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DEVELOPMENT OF CUTTING PROPAGATION TECHNIQUE FOR ORNAMENTAL PLANT *Allamanda cathartica* (RUKKATHANA)

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ABSTRACT

Allamanda cathartica is an indigenous, widely distributed plant in Sri Lanka and is identified as Rukkathana. It is cultivated for large yellow flowers which have numerous medicinal and ornamental values. The propagation of Allamanda cathartica through conventional cuttings has limitations since the sprouting process is very slow and the success rate is remarkably low. Therefore, with the objective of developing a suitable cutting propagation technique for Allamanda cathartica plants an experiment was carried out in a two factor factorial manner at the University of Colombo Institute for Agro-Technology and Rural Sciences, Hambantota, Sri Lanka. Different types of stem cuttings: hardwood, semi-hardwood, softwood and shoot tips were tested in different potting media of pure sand, pure coir dust and sand and coir dust at the ratio of parts by volume 1:1 under controlled environmental conditions. There were twelve treatment combinations and four replications each containing three units and those were arranged in a Complete Randomized Design manner. Survival, rooting, shoot length, number of roots and root weight were recorded and statistical analysis was done by SAS 9.1.3 package. The study revealed that shoot tips exhibited better survival in a mixture of sand:coir dust and sand only media, as well as in coir dust and a mixture of sand:coir dust for hardwood cuttings. However, the lowest survival was in semi hardwood planted in sand only compared to all other treatments. Shoot tips showed superior rooting and shoot length in pure coir dust and a mixture of sand:coir dust media, while other cuttings showed the lowest rooting when planted in sand only media. The highest root weight was observed in shoot tips planted in sand:coir dust media, followed by shoot tips in pure coir dust, while the lowest root weight was recorded in softwood, semi hardwood, and hardwood planted in sand only, as well as in softwood cuttings planted in sand:coir dust media. The results suggest that the choice of growth media should be based on the type of cutting to improve rooting and growth performance. Higher aeration in growth media was found to be crucial for improving root initiation and stimulating metabolic processes. It can be concluded that, shoot tips planted in sand with coir dust can be recommended for mass multiplication of Allamanda cathartica.

Keywords: Allamanda cathartica, Cutting, Media, Propagation, Rukkathana

INTRODUCTION

Vegetative or asexual propagation has been established for the reproduction of plants that exhibit desirable characteristics. Asexual methods of propagation used different plant parts such as roots, stems, or leaves of stock plants for grafting, tissue culture, division or cutting propagation. Generally, propagation by stem cutting has numerous advantages, many plants can be grown in high density trays from a limited amount of stock plants as compared to other sexual means of reproduction such as via seeds. It is typically less expensive, quicker and relatively simple (Hartmann *et al*., 2002). Stem cutting production involves removing the shoot tip from the mother plant and planting it in the growing substrate to root. This method allows for the retention of foliar flowering habits and characteristics that may not be carried over via seed production. Successful propagation of ornamental plants by rooting vegetative stem cuttings depends on several factors including the physiological status of stem cuttings, the propagation environment, fertility management, and growth regulator treatments, whether applied to the stock plant prior to harvesting or exogenously applied rooting hormones to stem cutting (Hartmann *et al*., 2002).

The capacity of each species to propagate vegetatively through cuttings is influenced by both internal and external factors. Internal factors comprise the physiological state, age, phytosanitary status, hormonal equilibrium, presence of anatomical barriers to rooting, presence of leaves and buds, and the season of the mother plant. External factors, as reported by Owusu *et al.* (2014), Amri *et al.* (2010),

and Dias *et al.* (2012), relate to the environmental conditions that occur during rooting, such as humidity, temperature and water availability.

