PLANTING OF *GONYSTYLUS BANCANUS* IN NON-PEAT SWAMP AREA

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ISMAIL, P., SHAMSUDIN, I., ABDUL RAHMAN, K., HASHIM W. S. & ISMAIL, H. 2007. Planting of *Gonystylus bancanus* in non-peat swamp area. *Gonystylus bancanus* is the most valuable timber species in peat swamp forests. It has high potential as plantation species since planting material can be raised easily either through seeds or vegetative propagation. However, establishment of forest plantations in peat swamp forest has many problems mainly due to poor accessibility and low soil productivity. Therefore, plantations may not be successful ventures without intensive management with high capital inputs. Establishment of *G. bancanus* plantations outside peat swamp areas would be a better solution. This study was conducted to investigate the potential of using *G. bancanus* as a plantation species in a non-peat swamp area. This paper reports on an 11-year planting trial conducted at the Forest Research Institute Malaysia whereby *G. bancanus* seedlings were planted in a non-peat swamp area. Survival was 52%, with an average of 816 cm total height and 9.1 cm diameter at breast height. Average yearly increments for total height and diameter at breast height were 69 and 0.95 cm year^{-1} respectively. In terms of wood strength, 11-year-old *G. bancanus* showed acceptable strength property and is useful for certain wood-based products. Based on physical and mechanical properties, this timber may be used for furniture manufacturing, internal joinery, holders and wooden toys. The limiting factors on utilization were the relatively small diameter and length of log.

Keywords: Ramin, survival, tree growth, strength properties, Peninsular Malaysia

ISMAIL, P., SHAMSUDIN, I., ABDUL RAHMAN, K., HASHIM W. S. & ISMAIL, H. 2007. Penanaman *Gonystylus bancanus* di kawasan bukan paya gambut. *Gonystylus bancanus* merupakan spesies kayu balak yang paling komersial di hutan paya gambut. Spesies ini berpotensi sebagai tanaman ladang memandangkan bahan tanaman boleh dihasilkan dengan mudah melalui biji benih atau pembiakan tampang. Bagaimanapun, penubuhan ladang hutan di kawasan paya gambut mempunyai banyak masalah terutamanya yang berkaitan dengan jalan perhubungan dan produktiviti tanah yang rendah. Oleh itu, ladang hutan mungkin tidak akan berjaya tanpa pengurusan intensif dengan modal yang tinggi. Penubuhan ladang *G. bancanus* di kawasan bukan paya gambut boleh digunakan sebagai jalan penyelesaian. Kajian ini dilakukan untuk menyelidiki potensi *G. bancanus* sebagai spesies ladang di kawasan bukan paya gambut. Kertas kerja ini melaporkan tentang percubaan tanaman *G. bancanus* selama 11 tahun di kawasan bukan paya gambut di FRIM. Kemandiriannya ialah 52% dengan purata tinggi penuh sebanyak 816 cm dan purata diameter pada paras dada sebanyak 9.1 cm. Purata pertumbuhan tahunan bagi tinggi penuh dan diameter pada paras dada ialah masing-masing 69 cm setahun dan 0.95 cm setahun. Dari segi kekuatan kayu, *G. bancanus* berumur 11 tahun mempunyai ciri-ciri kekuatan kayu yang mencukupi bagi menghasilkan beberapa jenis produk berasaskan kayu. Berdasarkan ciri-ciri fizikal dan mekanikal, kayu berkenaan boleh digunakan untuk membuat perabot, sambungan dalaman, pemegang dan alat permainan. Faktor yang mengehadkan penggunaannya ialah diameter yang kecil dan batang yang pendek.

INTRODUCTION

Among the species in the peat swamp forest (PSF), *Gonystylus bancanus* has special attractions and many studies have been carried out on this species. It is the most important source of *Gonystylus* timbers and considered as one of the major export timbers of South-East Asia (Soerianegara & Lemmens 1994) with a good market demand, both locally and overseas (Appanah *et al.* 1999). Timber of *G. bancanus* is categorized as light heavy hardwood with a wood density of about 655 kg m^{-3}. The timber is widely used for decorative cabinet making and furniture (Ng & Shamsudin 2001). It is also suitable for general light construction, and for interior decoration such as panelling, flooring, moulding and counter-tops.

A total of seven species of *Gonystylus* have been recorded in Peninsular Malaysia, but *G. bancanus*

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is the only one found in the PSF. The species is distributed in south-western Peninsular Malaysia, south-eastern Sumatra, Bangka and Borneo (Soerianegara & Lemmens 1994).

