Species

Shortening the reproductive age of baobab tree (*Adansonia digitata* L.) by air–layering

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ABSTRACT

This research aims to shortening the reproductive age of Baobab tree (*Adansonia digitata* L.) by developing air–layering propagation method/s. The study was conducted around El Obeid, Sheikan locality, North Kordofan State during the period of 2017/2018. 1.5 – 2m long branches were selected from 30 elite trees. The treatments were 2 girdling types x 2 layering position x 3 branch size. These were arranged in factorial experiment (CRD). The success rate of rooting was extremely high, with 58 out of 60 branches (97.7%) showing signs of rooting by the end of 16 weeks. The results of study found that half (50%) of branches layered at mid position with size between 21 – 30 cm were success and rooting 50% and number of leaves/branches were measured in each layered branch. No significant differences were found between air layering type and position and branches size in the all-field experiments. In the field it appears that all branch position shows the best short 62 average rooting days in 21 - 30 cm branch size while at nursery stage successful layering branches showed shorter leafing days range between 20 to 25 days on average. Air layering methods should be used in order to recover natural populations, when seeds are not available or are available in reduced amount and the best season for baobab air layering was late winter in low-lying, hotter climates.

Keywords: Baobab, Reproductive, Air Layering, Kordofan, Propagation

1. INTRODUCTION

Baobab (*Adansonia digitata* L.) belongs to Malvaceae family, is one of the most widely used indigenous priority tree species in sub-Saharan Africa, valued in the cosmetic industry for its seed oil and powdery fruit pulp for juice making (APG, 2009; Kamatou et al., 2011). *A. digitata* is a deciduous tree, usually not more than 20m tall, with a hugely swollen trunk of 3 - 10 m (up to 28 m on very old individuals) in diameter. It is one of the longest living trees in the world (3000 years). Bark is smooth, folded, reddish-brown or grayish brown. Primary branches are stout. Leaves are compound with 3-9 leaf - lets, each 5 - 15cm long. Flowers are large, white and solitary in leaf axils (Wickens, 1982; Bosch et al., 2004; Sacande et al., 2006). The trees typically begin to flower when they are 8 to 23 years old (El Amin, 1990; Bosch et al., 2004; Sacande et al., 2006). *A. digitatais* is widespread throughout the hot, drier regions of tropical Africa. In Sudan, the

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baobab is most frequently found on sandy soils and by seasonal streams 'khors' in short grass savannas. It forms belts in Central Sudan, in Kordofan, Darfur, Blue Nile, Upper Nile and Bahr el Ghazal (EL Amin, 1990). It is often found associated with the tamarind (*Tamarindus indica* L.) (Purseglove, 1982; Gebauer et al., 2002). Bush burning in the dry season, grazing and seed diseases limit the number of trees. Unfortunately, the population is declining and there is very low regeneration in its natural environment probably because of poor seed germination in some places and livestock, which readily eats the young trees. Under good conditions, rapid growth in diameter and height is possible, reaching 2 m in two years and up to 15 m in twelve years (FAO, 1988).

Reproductive age is the age at which the tree produces its first fruit crop (Schmidt, 1993). The capacity of trees to be propagated vegetative is similar to herbaceous plants, however, their greater size and complexity at maturity results in loss in rooting ability (Zimmerman, 1976). Air layering is a simple way of propagating fruit tree seedlings. Schmidt, (1993) defined it as the procedure to develop roots on undetached aerial parts of a plant by girdling or wounding the area where roots are desired and surrounding the area with rooting medium section of the trunk of a tree to create another tree. Air-layering is the stimulation of rooting on intact stems, by girdling a ring of the bark from around the part where roots should form and enclosing it in a moist rooting media (Leakey, 1985). In some species rooting occurs in 3 months or less while in others it may take two seasons (Creech, 1954).

Baobab tree can be propagated by seeds and vegetative as well. Conventional techniques such as cuttings, air layering and grafting are applicable to the species and are economically less costly but success rates are low. The success rate of cuttings does not exceed 30% in presence of IBA and is equivalent to 2% in absence of hormone (Assogbadjo et al., 2009). Moreover, the capacity for vegetative propagation in trees varies greatly between species and genotypes. These are affected by environment, physiological and anatomical state of the tree (Mkonda et al., 2003). N'doye et al., (2012) reported that study on chloroplast DNA shown that there are genetic differences between baobab populations from western and south-eastern Africa. The present study is aims to identify the success of air layering of big size diameter branches (10 – 50 cm) of *Adansonia digitata* and the optimum combination of season, layering position and branches size on effective rooting.

