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Original Article

Rooting of Athel (Tamarix aphylla) stem cuttings in water and Helsin media in a shade house without the use of plant growth regulators

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Abstract

The Athel (Tamarix aphylla) tree is a blessed tree mentioned in the Holy Quran as one of the paradise trees that were given to the Yemeni people and the Sheba kingdom in substitution of much more superior paradise trees. These trees are propagated vegetatively and utilised as windbreaks in desert horticulture farms to protect trees from the hot desert environment. So, the objective of this research was to find the optimum type of stem cuttings for vegetative propagation of Athel trees in two types of media under a shade house (E1 in water medium and E2 in Helsin (gravel) medium) as two separate trials. Both trials included hardwood, semi-hardwood, and softwood cuttings. Numerous root and vegetative parameters were evaluated 60 days after the planting. E1 and E2 trails were conducted independently using a completely randomized design (CRD). In both E1 and E2, hardwood stem cuttings had significantly higher rooting percentages (100% and 81%) over semi-hardwood (81.77% and 70%) and softwood (30% and 60%), respectively. The number of rooted eyes, the number of growing eyes per cutting, and the number of shoots per eye, as well as the length of the roots, varied significantly among E1 cuttings. In addition, the number of mature eyes per cutting, the number of shoots per eye, and the length of the shoots significantly differed among the three types of cutting for E2. This research demonstrated the high superiority of vegetative propagation of Athel cuttings in water medium without the use of plant growth regulators to induce adventitious roots or stimulate vegetative growth.

Key words: Athel, stem cutting, rooting, water medium, Helsin medium.

Introduction

The Athel (Tamarix aphylla) tree is a perennial evergreen tree that grows in different regions of Yemen, whether in valleys, plains, mountains, or deserts. The Athel was mentioned in the Holy Qur'an in the Sheba chapter when God Almighty described the land of Sheba, which is the land of Yemen, Marib, as the land of two paradises, and that the people of Sheba turned away, so the result was that God replaced their two paradises with other two paradises containing groups of trees, including the Athel trees. The God Almighty said, 'But they turned

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away, so We sent upon them the flood of the dam, and We replaced their two gardens with gardens of bitter fruit, tamarisks, and something of sparse lote trees' (Holy Quran, Surat Saba, verse 16). So, it is proved that Yemen is considered a native place of the Athel tree, and it is friendly to the farmers due to its various benefits .The importance of Athel trees refers to their use as windbreaks in some fruit orchards in deserts such as the Ma'rib and Al Jawf deserts, Yemen, and other farms worldwide. They provide protection from hot winds and sand particles, which negatively affect growth, flowers, and fruit production in economic farming. In addition, Athel trees fix and stabilise sand dunes (Mekki and Elmeleigy, 2012). The tree is drought-, heat-, and salt-tolerant. Its wood is resistant to termites and used in structures (Marijcke, 2003). Further, the wood is used in the manufacture of local farming tools, pushcarts, and some decorated items (Orwa *et al.*, 2009) .Many plants and plant parts can grow roots from cuttings when the conditions are right. This is important for the propagation of many woody plants, which can be done using stems, roots, or leaves as cutting sources when the right chemical, mechanical, and/or environmental conditions are met. Some species of woody plants root without using chemical promotion such as IBA, NAA, or IAA. Okunlola (2013) rooted Duranta repens shrub stem cuttings (softwood, semi-hardwood, and hardwood) without using plant hormones and found hardwood cuttings recorded the best results in terms of number of sprouts and roots and root length. He confirmed the superiority of hardwood cuttings, irrespective of their length, compared with softwood cuttings. Other researchers successfully used plant hormones to root stem cuttings.Thus, a lot of woody plants have not been rooted without using plant hormones, such as stem cuttings of jojoba (Simmondsia chinensis) shrubs (Eed and Burgoyne, 2014, 2015, 2019). In this trend, Rashid *et al.*, (2020) concluded that optimal application of IAA enhanced the growth of Tamarix aphylla. Sharma *et al.*, (2017) found that using plant growth regulators (IBA and IAA) gave more than 79% rooting of Tamarix aphylla by using the aeroponics method. They noticed that among the three types of stem cuttings (apical shoot, newly sprouted cuttings, and mature stem cuttings), maximum rooting (90%) was observed on mature stem cuttings. Al Makhmari (2016) used IBA plant hormone at 0, 500, and 1000 ppm at rooting Athel stem cuttings, i.e., softwood, semi-hardwood, and hardwood cuttings, and studied root length and shoot number. He found that 500 ppm concentration gave the best results for all. Malik and Hafeez (2017) found sprouting percentage and height of Tamarix aphylla were maximum in long cuttings over short cuttings in both open air and low polytunnel propagation conditions, but overall, the success rate was much higher under the low polytunnel. Furthermore, propagation in water and Helsin media techniques are beneficial in terms of nutrient solution recirculation, lower input costs per unit,