Gonystylus bancanus is a medium-sized to fairly large tree, occasionally attaining 90 cm diameter at breast height (dbh) and 45 m height with a clean straight bole of 20–30 m (Soerianegara & Lemmens 1994). A study by Appanah *et al.* (1999) showed that the species is the third most abundant species found at the Raja Musa Forest Reserve (FR) with a total basal area of 128 $m^2 ha^{-1}$ and a density of 210 stems ha^{-1} for individuals ≥15 cm dbh. Young individuals tend to clump together within a small area underneath the mother tree. Regeneration is mostly within a parameter of 10 m radius from the mother tree. The number decreases with increasing distance and no single seedling has been recorded at a distance of 20 m away from the mother tree (Shamsudin 1996).

The species shows regular flowering and fruiting behaviour with mass fruiting observed in 1993 and 2004 (Shamsudin, pers. obs.). It was found that in the Pekan FR on the east coast of Peninsular Malaysia, the species flowers at the beginning of the year and the mature fruits drop in March till April. Seeds of *G. bancanus* have a reasonably high percentage of germination of more than 80% (Shamsudin 1996, Ismail & Shamsudin 2003).

The species shows strong rooting through stem cutting (Mohamad Lokmal *et al.* 1992, Ismail & Shamsudin 2003) and has potential to produce plantlets through tissue culture (Shamsudin & Aziah 1992). Therefore, getting a perpetual supply of planting material, independent of fruiting seasons is very promising for *G. bancanus*. This important criterion qualifies the species to be considered as one of the potential timber species to be introduced for large-scale forest plantation.

This paper reports on results of an 11-year planting of *G. bancanus* in a non-peat swamp area. The main objective of the study was to investigate the suitability of planting *G. bancanus* as a forest plantation species in a non-peat swamp area.

MATERIALS AND METHODS

The planting trial started in 1993 at Field 15C, Forest Research Institute Malaysia (FRIM). Physical and chemical analyses of the soil were carried out. The site has good drainage system and is located adjacent to a small stream. It is an open area covered with grass. A total area of 20 × 40 m was demarcated for the trial and seedlings were planted in a row at 2 × 2 m spacing.

A total of 200 seedlings with average total height of 49 cm were used and about 20 g of slow release phosphate were applied in each planting hole. Survival and growth data were recorded and measured on a yearly basis after planting started except for 1995 due to some technical problems. Meanwhile, dbh measurement at 1.3 m above ground was recorded starting 1996. The average annual rainfall is about 2682 mm. For this paper, analysis was based on the measurement conducted in 2004.

Five trees were selected randomly and felled from the *G. bancanus* plot for strength property tests. The sampling of the test specimen was done in accordance to the International Standard Organization (ISO) procedures, ISO 3129:1975(E)––wood sampling methods and general requirements for physical and mechanical tests. Three types of strength properties were investigated. These were static bending, compression parallel to the grain and shear parallel to the grain. In addition, the specific gravity of the specimen at test was also measured.

RESULTS AND DISCUSSION

Soil properties

Soil properties of the planting site are shown in Table 1. The soil is classified as sandy loam with 60% sand, 20% silt and 20% clay. Meanwhile, Table 2 shows an example of peat soil properties with an average pH of 4.2 (Ismail 2001). Obviously, C availability in peat soil is very high with C/N ratio of more than 50%, which hinders the movement of nutrients. Therefore, soil in the planting site is considered more fertile compared with peat soil.

However, based on analysis and physical observation, soil in the planting site was considered moderately fertile. Therefore, about 100 g of NPK fertilizer were applied to all the trees annually. Fungus (Basidiomycetes group) caused mortality of some trees (Maziah 1998). Some of the trees suffered root disease or were affected by stem borer (*Zeuzera* spp.) (Azmi

2002). A plant pathologist and an entomologist were consulted to counter the problems of pests and diseases.

Survival

Table 3 shows that 11 years after planting, the percentage of survival was 52%. In general, survival was stable after seven years of planting with about 53% survival, although the survival slightly decreased to 52% in year 11. In the early stages, survival exhibited a declining pattern (the first six years) and started to stabilize after seven years.

A number of factors have been identified as causes of mortality of trees. In the early establishment, some of the trees died due to disturbances by wild boar. Wild boars used the area as feeding ground, which resulted in some of the trees being physically affected and subsequently died. There was an incidence of the El Nino phenomenon in 1998 (Santhira 2002). The incidence significantly affected plant growth as is shown by the total height results of only 39 cm year^{-1} as compared with the average of 69 cm year^{-1}.

