VEGETATIVE PROPAGATION OF THREE SELECTED LANDSCAPE TREE SPECIES BY STEM CUTTINGS

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APPROVAL SHEET

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(43388)

This report submitted in partial fulfilment of the requirement for the Degree of Bachelor of Science with Honours in Plant Resource Science and Management

Department of Plant Science and Environmental Ecology
Faculty of Resource Science and Technology
UNIVERSITY MALAYSIA SARAWAK

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APPROVAL SHEET

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DECLARATION

I am Nurfarhana Binti Abu Bakar, final year student of Plant Science and Management hereby declare that this thesis is based on my original work and effort with guidance of my supervisor, Prof. Dr Hamsawi bin Sani expect for quotations and citations, which have been duly acknowledged. No portion of the work referred to this report has been previously or concurrently submitted in support of an application for any other degree, university or institutions of higher learning.

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LIST OF ABBREVIATIONS

ANOVA - Analysis of Variance
MINITAB - A statistical package to analyzing the data
IBA - Indole-butyric acid
PGR - Plant Growth Regulator
Sp. - Species
$X^2$ - Chi-square
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ABSTRACT
A study was conducted to determine the effect of commercial Plant Growth Regulator (PGR) on rooting propensity on three landscape species. Four commercial PGRs - ROOTMONE®, AGR ROOTMORE®, SDAEX® and AKAR SERBAJADI® which all containing Indolebutyric Acid (IBA) were applied on stem cuttings of 9 month-old seedlings of Syzygium grande, 2-years old seedling of Syzygium polyanthum and 2 year-old coppice of Minusop elengi. Thirty cuttings of each species were collected for each treatment and planted in a plastic basin (50cm x 30 cm x 15cm - LxWxD) containing sieved river sand and the basins were placed randomly in the rooting bed that was equipped with simple misting system controlled by an electrical timer. The cuttings were assessed for their rooting on week four until week 12. The results show that PGR significantly influenced rooting propensity for both Syzygium species while M. elengi were recorded failed to root for every treatments. The overall rooting success of S. grande was 67% while S. polyanthum was 31%. PGR ROOTMONE® produced a 100% and the untreated cuttings (97%) rooting success for S. grande while PGR AKAR SERBAJADI® produced the highest rooting success of 70% with S. polyanthum. PGR were shown to other rooting parameters assessed such as number of roots, longest root, number of shoot, shoot dry weight, root dry weight and root/shoot ratio. As for S. grande number of roots (p=0.001), longest root (p=0.000), number of shoot (p=0.000) and root dry weight (p=0.0001) were significantly influenced by the PGR while S.polyanthum only number of root (p=0.004) and root dry weight (p=0.002) were significantly affected by PGR. Based on the result obtained, it could be concluded that S. grande is a much easier-to-root compared to S. polyanthum while Minusop elengi is a very difficult-to-root species. It is recommended for future study to use a pure hormone such as IBA with different level of concentration.

KEYWORDS: Landscape Tree, Vegetative Propagation, Rooting Propensity, Commercial PGR, Stem Cuttings

