Studies on the Establishment of Date Palm (*Phoenix dactylifera* 'Deglet Noor') Offshoots. Part II. Size of Offshoot

DONALD R. HODEL
University of California, Cooperative Extension
4800 E. Cesar Chavez Ave.
Los Angeles, California 90022 USA
drhodel@ucdavis.edu

AND

DENNIS R. PITTENGER
University of California, Cooperative Extension
Botany and Plant Sciences
Riverside, CA 92521-0125 USA

Date palm offshoots 10 to 35 cm in diameter have the highest survival rates. Offshoots this size probably have more roots when initially removed from the mother palm, more stored carbohydrates to provide energy for root growth and increased levels of naturally-occurring, root-promoting substances.

This article is the second of two exploring establishment of date palm offshoots. Part I (Hodel & Pittenger 2003) had an introduction discussing the background and importance of the date palm industry and the critical practice of propagating date palms from offshoots.

Date palm cultivars are clones that must be propagated vegetatively, nearly always relying on offshoots (young plants) that arise from the base of the mother palm. Researchers have reported many factors responsible for the success or failure of date palm offshoots to establish and survive (Hodel & Pittenger 2003). Size was frequently mentioned as an important factor; the literature generally stated that rooting is low in small offshoots and rises with increasing offshoot size to a point above which there is no additional advantage. The objective of our work was to determine the optimal offshoot size (diameter) for best establishment.

Previous Work

There is no research-based information correlating offshoot diameter with establishment and survival. The information that does exist is anecdotal. Albert (1926), Albert and Hilgeman (1935), Bader and Al-Yasiry (1986), Dowson (1982), Drummond (1919), Nixon and Carpenter (1978), Reuveni et al. (1972), Toutain (1966) and Zaid (1999) reported that offshoots of a wide range of sizes, weights, and ages will root and establish successfully. Reported sizes ranged from about 13 to 41 cm in base diameter, weights from about 2

1. Newly planted date palm offshoots used for this study, February, 1998, Indio, California.

to 41 kg, and ages from 3 to 12 years. Optimal ranges reported also varied greatly but were about 20–36 cm in diameter, 10–30 kg, and three to five years of age (Table1). Growers in California usually select offshoots 10–45 cm in diameter at the widest point.

Researchers typically focused on offshoot weight rather than base diameter, but weight has major disadvantages. It is nearly impossible to weigh an offshoot still attached to the mother palm, and weights do not necessarily reflect the water content of the offshoot or how many leaves and leaf bases were removed prior to weighing. Measuring the diameter of the offshoot base is less problematic but can still vary depending on whether the measurement was taken at the widest point or elsewhere. The widest point of the offshoot base when attached to the mother palm is usually concealed below the soil, further complicating diameter measurements. Albert (1926), Drummond (1919), and Zaid (1999) have attempted to correlate diameter of the base at the widest point with weight after leaf removal (Table 2).

Materials and methods

A commercial date grower in Indio, California permitted us to use a field that was newly planted in February, 1998 with 500 offshoots of *Phoenix dactylifera* 'Deglet Noor.' Workers had planted offshoots about three meters apart in rows about five meters apart in the field in full sun the same day that they were removed from the mother palm (Fig. 1). They placed the offshoots so that the roots were 20 to 45 cm below the soil surface, backfilled with the unamended soil removed when making the planting hole, and flood irrigated the field thoroughly. Field soil at the site was a fine sandy loam, and regular irrigations maintained it near field capacity during establishment.

Using a completely randomized experimental design, we collected data along five transects encompassing 117 offshoots, two diagonals from the four corners of the rectangular field and three randomly selected rows running the length of the field. We recorded diameter at the soil surface, height from the soil surface to the tip or highest point of the newest emerging leaf (leaf extension) (Fig. 2), and survival for each offshoot in the transect immediately after planting and every six months thereafter for two years. Successful offshoot establishment is dependent on new root growth (Hodel & Pittenger 2003); thus, we selected offshoot leaf extension and an increase in stem (offshoot) diameter because they are indicative of root growth (Hodel & Pittenger 2003; Tomlinson, 1990).

Data were subjected to ANOVA and mean separations using Fischer's Protected LSD Test. Offshoot diameters we measured and recorded are about 5–10 cm less than the actual widest diameter of the offshoot because, whether planted in the field or still attached to the mother palm, the widest point of an offshoot is below the soil surface. Because the offshoots varied greatly in initial height, we report the percent increase in leaf extension rather than the simple numerical increase.

