

# Impact of Different Layering Times and Polybag Colors on Root and Shoot Development of Aerial Offshoots for Barhi Date Palm (*Phoenix dactylifera*. L) Cultivar

Muawya Alasasfa

Department of Plant Production, Faculty of Agriculture, Mutah University, Jordan

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**Abstract** This study aimed to evaluate the effect of different colors of polybags and layering time on potential root and shoot development, since the lack of root initiation and slow leaves growth are considered as the main problems for aerial offshoots handling in date palm. The study was conducted at Ghour Al-Safi, in Jordan valley on Barhi date palm cultivar at mid-October Of 2019 to mid-October of 2021. Treatments including three layering periods (mid-October to mid-April, mid-February to mid-August, and mid-April to mid-October) and four different polyethylene bag colors (white, black, blue, brown) and transparent one (as control) were applied on aerial offshoots. Some shoot and root parameters were studied to determine the best layering time and polybag color that could increase the survival rate of aerial date palm offshoots. Root and shoot parameters were preference under blue polybag and layering time that extended from mid-October to mid-April than other treatments. Offshoots under the transparent polybag gave the lowest parameters and reflected poor rooting ability. Although polybag color played a significant role in the root ability for aerial offshoots compared with control, the root and shoot parameters data looked relatively similar between other colors. Layering period could also increase the quantity of new fronds and productive roots.

**Keywords** Date Palm, Air Layering, Aerial Offshoots, Polybag Color, Rooting, Barhi

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## 1. Introduction

The most dominant propagation method for date palm (*Phoenix dactylifera* L.) in arid and semi-arid regions is offshoots [1, 2, 3]. This propagation method is preferred for the most farmers because what it gives are identical to parent plants and is considered as a cheapest method [4, 5].

Offshoots are developing from the vegetative buds over the ground surface, and every date palm plant could produce 15-20 offshoots during their first 5-7 years old depending on the variety and climatic conditions. Generally, offshoots could be divided for two types: ground and aerial [1, 2, 3]. Of the total, 60–65% of date palm offshoots are at ground level, while the remaining are aerial [6]. Although, the offshoots are the preferred method, it has disappointing results; Poor or no root initiation is considered as one of the most serious problems, so that, each offshoots needs an excellent growth and development for both root and leaves [3,7, 8,9].

Alasasfa [10] noticed that the offshoot rooting is cultivar dependent and the high quality ones are difficult to root. In addition, the offshoots of commercial cultivars have always been difficult to cultivate and have a low survival rate. The demand on good quality variety has been tremendously increasing in the recent years, and the availability of a variety in huge number that has high quality is critical

because of high mortality of the date palm offshoots after planting in the field [1, 2, 3,10]. Several gardeners have reported survival rates from 10% to 90%, while survival rate of 50% to 80% is ideal.

Aerial offshoots are usually neglected by the farmers as they have a smaller number of roots as compared to ground offshoots but these offshoots can be planted after development of roots [11, 12]. Aerial offshoots could be planted after development of roots by different root promoting substances that can enhance rooting like hormone [13]. The Indole Butyric Acid (IBA) and naphthalene acetic acid (NAA) are in the rooting of date palm [2, 14]. Although Al-khateeb [9] reported that 75 g/offshoot and 100 g/offshoot concentrations of isoprothiolane seemed to improve the rooting of the date palm offshoot, many hormones have been shown to induce root initiation in various plant species [2,15, 16]. Several authors found that the supply of nitrogen into offshoots strongly influenced root initiation, with low or medium supply leading to the highest root initiation [17, 18].

In recent years, there has been a surge in the demand for offshoots of date palm, and in order to avoid the use of high priced hormones, and to go to organic farming, the researchers have to search for alternatives, which contribute encouraging roots formation in the aerial offshoots. Researchers and farmers tend to modify the potting material with different propagation media and structures to increase the growth and survival of date palm offshoots. One of the main affecting factors on root growth is the heat units that accumulated in the pot, so temperature in the root zone is critical for best root growth. Container pots are prone to heat stress, which is a major issue especially in areas with high air temperatures. According to Johnson [19], root growth significantly decreases when temperatures exceed 30 °C. Moreover, for several woody plants, root growth ceases entirely when temperatures go beyond 39 °C, as reported by Mathers [20].

The roots of some woody plants will die, if they are exposed to temperatures of 51°C for thirty minutes [21]. In their research conducted in Wong study [22], who examined the impact of elevated soil temperatures, on five different woody plant species; their findings revealed that among these species, peach roots exhibited the lowest tolerance towards high soil temperatures.

In 1969, the first practice of layering offshoots in polybags was introduced in Ivory Coast as a replacement for traditional field nurseries. This technique proved to be effective in producing healthy and robust roots [23]. When it comes to citrus plants, the use of polybags promotes the natural development of the root system, resulting in better growth after transplantation in the field. Additionally, polybags provide trees with increased resistance against strong winds and protection against drought [24]. Compared to bare root shoots, grown offshoots in polybags exhibit longer root lengths and have a higher survival rate under drought conditions [25], furthermore, the color of the

polybag or container can affect heat absorption. Markham [26] conducted a study on the effects of polybag color on soil temperatures, root development, and plant growth in various tree species. The study found that white containers were cooler than black containers, resulting in greater plant height and growth caliper in all studied species [26].