ABSTRAK
Sama kajian telah dilaksanakan untuk menentukan kecenderungan pemupukan bunga pokok ialah spesies pokok ialah spesies pokok yang mengandungi Indolebutyric Acid (IBA) yang digunakan pada pokok batang anak pokok berusia 12 bulan daripada Syzygium grande, anak pokok yang berusia 2 tahun Syzygium polyanthum dan pokok baru Minusop elengi yang berusia 2 tahun. Tiga puluh keratan setiap spesies yang ditanam di dalam bekas plastik (50cm x 30 cm x 15 cm - LxWxD) yang mengandungi pasir dengan yang telah disaring dan keratan dilestakan secara rawak di atas kastil perakaran yang telah dilengkapi dengan sistem kabung yang dikhual oleh pemasa elektrik. Keratan dinilai untuk perakaran mereka pada minggu keempat sehingga minggu ke enam belas. Keputusan menunjukkan bahawa PGR ketara dipengaruhi kemuncak kecenderungan untuk keseluruhan spesies Syzygium manakala M. elengi direkodkan gahil berasa untuk setiap rawatan. Keputusan perakaran keseluruhan S. grande adalah 67% manakala S. polyanthum adalah 31%. PGR ROOTMONE® menghasilkan 100% dan keratan yang tidak dirawat (97%) perakaran kejayaan S. grande manakala PGR AKAR SERBAJADI® ditunjukkan kejayaan tertinggi perakaran 70% dengan S. polyanthum. PGR ditunjukkan kepada parameter perakaran lain dinilai seperti bilangan akar, akar paling panjang, bilangan pucuk, berat kering daun dan akar, dan nisbah pucuk/akar. Bagi S.grande nomor akar (p = 0.001), akar terpanjang (p = 0.000), bilangan pucuk (p = 0.000) dan berat kering akar (p = 0.0001) telah dipengaruhi dengan ketara oleh PGR manakala S.polyanthum hanya bilangan akar (p = 0.004) dan berat kering akar (p = 0.002) telah terjejas dengan pengaruh PGR. Berdasarkan keputusan yang diperoleh, ia boleh disimpulkan bawa S. grande adalah lebih mudah untuk berakar berbanding S. polyanthum manakala Bunga Tanjung adalah spesies yang sangat sulit untuk berakar. Ia adalah disyorkan untuk kajian masa depan menggunakan hormon IBA dengan tahap kepekatuan yang berbeza.

Kata kunci: Pokok landskap, Propagasi Vegetasi, Kecenderungan Pengakaran, Pengawal Selia Pertumbuhan Tanaman komersial, Keratan Batang.
RESEARCH BACKGROUND

2.0 INTRODUCTION

Ornamental trees are very significant for landscaping as they widely recognize as green infrastructure of a city. They provide services to our ecosystem either directly or indirectly such as improvement for our environment, enhancing aesthetic value, enrich ecological and biodiversity element, and also health, economic, and social (Konijnendijk, 2008).

The specimen plants are selected for accenting an entryway or border, others for softening corners and harsh lines, or to provide a low transition from one point to another. Plants also useful for dividing spaces by separating use areas in the yard while some shrubs are used with trees to screen unpleasant views or to protect the yard from strong winds (McDaniel, 1982).

The increasing in urbanization lead to more trees need to be planted along the road, at the housing area, as well in the community playground. This mean that abundant planting stock is needed to meet the planting demand. Therefore a mass production of the landscape tree is needed (Day et al., 2009).

Traditionally seedlings are raised from seed. However, not many plant species bear fruit all the year round. Besides that, propagation by seed will takes time compared to vegetative propagation which can shorten the juvenile phase of the trees (Jaenicke & Beniest, 2002).

Hence, an alternative sources need to be explored to sustain the supply of tree seedlings. One of the potential techniques is vegetative propagation.
Vegetative propagation by tissue culture is the most efficient when comes to large scale production (Bhore & Preveena, 2011) but the technique requires sophisticated laboratory facilities (Day et al., 2009). Therefore, vegetative propagation by stem cuttings is the most preferable method. This has been discovered for about long time ago yet still be used as it is the easiest way to grow a tree, less cost needed, and less time used. This technique falls under vegetative propagation. The ability of the plant to reproduce known as totipotency, however some species are found hard to root (Toogod, 1999). Such problem in many cases can be overcome by the use of Plant Growth Regulators (PGR).

The ready-made PGR or rooting hormone had been commercialized and easily found in the market. Many commercial PGR were produced but none of them had been tested locally for their effectiveness in promoting rooting of the cuttings especially for cuttings from ornamental plants or landscape trees.

Hence the objectives of the present study include:

1. To determine the most effective commercial rooting hormone in rooting of cuttings.
2. To evaluate rooting propensity of the three tree landscape species.
3.0 LITERATURE REVIEW

3.1 Botanical description of *Syzygium* species and *Mimusops elengi*

*Syzygium* species are known as the largest genera of Myrtacea and was reported to have approximately 1200 species. They are 156 *Syzygium* species found in Borneo. They usually grow at open, shaded forest and along the riverbanks with soil pH about 6-7 (Ariyanti et al., 2012).

