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Two-year Performance of *Acacia crassicarpa* Provenances at Serdang, Malaysia

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ABSTRAK

Satu percubaan yang melibatkan lapan provenans Acacia crassicarpa *A. Cunn. ex Benth. diukur kemandirian dan pertumbuhan pada umur dua tahun. Dari kesemua provenans ini, tiga berasal dari Queensland utara, Australia, empat dari Papua New Guinea dan satu dari Irian Jaya, Indonesia. Kesemua provenans menunjuk kemandirian baik (>94%), tetapi berbeza dengan bererti ($p < 0.01$) dari segi pertumbuhan. Kesemua provenans mempunyai lebih dari 43% pokok yang berbatang satu. Untuk pengeluaran kayu, provenans dari Irian Jaya (Samlleberr) dan 2 provenans dari Queensland (Olive River dan Jardine River-Bamaga) dikenalpasti berpotensi baik.*

ABSTRACT

A trial of eight provenances of Acacia crassicarpa *A. Cunn. ex Benth. was assessed for survival and growth at age two years. Three provenances were from northern Queensland, Australia, four from Papua New Guinea and one from Irian Jaya, Indonesia. All provenances survived well (> 94%), but they differed significantly ($p < 0.01$) in their growth performance. All provenances had more than 43% of their trees with single stems. For timber production, the provenance from Irian Jaya (Samlleberr) and two provenances from Queensland (Olive River and Jardine River-Bamaga) were identified as promising.*

INTRODUCTION

Acacia crassicarpa A. Cunn. ex Benth., native to northeastern Queensland, Australia, southwestern Papua New Guinea, and southeastern Irian Jaya, Indonesia, is one of the humid/subhumid tropical acacias with potential for wood production for fuelwood, timber and pulp (Harwood 1992; Thomson 1994). It fixes nitrogen, grows rapidly, and competes effectively with weedy grasses. It appears able to tolerate a wide range of soil textures, with pH ranging from 4 to 8, and a dry season up to six months and annual rainfall as low as about 900 mm.

However, many of the acacia plantations in the Asian tropical regions are based on *Acacia mangium* and *Acacia auriculiformis* (Pinyopusarerk 1992). Early reports on the evaluation of several *A. crassicarpa* provenances in Thailand (Chittachumnonk and Sirilak 1991), Malaysia (Sim and Gan 1991), Sri Lanka (Weerawardane and Vivekanandan 1991), Hainan Island, China (Yang and Zeng 1991), Vietnam (Kha and Nghia 1991), and Laos (Latsamay 1991) indicate that their growth is either better or comparable to those of *A. mangium* and *A. auriculiformis*. These provenance trials of *A. crassicarpa* have also demonstrated the superior vigour of provenances from Western Province, Papua New Guinea over those from north Queensland (Thomson 1994). In Malaysia, the introduction of *A. crassicarpa* has been limited to Sabah (Sim and Gan 1991). This paper reports on the survival and growth of eight provenances of 2-year-old *A. crassicarpa* in a trial at Serdang, Peninsular Malaysia.

MATERIALS AND METHODS

Seedling Establishment

Eight seedlots of *A. crassicarpa* provided by the Australian Tree Seed Centre of Commonwealth Scientific and Industrial Research Organisation (CSIRO) were used. The seeds were collected from the species' natural distribution in northern Queensland, Australia, Papua New Guinea and Irian Jaya, Indonesia. This is one of the first provenance trials to include a seedlot from Irian Jaya, Indonesia for comparison with Papua New Guinean and Australian seed sources. Table 1 provides details of seed origin.

The seeds were pretreated by soaking in hot water at 80°C for 30 seconds and then in water at room temperature for 10 minutes. The procedure was repeated three times. The seeds were then air dried, sown in containers filled with washed river sand, and later transplanted into polythene bags. Inoculation with *Rhizobium* was not made in the nursery. The seedlings were about four months old when planted out.

Field Establishment

The field trial was established in January 1992 at Universiti Pertanian Malaysia (UPM) Farm, Serdang (latitude 3° 02'N, longitude 101° 42'E, altitude 32 m) representing a humid site under *Imperata cylindrica* grass. Mean annual rainfall is 2140 mm and mean annual temperature 26°C. The site experiences an average windspeed of 0.86 m/sec, receiving a daily average of 5.8 h of sunshine and an annual evaporation of 1527 mm. The soil is fine-loamy, mixed, Typic Hapludults, isohyperthermic and udic, with a pH of 4.4. The site was fully cultivated before planting.

