TREE QUALITY VARIATIONS IN DIFFERENT PROVENANCES OF ACACIA MANGIUM PLANTED IN THE PHILIPPINES

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FAIZUDDIN, M. & DALMACIO, R.V. 1996. Tree quality variation in different provenances of *Acacia mangium* planted in the Philippines. Highly significant ($p < 0.01$) variations in tree quality (i.e. main stem persistence, branch size and stem straightness) were observed in 5.5-y-old mangium (*Acacia mangium*) of different provenances planted under three different environmental conditions in the Philippines. The best provenances for main stem persistence, small branch size and stem straightness were 13229 (Claudie River, Qld.) in Ilocos Norte region, 13621 (Piru Ceram, Indonesia) in Masbate region and 13238 (Tully Mission Beach, Qld.) in Bukidnon region.

Key words: Mangium - provenances - main stem persistence - branch size - stem straightness

FAIZUDDIN, M. & DALMACIO, R.V. 1996. Variasi kualiti pokok dalam provenans *Acacia mangium* yang berbeza yang ditanam di Filipina. Variasi kualiti pokok (batang utama yang berterusan, saiz dahan, kelurusan batang) yang sangat bererti ($p < 0.01$), telah diperhatikan di dalam mangium (*A. mangium*) yang berumur 5.5 tahun daripada provenans berbeza yang ditanam di bawah keadaan persekitaran yang berbeza di Filipina. Provenans terbaik dari segi batang utama yang berterusan, saiz dahan yang kecil dan kelurusan batang adalah 13229 (Claudie River, Qld.) di daerah Ilocos Norte, 13621 (Piru Ceram, Indonesia) di daerah Masbate dan 13238 (Tully Mission Beach, Qld.) di daerah Bukidnon.

Introduction

The quantity and quality of wood are related to tree quality traits such as main stem persistence, branch size and stem straightness (Von Wedel *et al.* 1968, Ehrenherg 1970, Harris 1970, Blair *et al.* 1974, Guldager *et al.* 1980). These traits are influenced either by genetic or environmental factors or both (Duff & Nolan 1953, Squillace & Silen 1962, Fielding 1970, Daniel *et al.* 1980).

Mangium (*Acacia mangium* Willd.) has been widely used as a reforestation species due to its fast growth, high survival rate, and its multi-purpose uses such as pulp, sawn timber, fuelwood as well as controlling erosion and weeds in the

tropics. It is a suitable reforestation species on poor, acidic and degraded soils where indigenous species are bound to fail (Awang & Taylor 1993). However, Pettersson and Havmoller (1984) reported significant variations in the growth performance, and Faizuddin and Dalmacio (1992) in the survival and resistance to pests and diseases of the different provenances of mangium under different environmental conditions in the Philippines. This study was conducted in 1984 to determine variations in the different tree quality traits in different sites in the Philippines, and also to select the best provenances for large-scale plantations in the country.

Materials and methods

Study sites

The study was conducted in three sites, namely, Lubuagan, Vintar, Ilocos Norte (Region 1); Mapuyo, Mobo, Masbate (Region 5); and Lantapan, Malaybalay, Bukidnon (Region 10) in the Philippines, as shown in Figure 1.

