FERTILIZER TRIAL ON *CEIBA PENTANDRA* SEEDLINGS ON EX-TIN-MINING LAND IN PENINSULAR MALAYSIA

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PAUDYAL, B.K. & NIK MUHAMAD, M. 1995. Fertilizer trial on *Ceiba pentandra* seedlings on ex-tin-mining land in Peninsular Malaysia. Although Peninsular Malaysia has initiated the Compensatory Forest Plantation Project (CFPP) to overcome the expected shortage of timber for domestic consumption purposes, vast areas of degraded land such as ex-tin-mining areas need to be rehabilitated by the planting of forest tree species. However, no concerted effort has been made to utilize this unused land. *Ceiba pentandra,* a fast-growing indigenous tree species planted on ex-tin-mining areas in Selangor, has shown promising growth results. The fertilization of *C. pentandra* with 500 g NPK/seedling produced the best results. Further growth monitoring is essential to determine the suitability of this timber species for reclamation of ex-tin-mining land.

Keywords: *Ceiba pentandra* - fertilization - degraded land - reclamation suitability

PAUDYAL, B.K. & NIK MUHAMAD, M. 1995. Percubaan baja ke atas anak benih *Ceiba pentandra* ke atas tanah bekas lombong di Semenanjung Malaysia. Walaupun Semenanjung Malaysia telah merintis Projek Kompensatori Ladang Hutan (CFPP) bagi mengatasi kekurangan kayu yang dijangkakan untuk tujuan penggunaan domestik, kawasan tanah usang yang luas seperti kawasan tanah bekas lombong perlulah dipulihkan dengan menanam spesies pokok hutan. Bagaimanapun, tidak ada usaha-usaha yang dirancang untuk mempergunakan tanah yang tidak digunakan ini. *Ceiba pentandra,* satu spesies pokok asli yang cepat membesar telah ditanam di kawasan tanah bekas lombong di Selangor dan telah menghasilkan keputusan pertumbuhan yang memberangsangkan. Pembajaan *C. pentandra* menggunakan 500 g NPK/anak benih menghasilkan keputusan yang baik. Pengawasan pertumbuhan selanjutnya sangat perlu untuk menentukan kesesuaian spesies kayu ini bagi memulihguna tanah bekas lombong.

Introduction

Although imbued with luxuriant forest, Peninsular Malaysia is expected to face a timber shortage for domestic consumption by the year 2000. Freezaillah (1982) reported that with the current practice of forest exploitation and the rising demand for forest products, Peninsular Malaysia is going to face a timber deficit well before the turn of the century. Thus, to provide general utility timber for domestic consumption, Peninsular Malaysia has launched the Compensatory Forest Plantation Project (CFPP) by establishing plantations of fast-growing exotic timber species.

These forest plantations have mainly been established on marginal lands unsuitable for agriculture. However, no efforts have been made to use the vast areas of degraded land with low agricultural potential such as ex-tin-mining areas. Zakari (1990) has reported the successful establishment of a plantation of *Acacia mangium*, a fast-growing exotic timber species on an ex-tin-mining area at Semenyih, Selangor, Peninsular Malaysia. The information on utilization of ex-tin-mining land by planting tree species is scanty. Basically, no research has been done to introduce fast-growing indigenous timber species to reclaim such areas. Thus, it would be a timely step to focus research priority in this direction.

Tin tailing land in Malaysia is estimated to be about 250 000 ha (Bali 1982). The area is increasing at an average rate of more than 4000 ha per annum (Tan & Khoo 1981). These vast areas of unutilized land could be rehabilitated by planting fast-growing indigenous timber species. *Ceiba pentandra*, locally known as kakabu, is one of the fast-growing indigenous timber species that have been planted as test species on ex-tin-mining land in Peninsular Malaysia.

Kakabu is a tropical tree and thrives best at elevations below 45 m. It is widely planted in Asia for its fodder, food and fibre (Shekhar *et al.* 1990). It will grow under a wide range of conditions. However, for high production it requires abundant rainfall of 1250-1500 mm per annum (Purseglove 1984). For best results, kakabu should be planted on good, deep, permeable soils free from waterlogging. It is a deciduous, fast-growing tree reaching 10-30 m in height and is widely cultivated in southeast Asia and west Africa (Simmonds 1976, Purseglove 1984). It can be propagated by seeds and also by cuttings of size 5-7 cm in diameter and 120-180 cm long from 2-3-year-old stands. The tree yields kapok, which is the floss derived from the inner capsule wall. The kapok is used in life belts, life jackets, mattresses, pillows, saddles, sleeping bags, and other protected clothing. Large cuttings are used as fence posts, soft lightwood for canoes, and as stools and carvings; large plank buttresses may be used for making doors, tables and platters. The seeds contain 20-25% edible oil which is used for culinary purposes, as a lubricant, and for the manufacture of soap (Simmonds 1976).