A randomised complete block design with six replicates was used. Each replicated plot consisted of 16 trees (4 x 4) spaced at 3m x 3m. The plots were weeded every three months during the first year, and less frequently thereafter.

Assessment and Analysis

Measurements of height, diameter at breast height (dbh) and survival were made for all trees every six months after planting. Square root of the sum of the squares of each individual stem was used to calculate dbh of multi-stemmed trees. At 24 months, trees were also individually assessed for form following three classes:

Class 1: Tree with one main leading stem up to the tip. Branches are small, with a basal diameter less than 50% of the principal bole at the same height.

Class 2: Tree with more than one leading stem originating at a height more than 50 cm above the ground. The branching bole is considered a stem if its basal diameter is equal to or greater than 50% of the diameter of the principal bole at the same height.

Class 3: Tree with more than one leading stem originating below a height of 50 cm above the ground. The distinction of a branching bole is the same as for Class 2.

TABLE 1
Details of the eight provenances of seedlots of *Acacia crassicarpa*

No.	CSIRO Seedlot No.	Provenance		Lat. (S)	Long. (E)	Alt. (m)	No. parents
1	16128	Jardine River - Bamaga	QLD	11° 02'	142° 22'	20	15
2	17943	Olive River	QLD	12° 19'	142° 50'	60	5
3	17944	Claudie River	QLD	12° 48'	143° 18'	20	4
4	16598	Bimadebun Village	PNG	8° 37'	141° 55'	25	40
5	17548	Oriomo Old Zim	PNG	8° 48'	143° 06'	20	5
6	17552	Bensbach	PNG	8° 53'	141° 17'	25	35
7	17561	Limal-Malam	PNG	8° 40'	142° 43'	40	30
8	17849	Samlleberr, Irian Jaya	IND	8° 20'	141° 00'	40	5

QLD = Queensland, Australia; PNG = Papua New Guinea; IND = Indonesia

The two years' data were analysed for variance, and provenance means were compared using studentised range test. MPTStat, a statistical package developed by the Forestry/Fuelwood Research and Development Project of Winrock International, was used for the analyses.

RESULTS

Survival for all the provenances was high, percentages ranging from 94.5 to 100%, and showed no statistical differences among provenances (Tables 2 and 3). Lowest survival was recorded for the Bimadebun Village provenance from Papua New Guinea, while the Jardine River provenance from Queensland had 100%. survival.

However, the provenances showed significant differences in their height and diameter growth (Table 2). Significant differences were also recorded among provenances from Queensland and Papua New Guinea (Table 3). The overall ranking based on the mean of the ranks assigned for each parameter indicates that the Samlleberr provenance from Irian Jaya, Indonesia was the best performer, followed by two provenances from Queenland (Olive River and Jardine River). The poorest provenance was from Claudie River, Queensland. The four provenances from Papua New Guinea (Bimadebun Village, Oriomo Old Zim, Bensbach and Limal-Malam) were intermediate in their performance.

TABLE 2
Analysis of variance of survival, height, and diameter breast height (Dbh) of 2-year-old *Acacia crassicarpa* provenances

Parameter	Source of variation	df	Mean square	P. value	C.V. (%)
Survival	Provenance	7	15.283	0.5205	
	Replication	5	27.471	0.1831	
	Residual	35	17.061		4.2
Height	Provenance	7	4.896	0.0025	
	Replication	5	9.737	0.0000	
	Residual	35	1.216		13.2
Dbh	Provenance	7	5.627	0.0000	
	Replication	5	0.883	0.3773	
	Residual	35	0.802		10.2

TABLE 3
Performance of 2-year-old *Acacia crassicarpa* provenances

Provenance		Survival (%)	Height (m)	Diameter breast height (cm)	Composite ranking
Jardine River - Bamaga	QLD	100.0 a	8.8 abc	8.5 abd	3
Olive River	QLD	97.7 a	9.4 abcd	9.6 ae	2
Claudie River	QLD	97.7 a	6.7	7.1 bc	7
Bimadebun Village	PNG	94.5 a	7.4 ab	7.5 bc	8
Oriomo Old Zim	PNG	97.8 a	8.2 ab	7.8 b	5
Bensbach	PNG	97.7 a	8.9 abcde	8.4 abdf	4
Limal-Malam	PNG	96.7 a	8.6 a	9.4 a	5
Samlleberr, Irian Jaya	IND	98.8 a	9.0 abcde	9.6 ae	1

