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Growth Performance of 9-Years-Old selected 5 Indigenous Wood Species Planted on Degraded Forest Land

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Abstract: Studies on the growth performance on five selected indigenous trees species of *Azadirachta excelsa*, *Cinnamomum iners*, *Hopea pubescens*, *Intsia palembanica* and *Shorea leprosula* under open area planting technique on degraded forest area were carried out in Pasoh Forest Reserve Area, Negeri Sembilan. Evaluation on the growth and survival of these species were performed nine years after planting. An experimental design of Randomized Complete Block Design was adapted. The result shows that the survival rate of species planted ranged from 20.7 to 74.1% with *C. iners* attaining the highest survival rate followed by *A. excelsa* and the lowest was recorded by *S. leprosula*. *A. excelsa* exhibited the highest growth increment in terms of diameter at breast height (DBH) and height followed by *S. leprosula* and the lowest was recorded for *I. palembanica*. This indicates that some indigenous species can be adapted to rehabilitate degraded forestland.

Key words: Growth performance, indigenous species, degraded land, survival rate, tropical tree

Introduction

The world's forests are the focus of international attention because of the many environmental issues being discussed recently. According to FAO (2002), cited from Rashid (2004), the world's forests are estimated to cover 3.9 billion hectares or 29.8% of the earth's land surface. From this total, an estimated 1,751 million hectares or 44.9% are located in the developed countries while the balance of 2,149 million hectares or 55.1% are within the developing countries. About 95% of these forests are natural forests while 5% being plantation forests.

As globalization increases, the forest plantation has the potential to contribute to industrial wood and fiber in the coming decades. However, natural forest will not be able to supply all the demands. Therefore, plantations are expected to provide an increasing share of total industrial requirements and may even contribute a larger than natural forests by the end of this period (Hummel, 2001). Forest rehabilitation by introduction enrichment plants is commonly practiced in Malaysia in regenerating degraded land forest. However, the selection of the right species played a very important in determining the successful rehabilitate of the degraded forest land. The degraded forest land is referred to forests where trees are removed and are being farmed in an unsuitable manner.

Rehabilitation using indigenous timber species on a larger scale usually encountered the following obstacles; irregular supply and recalcitrance of seeds and high variability in growth of seedlings of as yet unknown genetic potential, as seedlings are raised from stumps or wildings (Wyatt-Smith, 1963).

Reforestation of logged over forests has been successfully implemented in some Forest Reserves Areas in Selangor, Perak and Negeri Sembilan (Lall Singh, 1970). Rehabilitation efforts in degraded land, was one of the main agenda in the country forest replanting programme. Sabah Forestry Development Authority (SAFODA) was chiefly created in 1976 to implement the reafforestation of wastelands in

shifting cultivation areas. Up to date an area of 50,000 ha was planted with the *Acacia mangium* plantation. This programme also established several trials plots to determine the practicability of enrichment planting (Domingo, 1979). The experiments were not successful with an average survival rate of only 20%. The best trial showed an overall survival rate of 59%. The most abundant species surviving was *Dryobalanops lanceolata* (Kapur) 74%, *Dipterocarpus caudiferus* (Keruing) 61% and *Parashorea tomentella* (White seraya) 58%.

The current studies also focus on the enrichment planting but on a different site with different soil characteristics. It aims on identifying on the best species for plantation and rehabilitation among selected wood species. Apart from that it also evaluates the quantitative information and to identify the growth and survival rates of selected indigenous species planted. Criteria for evaluation are based on good growth performance, high survival rate and also maintenance costs.

Materials and Methods

Five indigenous species were selected for the study. These are the dipterocarp and non-dipterocarp species comprising of *Azadirachta excelsa*, *Cinnamomum iners*, *Intsia palembanica*, *Hopea pubescens* and *Shorea leprosula*. The study area was located in Pasoh Forest Reserve Area, Negeri Sembilan (about 120 km from Kuala Lumpur). It covers an area of 2,450 hectares and was a logged and clear felled area (using the crawler tractor and left idle). The experimental plot chosen (42 ha.) was a degraded logged-over forest established in August, 1995. Various indigenous timber species were planted. The mean annual rainfall for a ten years period (1994 to 2003) was 1233.83 mm and the area experiences rainy season in November, October and April. The mean daily temperature was 20.3 to 30.7°C. The mean monthly relative humidity of the area was about 80%. The soil composed mainly of the Paleozoic sedimentary rocks, which is principally characterized by limestone, quartzite and shale (Wyatt-Smith, 1963). The vegetation of the area was predominated by *Intsia palembanica*, *Sindora* spp., *Shorea* spp. and *Dipterocarpus* spp., *Macaranga gigantea*, *Trema orientalis* and *Melastoma malabatricum* (Johari, 2000).