and ease of use and application by normal farmers.

Therefore, due to the huge benefits of Athel trees, i.e. protection of desert farms, stabilization of soil dunes, and their potential usages as windbreaks, this research was conducted with the objective of determining the best rooting medium and the stem cutting type to get the highest rooting percentage with superior root and vegetative growth from rooted cuttings.

Materials and Methods

The research was carried out in two independent experiments (E1 and E2) at organic Yemen greenhouses in Ma'rib governorate from the end of October to the end of December 2019 for 60 days in order to propagate Athel trees vegetatively by using stem cuttings .

1.Materials

1.1. Plant Materials

The cutting leaves were totally removed before planting. The 50–60 cm-long stem cuttings for the various types of cuttings studied were planted in specific media (E1 and E2) for 60 days, and then different rooting and growth parameters were recorded. They contain three types of stem cuttings, i.e., softwood, semi-hardwood, and hardwood, which were collected from many trees, their ages were nine years .

1.2. Rooting media

Two types of media were used, i.e., normal water medium (E1), which is normally used in plant watering, and Helsin medium (E2) (local gravels, yellowish, 6–8 mm in diameter, 1-2 g in weight).

2. Research Methods

Two separate experiments, E1 and E2, were done at the shade house of the Organic Yemen Corporation in the Jubah district of the Ma'rib Governorate.

2.1. First experiment

Ninety cuttings (softwood, semi-hardwood, and hardwood) with 50cm length, and 15-17mm diameter were planted in water medium in plastic containers (dimensions: 35cm height, 20cm width); each container had 30 cuttings from the three cutting types, the cuttings were placed vertically, and a third of their height was immersed in water. The water was replaced weekly up to the specified level. In the majority of cuttings, new shoots were observed first, and then roots were formed. Rooted cuttings were evaluated for their root and vegetative parameters after 60 days of planting. Then the cuttings were transferred to polyethene bags in a suitable medium to be used later.

2.2.Second experiment

Ninety cuttings (softwood, semi-hardwood, and hardwood) with 50–60 cm length were planted in Helsin medium under plastic tunnel conditions, 30 cuttings per type. Over the course of 2–3 days, depending on the humidity inside the tunnel, mist irrigation was done by hand. The majority of the cuttings formed new shoots. After 60 days, the cuttings were harvested, and their rooting and vegetative parameters were evaluated. Rooted cuttings were then transferred to polythene bags for different uses.

2.2.3. The studied parameters in both experiments included:

Rooting percentage	Number of grown eyes.
Number of rooted eyes.	Number of shoots per eye
Number of roots per eye.	Shoot length (cm).
Number of roots per eye.	----------

3. Statistical Analysis

The experiments were conducted in a one-way experiment with a completely randomized design (C.R.D) with three replicates per experimental unit, 10 cuttings per replicate per treatment. Obtained data on different parameters of rooted Athel cuttings were subjected to statistical analysis according to Gomez and Gomez (1983) and (Sastry, 2007). ANOVA values were obtained with Opstat1 software (O.P Sheron, Programmer, Computer Section, CCS HAU, Hisar, India) and means were separated with least significant difference (LSD) at $P \leq 0.05$.