Propagation of some ornamental plants is feasible through vegetative means, especially in plants that produce no seeds. The propagation of *Allamanda cathartica* in the vegetative mean is difficult, possibly due to the existence of latex within the plant parts that might suppress the root formation. Generally, this plant is propagated through stem cuttings using hardwoods or semi - hardwoods but with limited success. Hence, it is worth identifying an appropriate propagation technique having higher success. Hence, the present study was conducted to identify the most suitable propagation material and an appropriate potting medium for propagating the ornamental plant *Allamanda cathartica.*

METHODOLOGY

The research was carried out at the University of Colombo Institute for Agro-Technology and Rural Sciences in Hambantota, Sri Lanka. The area falls under the Low Country Dry Zone Agroecological region in Sri Lanka DL 5 where the mean annual temperature range is between 29ºC - 33ºC. The typical soil type of the area is Reddish Brown Earth.

Collection of planting materials
Healthy branches of *A. cathartica* were detached at early in the morning from a pest free healthy mother plants. Soon after detaching, the cut end of the branch was dipped in a bucket containing clean water to prevent it from drying through moisture losses during transport.

Preparation of planting material
Those branches were cut and separated as hardwood (fully matured brownish and woody parts), semi hardwood (partially matured and slightly woody), softwood (soft and succulent parts just below the shoot tip) and shoot tips (topmost three nodes with shoot tip) with three nodes. Those were separated under water to prevent air trapping in vascular systems that otherwise restrict the root formation. A slant cut was made at the abaxial end using a sharp blade to increase the surface area that facilitates rooting.

Treatment structure
The experiment involved a two factor factorial experiment with a total of 12 treatment combinations, each replicated four times with three experimental units. The experimental design was completely randomized.

The treatments were as follows;
T1 – Shoot Tip + Sand
T2 – Softwood + Sand
T3 – Semi hardwood + Sand
T4 – Hardwood + Sand
T5 – Shoot Tip + Coir dust
T6 – Softwood + Coir dust
T7 – Semi hardwood + Coir dust
T8 – Hardwood + Coir dust
T9 – Shoot Tip + Sand, Coir dust 1:1 mixture
T10 – Softwood + Sand, Coir dust 1:1 mixture
T11 – Semi hardwood + Sand, Coir dust 1:1 mixture
T12 – Hardwood + Sand, Coir dust 1:1mixture

Preparation of potting media
Pure coir dust, pure sand and a mixture of sand and coir dust 1 : 1 (v/v) were used as growing media for *A. cathartica*. Pure sand and coir dust were sieved to remove unwanted materials and to get fine particles to facilitate rooting.

Preparation of pots
Pots of 10cm x 15cm were prepared with black polyethylene (250 gauge) and holes at the bottom to facilitate the drainage of excess water. The pots were filled with the potting mixtures treated with a Captan fungicide to sterilize the media.

Planting of cuttings
Just before planting, the basal cut surfaces of all stem cuttings were garnished with a rooting hormone containing 0.03% Indole Butyric Acid to promote rooting. Each cutting type was carefully planted in polyethylene pots inserting at least a node completely to be inside the media.

Maintenance of cuttings
Planted cuttings were maintained under completely sealed propagator, covered using 500 gauge transparent polyethylene sheet. The structure was maintained under 50% shade condition throughout the period of four weeks. Watering of cuttings was not practiced during the period they were kept under the propagator.

Data collection
In the fourth week after the establishment following data were collected.

Survival percentage
Survival percentage was calculated using following equation;

$$\text{Survival percentage} = \frac{Survived\ cuttings}{No.of\ cuttings\ planted}\ x\ 100$$

Percentage of roote cuttings
Rooting percentage was calculated using following equation;

$$\text{Rooting percentage} = \frac{Rooted\ cuttings}{No.of\ cuttings\ survived}\ x\ 100$$

Number of leaves
Number of leaves were manually counted and recorded after two weeks.

Shoot length
Shoot length was measured in cm using a ruler after two weeks.

Number of roots per cutting
Newly emerged roots were counted manually and recorded.

Root weight
Roots were carefully separated and fresh weight was measured (g) using an analytical balance.