The tree, however, has gained little attention although it was an important commercial crop grown for its kapok fibre before 1940. This is probably due to the replacement of kapok fibre by synthetics. However, recent studies on kakabu in India and Africa have shown some promising results. Out of 13 hardwood species studied to evaluate their utility for raw material for the pulpwood industry in India, *Ceiba pentandra* was found most suitable followed by *Albizia falcataria, Eucalyptus grandis* and *Gmelina arborea* respectively (Subramanyam 1987). The potential of this species for agroforestry practices in India as a kakabu-cotton combination has been well demonstrated (Shekhar *et al.* 1990). Similarly, Suresh and Rai (1991), in another agroforestry experiment, reported that kakabu trees grown with cotton had higher tree height growth rate compared to trees grown with fodder grass (*Pennisetum purpureum* × *P. americanum*) which were completely eliminated. The tree has also been used as one of the most important bee forage species in Niger (Himsel 1991). These few studies, thus, exhibit the potential of this tree species.

The present study aims to evaluate the performance of kakabu tree when planted on ex-tin-mining land in Peninsular Malaysia. The study also aims to assess the growth performance of this tree under different fertilizer treatments.

Methodology

Study site

The study site was an ex-tin-mining land at Kampung Pasir, Semenyih, Ulu Langat, Selangor (Figure 1), about 30 km from the Universiti Pertanian Malaysia campus. The area is located at 2° 56' N and 101° 50' E (Shaharuddin 1966). The average annual temperature is 26 °C and mean annual precipitation is 2075.5 mm (Drainage and Irrigation Division, Ministry of Agriculture Malaysia 1983).

