NOTES

Acacia species planting trial at Segaliud Lokan, Sandakan, Sabah, Malaysia

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Acacia mangium was first introduced into Sabah as a fire-break species in 1966 (Pinso & Nasi 1991). However, in recent years, it has been planted quite extensively in many parts of Malaysia to provide raw material for the pulp and paper industry. This fast-growing species, whose natural habitats are in the humid tropical lowland of north-eastern Australia, Papua New Guinea (PNG) and eastern Indonesia, is given special consideration in forest plantation owing to its outstanding attributes, namely, growth and adaptability to less fertile soil. The total area planted with *A. mangium* in Sabah is about 56 000 ha or 50% of its plantation forest (Tan 1998). *Acacia mangium* has become the most popular legume species in the wet tropics. In many cases of rehabilitating degraded sites, it is often the only species planted due to its pronounced adaptability to sites of poor nutrient (Sim 1987, Thomas & Kent 1987, Thai *et al.* 1997, Chey & Intachat 2000). Apparently, there is an increasing concern about the risks of monoculture-planting on huge areas with this single species (Lee 1998). Identification of other potential species that can substitute *A. mangium* has been intensified to diversify the plantation activities in the state (Sim & Gan 1988).

This paper describes a species-provenance trial involving five species of *Acacia* and one hybrid, *A. mangium* × *A. auriculiformis*.

The study site is located at the northern part of the Segaliud Lokan Forest Reserve (5° 37' N, 117° 35' E), approximately 100 km south-west of Sandakan. The study was established in July 1991 and covers an area of about 2 ha. The soil is moderately acidic, with pH ranging from 4.3 to 4.9. Sandstone and mudstone form the parent materials, producing a soil texture from sandy loam to sandy clay loam (Acres & Folland 1975). Drainage system is considerably good due to its hilly terrain. Before planting, the area was heavily infested with *Pueraria phaseoloides* (Leguminosae) and patches of *Melastoma malabathricum* (Melastomataceae) and *Eupatorium odoratum* (Asteraceae).

The trial consisted of 11 seedlots comprising five *Acacia* species, namely, *A. mangium*, *A. auriculiformis*, *A. crassicarpa*, *A. cincinnata* and *A. aulacocarpa*, and a hybrid (*A. mangium* × *A. auriculiformis*). *Acacia mangium* was represented by four provenances while two provenances each represented either *A. cincinnata* or *A. crassicarpa* (Table 1). The *Acacia* hybrid, *A. auriculiformis* and *A. aulacocarpa* had one provenance each.

The trial was laid out in a randomised complete block design with four replicates of nine-tree square plots planted at 3 × 3 m espacement. No fertilisation was carried out throughout the study. Measurement for total height and diameter at breast height (dbh) was conducted 20 months after planting. Data of stem straightness and tree persistence (subject to forking) were also recorded. Stem straightness was scored based on five classes (1 = crooked tree with three or more severe bends, 2 = crooked tree with one to two severe bends, 3 = wavering tree with many small bends, 4 = slightly wavering with few small bends, 5 = straight tree). Trees having more than one leading stem were considered as forking.

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Table 1 Details of the 11 seedlots of *Acacia* selected for the species provenance trial

Species	Code	Provenance	Latitude	Longitude	Altitude (m)
A. mangium	man1	Sook ex-Muengo County, Sabah	5° 09' N	116° 21'E	1000
A. mangium	man2	Jalan Madu, Ulu Kukut, Sabah	6° 29' N	116° 34'E	140
A. mangium	man3	Olive River, QLD	12° 11' S	143° 01'E	160
A. mangium	man4	Oriomo River, PNG	8° 48' to 8° 52' S	143° 05' to 143° 11'E	10
Acacia hybrid	hyb	Jalan Madu, Ulu Kukut, Sabah	6° 29' N	116° 34'E	140
A. auriculiformis	auri	Mai Kussa River, PNG	8° 52' S	142° 03'E	15
A. crassicarpa	cras1	Dimisisi Village, PNG	8° 31' S	142° 13'E	50
A. crassicarpa	cras2	Daintree QLD	16° 16' S	145° 22'E	50
A. cincinnata	cin1	Mossman, QLD	16° 35' S	145° 25'E	410
A. cincinnata	cin2	Kuranda Australia	16° 37' S	145° 27'E	350
A. aulacocarpa	aula	Morehead, PNG	8° 40' S	141° 30'E	20

Note: PNG = Papua New Guinea, QLD = Queensland

Tree persistence was scored using six classes (1= double/multiple leaders from ground level, 2 = axis branched out in lowest quarter, 3 = axis branched out in the second quarter, 4 = axis branched out in the third quarter, 5 = axis branched out in the fourth quarter, 6 = complete persistence/free from forking). The data were then screened for outliers and verified prior to analysis. Analysis of variance of means for height, dbh, straightness and tree persistence for the plot was performed using the SAS Release 6.12 statistical package.

The results show significant differences between the species and provenances ($p < 0.05$) in height, dbh, tree persistence, straightness and survival at 20 months (Figure 1). Survival ranged from 63.9 (*A. cincinnata* of Kuranda Australia provenance (cin2)) to 94.4% (*Acacia* hybrid of Jalan Madu, Ulu Kukut (hyb) and *A. mangium* of Jalan Madu, Ulu Kukut (man2) and Olive River, QLD provenances (man3)). In general the *A. mangium* species performed best in all traits except for provenance of Sook ex-Muengo County (man1) that performed poorest in tree persistence. Being the tallest, and having the best stem form with a straight, single-leadered stem, the Oriomo River, PNG provenance (man4) was the most outstanding compared with the rest of the species and provenances tested. *Acacia crassicarpa* from Dimisisi Village, PNG (cras1) performed significantly better in height, dbh and tree persistence compared with that from Daintree, QLD (cras2). Although attributes showed by the *Acacia* hybrid were not as good as any of the *A. mangium* provenances in terms of height and diameter, it, however, was comparable in terms of stem straightness (2.5), tree persistence (5) and survival (94.4%).

