Variations in Growth Performance of Different Provenances of Mangium (*Acacia mangium* Willd.) Grown in the Philippines

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Abstract

Provenances of mangium (*Acacia mangium* Willd.) from Queensland (Australia), Papua New Guinea and Indonesia were planted under three site conditions of Ilocos Norte, Masbate and Bukidnon regions in the Philippines which are edaphically, climatically and topographically different from each other.

Highly significant *(P<0.01)* variations in diameter, height and merchantable height growth performances of 18 provenances at Ilocos Norte, 12 provenances at Masbate and 12 provenances at Bukidnon at 5.5 years after planting were observed. The best growth was observed in Bukidnon site, and the provenance 13240 (Ellerbeck Rd. Qld.) of the species exhibited the best growth performance at that site which could be selected for pilot plantation trials in the Philippines.

সারসংক্ষেপ

কুইন্সল্যাণ্ড (অষ্ট্রেলিয়া), পাপুয়া নিউগিনি এবং ইন্দোনেশিয়ার ম্যানজিয়াম (*Acacia mangium* Willd.) প্রজাতির কিছু প্রভেন্যান্স ফিলিপাইনের তিনটি অঞ্চল-বুকিডনন, মাসবাতে ও ইলোকস নর্তে এলাকায় বনায়ন করে পরীক্ষা করা হয়। মাটি, আবহাওয়া ও অবস্থানের বৈশিষ্ট্যে এলাকাগুলো সম্পূর্ণ আলাদা।

বুকিডননে ১৮টি এবং মাসবাতে ও ইলোকোস নর্তে প্রতিটিতে ১২টি প্রভেন্যান্স-এর সাড়ে পাঁচ বছর বয়সে গাছের ব্যাসার্ধ, উচ্চতা ও ব্যবসায়িক উচ্চতা নির্ণয় করে তাতে গুরুত্বপূর্ণ পার্থক্য পরিলক্ষিত হয়। ফলাফলে দেখা যায় যে, ম্যানজিয়ামের বৃদ্ধির জন্য বুকিডনন সবচেয়ে ভাল এলাকা এবং ১৩২৪০ (এলার -বেক রোড, কুইন্সল্যাণ্ড) প্রভেন্যান্সটি সবচেয়ে ভাল। কাজেই ফিলিপাইনের বুকিডনন এলাকায় ম্যানজিয়াম প্রভেন্যান্স ১৩২৪০-কে পাইলট বনায়নের জন্য নির্বাচন করা যেতে পারে।

Key words : Bukidnon, growth, mangium, Philippines, provenance, variation

Introduction

Mangium (*Acacia mangium* Willd.) is a fast growing tree species. It is a leguminous species and grows naturally in Australia, Indonesia and Papua New Guinea. It has wider uses in these countries for timber, pulp, fuelwood, veneer, furniture, particle board and charcoal (Sindusuwarno and Utomo 1981, Applegate and Nicholson 1986, NAS 1983, Logan 1986).

It can be grown on wide range of sites. It is easy to plant and cultivate (NAS 1983). It fixes nitrogen (Gavina and Garcia 1987) and can be used for converting wastelands into productive sites (Udarbe and Hepburn 1986, Racy and Ibrahim 1986). It can grow in poor acidic soils of the tropics and compete with *Imperata cylindrica* grass (Tham 1976, Jones and Keong 1980, Seibert and Kuncoro 1987), can tolerate extended drought (Midgley and Vivekanandan 1986) and can grow well in abandoned shifting cultivation sites (NAS 1983).

It is better in growth performance than many reforestation species such as *Gmelina arborea*, *Eucalyptus camaldulensis*, *Acacia auriculiformis*, *Leucaena leucocephala*, etc. (Yap 1986, NAS 1983, Kaplan 1979). Zashimuddin *et al.* (1983), Pinyopusarerk and Kora (1986), Chung *et al.* (1990), Hadi *et al.* (1990), Johari and Chew (1987), Khamis (1991), Atipanumpai (1989), Laskul (1991), Huynth and Nguyen (1992) reported significant differences in growth traits among provenances of the species.

It has become one of the widely planted hardwood species in the tropics (Moran 1992). Faizuddin and Dalmacio (1992, 1996) reported significant variations in survival and resistance to pests and diseases, tree quality traits such as main stem persistence, stem straightness and branch size of different provenances of mangium (*A. mangium*) in different parts of the Philippines. So, the selection of the well adapted and promising provenances of the species in growth traits is very important for its improvement for higher biomass production and economic gain for a particular site.