Means having the same letter are not significantly different at p = 0.05
Composite ranking = Means of survival, height and diameter breast height

TABLE 4
Percentage of trees in tree form classes of various provenances of *Acacia crassicarpa*

Provenance		Class 1	Class 2	Class 3
Jardine River - Bamaga	QLD	49.0	16.7	34.3
Olive River	QLD	56.0	14.9	28.5
Claudie River	QLD	48.5	36.9	14.6
Bimadebun Village	PNG	46.3	24.2	29.5
Oriomo, Old Zim	PNG	43.9	40.6	15.5
Bensbach	PNG	46.5	25.8	27.7
Limal-Malam	PNG	45.6	26.7	27.7
Samlleberr, Irian Jaya	IND	64.4	15.8	19.8

Tree form also differed markedly among the provenances (Table 4). Single-stemmed trees (Class 1) were the most prominent among the provenances. However, the number of trees within this class ranged only between 43.9 and 64.4%. The top three most vigorous provenances (Samlleberr, Indonesia, Olive River and Jardine River, Queensland) also had the highest percentage of single-stemmed trees with value of 64.4, 56.6 and 49% respectively.

DISCUSSION

The results indicate that all provenances survived well, with survival rate ranging from 94 to 100%, but differed markedly in their growth in terms of height, diameter and tree form. These differences were associated with both inter- and intra-variations from the two provenance regions in New Guinea/Irian Jaya and northern Queensland. Although the results are preliminary, this variation indicates the presence of genetic diversity in the species within its distributional range. Based on vigour and tree form, the provenance from Indonesia (Samlleberr, Irian Jaya) and two from Queensland (Olive River and Jardine River-Bamaga) are the most promising, and could be selected for further planting.

Comparison of the results obtained here with those from other sites such as at Ba Vi, Vietnam (Kha and Nghia 1991; Thomson 1994) suggests that the provenances evaluated exhibit strong genotype x environment interaction effect. That is, the performance of a particular provenance with respect to the others is not the same across sites. For example, the Jardine River-Bamaga from Queensland was the poorest performer at Ba Vi, while the Bimadebun Village provenance from Papua New Guinea, which was the poorest performer here, was the second top performer at Ba Vi. Williams and Luangviriyasaeng (1989) also found genotype-environment interaction with this species in Thailand. Therefore, further planting of the provenances recommended here should be restricted to sites similar to the trial site. It also implies that further testing of selected, promising provenances on other sites with different environmental conditions is needed. This should draw on the results obtained here, and those reported from similar trials in other countries.

Although the results indicate that there are clear differences in provenance means for different parameters, the potential of individual provenance in contributing towards the gene pool for future breeding programmes must not be discounted. It would be prudent to thin the plot, retaining superior individuals not only from those good provenances but also from poor ones based on plot means. This could prevent the exclusion of other desirable traits such as high wood basic density and resistance to diseases. It also implies that these parameters need to be further assessed for the purpose of a breeding programme to meet the needs of different end users.

One striking aspect about the overall results is the high growth rates obtained with the species. The ranges of calculated mean annual increments of height and dbh were 3.4-4.7 m and 3.6-4.8 cm respectively. In comparison, similar ranges for the top ten of the 28 provenances of *A. auriculiformis* tested in adjacent

adjacent plots were 3.0-3.5 m and 2.7-3.2 cm (Kamis Awang *et al.* 1994). Sim and Gan (1991) also reported the superiority of growth of *A. crassicarpa* over *A. auriculiformis, A. mangium, A.aulacocarpa* and *A. mearnsii* on four sites in Sabah, Malaysia. Similarly, Pinyopusarerk (1989) reported that a Papua New Guinean provenance averaged 10.8 m in height and 10.3 cm dbh at 2 years of age at Saitong, Thailand, slightly greater than the best provenance in this trial. This reinforces the view that *A. crassicarpa* has potential for industrial planting.

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