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Selection and Propagation Methods for *Ploiarium Alternifolium*, An Indigenous Tree Species For Slope Control: Case Study Of Sultan Azlan Shah Campus, Sultan Idris Education University, Malaysia

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Abstract

The area of green corridors encompassing the Sultan Azlan Campus (KSAS), Sultan Idris Education University (UPSI) is about 151km^2, approximately 19% of the total campus area. The green corridor is best described as a secondary forest composed of various indigenous tree species with potential erosion control and slope stabilization. This study aims to identify suitable species for erosion control at slope areas. One of the most promising species is *Ploiarium alternifolium*, which has been selected for this study and was propagated for use in erosion control. Three propagation techniques were applied, i.e., grafting, branch cutting and *in-situ* harvesting. The results show that grafting and *in-situ* harvesting were more efficient than branch cutting. Therefore, the use *Ploiarium alternifolium* in erosion control is a promising method and can be complimented by mechanical engineering methods.

Key words: UPSI, Green Corridors, *Ploiarium Alternifolium*, Propagation, Erosion Control

Introduction

Tropical rainforests of Malaysia house various flora and fauna species which are of significant ecological importance. The variety of flora and fauna species in tropical rainforests provides numerous benefits for humans, especially in terms of minimizing effects of mass trampling, soil erosion and landslides (Predrag & Goran, 2014). The existence of various indigenous tree and plant species in tropical rainforests provide resources of plants to be used for controlling erosion and stabilizing human-made and natural slopes in Malaysia. Several studies have reported positive effects of plants in controlling slope erosion, e.g. Normaniza (1998), Normaniza *et al.,* (2008), Mohamad *et al.,* (2011), Normaniza and Barakbah (2011) and Mohammed *et al.,* (2013).They have stated that plant species such as *Leucaena leucocephala, Acacia mangium, Dillenia suffruticosa, Bauhinia purpurea, Bixa orellana, Justicia betonica, Tabernaemontana corymbosa, Polyscias sp* and *Evodia latifolia* have a large potential for use in erosion control, slope reinforcement and stabilization. Two main methods are commonly used to reinforce and stabilize slopes after hill cutting: Mechanical engineering involves the use of permanent materials such as mortar and concrete, gravity retaining walls, sheet piles and gabions and changes the nature of the developed area. This method is also cost-intensive due to the use of materials such as steel pile, wire cage, rock, concrete, iron and cement in large amounts to build slope sub surface drains and stepped drains. In contrast, the bioengineering method involves the use of green elements such as close turfing and hydroseeding. In this method, coconut fibre or coir and jute are used as a spreadsheet before spraying grass seeds over the slope surface.

Several studies have showed that extensive tree root systems are most suitable for slope stabilization, e.g. by reducing soil water levels, providing essential nutrients for plant growth, increasing cohesion of soil and root, absorbing water and promoting photosynthesis (Normaniza & Barakabah, 2006; Pierret *et al.,* 2007; Baets *et al.,* 2008; Danjon *et al.,* 2008; Normaniza *et al.,* 2008). Thus, tree roots can indirectly prevent the edge of the slope from sliding all the way to the bottom. Tree root growth changes the physical and chemical soil properties and stabilizes soil structure (Wang *et al.,* 2003). Reinforcement of tree roots, partially in sloped or hilly areas, enhances the soil layer and creates a network that binds up each layer in the soil (Zhou *et al.,* 1997).

This study evaluated the use of local tree species in slope control as well as different propagating methods. Selection of local species was conducted at green corridors encompassing the Sultan Azlan Shah Campus (KSAS). This method is also expected to be combined with mechanical engineering methods based on physical and mechanical criteria.

Study Site and Methodology

The study was performed on the new campus of Sultan Idris Education University, Sultan Azlan Shah Campus (KSAS), which covers an area of 324.36 hectares (801.5 acres) (Figure 1). The green corridor is located in the eastern part of KSAS at an altitude of 120 meters above sea level and in the western and northern part at an altitude of 60 meters above sea level

(Mohamad Suhaily Yusri *et al*., 2013). The area of the green corridor (natural vegetation) in this campus covers 151 acres or 19% of the total KSAS area.