The objectives of this study were, therefore, to determine the variations among different provenances of mangium in diameter, height and merchantable height growth in different study sites of the Philippines and to select the best provenances(s) and the site(s) for its plantation and local seed sources in the country.

Material and methods

Description of the study sites

The study sites were Lubuagan, Vintar in Ilocos Norte (Region 1), Mapuyo, Mobo in Masbate (Region 5) and Lantapan, Malaybalay in Bukidnon (Region 10) which are located in the northern, central and southern parts of the Philippines. The three sites differ from each other in climatic, edaphic and topographic conditions which are shown in Table 1.

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

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 :	Average annual (mm)	1927.2	1941.9	2543.5
	Annual rainy day (no.)	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

Table 1. Contd.

Feature	Ilocos Norte (Region 1)	Masbate (Region 5)	Bukidnon (Region 10)
Soil			
pH (H_2O)	5.85	5.85	4.63
Soil depth (cm)	60	100	55
Soil textural class	Sandy clay loam	Sandy clay loam	Sandy loam
Organic matter (% wt.)	1.084	2.400	4.560
P (ppm)	6.35	14.20	4.00
K (ppm)	328.50	249.0	96.0
Total nitrogen (%)	0.25	0.16	0.43
Topography			
Slope (%)	28.0	6.0	30.0
Aspect	NW	SE	NW
Altitude (m)	291.0	195.0	984.0
Longitude	$12^0$45'E	$123^0$38'E	$124^0$56'E
Latitude	$18^0$2'N	$12^0$14'N	$8^0$3'N

Source : PAGASA Soil Report-12 & 23 of Soil Survey of the Republic of the Philippines, field observation.

Provenances studied

Eighteen provenances from Queensland (Australia), Papua New Guinea and Indonesia were established in different sites of the Philippines in 1984 by the Forest Management Bureau (FMB). But 18 provenances in the Ilocos Norte site,12 provenances both in the Masbate and Bukidnon sites were observed in the field during the study and data were collected from these provenances. The provenances were not the same in all the sites due to lack of seedlings. The list of the provenances tried in these three sites with their origin are given in Table 2.

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

Seed lot no. (provenances)	No. of parent tree	Origin				
		Locality	Latitude	Longitude	Altitude (m)	Viable seed/10 g
13229	6	Claudie River, Qld	$12^0$44'	$143^0$13'	60	500
13230	10	Mission Beach, Qld	$17^0$53'	$146^0$6'	0	300
13231	5	N.W. of Silkwood, Qld	$17^0$53'	$145^0$57'	40	230
13232	10	Cowley Beach Road, Qld	$17^0$41'	$146^0$5'	5	410
13233	10	Walsh's Pyramid, Qld	$17^0$6'	$145^0$48'	20	670
13234	10	Trinity Inlet, Qld	$17^0$2'	$145^0$48'	20	500
13235	5	Mourilyn Bay, Qld	$17^0$35'	$146^0$5'	10	400

Table 2. Contd.

Seed lot no. (provenances)	No. of parent tree	Origin				
		Locality	Latitude	Longitude	Altitude (m)	Viable seed/10 g
13236	5	Kurrimine, Qld	$17^{0}46'$	$146^{0}5'$	10	80
13237	10	El Arish, Qld	$17^{0}50'$	$146^{0}1'$	20	230
13238	10	Tully Mission Bch.Rd., Qld	$17^{0}50'$	$156^{0}2'$	70	420
13239	10	Syndicate Rd. Tully, Qld	$17^{0}55'$	$145^{0}52'$	50	400
13240	5	Ellerbeck Rd. Cardwell, Qld	$18^{0}14'$	$145^{0}58'$	60	550
13241	5	Broken Pole Creek, Qld	$18^{0}21'$	$146^{0}3'$	50	640
13242	10	Abergowrie Sf, Qld	$18^{0}26'$	$146^{0}1'$	60	600
13460	18	Oriomo River, Png	$8^{0}50'$	$143^{0}8'$	10	415
13621	9	Piru Ceram, Indsia	$3^{0}4'$	$128^{0}12'$	50	160
13622	15	Sidei, Indsia	$0^{0}46'$	$133^{0}34'$	30	860
13846	75	7 km Sse of Mossman, Qld	$16^{0}31'$	$135^{0}24'$	60	640

Source : Forest Management Bureau, Philippines, 1988.