Diameter at breast height

The average dbh increment from 1996 till 2004 was 0.95 cm year^{-1}(Table 4). Average dbh in 1996 was 1.5 cm, while in 2004 the average dbh was 9.1 cm. Figure 1 shows dbh class distribution in 2004 whereby the trees were distributed at ≥ 8.0 cm. In 2004, 9.7% of the survived trees had dbh > 13.0 cm.

Total height

The average total height increment over a period of 11 years was 69 cm year^{-1}(Table 5). At 11 years the average height of trees was 813 cm. Figure 2

Table 1 Summary of the soil chemical properties

Depth (cm)	N (%)	Org C (%)	Available P (ppm)	Exch. Ca (cmol kg^{-1})	Exch. Mg (cmol kg^{-1})	Exch. K (cmol kg^{-1})	pH (wet)
10	0.2	1.53	19.6	0.75	0.19	0.20	3.94
20	0.1	0.99	7.3	0.4	0.07	0.09	4.10
30	0.1	0.88	12.9	0.31	0.04	0.08	4.28

Table 2 Properties of peat soil

Depth (cm)	N (%)	Org C (%)	P (%)	Ca (%)	Mg (%)	K (%)
10	0.91	50.8	0.09	0.15	0.03	0.05
20	0.86	42.5	0.04	0.15	0.02	0.04
30	0.68	49.8	0.03	0.14	0.02	0.06

Source: Ismail (2001)

Table 3 Survival of *Gonystylus bancanus* 11 years after planting

Year	No. of trees survived	Survival (%)
1993	200	100
1994	177	89
1995	NA	NA
1996	142	71
1997	127	64
1998	116	58
1999	108	54
2000	106	53
2001	106	53
2002	106	53
2003	106	53
2004	104	52

NA = not available

Table 4 Average dbh measurement of planted trees from 1996 till 2004

Year	Average dbh (cm)	Increment (cm)
1996	1.5	–
1997	2.5	1.0
1998	3.2	0.7
1999	3.8	0.8
2000	5.5	1.7
2001	6.3	0.8
2002	7.4	1.1
2003	7.9	0.5
2004	9.1	1.2
	Average increment	0.95 (0.47)

Value in parenthesis denotes standard deviation.