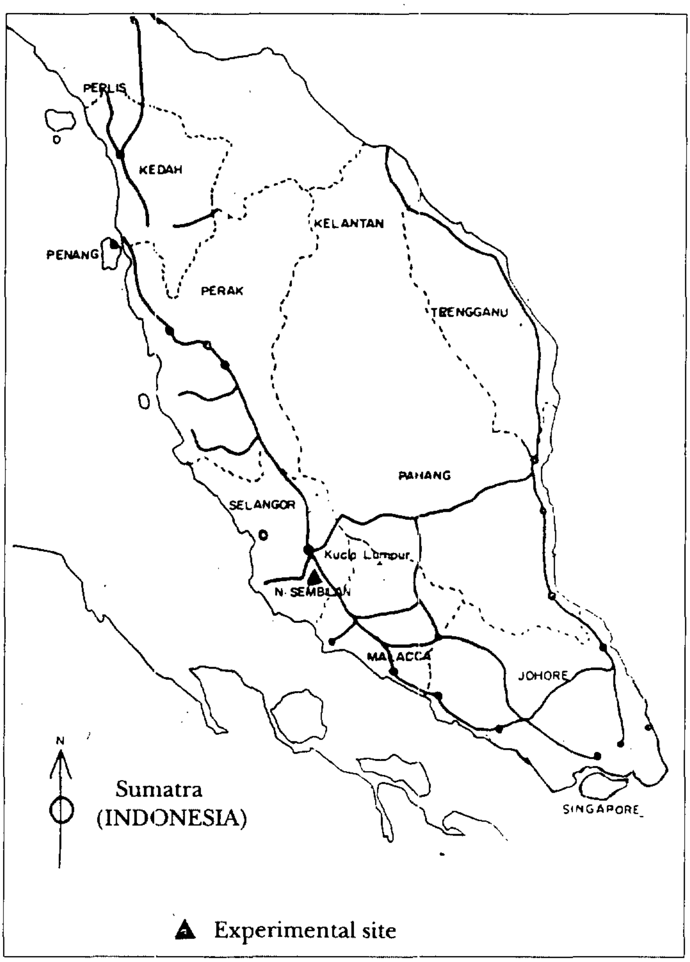

Figure 1. Map of Peninsular Malaysia showing the experimental site

Experimental layout and calculation

The experimental design is a randomised complete block design (RCBD) of four treatments with four replications. A 30 × 30 m square plot was taken and the plot was divided into four equal subplots. Six-month-old kakabu seedlings were planted at a spacing of 3 × 3 m. One row of seedlings covering a width of 3 m and two rows of seedlings covering a width of 6 m were planted as buffer zones to separate subplots and plots respectively. The number of trees fertilized in one subplot was 25. All 25 trees were measured in each subplot. Fertilizers were applied around the seedlings 0.3 m away from the base of the seedlings and later covered with soil. The fertilizer applied was Nitrophoska blue (12%N +12%P_2O_5 + 17%K_2O + 2% MgO and trace elements - boron + manganese + zinc + cobalt). The fertilizer treatments were as follows: control (no fertilizer), 200, 350 and 500 g NPK /seedling. The fertilizers applied for 500 kg NPK/seedling is equivalent to 60 kg ha^{-1} for N and P, 85 kg ha^{-1} for K, 10 kg ha^{-1} for Mg and 285 kg ha^{-1} for trace elements.

Planting started during the third week of March 1991 and fertilizer application was made in May and July in the same year as two equal split doses. The seedlings received half of the stated rate at each application time. The planted kakabu seedlings are shown in Figure 2.

Figure 2. Plantation of kakabu seedlings on the experimental site

The growth parameters measured monthly were base diameter and height of every seedling in each of the subplots. Base diameter was measured at a point 2.5 cm above the ground, and heigh terminal bud. These parameters were measur e second fertilization.

Soil samples from two depths, viz. ch of the subplots, were analysed to determine the nutrient status of the soil. These samples were taken at the four corners and at the middle of the subplot (5 soil samples/ subplot) and were combined to form one composite sample per subplot. Soil samples were air dried at room temperatures (22 °C) and sieved through a 2.0 mm stainless steel sieve. Soil pH was determined by a glass electrode pH-meter. Total N determination was done by the Kjeldahl digestion procedure (Bremner 1965) and the digests were analysed for N colorimetrically on the autoanalyser. The ammonium acetate method at pH 7 was used to determine the bases and CEC. Available P was determined by a spectrophotometer. The pipette method was adopted to measure the texture and the gravimetric method was used to determine soil moisture content.

Foliar samples from ten randomly selected trees per subplot were collected for nutrient analysis. The samples were combined into one composite sample and a subsample was taken from the composite sample for analysis. They were analysed to assess the nutrient status of the kakabu seedlings due to different fertilizer treatments. The foliar samples were dried in a forced draft-oven at 75 °C for 36 to 72 h. Dried materials were ground in a stainless Fritch pulverisette mill to pass through 1 mm round hole sieve. The foliar samples were analysed for total N, P, K, Ca and Mg by the wet digestion method. Total N and P were simultaneously analysed on the original digest by the autoanalyser. K, Ca and Mg were determined by atomic absorption spectrophotometry.

One Way Analysis of Variance (ANOVA) was employed to test the effects of treatments on growth parameters and foliar nutrient concentrations. Duncan's multiple range test was used to separate means at 5% probability level.

Results and discussion

Table 1 shows the physical and chemical properties of the soil before fertilization. The soil had a high sand content (>84%) which caused excessive drainage and leaching of nutrients. This is shown by the low CEC (2.47 meq/100 g soil). This is very low as compared to normal soils (>100 meq/100 g soil) under Malaysian conditions (Law & Tan 1973).

The monthly growth trend for base diameter and height is shown in Table 2 and illustrated in Figures 3 and 4. The results show that all fertilizer treatments had a highly significant effect ($p<0.001$) on height of the seedlings as compared with the control six months after fertilization. For the base diameter, except for the 200 g NPK g/seedling treatment, the other treatments had significant effect ($p<0.005$). The results also indicate clearly that after six months of fertilization, 500 g NPK/ seedling gave the best result for base diameter and height growth of the seedlings.

The nutrient levels in the foliage due to different fertilizer treatments are shown in Table 3. The results show that fertilization at 350 and 500 g NPK/seedling had a significant effect ($p<0.05$) on N and P foliar concentrations as compared with the control. However, there was no significant effect for the other nutrients (e.g. K, Ca and Mg).