Experimental design

The trial plantations were established as per Randomised Complete Block Design (RCBD) at a spacing of 3 m x 3 m. There were two replications/ blocks in each site because of the lack of seedlings. There were 25 trees in the centre and 24 trees in the peripheral buffer zones in each plot. The number of plots corresponded to the number of provenances in each block.

Measurements

Measurements of tree diameter, total height, merchantable height and crown length were measured. The diameter was measured at breast height (1.3 m from the ground) by using a diameter tape. Height was measured with the use of a long pole with graduations in centimeters. The merchantable height of the tree was computed from the total height of the tree minus the crown length. The measurements were taken at 5.5 years after planting in the field.

Data analysis

The data were statistically analysed using ANOVA to determine the extent of variation among the provenances and DMRT to determine the significant differences of means among the provenances.

Results and discussion

Diameter growth

Variations in diameter growth are shown in Table 3. There was a significant difference ($P<0.01$) in diameter growth in all the sites.

In Ilocos Norte, the proveances with the heighest diameter (10.18 cm) was 13234 (Trinity Inlet, Qld.) The other provenances such as 13229, Claudie River Qld. (9.68 cm); 13460, Oriomo River, Png (8.94 cm); 13242, Abergowrie Sf. Qld. (8.56 cm) ; 13622, Sidei, Indonesia (8.36 cm) ; 13231, N. W. of Silkwood (8.19 cm) and 13235, Mourilyn Bay (7.65 cm) also performed well. The poorest performance in diameter growth (3.02 cm) was exhibited by the provenance 13237, El Arish, Qld. (Table 3).

Table 3. Mean diameter (cm), tree height (m) and merchantable height (m) of dfferent provenances of *Acacia mangium* under Ilocos Norte, Masbate and Bukidnon site conditions.

Provenances	Ilocos Norte			Masbate			Bukidnon		
	Mean diameter (cm)	Mean tree height (cm)	Mean merchantable height (m)	Mean diameter (cm)	Mean tree height (m)	Mean merchantable height (m)	Mean diameter (cm)	Mean tree height (cm)	Mean merchantable height (m)
13229	9.682 ab	5.881 abc	3.919 a	14.360 bc	8.125 ab	2.875 bc	-	-	-
13230	7.230 abc	3.500 d	0.150 cde	16.162 bc	8.333 ab	4.458 a	-	-	-
13231	8.194 ab	4.564 abcd	0.844 cde	-	-	-	10.143 c	7.405 e	3.995 cd
13232	6.350 abc	3.882 cd	0.855 cde	-	-	-	-	-	-
13233	5.681 bc	3.320 d	0.606 cde	14.055 bc	7.115 bc	3.154 bc	45.130 ab	10.783 a	5.270 ab
13234	10.184 a	6.268 ab	1.216 bcd	-	-	-	45.438 ab	10.519 ab	5.963 a
13235	7.647 ab	4.220 abcd	0.929 cde	15.532 bc	7.992 abc	3.846 abc	46.733 ab	8.733 cd	5.047 abc
13236	7.301 abc	4.558 abcd	0.995 cde	16.263 bc	7.429 bc	3.679 abc	45.826 ab	9.648 ab	5.152 ab
13237	3.017 c	3.608 cd	0.012 e	13.360 c	6.625 c	2.750 bc	-	-	-
13238	7.134 abc	4.788 abcd	0.883 cde	15.909 bc	8.429 ab	3.643 abc	43.476 ab	10.265 ab	5.252 ab
13239	6.326 abc	4.473 abcd	2.127 b	-	-	-	43.412 ab	8.612 cd	4.194 bcd
13240	7.362 ab	2.119 bcd	0.860 cde	16.480 bc	8.333 ab	4.583 a	49.278 a	10.306 ab	5.178 ab
13241	6.617 abc	4.650 abcd	1.067 cde	18.697 b	8.429 ab	2.929 bc	44.650 ab	8.970 cd	3.595 d
13242	8.563 ab	4.983 abcd	1.733 bc	16.388 bc	7.562 bc	3.563 abc	37. 765 b	7.912 cd	3.853 d
13460	8.938 ab	6.522 a	1.755 bc	17.760 bc	8.313 ab	3.688 abc	41.727 ab	9.555 bc	4.291 bcd
13621	6.735 abc	4.404 abcd	1.226 bcd	25.800 a	9.250 a	4.250 ab	11.125 c	7.350 c	3.816 d
13622	8.355 ab	4.314 abcd	1.345 bc	-	-	-	-	-	-
13846	5.750 bc	4.125 bcd	0.975 cde	-	-	-	-	-	-

Note : In each column, any two means followed by same letter (s) are not significanty different at 5% level.
' - ' provenance not available.