Results

Offshoots 10–25 cm in diameter had significantly greater increases in diameter than those 25 cm or larger in diameter, and offshoots less than 20 cm in diameter had significantly greater increases in leaf extension than those 30 cm or larger in diameter (Table 3). Clearly, the larger the offshoot diameter the smaller the percent increase in leaf extension (Table 3). Although more than half the offshoots survived across all the size categories, those 10–35 cm in diameter had survival rates of 83 to 95 percent while those 35 cm or larger in diameter had a survival rate of only 74 percent (Table 3).

Discussion

Our findings show that date palm offshoots with initial base diameters at the soil surface from 10 to 25 cm had the greatest increases in leaf growth and base diameter and high survival rates (>83%). However, offshoots with initial base diameters from 25 to 35 cm had equally high survival rates but had smaller increases in leaf growth and base diameter, suggesting that they establish more slowly than the smaller offshoots. Only offshoots with initial base diameters greater than 35 cm showed lower survival rates (74%). These findings generally agree with accounts in the literature (Albert 1926, Albert & Hilgeman 1935, Bader & Al-Yasiry 1986, Dowson 1982, Drummond 1919, Nixon & Carpenter 1978, Reuveni et al. 1972, Toutain 1966, Zaid 1999).

Several related factors are probably responsible for better establishment and survival of date palm offshoots with base diameters from 10 to 35 cm, rather than smaller diameters. Reuveni et al. (1972) reported that carbohydrates stored in the offshoot, which provide the energy for root growth, and unnamed, naturally occurring, root-promoting and root-inhibiting substances, which control the initiation of root growth, are critical factors. Generally as offshoots increase in size they contain increased amounts of carbohydrates and root promoters and decreased amounts of root inhibitors. Later, Reuveni and Adato (1974) concluded that it was the root inhibitors rather than the root promoters that are primarily responsible in initiating root growth. Rooting ability is positively correlated with carbohydrate content and negatively correlated with root inhibitor content. The larger the offshoot is the greater the carbohydrate content and the smaller the content of root-inhibiting substances.

2 . Same date palm offshoots pictured in Figure 1 but two years later in February, 2000, Indio, California.

More recently, Al-Mana et al. (1996) concluded that naturally occurring rooting co-factors (substances) are probably responsible for initiation of offshoot root growth. These co-factors, thought to be phenolic compounds, may encourage rooting by protecting root-promoting hormones or auxins, like indoleacetic acid (IAA), from destruction by oxidizing enzymes. In the case of IAA the enzyme is IAA-oxidase.

Work with several auxins has tended to support the position that rooting co-factors or substances play a critical role in initiating date palm offshoot rooting. Bader and Al-Yasiry (1986), Gupta and Godara (1984) and Reuveni et al. (1972) reported that applications of indolebutyric acid (IBA) increased rooting of date palm offshoots. In contrast Reuveni et al. (1972) reported that napthaleneacetic acid (NAA), gibberellic acid (GA),

Table 1. Absolute and optimal ranges of size (base diameter at widest point), weight (after leaf removal), and age of offshoots for successful rooting and establishment as reported in the literature (Albert 1926, Albert & Hilgeman 1935, Bader & Al-Yasiry 1986, Dowson 1982, Drummond 1919, Nixon & Carpenter 1978, Reuveni et al. 1972, Toutain1966, Zaid 1999).

	Diameter (cm)	Weight (kg)	Age (years)
Absolute range	13–41	2–41	3–12
Optimal range	20–36	10–30	3–5

Table 2. Offshoot base diameter correlated with weight as reported in the literature.

Diameter (cm)	12–15	15–20	20–25	25–35
Weight (kg)	4.5–6.8	6.8–13.6	13.6–22.7	22.7–40.8

Table 3. Mean increase in base diameter, mean percent increase in leaf extension, and percent survival of date palm offshoots in six size classes, Indio, California, 1998-2000.

Initial Base Diameter (cm)[z]	Mean Increase Base Diameter (cm)[z,y]	Mean Percent Increase Leaf Extension[y,x]	Percent Survival (No. Survived/ No. Measured)
10–15	5.3 a	178 a	95 (35/37)
15–20	5.4 a	157 a	92 (12/13)
20–25	5.2 a	142 ab	83 (15/18)
25–30	0.3 b	123 ab	92 (12/13)
30–35	1.3 b	121 b	92 (12/13)
>35	0.8 b	76 c	74 (17/23)
LSD, $P = 0.05$	2.7	38	
Summary of ANOVA[w]	***	***	

[z] At soil surface; actual base diameters are 5 to 10 cm greater; see explanation in text.