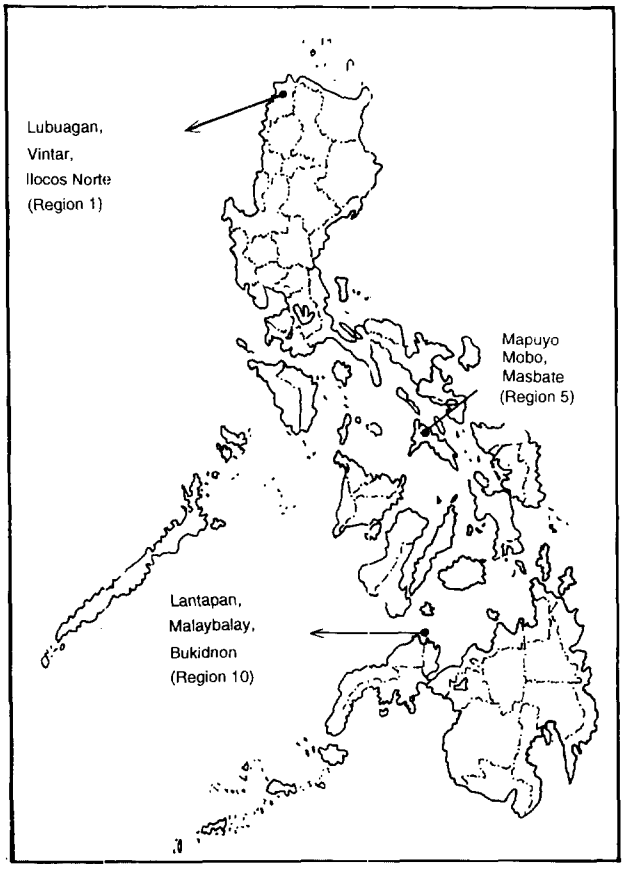

Figure 1. Map of the Philippines showing the three study sites

Site characteristics

The conditions at the three sites differ from each other with respect to (1) climate such as total rainfall, total number of rainy days, relative humidity, occurrence of natural calamities such as typhoon and fire; (2) soil such as pH depth, texture, organic matter (C, P, K, total nitrogen); and (3) topography such as average slope, aspect, altitude, longitude and latitude (Table 1).

The Bukidnon site has the highest average annual rainfall (2574 mm), organic matter, C (4.56%), elevation (985 ± 3 m) and slope (30%) compared to the other two sites (Table 1). Since the Bukidnon site receives high annual rainfall, distributed throughout the year, trees grow better here although located at higher elevation.

Table 1. Climatic, edaphic and topographic features of study sites in Ilocos Norte, Masbate and Bukidnon

Feature	Ilocos Norte (Region 1)	Masbate (Region 5)	Bukidnon (Region 10)
Climate:			
Temperature			
Average maximum monthly (°C)	31.7	31.6	28.7
Average minimum monthly (°C)	22.2	24.3	18.5
Rainfall			
Annual average (mm)	1927	1942	2544
Annual rainy days	96	170	221
Relative humidity (%)	76.0	82.0	82.0
Typhoon (yearly average)	16 times	4 times	0
Fires	0	Common (from March - May)	Very common
Soil:			
pH (H_20)	5.85	5.85	4.63
Soil depth (cm)	60	100	55
Soil textural class	Sandy clay	Sandy clay	Sandy loam
Organic matter C (% wt.)	1.08	2.40	4.56
P (ppm)	6.35	14.20	4.00
K (ppm)	328.5	249.0	96.0
Total nitrogen (%)	0.025	0.16	0.43
Topography:			
Slope (%)	28.0	6.0	30.0
Aspect	NW	SE	NW
Altitude (m a.s.l.)	291 ± 5	295 ± 1	985 ± 3
Longitude	120° 45'E	123° 38'E	124° 56'E
Latitude	18° 2'N	12° 14'N	8° 3'N

Sources: PAGASA, Soil Reports 21 & 23 of Soil Survey of the Republic of the Philippines, and field observations.

Provenances studied

Eighteen provenances were tested at Ilocos Norte and 12 at Masbate and Bukidnon. The details are given in Table 2.