Results and discussion

First experiment (E1)

The first experiment revealed the success of rooting all three types of Athel stem cuttings (softwood, middle, and hardwood) in water medium (E1) under shade house conditions, as shown in Table 1. and Figure 1. Compared to semi-hardwood stem cuttings (81.77%) and softwood stem cuttings (30.00%), hardwood stem cuttings achieved a rooting ratio of 100 percent, which was significantly higher. The number of rooted eyes was significantly greater on hardwood (11.33) and semi-hardwood (12.66) cuttings than on softwood (5.66) cuttings, whereas the number of roots per eye did not differ significantly among the three cutting types. Semi-hardwood cuttings had longer roots (6.16cm) than softwood cuttings (3.33cm). Hardwood and semi-hardwood cuttings produced more mature eyes and more shoots per eye than softwood cuttings.

Table 1. Rooting of Athel hardwood, semi-hardwood and softwood stem cuttings in water medium.

Cutting type	Rooting %	No of rooted eyes	No of roots/eye	Root length (cm)	No of grown eyes/cutting	No shoots/ eye	Shoot length (cm)
Hardwood	100.00 a (90.00)*	10.00 a	2.33 a	4.83 ab	14.00 a	3.00 a	5.00 a
Semi-hardwood	81.77 b (64.79)*	11.66 a	3.00 a	6.16 a	10.33 a	3.33 a	5.50 a
Softwood	30.00 c (33.14)*	5.66 b	2.66 a	3.33 bc	8.00 ab	2.00 b	4.66 a

***Data inside brackets were transformed by using angular transformation.**

-The values which have similar letters indicate no significant differences among means in the same column.

-Data were illustrated as means, the means were separated using LSD (Fisher's Post-Hoc Test, P≤5%).

- Evaluation was done 60 days after planting the cuttings.

Regarding shoot length, however, no significant effect was observed among the three types of cuttings. These results clearly demonstrate the superiority of hardwood cuttings rooted in water for almost all observed parameters, followed by semi-hardwood cuttings and softwood cuttings, which performed the worst.

In accordance with our previous findings (Eed *et al.*, 2015, 2017, and 2020) and (Eed and Al-Hajj, 2023), this observation holds true for the majority of stem cuttings from woody plants, with hardwood cuttings producing the best rooting results, followed by semi-hardwood cuttings. This is also due to the accumulation of nutrients and carbon sources in the various cells and layers of hardwood cuttings, such as parenchyma, phloem, and cortex, compared to softwood cuttings (Eed *et al.*, 2017; Hartmann, and Loreti 1995; Hacket, 1985; Haissig, 1974).

Fig. 1 Shows rooting of Athel cuttings in water medium after 60 days from planting.

Fig. 1 Shows rooting of Athel cuttings in water medium after 60 days from planting.

Second Experiment (E2)

Rooting of Athel hardwood, semi-hardwood, and softwood stem cuttings in Helsin medium, as shown in Table (2) and Fig. (2). Hardwood cuttings had a substantially higher rooting percentage (81%) than semi-hardwood (70%) and softwood (60.66%) cuttings, and semi-hardwood cuttings were significantly superior to softwood cuttings. This is due to superiority of hardwood cuttings over both semi-hardwood and softwood cuttings, and also superiority of hardwood cuttings against softwood cuttings as it was explained in E1. Despite their statistical differences, the parameters of number of rooted eyes, roots per eye, and root length did not differ substantially among the three types of cuttings. The other examined parameters for all evaluated cuttings varied considerably. On the other hand, the number of grown eyes per cutting of softwood cuttings was significantly greater than the number of grown eyes per cutting of both hardwood (6.66) and semi-hardwood (10.33) cuttings, but there was no significant difference between hardwood and semi-hardwood cuttings in terms of the number of eyes per cutting. The softwood cuttings produced more shoots per eye (2.66 shoots) than hardwood (2.06 shoots) and semi-hardwood (1.86 shoots) cuttings. The length of grown shoots in the three types of cuttings (hardwood: 17.86cm, semi-hardwood: 7.30cm, and softwood: 12.40cm) differed significantly. Generally, there is no constant value regarding increase or decrease of some vegetative parameters in woody plants; in some researches the number of shoots or shoot length of rooted cuttings increase with some plants in some seasons for a specific type of cuttings over the rest cutting types and the same cutting in the other season decrease their values (Eed and Burgoyne, 2019).