3.1.1 *Syzygium grande*

*Syzygium grande* also known as sea apple is a large and evergreen tree. This tree can reach height up to 45 meters while its bole diameter can grow until 75cm. It produces edible fruits that grow about 4cm long which has green leathery flesh when ripe (Fern, 2014a). *Syzygium grande*’s crown usually oblong, irregular and the branches are wide-spread type. Broad, elliptical apaxes, large, simple, shiny and leathery are characteristic of its leaves. The veins of the leaves are reported to have 9-13 well-spaced pairs. The flower produced by this tree have white colour of the petals. At the end of the twigs they grow in compact clusters and produce strong fragrance. As go down to the trunk, it shows that the base of the trunk is fluted, greyish in colour, rough, shallowly fissured and flaky as they aged (Kwek et al., 2009). Usually this tree commonly be found at rocky and sandy shores but they are widely planted as a wayside tree due to their attractiveness (Senterre et al. as cited in Corner, 1988).
3.1.2 Syzygium polyanthum

Common name of Syzygium polyanthum is Indian bay leaf and was widely distributed in lowland, primary and secondary forests, and also in bamboo forest (Fern, 2014b). This evergreen tree can grow approximately up to 30m height with 60cm diameter. The leaves have either oblong-elliptical, narrowly elliptical or lanceolate apex, with opposite arrangement and stated in previous study that they are simple type of leaves with petiole up to 12mm long. This glabrous leaves of Syzygium polyanthum have a panicle inflorescence (2-8cm long) that arising below the leaves, at times axillary. The sessile white flower produce an attractive fragrant especially when their blooming time. The globose fruits were observed to have dark red or purplish-black color when ripe with 1-seeded berry and have approximately 12mm in size (Ariyanti et al., 2012).

3.1.3 Mimusops elengi

Mimusops elengi is an evergreen tree from family Sapotaceae and also known as Bunga Tanjung in Malaysia. This large tree with dark grey fissured bark have opposite, elliptic, lanceolate, alternate and glabrous with rounded base, acute apex and wavy margins as their leaves characteristics. It has white aromatic flower and produced berry types of fruits which is oval in shape and smooth outer skin. This edible fruits turns its colour from green to yellow when ripe and has solitary seed and enclosed with a smooth, hard, thick integument, lined with a veined membrane (Roqaiya et al., 2015). This tree usually flower and fruit from March to April and is widely distributed in south India (Mitra, 1979)
3.2 Vegetative propagation through cuttings

Plant can be propagated either sexually or asexually. Asexual reproduction is propagating plant through their vegetative part such as roots, shoots, and leaves (Toogood, 1999). A plant can reproduce into new individual that is similar to their parent is known as vegetative propagation (Hartman et al., 2011). This is a very powerful technique to capture genetic superiority of a desired plant (Grattapaglia et al., 1995). This technique allows the plant to grow rapidly compared to propagating through seed which sometimes the seed will undergo dormancy state that cause the seed does not germinate unless it was planted at their favorable condition (Toogood, 1999).

Vegetative propagation is stated to be used widely in agricultural industries (Forbes & Watson, 1992) and was successfully used to propagate desired plant genotype in horticultural industries (Grattapaglia et al., 1995). According to Hartman & Kester (1983) there are several classifications of vegetative propagation which are cuttings, buddings, layering and micro propagation. Among this, cutting is the most economical, fast, modest and less additional knowledge or specific techniques needed.

Most cuttings were taken from a plant stem either internodal or nodal cuttings but there are also cuttings taken from roots and leaves. Adventitious root will protruded from the stem, leaf, or roots which is this process known as regenerative process (Toogood, 1999). Moreover cuttings taken from the plant tissue can be classified further according to plant part obtained. There are softwood cuttings, hardwood cuttings, deciduous cuttings, narrow-leaved evergreen
cuttings, semi hardwood cuttings, herbaceous cuttings, leaf, leaf-bud and root cuttings (Hartman & Kester, 1983).