Figure 1: Sultan Azlan Shah Campus, UPSI

The methods used in this study include plant surveillance by applying rapid ecological assessment methods using a 100m transect (Zahid *et al.,* 2013). Figure 2 shows the sampling location. Plant species were identified using leaves, flowers, and fruit samples. The samples were brought to the laboratory for further analysis. Each identified species on the transect was marked and the details were recorded.

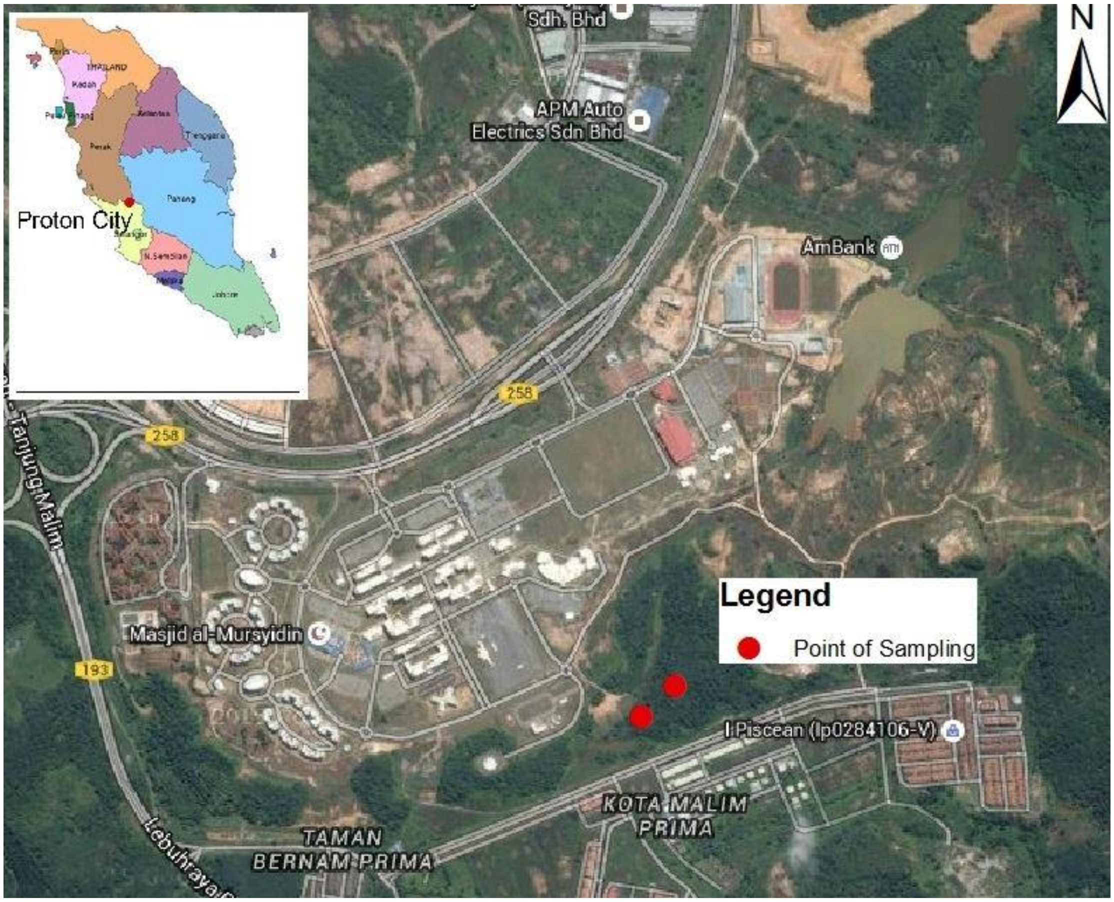

Figure 2: Sampling location

Tree species selection for slope control is based on multiple tree criteria. In terms of physical criteria, the tree species must develop long and durable roots which grow rapidly, as discussed in Zhou *et al.* (1997), Normaniza (1998), Wang *et al.* (2003), Morgan (2005), Normaniza *et al.* (2008), Tognetti *et al.* (2009), Mohamad *et al.* (2011), Normaniza and Barakbah (2011) and Mohammed *et al.* (2013). In this study, we applied three propagation methods, grafting, branch cutting (Mohamed *et al.,* 2014 & Libunao *et al.,* 2013), and *in-situ* harvesting.