This study aimed to study and evaluate the effect of different colors of polybags and layering time on potential root and shoot development to determine which aspects might be critical in their successful establishment.

## 2. Materials and Methods

### 2.1. The Experiment Site

The study was conducted at a special farm with Barhi date palm cultivar established in 2005 at Ghour Al-Safi / Jordan valley, which belongs to karak governorate in Jordan.

### 2.2. The Biological Material and Experimentally Variants

All mother plants are fourteen years old. The experiment was done in mid-October of 2019 to mid-October of 2021. All the chosen offshoots were aerial ones, same age and health status with three years old with approximately weight 14 - 20 kg. Three layering periods were repeated for two seasons; firstly (15.10.2019 to 15.04.2020, 15.02.2020 to 15.08.2020 and 15.04.2020 to 15.10.2020) secondly (15.10.2020 to 15.04.2021, 15.02.2021 to 15.08.2021 and 15.04.2021 to 15.10.2021) with four different polybag colors (white, black, blue, brown) and transparent one (as control) were chosen for each layering time. In order to control the layering period of the offshoots, the selected offshoots were prepared before one year from the date of layering. In each layering period, three offshoots were chosen for each polybag color, so there were 15 offshoots for each layering period and 45 offshoots for each season. Each aerial branch was wrapped using a different polybag color. The polyethylene bag was then securely secured at the top after the polybag had been wrapped around the base of each aerial offshoot, tied at the bottom, and filled evenly with 3:1 perlite and peat moss.

### 2.3. The Parameters

At the end of each mentioned layering period time, the aerial offshoots were separated from the mother plant and the following parameters for root and shoot were recorded.

#### 2.3.1. Root Parameters

Ten roots for each aerial offshoots were randomly chosen to record: average root length (cm), main root numbers and average root diameter (cm).

### 2.3.2. Shoot Parameters

Ten leaves were randomly chosen to get the differences in the offshoots parameter (average leaf length (cm), number of newly leaves emerged and trunk diameter (cm) at beginning and end of each layering time.

## 2.4. Statistical Analysis

The average of the two seasons was observed and analyzed using Statistical Polynomial Statistics (SPSS) software. An analysis of variance (ANOVA) was conducted and parameter means were divided according to an LSD test with a sensitivity of 5%. The experimental design used was a factorial completely randomized block design (CRBD).

## 3. Results

### 3.1. Effect of Polybag Color

#### 3.1.1. Root Parameters

There were significant differences between control and other colors in the root length (Table 1). The maximum root length, main root number and root diameter (14.24 cm, 5 and 0.65, respectively) were recorded with the blue bags, which were not significant with all colors except with control. The minimum root length, root number and root diameter (1.85cm, 1.04 and 0.13cm) were recorded with

control (transparent one). This indicates the superiority of other colors in the root characteristics from the transparent one (Table 1).

#### 3.1.2. Shoot Parameters

Date presented in Table 1 show that the maximum average leaf length of an offshoot (92.61 cm) was recorded with blue polybag, while the other colors (white, black and brown; 88.29cm, 83.95 cm and 79.41cm, respectively) gave no significant differences with control, (69.36 cm). The maximum number of newly leaves per offshoot and the offshoots diameter (1.52 and 7.17cm, respectively), were recorded with the blue polybag color, which was on par with all colors and control one.

### 3.2. Effect of Layering Time

#### 3.2.1. Root Parameters

The highest root length, root number and root diameter of an aerial offshoot (11.58 cm, 4.26 and 0.54 cm, respectively) were recorded with layering time that extended from mid-October to mid-April. This layering time has significant differences with period that extended from mid-February to mid- August related to root length and root number (9.81 cm, 3.26, respectively), but it was on par with layering time that extended from mid-April to mid-October as showed in Table 2. While root diameter was not significantly affected by the different layering time (Table 2).

**Table 1.** Effect of different polybag colors on some root and shoot parameters of aerial Barhi date palm offshoots

Polybag color	Average root length (cm)	Main root numbers	Average root diameter (cm)	Average leaf length (cm)	Number of new leaf	Offshoots diameter (cm)
Control	1.85 b	1.04 b	0.13 b	69.36 b	0.62 a	5.18 a
White	12.80 a	4.42 ab	0.60 a	88.29 ab	1.39 a	6.86 a
Black	12.33 a	4.39 ab	0.55 ab	83.95 ab	1.14 a	6.20 a
Blue	14.24 a	5.00 a	0.65 a	92.61 a	1.52 a	7.17 a
Brown	11.98 a	3.21 ab	0.54 ab	79.41 ab	1.30 a	6.65 a

\* The values in the same column with different letters differ significantly at LSD's level 0.05.

