GROWTH OF *ACACIA* HYBRID (*A. MANGIUM* × *A. AURICULIFORMIS*) ON COASTAL SANDY SOIL

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Of the many problem soils in Malaysia, the raised coastal sand dunes soil, also locally known as 'BRIS' or 'Jambu Series' soil (USDA Albic Quartzipsamment) is among the most challenging. The main hectarage lies along the coast of Kelantan, Terengganu and Pahang which experience extreme hot weather during dry season and flooding during wet season (Shamsuddin 1990). The topsoil (99% sand) usually exceeds one meter depth and have poor water and nutrient retention properties. Leaf scorching and plant wilting are widespread during dry season when air and surface soil temperatures are high especially in the afternoon (Amir 1999). Besides the sandy nature, soil heterogeneity is a common feature. Pockets of high carbon occur due to organic material accumulation.

Hybrids between *Acacia mangium* and *A. auriculiformis* are of interest for plantation establishment because they may combine the better form of *A. mangium* with the low heart rot incidence of *A. auriculiformis*. A plantation of *Acacia* hybrid was established at FRIM substation in Setiu in 2002 as a trial plantation on BRIS soil. At stand age of three years old, visual observation showed high variability in tree growth within the 1 ha area. At one corner, trees grew vigorously and produced an abundance of litter while at another, trees exhibited very poor growth with high mortality. To understand better the cause for these differences, soil and foliar samples were collected from the two contrasting sites and analyzed.

The study plot is located on undulating terrain of 2° slope, with the lower and poorer site in the south. The area was originally occupied by *Melaleuca* sp., *A. mangium*, short bushy plants and wild grasses. Meteorological data recorded on the site showed high rainfall during monsoonal season (October to December) with an annual average of 2800 mm for three consecutive years. The *Acacia* hybrid was propagated in FRIM's laboratory from tissue culture and raised in the nursery for six months before transplanting. Planting holes were dug without clearing the sites to avoid extreme soil temperature. The size of each hole was 1 m^3 and the holes were filled back with mineral soil, coconut husk and chicken dung upon planting. These planting media were added to improve water retention capacity and to provide additional nutrients to the soil. Seedlings were planted at 3 × 5 m and during the dry season, plants were watered occasionally. Compound fertilizer (NPK 15:15:15) was broadcasted around the canopy area yearly during moist season at 200 g $tree^{-1}$.

Soil and foliar samplings were carried out based on two comparative classifications, namely, good and poor growth sites. In each site, eight sampling locations were marked randomly. In each location, soils were taken from three different spots and combined into one composite sample and properly mixed. Exposed matured leaves from standing trees were collected for nutrient analysis. These samples were brought back to the laboratory, dried, ground and analyzed to determine their nutrient concentration. Tree height and dbh (diameter at breast height) were measured for all trees available at the good and poor sites.

From our study, we observed that survival rate was low at the poor site with only 53% survival compared with 87% at the good site (Table 1). Tree height and dbh were also higher at the good site. The average height of the trees at the good site was 729 cm while that at the poor site, 687 cm.

Table 1 Performance of three-year-old *Acacia* hybrid stands at good and poor sites on BRIS soil (±SE)

Site	Height (cm)	Dbh (cm)	Survival (%)
Good	729 ± 100 a	9.40 ± 0.13 a	87
Poor	687 ± 95 b	8.95 ± 0.20 b	53

Means in column with the same letter are not significantly different at $p < 0.05$.

The results of soil and foliar nutrient analysis are shown in Tables 2 and 3 respectively. Total N, organic C, exchangeable Ca and exchangeable Mg were higher at the good site compared with the poor site (Table 2). Available P, although not statistically different, was also higher at the good site. However, there were no significant differences in leaf nutrient concentrations between trees at the good site compared with the poor site (Table 3).

Our study showed that the site that supported good growth was clearly superior in soil nutrient levels. However, foliar nutrient levels were not significantly different between fast- and slow-growing trees. This indicates that whereas soil fertility has a dramatic

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Table 2 Nutrient concentration in soil samples from good and poor sites under three-year-old *Acacia* hybrid stand

Site	C	N	C/N	Available P	Exchangeable K	Exchangeable Ca	Exchangeable Mg
	Soil nutrient content						
	(%)			(mg/kg)	(cmol/kg)		
Good	6.13 ± 2.60 a	0.27 ± 0.14 a	22.7	0.81 ± 0.09 a	0.017 ± 0.002 a	0.49 ± 0.15 a	0.10 ± 0.03 a
Poor	1.71 ± 0.17 b	0.06 ± 0.01 b	28.5	0.63 ± 0.07 a	0.015 ± 0.002 a	0.19 ± 0.03 b	0.05 ± 0.01 b
Level of significance	$p < 0.001$	$p < 0.01$		ns	ns	$p < 0.05$	$p < 0.05$

Note: Data are means of eight replicates. Means in columns with the same letter are not significantly different; ns = not significant

Table 3 Nutrient concentration in foliar samples from good and poor sites under three-year-old *Acacia* hybrid stand

Site	C	N	P	K	Ca	Mg
	Plant nutrient content					
	(%)					
Good	33.70 ± 3.35 ns (2807 g)	2.12 ± 0.14 ns (176.6 g)	0.18 ± 0.03 ns (15.0 g)	0.33 ± 0.02 ns (27.5 g)	0.33 ± 0.05 ns (27.5 g)	0.18 ± 0.01 ns (15.0 g)
Poor	39.00 ± 3.36 ns (1026 g)	2.00 ± 0.11 ns (52.6 g)	0.17 ± 0.03 ns (4.5 g)	0.32 ± 0.02 ns (8.4 g)	0.34 ± 0.05 ns (8.9 g)	0.19 ± 0.01 ns (5.0 g)

Data are means of eight replicates; ns = not significant. Figures in parentheses are nutrient content in total foliar biomass.

effect on growth rate, it has little or no effect on foliar nutrient concentrations. This contradicts an earlier finding by Amir and Mona (1991) that trees growing on fertile soils have higher nutrient concentration compared with those growing on less fertile soils. The difference in nutrient accumulation was only obvious when calculated based on total leaf biomass, where trees at the good site accrued higher nutrient. Higher soil nutrient availability at the good site allowed for higher nutrient uptake by roots, leading to better tree growth and biomass production.

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