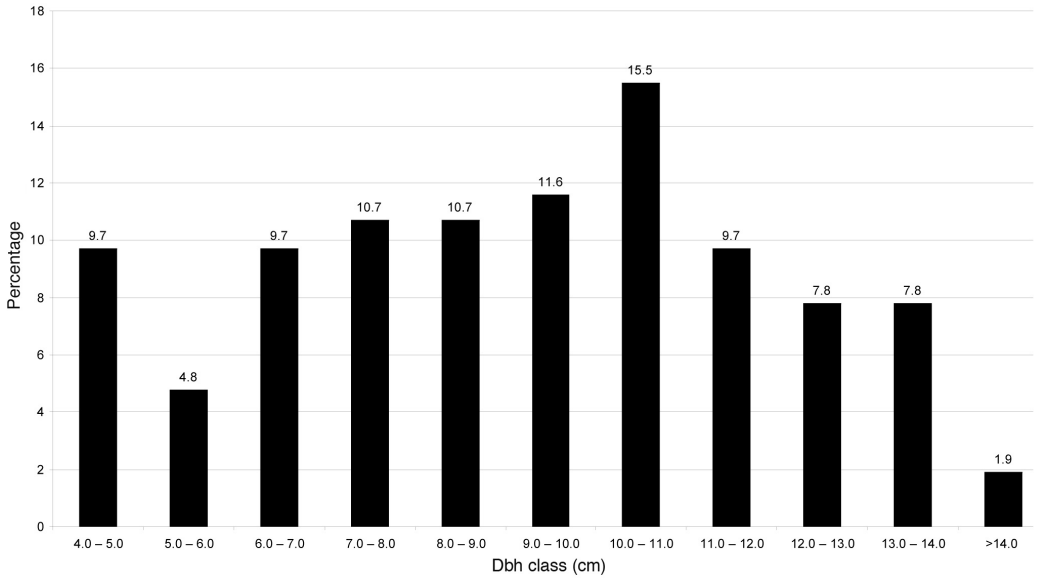

Figure 1 Dbh classes distribution in percentage of the planted trees in 2004

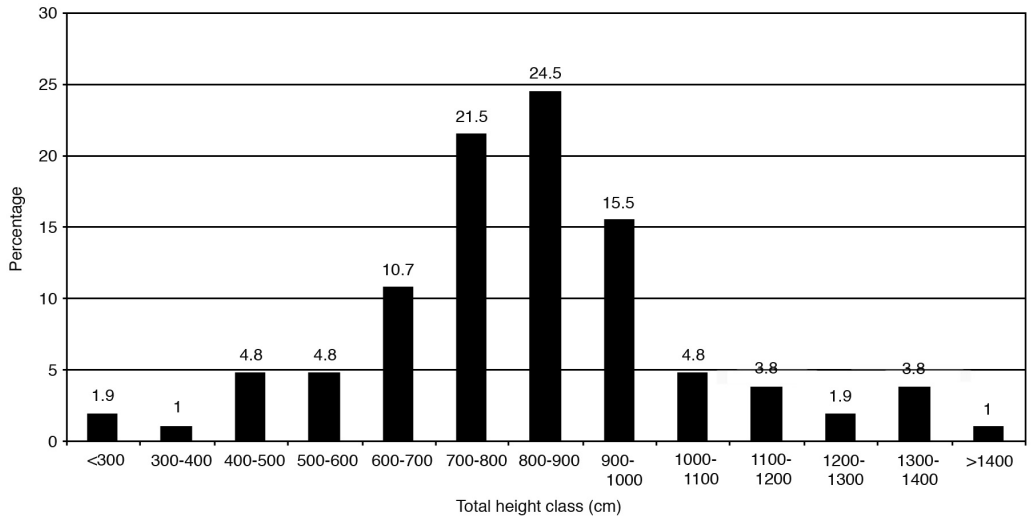

Figure 2 Total height class distribution of the planted trees in 2004

Table 5 Average yearly total height measurement

Year	Average total height (cm)	Increment (cm)
1993	49	–
1994	91	42
1995	NA	NA
1996	202	111
1997	272	70
1998	306	34
1999	391	85
2000	490	99
2001	562	72
2002	624	62
2003	753	129
2004	813	60
	Average increment	69 (28)

NA = not available
Value in parenthesis denotes standard deviation.

shows the total height class distribution of the planted trees in 2004. In 1993 when the trees were planted, all trees were less than 100 cm. In the latest measurement (2004), the majority of the trees were ≥ 800 cm tall. In 2004, 3.9% of the survived trees had individual total height of > 1300 cm. The average total height and dbh increment 11 years after planting were 69 cm and 0.95 cm year^{-1} respectively.

Only about 25% of the trees had total height of less than 800 cm. Most of these trees were located at the fringe of the planting plot, so that they were negatively affected by shading effect from nearby plants. On the contrary, most of the tall trees (total height ≥1000 cm) were located in centre of the planting plot. Based on this study and a study by Ismail (2001), it can be concluded that *G. bancanus* requires relatively high quantity of light. Height has positive association with dbh whereby tall trees have higher dbh.

Stand Visualization System

Stand Visualization System (SVS) is used to assess the stand condition in three dimensions. In general, the software allows the assessment of various stand parameters such as different view layout, summary of stocking, species composition, structural diversity and status of crown development. The images produced by SVS provide a self-explanatory representation of stand conditions, which could assist communication on silvicultural treatments and forest management alternatives (Abd. Rahman *et al.* 2004).

It is more suitable in even-aged stand such as the forest plantation. In this study, the use of SVS was to determine the status of crown development. Parameters needed to develop the SVS diagram are tree position, total tree height, crown height and crown diameter. Figure 3 shows that most of the trees, particularly those located in the middle of the plot, have their crown already touching. It shows that the spacing of 2 × 2 m may not be suitable for use in *G. bancanus* planting. Greater initial spacing such as 3 × 3 m or 3 × 4 m may be more suitable.

Further studies on appropriate spacing and silvicultural treatments such as thinning regime are necessary. The SVS diagram also showed that larger trees were mostly located in the centre of the plot. This is because there was enough light in the centre of the plot compared with the fringe of the plot that was slightly covered by other plants.

Strength properties

The results of mean strength properties are presented in Table 6. The comparison of the properties in terms of modulus of rupture (MOR), modulus of elasticity (MOE), compression and shear with rubberwood of 14 years old and mature *G. bancanus* were also tabulated (Lee *et al.* 1979, Anonymous 1993).