Data analysis
Collected data were statistically analyzed using ANOVA procedures and the difference between the treatments means was compared using Duncan's Multiple Range Test (DMRT) at 5% significance level by SAS 9.1.3 package.

RESULTS AND DISCUSSION

Survival percentage of cuttings
Significant interactions ($P<0.05$) were found between the growth media and type of cutting on survival percentage of cuttings of *A. cathartica* (Table 1). Higher survival rates were found in shoot tips planted in mixture of sand:coir dust media (CD) and sand only media, hard wood cuttings planted in coir dust media and mixture of sand:coir dust media when compared to other treatment combinations except shoot tips, soft wood cuttings and semihard wood cuttings planted in coir dust media. The lowest survival percentage was observed where semi hardwood cuttings planted in sand only media, compared to all other treatment combinations. Sand can function as a growth medium whether it is employed alone or in combination with other substances. It appears likely that sand possesses the characteristics of an ideal growth medium, including a sufficient amount of gas-filled pore space and an oxygen diffusion rate for healthy respiration to maintain root uptake (Fonteno and Nelson, 1990). High aeration in a growth medium is especially crucial for improving root initiation and stimulating metabolic processes (Yeboah and Amoah 2009). Further, adequate drainage in the propagation media ensures that excess water can drain away, allowing air to fill the spaces between particles. Oxygen is vital for root development as it facilitates cellular respiration, which provides energy for root growth. While cuttings require sufficient moisture to initiate root formation, excessively water-retentive media can be harmful (Eed *et al.*, 2015).
In order to prevent cuttings from rotting, the medium must have adequate drainage. When considering the drainage qualities, sand is a good medium. According to Meerow (2007), coir dust offers exceptional structural stability, water absorption, drainage, and cation exchange capability. Therefore, it is crucial to mix these media types to create a medium with the best drainage and aeration.

Percentage of rooted cuttings
It was revealed that, there was a significant interaction ($P<0.05$) effect between the tested factors in rooting percentage of cuttings of *A. cathartica* (Table 1). Shoot tips planted in pure coir dust and mixture of sand with coir dust media showed significantly highest rooting percentage while softwood, semi hardwood and hardwood cuttings planted in sand only media showed lowest rooting percentage. Similar results were reported by Waziri *et al*. (2015), the favorable effects of the coir dust based media on sprouting, the number of leaves, plant height, diameter, and leaf size seen in this study were probably caused by the availability of sufficient moisture content to induce rooting and root growth.
Eed *et al.*, (2015) mentioned that, the effect of interaction between the two factors of growing media and type of stem cutting on *Bougainvillea spectabilis* plants proved that, the basal stem cutting gained significantly the highest rooting percentage at all growing media used, compared with the middle and terminal cuttings. According to Hartmann *et al.* (1990), variations in the stems degree of juvenility may have an impact on nodal position and, consequently, root production. In vertically growing stock plants, alterations in environmental conditions, such as radiation intercepted, may also have an impact on the rooting response. However, changes in the rate of maturation along the shoot could influence root production (Jensen, 1967). In general, the capacity to initiate roots rises with distance from the apex (Hansen, 1986).

Shoot length
There was a significant ($P<0.05$) interaction between growth media and cutting type on shoot length of *A. cathartica* (Table 1). Shoot tips planted in a mixture of sand with coir dust showed highest shoot length (Plate 1). It was followed by all the other cutting types planted in all the tested media. This result might be due to the fact that shoot tip cutting generally produces a new plant faster since a well-developed shoot is already present as reported by Gary (1982). The results of this study agreed with the results of Hartmann and Kester (1975) who reported that the presence of leaves on cutting stimulates the influence on root. Similarly, Ismail (2011) found that the shoot tip cutting of *Dieffenbachia* species gave high percentage of rooted compared to other cutting. An experiment on *Bougainvillea* by Eed *et al.*, (2015) indicated that, highest plant height was significantly recorded with medium containing soil + sand (1:1), whereas the lowest value for this character was observed with medium composed of soil only, in comparisons with the other media studied.