Grafting represents a way of obtaining offshoots from the primary tree by lumping the clay on small branch of the primary stem. The tree skin stems of around 1 inch in length are removed from the tree, the mucus on the tree trunk is dried, and with the removed stems are covered with top soil. Branch cutting, in contrast, represents the easiest way to obtain offshoots. In this method, a small tree branch of about 20 cm length and with about two leaves is cut off and planted directly into a polybag at a depth of 5 cm. In the *in-situ* harvesting method, offshoots are obtained directly by collecting saplings around the primary tree. For this method, the samplings at a distance of 10 cm from the base of the primary tree are dug out and inserted into a polybag filled with soil. Ideally, saplings have a height of about 50 to 130 cm. All propagated trees should be placed under black netting and watered to avoid water stress.

Results and Discussion

The green corridor in KSAS is a mature secondary forest which brings the dynamics of biodiversity including some mature tall trees (Zahid *et al.,* 2013). According to Zahid *et al.*(2013), KSAS is home to 15 tree species with high conservation status. Previous studies in the area have found indigenous species such as (*Ploairium alternifolium*), senduduk (*Melastoma malabathricum*), simpoh (*Dillenia suffroticosa*) and *Antidesma sp.*, which can potentially be used in erosion control. However, we chose the species *Ploairium alternifolium* (cicada tree) for this study due to its unique physiology; it grows long roots, is able to grow in dry areas and dominates to habitats in the study area: one on the top of a hill and one in a swampy area (Photos 1 and 2).

Photo 1: *Ploairium alternifolium* growing in a hilly area

Photo 2: *Ploairium alternifolium* growing in a swampy area

Ploiarium alternifolium (Vahl) Melchior is a member of the Theaceae family and naturally occurs in Malaysia, Cambodia, Thailand, Indonesia and in some other Southeast Asian countries (Chong *et al*., 2009). It is a species of low risk conservation status and grows up to a height of 20 or 30 m. It has a tall and straight trunk with a diameter of 15cm at breast height. Specimens growing in swampy habitats produce long stilt roots (Photo 3).

Ploiarium alternifolium naturally occurs in secondary forests and in bush land up to 700 m asl, only rarely at altitudes beyond 1,300 m. Cicada trees commonly grow in large groups, dominating the vegetation community, and can often be found on dry and acidic sandy soils (Corner, 1988; Tan, 2011). However, they also frequently occur in shallow freshwater swamp areas and at the base or bottom of rocky rivers, but rarely grow in the peat swampy areas of brackish water (Chong et al., 2009). In rocky and shallow soils, they only grow as small shrubs, but still produce flowers and fruits.

Photo 3: Stilt root system of *Ploiarium alternifolium* in a marshy area

In this study, we used grafting, branch cutting and *in-situ* harvesting for cicada tree breeding (see Photos 4, 5, 6). Propagated trees were place under black netting (Photos 7). Our results show that grafting and *in-situ* harvesting are more effective than branch cutting for *P.alternifolium* propagation, possibly because this species has a relatively high growth rate and reached a suitable height after two months of cultivation, enabling planting at the slopes.

However, with the *in-situ* harvesting method, tree roots reached higher lengths within a shorter period of time compared to the grafting method (Figure 3). This was shown when cicada trees in three roots monitoring parcels showed height a growth of 6.4cm per month and increased up to 14.5cm in the second month. This was possibly caused by the specific root profile, the heart-root system (Photo 8), which allows the tree roots to rapidly grow and spread (Mohamad *et al*., 2011). Tognetti *et al*. (2009) also explained that this heart-root system can reduce water in the soil and redirect the water into the main body of the tree.