The success of cutting technique in propagating plant had been proven compared to other technique of vegetative propagation in previous study. Based on previous study it's stated that vegetative propagation through stem cutting produce higher success percentage compared to grafting technique (Takoutsing et al., 2014). As an example, rubber tree (*Hevea brasiliensis*) shows 90% growth success when propagate by stem cuttings in order to multiply this valuable trees for cultivation and if they are propagate through seed it takes almost a year to be raised before transplanting to the field. Propagation through stem cuttings for rubber tree can help to reduce the time of nursery management besides, it help minimize cost and effort of producing planting materials (Corpuz, 2013).
3.3 Factors affecting rooting of cuttings

3.3.1 PGR or Commercial hormone

Plant growth regulator (PGR) or commercial hormone is a synthetic plant hormone that helps to encourage rooting of cuttings for different types of plant but different plants required different concentration (Cerveny & Gibson, 2005). Different concentration of IBA hormone gives different effect towards the root growth. Higher concentration of hormone caused an increase in root numbers that protruded from the stem cut while lower concentration will not affect the root growth (Saglam et al., 2013).

PGR is very essential for certain species of tree for the cuttings to root. High concentration of PGR is need for hardly rooted species compared to easily rooted species. However, certain plant such as Hevea brasiliensis, they will root more when less concentration of PGR is applied (Corpuz, 2013). Therefore, in horticultural industries they produce rooting hormone that can be applied to all types of tree which is very practical.

When PGR is applied to the surface of cuttings, the cuttings will undergo differentiation of cell and tissue in order for the callus to form then forming roots. The commercial hormone is available in powder, gel or liquid form (Toogood, 1999). Nowadays a ready-made rooting hormone that can be used anytime without need to be prepared according concentration needed by the plants are really needed as they are very easy to use (Hartman & Kester, 1983), therefore a lot of different brands of commercial hormone are sold in the market which usually in powder form.
3.3.2 Sand as rooting media

Type of media for cutting is very essential. Nursery production industries use variety of growing media especially in ornamental plant production (Bhore & Preveena, 2011). A medium for propagation must have moisture-retentive and also porous to keep it aerated and it must be sufficiently free-draining to prevent from waterlogged but not until the medium dries out (Toogood, 1999). A pH conducive for plant growth must be provided by the best media to permit water infiltration and movement (Hartman et al., 2011).

Sand is widely used in the past as the medium for propagation as it is not costly and readily available. Even though sand not moisture retentive but it is course enough to allow water to drained freely and sand was reported to be the best media for rooting medium as it can prevent the cuttings from fungus and bacteria interaction (Hartman et al., 2011).

3.3.3 Age of cuttings

Rooting ability of most species will decrease as the age of stock plant increase. Therefore, juvenile tissue is used in common practice to achieve a better organogenesis in the propagation of trees from cuttings (Hartman et al., 2011). In the study on effect of ontogenic age on root and shoot, a conclusion had been made which is juvenility influence early root and shoot development of *Tebubia heterophyla* cuttings. Juvenile cuttings (18month) produce more leaves than 19-60 month older plants (Awang et al., 2011). In the study also mention that
older stock plant has the ability to generate new shoots but no roots produced. The cuttings will eventually die if no root is produced after all the food reserve had diminished.

*Shorea ovalis, S. parvifolia, S.leprosula and S. acuminata*, also can easily rooting if cutting materials are prepared from young stock plants. Stem cutting for 6-12 month old *Hopea odorata* shows rooting success rates more than 75%, as compared to those taken from 18-21 month-old saplings that had rooting success rates of less than 50% (Forestry Department Peninsular Malaysia,1998)

### 3.3.4 Air humidity

In order to produce optimal rooting for leafy cuttings, water potential need to be maintained so that the humidity level become stable for photosynthesis and transpiration activity keep going and the turgidity of the cuttings can be maintained (Loach, 2008). Therefore misting is crucial for propagation through cutting. Misting propagation is widely used to provide bottom heat in order to stimulate rooting and constant humidity, so the cutting will always be moist and cool (Toogood, 1999). This misting technique make the hard to root species to possibly to root as they help to keep slowly rooting cuttings to survive for a longer period by giving them chance to root before dying (Hartman et al.,2011).
4.0 MATERIAL AND METHOD

4.1 Experiment site
The experiment was carried out at a greenhouse located in the east campus of the University of Malaysia Sarawak. The rooting bed was made of wood, covered with a transparent plastic sheet.