Table 2 Rooting of Athel hardwood, semi-hardwood and softwood stem cuttings in Helsin medium

Cutting type	Rooting %	No of rooted eyes	No of roots/eye	Root length (cm)	No of grown eyes/cutting	No shoots/ eye	Shoot length (cm)
Hardwood	81.00 a (9.05)*	11.33 a	1.44 a	8.56 a	6.66 b	2.06 ab	17.86 a
Semi-hardwood	70.00 b (8.48)	12.66 a	1.33 a	5.73 a	10.33 b	1.86 b	7.30 c
Softwood	60.66 c (7.85)	11.33 a	1.66 a	12.53 a	26.00 a	2.66 a	12.40 b

*Data inside brackets were transformed by using square root transformation.

- The values which have similar letters indicate no significant differences among means, in the same column.
- Data were illustrated as means, the means were separated using LSD (Fisher's Post-Hoc Test, P≤5%).
- Evaluation was done 60 days after planting the cuttings.

Fig. 2 Shows rooting and growth of Athel cuttings in Helsin medium after 60 days of planting.

- This superior result was achieved without the use of plant growth regulators, making this procedure simple to implement for any farmer.
- Athel is native to the Yemeni Republic's Ma'rib (Sheba land) governorate. It has become known.
- The potential reasons for water medium's superior rooting percentage compared to Helsin medium include the constant availability of moistened medium, the convenience of monitoring cutting status to prevent adverse effects, and the slightly reduced messiness of water medium, which makes it particularly suitable for interior activities.

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تجذير العقل الساقية لأشجار الأثل (*Tamarix aphylla*) في بيئات الماء والهيلسن في بيت الظل بدون استخدام منظمات النمو النباتية

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المستخلص

شجرة الأثل هي شجرة مباركة ذُكرت في القرآن الكريم كواحدة من أشجار الجنة التي أُعطيت لقوم سبأ في اليمن بعد أن أزال الله جنتيهم وأبدلهم بجنتين أخريين تحويان أشجاراً مختلفة من ضمنها شجرة الأثل. هذه الأشجار تتكاثر خضرياً وتستخدم كمصدات للرياح في البساتين في الظروف الصحراوية؛ لذلك يهدف البحث إلى إكثار الأشجار خضرياً باستخدام العقلة وتحديد أفضل نوع من العقل الساقية للاستخدام في الإكثار الخضري لهذه الأشجار في نوعين من البيئات تحت ظروف بيت الظل (ت 1: بيئة الماء، ت 2: بيئة الهيلسن (بيئة حصوية)) على شكل تجربتين مستقلتين. كلا التجربتين استخدم فيها العقل المتخشبة، النصف متخشبة، الغضة. درست العديد من صفات النمو الجذري والخضري للعقل قيد الدراسة بعد 60 يوما من الزراعة واستخدم في التجربتين التصميم التام العشوائية (C.R.D). أظهرت النتائج أن العقلة الخشبية في كلا التجربتين ت 1 و ت 2 سجلت أعلى نسبة مئوية للتجذير (100%، 80%) مقارنة بالعقل النصف متخشبة (81.77%، 70%) والعقل الغضة (30%، 60%) على الترتيب. عدد العيون المجذرة، عدد العيون النامية / العقلة، عدد النموات / العين، وبالمثل طول الجذور جميعها اختلفت قيمها بشكل معنوي في ت 1، وبالمثل فإن عدد العيون النامية / العقلة، عدد النموات / العين وطول النموات اختلفت قيمها معنوياً في أنواع العقل الثلاث المستخدمة في ت 2. أثبت البحث الكفاءة العالية للإكثار الخضري باستخدام العقلة الساقية في بيئة الماء دون الحاجة لاستخدام منظمات النمو النباتية بغرض استحثاث وتشجيع تكوين الجذور العرضية على العقل الساقية.

الكلمات المفتاحية: الأثل، العقل الساقية، التجذير، بيئة الماء، بيئة الهيلسن.

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