Photo 4: Grafting method

Photo 5: Branch cutting method

Photo 6: *In-situ* harvesting method

Photo 7: *Ploiarium alternifolium* trees are placed under black netting

Photo 8: Heart-root system of *Ploiarium alternifolium*

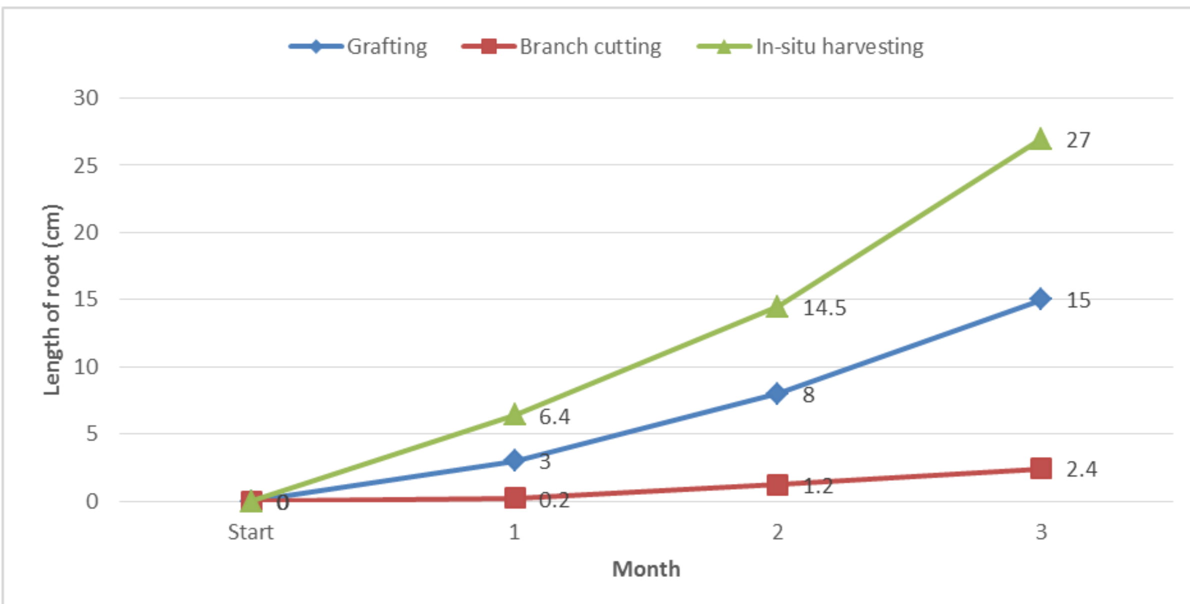

Figure 3: Length of *Ploiarium alternifolium* tree roots based on months and breeding methods

The propagated trees are generally ready to be planted into the field when the roots reach a length of up to 10 cm. If roots are too long, tree growth is negatively impacted due to competition for nutrients and knots within the roots. Knotted roots have a lower ability to penetrate the soil, leading to decreased tree growth. Moreover, in this case, tree roots are considered as still young and ready to spread after being planted into the field.

Height and diameter measurements were conducted to assess tree growth based on treatment month and breeding method. Breeding through in-situ harvesting was most successful with an average height increase of 130cm, followed by the grafting method with 66cm average height increase; branch cutting only resulted in an average height increase of 21 cm (Figure 4). Overall, height increase was parallel with stemdiameter increase and dependent on treatment month and breeding method (Figure 5). However, grafting method and *in-situ* harvesting showed a more consistent increase compared to branch cutting.