Table 1. Physical and chemical properties of the soil before fertilization

	Depth (cm)	Treatment subplots T0	T1	T2	T3
Physical					
Sand (%)	A	87.23	86.37	88.39	88.01
	B	84.43	87.61	87.93	87.53
Silt (%)	A	3.65	2.78	4.87	5.12
	B	4.20	3.21	4.62	5.26
Clay (%)	A	9.22	10.85	6.74	6.87
	B	11.37	9.18	7.45	7.21
Moisture content (%)	A	0.83	0.78	0.86	0.68
	B	0.30	0.24	0.23	0.18
Chemical					
pH	A	4.28	4.12	4.21	4.06
	B	4.37	4.42	4.30	4.52
N (%)	A	0.01	0.02	0.03	0.05
	B	0.02	0.03	0.03	0.05
P (ppm)	A	12.28	17.29	21.67	18.18
	B	24.83	29.52	24.25	22.69
K (meq 100 g^{-1})	A	0.10	0.11	0.11	0.09
	B	0.08	0.07	0.09	0.05
Mg (meq 100 g^{-1})	A	0.02	0.02	0.01	0.02
	B	0.02	0.01	0.01	0.01
Ca (meq 100 g^{-1})	A	1.21	1.32	1.20	1.30
	B	1.47	1.65	1.68	1.43
CEC (meq 100 g^{-1})	A	2.49	2.47	2.53	2.76
	B	2.67	2.32	2.40	2.11

Note: A = 0-15 cm
B = 15-30 cm
T0 = Control (no fertilizer)
T1 = 200 g NPK/seedling
T2 = 350 g NPK/seedling
T3 = 500 g NPK/seedling

The seedlings in the present study exhibited a growth rate of 12.27 cm mth^{-1} (1.4 m y^{-1}) for height and 3.26 mm mth^{-1} (3.9 cm y^{-1}) for diameter. The growth is better as compared to other indigenous species planted. In Sabah, Rahim and Anuar (1992) reported an annual height increment of 85 cm for *Shorea beccariane* and 95 cm for *Dryobalanops lanceolata* for 2-year-old stands. Ang *et al.* (1992) recorded mean monthly height increment of 2.2 cm for *Hopea odorata* stands on a decking site of a logged-over hill forest at the stand age of 2 y. However, in

Table 2. Height and base diameter of kakabu seedlings fertilized with NPK at different rates

Fertilizer treatments	Height (cm) 1 month	2 month	3 month	4 month	5 month	6 month
T0	34.30	40.46	46.58	49.20	53.04	59.22d
T1	32.72	38.50	43.30	50.30	59.50	67.89c
T2	32.88	40.30	50.80	61.30	70.00	75.79b
T3	32.32	43.70	54.50	63.80	74.27	93.68a
			Base diameter (mm)			
T0	4.12	6.10	7.20	8.50	10.20	12.91c
T1	3.65	5.80	7.30	9.10	11.80	13.34c
T2	3.72	6.20	8.00	10.80	13.20	16.33b
T3	3.67	6.50	9.30	13.40	16.20	19.97a

1Note: T0 = Control (no fertilizer)
T1 = 200 g NPK/seedling
T2 = 350 g NPK/seedling
T3 = 500 g NPK/seedling

Means with the same letter are not significantly different ($p<0.05$)

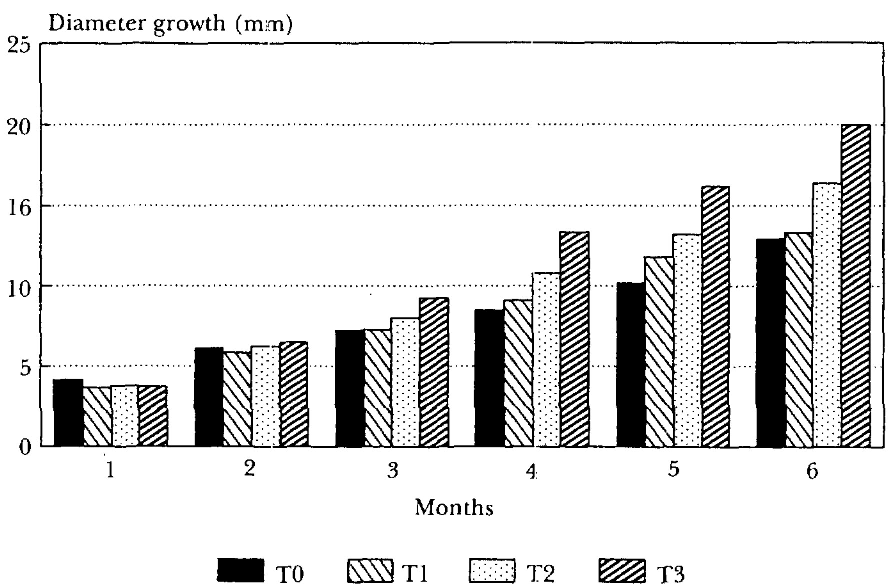

Figure 3. Monthly growth rate

comparison to fast-growing exotic tree species, such as, *Acacia mangium* and *Acacia auriculiformis*, the growth is low. Kamis (1994) reported mean annual height increments of 3.0 m for *A. mangium* and 3.5 m for *A. auriculiformis* at the age of 18 months on tin-tailing areas.

