.3 roots/off-shoots respectively; fewer numbers of roots were resulted by control treatment, the combination of IBA + 0.4 mg/l pbz, maximum numbers/offshoot performed at 4000 ppm IBA + 0.4 mg/l pbz 20.3 roots/offshoot belonging with 2000 and 1000 ppm IBA + 0.4 mg/l pbz 16.0 and 11.7 roots/offshoot. Positive effect was found with different weights of offshoot 4, 8 and 12 kg/offshoot with single treatment of IBA (3.0, 10.0 and 19.8 respectively) and the combination with 0.4 mg/l pbz, 12 kg/offshoot recorded 20.3 roots/offshoot respectively sequenced with 8 and 4 kg/offshoot which recorded 10.0 and 12.3 roots/offshoot with significant variance among them. Significant interaction was revealed at 4000 ppm IBA+ 0.4 mg/l pbz with 12 kg/offshoot. Data on the offshoot diameter, root length and root numbers proved the significant relation the effect of IBA was supported by other scientists, Sun and Bassuk [21] reported that IBA at 500-2000 ppm increased percent of rooting and root numbers of apple rootstock MM.106 (*Malus domestica* Borkh), Gaspar *et al.* [22] stated that, adventitious rooting can also be promoted by the application of auxins in combination with phenols. Al-Jabary [23] injection aerial date palm offshoot cultivar Hillawi with IBA increased rooting percent, root length, numbers and diameter, Al-Samaraec [24] showed that, IBA different treatments increased rooting percentage, root length, numbers of roots and leaves of *Lawsonia inermis* L. Zebari [25] found that, high levels of IBA 1500 and 2000 mg/l were increased diameter of shoots in fig cultivars.

## REFERENCES

1. Saaidi, M., G. Duvauchelle and G. Duvauchelle, 1979. Multiplication du palmier dattier. Etude des quelques Facteurs conditionnant La reprise vegetative des rejets de palmier dattier. Fruits, 34: 555-561.