2. MATERIALS AND METHODS

Study Area

North Kordofan State lies between latitudes 16°38"N and 12°14"N and longitudes 26°46"E and 32°22"E. The state total area is 185,302 km² at an altitude of 1,500 feet, divided into eight Localities: Sheikan, Um Rowaba, Bara, West Bara, Um Dam Haj Ahmed, Um Kraidim, Sodari and Gabrat El Sheikh. Sheikan locality is composed of four districts. These are Kazgail, Abu Haraz, Khor Tagget and Umashira, in addition is a non- demarcated rural council for nomads, which represents the nomadic people who move within the previously mentioned demarcated rural council. Sheikan locality located in the central part of Kordofan region. Elobeid city is the capital of North Kordofan State and the centre of the area councils. Where, the biggest crop market for gum Arabic commodity in the world is located.

Vegetation in the state is found in low rainfall woodland savannah zone. The latitude 13º N is divided the state into two parts, the desert area with annual rainfall 60 mm in north and semi desert with annual rainfall 240 mm that of the south. At the far southern part of the state, the rain fall reaches 440 mm per year. The vegetation classified into zones based on mean annual rainfall or rain belts and soil types. Three vegetation zones covered area including: Desert (0 – 74 mm) characterized by an association of *Acacia tortilis*, *Acacia raddiana* and *Capparis decidua*; semi-desert (74 - 300 mm), vegetations are *Capparis decidua*, *Salvadora persica*, *Ziziphus spina-christi* and low rainfalls (300 – 1000 mm); vegetations are *Acacia senegal*, *Combretum spp*. and *Leptadenia pyrotechnica*. Many types of soils are categorized, sandy soils (goz) with low water holding capacity and poor fertility status constitute more than 70% of the agricultural land, sandy clay soils (gardud), which constitute 20%, clay soils which are characterized with high fertility as Abu habel land and cracking clay soil.

The population of Sheikan locality is about 1,430,000 inhabitants, from which 42.2% are women (Department of Statistic, 2003). The population number in villages varies according to the agricultural calendar and nomadic season. The average family size includes about eight individuals. In the past the family size was considered as a measure of wealth and status, nowadays, due to the prevailing of harsh economic conditions, there is a tendency towards small family size. Migration is common in the area and it is of two types; internal and external (Arab country) with rate of 18% for male and 0.4% for female. Internal migration is represented by casual labour for many agricultural areas of Sudan, which constitutes a source of marginal labour to the main urban centers and inter-rural migration, taking many forms: The regular migration of the nomads, the farmers' movements to area of rich resources and the drought displaced sufferers.

Methodology

Air layering's were initiated at Khor Tagat, about 8 kilometres eastern Elobeid, Sheikan locality, North Kordofan State. Khor Tagat area is located at 13°11´N 30°18´E at altitude 560 m. It received mainly average rainfall in the year about 350 mm. The soil in the area is characterised by sandy loamy types (Gurashi and Kordofani, 2014).

Plant Materials

Survey and primary selection of *Adansonia digitata* trees were started in beginning of November 2017. Local composite was prepared for air layering. Then thirty trees from each location were selected. After that two 1.5 m long branches were selected from each tree.
2 Equipments
Selected tools and equipment include: Iron wire; plastic containers (layering and transplanting); compost (local and CHM or FYM); knives and labels were used to conduct air layering experiment.

Methods

Two methods to enhance accumulation of carbohydrates and photosynthetic the rooting proposed region was done as the following:

Girdling (about 1 to 2 cm were removed around the stem and through the bark and cambium layer according to (Tomar, 2016).
with copper wire.
Layering position
near the base of the branch
at the middle of the branch
Branch size
10 cm < Diameter< 20cm
21 cm < Diameter< 30 cm
Above 302.2.4. Layout

The treatments were arranged as 2x2x3 factorial experiment in Completely Randomized Design (CRD) with three replicates.