An experimental design of Randomized Complete Block Design (RCBD) was used to analyze the data obtained from three replications of 30×150 m block. Each block subdivided into 30 subplots with 5×10 m each. In each subplot, a total of 15 seedlings were line-planted at a spacing of 2×2 m. The total number of potted-seedlings planted was 1,350. Open planting technique had been used.

The growth criteria measured were the diameters at breast height and the total height of the planted wood spp. Diameter breast height (DBH) taken at 1.3 m from root collar by using Digimatic Diameter Calliper. The height of the plants measured from the root collar to the base of the top bud by using Height poll and Haga. Measurement of the data was recorded to two decimal points. The survival percentage of each species was also noted.

Data was subjected to the analysis of Variance and Duncan's Multiple Range Test. An Analysis of Variance was used to evaluate the growth performance of the species.

Results

Table 1 shows the mean diameter at breast height (DBH), mean total height, mean diameter and mean height increment of the *Azadirachta excelsa*, *Cinnamomum iners*, *Intsia palembanica*, *Hopea pubescens* and *Shorea leprosula* evaluated.

Survival Rate of Trees

From the results obtained the survival rate of all the 5 species studied shows some variation after 9 years of cultivation. The survival rate varies from species to species. The results as exhibited

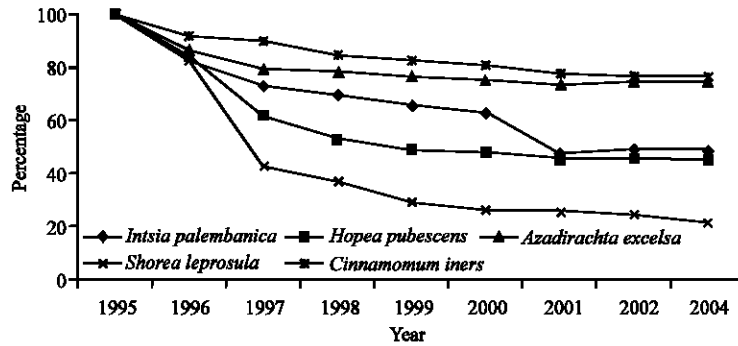


Fig. 1: Survival rate of nine years old of five tree species planted at open area

Table 1: Mean for total Diameter at Breast Height (cm), total height, diameter and height increment after 9 years old of five tree species

Species (survival rate)	No. of trees	Total DBH (2002)	Total DBH by block	*Mean total DBH (2004)	*Mean increment (2002- 2004)	*Mean increment diameter (cm year ⁻¹)	Total Height (2002)	Total height by block	*Mean total height (2004)	*Mean increment (2002- 2004)	*Mean increment height (m year ⁻¹)
<i>A. excelsa</i> (74.10%)	1	37	10.56	9.71	12.67 ^a	2.11 ^a	10.23	11.28	12.98 ^a	2.75 ^a	1.38
	2	32		13.69				13.85			
	3	31		15.16				14.12			
<i>C. iners</i> (76.3%)	1	37	7.4	9.03	9.36 ^c	1.96 ^c	4.46	6.04	6.00 ^d	1.54 ^d	0.77
	2	33		10.41				6.47			
	3	33		8.68				5.47			
<i>H. pubescens</i> (44.4%)	1	21	5.26	7.97	7.28 ^d	2.02 ^b	5.36	7.01	7.43 ^c	2.07 ^c	1.04
	2	29		7.42				8.07			
	3	16		5.42				6.46			
<i>I. palembanica</i> (48.2%)	1	20	3.98	5.79	5.91 ^d	1.93 ^b	4.21	5.42	5.82 ^d	1.61 ^d	0.81
	2	26		6.07				6.07			
	3	19		5.83				5.9			
<i>S. leprosula</i> (20.7%)	1	11	9.10	9.28	11.15 ^b	2.05 ^a	8.86	11.46	11.18 ^b	2.32 ^b	1.16
	2	9		10.95				10.15			
	3	8		13.92				11.95			