Table 2. Seed lot description for 18 *Acacia mangium* provenances

Seed lot No. (provenances)	No. of parent trees	Locality	Origin Latitude	Origin Longitude	Alt. (m)	Viable seeds/ 10 g
13230	10	Mission Beach, Qld.	17° 53'	146° 6'	0	300
13231	5	NW of Silkwood, Qld	17° 42'	145° 57'	40	230
13232	10	Cowley Beach Road, Qld.	17° 41'	146° 5'	5	410
13233	10	Walsh's Pyramid, Qld	17° 6'	145° 48'	20	670
13234	10	Trinity Inlet, Qld.	17° 2'	145° 48'	20	500
13235	5	Mourilyn Bay, Qld.	17° 35'	146° 5'	10	400
13236	5	Kurrimine, Qld.	17° 46'	146° 5'	10	80
13237	10	El Arish, Qld.	17° 50'	146° 1'	20	230
13238	10	Tully Mission Beach, Qld.	17° 50'	146° 2'	70	420
13239	10	Syndicate Rd. Tully, Qld.	17° 55'	145° 52'	50	400
13240	5	Ellerbeck Rd., Qld.	18° 14'	145° 58'	60	550
13241	5	Broken Pole Creek, Qld.	18° 21'	146° 3'	50	640
13242	10	Abergowrie SF, Qld.	18° 26'	146° 1'	60	600
13229	6	Claudie River, Qld.	12° 44'	143° 13'	60	500
13460	18	Oriomo River, PNG	8° 50'	143° 8'	10	415
13621	9	Piru Ceram, Indonesia	3° 4'	128° 12'	50	160
13622	15	Sidei, Indonesia	0° 46'	133° 34'	30	860
13846	75	7 km SSE of Mossman, Qld	16° 31'	145° 24'	60	640

Source: Forest Management Bureau, Philippines, 1988.

Experimental design and layout

The trial plantations in each site were established in a Randomised Complete Block Design (RCBD). The planting spacing was 3 × 3 m. There were only two blocks in each site due to shortage of seedlings. One plot was established for each provenance. In total, there were 45 trees in each plot, 25 trees in the centre surrounded by a row of 24 trees as buffer.

Tree growth performance (stand description)

The growth performance of trees such as average diameter, height, merchantable height, crown length and crown diameter at three site conditions were recorded at five years after planting.

The best diameter growth of 49.27 cm was observed at Bukidnon and the lowest diameter growth of 10.15 cm was observed at Ilocos Norte. The intermediate diameter growth of 15.80 cm was observed at Masbate. The best height growth of 10.78 m, intermediate height growth of 9.25 m and the lowest height

growth of 6.52 m as well as merchantable height growth of 5.94, 4.58 and 3.92 m were observed at Bukidnon, Masbate and Ilocos Norte respectively.

A crown length and the widest crown diameter of 5.50 and 8.86 m respectively were observed at Bukidnon. The same crown length and smaller crown diameter of 5.50 and 6.75 m respectively were observed at Masbate while the lowest crown length and crown diameter of 5.12 and 3.50 m respectively were observed at the Ilocos Norte site.

Data collection

Data on tree quality traits such as main stem persistence, branch size and stem straightness of 5.5-y-old plantations were gathered by scoring. There were four categories/classes of scorings for each tree character/trait. The best performance was scored 4 and the poorest was scored 1. Scoring generally followed the guide of Keiding *et al.* (1986):

Scoring system

I. Main stem persistence

Categories	Score
Main stem persisting up to the 1st quarter of the tree from its base	1
Main stem persisting up to the 2nd quarter from the base of the tree	2
Main stem persisting up to the 3rd quarter of the tree from its base	3
Main stem persisting up to the 4th quarter of the tree from its base	4

II. Branch size

Categories	
Main branch with the same diameter size as the main stem	1
Main branch with 3/4 the diameter size of the main stem	2
Main branch with 1/2 the diameter size of the main stem	3
Main branch with 1/4 or less of the diameter size of the main stem	4

III. Stem straightness

Categories	
Stem is straight up to the 1st quarter of the tree from its base	1
Stem is straight up to the 2nd quarter of the tree from its base	2
Stem is straight up to the 3rd quarter of the tree from its base	3
Stem is straight up to the 4th quarter (top) of the tree from its base	4

Statistical analysis

The data were statistically analysed by Analysis of Variance to determine the extent of variation among provenances and by Duncan's Multiple Range Test (DMRT) to determine the significant differences of means among provenances.

Results and discussion

Variation in main stem persistence

A highly significant variation among provenances in the main stem persistence was observed in all the sites (Table 3).

In Ilocos Norte, provenance 13229 (Claudie River, Qld.) was the best followed by 13239 (Syndicate Rd. Tully, Qld.), 13621 (Piru Ceram, Indonesia), 13460 (Oriomo River, PNG), 13235 (Mourilyn Bay, Qld.) and 13242 (Abergowrie SF, Qld.). Forking was most prominent in provenance 13846 (7 km SSE of Mossman, Qld.)