**Table 2.** Effect of different layering time on some root and shoot parameters of aerial Barhi date palm offshoots

Layering time	Average root length (cm)	Main root number	Average root diameter (cm)	Average leaf length (cm)	Number of new leaf	Offshoots diameter (cm)
Mid-October – Mid-April	11.58 a	4.26 a	0.54 a	87.35 a	1.44 a	7.19 a
Mid-February – Mid-August	9.81 b	3.26 b	0.46 a	78.33 b	0.94 b	5.53 b
Mid-April – Mid-October	10.52 ab	3.31 ab	0.48 a	82.49 a	1.25 a	6.52 a

\* The values in the same column with different letters differ significantly at LSD's level 0.05.

### 3.2.2. Shoot Parameter

Table 2 shows that the maximum leaf length, number of new leaf and offshoot diameter (87.35 cm, 1.44 and 7.19 cm, respectively) were recorded with the layering time that extended from mid-October to mid-April, which was on par with the period that extended from mid-April to mid-October (82.49 cm, 1.25 and 6.52 cm, respectively). The minimum leaf length, number of new leaf and offshoots diameter (78.33 cm, 0.94 and 5.53 cm, respectively) were recorded with the period that extended from mid-February to mid-August, and they were significant differences among the layering times (Table 2).

#### C. Correlation among and between the treatments:

The results indicated that there was no correlation between the polybag color and layering time, while there was a significant positive correlation between the polybag color and root length, but for the other root and shoot parameters, there was a positive correlation, but it was not significant as shown in Table 3.

In addition, Table 3 shows that there is a positive but non-significant correlation between layering and root parameters, but there is a negative, non-significant correlation between layering and others shoot parameters.

## 4. Discussion

In the present study different polybag colors have been tried in three different layering times, and the rooting capacity has been correlated with of exogenous promoter like polybag color and the layering time. The blue polybag was found to be considerably superior in practically all of the root and shoot characteristics examined in the experiment, according to the results (Tables 1 and 2). This

outcome may be the consequence of variations in humidity, temperature, illumination, and sun exposure within the blue polybags, which would improve the roots of aerial offshoots. Moreover, blue bags reflect high-energy waves and absorb colors from the entire spectrum.

The prior outcomes make it evident that the aerial offshoots that are treated with different polybag colors have given higher values in most characters than the transparent one. However, these results are in agreement with results of [13, 27, 28], who found that the incubated aerial offshoots had encouraged the rooting. This observation is consistent with the research of [13, 27, 28], which demonstrates that, in contrast to the transparent polybag; the blue polybag causes cellular division and the accumulation of natural auxins, carbohydrates, and other substance. This may result in an increase in transpiration rate as well as ethylene synthesis, which plays a significant role in the stimulation and formation of emergent roots.

These findings also corroborate those of Alam [29], who established that the three olive tree cultivars' root numbers, lengths, and diameters increased because of the layering period, explaining the interval following harvest, during which there were no fruit bunches, may have contributed to the layering time's beneficial effects on enhancing and elevating the aforementioned characteristics. Additionally, these results concur with those of Zirari [12], who showed that auxin significantly accumulated in the incubated area following fruit harvesting, which promotes root growth. They also verified that when treated with varying layering durations, there was an increase in the quantity of new fronds and productive roots. Mathers [20] observed that heat-induced injury to early roots results in decreased calcium absorption and damaged new root development; since calcium is necessary for cell elongation and division, it plays a crucial role in the production of new roots.

**Table 3.** Correlation among different polybag colors and layering time on some root and shoot parameters of aerial Barhi date palm offshoots

	Polybag color	Layering Time	Average root length	Main root number	Average root diameter	Number of new leaf	Average leaf length	Offshoots diameter
<b>Polybag color</b>	1	.000	0.524*	0.321	0.455	0.378	0.170	0.361
<b>Layering time</b>		1	0.049	0.010	0.037	-0.187	-0.130	-0.317
<b>Average root length</b>			1	0.955**	0.988**	0.826**	0.851**	0.798**
<b>Main root number</b>				1	0.955**	0.844**	0.897**	0.830**
<b>Average root diameter</b>					1	0.839**	0.885**	0.821**
<b>Number of new leaf</b>						1	0.918**	0.958**
<b>Average leaf length</b>							1	0.901**
<b>Offshoots diameter</b>								1

\* Correlation is significant at the 0.05 level.

\*\*Correlation is significant at the 0.01 level.

## 5. Conclusions

The layering times of the offshoots had very positive results when compared among each other. The number of leaves, velocity of rooting, and length of the roots all increase with the offshoots' roots and vegetative development. The findings also imply that layering times result in more roots, both in terms of quantity and length, as well as more new leaves. In addition, because the number of research presented on the layering time is very few regarding for date palm in Jordan Valley. A future study should be done to determine the reason why the layering period that extended from mid-October to mid-April is superior over the rest layering periods. It could be through its relationship with the internal and external temperature of the medium in that period, also the amount of hormones that related to encouraging the formation of roots.

## Conflict of Interest

The author reports that no conflicts of interest.

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