Time of Air Layering

The first experiment of air layering begins in 26/11/2017 of late winter in low-lying, hotter climates; air layering can be done from late winter through to spring (February). While the second experiment started in the 17/03/2018 of the time to do air layering is normally the same time as when fruit trees start to grow new leaves (June-July).

Parameters Measured

The following parameters were measured, recorded and calculated including time to first rooting, rooting %, number of leaves/branch and survival rate after transplanting. The air-layers were watered every 21 days (if needed) to maintain the moistness of the media.

Data Analysis

The analyses were carried out using SAS program and Statistix software statistical packages. Survival analysis was used to examine the success rate of rooting over time. Analysis of variance for factorial experiment in CRD will be done for the collected data.

3. RESULTS AND DISCUSSION

Results

Air layering set on *Adansonia digitata* fruit trees well rooting using girdling methods while raping with wire method did not rooting at all in different branches size and positions throughout the experiments. Considering air layering success, the success rate of rooting was extremely high, with 58 out of 60 branches (97.7%) showing signs of rooting by the end of 16 weeks. the study found that half (50%) of branches layered at mid position with size between 21 – 30 cm were success followed by 43.3% of them with branches size above 30 cm. While layering at base position the success was reach 40% in branches size 10 - 20 cm followed by 23.3% in 21 – 30cm size (Table 1).

Table 1 Effects of layering position and branch size on number and % of success branches of *Adansonia digitata* in winter season 2017/2018.

Air layering position	Branch size	Air layering success	
		No.	(%)
At mid position	10 - 20 cm	13	43.3
	21 - 30 cm	15	50
	Above 30 cm	2	0
	Total	30	100
At base position	10 - 20 cm	12	40
	21 - 30 cm	7	23.3
	Above 30 cm	5	16.7
	Total	30	100

Maximum rooting percentages was 50% and 43.3% attained in mid position of air layering branches in size class 21 – 30 cm and size class 10 -20 cm while 40% at base position of size class 10 -20 cm (Table 2). No significant differences were found between air layering type and position and branches size in the all-field experiments. In the field results, it appears that all branch position shows the best 62 short average rooting days in 21 -30 cm branch size, followed 76 and 81 rooting days in 10 – 20 cm and above 30 cm branch size in at base position respectively, while no roots have seen in mid layering position above 30cm branches (Table 2). Moreover, at nursery stage successful layering branches showed shorter leafing days range between 20 to 25 days on average in which above 30cm branch size combined with above 30 cm size was the best for shortest leafing days throughout the experiment.

After growing branches cut and transplanting to nursery in plastic bags survival trees was assess. The study showed that girdling at the base were reach 100% survival rate in rooting in above 30cm branches size class, followed by 96% in base and mid branches position in 10 – 20cm size class (Table 3). Furthermore, leaves were start growing in nursery after transplanting, accordingly survival rate were found high 92% and 90% in 10 – 20 cm and 20 – 30 cm mid and base branches layering position respectively.

Table 2 Effects of air-layer, position and branches sizes on mean rooting and leafing days of *Adansonia digitata* in winter season 2017/2018.

Air-layering types	Position in branch	Branch size classes	No. of trees	Mean rooting days	Leafing days
Girdling	Mid	10 - 20 cm	25	75.97^{A}	25.24^{A}
		21 - 30 cm	22	61.91^{A}	23.64^{A}
		Above 30 cm	9	0	0
		Means	23	68.94	24.44
Girdling	At the base	10 - 20 cm	25	75.97^{A}	25.24^{A}
		21 - 30 cm	22	61.91^{A}	23.64^{A}
		Above 30 cm	9	81^{A}	20^{A}
		Means	14	54.72	22.96

Table 3 Effects of air-layer, position and branches sizes on survival rates % of *Adansonia digitata* in winter season 2017/2018.