Table 3. Main stem persistence of different provenances of *Acacia mangium* in Ilocos Norte, Masbate, and Bukidnon

Ilocos Norte		Masbate		Bukidnon	
Provenance	Mean	Provenance	Mean	Provenance	Mean
13229	3.750 a	13621	4.000 a	13238	3.952 a
13239	3.400 ab	13460	3.875 ab	13239	3.824 ab
13621	3.308 ab	13229	3.750 ab	13460	3.818 ab
13460	3.300 ab	13238	3.571 abc	13231	3.714 ab
13235	3.286 abc	13230	3.500 abc	13621	3.688 ab
13242	3.167 abcd	13242	3.500 abc	13234	3.688 ab
13234	3.071abcd	13240	3.500 abc	13233	3.322 ab
13230	3.000 abcd	13237	3.000 bc	13240	3.500 ab
13238	2.889 abcd	13235	3.000 bc	13241	3.500 ab
13231	2.857 abcd	13236	2.929 bc	13241	3.500 ab
13233	2.833 abcd	13233	2.769 c	13235	3.400 ab
13237	2.833 abcd	13241	1.714 d	13236	3.304 b
13232	2.773 abcd				
13241	2.667 abcd				
13236	2.364 bcd				
13240	2.308 bcd				
13222	2.059 cd				
13846	2.000 d				

Means in each column followed by the same letter(s) are not significantly different at $p<0.05$.

In Masbate, provenance 13621 (Piru Ceram, Indonesia) was the best while provenance 13241 (Broken Pole, Creek, Qld.) the poorest (Table 3). Provenances such as 13460 (Oriomo River, Qld.) 13229 (Claudie River, Qld.), 13238 (Tully Mission Beach, Qld.) and 13230 (Mission Beach, Qld.) were also good.

In Bukidnon, the best provenance was 13238 (Tully Mission Beach, Qld.) while provenance 13236 (Kurrimine, Qld.) was the poorest (Table 3).

Daniel *et al.* (1980) stated that cessation of stem growth is strongly influenced by adverse temperature and water relations in late summer which in turn are related to growing space. Duff and Nolan (1953) reported that vertical tree growth is influenced by fluctuating weather conditions and genetic factors. Since the weather conditions in each site were the same throughout the growing period, the differences in the presistence of the main stem could be due to genetic factors. This means that provenances are not equally adapted to the new environmental conditions.

Variation in branch size

The results of the variation in branch size are shown in Table 4. The branch size variation among provenances was highly significant ($p< 0.01$) in all sites.

Provenances 13229 (Claudie River, Qld.), 13233 (Walsh's Pyramid, Qld.), 13237 (El Arish, Qld.) and 13241 (Broken Pole Creek, Qld.) were noted to be the best in having small branches in Ilocos Norte (Table 4).

The best provenances with small branches in Masbate were 13238 (Tully Mission Beach, Qld.), 13237 (El Arish, Qld.), 13621 (Piru Ceram, Indonesia). The poorest provenance was 13241 (Broken Pole Creek, Qld.).

In Bukidnon, the best provenances with small branches were 13231 (NW of Silkwood, Qld.) and 13621 (Piru Ceram, Indonesia). The poorest provenance was 13242 (Abergowrie SF, Qld.).

Since the provenances were planted at similar spacing the variations in branch size were due to genetic composition of the provenances. According to Werren (1991), Queensland provenances had wide and deep crowns whilst Indonesian provenances had fewer branches and a lighter crown in Sumatra, Indonesia.

Table 4. Branch sizes of different provenances of *Acacia mangium* in Ilocos Norte, Masbate, and Bukidnon