Number of roots
Significant interaction ($P<0.05$) was found between growth media and cutting types on number of roots of *A. cathartica* (Table 1). Shoot tips planted in pure

Table 1. Survival %, percentages of cuttings produced roots, shoot length, root number and root weight of different cutting types in different potting media

Media types (M)	Cutting Type (C)	Survival (%)	Percentage of cuttings produced roots (%)	Shoot length (cm)	Root number	Root weight (g)
Sand	Tip	91.67^{a}	91.67^{ab}	2.30^{b}	10.50^{b}	0.30^{c}
Sand	Softwood	58.33^{bc}	8.33^{d}	1.63^{b}	1.67^{e}	0.06^{d}
Sand	Semi hardwood	16.67^{d}	16.67^{d}	1.25^{b}	2.00^{e}	0.05^{d}
Sand	Hardwood	33.33^{cd}	11.11^{d}	2.19^{b}	2.00^{e}	0.06^{d}
CD	Tip	75.00^{ab}	100.00^{a}	3.28^{b}	16.23^{a}	1.33^{b}
CD	Softwood	75.00^{ab}	66.67^{bc}	2.15^{b}	3.50^{de}	0.10^{cd}
CD	Semi hardwood	83.34^{ab}	83.34^{ab}	3.25^{b}	4.71^{d}	0.23^{cd}
CD	Hardwood	91.67^{a}	91.67^{ab}	3.33^{b}	5.29^{d}	0.27^{cd}
Sand + CD	Tip	100.00^{a}	100.00^{a}	7.35^{a}	17.94^{a}	1.57^{a}
Sand + CD	Softwood	66.67^{bc}	75.00^{abc}	1.77^{b}	7.75^{c}	0.05^{d}
Sand + CD	Semi hardwood	50.00^{bc}	50.00^{c}	2.83^{b}	10.50^{b}	0.09^{cd}
Sand + CD	Hardwood	91.67^{a}	83.34^{ab}	3.12^{b}	7.75^{c}	0.19^{cd}
	M × C	*	*	*	*	*

CD – Coir Dust; Means followed by the different superscripts in a same column are significantly different at DMRT 5%. '' represents significant at 5% and 'ns' represents not significant.*