4.2 Source of cutting
The tree species used were known as *Syzygium grande*, *Mimosop elengi*, and *Syzygium polyanthum*. All three species used in this experiment were available in Universiti Malaysia Sarawak. Cuttings for *S. grande* species were taken from 12-month-old potted seedlings that were planted in UNIMAS’s greenhouse. While *S. polyanthum* were taken from two-year-old coppice shoot near the main gate of UNIMAS. Cuttings for *M. elengi*, were collected from rejuvenated two-year-old coppice shoot from a 10-year-old tree.

4.3 Media and Plant Growth Regulator (PGR)
In this experiment, sieved river sand media were used and were placed in a plastic basin (50cmx30cmx15cm). Each basin was assigned for each treatment. The treatment consisting of four commercial hormones that contain IBA, but none of them mention the concentration of the IBA.

- **Treatment 1**: Control
- **Treatment 2**: SADEX®
- **Treatment 3**: AKAR SERBAJADI®
- **Treatment 4**: AGR ROOTMORE®
Treatment 5: ROOTMONE

4.4 Cuttings preparation

Stem cuttings of 10cm long were collected from the mother plant. A total of 150 cuttings were prepared for each species. The top most leaf was retained and trimmed into half if it was too large to reduce water loss. A sharp secateurs was used to cut a single node cutting from the stock plant in the early morning to ensure the water loss in the plant through transpiration is low. The cuttings were placed in a pail containing tap water to keep them turgid, wet, and fresh. Then, cuttings were washed in water treated with fungicides.

Cuttings for each species was dipped into four different types of powder type commercial rooting hormone (PGR) before planting them into the river sand media for 60 seconds. Each treatment had 30 cuttings for each species. All cuttings for each treatment were arranged in columns of five and row of six in the plastic basin respectively. The entire plastic basin for each treatment and species were arranged randomly in the rooting bed. The rooting bed was equipped with single misting unit to maintain high humidity in the rooting bed. The misting was controlled by electrical timer at five minutes per cycle for two times per day.

4.5 Observation and Assessments

On the fourth week, all 450 cuttings were assessed for rooting. A cutting is considered rooted if more than 0.5cm of root was seen protruded from the base of cuttings. The date and number of cuttings rooted were recorded. The rooted cutting was marked with round rubber band until
the end of the experiment, so they are easily differentiated from unrooted cuttings. The number of new shoot also was recorded.

Next, on the week 12, cuttings were be slowly pulled out from the media to count the total number of roots and the length of the roots. After that, in order to get the dry weight of root and shoot the cutting were dried in oven for about 48 hours at 65°C. All the data will be recorded for analysis.

4.6 Experimental Design

The experiment will used 3x5 factorial design where three species and five different commercial hormones. Each treatment will consist of 30 cuttings as shown in Table 1.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T1: control</th>
<th>T2: SADEX</th>
<th>T3: AKAR SERBAJADI</th>
<th>T4: AGR ROOTMORE</th>
<th>T5: ROOTMONE</th>
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<td>Syzygium polyanthum</td>
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<tr>
<td>Mimosops elongi</td>
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</tbody>
</table>
4.7 Experimental Layout

Five treatments were applied to each species. The arrangement of the plastic basin for all treatment for three species in the rooting bed is shown in Figure 1. and the arrangement of the cuttings in the plastic basin (columns of five and row of six) is shown in Figure 2.

Figure 4.7.1: The arrangement of the plastic basin in the rooting bed

Figure 4.7.2: The arrangement of the cuttings in the plastic basin