Ilocos Norte		Masbate		Bukidnon	
Provenance	Mean	Provenance	Mean	Provenance	Mean
13229	4.000 a	13238	4.000 a	13231	4.000 a
13233	4.000 a	13230	4.000 a	13621	4.000 a
13237	4.000 a	13235	4.000 a	13240	3.889 ab
13241	4.000 a	13237	4.000 a	13238	3.714 ab
13460	3.967 a	13621	4.000 a	13460	3.364 bc
13239	3.867 ab	13236	3.857 ab	13236	3.261 bcd
13232	3.864 ab	13233	3.846 ab	13233	3.261 bcd
13621	3.769 ab	13460	3.750 ab	13239	3.235 bcd
13234	3.741 abd	13242	3.750 ab	13234	2.875 cde
13238	3.667 abc	13240	3.667 ab	13241	2.700 cde
13242	3.667 abc	13229	3.250 bc	13235	2.667 de
13231	3.214 bcd	13241	2.857 c	13242	2.529 e
13235	3.143 bcd				
13240	3.000 cd				
13230	3.000 cd				
13622	3.000 cd				
13846	2.500 de				
13236	2.182 e				

Means in each column followed by the same letter(s) are not significantly different at $p<0.05$.

Variation in the stem straightness

Variation in stem straightness was highly significant ($p < 0.01$) in the three sites. In Ilocos Norte, the best provenances for stem straightness were 13229 (Claudie River, Qld.) and 13242 (Abergowrie SF, Qld.) while the poorest performer was 13236 (Kurrimine, Qld.) (Table 5).

In Masbate, many provenances with the best bole characteristics were observed. These were 13621 (Piru Ceram, Indonesia), 13460 (Oriomo River, PNG), 13240 (Ellerbeck Rd., Qld.), 13229 (Claudie River, Qld.), 13230 (Mission Beach, Qld.), 13242 (Abergowrie SF, Qld.), 13238 (Tully Mission Beach, Qld.), 13237 (El Arish, Qld.) and 13235 (Mourilyn Bay, Qld.). The poorest provenance was 13241 (Broken Pole Creek, Qld.).

Table 5. Stem straightness of different provenances of *Acacia mangium* at Ilocos Norte, Masbate and Bukidnon

Ilocos Norte		Masbate		Bukidnon	
Provenance	Mean	Provenance	Mean	Provenance	Mean
13229	4.000 a	13621	3.500 a	13238	3.857 a
13242	4.000 a	13460	3.375 a	13234	3.688 ab
13241	3.667 ab	13240	3.333 a	13460	3.636 ab
13621	3.462 abc	13229	3.250 a	13236	3.609 ab
13460	3.300 abc	13230	3.250 a	13233	3.478 abc
13231	3.286 abc	13242	3.125 a	13239	3.471 abc
13239	3.200 abc	13238	3.000 a	13240	3.444 abc
13233	3.111 abcd	13237	3.000 a	13231	3.333 abc
13234	3.071 abcd	13235	3.000 a	13621	3.250 abc
13230	3.000 abcd	13233	2.769 a	13241	3.100 bc
13240	2.923 bcd	13236	2.571 a	13235	3.069 bc
13238	2.889 bcd	13241	1.714 b	13242	2.882 c
13235	2.857 bcd				
13232	2.818 bcd				
13622	2.766 bcd				
13237	2.667 bcd				
13846	2.500 cd				
13236	2.091 d				

Means in each column, followed by the same letter(s) are not significantly different at $p<0.05$.

In Bukidnon, the best provenance was 13238 (Tully Mission Beach, Qld.) and the poorest performer was 13242 (Abergowrie SF, Qld.)

The stem straightness of a tree is mainly influenced by the genotype and environmental factors such as growing space (Squillace *et al.*1962.). In this study, the growing spaces were the same. Therefore, the differences in stem character among provenances in all the sites could be attributed to genotypes/provenances which responded differently to the existing environmental condition.

According to Werren (1991), the Claudie River, Queensland provenances had straight stems and heavy crowns when planted in Sumatra, Indonesia. He also mentioned that Cardwell provenances had good stem forms. Mead and Miller (1991) also reported large provenance differences in both stem straightness and the frequency of multiple leaders in mangium grown in Peninsular Malaysia.

Conclusion

The study shows that different provenances of *Acacia mangium* performed differently at the three sites. Therefore, the best performer in each site should be selected carefully according to the objective of the management.

As far as growth form is concerned, the provenances 13229, 13239 and 13621 should be chosen for the Ilocos Norte region; 13238, 13460 and 13621 for the Masbate region and 13231, 13238 and 13621 for the Bukidnon region.

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