Acacia aulacocarpa (aula) exhibited poor performance in height, dbh and tree persistence. Nevertheless, it had straight trees comparable with the *A. mangium* provenances and *Acacia* hybrid. Generally, *A. auriculiformis* from Mai Kussa River, PNG (auri) seemed to perform poorly in all the traits studied. Although both provenances of *A. cincinnata* (cin1 and cin2) did not show impressive growth performance particularly in height, dbh and straightness, incidence of forked trees was moderately low in this species.

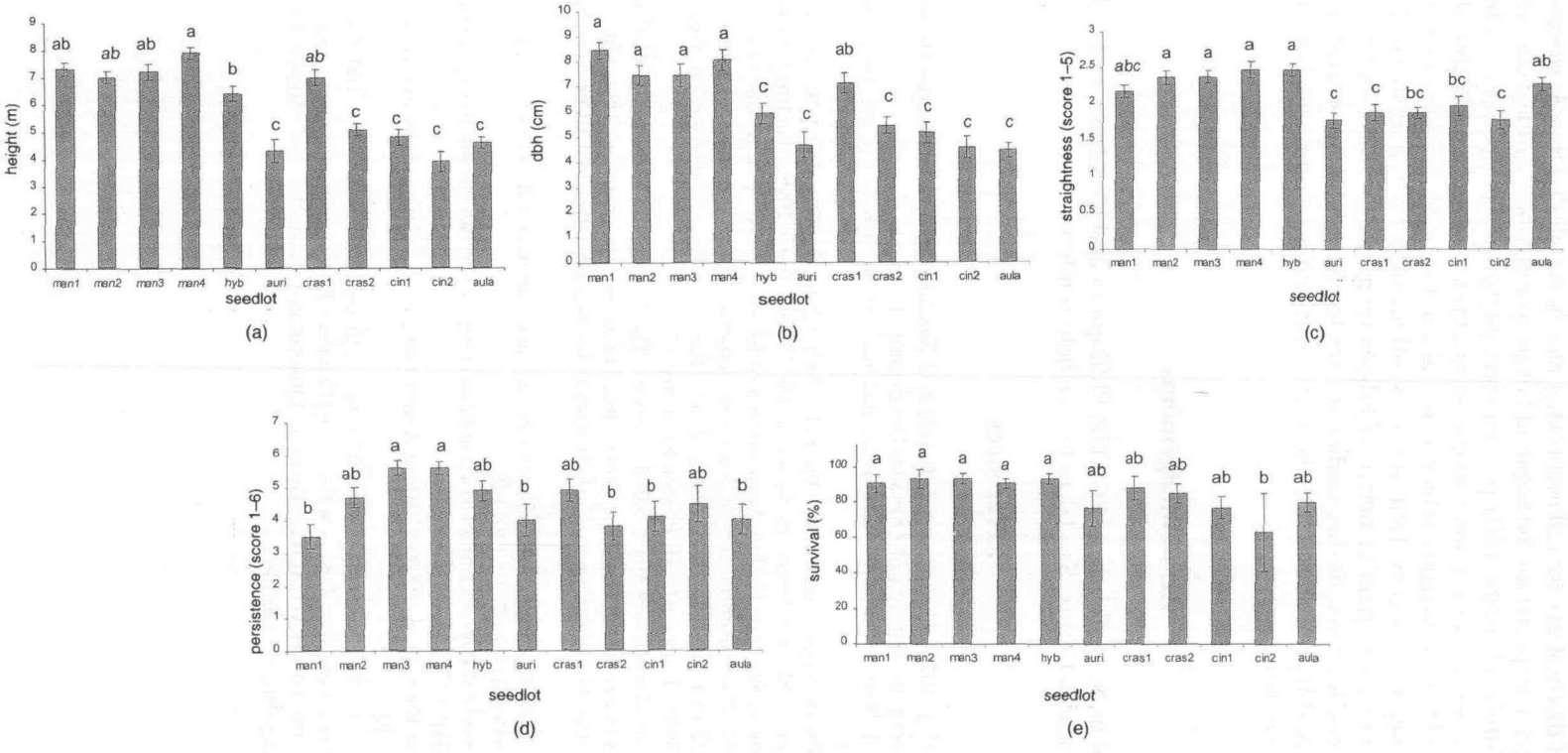

Figure 1 Mean for (a) height, (b) diameter at breast height (dbh), (c) straightness, (d) persistence and (e) survival (with standard error). Means with the same letter are not significantly different at 5% level (Duncan's multiple range test ($p < 0.05$)). See Table 1 for details of the seedlots.

From the results of this trial to date (20 months), it may be concluded that *A. mangium* is the best performing *Acacia* species for the Segaliud Lokan area in Sabah. *Acacia crassicarpa*, particularly that of Dimisisi Village, PNG provenance, performed almost as well, but *A. auriculiformis, A. cincinnata* and *A. aulacocarpa* were significantly poorer. Within the species, the trial showed that provenance selection is vital and that hybridisation can bring about definite advantages. This is evident in the excellent stem form and survival of the hybrid, in addition to its comparable height and diameter growth performance to the *A. mangium* provenances. However, further studies are needed on species and provenance growth performance at different sites. Only then can convincing recommendations be made to prospective plantation growers.

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