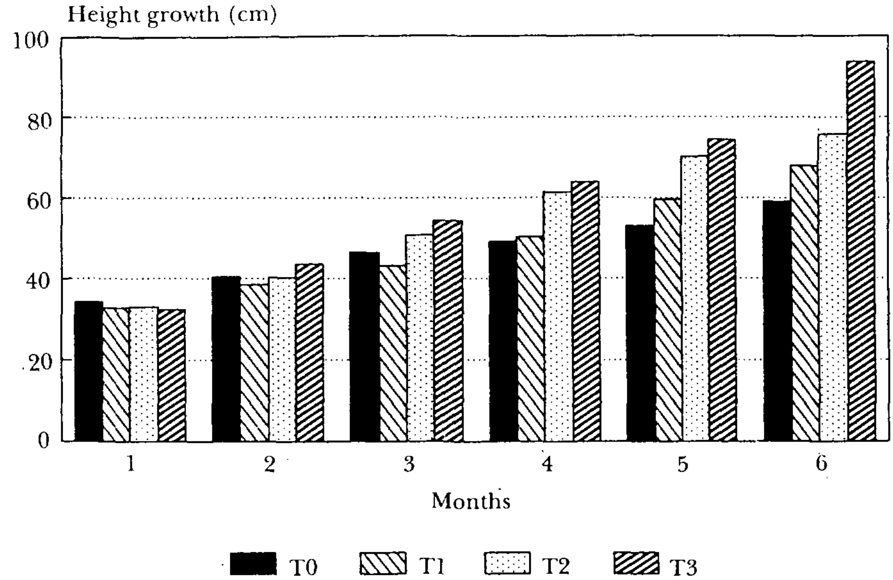

Figure 4. Monthly growth rate

Table 3. Foliar nutrient concentrations in kakabu seedlings

Treatments	N	P	K %	Ca	Mg
T0	1.43d	.08d	.04a	.08a	.01a
T1	1.51c	.12c	.04a	.06b	.01a
T2	1.61b	.19b	.05a	.08a	.02a
T3	1.73a	.27a	.05a	.09a	.02a

Note: To = Control (no fertilizer)
T1 = 200 g NPK/seedling
T2 = 350 g NPK/seedling
T3 = 500 g NPK/seedling

Means with the same letter are not significantly different ($p<0.05$) as determined by Duncan's multiple range test.

Paudyal and Nik Muhamad (1992) reported the foliar concentrations in an 18-month-old *Acacia mangium* plantation in Peninsular Malaysia as 1.83% for N, 0.16% for K, 0.52% for Ca and 0.11% for Mg. The nutrient levels for *A. mangium* are higher as compared to kakabu foliage. This was probably because of two factors - firstly, *A. mangium* is a leguminous tree species, which enriches the soil, and secondly, the site for the kakabu plantation was an ex-tin-mining land which is generally poorer in nutrients than other sites. Abang Naruddin (1981) reported the foliar nutrient concentrations in approximately 3-year-old *Pinus* *caribaea* needles in Peninsular Malaysia as 0.99% for N, 0.06% for P, 0.83% for K, 0.48% for Ca and 0.074% for Mg. Foliar nutrient concentrations for *Pinus wallichiana* in Pakistan have been found to be 0.46% for N, 0.14% for P, and 0.50% for K (Sheikh & Bangash 1985). Vail *et al.* (1961) have reported 0.52-2.47% N, 0.13 - 0.3% P, and 0.38 - 2.18% K concentrations, in healthy needles of *Pinus contorta, Pinus radiata* and *Pinus patula.* Similar results have been reported for *Cedrus deodara* planted at different sites in Azad Kashmir, Pakistan (Sheikh *et al.* 1984).

Conclusion

The necessity of utilizing vast areas of degraded land such as ex-tin-mining areas is now highly recognized given the present conditions of growing wood demand and dwindling wood production trend. It would thus be worthwhile if fast-growing indigenous tree species could be successfully planted on these adverse sites. Planting of kakabu seedlings on ex-tin-mining area was a preliminary step in that direction.

Kakabu planting at Semenyih has clearly demonstrated the potential of using this tree species for reclaiming ex-tin-mining areas. Fertilization significantly increased the base diameter, height of seedlings and also foliar N and P concentrations. However, foliar K, Ca and Mg concentrations exhibited no significant effect. Although 500 g NPK/seedling gave overall best result, more research needs to be addressed to determine the optimum fertilizer dose, frequency of fertilization and further growth response.

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