All data taken from mean of three replicates. * Mean for total DBH, total height and increment height (by column) are significantly different ($p \leq 0.05$) by Duncan's New Multiple Range Test

in Table 1 and Fig. 1 showed that the survival rate of *Cinnamomum iners* (76.3%) was the highest followed by *Azadirachta excelsa* (74.1%), *Intsia palembanica* (48.2%) and *Hopea pubescens* (44.4%). The *Shorea leprosula* recorded the lowest survival rate at only 20.7%. Of the five species studies, the non dipterocarp species showed better survival rates as compared to the dipterocarp species.

Growth Diameter Trees

From the Table 1, the highest mean increment of diameter at breast height (DBH) for two years periods (2002-2004) (recorded when the trees were at ages 7 to 9 years) by *Azadirachta excelsa* which is 2.11 cm, followed by *Shorea leprosula*, *Hopea pubescens*, *Cinnamomum iners* and *Intsia palembanica* which are 2.05, 2.02, 1.96 and 1.93 cm respectively. However, statistical analysis conducted showed no significant difference ($p = 0.05$) between the increments of DBH.

Growth Height Trees

The highest mean increment of height (Table 1) for two years periods (2002-2004) (recorded when the trees were at ages 7 to 9 years) was recorded by *Azadirachta excelsa* at 2.75 m and followed by *Shorea leprosula*, *Hopea pubescens*, *Intsia palembanica* and *Cinnamomum iners* at 2.32, 2.07, 1.61 and 1.54 m, respectively. Statistical analysis showed a significant difference ($p \leq 0.05$) between the

increments of height except *C. iners* and *I. palembanica*. *A. excelsa* also had the highest mean annual increment of height is 1.38 m year⁻¹. Meanwhile, *S. leprosula*, *H. pubescens*, *I. palembanica* and *C. iners* have gained 1.16, 1.04, 0.81 and 0.77 m year⁻¹, respectively.

Discussion

The survival rate of the cultivated species depends very much on the genetic and their adaptability to the environment. However, there are two factors that influenced growth performance of species in forestland, which are by edaphic and climatic factors. Edaphic factors refer to soil properties such as soil texture, moisture content, bulk density, particle density, organic matter and nutrient content. Environment factors like weather condition, pest attack and animal distribution, planting technique, weed competition and poor soil condition are the factors possibly lead to variation in survival rate and growth performance (Evans *et al.*, 1992). In addition, growing space also contribute to the growth performance (Zaki *et al.*, 1998). According Zaki *et al.* (1999) the rehabilitation of tropical rainforests: some experiences in Indonesia and Malaysia. growth in terms of height and diameter increment are influenced by the big growing space. However, this would most likely to promote weed or climbers to grow and invade the site.

The mean increment in diameter and the tree height shows an almost similar pattern except in the species of *C. iners* and *I. palembanica* where they change places from mean diameter to tree height. Similar results were obtained by Appanah and Weinland (1993) in their studies on same indigenous wood species in ex-mining land.

The previous data collected in 2002 (Sainih, 2003) show the mean annual increments height of 1.34, 1.83, 0.98, 0.74 and 0.65 m year⁻¹, respectively. In the present study, however, decreases in the mean annual increment of height were observed. Appanah and Weinland (1993) also obtained similar results in the annual increment in height for *S. leprosula* and *I. palembanica*.

Conclusions

Cinnamomum iners (76.3%) shows the highest survival rate, followed by *Azadirachta excelsa* (74.1%), *Intsia palembanica* (48.2%) and *Hopea pubescens* (44.4%).

Azadirachta excelsa has the highest mean increment of diameter at DBH at 2.11 cm, followed by *Shorea leprosula*, *Hopea pubescens*, *Cinnamomum iners* and *Intsia palembanica* which are 2.05, 2.02, 1.96 and 1.93 cm, respectively.

Azadirachta excelsa possess the highest increment of height at 2.75 m and followed by *Shorea leprosula*, *Hopea pubescens*, *Intsia palembanica* and *Cinnamomum iners* at 2.32, 2.07, 1.61 and 1.54 m, respectively.

Overall performance indicates that *Azadirachta excelsa* and *Cinnamomum iners* have good performance both in survival rate and growth in the open planting technique.

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