Taking the age factor into account, this juvenile thinning stock of *G. bancanus* timber shows considerable acceptable strength properties. The mean specific gravity was 0.53. This value is in the minimum range as stated in the Malaysian Grading Rules or MGR (Anonymous 1987). The MGR categorizes *G. bancanus* timber under light hardwood with depicted specific gravity

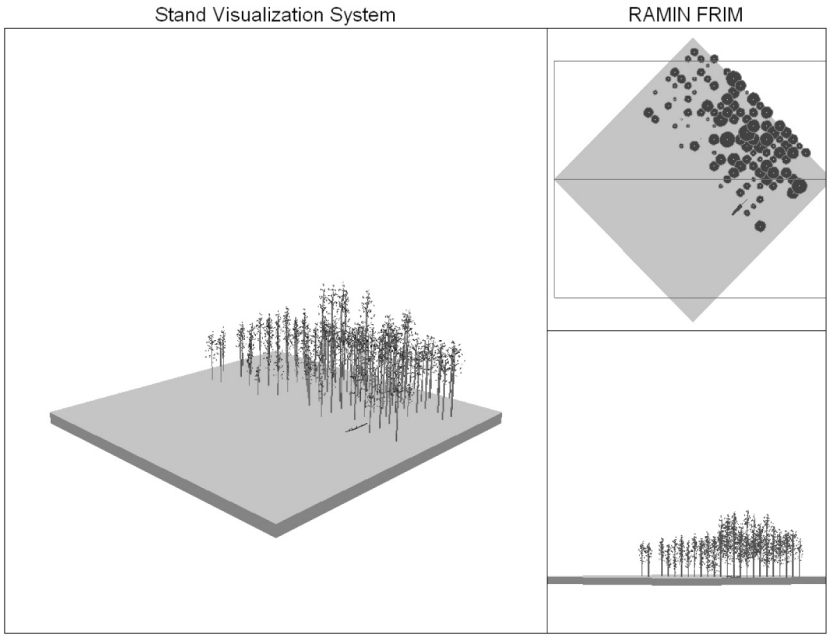

Figure 3 The SVS diagram for status of crown development of the *G. bancanus* stands in 2004 (aerial and vertical views)

Table 6 Comparison of mean strength properties of 11-year-old planted *G. bancanus* with mature *G. bancanus* and rubberwood

Material	Specific gravity	Static bending (MPa)		Compression (MPa)	Shear (MPa)
		MOR	MOE		
Planted *G. bancanus* aged 11 years	0.53	75.7 (6.8)	8150 (1,087)	37.2 (3.3)	10.2 (1.1)
Mature *G. bancanus* (Lee *et al.* 1979)	0.59	88.0 (6.9)	13 900 (1,310)	48.8 (4.1)	8.5 (1.05)
Rubberwood of PB260 clone aged 14 years (Anonymous 1993)	0.58	81.2 (5.7)	8564 (1,337)	33.5 (2.7)	12.48 (0.93)

Values in parentheses denote standard deviations.

range between 0.53 and 0.78. Since all the values published in the MGR were derived from previous records (since 1940 and 1950), it can be considered as values for mature *G. bancanus*. Means MOR and MOE for planted *G. bancanus* were 75.7 and 8150 MPa respectively. Both MOR and MOE values were 13.9 and 41.4% lower than mature *G. bancanus*. This is expected as bending strength is generally considered to be directly related to specific gravity.

The shear strength for planted *G. bancanus* was relatively higher as compared with mature *G. bancanus*. The strength is a measurement of the ability to resist internal slipping of one part upon another along the grain. Such property is important for timber construction and furniture components, especially jointing parts. Technically, the timber is able to hold up high shear stress for use as furniture components.

In term of compression property, the timber could withstand stress up to 37.2 MPa. This value, however, is lower as compared with mature *G. bancanus* but higher than 14-year-old rubberwood. These results may be due to higher specific gravity for both timbers during testing and also the age factor.

Technically, *G. bancanus* timber from 11-year-old thinning stocks showed an acceptable strength property and could be used for several uses. Based on physical and mechanical

properties, this timber could be used in furniture manufacturing, internal joinery, holders and wooden toys. However, problems may rise from the diameter and length of logs. The logs were considered too small to be recovered into an acceptable number and be sawn into sizes for furniture components. Furthermore, the recovery rate may, to a certain extent, reduce after the drying process. Taking the diameter factor into account, it is suggested that the 11-year-old *G. bancanus* logs be converted into fibre or particles for composite products such as particleboard and fiberboard.

CONCLUSIONS

The species maintained a vigorous sprouting ability even in non-peat swamp area. A medium percentage of survival during the critical period of establishment between 1 and 11 years is an indication that the species has potential for forest plantation in areas outside PSF habitats. Based on physical and mechanical properties, the 11-year-old timber is suitable for certain wood-based products. However, limitation in terms of size and length of logs should be considered in utilization.

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