2. Al-Shahib, W. and R.J. Marshall, 2003. The fruit of the date palm: its possible use as the best food for the future. *International Journal Food Sci. Nutr.*, 54: 247-59.
3. Anonymous, 2009. Area, production and export of fruit, vegetables and condiments. *Fruit, Vegetables and Condiments. Pakistan Journal of Agricultural Science*, 25: 1-2, Ministry of Food and Agriculture, Economic Wing, Islamabad, Pakistan.
4. Tomlinson, P.B., 1990. *The structural biology of palms* (Oxford University Press, New York). [www.google.com](http://www.google.com)
5. Nasir, M.J. 1996. Effect of IBA on rooted and unrooted off-shoots of date palm (*Phoenix dactylifera* L.) cultivar Hillawii. M.Sc. Thesis, Dept. Hort., Univ. Agric. Faisalabad, Pakistan.
6. Fett-Neto, A.G., P.S. Fett, L.W.V. Goulart, G. Pasquali, R.R. Termignoni and A.G. Ferreira, 2001. Distinct effect of auxin and light on adventitious root development in *Eucalyptus saligna* and *Eucalyptus globules*. *Tree Physiol.*, 21: 457-464.
7. Hodel, D.R., D.R. Pittenger and A.J. Downer, 2003. Effects of leaf removal and tie up on juvenile, transplanted of canary Island date palms (*Phoenix dactylifera* L.) and queen palms (*Syagrus ramanzoffiana*). *Palms*, 47(4): 177-184.
8. Al-Najm, A.R.A., 2009. Effect of Indole butyric acid and Indole-3-acetic acid on root initiation of date palm (*Phoenix dactylifera*)c.v Hillawi. *Basrah Journal for Date Palm Research*, 8(1): 13-20.
9. Afzal, M., M.A. Khan, M.A. Pervez and R. Ahmed, 2011. Root induction in the aerial off-shoots of date palm (*Phoenix dactylifera* L.) cultivar Hillawi. *Pakistan Journal of Agri. Sci.*, 48(1): 11-17.
10. Zirari, A. and L.L. Ichir, 2010. Effect of exogenous Indole butyric acid (IBA) on rooting and leaf growth of small date palm off-shoots (*Phoenix dactylifera* L.) derived from adult vitro plants of Najda cultivar. *International Society for Horticulture Science*, [www.Google.com](http://www.Google.com)
11. Zaid, A. and P.F. De wet, 2012. Date Palm Propagation: Offshoot propagation. [www.agrihunt.com](http://www.agrihunt.com), [www.google.com](http://www.google.com).
12. Snedecor, G.W. and W. G. Cochran, 1972. *Statistical Method 6<sup>th</sup>*. The Iowa State University Press, Ames., Iowa U.S.A., pp: 59.
13. Al-Ghamdi, A., 1988. Rooting of date palm off-shoots as affected by offshoot size, cultivar and Indole butyric acid injection. *Acta Horticulturae*, 226: 379-388.
14. El-Henawy, S., 2009. The basics of planting palm seedlings. [www.google.com](http://www.google.com)
15. Bhatt, B.B. and K.K. Tomar, 2010. Effects of IBA on rooting performance of *Citrus aurantifolia* swingle (Kagzi-Lime) in different growing conditions. *Nature and Science*, 8(7): 8-11.
16. Chandy, K.T., 2013. Date Palm, booklet No. 464. [www.google.com](http://www.google.com)
17. Rizk, S.A.Y., 2006. Some factors affecting on rooting ability of Sewy date palm off-shoots in Sewa Oasis, Egypt, 2-Effect of offshoot weight and auxin application on rooting % and growth of Sewy date palm. *Minufiya Journal Agric. Res.*, 31(4): 1007-1015.
18. Bakr, E.I., G.M.M. Haseeb, S. E. El-Kosary and M.A.M. Bakir, 2010. Using date palm suckers as material for vegetative propagation by growth regulators injection. *The Bulletin of Faculty of agriculture Cairo University*, 61(1): 63-78.
19. Srivastava, K.K., S. Hamid, B. Das and K.M. Bhatt, 2006. Effects of Indole butyric acid and variety on rooting of leaf less cuttings of Kiwi fruit under zero-energy-humidity-Chamber. *Envis Bulletin*, 14(1): 1-4.
20. El-Hodairi, M.H.A.A., S.B. Ibrahim and M.A. Hamza, 1998. Interaction effects of the sequential applications of some growth regulators on the growth of date palm trees (*Phoenix dactylifera* L.). *The First International Conference on Date Palms*, Al-Ain, United Arab Emirates March, pp: 8-10.
21. Sun, W.Q. and N.L. Bassuk, 1991. Effects of banding and IBA on rooting and bud break in cuttings of apple rootstock MM 106 and *Franklinia*. *Journal of Environ. Hort.*, 9(1): 40-43.
22. Gaspar, T., C. Kevers and J.F. Hausman, 1997. Indissociable chief factors in the inductive phase of adventitious rooting. *Biology of Root Formation and Development Basic Life Science*, 65: 55-63.
23. Al-Jabary, K.A.M.A., 2010. Effect of IBA injection and different concentrations of fertilizer NPK on root and shoot characteristics of aerial date palm offshoot (*Phoenix dactylifera* L. cultivar Hillawi). *Basrah Journal of Agricultural Science*, 23(1): 127-141.
24. Al-Samaraec, S.M.S., 2010. Influence of cutting type, IBA concentrations on rooting ability of cutting of *Lawsonia inermis* L. *Basrah Journal of Agricultural Science*, 23(1): 95-107.
25. Zebari, S.M.K.A., 2011. Effect of auxin (IBA) on rooting and seedlings growth of six fig cultivars (*Ficus carica* L.). *Journal of Tikrit University for Agriculture Science*, 11(1): 119-125.