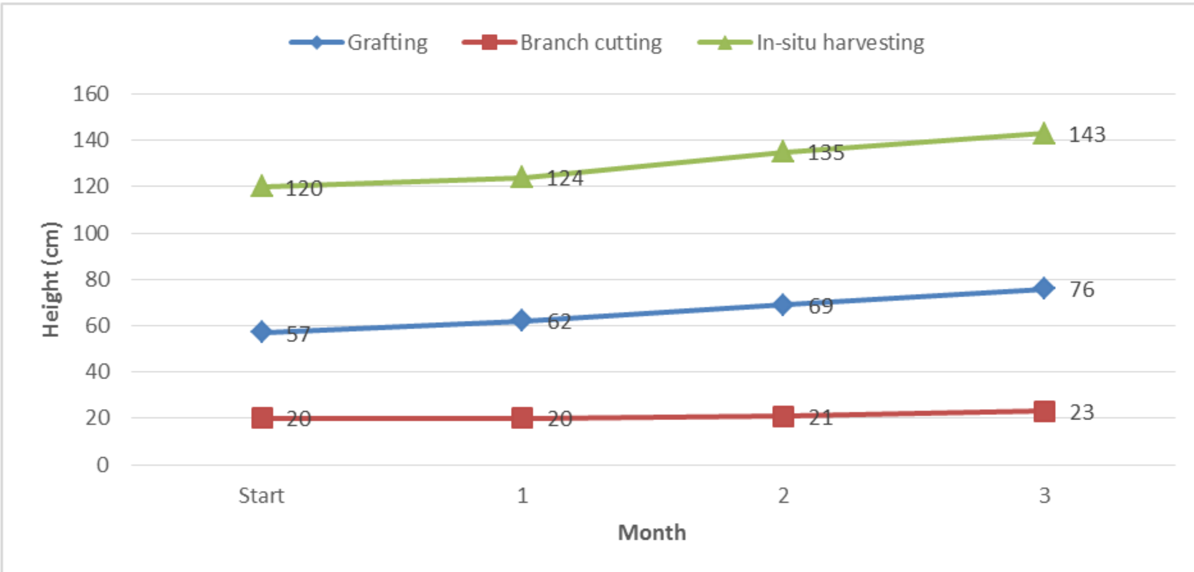

Figure 4: Height growth of *Ploiarium alternifolium* trees based on month and breeding method

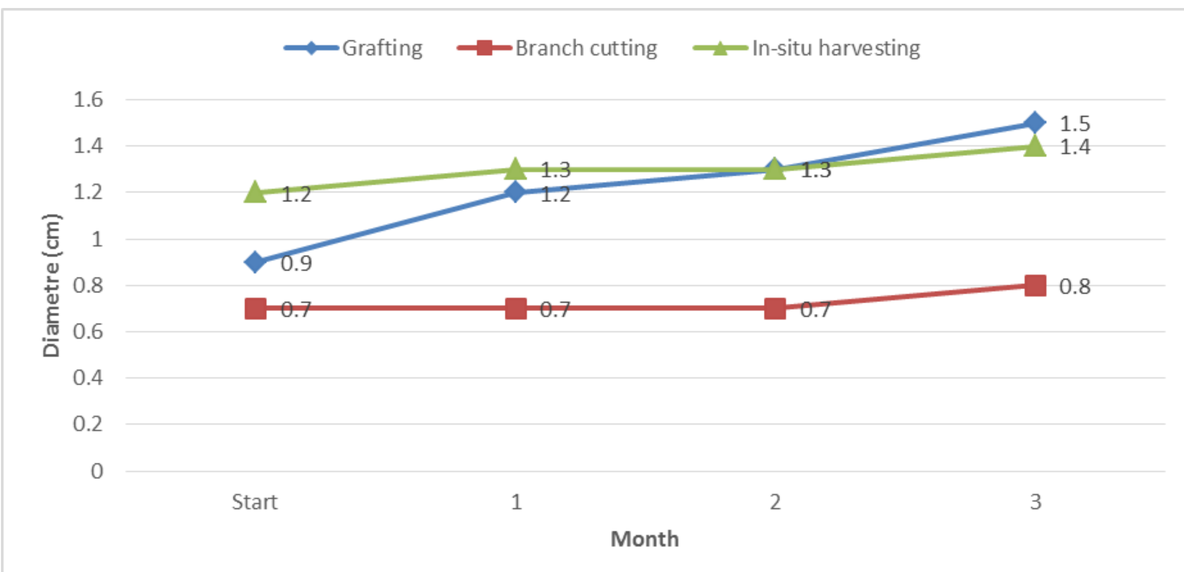

Figure 5: Diameter growth of *Ploiarium alternifolium* trees based on month and breeding method

Ploiarium alternifolium is a fast-growing species and capable of living in dry and marshy areas; it is easy to breed and cultivate. Its long roots are advantageous for planting in slope stabilization programs and propagated trees can be used after a cultivation period of two months. Thus, the use of *Ploiarium alternifolium*in erosion control represents a promising alternative to mechanical engineering methods. Using tree species in slope stabilization also directly contributes to biodiversity enhancement. In addition, *Ploiarium alternifolium*is also a suitable species for reforestation programs due to its ability to spread seeds and dominate in their habitat.

Conclusion

Ploiarium alternifolium is a tree species which is easy to propagate via grafting or *in-situ* harvesting, strong and able grow in either dry or swampy areas; offshoots can be used after a two-month cultivation period. Thus, this species is potentially useful for erosion control and slope stabilization. In addition, *Ploiarium alternifolium* has long and fast-growing roots which are suitable to reinforce the soil structure, especially onslopes and in marshyareas. We therefore suggest the use of *Ploiarium alternifolium* in erosion control, possibly combined with mechanical engineering methods.

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