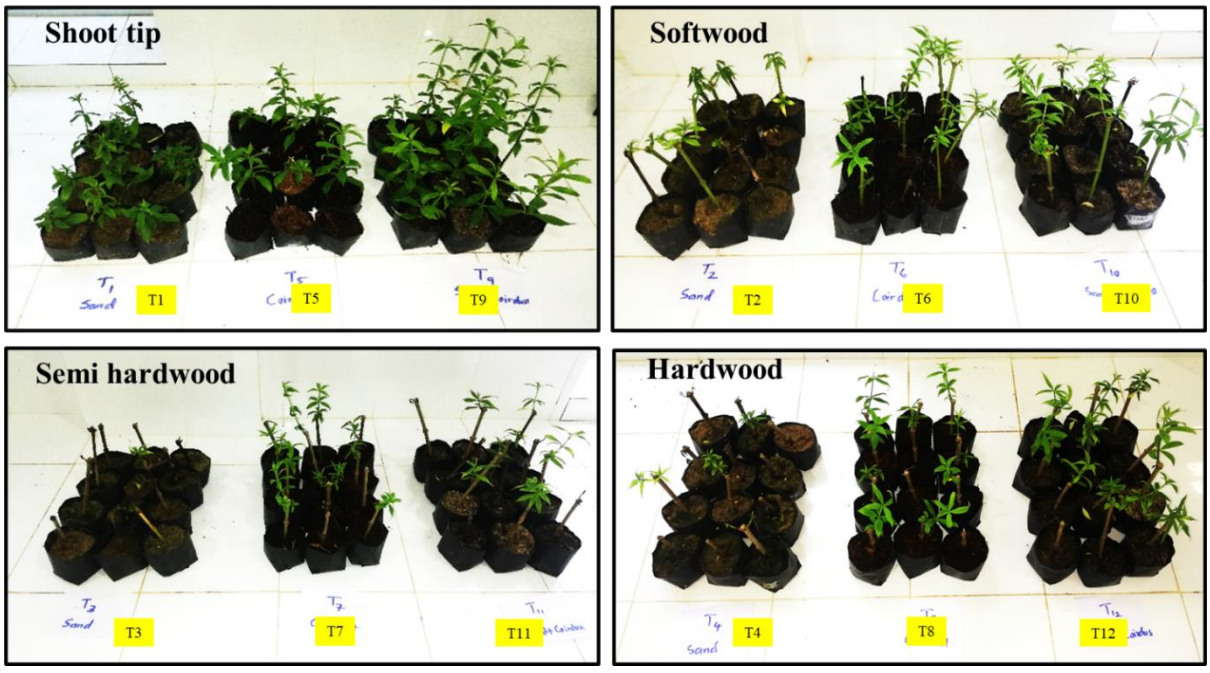

Plate 1. Overview of the *A. cathartica* plants in propagation experiment

coir dust and a mixture of coir dust and sand produced significantly higher number of roots. Lower values were recorded in softwood, semi hardwood and hardwood cuttings planted in sand only media. The variability in responses are likely related to differences in physical properties of the growth media (Khayyat *et al.,* 2007) and the supply of air and water to the growing plant (Baiyeri, 2003). Water can present a major barrier to the diffusion of oxygen so that excess water may result in anoxia at the base of the cutting (Loach, 1985). A similar study done using sawdust and sand as growth media exhibited that the sawdust showed lower need for irrigation than sand or sand:sawdust throughout the experimental period suggesting that it retained most of the water that was supplied to it. The potential for this growth medium to retain large amounts of water at the expense of plant growth and survival has been demonstrated by Ofodile *et al.* (2013) and Caspa *et al.* (2014). This can be applied for coir dust also having similar properties.

Root weight

A significant interaction (P<0.05) was observed on root weight between the tested factors; growth media and cutting types of *A. cathartica* (Table 1). It was recorded that, highest root weight found on the shoot tips planted in a mixture of coir dust: sand (1:1) media followed by a shoot tip planted in a coir dust only media. The lowest values were recorded in softwood, semi hardwood and hardwood cuttings planted in sand only media and soft wood cuttings planted in mixture of sand:coir dust (1:1) media. Enhanced aeration potential and drainage capacity/porosity, which promote root development and spreading, are responsible for better root growth (Hartmann and Kester, 1975; Olabunde and Fawusi, 2003; Puri and Thompson, 2003). Yeboah and Amoah (2009) found that increased aeration in rooting media is responsible for boosting metabolic processes and enhancing root initiation. Their research focused on the rooting performance of *Vitellaria paradoxa*. According to the result, the rooting potential of cuttings can be greatly influenced by the type of rooting media utilized. The study done by Muhammad Farooq *et al.* (2018) showed that the potting medium had a substantial impact on the fresh weight of roots per cutting. Also, the study done by Haile Abebe (2017) discovered that the rooting media had a substantial impact on root fresh weight and showed that least root mass was discovered in stem cuttings rooted in agricultural soil. Significant impacts of rooting material on the root fresh weight of rooted cuttings were also found by Shah *et al.* in 2006.

CONCLUSIONS

The study found that the survival and rooting percentages of the cuttings were significantly affected by the interaction of the media and cutting type. Shoot tips generally had higher survival rates and produced longer shoots, while semi-hardwood and hardwood cuttings planted in sand media showed lower values. The study highlights the importance of proper growth media selection, particularly in terms of drainage, porosity, and aeration, in enhancing root development and overall plant growth. The findings can be useful for plant propagators and farmers to select appropriate media and cutting for successful propagation of different plant types.

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