Air-layering types	Position in branch	Branch size classes	No. of trees	Rooting Survival rate %	Leafing Survival rate %
Girdling	Mid	10 - 20 cm	25	96	92
		21 - 30 cm	22	77.27	90.91
		Above 30 cm	9	0	0
		Means	23	86.64	91.45
Girdling	At the base	10 - 20 cm	25	96.00	92.00
		21 - 30 cm	22	77.27	90.91
		Above 30 cm	9	100.00	54.55
		Means	14	91.09	79.15

Figure (2) illustrate rooting days of air layering in branches of Baobab trees in the field. It appeared that air layering at mid branches position rooting days was started after 68 days on average in the base branch, while started after 72 days in mid branch on average branches size 18cm on both positions. The study showed that air layering at mid branches position leafing days was started after 29 days on average in the base branch, while started after 30 days in mid branch on average branches size 18cm on both positions (Figure 2).

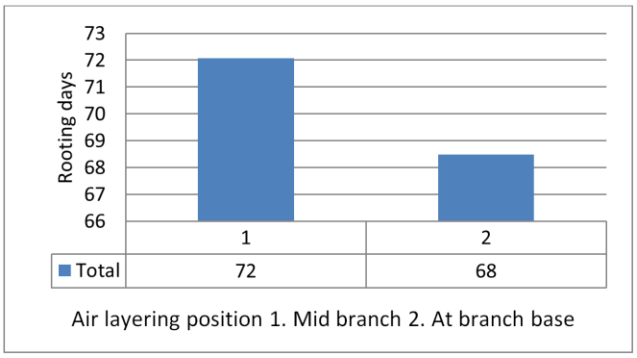

Figure 1 Rooting days in different layering position of Baobab tree.

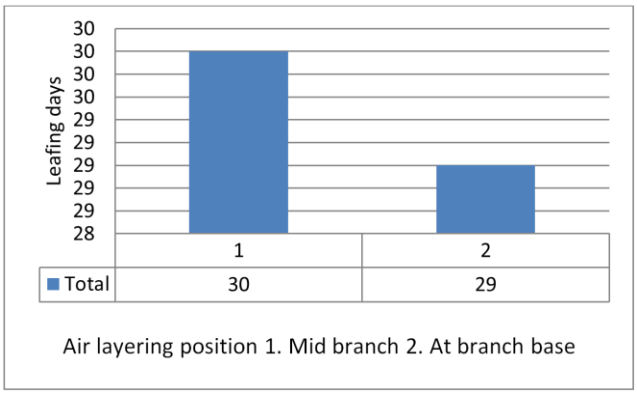

Figure 2 Leafing days in different layering position of Baobab tree.

Discussion

The success rate of rooting was extremely high, with 58 out of 60 branches (97.7%) showing signs of rooting by the end of 16 weeks in the field. This in the line of (Yeo et al., 2011) who studied (94.2%) showing signs of rooting by the end of 20 weeks in endangered species *Fagraea auriculatum Jack* (Gentianaceae). It appears that all branch position shows the best 62 short average rooting days in 21 -30 cm branch size using girdling method of air layering, while at nursery stage layering at mid branches position leafing days was started after 29 days on average in the base branch, while started after 30 days in mid branch on average branches size 18 cm on both positions. Shortening times of rooting, leafing and then fruiting of *Adansonia digitata* trees this well encourage farmers to increase number of productive trees by implementing air layering techniques and furthermore reproduction of high yielding and good quality trees in the future. Also rising awareness towards the importance of tree vegetative propagation between farmers after acknowledges the study findings (Table 1 and 2). (Tomar, 2016) reported the impact of seasonal changes on air layering and rooting hormone in *Spondias pinnata*. (Mwang & Lulandala, 2011) studied air layering and its potential in propagating *Uapaca kirkiana*: A fruit tree from the miombo woodland, Tanzania.

4. CONCLUSION AND RECOMMENDATIONS

The study was concluded that time to first rooting was after 62 days; rooting 50% and number of leaves/branches were measured in each layered branch. The most challenges face baobab air layering is in cutting the big branches and transplanting to nursery stage because they were heavy and need more care. Air layering methods should be used in order to recover natural populations, when seeds are not available or are available in reduced amount and the best season for baobab air layering was late winter in low-lying, hotter climates. Further study is needed specially application of growth hormones.

Ethical approval

Baobab tree (*Adansonia digitata* L.), was observed in the study. The ethical guidelines for plants & plant materials are followed in the study for sample collection & experimentation.

Informed consent

Not applicable.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

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