[y] Means followed by the same letter are not significantly different; P = 0.05; completely randomized design.

[x] Calculated as: (overall height change/initial height) × 100.

[w] *** = significant at $P \leq 0.001$.

and several other compounds did not increase rooting. However, Al-Mana et al. (1996) reported that NAA did increase rooting of date palm offshoots.

The factors responsible for decreased survival of the largest offshoots are not as clear. Perhaps their larger size creates a lower root-to-shoot ratio, which makes them more susceptible to desiccation prior to sufficient new root growth, or perhaps other growth-inhibiting substances are produced in larger quantities

Conclusions

Offshoots with base diameters of 10 to 35 cm at the soil line when still attached to the mother palm are at their optimal size for removal and replanting. Offshoots this size probably have more roots when initially removed from the mother tree, a critical factor because over two-thirds of all new roots on an offshoot arise from preexisting roots cut and severed during removal (Hodel & Pittenger 2003). Also, offshoots this size have more stored carbohydrates to provide energy for root growth and increased levels of naturally-occurring, root-promoting substances. Offshoots smaller than 10 cm diameter likely have fewer existing roots, smaller amounts of stored carbohydrates, and smaller levels of root-promoting substances. While offshoots larger than 35 cm diameter may have more roots and higher levels of carbohydrates and root-promoting substances, their large size and

heavy weight make removal, handling, and planting more difficult and problematic. Future work might investigate the causes of lower leaf and root growth and survival rates with these larger offshoots. Perhaps it is simply their lower root mass to shoot ratio that is responsible for the reduced growth and survival.

Acknowledgments

We gratefully acknowledge Duane Young of W.D. Young and Sons, Indio, California for providing access to a date grove to conduct our study.

LITERATURE CITED

ALBERT, D.W. 1926. Propagation of date palms from offshoots. Univ. Ariz. Agric. Exp. Sta. Bull. 119. Tucson.

ALBERT, D.W. AND R.H. HILGEMAN. 1935. Date growing in Arizona. Univ. Ariz. Agric. Exp. Sta. Bull. 149. Tucson.

AL-MANA, F.A., M.A. EL-HAMADY, M.A. BACHA AND A.O. ABDELRAHMAN. 1996. Improving root development on ground and aerial roots of date palm offshoots. Principes 40: 179–181, 217–219.

BADER, S.M. AND A.M. AL-YASIRY. 1986. Rooting promotion of date palm (Zahidi cv.) using IBA auxin. Proc. Agric. Res., Fourth Sci. Conf. 1(pt. 2): 1301–1308. Baghdad.

DOWSON, V.H.W. 1982. Date production and protection. United Nations FAO Plant Production and Protection Paper 35. Rome.

DRUMMOND, B. 1919. Propagation and culture of the date palm. USDA Farmer's Bull. 106. Washington, D.C.

GUPTA, O.P. AND N.R. GODARA. 1984. Rooting in aerial suckers of date palm. Haryana Agric. Univ. J. Res. 14: 82–84.

HODEL, D.R. AND D.R. PITTENGER. 2003. Studies on the establishement of date palm (*Phoenix dactylifera* L. 'Deglet Noor') offshoots. Part 1. Observations on root development and leaf growth. Palms 47: 191–200.

NIXON, R.W. AND J.B. CARPENTER. 1978. Growing dates in the United States. USDA Inform. Bull. 207. Washington, D.C.

REUVENI, O., Y. ADATO AND H. LILIEN-KIPNIS. 1972. A study of new and rapid methods for the vegetative propagation of date palms. Proc. Forty-ninth Ann. Date Growers Inst.: 17–23. Indio, CA.

REUVENI, O. AND I. ADATO. 1974. Endogenous carbohydrates, root promoters, and root inhibitors in easy- and difficult-to-root date palm (*Phoenix dactylifera* L.) offshoots. J. Amer. Soc. Hort. Sci. 99(4): 361–363.

TOMLINSON, P.B. 1990. The Structural Biology of Palms. Oxford University Press, New York.

TOUTAIN, G. 1966. Note sur la vegetative des rejets de palmier dattier. Al Awania 20: 125–130.

ZAID, A. (ed.). 1999. Date palm cultivation. United Nations FAO Plant Production and Protection Paper. 156. Rome.

CLASSIFIED