In Masbate, the best diameter growth was exhibited by the provenance 13621, Piru Ceram, Indonesia (25.8 cm). The poorest performance was observed in the provenance 13237, El Arish, Qld (13.4 cm).

In Bukidnon, the diameter growth ranged from 49.28 cm to 10.14 cm. The highest diameter growth (49.28 cm) was ovserved in the provenances, 13240 (Ellerbeck Rd. Cardwell, Qld.) followed by 13235, Mourilyn Bay, Qld. (46.73 cm) and 13236, Kurrimine, Qld (45.83 cm). The lowest diameter growth (10.14 cm) was observed in the provenance 13231, N.W. of Silkwood, Qld (Table 3).

The provenances responded differently to different environmental conditions.

Height growth

Significant differences ($P<0.01$) in growth among the provanances were obseved in all the sites (Table 3).

In Ilocos Norte, maximum height (6.52 m) was observed in 13460, Oriomo River Png while the lowest height growth (3.32 m) was observed in 13233, Walsh's Pyramid, Qld. The other provenances showing better height growth were 13234, Trinity Inlet, Qld. (6.27 m) and 13238, Tully Mission Beach, Rd. Qld. (4.79 m) which are shown in Table 3.

In Masbate site, the best growth was observed in provenance 13621, Piru Ceram, Indonesia (9.25 m) and the poorest growth was observed in provenance 13237, El Arish, Qld. (6.63 m).

In Bukidnon, maximum height growth (10.78 m) was observed in provenance 13233, Walsh's Pyramid Road. The other provenance with better growth perfromance was 13234, Trinity Inlet, Qld. (10.52 m), The lowest height growth (7.35 m) was noted in provenance 13621, Piru Ceram, Indonesia (Table 3).

Variations in merchantable height

The merchantable height growth was highly significant ($P<0.01$) among provenances in all the three sites. The results of variations in merchantable height growth are shown in Table 3.

Under Ilocos Norte site conditons, the maximum merchantable height growth was 3.92 m which was obserbed in provenance 13229, Claudie River, Qld.

Under Masbate site conditions, the best merchantable height growth was seen in provenances 13240, Ellerbeck Rd. Cardwell, Qld. (4.58 m); 13230, Mission Beach, Qld, (4.46 m) and 13621, Piru Ceram, Indonesia (4.25 m). The lowest merchantable height (2.75 m) was observed in the provenance 13237, El Arish, Qld. (Table 3).

In Bukidnon, the largest merchantable height growth was observed in provenance 13234, Trinity Inlet, Qld. (5.96 m). The lowest merchantable height growth (3.60 m) in this site was observed in provenance 13241, Broken Pole Creek, Qld. (Table 3).

The differences in merchantable height growth in the three sites could be due to the fact that the provenances have adapted differently to the varied environmental conditions.

In this study, significant differences in growth were observed among different provenances. Zashimuddin *et al.* (1983) reported significant differences in height growth of different provenances of mangium in Bangladesh. Hegedon and Nixon (1984) and Havmoller (1989) also reported significant differences in height growth of different provenances of mangium in the Philippines. Significant differences in growth performances of different provenances were also reported by Chung *et al.* (1990) in China, Hadi *et al.* (1990) in Indonesia, Johari and Chew (1987) and Khamis (1991) in Malaysia, Atipanumpai (1989) in Thailand and Huynth and Nguyen (1992) in Vietnam.

Conclusion

From the study it can be concluded that different provenances have adapted differently to different environmental conditions. The best growth performance was observed under

Bukidnon condition because of higher annual rainfall of uniform distribution throughout the year. The different provenances performed differently for diameter, height, and merchantable height growth in different sites. So, different provenances should be selected for different growth traits for different sites in the country. Bukidnon could be selected as a best site for pilot plantations and local seed sources, and the provenance 13240 (Ellerbeck Rd.Cardwell, Qld.) could be selected for diameter, height, and merchantable height growth of mangium for that site.

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